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# Some factors influencing the slicing quality and the palatability of canned beef

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# SOME FACTORS INFLUENCING
# THE SLICING QUALITY AND THE PALATABILITY
# OF CANNED BEEF

by

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# INTRODUCTION

Good slicing quality in meat is a desirable characteristic not usually secured in the canned product. The long processing time at high temperature during canning causes changes to occur in the muscle fibers and in the connective tissue so that the meat tends to fall apart and be stringy. These changes are not well understood and are suitable for investigation from many standpoints. For this study some of the physical aspects of the slicing quality and the palatability of canned beef have been considered.

The addition of table salt to meat during cooking is known to affect the flavor. Some experimental work has shown that immersion of cubes of beef in various brining solutions prior to cooking improves the tenderness, juiciness, and texture as well as the flavor. The hydrogen ion concentration of meat is a factor of importance in the catalytic changes that occur during aging of raw meat and during the cooking or canning process. The lactic acid content of the meat influences to considerable extent the pH under various storage and cooking conditions. Since substances added to the surface of meat, unless given a long time for penetration, tend to affect only the surface portions, it was decided to inject certain solutions into the meat. The substances selected for experimentation were sodium chloride, lactic acid, and a mixture of the two substances.

In order to have cuts of meat from the same anatomical position, matching pairs of muscles were separated from the carcass and divided into cuts. The cuts from one side of the animal were injected and those from the other side served as controls. Four animals of the same carcass grade and one animal of a lower grade were used. After a suitable aging period the cuts of beef were canned. The processing time for the meat from three of the animals was a period considered to be safe from a bacteriological standpoint; a longer processing, typical of that often used in canning meat, was used for the other two animals.

The principal characteristics compared in the control and in the injected samples follow: (1) slicing quality, as indicated by number and character of slices obtained, by weight of unsliceable meat, and by judges' scores for sliceability, (2) palatability, as determined by judges' scores for aroma, flavor of meat and of liquid, tenderness, juiciness, and texture, and (3) microscopic appearance of muscle fibers and connective tissue of the rib portion of the longissimus dorsi muscle.

## REVIEW OF LITERATURE

References to the slicing quality of beef in the literature are practically nil. Indirectly this quality has been considered from the standpoint of tenderness and texture of various meats. Much of the work pertaining to the palatability of beef is related to fresh or to frozen beef prepared by roasting, broiling, stewing, or cooking in deep fat. Canned beef or other canned meat has been studied primarily in regard to the bacteriological aspects and the adequacy of processing methods or to the retention of nutrients.

Considerable attention has recently been directed to the physical and chemical changes taking place in living muscle and to post-mortem changes occurring after slaughter of animals for food.

### Structure and Composition of Skeletal Muscle

In its physical aspects skeletal muscle is made up of bundles of muscle fibers held together with connective tissue. This arrangement is apparent even to the unaided eye, but becomes increasingly evident on microscopic examination. Maximow and Bloom (20) state that skeletal muscle fibers are from 10 to 100 or more microns in thickness and the length is usually shorter than that of the muscle. The boundary of the fiber is a transparent film (sarcolemma) and within it are long parallel threads (myofibrils), interfibrillar substances (sarcoplasm), and nuclei. The myofibrils have a maximum diameter of 1 to 2 microns and extend parallel to the long axis of the fiber giving the appearance of longitudinal striations within the fiber. Along the length of each fibril are alternate dark (A) and light (I) disks or bands which appear as crosswise striae in the muscle fiber. The myofibrils are the contractile part of the fiber.

The connective tissue meshwork of muscle is designated as endomysium if it surrounds the fibers within a bundle, as perimysium if it surrounds the bundle, and as epimysium if it forms the sheath around the muscle. Some fat globules are located within the connective tissue, as are blood and lymph vessels and nerves. The connective tissue has both collagenous and elastic fibers, the former being long, straight or wavy and containing fibrils, whereas the latter are usually branched and are lacking in fibrils. Collagenous fibers usually have a parallel arrangement; the elastic ones often appear singly. Tendons contain much collagenous tissue and ligaments are high in elastic connective tissue.

## Proteins of Muscle

The proteins making up the different parts of the muscle have received considerable study. Bailey (5) refers to collagen and elastin as extracellular proteins and to the protein components of the sarcoplasm and fibrils as intracellular.

### Intracellular proteins

Bailey (5) states that the fibrils consist of myosin (a globulin), a concentrated gel, and that sarcoplasm contains some proteins that are globulin-like and others that are albuminous in nature. Bate-Smith (6) in 1937 listed four intracellular proteins, two of which, myosin and globulin X, were said to be globulins and two, myogen and myoalbumin, were albumins. He listed the percentage composition of each in muscle as the following: myosin, 63 per cent; globulin X, 9 per cent; and myogen and myoalbumin together, 10 per cent. The isoelectric points were reported as: myosin, pH 5.5; globulin X, pH 5.2; myogen, pH 6.5-6.7; and myoalbumin, pH 3.0-3.5.

Myosin has been studied more extensively than the other intracellular proteins. Astbury and Bell (3, pp. 696-697) state that the pattern of structure of myosin is similar to the keratin of mammalian hair and both belong to the large group of fibrous proteins, the characteristics of which are summarized in these words:

> . . . that the structural unit of the group is a 'grid' consisting of long polypeptide chains crosslinked by means of their side-chains, that the main-chains of this grid are not normally in the extended configuration but are thrown into a sequence of folds transverse to the side-chains, and that when the fibers are stretched the grid is pulled out flat, only to return to its folded configuration when the tension is released.

The reversible transformation within the molecule from folded to extended form is said to be the basis of the long-range elastic properties of the fibrous proteins. Astbury and Dickinson(4) describe the myosin in muscle as being in the form of long chain-bundles of submicroscopic size extending approximately parallel to the axis of the muscle fiber. They state that the protein chains are normally in the folded configuration. They refer to "supercontraction" as the condition thought to exist when a muscle is placed in hot water or steam. More or deeper folds exist.

Astbury (2) reports the following values for the approximate number of amino acid residues (total 576) in what he calls the more reliable amino acids of rabbit myosin: cystine/2 plus cysteine, 8; methionine, 15; serine, 23; threonine, 21; tyrosine, 13; tryptophan, 3; aspartic acid plus amide, 45; glutamic acid plus amide, 101; arginine, 27; lysine, 47; histidine, 7; amides, 57. A small proportion of phosphorus is part of the permanent structure of myosin. He emphasizes the packing together of side chains in triads on alternate sides of the main chain and the alternate polar and nonpolar arrangement of individual side chains. He states that this kind of structural arrangement is in harmony with the concept that myosin "is both the working elastic mechanism in muscle and also a principal enzyme (adenosine triphosphatase) in the elastic cycle" (2, pp. 85-86).

Szent-Györgyi (33, 34, 35) published work in 1945, 1947, and 1948 in which myosin is recognized not as a single protein but as a complex made of two proteins. He assigned the name of actomyosin to the complex, retained the name of myosin for one of the proteins, and gave the new name of actin to the second protein. Since actin exists in both globular and fibrous forms, he designated the former as G-actin and the latter as F-actin. The complex has both globular and fibrous forms, G- and F-actomyosin, respectively. Szent-Györgyi enumerated several physical and chemical characteristics for each of these proteins. The protein he called myosin has an isoelectric point of pH 5.2, is soluble in water giving a limpid solution, behaves like a globulin except for solubility in water, has a tendency to form threads when slightly denatured, and is quantitatively precipitated from watery solution by small concentrations of neutral salts, such as KCl, but the precipitate dissolves again if the concentration of salt is increased. In regard to the action of myosin with adenosine triphosphate, he states (33, p. 13): "The ATP adsorption is an exceedingly labile function of myosin . . . ." He points out that as K is adsorbed, myosin becomes more and more capable of binding ATP also. Ca or Mg alone in low concentration does not cause ATP to be adsorbed, but in the presence of KCl they greatly increase the adsorption of ATP.

Actin is more stable than myosin, according to Szent-Györgyi (33). It has an isoelectric point of pH 4.7, is readily denatured by heat, and is not precipitated by alkali salts. The F- and G- forms have widely different properties and the transformation from one form to the other is thought to occur in each contraction cycle in living muscle. F-actomyosin is formed from F-actin and myosin and is described by Szent-Györgyi as "a typically fibrous colloid with very long particles" (33, p. 24). G-actomyosin can be prepared by bringing about contraction of the F- form. In explaining the action of these proteins in muscle action, he pictures actomyosin as an elongated particle composed of two parallel parts, one of which is long and continuous (myosin) and the other of which (actin) is discontinuous and capable of becoming globular. The elongated part shrinks more rapidly than its partner, which causes the particle to bend into a circular shape. He represents the fibril as a spiral rod.

This spiral nature of myofibrils is questioned by Speidel (32). By the use of striated muscle from the sea spider, and, to a limited extent, muscles of shrimp, frog, and rabbit, Speidel was able to show by means of photomicrographs that the cross striae in the myofibrils are arranged transversely, not spirally.

Extracellular proteins

The principal extracellular or structural proteins in muscle are collagen and elastin. The chief characteristics of collagen, as stated by Bull (11), are the inelasticity at body temperature, the high content of proline and hydroxyproline, the ability to contract spontaneously to about one-fourth of its length when heated to about 60°C., long range elasticity of the contracted fiber while hot, and the spontaneous partial recovery of length on immersion of the fiber in cold water after contraction. The thermally contracted collagen has an amorphous X-ray diffraction pattern. Astbury (2) states that few chemical analyses have been carried out on pure collagen fibers; gelatin has been analysed much more extensively. He reports that the X-ray patterns of collagen fibers and of oriented gelatin have the same main features but differ in certain details such as high spacings in true collagen that are lacking in the gelatin pattern. The general molecular plan of the collagen group is a repetition of glycine and imino residues along the polypeptide chains at intervals of three residues.

An outstanding characteristic of elastin is its elastic quality at room temperature. Bull (11) states that the unstretched elastin from ligamentum nuchae has a completely amorphous diffraction pattern. Stretching to 200 per cent extension results in some orientation of X-ray spacings but no new spacings occur. He mentions the high proline content of elastin.

Denaturation of proteins

Mirsky (21) discusses denaturation of proteins in general, then considers a special case, that of denaturation of myosin. He points out that the most frequent signs of instability of protein, i.e., tendency to denature, are loss of solubility and loss or impairment of a specific property. Among the properties affected by denaturation, according to this author, are: crystal form, solubility, viscosity, chemical changes, reversibility, formation of fibers, and configuration. He states in connection with these properties that many native forms of proteins have been crystallized but not the denatured forms. He says that at the isoelectric point a denatured protein cannot be dissolved in neutral salts as can native globulins; that denatured proteins are more viscous than native ones; the number of SH, S-S, and phenol groups is increased by denaturation; and that denaturation is a change from a compact to an extended configuration. In writing of the reversibility of denaturation, he cites evidence that coagulation takes place in two steps, the first being reversible, the second not reversible, the latter occurring at a slightly higher temperature than the former. Anson (1) enumerates the following agents which can cause denaturation of protein to occur: heat, surface action, ultra-violet light, high pressure, organic solvents such as alcohol, and reagents which can dissolve coagulated protein such as acid, alkali, urea, detergents, and others. He states that the molecule of protein opens up and changes its shape during denaturation.

## Variations among Muscles and among Animals

The manner in which meat is divided into retail cuts in the United States often results in the inclusion of several muscles in each steak, roast, or piece of meat to be cooked. Differences in tenderness, texture, and other characteristics of individual muscles make it difficult to secure uniformly well prepared meat. Ramsbottom and Strandine (28) made a systematic study of some of the physical differences among the major muscles constituting the beef carcass. Although they were primarily interested in the factors responsible for tenderness, they reported data on the identification, location, composition, weight, pH, tenderness, and histological rating of 50 representative muscles in three heifer carcasses of the same grade. The variation in fat content of the muscles was found to be from an average of 1.5 per cent in the extensor carpi radialis of the foreshank to an average of 18.1 per cent for the intercostal muscles. The average moisture content of the first named muscle was 76 per cent, whereas the latter contained 62.5 per cent moisture. The average fat content of all muscles was 5.7 per cent; the moisture, 72.2 per cent. The average weight of the smallest muscle studied (sartorius) was 0.4 pound; of the largest (biceps femoris) 10.2 pounds. Comparisons of tenderness were made by means of (1) histological rating of collagenous and of elastic connective tissue content, (2) shear force of both raw and cooked beef, and (3) judges' scores for tenderness of the cooked meat. The lowest average shear force for a 1/2-inch cylinder of raw beef was 3.8 pounds for the longissimus dorsi muscle; the highest, 26.0 pounds for the cutaneous muscle. For the cooked beef, the average shear force values varied from 7.1 pounds (psoas muscles) to 16.3 pounds (rhomboideus). Correlations that were statistically significant were found between the histological rating of the raw beef and the shear force of the cooked meat.

Prudent (27) used a chemical method for determination of collagen and elastin in four beef muscles from each of two animals. She found differences among the muscles and between the animals in the percentages of the collagen and elastin nitrogen in relation to total nitrogen. The dairy cow (carcass grade Cutter) had a higher collagen nitrogen but a lower elastin nitrogen content than the steer (carcass grade Good). She stated that the muscles of the cow were smaller than those of the steer and that the fat and connective tissue of the cow were bright yellow.

Paul (23) found a significant difference in the diameters of muscle fibers in various muscles as revealed by histological study. The differences among muscles were highly significant after the meat was cooked. She grouped the muscles according to diameter of fibers as follows: smallest, semitendinosus, psoas major, adductor; medium, semimembranosus and biceps femoris; largest, vasti. The gastrocnemius muscle had the largest fibers but they shrank the most, hence did not fit well into the arbitrary groups. She found there was no high correlation between the number of muscle fibers per bundle and the tenderness of the meat.

Harrison (18) compared the histological characteristics of four muscles from three grades of animals and found the psoas major muscle, which is the most tender of the four, had slender fibers with distinct cross striae. There was little connective tissue in the psoas muscle compared to moderate or large amounts in the others. The muscle fibers of the older animal were more gnarled and worn than those in the younger animals. Fat located between the muscle fibers was noticeable in the aged animal. The sections from two animals contained larger amounts of collagen than sections from the other two.

Deatherage and Harsham (15) found differences in the initial tenderness levels of beef cattle as revealed by judges' scores for tenderness of broiled steak the second or third day after slaughter of the animals. Paul and McLean (25) used roasts from veal calves of three different carcass weights, approximately 50, 125, and 200 pounds. After roasting to internal temperatures of 71°, 77°, 82°, or 88°C., the cuts from the smallest animal were judged to be the most tender, even though this meat had no apparent intramuscular fat and very little fat between the muscles.

In another phase of the study Paul and McLean (26) observed variations in the histological structure of the muscles from the hind quarter of veal. Differences in amounts of connective tissue and in size of fasciculi were marked. The semitendinosus and the biceps femoris muscles were judged after cooking as the juiciest of the muscles studied. The former of these muscles (judged to be tender as well as juicy) had much connective tissue with abundant elastic fibers and the fasciculi were medium in size. The latter muscle had thick masses of connective tissue in the perimysium but most of the fibers were collagenous rather than elastic. The semimembranosus was described as the driest and one of the toughest of the muscles studied. The connective tissue was relatively small in amount and most of the fibers were of the collagenous type.

## Influence of pH

According to Fenn and Maurer (16), the pH of intercellular fluids in living tissue (frog muscle) is 7.3 to 7.5 and the pH of the interior fibers is 6.9 or lower. They state that post mortem a pH of 5.6 to 6.0 is common and a value of 5.3 is possible. Bate-Smith (7) states that he found a range of pH values of 5.36 to 5.80 for the psoas muscles of beef from 29 carcasses and a range of 5.5 to 6.0 for the pH of thigh muscles from 6 other beef animals. He makes the statement that a variation in pH between 5.4 and 6.0, except for occasional values outside this range, may be expected for beef in full rigor. Ramsbottom et al. (29) in their study of 25 representative beef muscles found a range of pH values from 5.5 to 5.8. In a later work on 50 beef muscles, Ramsbottom and Strandine (28) reported a range of 5.5 to 6.0 and an average pH of 5.7.

Hall, Latschar, and Mackintosh (17) in studying the problem of "dark cutting" beef found this kind of beef to have an abnormally high pH. Among the other characteristics observed were "low glucose, practically no glycogen, high inorganic phosphate, low oxidation potential, and rapid oxygen uptake" (17, p. 81). They give the value of pH 6.4 as characteristic of black beef and 5.4 for light beef. They found approximately 900 milligrams lactic acid per 100 grams bright rib eye meat having a pH of 5.50, whereas the addition of approximately 450 milligrams of lactic or pyruvic acid was required to bring the pH of 100 grams of beef rib eye from pH 6.50 to 5.50. They conclude that the difference of primary importance between bright and dark beef is the difference in the amount of lactic acid present. They say the cause of dark cutting beef appears to be a deficiency of glycogen in the tissues at the time of slaughter.

Winkler (39) was able to show a relationship between the color of beef and its pH. He injected samples of minced pork and of beef with solutions of dilute lactic acid or of ammonia, stored the samples at 0°C. for 3 to 5 days, and by means of a color comparator determined differences in color and in the scatter of the wave bands. Choosing the curve for the scatter of the red band for pork as typical (although the pH curve for beef is said to be similar), he points out that from pH about 4.5 to 5.5 the meat becomes lighter and beyond 5.5 darker in color. In another phase of the study Winkler (40) tested the work required to shear raw beef and pork samples (loin of beef from three animals) in which the pH values had been adjusted by injection of lactic acid or ammonia solutions. He concluded that the "addition of sufficient lactic acid or ammonia to raw pork or beef made the meat more tender" (40, p. 13). He pointed out a greater variability in tenderness in beef from different animals than in pork, even though the samples were at the same pH.

Bate-Smith (7) in reviewing the significance of pH in the ripening of beef enumerates these characteristics of meat at the upper end of the pH range: dark color, slimy or sticky feel, flabbiness, juice not readily expressed, high electrical resistance; salt does not readily penetrate it from curing pickle. He refers to them as defects in the meat and believes they are related to the substance of which the fibrils of the muscle is composed. The main protein constituent, myosin, has an isoelectric point a little above pH 5.3 at which point there is minimum of swelling. He describes the myosin of living muscle as a weak jelly, and states that as the pH falls this jelly shrinks; at pH 6.5 to 6.0 the fibrils shrink apart and scatter light. He attributes high electrical resistance and high pH to swelling of the fibers and the accompanying narrowness of the channels through which ions can move freely. The stickiness at high pH's he says is due not only to swelling of the fibers but also to some dissolution of myosin.

## Post-mortem Changes during Aging of Beef

The outstanding change which occurs soon after slaughter of the animal is a stiffening of the muscles, i.e., the development of rigor mortis. Bate-Smith (7) in writing of rigor mortis and aging of beef relates rigor to glycolysis and the breakdown of adenosine triphosphate. The lactic acid produced from the glycogen acidifies the muscle so that the pH steadily falls from near 7.4 as circulation stops. He emphasizes that the production of acid is not the cause of rigor mortis even though a change in pH greatly affects the physical characteristics of myosin. He states (7, p. 7) that "when sufficient acid is produced, rigor always sets in when the muscle reaches a pH in the neighborhood of 6.3." The removal of adenosine triphosphate from muscle is cited by him as the immediate cause of the stiffening in muscle during rigor. He does not state how rigor is resolved, but says (7, p. 33):

> The actual cause of the increase in tenderness during the ripening process has not been elucidated. The most likely theory is that it is due to proteolysis by tissue proteinase, such as cathepsin.

Paul, Lowe, and McClurg (24) noted a difference in the fat of roasts cooked without storage and of those aged 1 day or longer. In the former the fat was soft and oily, whereas the fat of the latter was firm and brittle. The surface of roasts stored for 0 or 1 day was dry; those stored 2 and 4 days were moist; by the 9th day moisture collected in the paper about the roasts but the surface of the meat was fairly dry; and at 18 days the surface was sticky. The roasts cooked without storage developed rigor during the roasting process, with the exception of the psoas major which had become stiff before it was put into the oven. The psoas was out of rigor by the time the roasting was completed, but the other muscles were stiff, hard, and very difficult to cut. The authors (24, p. 224) describe the procedure of trying to cut the meat in rigor as "similar to cutting a rubber cork." The stored roasts were out of rigor when cooked and the tenderness increased up to the 9th day of storage. With 18 days of storage the results were variable. Deatherage and Harsham (15) compared the tenderness of beef at various intervals of storage up to 41 days. They found a fairly consistent tenderizing effect with increased storage up to 17 days; after that time some carcasses continued to increase steadily in tenderness and others became more tough at one or more of the aging periods.

Harrison (18) compared the tenderness of three grades of beef after aging periods of 1, 2, 5, 10, 20, and 30 days.

The average scores for all roasts indicated a gradual increase in tenderness as aging progressed, with the greatest increase occurring in the first 10 days. For individual muscles the relation of tenderness to time of aging was not always linear. She studied the histological structure of muscles at the different storage periods. Disintegration of muscle fibers was evident at about the 10th day of storage in three of the four animals and became increasingly evident at the 20th and 30th days of aging. This disintegration was described as consisting of destruction of the striae in strips of the muscle fibers, resulting in increased fragility of fibers.

Prudent (27) analyzed samples of meat from two of the animals of Harrison's study to determine the amount of chemical breakdown occurring in collagen and elastin during storage of the meat. She found that the length of the storage period had little if any effect on the degradation of collagen and elastin of the muscles studied. The tenderizing effect which had occurred, as shown in the findings of Harrison (18), could not be explained on the basis of the degradation of collagen and elastin during storage. — method at fault.

The length of the storage period has an effect on other factors of beef than tenderness. Paul (23) reported an increase in electrical conductivity with storage. Juiciness, as indicated by judges' scores, gradually increased with storage time; the amount of press fluid dropped markedly from the 2d to the 9th day of storage, then rose to a high figure at the 18th day. The aroma scores increased up to 9 days, but dropped after 18 days of storage. The flavor of fat became less desirable with the increased length of storage period; by 18 days it had developed rancidity.

Paul measured the pH of raw beef from various muscles during aging periods of 0, 1, 2, 4, 9, and 18 days. She states that the changes during storage followed the usual pattern, namely, "a drop followed by a slow rise" (23, p. 69). The changes in pH during storage were computed to be highly significant and the differences between muscles to be significant. The muscles having the highest pH were also said to have had the strongest odor of any of the aged roasts before cooking.

Harrison (18) reported acidification of muscle post mortem and described the change as rapid during the first 1 to 2 hours. There was a slow rise in the pH of the muscles during storage. The average values for all muscles for 1, 2, 5, 10, 20, and 30 days of aging were 5.47, 5.45, 5.47, 5.49, 5.51, and 5.88, respectively.

The weight lost by roasts during various aging periods was determined by Harrison (18). The loss was greatest for the meat from the carcasses graded Good; intermediate, for the meat from the carcass graded Commercial; least, for that from the carcass of Cutter grade. The roasts lost slightly more weight as the aging time increased. Muscles differed in the amount of weight lost during aging.

## Changes during the Cooking of Beef

The changes that occur during the cooking of beef are so complex that it is very difficult to determine the role of the individual factors. Some studies have been made of the effect of heating on portions of animal tissue composed principally of collagenous or of elastic tissue, i.e., of tendons and of ligaments, respectively.

### Changes in tendons and ligaments

Harrison (18) used strips of tendon from around the anterior end of the longissimus dorsi muscle and from the Achilles tendon. The strips were heated in distilled water at 60°, 65°, 70°, and 95°C. for periods varying from 15 seconds to 30 minutes. She reported a progressive decrease in length of tendons as the temperature was increased. With increased length of time of heating, the length was found to decrease in the first stages, with no further shortening occurring as heating was continued. Softening occurred that was evident in the lower shear force values for the heated than for unheated samples. Strips of ligamentum nuchae were heated in distilled water at 70° and at 95°C. for 30 minutes, and for 1 and 2 hours. The strips became thicker and wider on heating than when raw. They tended to decrease in length with cooking but the changes were small compared to those in the tendons. Considerable variation in results was noted among animals and even among samples from the same animal. The shear force values for the ligaments heated at 95° or 70°C, showed evidence of a tenderizing effect on the elastic tissue. This is contrary to the belief that cooking does not affect elastic tissue.

Ramsbottom et al. (29) compared the relative tenderness of raw connective tissue from the infraspinatus and biceps femoris muscles and found that more than 120 pounds (the capacity of the shearing device) were required to shear it. After cooking, the force required was 21.5 pounds. Yellow elastic tissue (ligamentum nuchae) had a shear force value of 81.1 pounds raw and 42.3 pounds cooked. Fatty tissue improved materially in tenderness during cooking irrespective of the content of connective tissue. The rectus femoris muscle increased in toughness on cooking. Hence these authors concluded that factors other than connective tissue and fat have a considerable effect on tenderness of meat. They state that coagulation and denaturation of protein are among the factors which have a greater negative effect than the positive effect of partial hydrolysis of collagen.

Changes in meat

Ramsbottom and Strandine (28) tested the theory that cooking tenderizes beef. In their study of 50 representative muscles from three heifer carcasses graded Good, they found that cooking the meat to an internal temperature of 76.7°C. (170°F.) in lard at 121.1°C. (250°F.) resulted in shear force values that were higher than for the raw meat for 35 of the 50 muscles. These results indicated a decrease in tenderness with cooking. Ramsbottom et al. (29) reported that in preliminary tests the beef cooked in lard at 121.1°C. (250°F.) cooked more quickly to 170°F. than in the oven at 162.8°C. (325°F.). The oven-cooked meat was consistently more tender and had less variability between muscles than the meat cooked in deep fat.

Cover (12) studied the effect of extremely low rates of heat penetration in relation to tenderness of beef. Two oven temperatures were used, 80°C. (176°F.) for the experimental roasts and 125°C. (257°F.) for the controls. She found that the well-done stage as judged by subjective methods was reached at an internal temperature of 70°C. for the experimental roasts compared to an internal temperature of 80°C. for the control roasts. Similarly, the rare stage was reached at 58° or 59°C. with extremely slow roasting and at 63°C. with roasting at 125°C. A very much longer time in the oven was required at 80°C. than at 125°C. to reach a given internal temperature. The roasts cooked slowly were reported to be more tender by all measures than those cooked at the higher temperature. Without exception, the roasts which required as much as 30 hours (in the 80°C. oven) to lose their pink color were tender, but the roasts cooked a shorter time (in either oven) were not always tender. Roasts from the extremely slow oven lacked the usual plump appearance; those cooked to the well-done stage were so tender as to offer no resistance to cutting or chewing and the texture was described as mealy or powdery in the mouth. The actual moisture content was not determined, but the meat seemed dry as it was chewed.

In the study of veal roasts cooked in ovens at 163°C. (325°F.), Paul and McLean (25) found that in general the color and the palatability factors (flavor, texture, and tenderness) improved with each increase of internal temperature (71°, 77°, 82°, and 88°C.) for the three sizes of animals. Juiciness decreased with increased internal temperature. Cooking losses and the cooking time increased as the internal temperature was increased. The amount of soluble nitrogen in the meat, contrary to the trend expected if collagen is changed to gelatin, showed a decrease from the raw meat through the various stages of cooking. The histological changes observed in the connective tissue of the cooked veal were of two types: (1) an apparent swelling or "spreading" of the collagenous fibers particularly in the semitendinosus muscle, but no change in the elastic fibers, and (2) a disruption in the fine connective tissue sheath (endomysium) of the individual muscle fibers. Both of these changes would contribute to increased tenderness in the meat. They further point out that there was some evidence of disruption in the sarcolemma of the muscle fibers during cooking. This was shown as a change in the edges of the muscle fibers from a smooth, straight appearance in the raw veal to a rough, irregular outline in the roasted meat. The staining reaction of the cooked connective tissue was observed to be less intense than that of the raw tissue. These authors describe in some detail the distribution and character of the collagenous and elastic tissue in each of the several muscles studied. (See Paul and McLean, 26.)

Bell et al. (9) used a chemical method for measuring the tenderizing effect of cooking on meat. For beef boiled in an excess of water to 85°C., they reported a conversion of collagen to gelatin to the extent of about 22 per cent. The percentage of protein represented by gelatin in the raw meat was 10.86 and that in the cooked meat was 8.37. Prudent (27) secured results of an opposite nature. She found by chemical determinations that cooking to 70°C. by immersion in fat at 96° to 98°C. resulted in little if any changes in the collagen and elastin content of the muscles studied.

The pH values for cooked meat have been reported to be slightly higher than for uncooked meat. Harrison (18) found average pH values of 5.76, 5.74, 5.77, 5.78, 5.73, and 5.87, respectively, for the cooked roasts aged for 1, 2, 5, 10, 20, and 30 days. Bendall (10) cooked beef at 100°C. for 1 hour and found considerable shift to the alkaline side.

## Aroma and Flavor of Beef

Crocker (14) has made a critical analysis of the flavor of unaged beef and of the influence of boiling and of low-temperature heating on the flavor. He states that the flavor of raw meat is mostly in the juice, not the fiber, and that the flavor is "weak, sweetish, salty and generally blood-like" (14, p. 180). He says that most of the flavor of cooked meat comes from the meat fiber. He describes the flavor of cooked beef in these words (14, p. 180):

> This meaty flavor, typical of cold roast beef or pot roast, was apparently due to volatile substance detected by the sense of smell, even though chewing was needed to release it. It was fragrant, moderately acidic, only slightly burnt, and distinctly caprylic. It was definitely sulfury.

He says that cooked meat flavor is essentially an odor, for only a trace of sweetness was evident when the nostrils were held. Some astringency in the mouth was noted. The effect of length of time of boiling was studied and the flavor of cooked beef was found to increase up to 3 1/2 hours of boiling, whereas after that time a gradual loss of flavor occurred. Beef boiled in a citric acid solution (2 per cent strength based on the weight of the meat) had an acetic-like odor and caprylic flavor resembling corned beef. The pH of the raw beef was 6, that of the meat cooked in citric acid solution was 3.5. Beef boiled in 1 per cent sodium bicarbonate solution developed a pH of 8.87 and was said (14, p. 180) to have "an aminic and sulfury odor, suggestive of both clams and eggs, with some piperidine evident" and the taste was described as "very weak." Beef bones were found to contribute almost no flavor but gave gelatin and tallow to preparations. Marrow and tissue fats were said to contribute little meat flavor.

## Effect of Added Substances

In some preliminary investigations Sair and Cook (30) observed a relationship between the amount of drip from meat (prior to freezing) and the pH of the tissues. They decided to extend the study of this relationship by artificially adjusting the pH of meat samples. They injected 20 milliliters of lactic acid or ammonium hydroxide of suitable concentration into 800- to 900-gram pieces of pork, beef, and mutton with a calibrated 5-milliliter hypodermic syringe. The injections were made at numerous uniformly distributed points. Those samples not requiring an adjustment of pH were injected with 20 milliliters of distilled water. After storage of the injected samples for 3 days at 0°C., the samples were minced and divided into experimental lots, some to be frozen and others to be left unfrozen as controls. These investigators found a marked relation between the amount of drip and the pH of the meat. The maximum drip was obtained between pH 5.0 and pH 5.2 for all three kinds of meat. They plotted curves for the drip from the frozen (total) and unfrozen (control) samples. The curves descended slightly on the acid side to pH 4.4 (the lowest pH value tested) and also descended, but more sharply, on the alkaline side to about pH 6.4. At pH 6.4 the difference in the drip from the control and frozen samples (net drip, difference between amount for control and frozen samples) became zero and the amount of drip was very small. The shape of the drip curves was nearly identical for the three kinds of meat, but the quantity of liquid exuding from unfrozen beef was slightly less than the amount from pork or mutton.

Snyder (31) studied the effect on cooking losses of the addition of salt to the surface of beef roasts before roasting and of the addition of salt to beef stew before cooking. She reported the formation of a crusty outside layer and a penetration of salt flavor to the depth of less than 1/2 inch below the surface of the roasts. There was a development of gray color within the meat which corresponded to the depth of penetration of salt flavor. In the case of the stews there was said to be no texture or color differences in the salted and unsalted cubes, but there was an improvement in flavor due to the addition of salt.

Crain (13) and Tofte (37) treated 3-inch cubes of beef with three types of brining solutions: (1) salt, 10 gm. to 100 cc. water, (2) vinegar, 25 cc. to 75 cc. water, and (3) salt and sugar, 7.5 gm. of each to 100 cc. water. After standing in the brining solution for 72 hours in the refrigerator, the cubes of meat were seared, then cooked in covered stew pan or Dutch oven to an interior temperature of 205°F. (200°F. in the case of the vinegar-treated meat). The brined samples gained in weight prior to cooking; the controls lost weight. Cooking losses were higher, however, for the brined than for the unbrined samples. The vinegar-treated meat had a lower pH than the controls, but the difference was more marked in surface samples than in those from the interior. The pH values were generally higher for cooked than for raw meat. Tofte reported low pH's for vinegar-treated samples even after cooking, but Crain found no significant differences after cooking due to vinegar treatment. All three brining treatments resulted in tenderization of the meat, except for one animal reported by Tofte, the meat of which was moderately tender before brining. The judges generally preferred the brined meat to the controls in flavor and in juiciness, but the differences were much greater for salt or salt-sugar treatment than for vinegar. Scores for aroma were variable but in general were slightly higher in brined than in control samples.

Both investigators (13, 37) described color changes in the brined samples. The vinegar-treated meat became purplish gray in the outer portions and was dark on cooking; salt-treated meat was slightly gray. Many samples immersed in the salt or the salt-sugar solution developed iridescence on the surface; only a few control or vinegar-treated samples had this characteristic. Brined samples failed to develop a brown exterior during searing. Tofte (37) studied the histological effect of brining the beef cubes. She found a decrease in the distinctness of outline of the muscle fibers and decreased clarity in differential staining of connective tissue and muscle fibers as a result of the brining treatment. In the slides of cooked meat the collagen was barely apparent; the elastin showed no perceptible change. The amorphous appearance of brined meat and the differences between surface and interior samples of vinegar-treated meat were less marked after cooking than while raw.

Bate-Smith (8) reported the use of phosphate solution to aid in tenderization of beef. The concentration giving the greatest effect was 0.2 M, but an appreciable effect was noted with a fourth of that concentration. A suitable mixture of mono- and di-hydrogen phosphate to give a pH value between 6 and 7 was used. The addition of concentrated meat stock from previous cooking was recommended by this investigator as an alternative method of securing a tenderizing effect. Lowe (19) describes short studies in which 0.2 M and 0.4 M mixtures of $NaH_2PO_4$ and $Na_2HPO_4$ were added to stews or in which the beef was brined in the phosphate solutions. The addition of broth to stews was also studied. Results for any of these treatments varied with the size of the beef cubes. In small cubes, the salt solution penetrated a larger proportion of the cube and tenderizing occurred. There was less effect on large cubes. The flavor of the treated samples was generally preferred by judges to that of the meat left untreated.

The immersion of cuts of beef in solutions of calcium chloride was also reported by Lowe (19). The lower concentrations (0.1 M and 0.2 M) had no appreciable effect on shearing strength, press fluid, or the qualities tested subjectively. The higher concentrations (0.4 M and 0.5 M) imparted a bitter flavor. Some weight gains and a higher content of calcium in the brined than in the unbrined meat were found, but the differences were less marked in cooked than in raw samples.

## Canning Procedures

Directions for the commercial preparation and processing of various fruits and vegetables are available in the literature, but the references for commercially canned meats are very limited. A bulletin of the National Canners Association Research Laboratory (22), which outlines canning methods for several low-acid foods in metal containers, provides no time or temperature tables for meat and meat products but refers the reader to directions from research laboratories connected with the canning industry.

The Bureau of Human Nutrition and Home Economics (38) has published a bulletin for use in the home canning of meats. The directions for the raw packing of beef, veal, pork, or lamb as large pieces include the following selected points: trimming away excess fat, placing pieces of meat in the cans with the grain of the meat running lengthwise, filling tin cans to the top with raw meat, preheating the open cans of meat in water extending to about 2 inches below the rim for a period of about 50 minutes in tin cans or to 170°F. for the meat at the center of the jar, sealing tin cans, and processing at once in a steam-pressure canner at 10 pounds pressure (240°F.) for 65 minutes for number 2 tin cans (75 minutes for pint and 90 minutes for quart glass jars).

A technical bulletin by Toepfer et al. (36) reports the findings from experiments in processing inoculated packs of low-acid foods by home canning methods. Recommendations were formulated for various foods in certain sizes of cans based on the data from the heat penetration studies. For pork and beef, the recommended processing temperature is 240°F. and the time periods for certain sizes of cans are the following: beef in quart jars, 90 minutes; pork in quart jars, pint jars, number 3 or number 2 1/2 cans, and number 2 cans, respectively, 90, 90, 75, and 65 minutes. These investigators point out that the processes may be more severe than necessary for home canning, but no reduction is advisable until sufficient data on heat resistance and thermal-death-time curves of spoilage organisms in food media are available.

# EXPERIMENTAL PROCEDURE

## Preliminary Investigations

In the preliminary part of the study, several different substances were tested for their effect on the slicing quality and palatability of canned beef. Solutions of phosphate, of chloride, and of acid in various concentrations and mixtures were used, and the injected meat was stored for different lengths of time before canning. For example, a solution of mono- and di-sodium phosphate in 0.1 M and 0.2 M concentrations was used for injection of beef cuts and the meat was aged for 4, 9, or 14 days. Some other solutions tested were sodium chloride and a mixture of sodium chloride with lactic acid or with mono-sodium phosphate for three different aging periods. A few cuts of meat were injected with calcium hydrogen phosphate solution or with this substance in combination with sodium chloride. A few experiments were done in which the solution used for injection was one of the following: ascorbic acid, ascorbic acid and sodium chloride, or ascorbic acid, sodium chloride, and lactic acid.

Little or no improvement in slicing quality was noted for injected samples in comparison with control samples with phosphate or ascorbic acid treatment. Samples treated with sodium chloride, even though they showed no improvement in sliceability, were found to be much more tender than the controls. An improvement in the texture of the meat was noted and the flavor was more desirable than in the untreated samples. Sodium chloride-lactic acid-treated samples showed slicing quality that was slightly improved or similar to that of the control samples without impairment in palatability.

On the basis of these preliminary findings, the treatments selected for further investigation were the use of the following three kinds of solutions for injection of the raw beef prior to aging and canning: (1) sodium chloride, (2) lactic acid, and (3) a mixture of sodium chloride and lactic acid.

## Selection of Animals

Five animals were used in the study after a period in which meat from the same number of animals had been used in preliminary investigations. All the animals were procured by the Animal Husbandry Department of the College. Four animals were steers of beef type purchased from a farmer near Ames, and the fifth was an aged dairy cow purchased from another farmer. The four steers were identified as Animals VI, VII, VIII, and IX, respectively, and the cow, as Animal X. The carcass grade of each of the steers was Commercial and that of the cow was Cutter in accordance with U. S. Government standards.

### Slaughter of Animals, Separation of Muscles, and Division into Cuts

Each of the animals was slaughtered in the Animal Husbandry abattoir by E. A. Kline, Instructor in Animal Husbandry, and Julius T. Jensen, Meat Laboratory Assistant, or by students under their direction. The carcass was divided into halves and the two sides of beef were allowed to hang in the cooler at $34^{o}$ to $36^{o}$F. until the following day. The sides of beef were divided into quarters between the 12th and 13th ribs and matching pairs of muscles were separated from the carcass. Belle Lowe, Professor of Foods and Nutrition, Alma R. Plagge, Research Associate, and the author separated the muscles from the carcass, divided the muscles into cuts, and carried on the preparation of the meat for canning and subsequent testing.

The muscles selected for use because of their suitable size, shape, and structure were the following: (1) longissimus dorsi, loin portion, (2) longissimus dorsi, rib portion, (3) psoas major and psoas minor, (4) semitendinosus, (5) semimembranosus, and (6) biceps femoris.

Before division into cuts, the extraneous fat and heavy connective tissue were trimmed from the muscle. From three positions within each muscle, small samples of meat were taken for histological and for pH determinations. The location of each position is indicated in the diagram of the respective muscle (Figures 1, 2, 3, 4, and 5). The approximate size of each histological sample was 3 cm. x 1 cm. x 1 cm. The sample was cut in half crosswise and the two pieces were placed in an individual bottle of formalin-physiological salt solution for fixation. Each sample for pH determination was cut to a weight of 10 grams, wrapped individually in moisture-vapor-proof cellophane, and frozen at -30°F. to be kept for later assay.

The size and general shape of the beef muscles used in the study were suited to canning in the number 2 size of tin can (diameter, 3 7/16 inches; height, 4 9/16 inches). Some advantages were that peices of meat approximately the size of the container could be cut from the muscles, the canning procedures could be carried out to advantage, and suitable samples for testing could be secured from the canned meat. For the experimental work of the problem, cuts of beef were needed which would be large enough to fit the container after removal of pH and histological samples and which would provide for losses in weight during aging. By dividing each of the smaller muscles into three parts and the larger muscles into six parts, pieces of approximately the desired

Figure 1. Longissimus Dorsi Muscle.

| | | |
|---|---|---|
| A, B, and C | - | Cuts of beef for canning. |
| a and b | - | Histological and pH samples, respectively, from muscle before division into cuts and after aging one day. |
| c and d | - | Histological and pH samples, respectively, from beef cuts aged eight days. |
| e and f | - | Histological and pH samples, respectively, from canned beef. |
| g, h, and i | - | Slices for scoring by judges. |

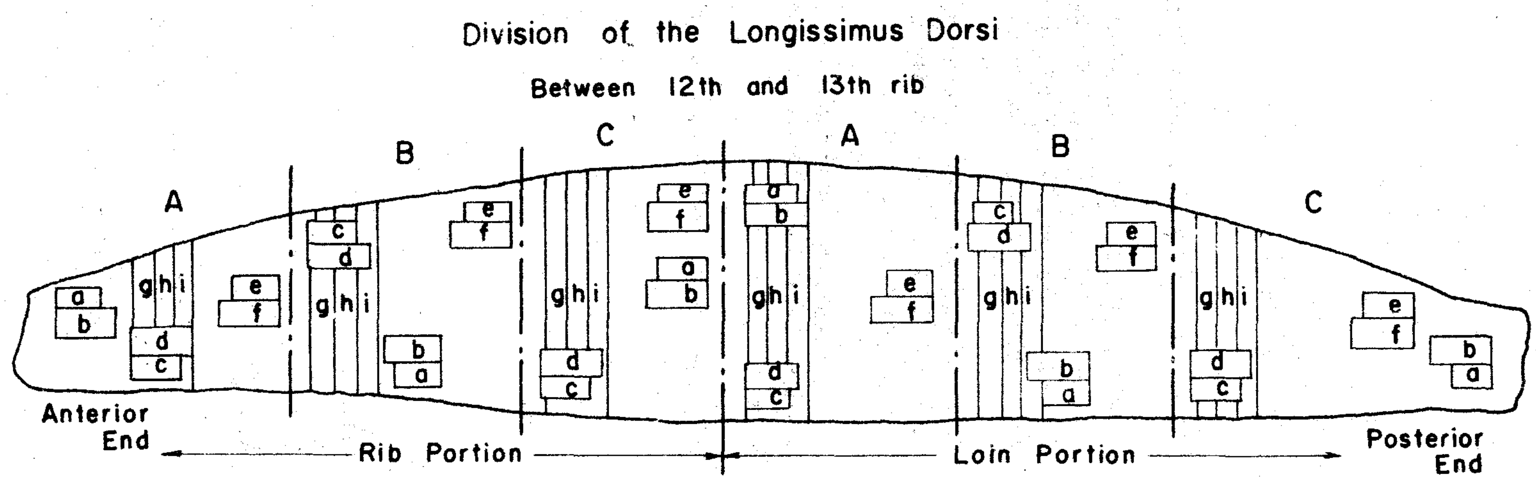


**Figure 1.**

Longissimus Dorsi Muscle.

Figure 2. Psoas Major and Psoas Minor Muscles.

A, B, and C - Cuts of beef for canning.

a and b - Histological and pH samples, respectively, from muscle before division into cuts and after aging one day.

c and d - Histological and pH samples, respectively, from beef cuts aged eight days.

e and f - Histological and pH samples, respectively, from canned beef.

g, h, and i - Slices for scoring by judges.

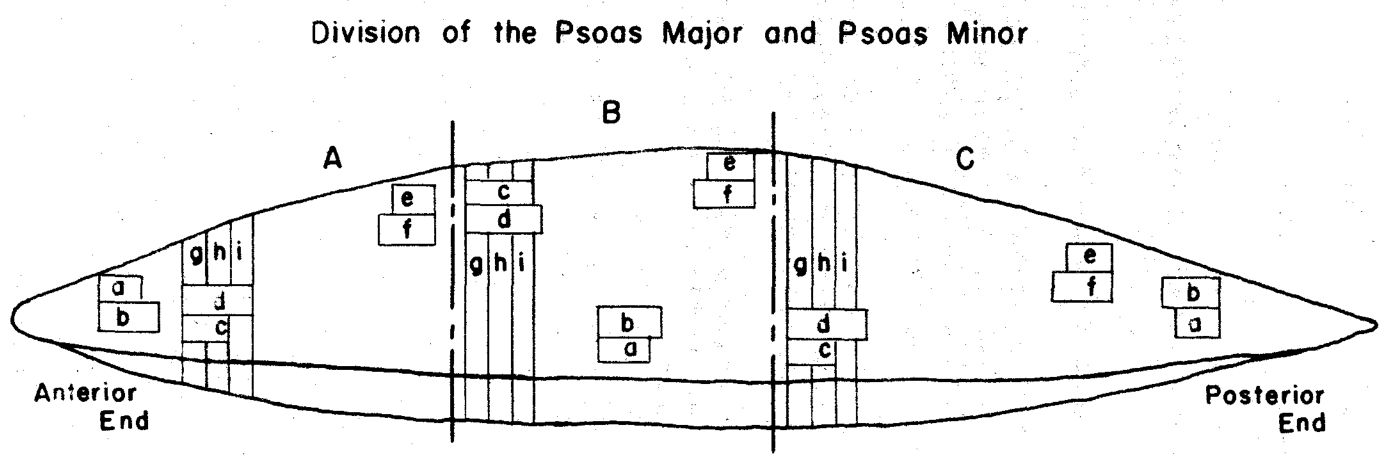


**Figure 2.**

**Psoas Major and Psoas Minor Muscles.**

Figure 3. Semitendinosus Muscle.

| | | |
|---|---|---|
| A, B, and C | - | Cuts of beef for canning. |
| a and b | - | Histological and pH samples, respectively, from muscle before division into cuts and after aging one day. |
| c and d | - | Histological and pH samples, respectively, from beef cuts aged eight days. |
| e and f | - | Histological and pH samples, respectively, from canned beef. |
| g, h, and i | - | Slices for scoring by judges. |

Division of the Semitendinosus

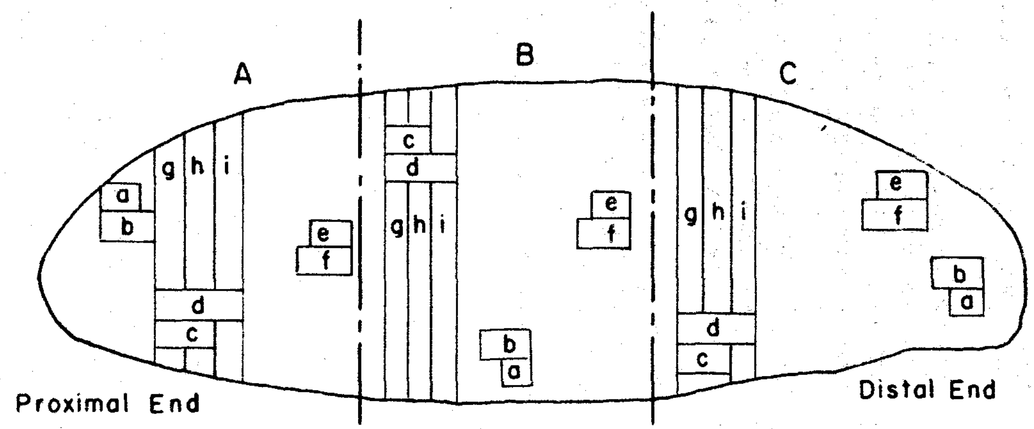


**Figure 3.**

**Semitendinosus Muscle.**

Figure 4. Semimembranosus Muscle.

| | | |
|---|---|---|
| A, B, C, D, E, and F | - | Cuts of beef for canning. |
| a and b | - | Histological and pH samples, respectively, from muscle before division into cuts and after aging one day. |
| c and d | - | Histological and pH samples, respectively, from beef cuts aged eight days. |
| e and f | - | Histological and pH samples, respectively, from canned beef. |
| g, h, and i | - | Slices for scoring by judges. |

Division of the Semimembranosus

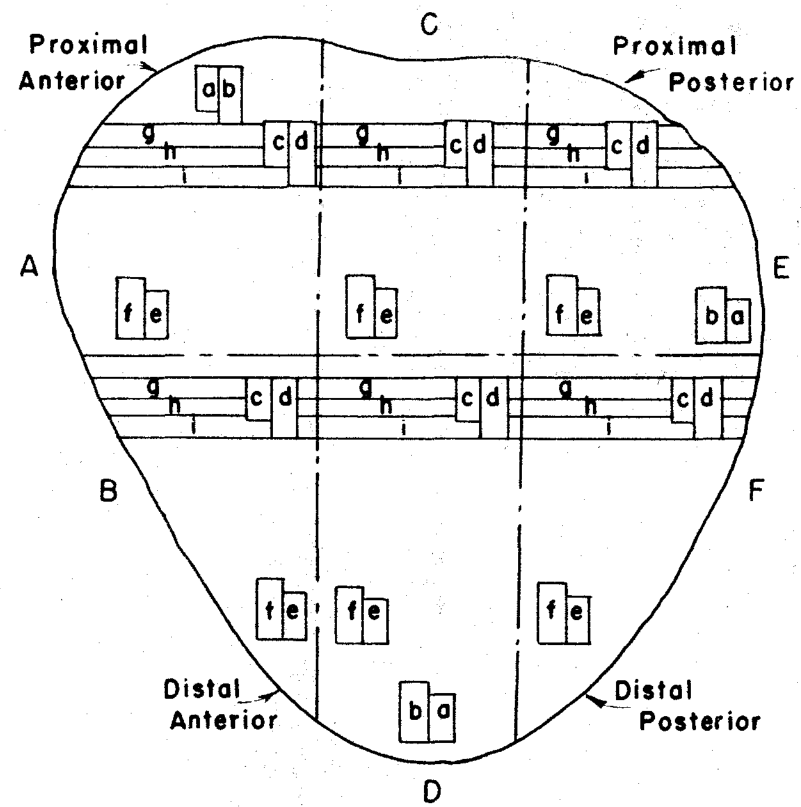


**Figure 4.**

**Semimembranosus Muscle.**

Figure 5. Biceps Femoris Muscle.

| | | |
|---|---|---|
| A, B, C, D, E, and F | - | Cuts of beef for canning. |
| a and b | - | Histological and pH samples, respectively, from muscle before division into cuts and after aging one day. |
| c and d | - | Histological and pH samples, respectively, from beef cuts aged eight days. |
| e and f | - | Histological and pH samples, respectively, from canned beef. |
| g, h, and i | - | Slices for scoring by judges. |

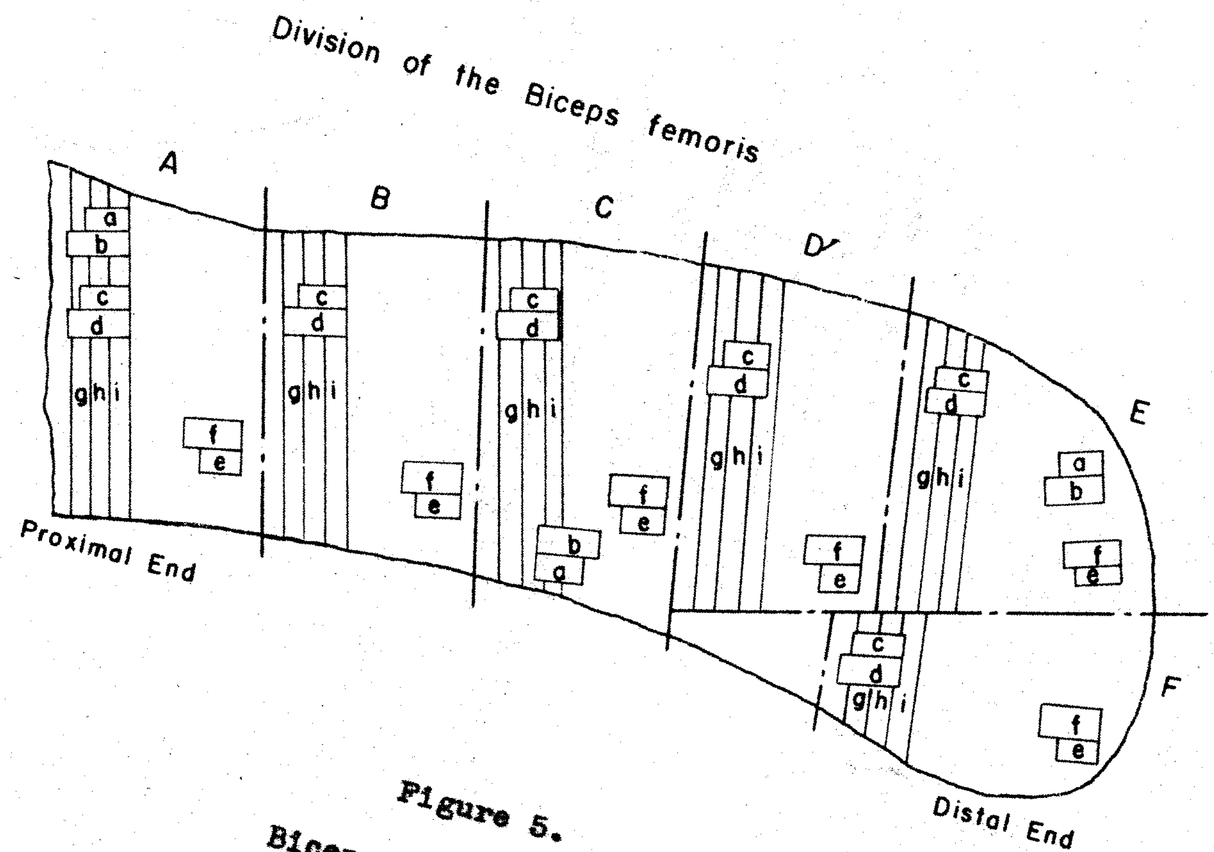


**Figure 5.**

**Biceps Femoris Muscle.**

size were obtained. The pieces were trimmed to approximately 600-gram weight (600 to 610 grams). When the piece was already smaller than the desired weight (in only a few cases), a second piece or "filler" of meat from the same animal was included to make a suitable total weight.

The weight of each of the matching cuts of meat, trimmed to size as indicated, was recorded and each cut was labeled to indicate sample number and orientation within the muscle. Glass beakers of 600-milliliter capacity had been provided for storage of the individual cuts of meat. The piece of meat in each case was put into the beaker so the anterior (or proximal) end was uppermost. Control samples (those from the left side of the carcass) were covered with moisture-vapor-proof cellophane held in place with a rubber band, and were placed in the cooler at $34^{\circ}$ to $36^{\circ}$F. for aging. Samples to be injected (those from the right side of the carcass) were placed in the beakers and the injection was carried out, as described in another part of this paper, with the beaker serving as container for any solution that separated from the meat. The control samples were left uninjected so they would be representative of beef as it is usually canned.

## Injection of Cuts of Meat

### Equipment

The needles used for injection of the meat were made at the College Instrument Shop and consisted of 4 hypodermic needles mounted 3/4 inch apart in the shape of a square. Each needle was approximately 3 inches long and had a bore of approximately 1/16 inch. The instrument was screwed into the nozzle of a pressure pump (one regularly used by the Animal Husbandry Department for injecting hams and shoulders of pork). The pressure exerted by the pump was 30 pounds per square inch when the hand-control lever was pressed to the limit. By insertion of a wedge below this lever, the device was operated at a pressure slightly under 30 pounds.

### Solutions used for injection

Three kinds of solutions were used for injection of the meat. The sodium chloride solution was made in 15 per cent strength by using the proportion of 150 grams of chemically pure sodium chloride made to 1000 milliliters with distilled water. The solution was stirred until the salt dissolved and was then filtered. Salimeter and temperature readings were taken. In each case the temperature was 22°C. (71.6°F.) and the salimeter reading showed a saturation of 51 per cent. (According to the statement on the instrument, 100 per cent saturation equals 26.395 per cent sodium chloride, and the instrument is calibrated to show the saturation at 60°F.)

The lactic acid solution was made by adding lactic acid (85 per cent strength) to distilled water until the solution gave readings of pH 3.4 when tested with the pH meter. Very small amounts of lactic acid were added at one time and repeated readings were taken until the desired pH had been reached.

The solution containing a mixture of sodium chloride and lactic acid was made by using a portion of the 15 per cent sodium chloride solution already described and adding very small amounts of lactic acid (85 per cent strength) to it until repeated readings of the pH meter indicated a pH of 3.4 for the solution.

The quantity of each of the three solutions made for the treatment of the meat samples from each animal was 3500 milliliters (approximately 1 gallon). The solutions were stored in glass jugs in the refrigerator at 4°C. for 1 or 2 days. Several hours prior to use for injection of samples, the containers of solution were removed from the refrigerator and allowed to come to laboratory temperature (17° to 19°C.).

Method of injection

As has been stated, beef cuts from the right side of the carcass were injected and the matching cuts from the left side were used uninjected as controls. Since three or six cuts had been secured from each muscle, it was possible to treat one cut from each muscle, or two cuts in the case of the large muscles, with each of the three solutions. For Animal VI, the particular cut from each muscle to receive a particular kind of treatment was determined by random selection; for succeeding animals, the order was rotated. The design for treatment of the cuts from each animal is shown in Table 1.

Preliminary experiments had indicated that injection to approximately 10 per cent increase in weight per cut would be a suitable working standard. Since the samples had been trimmed to weights within the range of 600 to 610 grams, it was decided to inject the samples so that the weight of sample plus injecting solution was 60 grams above that of the sample itself. Preliminary work had also shown that even though the liquid was injected into the meat, some of it tended to flow from the cut surfaces. By having the piece of meat in the beaker while it was being injected and during subsequent storage, this liquid was held in close contact with the meat, even though all of it did not stay within the interior.

With the beaker of meat resting on one pan of a laboratory balance and weights sufficient for a 60-gram increase on the other pan, the 4-needle hypodermic instrument was inserted

Table 1. Design for Injection of Beef Cuts. Position of sample in muscle is indicated in Figures 1, 2, 3, 4, and 5.

| Animal no. | Sodium chloride | | Lactic acid | | Sodium chloride and lactic acid | |
|---|---|---|---|---|---|---|
| | Posi- tion | Sample no. | Posi- tion | Sample no. | Posi- tion | Sample no. |
| Longissimus dorsi, loin portion | | | | | | |
| VI | A | 162 | B | 163 | C | 164 |
| VII | C | 188 | A | 186 | B | 187 |
| VIII | B | 211 | C | 212 | A | 210 |
| IX | A | 234 | B | 235 | C | 236 |
| X | C | 260 | A | 258 | B | 259 |
| Longissimus dorsi, rib portion | | | | | | |
| VI | C | 167 | B | 166 | A | 165 |
| VII | A | 189 | C | 191 | B | 190 |
| VIII | B | 214 | A | 213 | C | 215 |
| IX | C | 239 | B | 238 | A | 237 |
| X | A | 261 | C | 263 | B | 262 |
| Psoas major and psoas minor | | | | | | |
| VI | A | 168 | C | 170 | B | 169 |
| VII | B | 193 | A | 192 | C | 194 |
| VIII | C | 218 | B | 217 | A | 216 |
| IX | A | 240 | C | 242 | B | 241 |
| X | B | 265 | A | 264 | C | 266 |
| Semitendinosus | | | | | | |
| VI | B | 172 | A | 171 | C | 173 |
| VII | C | 197 | B | 196 | A | 195 |
| VIII | A | 219 | C | 221 | B | 220 |
| IX | B | 244 | A | 243 | C | 245 |
| X | C | 269 | B | 268 | A | 267 |
| Semimembranosus | | | | | | |
| VI | D | 177 | A | 174 | B | 175 |
| | F | 179 | E | 178 | C | 176 |
| VII | B | 199 | D | 201 | A | 198 |
| | C | 200 | F | 203 | E | 202 |
| VIII | A | 222 | B | 223 | D | 225 |
| | E | 226 | C | 224 | F | 227 |
| IX | D | 249 | A | 246 | B | 247 |
| | F | 251 | E | 250 | C | 248 |
| X | B | 271 | D | 273 | A | 270 |
| | C | 272 | F | 275 | E | 274 |

(continued)

Table 1 (continued)

| Animal no. | Sodium chloride | | Lactic acid | | Sodium chloride and lactic acid | |
|---|---|---|---|---|---|---|
| | Posi-tion | Sample no. | Posi-tion | Sample no. | Posi-tion | Sample no. |
| Biceps femoris | | | | | | |
| VI | E | 184 | A | 180 | B | 181 |
| | F | 185 | C | 182 | D | 183 |
| VII | B | 205 | E | 208 | A | 204 |
| | D | 207 | F | 209 | C | 206 |
| VIII | A | 228 | B | 229 | E | 232 |
| | C | 230 | D | 231 | F | 233 |
| IX | E | 256 | A | 252 | B | 253 |
| | F | 257 | C | 254 | D | 255 |
| X | B | 277 | E | 280 | A | 276 |
| | D | 279 | F | 281 | C | 278 |

lengthwise of the grain of the meat. Operation of the lever of the pressure pump as the instrument was slowly withdrawn permitted the solution to enter the meat. The needles were inserted three times in each cut of meat so that the resulting points of injection were about equally spaced. Usually it was necessary to add a little more solution at the top of the beaker to bring the weight to the desired figure. Occasionally it was necessary to pour off a small amount of the liquid to secure the proper weight of sample plus injecting solution. After injection of the sample, the container of meat was covered with moisture-vapor-proof cellophane and stored in the cooler beside the respective control sample.

## Aging the Cuts

The control and injected cuts of beef were permitted to remain in the cooler at 34° to 36°F. for a period of 1 week after cutting (8 days after slaughter of the animal).

## Canning the Meat

### Equipment

The canning equipment was of commercial type and was located in the Food Processing Laboratory. The steamer, can sealer, and processing retort were operated by R. G. Tischer, Research Associate Professor of Horticulture. Plain tin cans, number 2 size, were used as containers for the meat. The lids had a rubber-like sealing compound at the rim.

### Preparation of samples

The cuts of meat, after aging 8 days, were taken from the cooler, removed from the beakers, and individually weighed. The "drip" and/or surplus solution were discarded without weighing. From the anterior end of each cut, samples for histological study and for pH determinations were taken as previously described.

Since it was desired to have a minimum of 20 ounces (567 grams) of raw meat to put into each can, the piece was trimmed to a weight within the range of 568 to 578 grams. In a few instances the "filler" of meat from the same animal was used to make up for the difference in weight. After a record of its weight was made, the cut of meat was put into the can with anterior end of the cut uppermost. A thermometer was inserted in each of four pairs of representative cans so that the bulb of the thermometer was near the center of the cut of meat. The square of cellophane which had been over the top of the beaker during storage was transferred to the top of the can to remain during the preheating of the meat before sealing. From each animal 48 cans of meat were used for processing plus some reserve cans, making a total of 56 for a retort load. This number of cans was sufficient to fill the retort to approximately one-third of its capacity.

Preheating the meat

The cans of meat resting on metal trays were loaded into a three-compartment steamer for preheating. The doors of the steamer were left slightly ajar so that atmospheric pressure would be maintained. A preliminary test had shown that approximately 1 hour of steaming was necessary for the meat at the center of the can to reach a temperature of 170°F. or higher. At the end of an hour of heating the cans were removed from the steamer, the thermometers read, the cellophane covers removed, and the cans closed on the automatic sealing machine.

Processing the meat

The cans of meat were immediately transferred to the processing retort and arranged with metal racks separating the tiers of cans. The retort was closed, the steam turned on, and the automatic device for recording temperature and time within the retort was adjusted. Processing was carried out at 10 pounds pressure (240°F.) for 65 minutes for the meat from animals VI, VII, and VIII; for 90 minutes in the case of Animals IX and X. Within a minute after opening the steam valve, the pressure had reached 10 pounds within the retort.

At the end of the processing period the steam was turned off and the valves were adjusted so that running cold water was circulated through the retort to cool the cans. The cooled cans were dried and two of the reserve cans were placed in an incubator at 100°F. for observation of keeping quality at an elevated temperature. All the other cans remained at room temperature overnight and then were transferred to the cooler for storage at 34° to 36°F. until they were opened for evaluation of the meat. The cans were stored in the cooler because it was the only convenient storage space available.

## Evaluation of the Canned Meat

Preparation for evaluation

During an 8-day evaluation period, six cans of meat were opened daily. The six cans opened on any particular day were from the same pair of muscles and represented the three kinds of injection. The order in which the meat from the various muscles was tested was determined by drawing lots. The design for the order of evaluation of canned beef samples is shown in Table 2. Each day the six cans to be opened on the following day were removed from storage in the cooler and were allowed to come to room temperature.

Table 2. Design for the Evaluation of Canned Beef Samples

| Animal no. | Control and injected samples evaluated each day | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st | 2d | 3d | 4th | 5th | 6th | 7th | 8th |
| VI | 168 | 180 | 165 | 174 | 162 | 171 | 181 | 175 |
| | 169 | 183 | 166 | 176 | 163 | 172 | 182 | 177 |
| | 170 | 185 | 167 | 179 | 164 | 173 | 184 | 178 |
| VII | 192 | 189 | 186 | 200 | 198 | 195 | 204 | 206 |
| | 193 | 190 | 187 | 202 | 199 | 196 | 205 | 207 |
| | 194 | 191 | 188 | 203 | 201 | 197 | 208 | 209 |
| VIII | 213 | 228 | 216 | 210 | 219 | 224 | 230 | 222 |
| | 214 | 229 | 217 | 211 | 220 | 226 | 231 | 223 |
| | 215 | 232 | 218 | 212 | 221 | 227 | 233 | 225 |
| IX | 243 | 234 | 253 | 240 | 237 | 246 | 252 | 247 |
| | 244 | 235 | 254 | 241 | 238 | 248 | 255 | 249 |
| | 245 | 236 | 256 | 242 | 239 | 251 | 257 | 250 |
| X | 278 | 261 | 272 | 270 | 267 | 258 | 276 | 264 |
| | 279 | 262 | 274 | 271 | 268 | 259 | 277 | 265 |
| | 281 | 263 | 275 | 273 | 269 | 260 | 280 | 266 |

Before a can was opened, a measurement was taken of the vacuum developed within the can by inserting a vacuum gauge through the lid. Following this measurement the can was opened and the liquid was drained into a bowl for weighing. A portion of the liquid (approximately 35 milliliters) was poured into a screw-topped glass jar and put into the refrigerator for storage at 4°C. until the following day when it was observed for the amount of gelation which had occurred. The remainder of the liquid was poured into a 400-milliliter beaker for observation of the color and general appearance, and for sampling by the judges when scoring flavor of the liquid. The meat from the can was weighed in the same bowl that had been used for the juice, samples for histological study and for pH determination were removed from the piece of meat, and the meat was ready for slicing.

<u>Slicing the meat</u>

A hand-operated mechanical slicer with rotary blade was used to slice the meat from each can. Slices were cut 3/8 inch in thickness. Slicing was begun at the anterior end of the cut of meat, the end uppermost in the can. Individual squares of waxed paper were placed on the platform of the slicer to receive each slice as it came from the blade. The papers were numbered to show the sequence of the slices. Even when the meat was so crumbly as to not give a true slice, whatever amount of meat came through the machine with one revolution of the blade was placed upon the respective paper and was later counted in determining the "possible number of slices." The slicings from each can of meat were arranged consecutively on a tray for counting the number of slices obtained and for observation of the quality of the slices.

In determining the count of slices, the meat was considered to be a slice if it held together for approximately three-fourths or more of its area. Doubtful cases of "holding together" were tested by picking up the slice with a wire clamp and suspending the slice vertically for about 5 seconds. Distinction was made between slices as to quality, i.e., if they held together for almost the entire area they were classed as firm slices; if they crumbled for about one-fourth of their area they were classed as crumbly slices. Crumbliness more extensive than this meant that the meat was not counted as a "slice obtained" but was considered to be part of the "unsliceable portion." Weight of the total unsliceable portion was recorded for each can and the count of these very crumbly slices was considered in determining the "possible number of slices" from the can. While the slicings from each can of meat were still spread out on the trays, observations were made of the color, iridescence, and general appearance of the meat.

Scoring the meat

Slices obtained from certain relative positions in the cut of meat were presented to each of the three judges for scoring. Judge number 1 received the second slice (counting from the anterior end of the cut), judge number 2 the third slice, and judge number 3 the fourth slice (indicated as g, h, and i, respectively, in Figures 1, 2, 3, 4, and 5). Each slice was individually wrapped in waxed paper, marked with a code number, and placed in an individual plastic bag. One such slice from each of the six cuts of meat to be judged that day was presented to each judge for scoring and each judge poured some of the liquid from the beakers into a cup for tasting. Both the meat and the liquid were at room temperature when scored. Sliceability and the desirability of the following six palatability factors were scored by the judges: aroma, flavor or meat, flavor of liquid, tenderness, juiciness, and texture. The scoring range for each factor was a score of 10 for extremely good quality to a score of 1 for extremely poor quality. A copy of the score sheet is given in the Appendix.

Gelation of liquid

Observations were made of the amount of gelation that had occurred in the liquid during refrigeration for approximately 24 hours. The jars were taken from the refrigerator, the screw cap was removed and the contents of the jar were turned onto a plate. If gelation had taken place, a thin-bladed knife was run once around the interior of the jar to loosen the jellied material from the glass. The rigidity of the gel as it rested on the plate and as a knife was cut through it was observed. If the material was still liquid, the consistency was observed.

## Measurement of pH

At three different stages there were samples removed for pH determinations, namely, (1) from three positions in the muscle 1 day after slaughter of the animal and before the muscle was divided into cuts, (2) from the anterior end of the beef cuts on the 8th day after slaughter, and (3) from the posterior end of the piece of canned meat before the slicing was done. The positions within the muscle from which these samples and also those for histological study were taken are shown in the diagrams of the respective muscles (Figures 1, 2, 3, 4, and 5). Each 10-gram sample for pH determination was wrapped in moisture-vapor-proof cellophane and the samples for 1 day were placed in a bag. Samples were stored temporarily (about 2 hours) in the refrigerator at 4°C., transferred to the quick-freezing compartment at the Meats Laboratory for freezing at -30°F., and finally stored at 0°F. until the 13th or 14th day, at which time the samples were removed for measurement of the pH value.

A Coleman pH meter was the instrument used for this determination. The samples were prepared for testing by removing from zero storage, placing a few at a time at room temperature (leaving the remainder in the refrigerator), cutting four or five times through the 10-gram sample with a sharp knife, and exposing the cut pieces to the air for a few minutes until the meat was partially thawed. The pieces were placed in the stainless steel cup of a Waring blendor. Distilled water was added (25 milliliters for the raw meat, 30 milliliters for the canned) and the blendor was run for 30 seconds. This procedure resulted in maceration of the sample and elevation of the temperature to approximately 25$^{o}$C. Some of the mash was placed in the cup of the pH meter and the reading for the sample was taken.

Histological study

Samples from the longissimus dorsi muscle, rib portion, were selected for histological study. The judges' ratings of palatability factors had shown greater differences between control and injected samples for this muscle than for the other muscles. Histological sections were cut either 25 or 30 microns thick on the freezing microtome. Weigert's stain for elastic connective tissue and Van Gieson's stain for collagen were used to selectively stain these compounds. The muscle fibers appeared yellow-green to reddish orange, the elastic tissue blue-black, and the collagen bright pink with this staining technique. The nuclei were not differentiated; fat deposits were not stained but could be detected by the shape of the colorless areas within the connective tissue.

## RESULTS AND DISCUSSION

The purpose of the investigation, as stated earlier in this paper, was to study the effects on certain physical and organoleptic properties of canned beef of injecting the raw meat with solutions of sodium chloride, of lactic acid, or of sodium chloride and lactic acid. For each experimental cut of beef injected with appropriate solution, there was an uninjected control sample from the corresponding position on the opposite side of the animal. Comparisons are made between the results for the matching pairs of samples.

Detailed tables of data are given in the Appendix as follows: Table 1, Palatability of Canned Beef; Tables 2 and 3, Slicing Quality of Canned Beef; Tables 4 and 5, pH of Beef; Table 6, Weight Changes before Canning; Table 7, Weight of Canned Meat and of Liquid; Tables 8 to 22, inclusive, analyses of variance of canned beef scores for flavor, tenderness, juiciness, texture, and slicing quality. Summary tables and graphs of the results are included under the heading, Results and Discussion.

## Palatability of Canned Beef

The palatability of the canned beef was determined by judges' scores for six characteristics of the meat: aroma, flavor of meat and of liquid, tenderness, juiciness, and texture. The judges were experienced in evaluating meat without the addition of table salt during or after cooking. The three judges were consistent in their ratings of palatability of the meat. This was shown by statistical analysis by individual judges of some of the scores given to samples of the canned beef. The uniformity of scoring was sufficiently high that for the remainder of the statistical part of the study, the results were analyzed on the basis of total scores, rather than by scores of individual judges.

The results for four of the palatability factors (flavor, tenderness, juiciness, and texture) and for the judges' rating of slicing quality were selected for statistical analysis. Other results are considered from the standpoint of trends shown, but not on the basis of statistical significance. For purposes of treating the results statistically, Animals VI, VII, and VIII, the meat of which was processed for 65 minutes, were grouped together; Animals IX and X, although of different carcass grade but with the same processing time of 90 minutes, were placed in a second group.

Aroma

The averages of the aroma scores for the canned beef from Animals VI, VII, and VIII were nearly identical for control and injected samples for the three kinds of injection. These average values for aroma, as shown in Table 3, lie within the narrow range of 7.7 to 8.1. For the meat of Animal IX, which was processed for 90 minutes, the average scores for aroma were slightly lower than for the meat for the three animals processed 65 minutes. These data were not analyzed statistically and the differences may be too small to be significant. The meat of Animal X was judged to be less desirable in aroma than that of the other four animals. The average values for control and injected samples for the three kinds of treatment, as shown in Table 3, were within the range of 6.1 to 6.6. Animal X was the aged dairy cow (carcass grade Cutter) and the meat, even before canning, was noted to have a stronger odor than that of the other animals. The injected samples for Animal X had slightly higher average scores for aroma than the control for each of the three treatments, but the differences are probably too small to be significant.

Thus, on the basis of judges' scores, it is evident that injection of the meat had little or no effect on the aroma of the canned meat. The samples processed 90 minutes had

Table 3. Averages of Palatability Scores.

| Animal* no. | No. of muscles | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tenderness | Juiciness | Texture |
| | | | Meat | Liquid | | | |
| | | SODIUM CHLORIDE INJECTION | | | | | |
| Control samples | | | | | | | |
| VI | 6 | 7.9 | 7.3 | 6.4 | 7.1 | 5.7 | 5.7 |
| VII | 6 | 8.0 | 7.5 | 6.6 | 7.4 | 6.4 | 6.3 |
| VIII | 6 | 7.7 | 7.6 | 6.1 | 7.2 | 5.9 | 5.8 |
| Av. (3 animals) | | 7.9 | 7.5 | 6.4 | 7.2 | 6.0 | 5.9 |
| IX | 6 | 7.5 | 7.2 | 5.7 | 7.8 | 4.5 | 5.7 |
| X | 6 | 6.2 | 4.9 | 4.2 | 7.3 | 4.4 | 4.7 |
| Av. (2 animals) | | 6.8 | 6.0 | 5.0 | 7.6 | 4.4 | 5.2 |
| Av. (5 animals) | | 7.5 | 6.9 | 5.8 | 7.4 | 5.4 | 5.6 |
| Injected samples | | | | | | | |
| VI | 6 | 7.8 | 8.0 | 7.2 | 8.1 | 6.7 | 7.1 |
| VII | 6 | 7.8 | 8.2 | 7.5 | 8.6 | 6.6 | 7.2 |
| VIII | 6 | 7.9 | 8.1 | 7.2 | 8.0 | 6.6 | 6.9 |
| Av. (3 animals) | | 7.8 | 8.1 | 7.3 | 8.2 | 6.6 | 7.1 |
| IX | 6 | 7.4 | 7.9 | 7.1 | 8.7 | 4.8 | 6.8 |
| X | 6 | 6.6 | 5.7 | 5.2 | 8.7 | 5.4 | 6.1 |
| Av. (2 animals) | | 7.0 | 6.8 | 6.2 | 8.7 | 5.1 | 6.4 |
| Av. (5 animals) | | 7.5 | 7.6 | 6.8 | 8.4 | 6.0 | 6.8 |

(continued)

*Animals VI, VII, and VIII were steers, carcass grade Commercial, processed 65 minutes; Animal IX was a steer, carcass grade Commercial, processed 90 minutes; Animal X was a cow, carcass grade Cutter, processed 90 minutes.

Table 3 (continued)

| Animal no. | No. of muscles | Aroma | Flavor: Meat | Flavor: Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | | Palatability scores | | | | |
| **SODIUM CHLORIDE AND LACTIC ACID INJECTION** | | | | | | | |
| Control samples | | | | | | | |
| VI | 6 | 7.9 | 7.5 | 6.5 | 7.7 | 6.3 | 6.2 |
| VII | 6 | 8.0 | 7.6 | 6.8 | 7.6 | 6.3 | 6.3 |
| VIII | 6 | 7.7 | 7.6 | 6.2 | 7.0 | 6.2 | 6.0 |
| Av. (3 animals) | | 7.9 | 7.6 | 6.5 | 7.4 | 6.3 | 6.2 |
| IX | 6 | 7.4 | 7.2 | 5.6 | 7.6 | 4.5 | 5.7 |
| X | 6 | 6.2 | 5.2 | 4.0 | 7.4 | 4.4 | 4.8 |
| Av. (2 animals) | | 6.8 | 6.2 | 4.8 | 7.5 | 4.4 | 5.2 |
| Av. (5 animals) | | 7.4 | 7.0 | 5.8 | 7.5 | 5.5 | 5.8 |
| Injected samples | | | | | | | |
| VI | 6 | 8.0 | 8.0 | 7.4 | 8.4 | 6.9 | 7.6 |
| VII | 6 | 7.9 | 8.2 | 7.8 | 8.6 | 6.8 | 7.1 |
| VIII | 6 | 8.0 | 8.2 | 7.5 | 8.3 | 6.7 | 7.4 |
| Av. (3 animals) | | 8.0 | 8.1 | 7.6 | 8.4 | 6.8 | 7.4 |
| IX | 6 | 7.5 | 8.0 | 7.2 | 8.9 | 5.1 | 7.0 |
| X | 6 | 6.4 | 5.8 | 5.3 | 8.9 | 4.9 | 6.2 |
| Av. (2 animals) | | 7.0 | 6.9 | 6.2 | 8.9 | 5.0 | 6.6 |
| Av. (5 animals) | | 7.6 | 7.6 | 7.0 | 8.6 | 6.1 | 7.1 |

(continued)

Table 3 (continued)

| Animal no. | No. of muscles | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| | | | LACTIC ACID INJECTION | | | | |
| Control samples | | | | | | | |
| VI | 6 | 8.1 | 7.4 | 6.4 | 7.6 | 6.3 | 6.6 |
| VII | 6 | 7.8 | 7.6 | 6.9 | 7.6 | 6.2 | 6.0 |
| VIII | 6 | 7.7 | 7.5 | 6.1 | 6.7 | 5.6 | 5.6 |
| Av. (3 animals) | | 7.9 | 7.5 | 6.5 | 7.3 | 6.0 | 6.1 |
| IX | 6 | 7.5 | 7.3 | 5.5 | 7.8 | 4.8 | 5.9 |
| X | 6 | 6.1 | 5.0 | 3.9 | 7.2 | 4.2 | 4.5 |
| Av. (2 animals) | | 6.8 | 6.2 | 4.7 | 7.5 | 4.5 | 5.2 |
| Av. (5 animals) | | 7.4 | 7.0 | 5.8 | 7.4 | 5.4 | 5.7 |
| Injected samples | | | | | | | |
| VI | 6 | 8.0 | 7.7 | 6.6 | 7.7 | 6.5 | 6.8 |
| VII | 6 | 7.9 | 7.4 | 6.7 | 7.4 | 6.1 | 6.2 |
| VIII | 6 | 7.8 | 7.6 | 6.1 | 6.5 | 5.7 | 5.4 |
| Av. (3 animals) | | 7.9 | 7.6 | 6.5 | 7.2 | 6.1 | 6.1 |
| IX | 6 | 7.4 | 7.2 | 5.6 | 7.6 | 4.5 | 5.7 |
| X | 6 | 6.4 | 5.2 | 4.5 | 7.7 | 4.8 | 5.2 |
| Av. (2 animals) | | 6.9 | 6.2 | 5.0 | 7.6 | 4.6 | 5.4 |
| Av. (5 animals) | | 7.5 | 7.0 | 5.9 | 7.4 | 5.5 | 5.9 |

slightly lower average scores for aroma of the canned beef than those processed 65 minutes. The scores for meat from the aged dairy cow were markedly lower than for the other animals, and only a slight improvement in aroma was noted as a result of injection with any of the three solutions.

## Flavor

An improvement in the flavor of the meat injected with either sodium chloride solution or with sodium chloride and lactic acid solution, in comparison with the control samples, is shown by the data in Table 3 and Figures 6 and 7. An analysis of variance of the results shows that the differences were highly significant.

The flavor differences between muscles were not significant for either group of animals, nor between animals of the first group. Within the second group, composed of Animals IX and X, the flavor differences between the meat of the two animals were highly significant. The meat of Animal X, the aged dairy cow, was strong in flavor. The average scores for this factor, as shown in Table 3, are 5.7 and 4.9, respectively, for sodium chloride-injected and the control samples, whereas, for Animal IX the values are 7.9 and 7.2, respectively. Similarly, for samples treated with combined sodium chloride and lactic acid, Animal X had values of 5.8 and 5.2, respectively, for injected and control samples, compared to

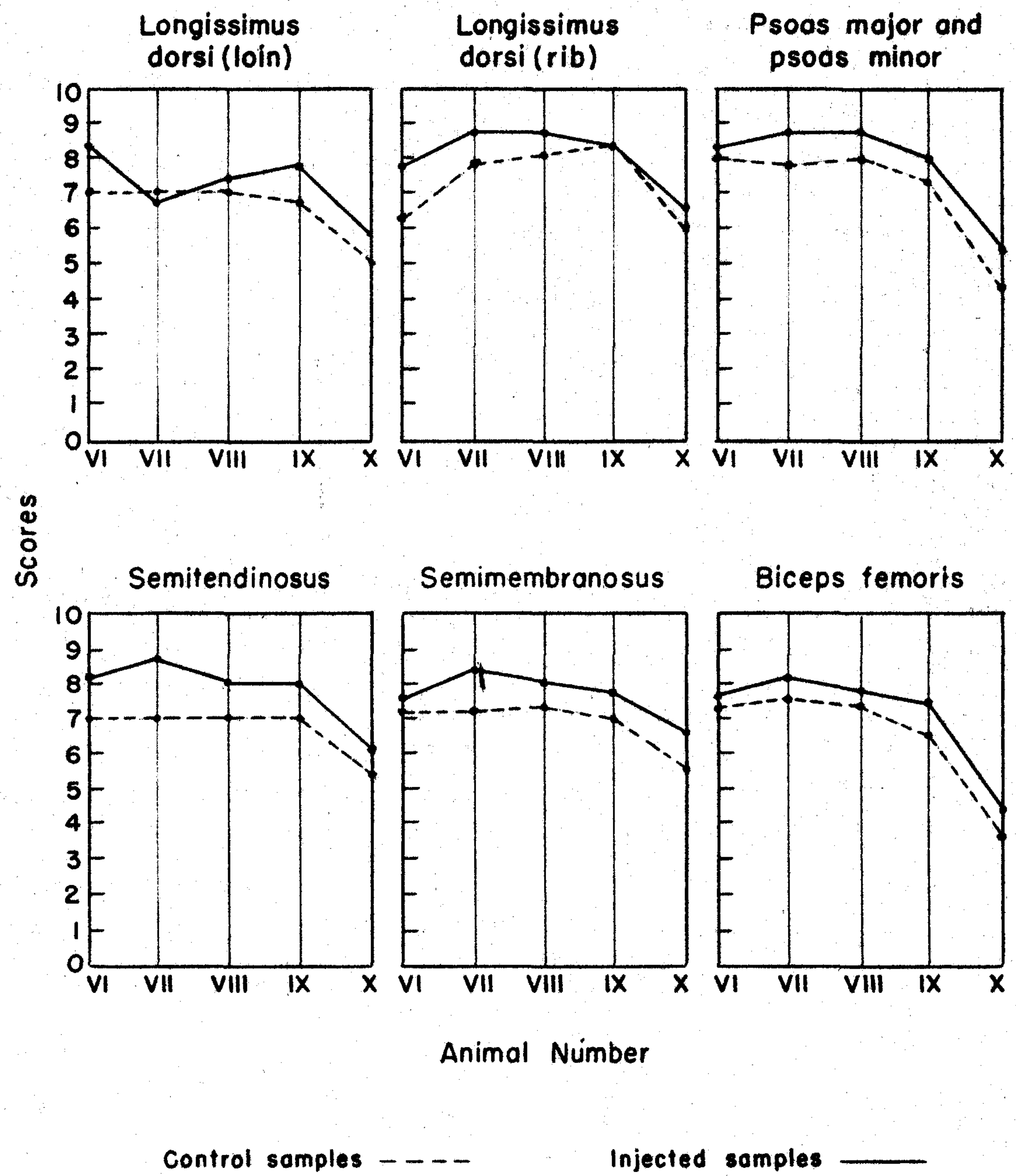


Figure 6. Scores for Flavor of Canned Beef.
Sodium chloride injection.

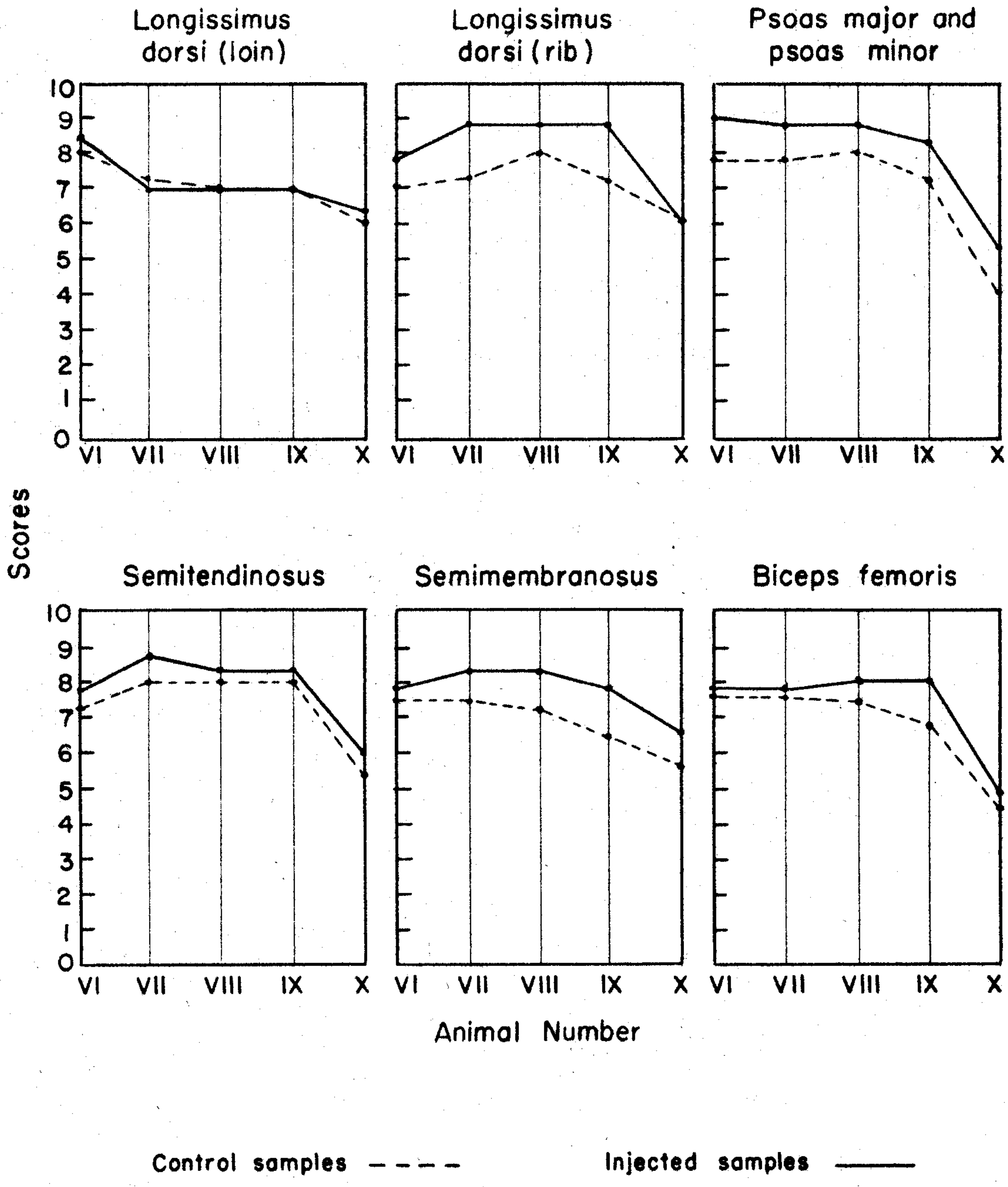


Figure 7. Scores for Flavor of Canned Beef.
Sodium chloride and lactic acid injection.

8.0 and 7.2 for Animal IX.

Lactic acid injection made no significant difference in the flavor of control and injected samples of beef for either group one or group two (Figure 8). The flavor differences between Animal IX and Animal X were highly significant, as was true in the results for the other two kinds of injection.

Thus, injection of the raw meat with either sodium chloride or with sodium chloride-lactic acid solution was shown to have a favorable effect on the flavor of the canned meat, the differences between injected and control samples being highly significant. Injection with lactic acid, on the other hand, made no significant difference in the judges' rating of the flavor of the canned meat.

## Flavor of the liquid

The results for the flavor of the liquid show the same general pattern as those for the flavor of the meat, but the level of scores is markedly lower for the liquid than for the meat, as shown by the average values in Table 3. Comments of the judges as to flavor of the liquid included such descriptive terms as "metallic" and "bitter." For the older animal, the liquid was said to have a "very strong flavor." For the samples treated with either solution containing sodium chloride, the judges repeatedly commented that the juice was

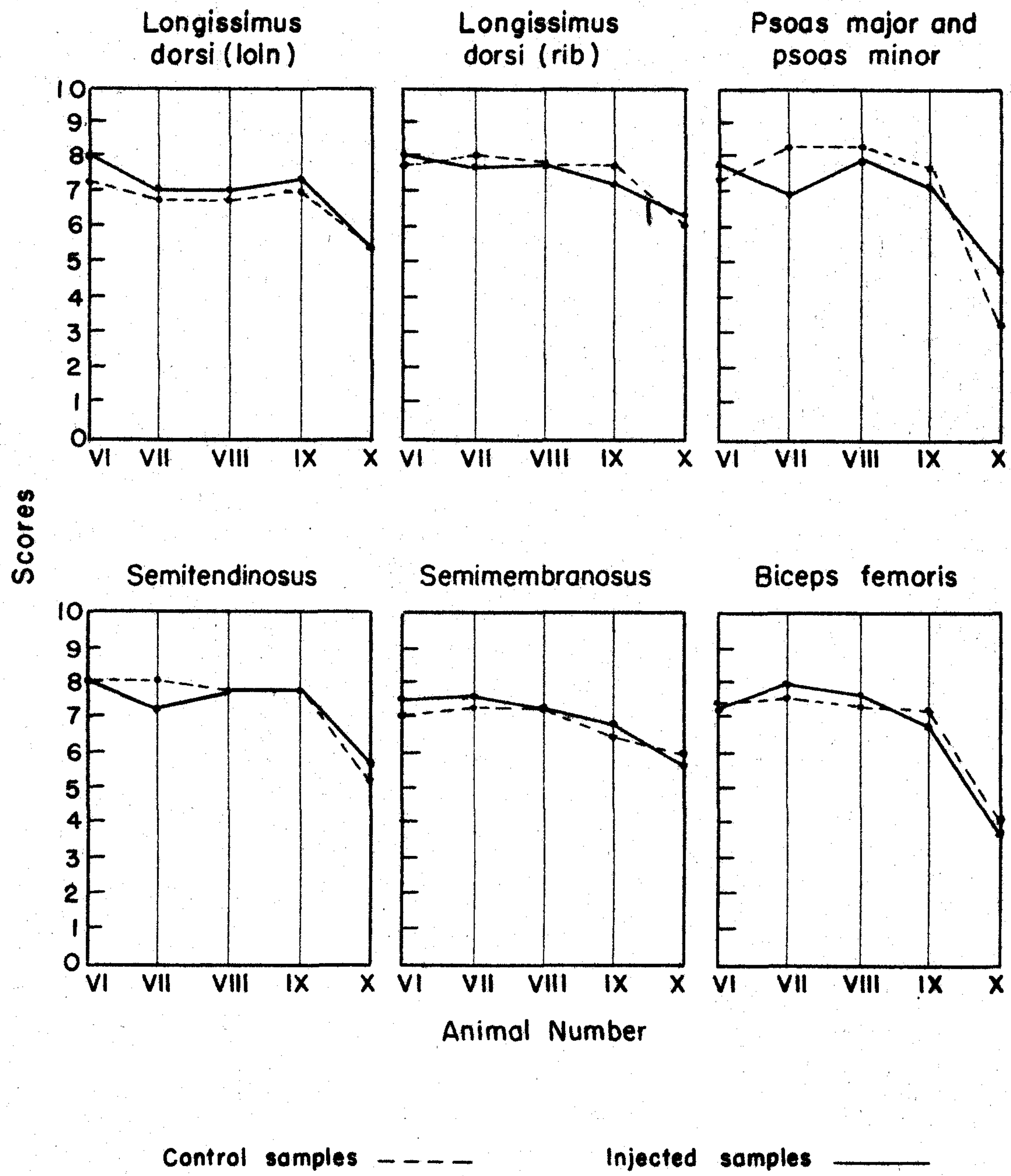


Figure 8. Scores for Flavor of Canned Beef.
Lactic acid injection.

"salty" or "a little too salty," whereas the meat was not similarly designated. Even though the flavor of the liquid was often indicated as salty, the average scores for flavor of the liquid (Table 3 and Figures 9 and 10) were higher for injected than for control samples for either of the solutions containing salt. The lactic acid treatment had no consistent effect on the flavor of the liquid, as shown in Table 3 and Figure 11.

Tenderness

The tenderizing effect of both sodium chloride and sodium chloride-lactic acid treatment is shown by judges' scores for tenderness of the canned beef (Table 3). The analysis of variance indicates that the differences between injected and control samples were highly significant. Lactic acid injection had no significant tenderizing effect on the meat.

For samples from Animals VI, VII, and VIII with sodium chloride injection, there was no significant difference in tenderness among animals, but there was a difference, significant at the .05 level, among the muscles. The psoas muscles received high scores for tenderness; the longissimus dorsi, loin portion, was rated lower, in general, than the other muscles of these three animals. The average tenderness scores for control samples of Animals IX and X (Table 3 and Figure 12) were lower for the aged dairy cow than for the

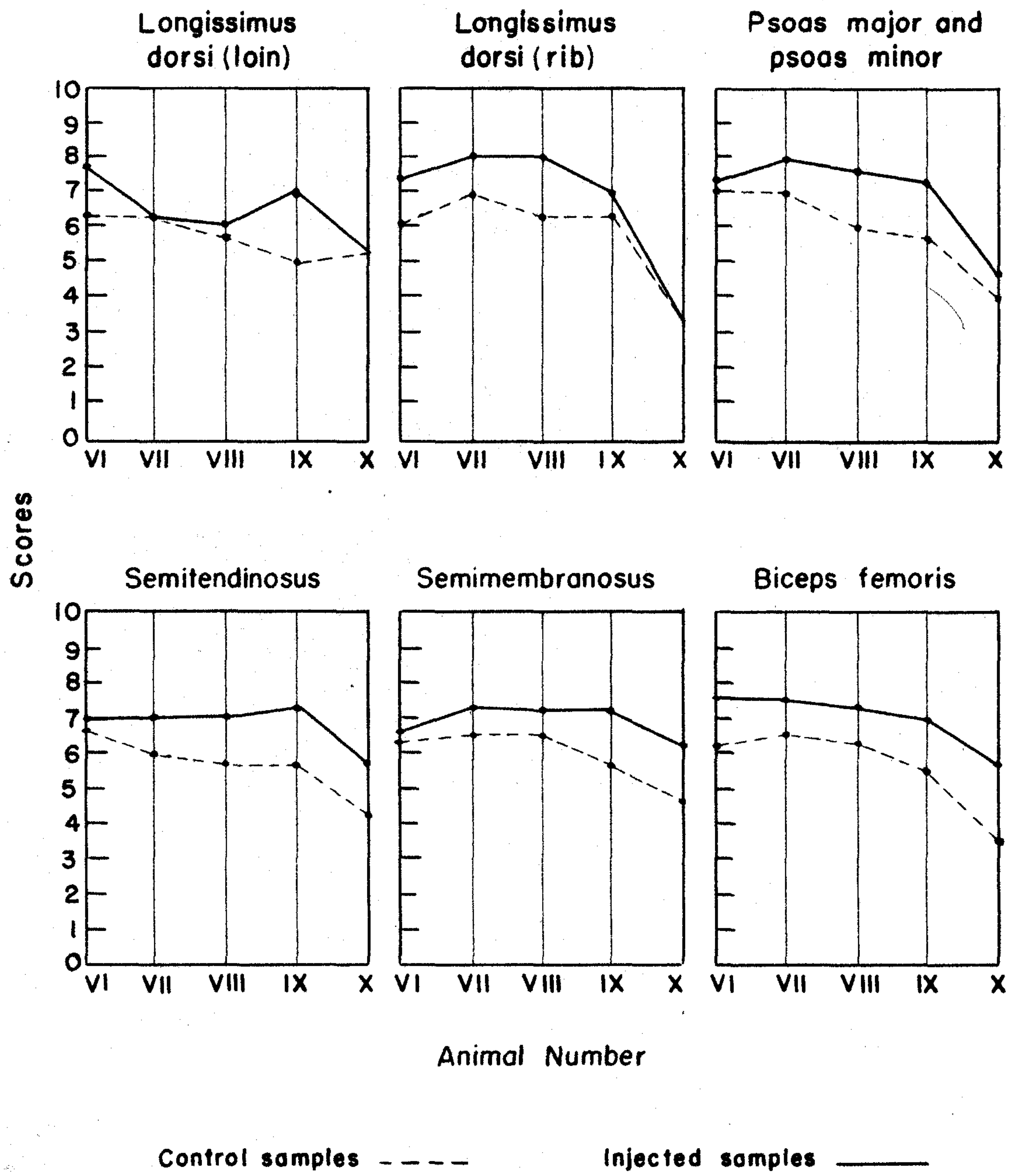


Figure 9. Scores for Flavor of Liquid from Canned Beef. Sodium chloride injection.

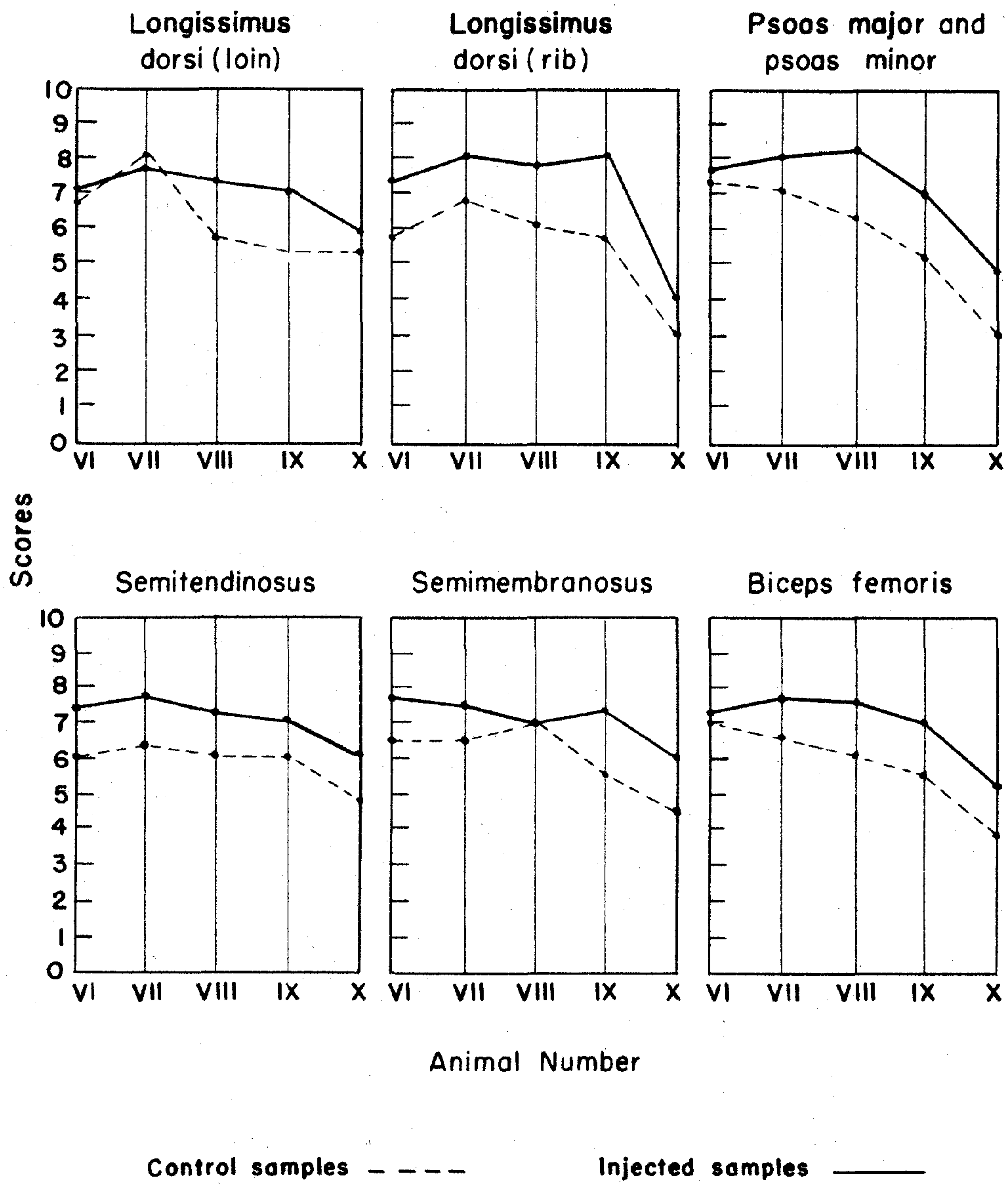


Figure 10. Scores for Flavor of Liquid from Canned Beef. Sodium chloride and lactic acid injection.

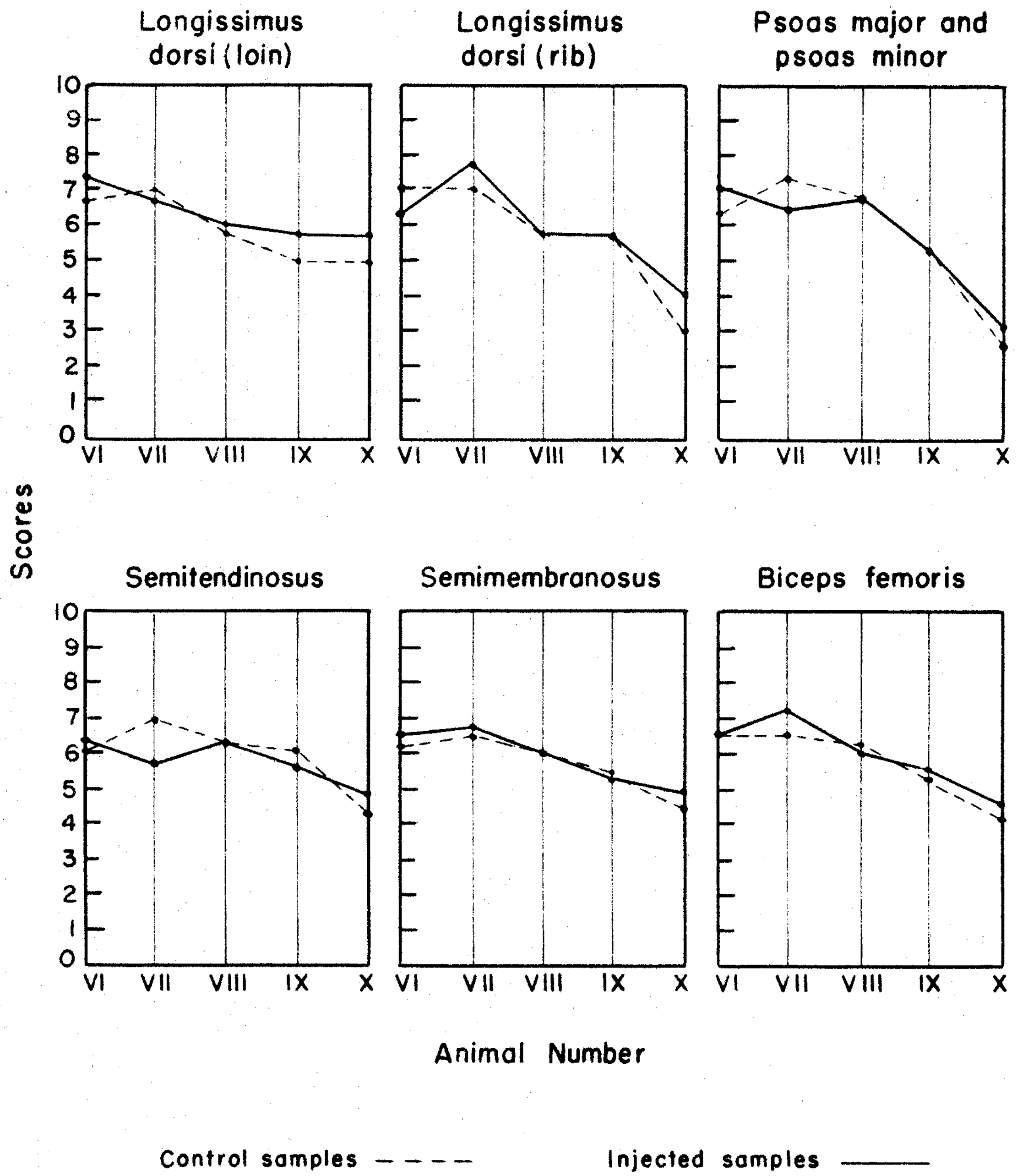


Figure 11. Scores for Flavor of Liquid from Canned Beef. Lactic acid injection.

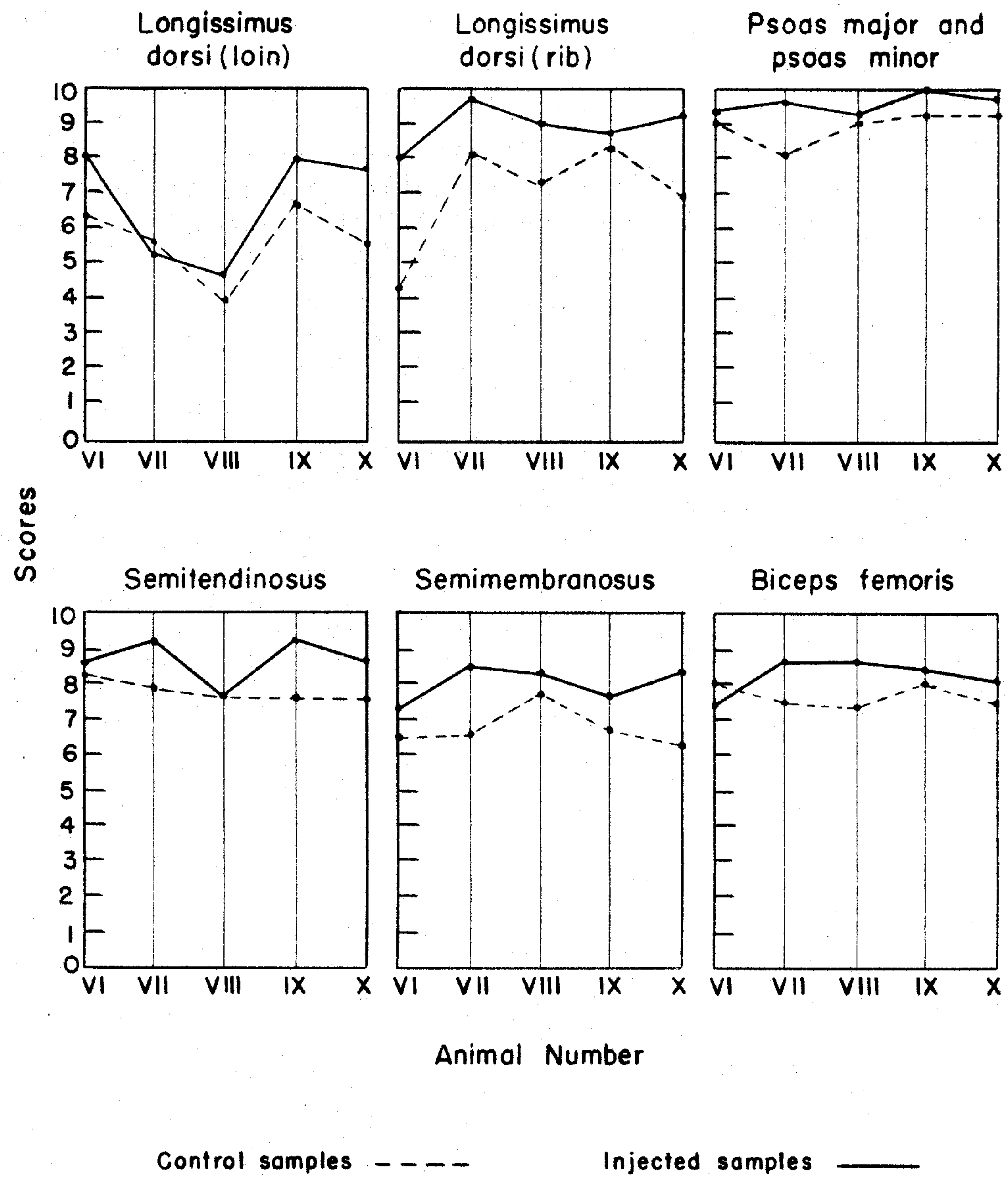


**Figure 12. Scores for Tenderness of Canned Beef. Sodium chloride injection.**

beef steer. The meat from both animals was made more tender by injection with sodium chloride solution and the differences owing to treatment were highly significant. The tenderizing effect was more marked for the meat from the older animal than for the meat from the younger animal.

Results for sodium chloride and lactic acid in combination were similar to those for sodium chloride alone; i.e., the injected cuts for both groups of animals received higher average tenderness ratings than the control samples (Table 3 and Figure 13. These differences were highly significant. The differences in tenderness of muscles for the first group of animals were significant at the .05 level; for the second group, at the .01 level. The psoas muscles ranked highest, and the loin portion of the longissimus dorsi muscle lowest, in the average tenderness scores among the five animals. The meat of the aged dairy cow would be expected to be less tender than the meat of the steer, but for the samples included in the sodium chloride-lactic acid treatment, no significant differences in tenderness between animals were shown. This may be explained on the basis of the long processing period (90 minutes) for Animals IX and X during which time the connective tissue may have become softened in the meat of both animals. A second factor would be the small number of animals in the group. The differences would have to be large

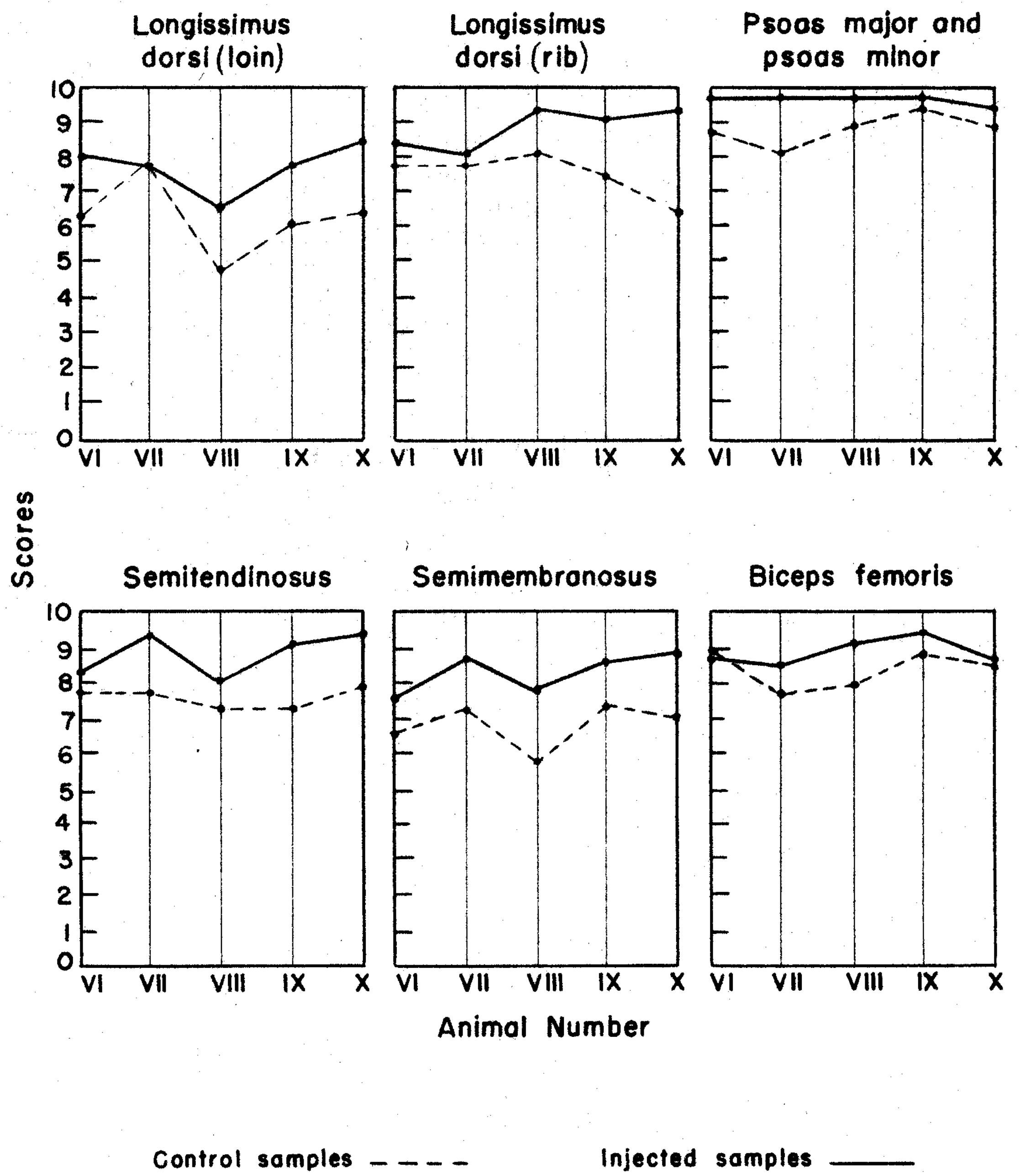


Figure 13. Scores for Tenderness of Canned Beef.
Sodium chloride and lactic acid injection.

to be classed as significant with only two animals in the group.

Although the lactic acid injection of beef did not have a significant effect on the tenderness of the meat (Figure 14), the data showed there were differences in tenderness among muscles that were significant at the .01 level for Animals VI, VII, and VIII, but only at the .05 level for Animals IX and X. Differences among animals were highly significant for the first group of animals, but not significant for the second group. The same factors, i.e., the long processing period and the small number of degrees of freedom in the statistical analysis of the results, may explain the fact that the differences in tenderness between Animals IX and X were too small to be significant.

In general, it may be said that the tenderness of meat, as revealed by judges' scores, indicated differences among muscles and to some extent among animals. Injection of the raw meat with sodium chloride solution or with combined sodium chloride and lactic acid solution resulted in improved tenderness of the canned beef.

Juiciness

Judges' scores for juiciness of the canned beef showed no significant differences due to animal variation for either

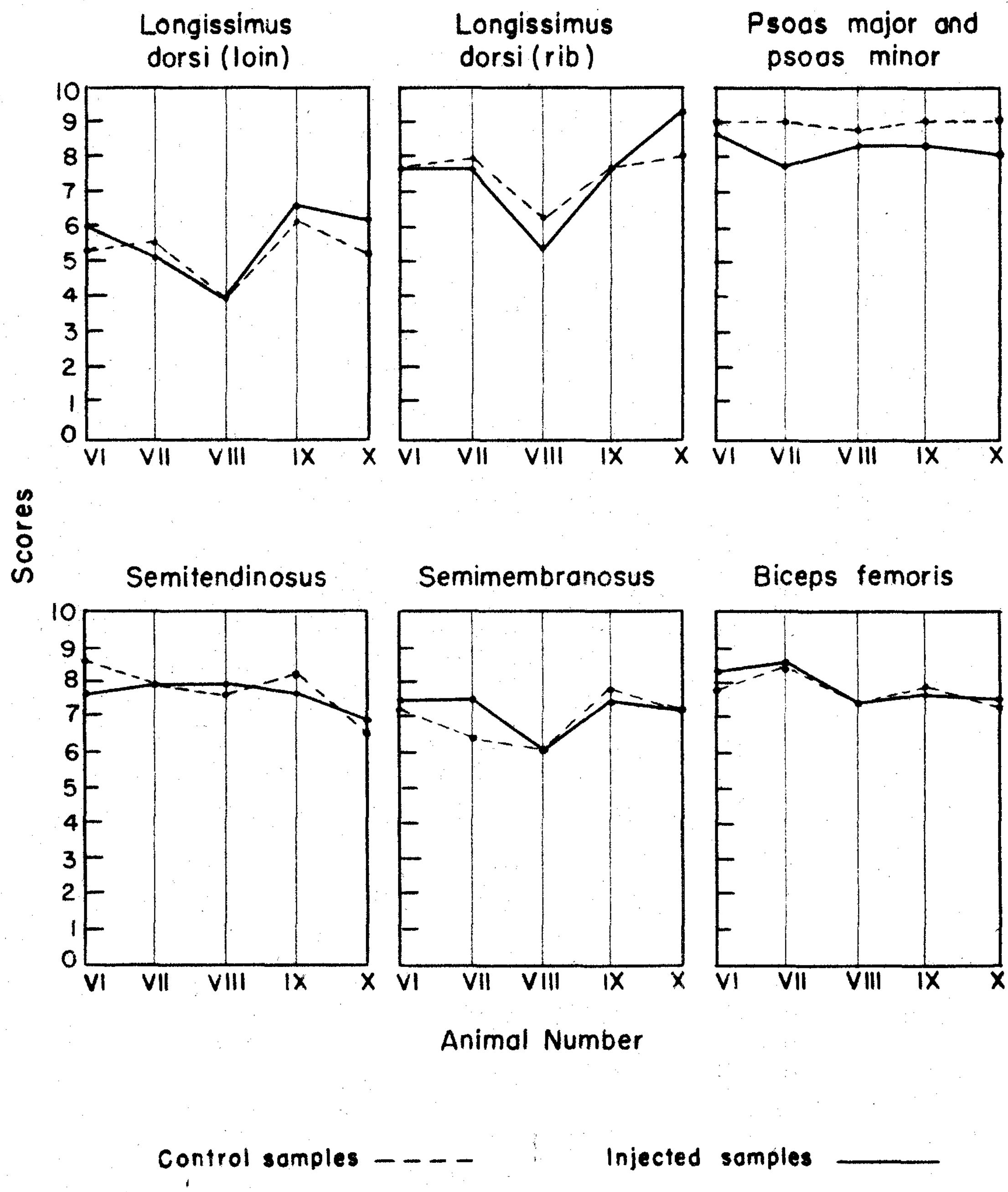


**Figure 14. Scores for Tenderness of Canned Beef. Lactic acid injection.**

group. The muscle variation for Animals VI, VII, and VIII was not significant for samples included in the tests with sodium chloride but was highly significant for the samples used with the other two kinds of treatment. Muscle differences were not significant for Animals IX and X.

In general, the judges' rating of juiciness of the canned beef tended to be medium or fairly low. Average scores ranging from 6.9 to 5.6 for animals processed 65 minutes and from 5.4 to 4.2 for animals processed 90 minutes are shown in Table 3. These results are shown graphically in Figures 15, 16, and 17.

Injection of the raw meat with sodium chloride solution improved the juiciness of the samples processed for 65 minutes, but had no significant effect on those processed 90 minutes.

The improvement in juiciness brought about by injection of the meat with the combination of sodium chloride and lactic acid solution was significant at the .05 level for both groups of animals. In the meat processed 65 minutes, there was inconsistency of results for the different muscles. The injected samples of biceps femoris and loin portion of longissimus dorsi were similar to or less juicy than the control samples in contrast to improved or similar juiciness for injected samples of other muscles (Figure 16).

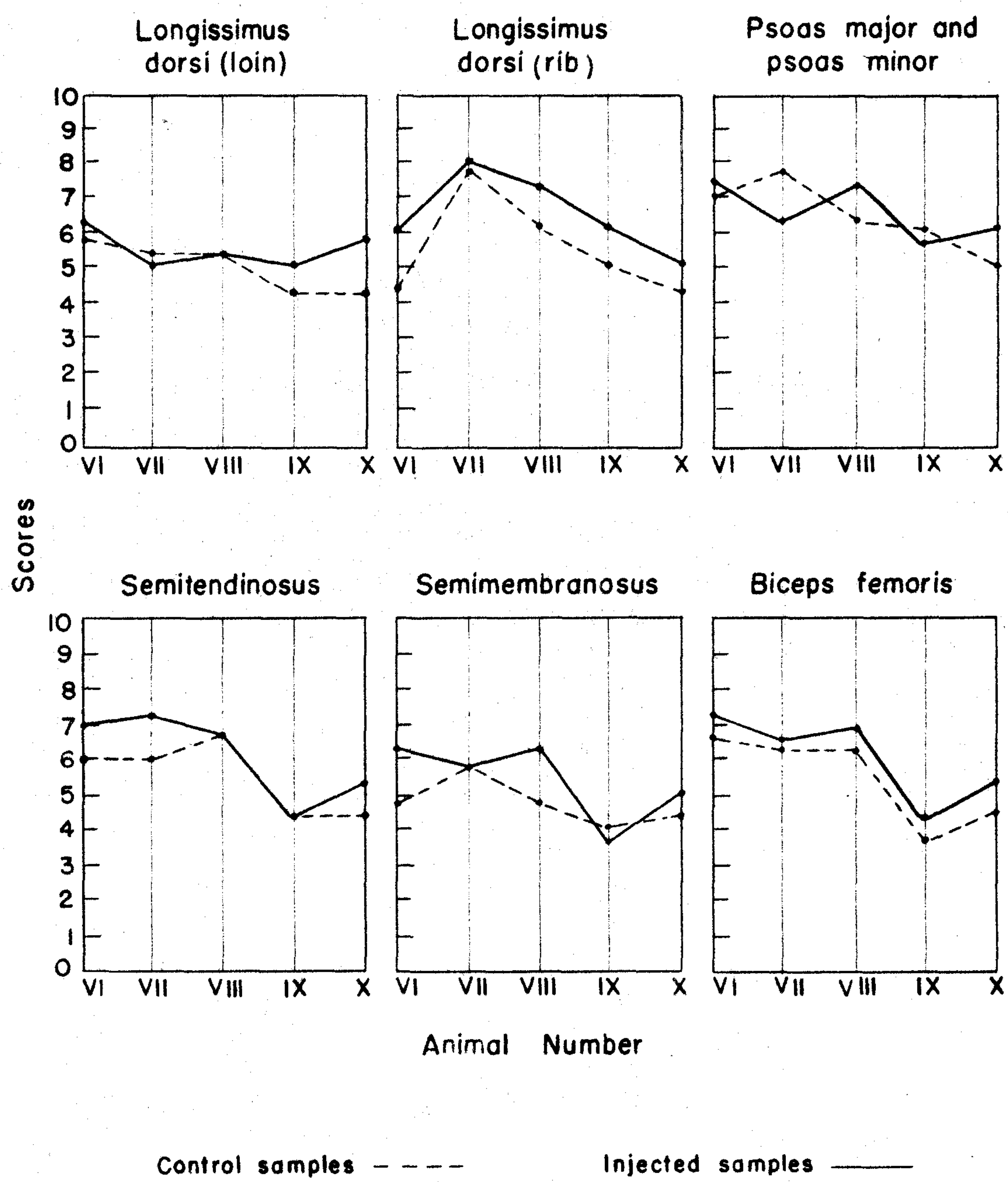


Figure 15. Scores for Juiciness of Canned Beef. Sodium chloride injection.

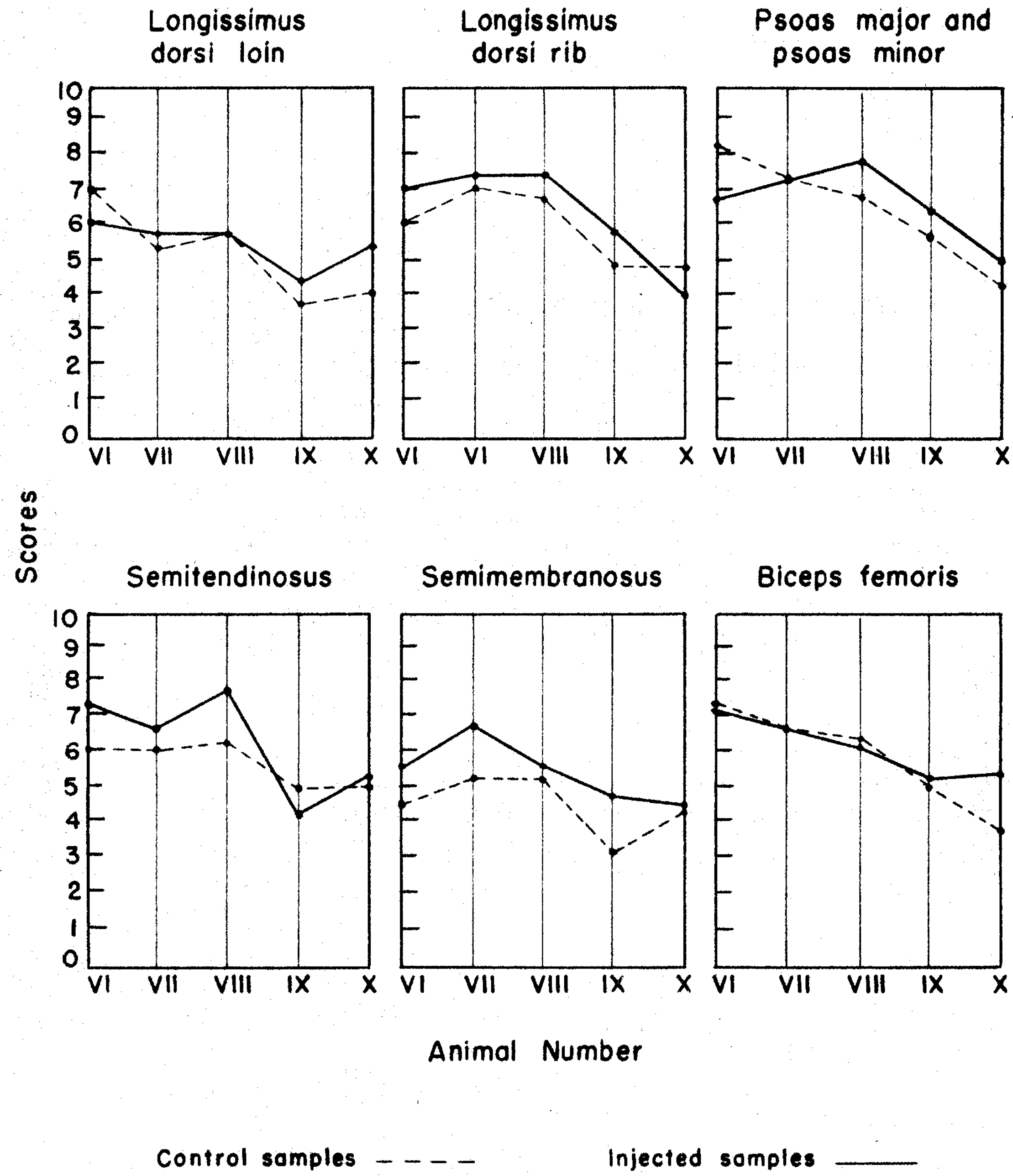


Figure 16. Scores for Juiciness of Canned Beef.
Sodium chloride and lactic acid injection.

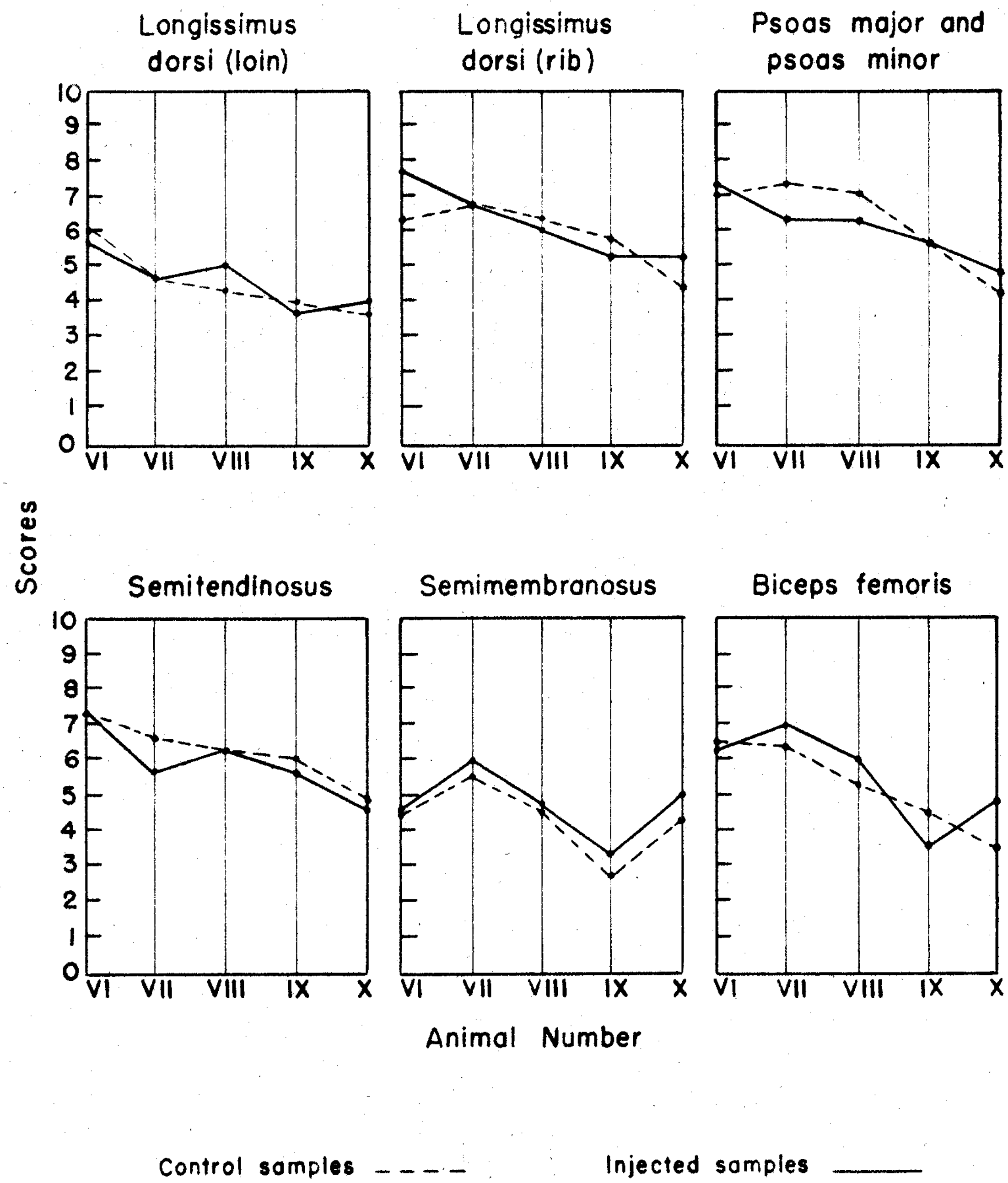


Figure 17. Scores for Juiciness of Canned Beef. Lactic acid injection.

The muscle differences of the samples of meat included in the experiments with lactic acid injection were not significant for the animals of group two, but for group one there was a highly significant difference among muscles. Meat from the loin portion of the longissimus dorsi and from the semimembranosus ranked lower in juiciness than the other muscles (Figure 17).

Improvement in juiciness of canned meat by injection with sodium chloride solution or with a combination of sodium chloride and lactic acid solution was less marked than the improvement in tenderness. Lactic acid injection had little effect on either tenderness or juiciness of the canned meat.

Texture

Texture scores showed considerable variation. The differences among muscles were shown to be significant at the .05 level for the meat from Animals IX and X and also for the samples included in the sodium chloride treatment from Animals VI, VII, and VIII. The texture differences among muscles were highly significant for the samples included in the other two injection treatments of the latter group. In general the psoas muscles were considered by the judges to have the most desirable texture; the longissimus dorsi loin and the semimembranosus, the least desirable texture of the muscles studied (Figures 18, 19, and 20). A highly

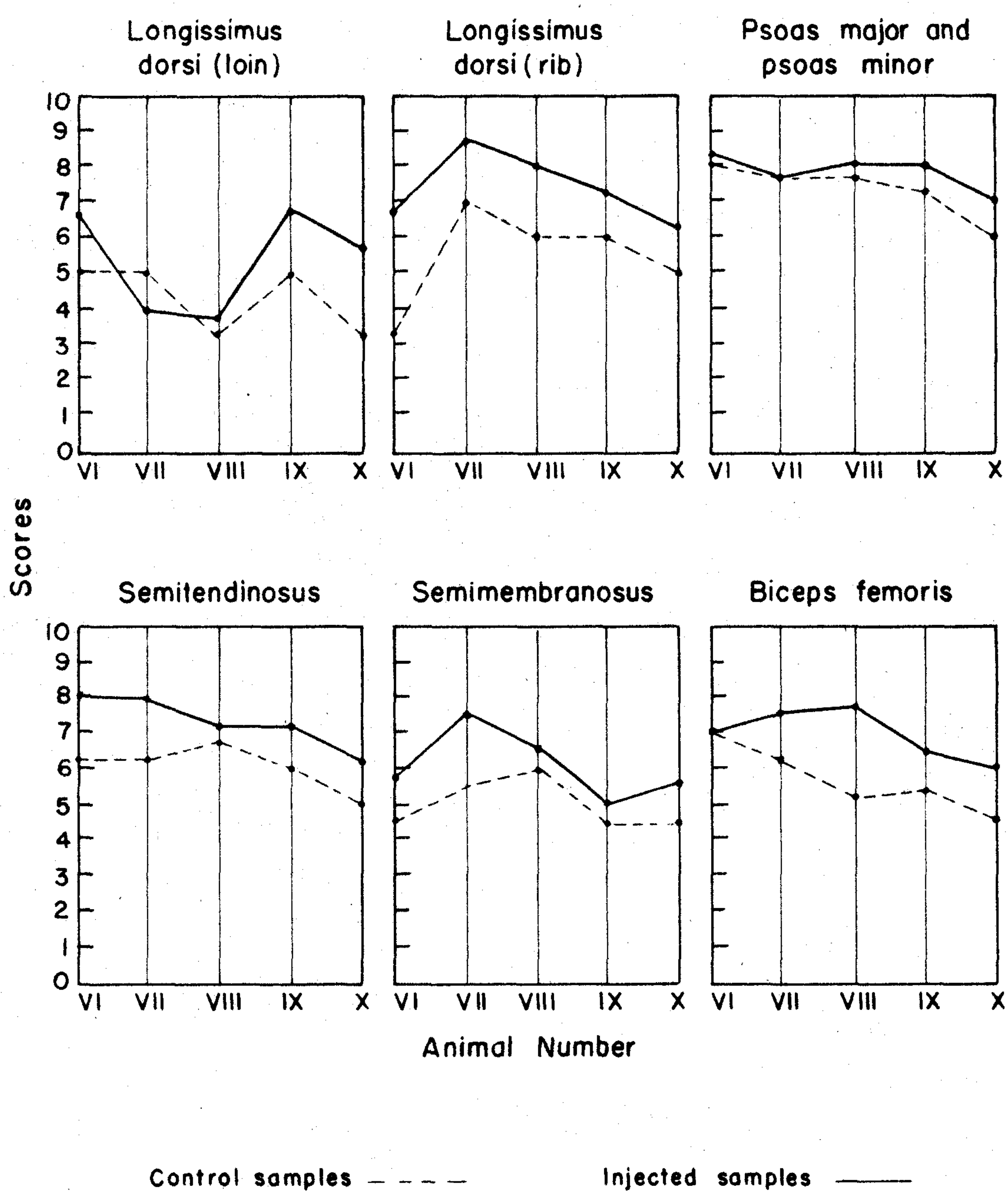


**Figure 18. Scores for Texture of Canned Beef. Sodium chloride injection.**

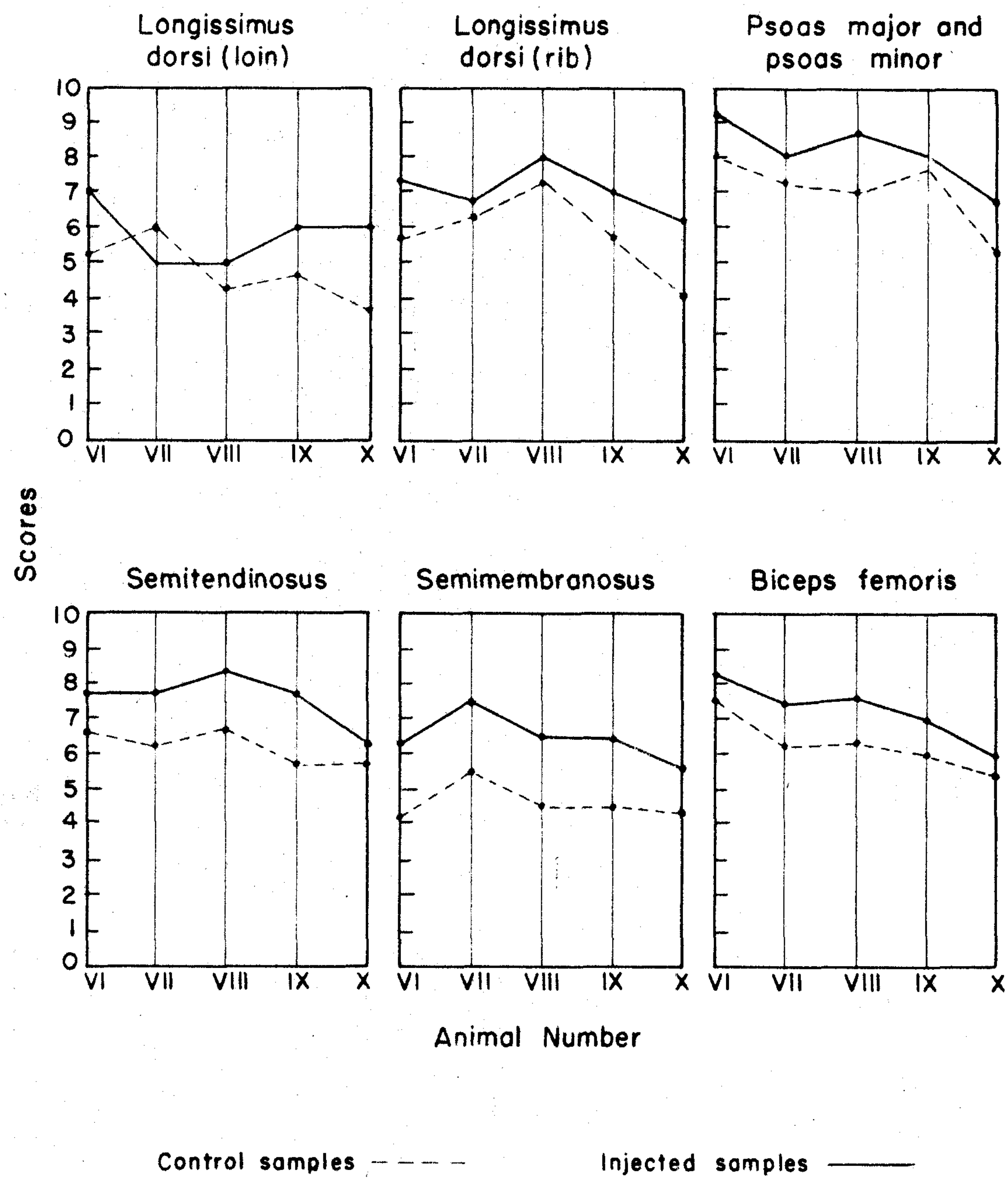


Figure 19. Scores for Texture of Canned Beef.
Sodium chloride and lactic acid injection.

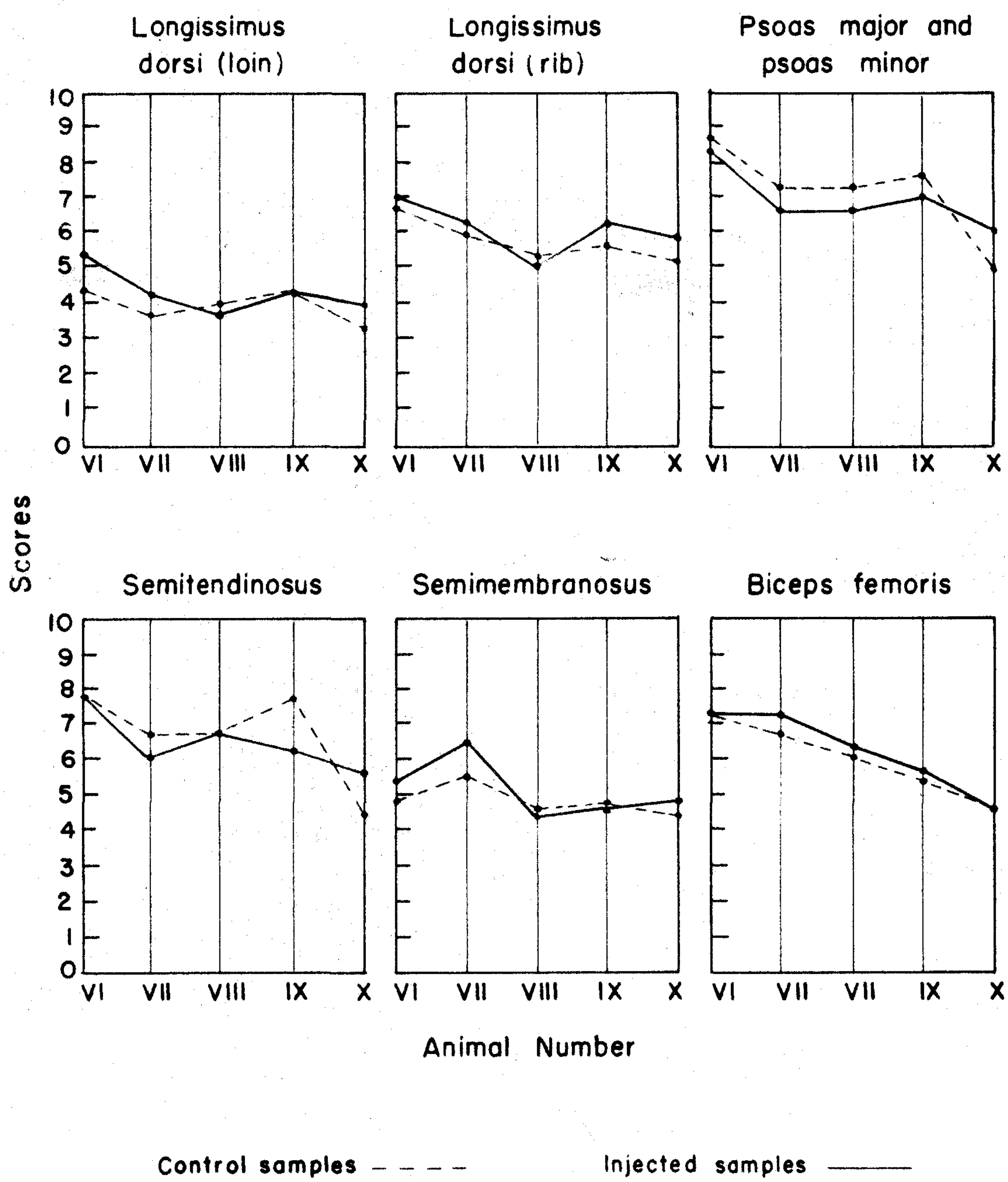


**Figure 20. Scores for Texture of Canned Beef. Lactic acid injection.**

significant improvement in the texture of the meat was shown by injection with sodium chloride solution or with sodium chloride and lactic acid solution. Average scores (Table 3) for texture of the meat from the five animals were 6.8 and 5.6, respectively, for injected and control samples with sodium chloride treatment; for the combined sodium chloride and lactic acid treatment, 7.1 and 5.8, respectively.

Lactic acid treatment had no significant effect on the texture scores of the canned beef. The average texture scores for the five animals were, respectively, 5.9 and 5.7 for the injected and uninjected meat (Table 3).

Thus, a marked improvement in texture was found in the canned meat as a result of injection of the raw beef with either sodium chloride solution or with the solution in which sodium chloride was combined with lactic acid. No significant change in texture was brought about by injection of the meat with lactic acid solution alone.

The uniformity of penetration of any of the solutions injected into the beef cuts was not determined. An effort was made to insert the needles so the distances between openings would be approximately equal. The pressure pump was operated as evenly as possible, but there was no automatic control to insure the uniform delivery of a specific amount of solution within a given area of the meat. Unequal distribution of the solution within the meat may account for some of the variations observed in the results.

## Histological Appearance of Beef Fibers

The rib portion of the longissimus dorsi muscle was used for histological study. Longitudinal microscopic sections were made of the fresh muscle aged 1 day, of the beef cuts aged 8 days, and of the canned beef. The effects of the three kinds of injection on the microscopic structure of the muscle fibers and the connective tissue were noted. Photomicrographs were taken of certain representative sections. Most of the pictures were of samples from Animal X. Sections were used which show the appearance of the meat from that muscle at the different aging periods, with different kinds of injection, and after canning. A few pictures of sections from other animals were included for comparison.

Sections for microscopic examination were small and represent only a limited area of the muscle. And, as has been previously mentioned, the injected solutions may not have been distributed uniformly throughout the muscle. An effort was made to obtain areas typical of the major portion of the section.

The samples of beef which had received certain of the treatments were especially difficult to section for mounting on slides. Sodium chloride-treated samples were very troublesome. The uncooked samples were much more difficult to handle in sectioning and in mounting than the cooked ones. Hence, the appearance of the samples from the five animals was taken into consideration for the following descriptions. Disintegration appeared more slowly in the fibers of Animal VIII than in the muscle fibers of the other animals. This is reflected in the low tenderness scores of the canned beef from Animal VIII, particularly for control samples.

Harrison (18) has described the appearance of longitudinal sections of beef from various muscles after aging from one to 30 days. Each muscle had certain characteristics and the muscle fibers changed with aging. Very wavy, kinked fibers were characteristic of fresh muscle tissue, although waves did not always form in the fresh samples. Another characteristic of lack of aging was the longitudinal striations. The longitudinal striations predominated in the wavy fibers and often in the straight fibers of freshly cut beef. Harrison observed no longitudinal striae in the psoas muscle at any aging period. She did observe very heavy longitudinal striations in the longissimus dorsi muscle fibers. Sometimes both longitudinal and cross striae were distinct in some areas of a fiber, giving a checked appearance.

As the muscle aged the contractions were not so great and the fibers were less wavy. The longitudinal striae gradually became less distinct in most areas of the fibers, the cross ones more distinct, although the longitudinal ones sometimes remained in the waved fibers. With further aging Harrison (18) and Paul (23) both observed disintegration or disappearance of the striations. This first occurred in narrow areas or cracks at wide intervals. With longer aging these disintegrated areas increased in size and numbers. The appearance of disintegration of the striae and its increase with aging were correlated with the increasing tenderness in a majority of the muscles.

The rate at which disintegration appeared varied in different muscles and was more rapid in the same muscle in some animals than in others.

Fresh muscle

The appearance of the muscle fibers of the rib portion of the longissimus dorsi muscle after 1 day of aging is shown in Figure 21. The wavy fibers and the contracture nodes are characteristic of fresh muscle. Longitudinal striae are visible in parts of the fibers, but the magnification for the photomicrograph was not great enough to show them clearly.

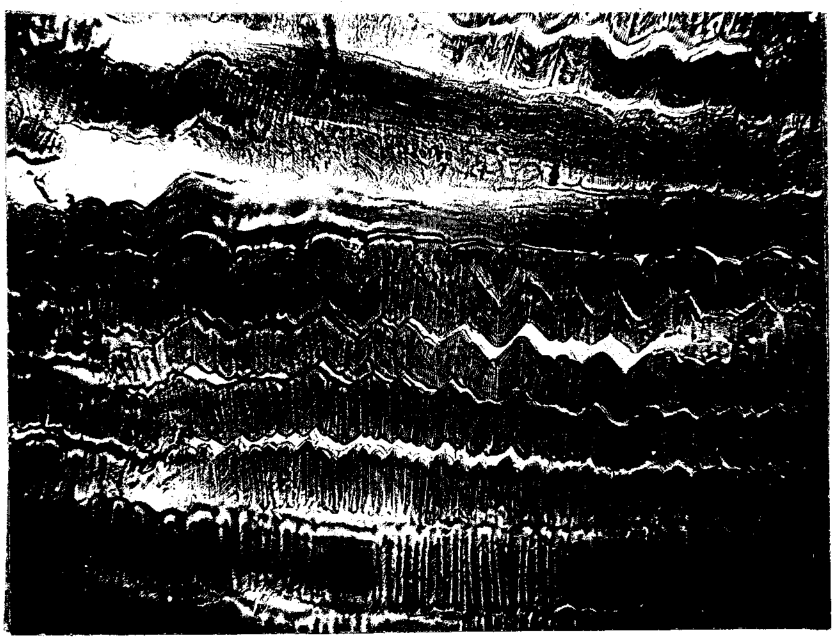

Figure 21. Fresh, Longissimus Dorsi, Rib Portion, Middle Position. Aged One Day. Animal X. (Magnification 150x)

This section is typical of fresh muscle. The fibers are wavy and contracture nodes are present.

Sodium chloride injection

Since the control samples aged 8 days had not been injected, they represent raw beef cuts which had aged a longer time than the samples from the fresh muscle. The upper picture in Figure 22 is a photomicrograph of a control sample from the sodium chloride-treated series of cuts. This section has the typical appearance of uncooked meat in which some resolution of rigor has taken place. The fibers are nearly straight, shallow waves are present, and the accordion-pleated effect of the fresh muscle has disappeared. The longitudinal striae are still distinct, particularly in waved portions of the fibers, and the sarcolemma is smooth except where a few cracks in the fibers have occurred.

The typical appearance of the raw beef injected with sodium chloride and aged 8 days is illustrated in the lower picture of Figure 22. The section was cut partially transverse of the fibers. In addition the connective tissue did not hold the muscle fibers together in the sodium chloride-treated meat. The segments of the fibers, however, show many cracks and broken places and much disintegration. The cross striae predominated over the longitudinal ones. These are characteristics which would be expected to contribute to tenderization in meat. It is interesting that for this particular sample of canned beef (number 261) the judges' score

Figure 22. Sodium Chloride Injection. Longissimus
Dorsi, Rib Portion. Animal X.
Upper: Aged, Control Sample No. 261.
(Magnification 85x)
Lower: Aged, Injected Sample No. 261.
(Magnification 150x)

for tenderness of the control sample was 7.0 and of the injected sample, 9.3 (Table 1, Appendix), indicating that the injected sample was rated more tender than the control.

A cut of meat from another animal (Animal IX) receiving the sodium chloride injection and aged for 8 days is illustrated in the upper picture of Figure 23. The fibers are fairly straight, and the disintegration fissures are not as numerous as in Animal X, but the parallel course of the fibers has been maintained better than in Animal X. It appears that the tenderizing effect of sodium chloride was not as extensive in this cut of meat as in that of Animal X. The tenderness score received by this cut of meat after canning (Table 1, Appendix) is higher than for its control (8.7 for the injected; 8.3 for the control), but not as high as the score of 9.3 for the sodium chloride-injected cut of the same muscle in Animal X.

The histological appearance of uninjected canned beef is shown in Figure 23, lower picture. The section is from the sodium chloride-treated series of Animal X, but was a control sample. The fibers have a dense, compact appearance and follow a fairly straight course. The whole section has a rather foggy appearance. An examination under high power shows the edges of the fibers to be uneven. There is much granular material, probably disintegration products of

Figure 23. Sodium Chloride Injection. Longissimus Dorsi, Rib Portion.
Upper: Aged, Injected Sample No. 239. Animal IX. (Magnification 150x)
Lower: Canned, Control Sample No. 261. Animal X. (Magnification 115x)

collagen since this granular material was found only in the canned beef sections, near the edges of the fibers and between adjacent ones, or within extensive areas of whole fibers.

Microscopic sections of the canned beef injected with sodium chloride solution have the same dense, compact appearance as the canned control samples. The fibers are generally straight and parallel, but have numerous disintegrated areas. Granular material is located within disintegrated areas of the fibers as well as along the edges of fibers and between adjacent ones. Little connective tissue is visible between the fibers.

Harrison (18) noted the opaque appearance of the sections from cooked beef roasts, and Paul (23) reported a decrease in the diameter of the muscle fibers with cooking, as observed from microscopic sections of raw and cooked roasts.

<u>Sodium chloride and lactic acid injection</u>

A control sample is shown in Figure 24, upper picture. The beef had been aged 8 days and was a cut from the same muscle of Animal X as the control sample of the sodium chloride series.

The fibers in the section are typical of those found in

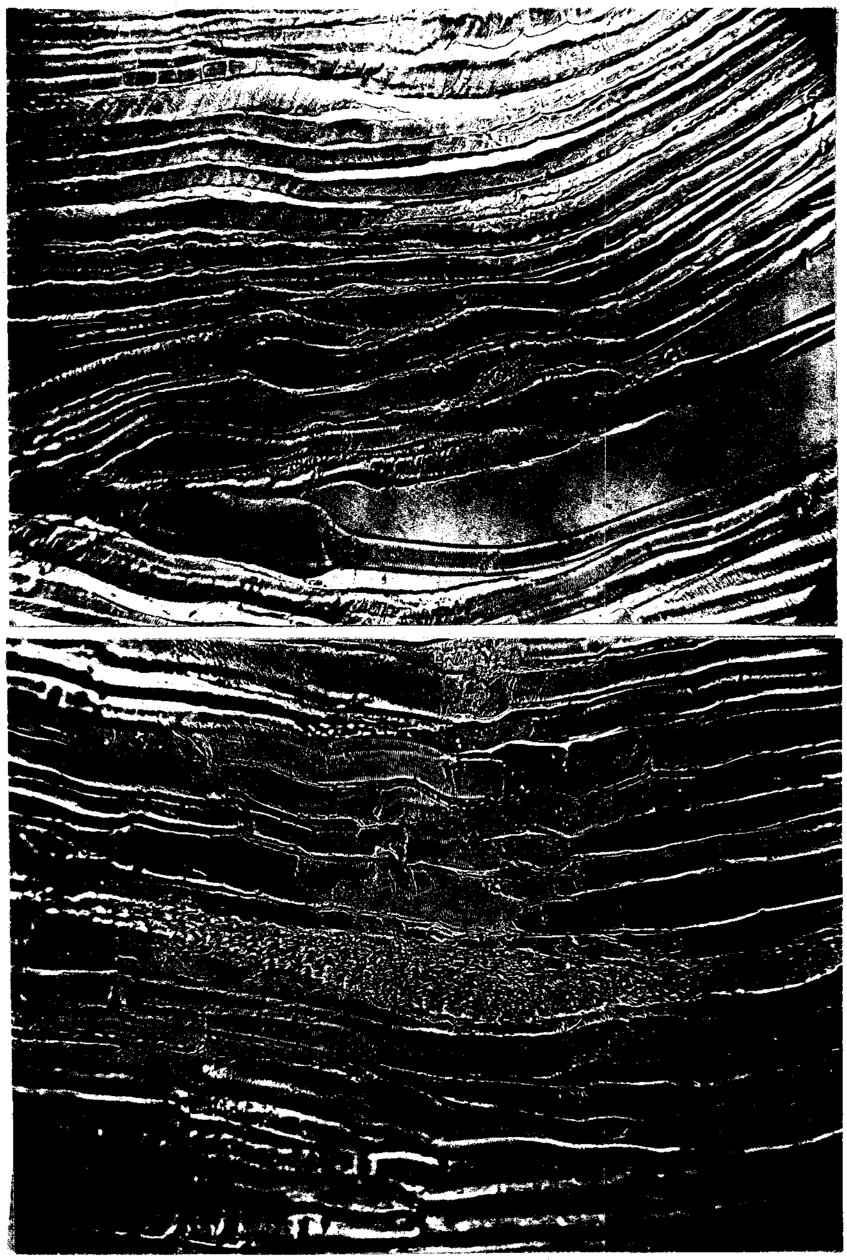

Figure 24. Sodium Chloride and Lactic Acid Injection.
Longissimus Dorsi, Rib Portion. Animal X.
Upper: Aged, Control Sample No. 263.
(Magnification 150x)
Lower: Aged, Injected Sample No. 263.
(Magnification 150x)

other cuts aged 8 days. There are some waved fibers, but not so many as in the fresh sections. Shallow waves with fairly distinct longitudinal striations, some nodes, and a few disintegration cracks in the fibers can be seen. The cross striae predominate in the straight fibers.

A section of the matching injected sample aged 8 days is shown in Figure 24, lower picture. The disintegration of the fibers is more pronounced than in the control sample.

The histological sections of the control and injected samples of canned meat from the rib portion of the longissimus dorsi muscle are pictured in Figure 25. The disintegration cracks are more numerous and the areas more extensive in the injected than in the control sample. This is in keeping with the higher tenderness scores given by the judges to the sodium chloride-lactic acid-injected meat than to control samples.

Examples of canned beef injected with combined sodium chloride and lactic acid from two other animals are shown in Figure 26. The upper picture represents meat from the longissimus dorsi, rib portion, of Animal VII, which was processed 65 minutes; the lower picture, meat of Animal IX, which was processed 90 minutes. Both sections show straight fibers that are dense and compact and that have considerable disintegration. Granular material is present within and between the fibers. The meat processed the longer time has a

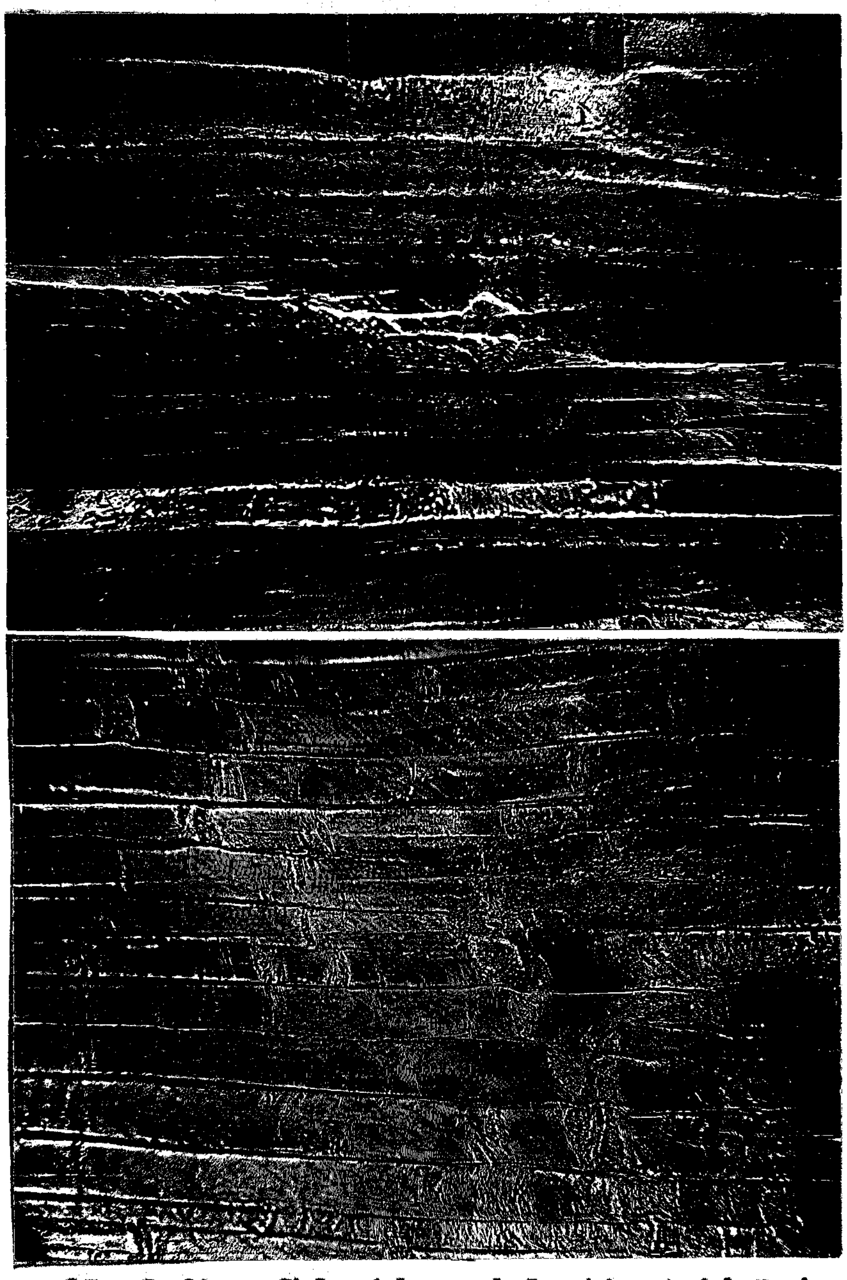

Figure 25. Sodium Chloride and Lactic Acid Injection. Longissimus Dorsi, Rib Portion. Animal X.
Upper: Canned, Control Sample No. 263. (Magnification 150x)
Lower: Canned, Injected Sample No. 263. (Magnification 150x)

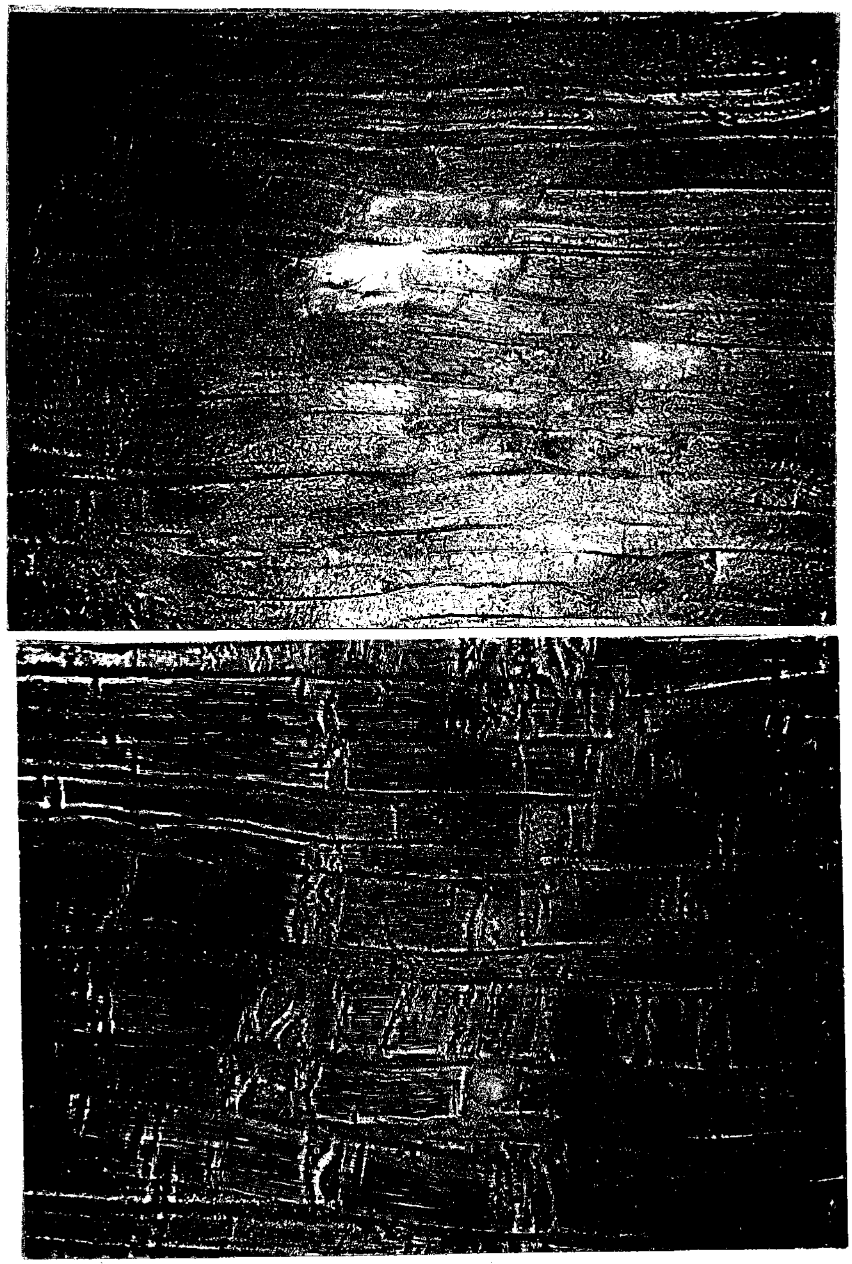

Figure 26. Sodium Chloride and Lactic Acid Injection.
Longissimus Dorsi, Rib Portion.
Upper: Canned, Injected Sample No. 191.
Animal VII. (Magnification 115x)
Lower: Canned, Injected Sample No. 238.
Animal IX. (Magnification 165x)

larger amount of disintegration (probably animal variation) in the fibers and looks more fragile than the meat processed the shorter time.

Lactic acid injection

The aged samples of the series treated with lactic acid were found to have histological features very nearly like those of the control samples. The disintegration is a little more pronounced and the fibers slightly less wavy in the cuts receiving the lactic acid injection than in the controls. (See Figure 27.)

The canned samples of the lactic acid series are illustrated in Figure 28. The areas of disintegration are a little more extensive in the injected than in the uninjected cut of beef but, otherwise, the two cuts are similar in microscopic structure. This agrees with the uniformity of the scores given by the judges to the palatability factors of control and lactic acid-treated samples of canned beef.

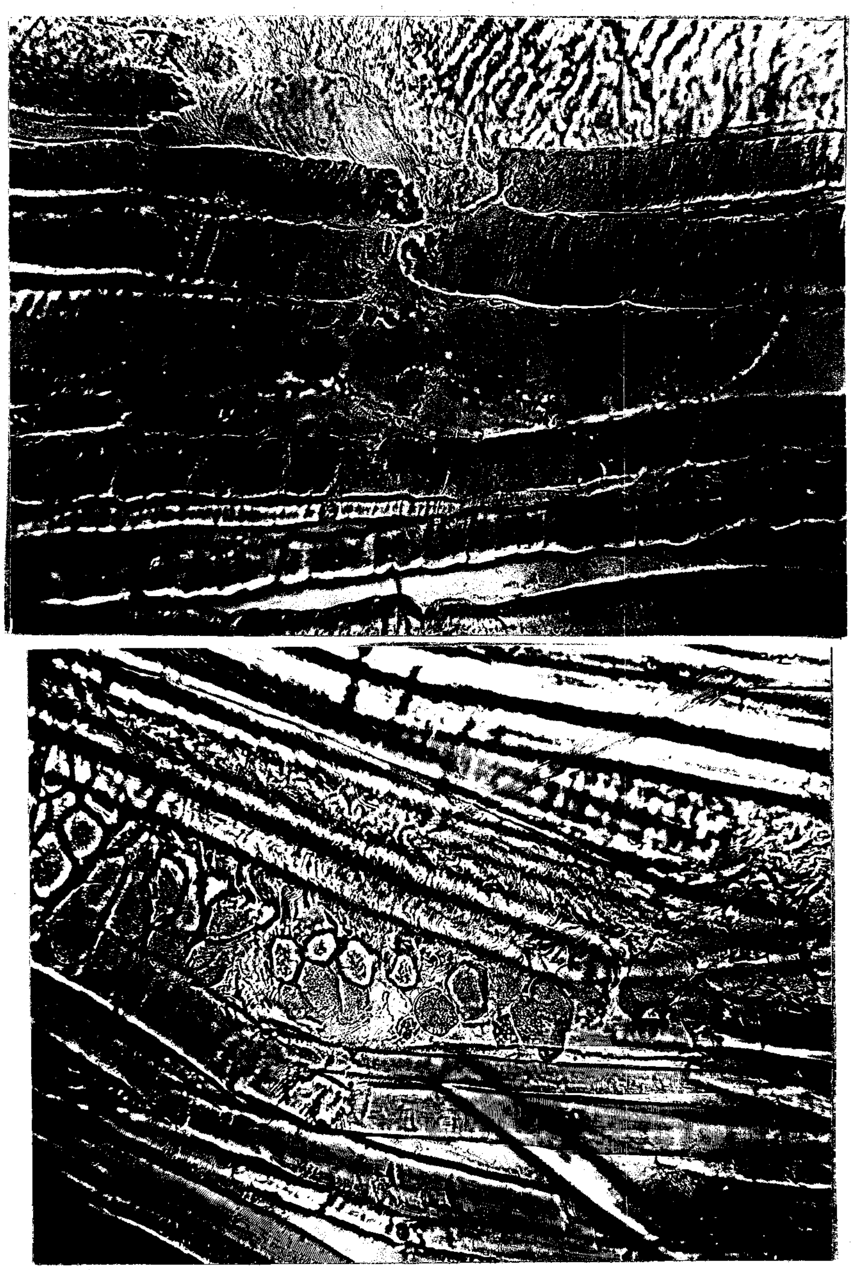

Figure 27. Lactic Acid Injection. Longissimus Dorsi, Rib Portion. Animal X.

Upper: Aged, Control Sample No. 262. (Magnification 150x)

Lower: Aged, Injected Sample No. 262. (Magnification 150x)

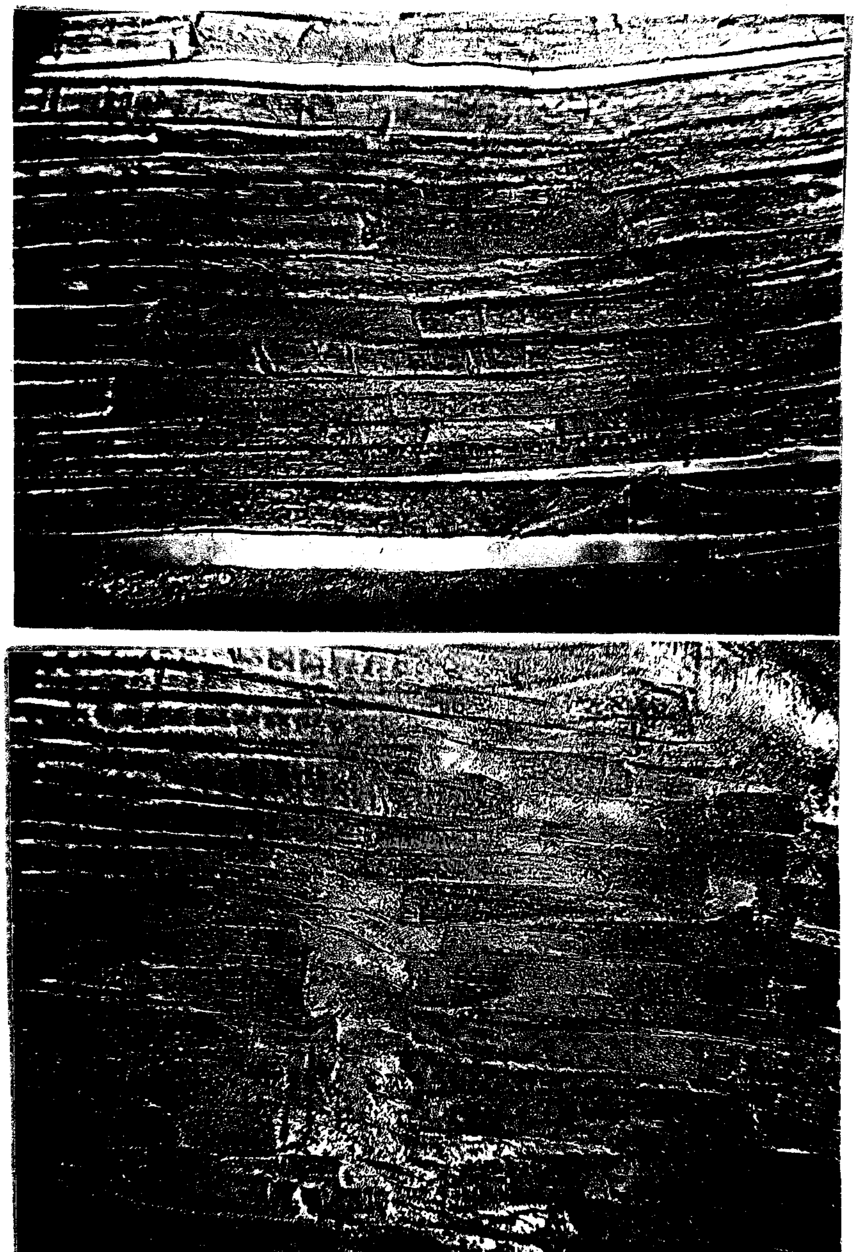

Figure 28. Lactic Acid Injection. Longissimus Dorsi, Rib Portion. Animal X.

Upper: Canned, Control Sample No. 262. (Magnification 150x)

Lower: Canned, Injected Sample No. 262. (Magnification 150x)

## Slicing Quality of Canned Beef

The slicing quality of the canned beef was evaluated in three ways: (1) by count of the number of slices obtained from each can, (2) by weight, and (3) by judges' scores. Slices were classified as firm or crumbly. If practically the whole section held together after cutting on the machine it was called a firm slice. If between three-fourths and the whole slice held together it was classified as crumbly. If less than three-fourths of the slice held together it was grouped with the unsliceable portion. Slices were rated by the scoring panel on the proportion of the slice holding together. The scores were based on a value of 10 for extremely good slicing quality and 1 for poor quality.

The averages of the numbers of slices obtained for firm, crumbly, and total slices are shown in Table 4. Variability in the sliceability of the canned beef occurred among muscles and among animals. Furthermore, cuts from the same muscle sometimes gave variable results.

None of the three types of injection improved the slicing quality appreciably. The average figures (Table 4) for the firm slices from samples of all animals in the sodium chloride series were 39.8 and 39.3 per cent for the control and injected cuts, respectively. The results are presented

Table 4. Averages of Numbers of Slices Obtained.

| Animal no. | No. of muscles | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| | | | | SODIUM CHLORIDE INJECTION | | | |
| Control samples | | | | | | | |
| VI | 6 | 5.0 | 3.9 | 10.5 | 48.1 | 37.1 | 85.2 |
| VII | 6 | 3.9 | 3.4 | 11.2 | 34.0 | 31.4 | 65.4 |
| VIII | 6 | 4.8 | 3.7 | 11.2 | 44.1 | 32.2 | 76.3 |
| Av. (3 animals) | | 4.6 | 3.7 | 11.0 | 42.1 | 33.6 | 75.6 |
| IX | 6 | 3.3 | 3.1 | 11.1 | 32.7 | 26.8 | 59.5 |
| X | 6 | 4.7 | 4.5 | 11.4 | 40.1 | 39.6 | 79.8 |
| Av. (2 animals) | | 4.0 | 3.8 | 11.2 | 36.4 | 33.2 | 69.6 |
| Av. (5 animals) | | 4.3 | 3.7 | 11.1 | 39.8 | 33.4 | 73.2 |
| Injected samples | | | | | | | |
| VI | 6 | 6.0 | 2.8 | 10.4 | 58.2 | 26.0 | 84.2 |
| VII | 6 | 4.0 | 3.3 | 11.3 | 34.4 | 29.4 | 63.9 |
| VIII | 6 | 2.8 | 3.6 | 11.1 | 27.4 | 32.7 | 60.1 |
| Av. (3 animals) | | 4.3 | 3.2 | 10.9 | 40.0 | 29.4 | 69.4 |
| IX | 6 | 2.3 | 1.6 | 10.6 | 24.0 | 14.8 | 38.8 |
| X | 6 | 6.3 | 3.4 | 11.6 | 52.6 | 31.1 | 83.7 |
| Av. (2 animals) | | 4.3 | 2.5 | 11.1 | 38.3 | 23.0 | 61.2 |
| Av. (5 animals) | | 4.3 | 2.9 | 11.0 | 39.3 | 26.8 | 66.1 |

(continued)

Table 4 (continued)

| Animal no. | No. of muscles | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| SODIUM CHLORIDE AND LACTIC ACID INJECTION | | | | | | | |
| Control samples | | | | | | | |
| VI | 6 | 3.7 | 4.7 | 10.6 | 33.2 | 44.9 | 78.1 |
| VII | 6 | 5.1 | 3.4 | 11.3 | 45.2 | 29.7 | 74.9 |
| VIII | 6 | 3.2 | 4.9 | 11.3 | 31.0 | 42.9 | 73.9 |
| Av. (3 animals) | | 4.0 | 4.3 | 11.1 | 36.5 | 39.2 | 75.6 |
| IX | 6 | 2.0 | 2.1 | 10.2 | 20.1 | 20.3 | 40.4 |
| X | 6 | 5.5 | 1.9 | 11.8 | 47.3 | 16.2 | 63.4 |
| Av. (2 animals) | | 3.8 | 2.0 | 11.0 | 33.7 | 18.2 | 51.9 |
| Av. (5 animals) | | 3.9 | 3.4 | 11.0 | 35.4 | 30.8 | 66.1 |
| Injected samples | | | | | | | |
| VI | 6 | 4.3 | 4.3 | 10.6 | 39.8 | 42.2 | 82.0 |
| VII | 6 | 3.4 | 3.8 | 10.8 | 31.7 | 35.2 | 66.8 |
| VIII | 6 | 3.8 | 5.2 | 10.9 | 35.0 | 46.6 | 81.6 |
| Av. (3 animals) | | 3.8 | 4.4 | 10.8 | 35.5 | 41.3 | 76.8 |
| IX | 6 | 1.2 | 2.8 | 10.4 | 13.4 | 26.6 | 40.0 |
| X | 6 | 5.1 | 3.5 | 11.2 | 44.6 | 31.2 | 75.8 |
| Av. (2 animals) | | 3.2 | 3.2 | 10.8 | 29.0 | 28.9 | 57.9 |
| Av. (5 animals) | | 3.6 | 3.9 | 10.8 | 32.9 | 36.4 | 69.2 |

(continued)

Table 4 (continued)

| Animal no. | No. of muscles | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| LACTIC ACID INJECTION | | | | | | | |
| Control samples | | | | | | | |
| VI | 6 | 5.2 | 3.7 | 10.8 | 47.3 | 34.3 | 81.6 |
| VII | 6 | 4.2 | 2.8 | 11.4 | 37.5 | 26.2 | 63.7 |
| VIII | 6 | 3.6 | 2.7 | 11.3 | 33.4 | 23.5 | 56.9 |
| Av. (3 animals) | | 4.3 | 3.1 | 11.2 | 39.4 | 28.0 | 67.4 |
| IX | 6 | 2.2 | 2.4 | 10.8 | 20.9 | 22.2 | 43.1 |
| X | 6 | 5.8 | 1.9 | 11.2 | 51.4 | 17.2 | 68.6 |
| Av. (2 animals) | | 4.0 | 2.2 | 11.0 | 36.2 | 19.7 | 55.8 |
| Av. (5 animals) | | 4.2 | 2.7 | 11.1 | 38.1 | 24.7 | 62.8 |
| Injected samples | | | | | | | |
| VI | 6 | 3.9 | 4.0 | 10.9 | 34.4 | 37.4 | 71.8 |
| VII | 6 | 4.8 | 2.2 | 10.9 | 42.3 | 19.9 | 62.2 |
| VIII | 6 | 6.5 | 1.9 | 11.2 | 58.6 | 16.6 | 75.2 |
| Av. (3 animals) | | 5.1 | 2.7 | 11.0 | 45.1 | 24.6 | 69.7 |
| IX | 6 | 2.2 | 2.2 | 10.6 | 20.8 | 21.5 | 42.2 |
| X | 6 | 6.2 | 2.9 | 11.0 | 56.6 | 26.0 | 82.6 |
| Av. (2 animals) | | 4.2 | 2.6 | 10.8 | 38.7 | 23.8 | 62.4 |
| Av. (5 animals) | | 4.7 | 2.6 | 10.9 | 42.5 | 24.3 | 66.8 |

graphically for each animal in Figure 29.

Sodium chloride and lactic acid together were no more effective than sodium chloride alone in improving the slicing quality of the beef. The figures for the average percentages of firm slices from the five animals were 35.4 and 32.9, respectively for control and injected samples in the sodium chloride-lactic acid series. The results for individual animals are shown in graphs, Figure 30.

The results with lactic acid injection were only slightly more favorable than for the other two kinds of injection. The averages for the firm slices from the five animals were 42.5 per cent for the injected meat and 38.1 per cent for the uninjected samples. However, the variability of results for the different animals (Figure 31) was so large that no real improvement in slicing quality was secured.

The averages of the judges' scores for slicing quality of the canned beef are given in Table 5. The differences in scores between the control and injected samples were not large enough to be significant with the sodium chloride series. The differences between muscles as to slicing quality were highly significant. The semitendinosus was rated the highest of the muscles in sliceability; the semimembranosus, the lowest. Within the group composed of Animals VI, VII, and VIII, the differences among animals were not significant,

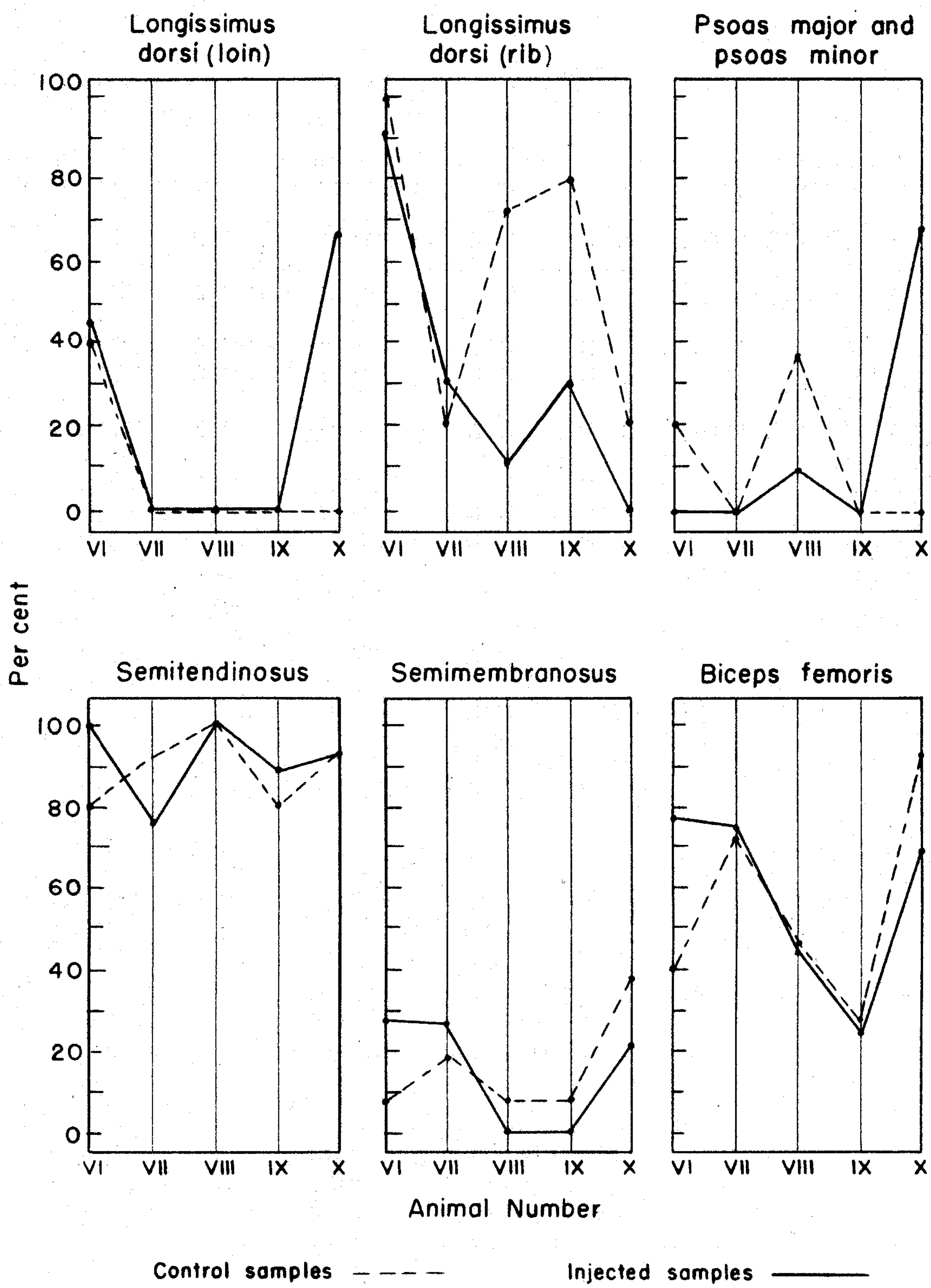


**Figure 29. Number of Firm Slices. Sodium chloride injection.**

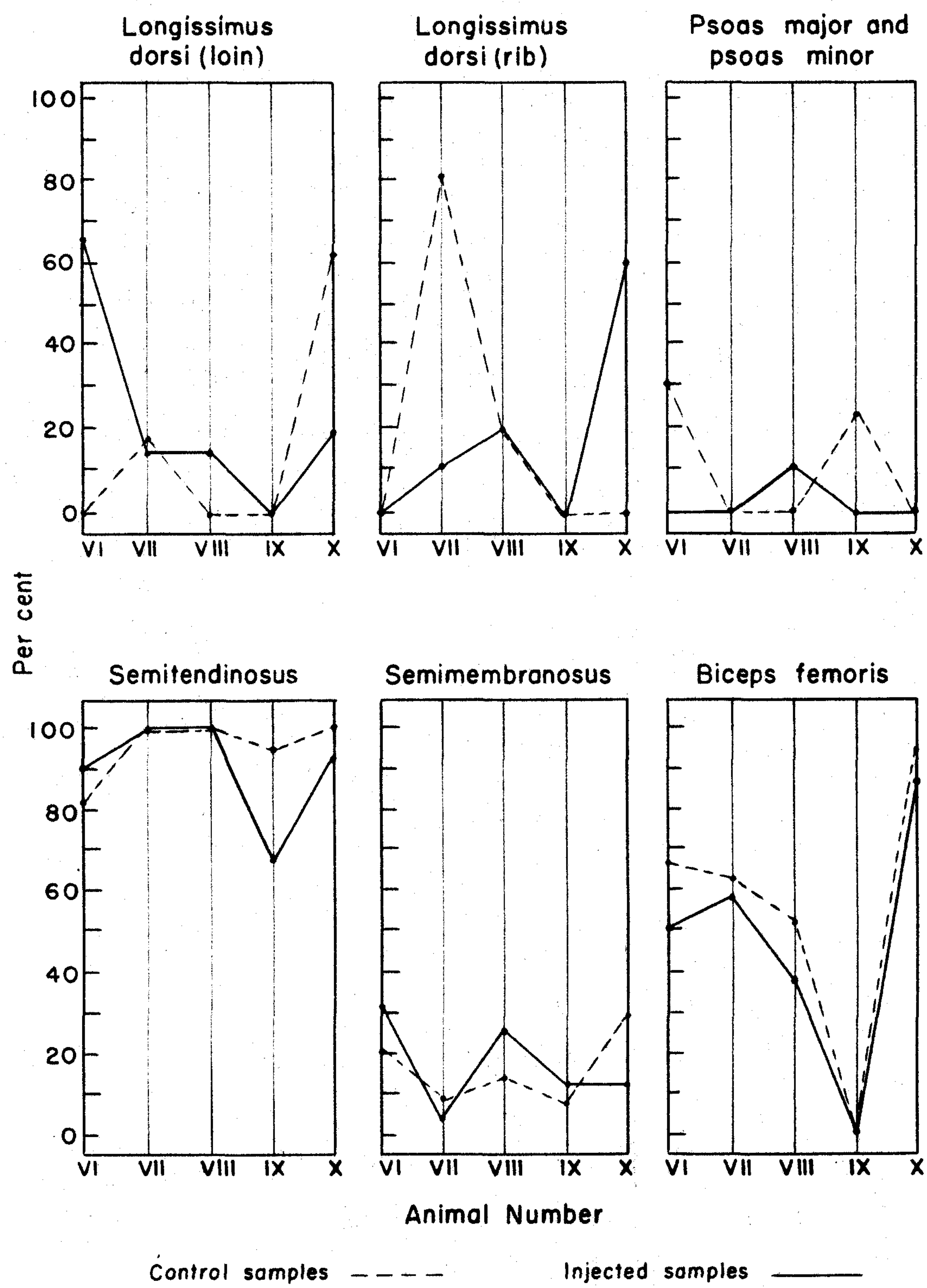


**Figure 30. Number of Firm Slices.
Sodium chloride and lactic acid
injection.**

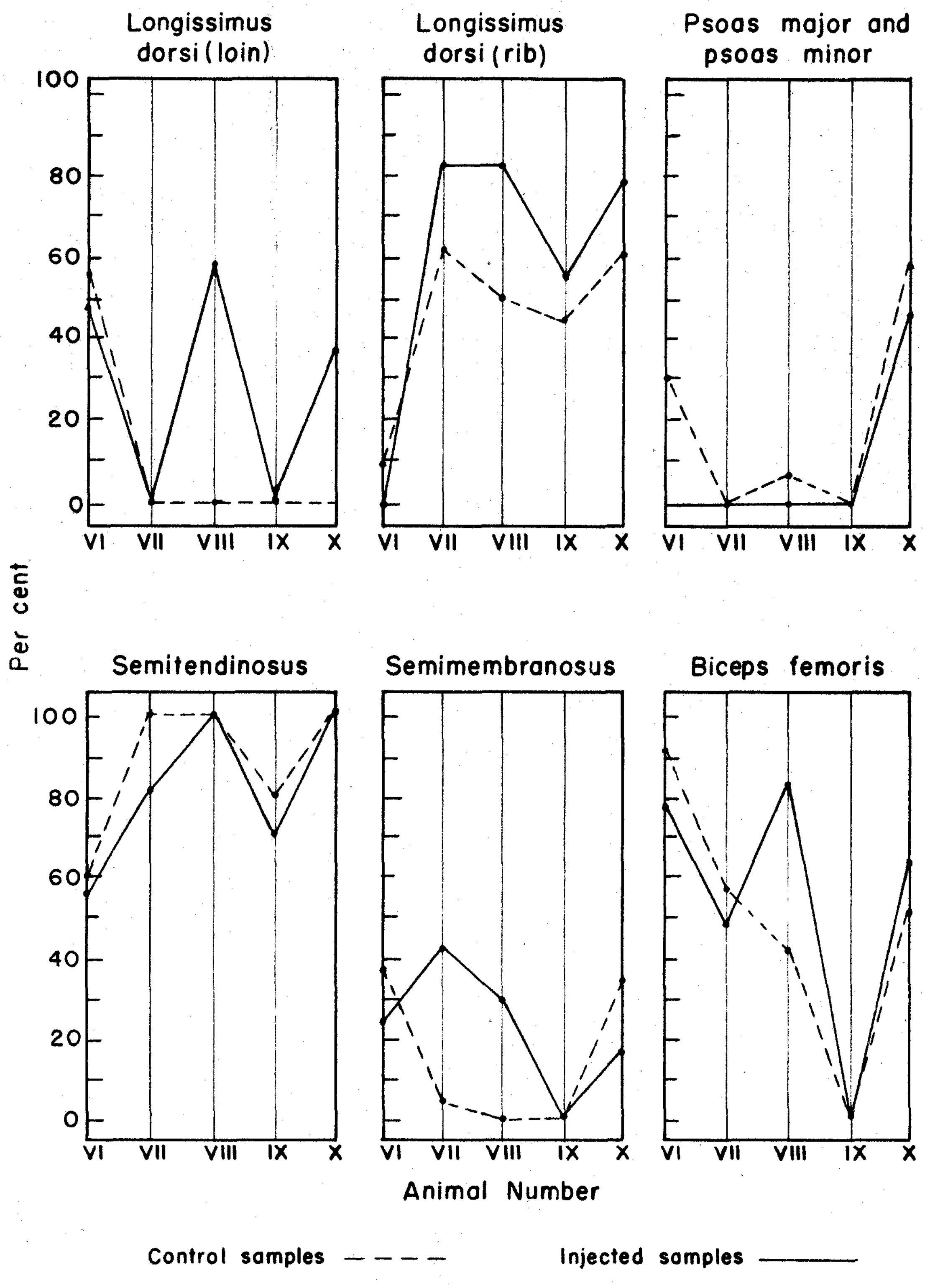


Figure 31. Number of Firm Slices.
Lactic acid injection.

Table 5. Averages of Judges' Ratings of Sliceability and Averages of Sliceability on Basis of Weight.

| Animal no. | No. of muscles | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| | | | SODIUM CHLORIDE INJECTION | | | |
| Control samples | | | | | | |
| VI | 6 | 7.6 | 383 | 46 | 338 | 87.8 |
| VII | 6 | 7.6 | 392 | 111 | 281 | 71.4 |
| VIII | 6 | 7.9 | 370 | 73 | 296 | 80.2 |
| Av. (3 animals) | | 7.7 | 382 | 77 | 305 | 79.8 |
| IX | 6 | 7.0 | 377 | 132 | 245 | 65.2 |
| X | 6 | 7.2 | 357 | 69 | 288 | 81.0 |
| Av. (2 animals) | | 7.1 | 367 | 100 | 266 | 73.1 |
| Av. (5 animals) | | 7.5 | 376 | 86 | 290 | 77.1 |
| Injected samples | | | | | | |
| VI | 6 | 7.6 | 370 | 45 | 325 | 87.9 |
| VII | 6 | 6.8 | 384 | 125 | 259 | 68.9 |
| VIII | 6 | 6.7 | 356 | 126 | 231 | 64.6 |
| Av. (3 animals) | | 7.0 | 370 | 99 | 272 | 73.8 |
| IX | 6 | 5.0 | 364 | 198 | 166 | 45.7 |
| X | 6 | 8.3 | 364 | 47 | 317 | 87.1 |
| Av. (2 animals) | | 6.6 | 364 | 122 | 242 | 66.4 |
| Av. (5 animals) | | 6.9 | 368 | 108 | 260 | 70.8 |

(continued)

Table 5 (continued)

| Animal no. | No. of muscles | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| SODIUM CHLORIDE AND LACTIC ACID INJECTION | | | | | | |
| Control samples | | | | | | |
| VI | 6 | 7.8 | 382 | 69 | 312 | 82.0 |
| VII | 6 | 7.5 | 387 | 82 | 305 | 79.3 |
| VIII | 6 | 7.2 | 372 | 80 | 292 | 78.6 |
| Av. (3 animals) | | 7.5 | 380 | 77 | 303 | 80.0 |
| IX | 6 | 5.4 | 369 | 194 | 175 | 47.5 |
| X | 6 | 7.5 | 367 | 124 | 243 | 67.0 |
| Av. (2 animals) | | 6.4 | 368 | 159 | 209 | 57.2 |
| Av. (5 animals) | | 7.1 | 375 | 110 | 265 | 70.9 |
| Injected samples | | | | | | |
| VI | 6 | 8.4 | 379 | 56 | 323 | 85.3 |
| VII | 6 | 6.2 | 384 | 113 | 270 | 71.4 |
| VIII | 6 | 7.6 | 356 | 56 | 300 | 84.3 |
| Av. (3 animals) | | 7.4 | 373 | 75 | 298 | 80.3 |
| IX | 6 | 6.1 | 361 | 195 | 166 | 46.0 |
| X | 6 | 7.9 | 366 | 68 | 299 | 81.5 |
| Av. (2 animals) | | 7.0 | 364 | 132 | 232 | 63.8 |
| Av. (5 animals) | | 7.2 | 369 | 98 | 272 | 73.7 |

(continued)

Table 5 (continued)

| Animal no. | No. of muscles | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| | | | **LACTIC ACID INJECTION** | | | |
| Control samples | | | | | | |
| VI | 6 | 8.2 | 379 | 57 | 322 | 84.5 |
| VII | 6 | 6.2 | 396 | 124 | 272 | 68.6 |
| VIII | 6 | 6.6 | 371 | 146 | 225 | 60.7 |
| Av. (3 animals) | | 7.0 | 382 | 109 | 273 | 71.3 |
| IX | 6 | 5.8 | 374 | 191 | 183 | 49.0 |
| X | 6 | 7.3 | 365 | 101 | 264 | 73.0 |
| Av. (2 animals) | | 6.6 | 370 | 146 | 224 | 61.0 |
| Av. (5 animals) | | 6.8 | 377 | 124 | 253 | 67.2 |
| Injected samples | | | | | | |
| VI | 6 | 7.6 | 371 | 84 | 288 | 77.8 |
| VII | 6 | 7.0 | 371 | 111 | 260 | 69.8 |
| VIII | 6 | 7.3 | 357 | 69 | 289 | 81.2 |
| Av. (3 animals) | | 7.3 | 366 | 88 | 279 | 76.3 |
| IX | 6 | 5.3 | 357 | 182 | 175 | 49.2 |
| X | 6 | 7.6 | 345 | 56 | 290 | 83.9 |
| Av. (2 animals) | | 6.4 | 351 | 119 | 232 | 66.6 |
| Av. (5 animals) | | 7.0 | 360 | 100 | 260 | 72.4 |

but the differences between Animals IX and X were highly significant.

The scores for slicing quality of the injected samples in the sodium chloride-lactic acid series were not significantly different from the control samples. Muscle differences were significant at the .01 level for Animals VI, VII, and VIII, but the differences were not quite large enough to be significant for Animals IX and X. The meat of Animal X sliced significantly better than that of Animal IX.

Lactic acid injection made no significant difference in judges' scores for slicing quality. Muscle differences were significant at the .05 level. The judges rated the meat of Animal X significantly higher in slicing quality than the meat of Animal IX. A possible explanation of the higher rating of Animal X in sliceability than for Animal IX is that the connective tissue of the aged dairy cow (Animal X) was firm enough, even after processing for 90 minutes, to hold the muscle fibers together.

The percentage values for sliceability calculated by deduction of the weight of the unsliceable meat from the weight of the meat in the can (See Table 5) are in good agreement with the values obtained by count of slices and by judges' ratings of sliceability.

## pH Values

The average pH values for the raw meat are approximately 5.45, regardless of aging 1 or 8 days or the kind of injection (Table 6). The range among the average values for the five animals is 5.61 to 5.37. Canned beef had higher pH values than the raw meat and the meat of Animal X, either cooked or uncooked, was higher in pH value than the meat of the other animals. Animal X was the aged dairy cow and the meat of this animal was a dark red color. The raw meat was sticky and rubbery and had a rather strong odor. Hall (17) reported a relationship between dark color in beef and high pH values. Bate-Smith (7) enumerated qualities found in beef having high pH values, among which were dark color, slimy or sticky feel, and flabbiness. The kind of injection had little apparent effect on the pH values of the raw or canned beef.

## Weight Changes

The animals used in this series of experiments were fairly uniform in weight. The live weights of the four steers were 816, 800, 830, and 930 pounds, respectively; the weight of the dairy cow was 965 pounds. The warm dressed weights of the half carcasses were, for left and right halves of each animal, respectively: 231, 232; 222, 216; 230, 233; 280, 275; and 195, 190 pounds. The cow had the highest

Table 6. Averages of pH Values.

| Animal no. | No. of muscles | Beef muscles (uninjected) aged one day | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | | pH | pH | pH |
| | | SODIUM CHLORIDE INJECTION | | |
| Left muscle | | | Control samples | |
| VI | 6 | 5.38 | 5.44 | 5.80 |
| VII | 6 | 5.42 | 5.44 | 5.68 |
| VIII | 6 | 5.40 | 5.38 | 5.75 |
| Av. (3 animals) | | 5.40 | 5.42 | 5.74 |
| IX | 6 | 5.38 | 5.37 | 5.64 |
| X | 6 | 5.61 | 5.55 | 5.93 |
| Av. (2 animals) | | 5.50 | 5.46 | 5.78 |
| Av. (5 animals) | | 5.44 | 5.44 | 5.76 |
| Right muscle | | | Injected samples | |
| VI | 6 | 5.39 | 5.43 | 5.77 |
| VII | 6 | 5.44 | 5.49 | 5.65 |
| VIII | 6 | 5.42 | 5.41 | 5.73 |
| Av. (3 animals) | | 5.42 | 5.44 | 5.72 |
| IX | 6 | 5.38 | 5.42 | 5.62 |
| X | 6 | 5.60 | 5.54 | 5.86 |
| Av. (2 animals) | | 5.49 | 5.48 | 5.74 |
| Av. (5 animals) | | 5.45 | 5.46 | 5.73 |

(continued)

Table 6 (continued)

| Animal no. | No. of muscles | Beef muscles (uninjected) aged one day | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | | pH | pH | pH |
| SODIUM CHLORIDE AND LACTIC ACID INJECTION | | | | |
| Left muscle | | | Control samples | |
| VI | 6 | (same as for sodium chloride injection) | 5.44 | 5.80 |
| VII | 6 | | 5.42 | 5.64 |
| VIII | 6 | | 5.39 | 5.73 |
| Av. (3 animals) | | | 5.42 | 5.72 |
| IX | 6 | | 5.39 | 5.65 |
| X | 6 | | 5.53 | 5.93 |
| Av. (2 animals) | | | 5.46 | 5.79 |
| Av. (5 animals) | | | 5.43 | 5.75 |
| Right muscle | | | Injected samples | |
| VI | 6 | (same as for sodium chloride injection) | 5.47 | 5.78 |
| VII | 6 | | 5.48 | 5.63 |
| VIII | 6 | | 5.41 | 5.70 |
| Av. (3 animals) | | | 5.45 | 5.70 |
| IX | 6 | | 5.42 | 5.64 |
| X | 6 | | 5.60 | 5.87 |
| Av. (2 animals) | | | 5.51 | 5.76 |
| Av. (5 animals) | | | 5.48 | 5.72 |

(continued)

Table 6 (continued)

| Animal no. | No. of muscles | Beef muscles (uninjected) aged one day | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | | pH | pH | pH |
| | | LACTIC ACID INJECTION | | |
| Left muscle | | | Control samples | |
| VI | 6 | (same as for | 5.42 | 5.80 |
| VII | 6 | sodium chloride | 5.48 | 5.67 |
| VIII | 6 | injection) | 5.40 | 5.73 |
| Av. (3 animals) | | | 5.43 | 5.73 |
| IX | 6 | | 5.38 | 5.65 |
| X | 6 | | 5.54 | 5.92 |
| Av. (2 animals) | | | 5.46 | 5.78 |
| Av. (5 animals) | | | 5.44 | 5.75 |
| Right muscle | | | Injected samples | |
| VI | 6 | (same as for | 5.47 | 5.82 |
| VII | 6 | sodium chloride | 5.48 | 5.68 |
| VIII | 6 | injection) | 5.41 | 5.73 |
| Av. (3 animals) | | | 5.45 | 5.74 |
| IX | 6 | | 5.38 | 5.65 |
| X | 6 | | 5.56 | 5.94 |
| Av. (2 animals) | | | 5.47 | 5.80 |
| Av. (5 animals) | | | 5.46 | 5.76 |

live weight but the lowest dressed weights for each half of the carcass of any of the animals. The weights of the muscles (untrimmed) after separation from the carcass are shown in Table 7.

The cuts of beef from each animal were trimmed to approximately a certain weight prior to aging. The averages of the weights of the beef cuts, of the beef plus injecting solution, and of the cuts after aging are shown in Table 8. The control samples lost a small percentage of their initial weight during the aging period; injected samples had higher average weights after aging than their initial weights, i. e., some of the injected solution remained in the meat at the end of 8 days of aging. Weight differences associated with a particular kind of injection were very small.

The average figures for the proportions of meat and of liquid in the can after processing were fairly uniform for the control and injected samples with the three kinds of injection (Table 9). Approximately two-thirds of the weight of meat put into the can was in the form of meat after processing and the other one-third was liquid. The differences in the percentage of liquid to meat for control and injected samples were too small to be of importance. The average values for the percentage of liquid in the cans of meat processed 90 minutes were no higher than for the meat processed 65 minutes.

Table 7. Weight of Muscles (Untrimmed) after Separation from Carcass.

| Muscle | Wt. of muscle (untrimmed) | |
|---|---|---|
| | Left | Right |
| | lb. | lb. |
| Animal VI | | |
| Longissimus dorsi, loin portion | 5.9 | 6.0 |
| Longissimus dorsi, rib portion | 7.5 | 7.2 |
| Psoas major and psoas minor | 4.1 | 3.7 |
| Semitendinosus | 3.5 | 3.4 |
| Semimembranosus | 8.5 | 8.6 |
| Biceps femoris | 8.5 | 9.1 |
| Animal VII | | |
| Longissimus dorsi, loin portion | 6.2 | 6.2 |
| Longissimus dorsi, rib portion | 7.8 | 8.0 |
| Psoas major and psoas minor | 3.7 | 4.3 |
| Semitendinosus | 3.1 | 3.4 |
| Semimembranosus | 9.1 | 8.7 |
| Biceps femoris | 9.3 | 8.9 |
| Animal VIII | | |
| Longissimus dorsi, loin portion | 5.9 | 6.5 |
| Longissimus dorsi, rib portion | 10.1 | 10.5 |
| Psoas major and psoas minor | 4.0 | 4.1 |
| Semitendinosus | 3.5 | 3.6 |
| Semimembranosus | 9.9 | 9.6 |
| Biceps femoris | 10.1 | 9.7 |
| Animal IX | | |
| Longissimus dorsi, loin portion | 7.0 | 6.9 |
| Longissimus dorsi, rib portion | 11.6 | 11.0 |
| Psoas major and psoas minor | 5.6 | 4.9 |
| Semitendinosus | 4.7 | 4.7 |
| Semimembranosus | 11.1 | 11.9 |
| Biceps femoris | 12.6 | 11.8 |
| Animal X | | |
| Longissimus dorsi, loin portion | 4.0 | 3.8 |
| Longissimus dorsi, rib portion | 7.0 | 5.9 |
| Psoas major and psoas minor | 3.8 | 3.2 |
| Semitendinosus | 2.8 | 2.9 |
| Semimembranosus | 11.5 | 11.9 |
| Biceps femoris | 8.4 | 8.1 |

Table 8. Averages of Initial Weights of Beef Cuts, of the Cuts Plus Injecting Solution, and of the Cuts after Aging.

| Animal no. | No. of muscles | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | SODIUM CHLORIDE INJECTION | | | |
| Control samples | | | | | |
| VI | 6 | 606 | | 600 | 99.0 |
| VII | 6 | 602 | | 593 | 98.5 |
| VIII | 6 | 606 | | 596 | 98.4 |
| Av. (3 animals) | | 605 | | 596 | 98.6 |
| IX | 6 | 605 | | 590 | 97.6 |
| X | 6 | 605 | | 599 | 99.0 |
| Av. (2 animals) | | 605 | | 594 | 98.3 |
| Av. (5 animals) | | 605 | | 596 | 98.5 |
| Injected samples | | | | | |
| VI | 6 | 605 | 665 | 638 | 105.5 |
| VII | 6 | 604 | 664 | 644 | 106.5 |
| VIII | 6 | 606 | 666 | 631 | 104.1 |
| Av. (3 animals) | | 605 | 665 | 638 | 105.4 |
| IX | 6 | 605 | 665 | 638 | 105.3 |
| X | 6 | 606 | 666 | 642 | 106.0 |
| Av. (2 animals) | | 606 | 666 | 640 | 105.6 |
| Av. (5 animals) | | 605 | 665 | 639 | 105.5 |

(continued)

Table 8 (continued)

| Animal no. | No. of muscles | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| SODIUM CHLORIDE AND LACTIC ACID INJECTION | | | | | |
| Control samples | | | | | |
| VI | 6 | 606 | | 597 | 98.6 |
| VII | 6 | 603 | | 594 | 98.5 |
| VIII | 6 | 606 | | 597 | 98.5 |
| Av. (3 animals) | | 605 | | 596 | 98.5 |
| IX | 6 | 604 | | 591 | 97.9 |
| X | 6 | 605 | | 597 | 98.6 |
| Av. (2 animals) | | 604 | | 594 | 98.2 |
| Av. (5 animals) | | 605 | | 595 | 98.4 |
| Injected samples | | | | | |
| VI | 6 | 606 | 666 | 636 | 105.1 |
| VII | 6 | 604 | 664 | 636 | 105.3 |
| VIII | 6 | 606 | 666 | 636 | 104.9 |
| Av. (3 animals) | | 605 | 665 | 636 | 105.1 |
| IX | 6 | 604 | 664 | 628 | 103.8 |
| X | 6 | 605 | 665 | 640 | 105.8 |
| Av. (2 animals) | | 604 | 664 | 634 | 104.8 |
| Av. (5 animals) | | 605 | 665 | 635 | 105.0 |

(continued)

Table 8 (continued)

| Animal no. | No. of muscles | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | LACTIC ACID INJECTION | | | |
| Control samples | | | | | |
| VI | 6 | 605 | | 600 | 99.3 |
| VII | 6 | 604 | | 594 | 98.4 |
| VIII | 6 | 606 | | 597 | 98.4 |
| Av. (3 animals) | | 605 | | 597 | 98.7 |
| IX | 6 | 606 | | 596 | 98.5 |
| X | 6 | 605 | | 598 | 98.9 |
| Av. (2 animals) | | 606 | | 597 | 98.7 |
| Av. (5 animals) | | 605 | | 597 | 98.7 |
| Injected samples | | | | | |
| VI | 6 | 604 | 664 | 624 | 103.3 |
| VII | 6 | 603 | 663 | 622 | 103.1 |
| VIII | 6 | 606 | 666 | 615 | 101.4 |
| Av. (3 animals) | | 604 | 664 | 620 | 102.6 |
| IX | 6 | 604 | 664 | 615 | 101.8 |
| X | 6 | 606 | 666 | 634 | 104.5 |
| Av. (2 animals) | | 605 | 665 | 624 | 103.2 |
| Av. (5 animals) | | 605 | 665 | 622 | 102.8 |

Table 9. Averages of Weights of Beef before Processing and Weights of Meat and of Liquid after Processing.

| Animal no. | No. of muscles | Wt. before processing | Wt. after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| | | SODIUM CHLORIDE INJECTION | | | | |
| Control samples | | | | | | |
| VI | 6 | 569 | 383 | 67.4 | 185 | 32.5 |
| VII | 6 | 570 | 392 | 68.8 | 173 | 30.3 |
| VIII | 6 | 569 | 370 | 64.9 | 195 | 34.3 |
| Av. (3 animals) | | 569 | 382 | 67.0 | 184 | 32.4 |
| IX | 6 | 569 | 377 | 66.3 | 184 | 32.4 |
| X | 6 | 569 | 357 | 62.8 | 188 | 33.0 |
| Av. (2 animals) | | 569 | 367 | 64.6 | 186 | 32.7 |
| Av. (5 animals) | | 569 | 376 | 66.0 | 185 | 32.5 |
| Injected samples | | | | | | |
| VI | 6 | 570 | 370 | 64.9 | 197 | 34.5 |
| VII | 6 | 570 | 384 | 67.4 | 180 | 31.6 |
| VIII | 6 | 570 | 356 | 62.5 | 206 | 36.1 |
| Av. (3 animals) | | 570 | 370 | 64.9 | 194 | 34.1 |
| IX | 6 | 568 | 364 | 63.9 | 180 | 31.6 |
| X | 6 | 569 | 364 | 64.0 | 185 | 32.4 |
| Av. (2 animals) | | 568 | 364 | 64.0 | 182 | 32.0 |
| Av. (5 animals) | | 569 | 368 | 64.5 | 190 | 33.2 |

(continued)

Table 9 (continued)

| Animal no. | No. of muscles | Wt. before processing | Wt. after processing Meat | | Liquid | |
|---|---|---|---|---|---|---|
| | | gm. | gm. | % | gm. | % |
| SODIUM CHLORIDE AND LACTIC ACID INJECTION | | | | | | |
| Control samples | | | | | | |
| VI | 6 | 569 | 382 | 67.0 | 183 | 32.2 |
| VII | 6 | 569 | 387 | 68.0 | 179 | 31.6 |
| VIII | 6 | 570 | 372 | 65.3 | 192 | 33.7 |
| Av. (3 animals) | | 569 | 380 | 66.8 | 185 | 32.5 |
| IX | 6 | 569 | 369 | 64.8 | 187 | 32.8 |
| X | 6 | 569 | 367 | 64.5 | 186 | 32.8 |
| Av. (2 animals) | | 569 | 368 | 64.6 | 186 | 32.8 |
| Av. (5 animals) | | 569 | 375 | 65.9 | 185 | 32.6 |
| Injected samples | | | | | | |
| VI | 6 | 570 | 379 | 66.5 | 178 | 31.3 |
| VII | 6 | 569 | 384 | 67.3 | 182 | 32.0 |
| VIII | 6 | 570 | 356 | 62.6 | 207 | 36.3 |
| Av. (3 animals) | | 570 | 373 | 65.5 | 189 | 33.2 |
| IX | 6 | 569 | 361 | 63.5 | 191 | 33.6 |
| X | 6 | 569 | 366 | 64.4 | 178 | 31.3 |
| Av. (2 animals) | | 569 | 364 | 64.0 | 184 | 32.4 |
| Av. (5 animals) | | 569 | 369 | 64.9 | 187 | 32.9 |

(continued)

Table 9 (continued)

| Animal no. | No. of muscles | Wt. before processing | Wt. after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| | | LACTIC ACID INJECTION | | | | |
| Control samples | | | | | | |
| VI | 6 | 569 | 379 | 66.6 | 187 | 32.8 |
| VII | 6 | 569 | 396 | 69.6 | 170 | 29.8 |
| VIII | 6 | 569 | 371 | 65.2 | 194 | 34.0 |
| Av. (3 animals) | | 569 | 382 | 67.1 | 184 | 32.2 |
| IX | 6 | 569 | 374 | 65.8 | 175 | 30.7 |
| X | 6 | 569 | 365 | 64.1 | 208 | 36.5 |
| Av. (2 animals) | | 569 | 370 | 65.0 | 192 | 33.6 |
| Av. (5 animals) | | 569 | 377 | 66.3 | 187 | 32.8 |
| Injected samples | | | | | | |
| VI | 6 | 569 | 371 | 65.2 | 191 | 33.6 |
| VII | 6 | 569 | 371 | 65.2 | 192 | 33.7 |
| VIII | 6 | 568 | 357 | 62.9 | 205 | 36.1 |
| Av. (3 animals) | | 569 | 366 | 64.4 | 196 | 34.5 |
| IX | 6 | 568 | 357 | 62.8 | 192 | 33.8 |
| X | 6 | 569 | 345 | 60.7 | 176 | 31.0 |
| Av. (2 animals) | | 568 | 351 | 61.8 | 184 | 32.4 |
| Av. (5 animals) | | 569 | 360 | 63.4 | 191 | 33.6 |

## General Characteristics of Beef Samples

Some characteristics noted in the raw meat have already been mentioned, i.e., the color, rubber-like quality, and stickiness of the meat of Animal X. Muscles of one animal differed in color; for example, the semitendinosus was noticeably lighter in color than the other muscles; one portion of the biceps femoris was a lighter pink than the rest of the muscle. During aging the amount of "drip" from the beef cuts of the dairy cow was small. The raw meat of this animal was very difficult to cut into pieces.

The slices of canned meat were observed for their general appearance. Much separation at the primary bundles of muscle fibers was noted. The connective tissue meshwork was either fragile or small in amount. A stringy texture in the meat was associated with the tendency to separate into small bundles of muscle fibers. Many of the samples injected with either of the solutions containing sodium chloride, and a few other samples, had an iridescent appearance at the surface of the slices.

The cans of meat placed in the incubator at 100°F. immediately after removal from the processing retort showed no signs of spoilage after 6 months or more of storage.

The fibrous nature of the cooked meat samples after maceration in the Waring blendor during the preparation of pH samples was noted. The semitendinosus, semimembranosus, and biceps femoris were particularly fibrous. The pull on the electric motor of the blendor was noticeable when the samples from the aged dairy cow were being macerated.

The liquid from the canned meat was brown, some samples having a yellow cast, others shading toward red. Some variations in the brightness or dullness were observed, but no definite pattern could be distinguished.

## Gelation of Liquid

Observations of the liquid from the canned beef after 24 hours of refrigeration showed wide variations in gelation. Some samples were stiff, quivering gels; others were thin, watery liquids. Varying degrees of gelation between these extremes were noted. In general, firmer gels were found among the samples from Animals VI, VII, and VIII, processed 65 minutes, than in those from Animals IX and X, processed 90 minutes. Gelation was less extensive for most of the samples from Animal IX than for those from the other animals.

It appeared that the processing time of 65 minutes was sufficient to bring about degration of collagen to gelatin, but that, by the end of 90 minutes, the gelatin was also partially degraded. The differences in results between Animals IX and X, both of which were processed 90 minutes, may be accounted for in the higher initial content of tough connective tissue in the aged dairy cow (Animal X) than in the younger animal. The injection treatment with sodium chloride, lactic acid, or the mixture of two in solution had no consistent effect on gelation of the liquid from the canned meat of any of the animals.

## SUMMARY

A study was made of the effect on canned beef of injecting the raw meat with one of the following solutions: sodium chloride, lactic acid, or a mixture of sodium chloride and lactic acid. The concentration of sodium chloride in each of the two salt-containing solutions was 15 per cent, making the proportion of approximately 1.5 grams of salt to 100 grams of meat after injection. The lactic acid solution, as well as the solution with both sodium chloride and lactic acid, contained sufficient acid to give a pH value of 3.4 for the solution.

Five animals were used in the study; four were steers (carcass grade Commercial) and one was an aged dairy cow (carcass grade Cutter). Matching pairs of the rib and loin portions of the longissimus dorsi, psoas major and psoas minor, semitendinosus, semimembranosus, and biceps femoris muscles were separated from the carcass 1 day after slaughter and divided into three or six cuts for aging and canning.

Cuts from the right side of the animal were injected; those from the left side were used as controls. All the cuts were aged 8 days at 34° to 36°F. prior to canning. Samples

for histological study and pH determinations were taken from the fresh muscle, the aged cuts, and from the canned meat. The meat from three steers was processed at 240°F. (10 pounds) for 65 minutes; from the fourth steer and the aged dairy cow, 90 minutes.

The canned meat was sliced on a mechanical slicer and representative slices were rated by the judges for six palatability factors. Slicing quality was evaluated by: (1) number and characteristics of slices obtained, (2) by weight of unsliceable meat, and (3) by judges' scores. Statistical analyses were made of the scores for flavor of the meat, tenderness, juiciness, texture, and slicing quality to determine the significance of the differences. Observations were made of the general appearance of the canned beef and the liquid.

Aroma scores for the canned beef were not affected by the injecting treatments, but were lower for the aged dairy cow than for the other animals.

Flavor, tenderness, and texture scores for the canned beef from the five animals were markedly improved (significant at the .01 level) by injection of the meat with either sodium chloride solution or the combination of sodium chloride and lactic acid. The lactic acid solution alone had no significant effect on these three palatability factors.

The scores for the flavor of the canned beef were not affected by the muscles used, but the beef of the aged dairy cow was undesirably strong flavored.

Tenderness was influenced by the injecting treatments and variations occurred among muscles and among animals.

Differences in texture were found in muscles and in animals. The psoas muscles had the highest rating; the loin portion of the longissimus dorsi and the semimembranosus, the lowest. Beef from the dairy cow had a low texture rating.

The average juiciness scores for the sodium chloride-injected samples of canned beef processed 65 minutes were higher than for the controls, but the differences between the juiciness scores for the injected samples processed 90 minutes and the control samples were not significant. Combined salt and lactic acid solution improved the juiciness of the injected samples compared to control samples, but the differences were significant only at the .05 level. Differences in the lactic acid-treated samples versus controls were within experimental error.

The flavor of liquid from the can was improved by treatment of beef with either of the salt-containing solutions.

Slicing quality of the canned beef was little affected by injection of the raw meat with any of the three solutions tested. Little variation in sliceability occurred among the cuts processed 65 minutes. Variations did occur among those processed 90 minutes; the beef from the cow sliced better than that from the steer. Muscles were markedly different in sliceability in all but one series of tests. The semitendinosus consistently sliced well.

The histological characteristics observed in the longitudinal sections of the rib portion of the longissimus dorsi helped to explain the results secured in the palatability scores. Some disintegration of the fiber striations had occurred after aging 8 days. The extent of this disintegration varied with the muscle and the animal.

The effect of injection with either sodium chloride solution or a mixture of sodium chloride and lactic acid was an increase in the number and extent of the disintegration fissures in the fibers. This disintegration would be expected to contribute to tenderness of the meat, and the judges rated the injected samples receiving either of these treatments as more tender than the controls. Samples injected with only lactic acid appeared much like the control samples in histological features.

The average pH values for the five animals were similar for fresh muscle and for the cuts of beef aged 8 days, regardless of injection treatment. These values were close to pH 5.45. The meat of the aged dairy cow was higher in pH than the meat of the steers and had the dark red color and the sticky, rubbery feel that are characteristic of meat of high pH. The canned beef samples of all animals were higher in pH than the raw meat. Injection with any of the three solutions had little effect on pH values of the meat after canning.

Small losses in weight were found in the control cuts of beef, but the average weight of the injected samples was greater after 8 days of aging than the initial weight. Thus some of the injected solution remained in the meat. The canned beef was approximately two-thirds meat and one-third liquid. Injection of the raw meat made little difference in the proportion of liquid to meat in the canned product.

## CONCLUSIONS

Under the conditions of this study the following conclusions are made:

1. As indicated by palatability scores, the injection of beef cuts with either sodium chloride solution or a combination of sodium chloride and lactic acid solution markedly improved the flavor, tenderness, and texture of the canned beef compared to uninjected control cuts. Juiciness was improved for some of the cuts but not for all. Injection of beef cuts with lactic acid solution had no significant effect on any of the six palatability factors evaluated. Aroma scores were little affected by the injection treatment of the meat. Flavor of the liquid from the can was slightly improved by injection with the salt-containing solutions but not by the lactic acid solution.

2. The slicing quality of the canned meat was fairly low, and no improvement was secured by injection of the raw meat with any of the three solutions tested. Sliceability of the canned beef, however, varied among the muscles and the animals.

3. The tenderness of the canned beef was related to the microscopic changes which occurred in the beef.

## LITERATURE CITED

1. Anson, M. L. Protein denaturation and the properties of protein groups. Adv. in Protein Chem. 2:361-386. 1945.

2. Astbury, W. T. X-rays and the stoichiometry of the proteins. Adv. in Enzymology 3:63-108. 1943.

3. -------- and Bell, F. O. Nature of the intramolecular fold in alpha-keratin and alpha-myosin. Nature (London) 147:696-699. 1941.

4. -------- and Dickinson, S. X-ray studies of the molecular structure of myosin. Proc. Roy. Soc. Lond. Ser. B 129:307-332. 1940.

5. Bailey, K. The proteins of skeletal muscle. Adv. in Protein Chem. 1:289-317. 1944.

6. Bate-Smith, E. C. Native and denatured muscle proteins. Proc. Roy. Soc. Lond. Ser. B 124:136-150. 1937.

7. -------- The physiology and chemistry of rigor mortis, with special reference to the aging of beef. Adv. in Food Research 1:1-38. 1948.

8. -------- Physiology of muscle proteins. Great Britain, Dept. Sci. Ind. Res., Report of the Food Investigation Board for the Year 1935. 1936.

9. Bell, E. F., Morgan, A. F., and Dorman, A. Collagen determination in cooked meat. Food Research 6: 245-263. 1941.

10. Bendall, J. R. The effect of cooking on the creatine-creatinine, phosphorus, nitrogen and pH values of raw lean beef. Jour. Soc. Chem. Ind. 65: 226-230. 1946.

11. Bull, H. B. Protein structure. Adv. in Enzymology 1:1-42. 1941.

12. Cover, S. Effect of extremely low rates of heat penetration on tendering of beef. Food Research 8:388-394. 1943.

13. Crain, E. R. Palatability studies of meat. II. A comparison of three brining solutions on paired less tender cuts, cooked by moist heat. Unpublished M. S. thesis. Ames, Iowa, Iowa State College Library. 1938.

14. Crocker, E. C. Flavor of meat. Editorial review. Food Research 13:179-183. 1948.

15. Deatherage, F. E., and Harsham, A. Relation of tenderness of beef to aging time at 33-35°F. Food Research 12:164-172. 1947.

16. Fenn, W. O., and Maurer, F. W. The pH of muscle. Protoplasma 24:337-345. 1935.

17. Hall, J. L., Latschar, C. E., and Mackintosh, D. L. Characteristics of dark-cutting beef. Survey and preliminary investigation. Kan. Agr. Exp. Sta. Tech. Bul. 58. Part 4. 1944.

18. Harrison, D. L. Histological, physical, and organoleptic changes in three grades of beef during aging. Unpublished Ph. D. thesis. Ames, Iowa, Iowa State College Library. 1947.

19. Lowe, B. Experimental cookery. 3d. ed. New York, John Wiley & Sons. 1943.

20. Maximow, A. A., and Bloom, W. A textbook of histology. 5th ed. Philadelphia, W. B. Saunders Co. 1948.

21. Mirsky, A. E. Protein denaturation. Cold Spring Harbor Symposia on Quantitative Biology 6:150-156. 1938.

22. National Canners Association. Research Laboratory. Processes for low-acid canned foods in metal containers. Bul. 26-L. 6th ed. Washington, D. C., The Assoc. 1946.

23. Paul, P. C. Changes in palatability, microscopic appearance, and electrical resistance in beef during the onset and passing of rigor and during subsequent storage. Unpublished Ph. D. thesis. Ames, Iowa, Iowa State College Library. 1943.

24. Paul, P., Lowe, B., and McClurg, B. R. Changes in histological structure and palatability of beef during storage. Food Research 9:221-233. 1944.

25. -------- and McLean, B. B. Studies on veal. I. Effect of different internal temperatures on veal roasts from calves of three different weights. Food Research 11:107-115. 1946.

26. -------- and --------. Studies on veal. II. Variations between some muscles of the hind quarter. Food Research 11:116-120. 1946.

27. Prudent, I. Collagen and elastin content of four beef muscles aged varying periods of time. Unpublished Ph. D. thesis. Ames, Iowa, Iowa State College Library. 1947.

28. Ramsbottom, J. M., and Strandine, E. J. Comparative tenderness and identification of muscles in wholesale beef cuts. Food Research 13:315-330. 1948.

29. --------, --------, and Koonz, C. H. Comparative tenderness of representative beef muscles. Food Research 10:497-509. 1945.

30. Sair, L. and Cook, W. H. Relation of pH to drip formation in meat. Canad. Jour. Res., Sect. D 16:255-267. 1938.

31. Snyder, C. M. The effect of salt on total cooking losses of various cuts of beef. Unpublished M. S. thesis. Ames, Iowa, Iowa State College Library. 1930.

32. Speidel, C. C. The fundamental transverse arrangement of cross striae in myofibrils of striated muscle. Anat. Rec. 100:91-100. 1948.

33. Szent-Györgyi, A. Chemistry of muscular contraction. New York, The Academic Press, Inc. 1947.

34. -------- Nature of life. A study on muscle. New York, The Academic Press, Inc. 1948.

35. -------- Studies on muscle. Acta Physiol. Scand. 9: supplement 25 (in English). Stockholm. 1945.

36. Toepfer, E. W., Reynolds, H., Gilpin, G. L., and Taube, K. Home canning processes for low-acid foods. U. S. Dept. Agr. Tech. Bul. 930. 1946.

37. Tofte, G. E. Palatability studies of meat. III. The effect of brine solutions on the fiber and connective tissue of paired less-tender cuts of beef. Unpublished M. S. thesis. Ames, Iowa, Iowa State College Library. 1940.

38. U. S. Bureau of Home Economics and Human Nutrition. Home canning of meat. U. S. Dept. Agr. AW1-110. 1946.

39. Winkler, C. A. Colour of meat: I. Apparatus for its measurement, and relation between pH and colour. Canad. Jour. Res., Sect. D 17:1-7. 1939.

40. -------- Tenderness of meat: I. A recording apparatus for its estimation, and relation between pH and tenderness. Canad. Jour. Res., Sect. D 17:8-14. 1939.

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# APPENDIX

Table 1. Palatability of Canned Beef. Average palatability scores grouped according to muscle used and processing time. Scoring range is 10 for extremely good quality to 1 for extremely poor quality.

| Animal* no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION | | | | | | | |
| Sodium chloride injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 162 | 7.7 | 7.0 | 6.3 | 6.3 | 5.7 | 5.0 |
| VII | 188 | 7.7 | 7.0 | 6.3 | 5.7 | 5.3 | 5.0 |
| VIII | 211 | 8.0 | 7.0 | 5.7 | 4.0 | 5.3 | 3.3 |
| Av. (3 animals) | | 7.8 | 7.0 | 6.1 | 5.3 | 5.4 | 4.4 |
| IX | 234 | 7.7 | 6.7 | 5.0 | 6.7 | 4.3 | 5.0 |
| X | 260 | 5.7 | 5.0 | 5.3 | 5.7 | 4.3 | 3.3 |
| Av. (5 animals) | | 7.4 | 6.5 | 5.7 | 5.7 | 5.0 | 4.3 |
| Injected samples | | | | | | | |
| VI | 162 | 7.7 | 8.3 | 7.7 | 8.0 | 6.3 | 6.7 |
| VII | 188 | 7.3 | 6.7 | 6.3 | 5.3 | 5.0 | 4.0 |
| VIII | 211 | 7.3 | 7.3 | 6.0 | 4.7 | 5.3 | 3.7 |
| Av. (3 animals) | | 7.4 | 7.4 | 6.7 | 6.0 | 5.5 | 4.8 |
| IX | 234 | 7.3 | 7.7 | 7.0 | 8.0 | 5.0 | 6.7 |
| X | 260 | 6.7 | 5.7 | 5.3 | 7.7 | 5.7 | 5.7 |
| Av. (5 animals) | | 7.3 | 7.1 | 6.5 | 6.7 | 5.5 | 5.4 |

(continued)

*Animals VI, VII, and VIII were steers, carcass grade Commercial, processed 65 minutes; Animal IX was a steer, carcass grade Commercial, processed 90 minutes; Animal X was a cow, carcass grade Cutter, processed 90 minutes.

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | | | | |
| **Lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 164 | 8.3 | 7.3 | 6.7 | 5.3 | 6.0 | 4.3 |
| VII | 187 | 7.7 | 6.7 | 7.0 | 5.7 | 4.7 | 3.7 |
| VIII | 210 | 8.0 | 6.7 | 5.7 | 4.0 | 4.3 | 4.0 |
| Av. (3 animals) | | 8.0 | 6.9 | 6.5 | 5.0 | 5.0 | 4.0 |
| IX | 236 | 8.0 | 7.0 | 5.0 | 6.3 | 4.0 | 4.3 |
| X | 259 | 6.3 | 5.3 | 5.0 | 5.3 | 3.7 | 3.3 |
| Av. (5 animals) | | 7.7 | 6.6 | 5.9 | 5.3 | 4.5 | 3.9 |
| Injected samples | | | | | | | |
| VI | 164 | 8.0 | 8.0 | 7.3 | 6.0 | 5.7 | 5.3 |
| VII | 187 | 7.7 | 7.0 | 6.7 | 5.3 | 4.7 | 4.3 |
| VIII | 210 | 7.7 | 7.0 | 6.0 | 4.0 | 5.0 | 3.7 |
| Av. (3 animals) | | 7.8 | 7.3 | 6.7 | 5.1 | 5.1 | 4.4 |
| IX | 236 | 7.3 | 7.3 | 5.7 | 6.7 | 3.7 | 4.3 |
| X | 259 | 6.3 | 5.3 | 5.7 | 6.3 | 4.0 | 4.0 |
| Av. (5 animals) | | 7.4 | 6.9 | 6.3 | 5.7 | 4.6 | 4.3 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender- ness | Juici- ness | Tex- ture |
| | | | Meat | Liquid | | | |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | | | | |
| Sodium chloride and lactic acid injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 163 | 7.7 | 8.0 | 6.7 | 6.3 | 7.0 | 5.3 |
| VII | 186 | 7.7 | 7.3 | 8.0 | 7.7 | 5.3 | 6.0 |
| VIII | 212 | 7.7 | 7.0 | 5.7 | 4.7 | 5.7 | 4.3 |
| Av. (3 animals) | | 7.7 | 7.4 | 6.8 | 6.2 | 6.0 | 5.2 |
| IX | 235 | 7.3 | 7.0 | 5.3 | 6.0 | 3.7 | 4.7 |
| X | 258 | 6.0 | 6.0 | 5.3 | 6.3 | 4.0 | 3.7 |
| Av. (5 animals) | | 7.3 | 7.1 | 6.2 | 6.2 | 5.1 | 4.8 |
| Injected samples | | | | | | | |
| VI | 163 | 8.0 | 8.3 | 7.0 | 8.0 | 6.0 | 7.0 |
| VII | 186 | 7.7 | 7.0 | 7.7 | 7.7 | 5.7 | 5.0 |
| VIII | 212 | 8.0 | 7.0 | 7.3 | 6.3 | 5.7 | 5.0 |
| Av. (3 animals) | | 7.9 | 7.4 | 7.3 | 7.3 | 5.8 | 5.7 |
| IX | 235 | 7.7 | 7.0 | 7.0 | 7.7 | 4.3 | 6.0 |
| X | 258 | 6.0 | 6.3 | 5.7 | 8.3 | 5.3 | 6.0 |
| Av. (5 animals) | | 7.5 | 7.1 | 6.9 | 7.6 | 5.4 | 5.8 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION | | | | | | | |
| **Sodium chloride injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 167 | 7.3 | 7.3 | 6.0 | 4.3 | 4.3 | 3.3 |
| VII | 189 | 7.7 | 7.7 | 7.0 | 8.3 | 7.7 | 7.0 |
| VIII | 214 | 7.3 | 8.0 | 6.3 | 7.3 | 6.0 | 6.0 |
| Av. (3 animals) | | 7.4 | 7.3 | 6.4 | 6.6 | 6.0 | 5.4 |
| IX | 239 | 7.3 | 8.3 | 6.3 | 8.3 | 5.0 | 6.0 |
| X | 261 | 6.3 | 6.0 | 3.3 | 7.0 | 4.3 | 5.0 |
| Av. (5 animals) | | 7.2 | 7.3 | 5.8 | 7.0 | 5.5 | 5.5 |
| Injected samples | | | | | | | |
| VI | 167 | 7.7 | 7.7 | 7.3 | 8.0 | 6.0 | 6.7 |
| VII | 189 | 8.0 | 8.7 | 8.0 | 9.7 | 8.0 | 8.7 |
| VIII | 214 | 8.0 | 8.7 | 8.0 | 9.0 | 7.3 | 8.0 |
| Av. (3 animals) | | 7.9 | 8.4 | 7.8 | 8.9 | 7.1 | 7.8 |
| IX | 239 | 7.7 | 8.3 | 7.0 | 8.7 | 6.0 | 7.3 |
| X | 261 | 7.0 | 6.3 | 3.3 | 9.3 | 5.0 | 6.3 |
| Av. (5 animals) | | 7.7 | 7.9 | 6.7 | 8.9 | 6.5 | 7.4 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Aroma | Flavor: Meat | Flavor: Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| **LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued)** | | | | | | | |
| __Lactic acid injection__ | | | | | | | |
| Control samples | | | | | | | |
| VI | 165 | 8.3 | 7.7 | 7.0 | 7.7 | 6.3 | 6.7 |
| VII | 190 | 8.0 | 8.0 | 7.0 | 8.0 | 6.7 | 6.0 |
| VIII | 215 | 7.7 | 7.7 | 5.7 | 6.3 | 6.3 | 5.3 |
| Av. (3 animals) | | 8.0 | 7.8 | 6.6 | 7.3 | 6.4 | 6.0 |
| IX | 237 | 7.3 | 7.7 | 5.7 | 7.7 | 5.7 | 5.7 |
| X | 262 | 6.7 | 6.0 | 3.0 | 8.0 | 4.3 | 5.3 |
| Av. (5 animals) | | 7.6 | 7.4 | 5.7 | 7.5 | 5.9 | 5.8 |
| Injected samples | | | | | | | |
| VI | 165 | 8.0 | 8.0 | 6.3 | 7.7 | 7.7 | 7.0 |
| VII | 190 | 8.0 | 7.7 | 7.7 | 7.7 | 6.7 | 6.3 |
| VIII | 215 | 7.7 | 7.7 | 5.7 | 5.3 | 6.0 | 5.0 |
| Av. (3 animals) | | 7.9 | 7.8 | 6.6 | 6.9 | 6.8 | 6.1 |
| IX | 237 | 7.7 | 7.3 | 5.7 | 7.7 | 5.3 | 6.3 |
| X | 262 | 6.7 | 6.3 | 4.0 | 9.3 | 5.3 | 6.0 |
| Av. (5 animals) | | 7.6 | 7.4 | 5.9 | 7.5 | 6.2 | 6.1 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Aroma | Flavor Meat | Flavor Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | | **Palatability scores** | | | | |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | | | | |
| <u>Sodium chloride and lactic acid injection</u> | | | | | | | |
| Control samples | | | | | | | |
| VI | 166 | 8.0 | 7.0 | 5.7 | 7.7 | 6.0 | 5.7 |
| VII | 191 | 8.7 | 7.3 | 6.7 | 7.7 | 7.0 | 6.3 |
| VIII | 213 | 8.0 | 8.0 | 6.0 | 8.0 | 6.7 | 7.3 |
| Av. (3 animals) | | 8.2 | 7.4 | 6.1 | 7.8 | 6.6 | 6.4 |
| IX | 238 | 7.3 | 7.3 | 5.7 | 7.3 | 4.7 | 5.7 |
| X | 263 | 6.3 | 6.0 | 3.0 | 6.3 | 4.7 | 4.0 |
| Av. (5 animals) | | 7.7 | 7.1 | 5.4 | 7.4 | 5.8 | 5.8 |
| Injected samples | | | | | | | |
| VI | 166 | 8.0 | 7.7 | 7.3 | 8.3 | 7.0 | 7.3 |
| VII | 191 | 7.7 | 8.7 | 8.0 | 8.0 | 7.3 | 6.7 |
| VIII | 213 | 7.7 | 8.7 | 7.7 | 9.3 | 7.3 | 8.0 |
| Av. (3 animals) | | 7.8 | 8.4 | 7.7 | 8.5 | 7.2 | 7.3 |
| IX | 238 | 7.3 | 8.7 | 8.0 | 9.0 | 5.7 | 7.0 |
| X | 263 | 6.7 | 6.0 | 4.0 | 9.3 | 4.0 | 6.3 |
| Av. (5 animals) | | 7.5 | 8.0 | 7.0 | 8.8 | 6.3 | 7.1 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES | | | | | | | |
| Sodium chloride injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 168 | 8.7 | 8.0 | 7.0 | 9.0 | 7.0 | 8.0 |
| VII | 193 | 8.3 | 7.7 | 7.0 | 8.3 | 7.7 | 7.7 |
| VIII | 218 | 8.3 | 8.0 | 6.0 | 9.0 | 6.3 | 7.7 |
| Av. (3 animals) | | 8.4 | 7.9 | 6.7 | 8.8 | 7.0 | 7.8 |
| IX | 240 | 7.3 | 7.3 | 5.7 | 9.3 | 6.0 | 7.3 |
| X | 265 | 6.3 | 4.3 | 4.0 | 9.3 | 5.0 | 6.0 |
| Av. (5 animals) | | 7.8 | 7.1 | 5.9 | 9.0 | 6.4 | 7.3 |
| Injected samples | | | | | | | |
| VI | 168 | 8.0 | 8.3 | 7.3 | 9.3 | 7.3 | 8.3 |
| VII | 193 | 7.7 | 8.7 | 8.0 | 9.7 | 6.7 | 7.7 |
| VIII | 218 | 8.3 | 8.7 | 7.7 | 9.3 | 7.3 | 8.0 |
| Av. (3 animals) | | 8.0 | 8.6 | 7.7 | 9.4 | 7.1 | 8.0 |
| IX | 240 | 6.7 | 8.0 | 7.3 | 10.0 | 5.7 | 8.0 |
| X | 265 | 6.3 | 5.3 | 4.7 | 9.7 | 6.0 | 6.7 |
| Av. (5 animals) | | 7.4 | 7.8 | 7.0 | 9.6 | 6.6 | 7.7 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Aroma | Flavor: Meat | Flavor: Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | | **Palatability scores** | | | | |
| **PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued)** | | | | | | | |
| <u>Lactic acid injection</u> | | | | | | | |
| Control samples | | | | | | | |
| VI | 169 | 8.7 | 7.3 | 6.3 | 9.0 | 7.0 | 8.7 |
| VII | 194 | 8.3 | 8.3 | 7.3 | 9.0 | 7.3 | 7.3 |
| VIII | 216 | 7.7 | 8.3 | 6.7 | 8.7 | 7.0 | 7.3 |
| Av. (3 animals) | | 8.2 | 8.0 | 6.8 | 8.9 | 7.1 | 7.8 |
| IX | 241 | 7.7 | 7.7 | 5.3 | 9.0 | 5.7 | 7.7 |
| X | 266 | 5.0 | 3.3 | 2.7 | 9.0 | 4.3 | 5.0 |
| Av. (5 animals) | | 7.5 | 7.0 | 5.7 | 8.9 | 6.3 | 7.2 |
| Injected samples | | | | | | | |
| VI | 169 | 8.3 | 7.7 | 7.0 | 8.7 | 7.3 | 8.3 |
| VII | 194 | 8.0 | 7.0 | 6.3 | 7.7 | 6.3 | 6.7 |
| VIII | 216 | 8.0 | 8.0 | 6.7 | 8.3 | 6.3 | 6.7 |
| Av. (3 animals) | | 8.1 | 7.6 | 6.7 | 8.2 | 6.6 | 7.2 |
| IX | 241 | 7.3 | 7.3 | 5.3 | 8.3 | 5.7 | 7.0 |
| X | 266 | 6.3 | 4.7 | 3.0 | 9.0 | 4.7 | 6.0 |
| Av. (5 animals) | | 7.6 | 6.9 | 5.7 | 8.4 | 6.1 | 6.9 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores: Aroma | Flavor: Meat | Flavor: Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued)

<u>Sodium chloride and lactic acid injection</u>

| Animal no. | Sample no. | Aroma | Flavor Meat | Flavor Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| Control samples | | | | | | | |
| VI | 170 | 8.3 | 7.7 | 7.3 | 8.7 | 6.7 | 8.0 |
| VII | 192 | 8.0 | 7.7 | 7.0 | 8.0 | 7.3 | 7.3 |
| VIII | 217 | 7.7 | 8.0 | 6.3 | 8.7 | 6.7 | 7.0 |
| Av. (3 animals) | | 8.0 | 7.8 | 6.9 | 8.5 | 6.9 | 7.4 |
| IX | 242 | 7.3 | 7.3 | 5.7 | 9.3 | 5.7 | 7.7 |
| X | 264 | 6.3 | 4.0 | 3.0 | 8.7 | 4.3 | 5.3 |
| Av. (5 animals) | | 7.5 | 6.9 | 5.9 | 8.7 | 6.1 | 7.1 |
| Injected samples | | | | | | | |
| VI | 170 | 8.3 | 9.0 | 7.7 | 9.7 | 8.3 | 9.3 |
| VII | 192 | 8.0 | 8.7 | 8.0 | 9.7 | 7.3 | 8.0 |
| VIII | 217 | 8.7 | 8.7 | 8.3 | 9.7 | 7.7 | 8.7 |
| Av. (3 animals) | | 8.3 | 8.8 | 8.0 | 9.7 | 7.8 | 8.7 |
| IX | 242 | 7.7 | 8.3 | 7.0 | 9.7 | 6.3 | 8.0 |
| X | 264 | 6.7 | 5.3 | 4.7 | 9.3 | 5.0 | 6.7 |
| Av. (5 animals) | | 7.9 | 8.0 | 7.1 | 9.6 | 6.9 | 8.1 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Aroma | Flavor: Meat | Flavor: Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| SEMITENDINOSUS MUSCLE | | | | | | | |
| **Sodium chloride injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 172 | 8.3 | 7.7 | 6.7 | 8.3 | 6.0 | 6.3 |
| VII | 197 | 8.3 | 7.7 | 6.0 | 8.0 | 6.0 | 6.3 |
| VIII | 219 | 7.7 | 7.7 | 5.7 | 7.7 | 6.7 | 6.7 |
| Av. (3 animals) | | 8.1 | 7.7 | 6.1 | 8.0 | 6.2 | 6.4 |
| IX | 244 | 8.3 | 7.7 | 5.7 | 7.7 | 4.3 | 6.0 |
| X | 269 | 6.0 | 5.3 | 4.3 | 7.7 | 4.3 | 5.0 |
| Av. (5 animals) | | 7.7 | 7.2 | 5.7 | 7.9 | 5.5 | 6.1 |
| Injected samples | | | | | | | |
| VI | 172 | 8.3 | 8.3 | 7.0 | 8.7 | 7.0 | 8.0 |
| VII | 197 | 8.3 | 8.7 | 7.7 | 9.3 | 7.3 | 8.0 |
| VIII | 219 | 8.0 | 8.0 | 7.0 | 7.7 | 6.7 | 7.3 |
| Av. (3 animals) | | 8.2 | 8.3 | 7.2 | 8.6 | 7.0 | 7.8 |
| IX | 244 | 7.7 | 8.0 | 7.3 | 9.3 | 4.3 | 7.3 |
| X | 269 | 6.3 | 6.0 | 5.7 | 8.7 | 5.3 | 6.3 |
| Av. (5 animals) | | 7.7 | 7.8 | 6.9 | 8.7 | 6.1 | 7.4 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Aroma | Flavor: Meat | Flavor: Liquid | Tender-ness | Juici-ness | Tex-ture |
|---|---|---|---|---|---|---|---|
| | | | | **Palatability scores** | | | |
| | | | SEMITENDINOSUS MUSCLE (continued) | | | | |
| <u>Lactic acid injection</u> | | | | | | | |
| Control samples | | | | | | | |
| VI | 173 | 8.0 | 8.0 | 6.0 | 8.7 | 7.3 | 7.7 |
| VII | 195 | 7.7 | 8.0 | 7.0 | 8.0 | 6.7 | 6.7 |
| VIII | 220 | 7.7 | 7.7 | 6.3 | 7.7 | 6.3 | 6.7 |
| Av. (3 animals) | | 7.8 | 7.9 | 6.4 | 8.1 | 6.8 | 7.0 |
| IX | 245 | 7.7 | 7.7 | 6.0 | 8.3 | 6.0 | 7.7 |
| X | 267 | 6.3 | 5.3 | 4.3 | 6.7 | 5.0 | 4.3 |
| Av. (5 animals) | | 7.5 | 7.3 | 5.9 | 7.9 | 6.3 | 6.6 |
| Injected samples | | | | | | | |
| VI | 173 | 8.3 | 8.0 | 6.3 | 7.7 | 7.3 | 7.7 |
| VII | 195 | 8.0 | 7.3 | 5.7 | 8.0 | 5.7 | 6.0 |
| VIII | 220 | 8.0 | 7.7 | 6.3 | 8.0 | 6.3 | 6.7 |
| Av. (3 animals) | | 8.1 | 7.7 | 6.1 | 7.9 | 6.4 | 6.8 |
| IX | 245 | 7.7 | 7.7 | 5.7 | 7.7 | 5.7 | 6.3 |
| X | 267 | 6.0 | 5.7 | 4.7 | 7.0 | 4.7 | 5.7 |
| Av. (5 animals) | | 7.6 | 7.3 | 5.7 | 7.7 | 5.9 | 6.5 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| SEMITENDINOSUS MUSCLE (continued) | | | | | | | |
| **Sodium chloride and lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 171 | 7.7 | 7.3 | 6.0 | 7.7 | 6.0 | 6.7 |
| VII | 196 | 8.0 | 8.0 | 6.3 | 7.7 | 6.0 | 6.3 |
| VIII | 221 | 7.7 | 8.0 | 6.0 | 7.3 | 6.3 | 6.7 |
| Av. (3 animals) | | 7.8 | 7.8 | 6.1 | 7.6 | 6.1 | 6.6 |
| IX | 243 | 7.7 | 8.0 | 6.0 | 7.3 | 5.0 | 5.7 |
| X | 268 | 6.3 | 5.3 | 4.7 | 7.7 | 5.0 | 5.7 |
| Av. (5 animals) | | 7.5 | 7.3 | 5.8 | 7.5 | 5.7 | 6.2 |
| Injected samples | | | | | | | |
| VI | 171 | 8.3 | 7.7 | 7.3 | 8.3 | 7.3 | 7.7 |
| VII | 196 | 8.0 | 8.7 | 7.7 | 9.3 | 6.7 | 7.7 |
| VIII | 221 | 8.0 | 8.3 | 7.3 | 8.0 | 7.7 | 8.3 |
| Av. (3 animals) | | 8.1 | 8.2 | 7.4 | 8.5 | 7.2 | 7.9 |
| IX | 243 | 7.7 | 8.3 | 7.0 | 9.0 | 4.3 | 7.7 |
| X | 268 | 6.0 | 6.0 | 6.0 | 9.3 | 5.3 | 6.3 |
| Av. (5 animals) | | 7.6 | 7.8 | 7.1 | 8.8 | 6.3 | 7.5 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tenderness | Juiciness | Texture |
| | | | Meat | Liquid | | | |
| SEMIMEMBRANOSUS MUSCLE | | | | | | | |
| Sodium chloride injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 177 | 7.3 | 7.3 | 5.3 | 5.7 | 5.0 | 4.0 |
| | 179 | 7.3 | 7.0 | 7.3 | 7.3 | 4.7 | 5.0 |
| Av. | | 7.3 | 7.2 | 6.3 | 6.5 | 4.8 | 4.5 |
| VII | 199 | 7.7 | 7.0 | 6.7 | 6.3 | 5.0 | 5.0 |
| | 200 | 7.7 | 7.3 | 6.3 | 7.0 | 6.7 | 6.0 |
| Av. | | 7.7 | 7.2 | 6.5 | 6.6 | 5.8 | 5.5 |
| VIII | 222 | 7.3 | 7.3 | 6.3 | 7.3 | 4.7 | 5.7 |
| | 226 | 7.3 | 7.3 | 6.7 | 8.3 | 5.0 | 6.3 |
| Av. | | 7.3 | 7.3 | 6.5 | 7.8 | 4.8 | 6.0 |
| Av. (3 animals) | | 7.4 | 7.2 | 6.4 | 7.0 | 5.1 | 5.3 |
| IX | 249 | 6.7 | 7.3 | 5.7 | 6.7 | 4.7 | 4.0 |
| | 251 | 7.3 | 6.7 | 6.0 | 7.0 | 3.3 | 4.7 |
| Av. | | 7.0 | 7.0 | 5.8 | 6.8 | 4.0 | 4.4 |
| X | 271 | 7.0 | 5.7 | 4.7 | 6.0 | 4.3 | 3.7 |
| | 272 | 6.7 | 5.3 | 4.7 | 6.7 | 4.3 | 5.0 |
| Av. | | 6.8 | 5.5 | 4.7 | 6.4 | 4.3 | 4.4 |
| Av. (5 animals) | | 7.2 | 6.8 | 6.0 | 6.8 | 4.7 | 5.0 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | | |
| **Sodium chloride injection** (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 177 | 7.3 | 8.0 | 6.7 | 7.3 | 6.3 | 6.7 |
| | 179 | 7.7 | 7.3 | 6.3 | 7.0 | 6.0 | 5.0 |
| Av. | | 7.5 | 7.6 | 6.5 | 7.2 | 6.2 | 5.8 |
| VII | 199 | 7.7 | 8.0 | 7.3 | 8.3 | 5.3 | 7.0 |
| | 200 | 8.0 | 8.7 | 7.3 | 9.0 | 6.3 | 8.0 |
| Av. | | 7.8 | 8.4 | 7.3 | 8.6 | 5.8 | 7.5 |
| VIII | 222 | 8.0 | 7.7 | 7.0 | 8.7 | 6.3 | 6.7 |
| | 226 | 7.7 | 8.3 | 7.3 | 8.0 | 6.0 | 6.7 |
| Av. | | 7.8 | 8.0 | 7.2 | 8.4 | 6.2 | 6.7 |
| Av. (3 animals) | | 7.7 | 8.0 | 7.0 | 8.1 | 6.1 | 6.7 |
| IX | 249 | 7.0 | 7.7 | 7.0 | 7.3 | 4.0 | 4.7 |
| | 251 | 8.0 | 8.0 | 7.3 | 8.3 | 3.3 | 5.3 |
| Av. | | 7.5 | 7.8 | 7.2 | 7.8 | 3.6 | 5.0 |
| X | 271 | 7.0 | 6.3 | 6.3 | 8.0 | 5.7 | 5.3 |
| | 272 | 6.7 | 6.7 | 6.0 | 8.7 | 4.3 | 5.7 |
| Av. | | 6.8 | 6.5 | 6.2 | 8.4 | 5.0 | 5.5 |
| Av. (5 animals) | | 7.5 | 7.7 | 6.9 | 8.1 | 5.4 | 6.1 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Aroma | Palatability scores Flavor Meat | Liquid | Tender-ness | Juici-ness | Tex-ture |
|---|---|---|---|---|---|---|---|
| | | | **SEMIMEMBRANOSUS MUSCLE (continued)** | | | | |
| **Lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 175 | 7.3 | 7.3 | 6.0 | 6.7 | 5.3 | 4.0 |
| | 176 | 7.7 | 6.7 | 6.3 | 7.7 | 3.7 | 5.7 |
| Av. | | 7.5 | 7.0 | 6.2 | 7.2 | 4.5 | 4.8 |
| VII | 198 | 7.7 | 6.7 | 6.3 | 6.7 | 5.0 | 5.7 |
| | 202 | 7.3 | 7.7 | 7.0 | 6.3 | 6.0 | 5.0 |
| Av. | | 7.5 | 7.2 | 6.6 | 6.5 | 5.5 | 5.4 |
| VIII | 225 | 7.7 | 7.0 | 6.3 | 6.3 | 5.0 | 4.0 |
| | 227 | 7.3 | 7.3 | 5.7 | 5.7 | 4.3 | 4.3 |
| Av. | | 7.5 | 7.2 | 6.0 | 6.0 | 4.6 | 4.2 |
| Av. (3 animals) | | 7.5 | 7.1 | 6.3 | 6.6 | 4.9 | 4.8 |
| IX | 247 | 7.0 | 7.0 | 5.3 | 8.0 | 2.7 | 4.7 |
| | 248 | 7.3 | 6.3 | 5.7 | 7.7 | 3.0 | 4.7 |
| Av. | | 7.2 | 6.6 | 5.5 | 7.8 | 2.8 | 4.7 |
| X | 270 | 6.7 | 6.0 | 5.0 | 7.3 | 4.0 | 4.0 |
| | 274 | 7.0 | 6.0 | 4.3 | 7.3 | 4.3 | 4.7 |
| Av. | | 6.8 | 6.0 | 4.6 | 7.3 | 4.2 | 4.4 |
| Av. (5 animals) | | 7.3 | 6.8 | 5.8 | 7.0 | 4.3 | 4.7 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | | |
| <u>Lactic acid injection</u> (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 175 | 7.7 | 7.3 | 7.0 | 7.7 | 4.0 | 5.0 |
| | 176 | 7.7 | 7.7 | 6.0 | 7.3 | 5.3 | 5.7 |
| Av. | | 7.7 | 7.5 | 6.5 | 7.5 | 4.6 | 5.4 |
| VII | 198 | 8.0 | 7.3 | 7.0 | 7.3 | 5.0 | 6.0 |
| | 202 | 7.7 | 8.0 | 6.7 | 7.7 | 7.0 | 7.0 |
| Av. | | 7.8 | 7.6 | 6.8 | 7.5 | 6.0 | 6.5 |
| VIII | 225 | 7.3 | 7.0 | 6.0 | 5.3 | 6.3 | 4.0 |
| | 227 | 7.7 | 7.3 | 6.0 | 6.7 | 3.3 | 4.7 |
| Av. | | 7.5 | 7.2 | 6.0 | 6.0 | 4.8 | 4.4 |
| Av. (3 animals) | | 7.7 | 7.4 | 6.4 | 7.0 | 5.1 | 5.4 |
| IX | 247 | 7.0 | 6.7 | 5.0 | 8.0 | 3.0 | 4.3 |
| | 248 | 7.3 | 7.0 | 5.7 | 7.0 | 3.3 | 5.0 |
| Av. | | 7.2 | 6.8 | 5.4 | 7.5 | 3.2 | 4.6 |
| X | 270 | 6.7 | 5.7 | 5.0 | 7.7 | 5.0 | 5.0 |
| | 274 | 6.3 | 5.7 | 5.0 | 6.7 | 5.0 | 4.7 |
| Av. | | 6.5 | 5.7 | 5.0 | 7.2 | 5.0 | 4.8 |
| Av. (5 animals) | | 7.3 | 7.0 | 5.9 | 7.1 | 4.7 | 5.1 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Aroma | Palatability scores: Flavor Meat | Flavor Liquid | Tender-ness | Juici-ness | Tex-ture |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | | |
| **Sodium chloride and lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 174 | 7.7 | 7.7 | 6.3 | 7.3 | 5.3 | 4.7 |
| | 178 | 7.7 | 7.0 | 6.7 | 6.0 | 3.7 | 3.7 |
| Av. | | 7.7 | 7.4 | 6.5 | 6.6 | 4.5 | 4.2 |
| VII | 201 | 7.7 | 6.7 | 6.7 | 6.0 | 4.7 | 5.0 |
| | 203 | 8.0 | 8.0 | 6.3 | 8.3 | 5.7 | 6.3 |
| Av. | | 7.8 | 7.4 | 6.5 | 7.2 | 5.2 | 5.6 |
| VIII | 223 | 7.3 | 7.0 | 7.7 | 6.0 | 5.0 | 4.7 |
| | 224 | 7.3 | 7.3 | 6.3 | 5.3 | 5.3 | 4.3 |
| Av. | | 7.3 | 7.2 | 7.0 | 5.6 | 5.2 | 4.5 |
| Av. (3 animals) | | 7.6 | 7.3 | 6.7 | 6.5 | 5.0 | 4.8 |
| IX | 246 | 7.3 | 6.7 | 5.7 | 6.7 | 3.0 | 4.0 |
| | 250 | 7.7 | 6.3 | 5.3 | 7.7 | 3.0 | 5.0 |
| Av. | | 7.5 | 6.5 | 5.5 | 7.2 | 3.0 | 4.5 |
| X | 273 | 7.0 | 5.7 | 5.0 | 6.3 | 3.7 | 4.0 |
| | 275 | 6.3 | 5.7 | 4.0 | 7.7 | 5.0 | 4.7 |
| Av. | | 6.6 | 5.7 | 4.5 | 7.0 | 4.4 | 4.4 |
| Av. (5 animals) | | 7.4 | 6.8 | 6.0 | 6.7 | 4.5 | 4.6 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Aroma | Flavor Meat | Flavor Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | SEMIMEMBRANOSUS MUSCLE (continued) | | | | | |
| **Sodium chloride and lactic acid injection** (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 174 | 7.7 | 8.0 | 7.7 | 8.3 | 6.3 | 7.0 |
| | 178 | 7.3 | 7.7 | 7.7 | 7.0 | 5.0 | 5.7 |
| Av. | | 7.5 | 7.8 | 7.7 | 7.6 | 5.6 | 6.4 |
| VII | 201 | 8.0 | 8.3 | 8.0 | 8.3 | 6.7 | 7.3 |
| | 203 | 7.7 | 8.0 | 7.0 | 8.7 | 6.7 | 7.7 |
| Av. | | 7.8 | 8.2 | 7.5 | 8.5 | 6.7 | 7.5 |
| VIII | 223 | 7.7 | 8.0 | 6.0 | 7.7 | 5.7 | 6.3 |
| | 224 | 8.0 | 8.3 | 8.0 | 7.7 | 5.3 | 6.7 |
| Av. | | 7.8 | 8.2 | 7.0 | 7.7 | 5.5 | 6.5 |
| Av. (3 animals) | | 7.7 | 8.1 | 7.4 | 7.9 | 5.9 | 6.8 |
| IX | 246 | 7.3 | 7.7 | 7.3 | 8.0 | 4.7 | 6.0 |
| | 250 | 7.7 | 8.0 | 7.3 | 9.0 | 4.7 | 6.7 |
| Av. | | 7.5 | 7.8 | 7.3 | 8.5 | 4.7 | 6.4 |
| X | 273 | 7.0 | 6.3 | 6.0 | 8.7 | 5.0 | 6.0 |
| | 275 | 6.7 | 6.7 | 6.0 | 8.7 | 4.0 | 5.3 |
| Av. | | 6.8 | 6.5 | 6.0 | 8.7 | 4.5 | 5.6 |
| Av. (5 animals) | | 7.5 | 7.7 | 7.1 | 8.2 | 5.4 | 6.5 |

Palatability scores

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| | | BICEPS FEMORIS MUSCLE | | | | | |
| **Sodium chloride injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 184 | 8.0 | 8.0 | 6.0 | 8.3 | 7.0 | 8.0 |
| | 185 | 8.0 | 6.7 | 6.3 | 7.7 | 6.3 | 6.0 |
| Av. | | 8.0 | 7.4 | 6.2 | 8.0 | 6.6 | 7.0 |
| VII | 205 | 8.3 | 7.3 | 6.3 | 7.7 | 6.3 | 6.3 |
| | 207 | 7.7 | 8.0 | 6.7 | 7.3 | 6.0 | 6.3 |
| Av. | | 8.0 | 7.6 | 6.5 | 7.5 | 6.2 | 6.3 |
| VIII | 228 | 7.7 | 7.7 | 6.3 | 8.0 | 7.7 | 5.7 |
| | 230 | 8.0 | 7.0 | 6.3 | 6.7 | 4.7 | 4.7 |
| Av. | | 7.8 | 7.4 | 6.3 | 7.4 | 6.2 | 5.2 |
| Av. (3 animals) | | 7.9 | 7.5 | 6.3 | 7.6 | 6.3 | 6.2 |
| IX | 256 | 7.3 | 6.3 | 5.3 | 7.3 | 4.0 | 4.7 |
| | 257 | 7.3 | 6.7 | 5.7 | 8.7 | 3.0 | 6.0 |
| Av. | | 7.3 | 6.5 | 5.5 | 8.0 | 3.5 | 5.4 |
| X | 277 | 5.7 | 3.3 | 3.3 | 6.7 | 3.7 | 3.3 |
| | 279 | 6.7 | 3.7 | 3.7 | 8.3 | 5.0 | 6.0 |
| Av. | | 6.2 | 3.5 | 3.5 | 7.5 | 4.4 | 4.6 |
| Av. (5 animals) | | 7.5 | 6.5 | 5.6 | 7.7 | 5.4 | 5.7 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores: Aroma | Flavor: Meat | Flavor: Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | BICEPS FEMORIS MUSCLE (continued) | | | | | |
| Sodium chloride injection (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 184 | 7.7 | 7.7 | 8.0 | 6.3 | 7.3 | 6.3 |
| | 185 | 7.7 | 7.7 | 7.3 | 8.7 | 7.0 | 7.7 |
| Av. | | 7.7 | 7.7 | 7.6 | 7.5 | 7.2 | 7.0 |
| VII | 205 | 7.7 | 8.0 | 8.0 | 8.3 | 6.0 | 7.3 |
| | 207 | 7.7 | 8.3 | 7.3 | 9.3 | 7.0 | 8.0 |
| Av. | | 7.7 | 8.2 | 7.6 | 8.8 | 6.5 | 7.6 |
| VIII | 228 | 8.0 | 8.0 | 7.0 | 9.0 | 7.3 | 8.3 |
| | 230 | 7.7 | 7.7 | 7.3 | 8.7 | 6.3 | 7.3 |
| Av. | | 7.8 | 7.8 | 7.2 | 8.8 | 6.8 | 7.8 |
| Av. (3 animals) | | 7.7 | 7.9 | 7.5 | 8.4 | 6.8 | 7.5 |
| IX | 256 | 7.0 | 7.7 | 7.0 | 8.0 | 4.7 | 6.0 |
| | 257 | 7.3 | 7.3 | 7.0 | 9.0 | 3.7 | 7.0 |
| Av. | | 7.2 | 7.5 | 7.0 | 8.5 | 4.2 | 6.5 |
| X | 277 | 6.0 | 4.3 | 5.7 | 7.7 | 4.3 | 5.7 |
| | 279 | 7.3 | 4.3 | 5.7 | 8.7 | 6.0 | 6.3 |
| Av. | | 6.6 | 4.3 | 5.7 | 8.2 | 5.2 | 6.0 |
| Av. (5 animals) | | 7.4 | 7.1 | 7.0 | 8.4 | 6.0 | 7.0 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | | |
| **Lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 181 | 8.0 | 7.7 | 6.3 | 8.3 | 6.3 | 7.7 |
| | 183 | 7.7 | 7.0 | 6.7 | 7.3 | 6.7 | 6.7 |
| Av. | | 7.8 | 7.4 | 6.5 | 7.8 | 6.5 | 7.2 |
| VII | 204 | 8.0 | 7.3 | 6.0 | 8.7 | 6.7 | 6.7 |
| | 206 | 7.7 | 8.0 | 7.3 | 8.0 | 6.0 | 6.7 |
| Av. | | 7.8 | 7.6 | 6.6 | 8.4 | 6.4 | 6.7 |
| VIII | 232 | 8.3 | 7.3 | 6.0 | 7.0 | 5.3 | 6.3 |
| | 233 | 7.3 | 7.3 | 6.3 | 7.7 | 5.3 | 5.7 |
| Av. | | 7.8 | 7.3 | 6.2 | 7.4 | 5.3 | 6.0 |
| Av. (3 animals) | | 7.8 | 7.4 | 6.4 | 7.9 | 6.1 | 6.6 |
| IX | 253 | 7.0 | 7.3 | 5.3 | 8.3 | 6.0 | 6.3 |
| | 255 | 7.0 | 7.0 | 5.3 | 7.3 | 3.3 | 4.3 |
| Av. | | 7.0 | 7.2 | 5.3 | 7.8 | 4.6 | 5.3 |
| X | 276 | 5.0 | 3.7 | 5.0 | 7.0 | 3.3 | 4.0 |
| | 278 | 6.3 | 4.3 | 3.0 | 7.3 | 3.7 | 5.0 |
| Av. | | 5.6 | 4.0 | 4.0 | 7.2 | 3.5 | 4.5 |
| Av. (5 animals) | | 7.2 | 6.7 | 5.7 | 7.7 | 5.3 | 5.9 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores | | | | | |
|---|---|---|---|---|---|---|---|
| | | Aroma | Flavor | | Tender-ness | Juici-ness | Tex-ture |
| | | | Meat | Liquid | | | |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | | |
| Lactic acid injection (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 181 | 7.7 | 7.3 | 6.7 | 8.7 | 7.0 | 7.7 |
| | 183 | 8.0 | 7.0 | 6.3 | 8.0 | 5.7 | 6.7 |
| Av. | | 7.8 | 7.2 | 6.5 | 8.4 | 6.4 | 7.2 |
| VII | 204 | 8.0 | 8.0 | 7.3 | 8.7 | 7.7 | 7.0 |
| | 206 | 7.7 | 8.0 | 7.0 | 8.3 | 6.3 | 7.3 |
| Av. | | 7.8 | 8.0 | 7.2 | 8.5 | 7.0 | 7.2 |
| VIII | 232 | 8.3 | 7.7 | 6.3 | 7.0 | 6.3 | 6.0 |
| | 233 | 7.3 | 7.7 | 5.7 | 7.7 | 5.7 | 6.3 |
| Av. | | 7.8 | 7.7 | 6.0 | 7.4 | 6.0 | 6.2 |
| Av. (3 animals) | | 7.8 | 7.6 | 6.6 | 8.1 | 6.5 | 6.9 |
| IX | 253 | 7.7 | 7.3 | 5.3 | 8.3 | 4.3 | 6.0 |
| | 255 | 7.0 | 6.3 | 5.7 | 7.0 | 2.7 | 5.0 |
| Av. | | 7.4 | 6.8 | 5.5 | 7.6 | 3.5 | 5.5 |
| X | 276 | 5.7 | 3.7 | 4.3 | 7.0 | 4.3 | 4.0 |
| | 278 | 7.0 | 4.0 | 5.0 | 7.7 | 5.3 | 5.0 |
| Av. | | 6.4 | 3.8 | 4.6 | 7.4 | 4.8 | 4.5 |
| Av. (5 animals) | | 7.4 | 6.7 | 6.0 | 7.9 | 5.5 | 6.1 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Palatability scores: Aroma | Flavor: Meat | Flavor: Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | **BICEPS FEMORIS MUSCLE (continued)** | | | | | |
| Sodium chloride and lactic acid injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 180 | 7.7 | 8.0 | 7.0 | 9.0 | 7.7 | 8.3 |
| | 182 | 8.0 | 7.3 | 7.0 | 9.0 | 7.0 | 7.0 |
| Av. | | 7.8 | 7.6 | 7.0 | 9.0 | 7.4 | 7.6 |
| VII | 208 | 7.7 | 7.3 | 6.7 | 7.0 | 7.3 | 6.3 |
| | 209 | 8.3 | 8.0 | 6.3 | 8.3 | 6.3 | 6.3 |
| Av. | | 8.0 | 7.6 | 6.5 | 7.6 | 6.8 | 6.3 |
| VIII | 229 | 7.7 | 8.0 | 6.3 | 8.3 | 7.0 | 7.0 |
| | 231 | 7.7 | 7.0 | 5.7 | 7.3 | 5.7 | 5.7 |
| Av. | | 7.7 | 7.5 | 6.0 | 7.8 | 6.4 | 6.4 |
| Av. (3 animals) | | 7.8 | 7.6 | 6.5 | 8.1 | 6.9 | 6.8 |
| IX | 252 | 6.7 | 6.7 | 6.0 | 9.3 | 4.3 | 6.3 |
| | 254 | 7.7 | 7.0 | 5.0 | 8.0 | 5.7 | 5.7 |
| Av. | | 7.2 | 6.8 | 5.5 | 8.6 | 5.0 | 6.0 |
| X | 280 | 5.3 | 4.3 | 3.7 | 8.0 | 3.0 | 5.0 |
| | 281 | 6.7 | 4.0 | 4.0 | 8.7 | 4.7 | 6.0 |
| Av. | | 6.0 | 4.2 | 3.8 | 8.4 | 3.8 | 5.5 |
| Av. (5 animals) | | 7.3 | 6.7 | 5.8 | 8.3 | 5.9 | 6.4 |

(continued)

Table 1 (continued)

| Animal no. | Sample no. | Aroma | Flavor Meat | Flavor Liquid | Tenderness | Juiciness | Texture |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | | |
| Sodium chloride and lactic acid injection (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 180 | 8.0 | 7.7 | 7.0 | 9.0 | 7.3 | 8.3 |
| | 182 | 8.0 | 8.0 | 7.7 | 8.7 | 7.3 | 8.0 |
| Av. | | 8.0 | 7.8 | 7.4 | 8.8 | 7.3 | 8.2 |
| VII | 208 | 7.7 | 8.0 | 7.7 | 8.0 | 7.0 | 7.7 |
| | 209 | 8.3 | 7.7 | 7.7 | 8.7 | 6.7 | 7.3 |
| Av. | | 8.0 | 7.8 | 7.7 | 8.4 | 6.8 | 7.5 |
| VIII | 229 | 7.7 | 7.7 | 8.0 | 9.0 | 6.0 | 7.7 |
| | 231 | 8.0 | 8.3 | 7.3 | 9.0 | 6.3 | 7.7 |
| Av. | | 7.8 | 8.0 | 7.6 | 9.0 | 6.2 | 7.7 |
| Av. (3 animals) | | 7.9 | 7.9 | 7.6 | 8.7 | 6.8 | 7.8 |
| IX | 252 | 7.0 | 8.0 | 7.0 | 9.7 | 4.7 | 7.0 |
| | 254 | 7.3 | 8.0 | 7.0 | 9.0 | 5.7 | 7.0 |
| Av. | | 7.2 | 8.0 | 7.0 | 9.4 | 5.2 | 7.0 |
| X | 280 | 5.7 | 5.3 | 5.7 | 8.3 | 4.7 | 5.7 |
| | 281 | 7.0 | 4.3 | 4.7 | 8.7 | 6.0 | 6.3 |
| Av. | | 6.4 | 4.8 | 5.2 | 8.5 | 5.4 | 6.0 |
| Av. (5 animals) | | 7.5 | 7.3 | 7.0 | 8.8 | 6.2 | 7.3 |

Table 2. Slicing Quality of Canned Beef. The number of slices obtained grouped according to muscle used and processing time.

| Animal* no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION | | | | | | | |
| Sodium chloride injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 162 | 4 | 4 | 10 | 40.0 | 40.0 | 80.0 |
| VII | 188 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| VIII | 211 | 0 | 7 | 12 | 0 | 58.3 | 58.3 |
| Av. (3 animals) | | 1.3 | 4.7 | 11.0 | 13.3 | 41.9 | 55.2 |
| IX | 234 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| X | 260 | 0 | 6 | 11 | 0 | 54.5 | 54.5 |
| Av. (5 animals) | | 0.8 | 4.6 | 11.0 | 8.0 | 41.5 | 49.5 |
| Injected samples | | | | | | | |
| VI | 162 | 5 | 3 | 11 | 45.4 | 27.3 | 72.7 |
| VII | 188 | 0 | 4 | 13 | 0 | 30.8 | 30.8 |
| VIII | 211 | 0 | 2 | 13 | 0 | 15.4 | 15.4 |
| Av. (3 animals) | | 1.7 | 3.0 | 12.3 | 15.1 | 24.5 | 39.6 |
| IX | 234 | 0 | 0 | 11 | 0 | 0 | 0 |
| X | 260 | 8 | 1 | 12 | 66.7 | 8.3 | 75.0 |
| Av. (5 animals) | | 2.6 | 2.0 | 12.0 | 22.4 | 16.4 | 38.8 |

(continued)

*Animals VI, VII, and VIII were steers, carcass grade Commercial, processed 65 minutes; Animal IX was a steer carcass grade Commercial, processed 90 minutes; Animal X was a cow, carcass grade Cutter, processed 90 minutes.

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | | | | |
| Lactic acid injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 164 | 6 | 4 | 11 | 54.5 | 36.4 | 90.9 |
| VII | 187 | 0 | 0 | 13 | 0 | 0 | 0 |
| VIII | 210 | 0 | 0 | 12 | 0 | 0 | 0 |
| Av. (3 animals) | | 2.0 | 1.3 | 12.0 | 18.2 | 12.1 | 30.3 |
| IX | 236 | 0 | 2 | 11 | 0 | 18.2 | 18.2 |
| X | 259 | 0 | 0 | 11 | 0 | 0 | 0 |
| Av. (5 animals) | | 1.2 | 1.2 | 11.6 | 10.9 | 10.9 | 21.8 |
| Injected samples | | | | | | | |
| VI | 164 | 6 | 4 | 12 | 50.0 | 33.3 | 83.3 |
| VII | 187 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| VIII | 210 | 7 | 2 | 12 | 58.3 | 16.7 | 75.0 |
| Av. (3 animals) | | 4.3 | 3.0 | 11.7 | 36.1 | 25.8 | 61.9 |
| IX | 236 | 0 | 2 | 12 | 0 | 16.7 | 16.7 |
| X | 259 | 4 | 3 | 11 | 36.4 | 27.3 | 63.7 |
| Av. (5 animals) | | 3.4 | 2.8 | 11.6 | 28.9 | 24.3 | 53.2 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | | | | |
| Sodium chloride and lactic acid injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 163 | 0 | 7 | 11 | 0 | 63.6 | 63.6 |
| VII | 186 | 2 | 6 | 11 | 18.2 | 54.5 | 72.7 |
| VIII | 212 | 0 | 5 | 13 | 0 | 38.5 | 38.5 |
| Av. (3 animals) | | 0.7 | 6.0 | 11.7 | 6.1 | 52.2 | 58.3 |
| IX | 235 | 0 | 0 | 10 | 0 | 0 | 0 |
| X | 258 | 7 | 1 | 11 | 63.6 | 9.1 | 72.7 |
| Av. (5 animals) | | 1.8 | 3.8 | 11.2 | 16.4 | 33.1 | 49.5 |
| Injected samples | | | | | | | |
| VI | 163 | 8 | 2 | 12 | 66.7 | 16.7 | 83.4 |
| VII | 186 | 2 | 2 | 12 | 16.7 | 16.7 | 33.4 |
| VIII | 212 | 2 | 7 | 12 | 16.7 | 58.3 | 75.0 |
| Av. (3 animals) | | 4.0 | 3.7 | 12.0 | 33.4 | 30.6 | 63.9 |
| IX | 235 | 0 | 0 | 12 | 0 | 0 | 0 |
| X | 258 | 2 | 6 | 11 | 18.2 | 54.5 | 72.7 |
| Av. (5 animals) | | 2.8 | 3.4 | 11.8 | 23.7 | 29.2 | 52.9 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION | | | | | | | |
| **Sodium chloride injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 167 | 10 | 0 | 10 | 100.0 | 0 | 100.0 |
| VII | 189 | 2 | 5 | 10 | 20.0 | 50.0 | 70.0 |
| VIII | 214 | 8 | 1 | 11 | 72.7 | 9.1 | 81.8 |
| Av. (3 animals) | | 6.7 | 2.0 | 10.3 | 64.2 | 19.7 | 83.9 |
| IX | 239 | 8 | 1 | 10 | 80.0 | 10.0 | 90.0 |
| X | 261 | 2 | 5 | 10 | 20.0 | 50.0 | 70.0 |
| Av. (5 animals) | | 6.0 | 2.4 | 10.2 | 58.5 | 23.8 | 82.4 |
| Injected samples | | | | | | | |
| VI | 167 | 9 | 0 | 10 | 90.0 | 0 | 90.0 |
| VII | 189 | 3 | 2 | 10 | 30.0 | 20.0 | 50.0 |
| VIII | 214 | 1 | 7 | 10 | 10.0 | 70.0 | 80.0 |
| Av. (3 animals) | | 4.3 | 3.0 | 10.0 | 43.3 | 30.0 | 73.3 |
| IX | 239 | 3 | 3 | 10 | 30.0 | 30.0 | 60.0 |
| X | 261 | 0 | 7 | 10 | 0 | 70.0 | 70.0 |
| Av. (5 animals) | | 3.2 | 3.8 | 10.0 | 32.0 | 38.0 | 70.0 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | | | | |
| Lactic acid injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 165 | 1 | 7 | 11 | 9.1 | 63.6 | 72.7 |
| VII | 190 | 7 | 4 | 11 | 63.6 | 36.4 | 100.0 |
| VIII | 215 | 5 | 4 | 10 | 50.0 | 40.0 | 90.0 |
| Av. (3 animals) | | 4.3 | 5.0 | 10.7 | 40.9 | 46.7 | 87.6 |
| IX | 237 | 5 | 4 | 11 | 45.4 | 36.4 | 81.8 |
| X | 262 | 6 | 2 | 10 | 60.0 | 20.0 | 80.0 |
| Av. (5 animals) | | 4.8 | 4.2 | 10.6 | 45.6 | 39.3 | 84.9 |
| Injected samples | | | | | | | |
| VI | 165 | 0 | 4 | 10 | 0 | 40.0 | 40.0 |
| VII | 190 | 9 | 2 | 11 | 81.8 | 18.2 | 100.0 |
| VIII | 215 | 9 | 2 | 11 | 81.8 | 18.2 | 100.0 |
| Av. (3 animals) | | 6.0 | 2.7 | 10.7 | 54.5 | 25.5 | 80.0 |
| IX | 237 | 6 | 2 | 11 | 54.5 | 18.2 | 72.7 |
| X | 262 | 7 | 1 | 9 | 77.8 | 11.1 | 88.9 |
| Av. (5 animals) | | 6.2 | 2.2 | 10.4 | 59.2 | 21.1 | 80.3 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained Firm | No. slices obtained Crumbly | Possible no. slices | Slices obtained Firm | Slices obtained Crumbly | Slices obtained Total |
|---|---|---|---|---|---|---|---|
| | | | | | % | % | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | | | | |
| **Sodium chloride and lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 166 | 0 | 5 | 10 | 0 | 50.0 | 50.0 |
| VII | 191 | 9 | 1 | 11 | 81.8 | 9.1 | 90.9 |
| VIII | 213 | 2 | 7 | 10 | 20.0 | 70.0 | 90.0 |
| Av. (3 animals) | | 3.7 | 4.3 | 10.3 | 33.9 | 43.0 | 77.0 |
| IX | 238 | 0 | 2 | 10 | 0 | 20.0 | 20.0 |
| X | 263 | 0 | 1 | 12 | 0 | 8.3 | 8.3 |
| Av. (5 animals) | | 2.2 | 3.2 | 10.6 | 20.4 | 31.5 | 51.8 |
| Injected samples | | | | | | | |
| VI | 166 | 0 | 8 | 10 | 0 | 80.0 | 80.0 |
| VII | 191 | 1 | 8 | 10 | 10.0 | 80.0 | 90.0 |
| VIII | 213 | 2 | 7 | 10 | 20.0 | 70.0 | 90.0 |
| Av. (3 animals) | | 1.0 | 7.7 | 10.0 | 10.0 | 76.7 | 86.7 |
| IX | 238 | 0 | 2 | 10 | 0 | 20.0 | 20.0 |
| X | 263 | 6 | 1 | 10 | 60.0 | 10.0 | 70.0 |
| Av. (5 animals) | | 1.8 | 5.2 | 10.0 | 18.0 | 52.0 | 70.0 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained Firm | No. slices obtained Crumbly | Possible no. slices | Slices obtained Firm % | Slices obtained Crumbly % | Total % |
|---|---|---|---|---|---|---|---|
| PSOAS MAJOR AND PSOAS MINOR MUSCLES | | | | | | | |
| Sodium chloride injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 168 | 2 | 8 | 10 | 20.0 | 80.0 | 100.0 |
| VII | 193 | 0 | 6 | 11 | 0 | 54.5 | 54.5 |
| VIII | 218 | 4 | 5 | 11 | 36.4 | 45.4 | 81.8 |
| Av. (3 animals) | | 2.0 | 6.3 | 10.7 | 18.8 | 60.0 | 78.8 |
| IX | 240 | 0 | 6 | 13 | 0 | 46.2 | 46.2 |
| X | 265 | 0 | 9 | 12 | 0 | 75.0 | 75.0 |
| Av. (5 animals) | | 1.2 | 6.8 | 11.4 | 11.3 | 60.2 | 71.5 |
| Injected samples | | | | | | | |
| VI | 168 | 0 | 7 | 10 | 0 | 70.0 | 70.0 |
| VII | 193 | 0 | 2 | 10 | 0 | 20.0 | 20.0 |
| VIII | 218 | 1 | 3 | 11 | 9.1 | 27.3 | 36.4 |
| Av. (3 animals) | | 0.3 | 4.0 | 10.3 | 3.0 | 39.1 | 42.1 |
| IX | 240 | 0 | 0 | 11 | 0 | 0 | 0 |
| X | 265 | 8 | 2 | 12 | 66.7 | 16.7 | 83.4 |
| Av. (5 animals) | | 1.8 | 2.8 | 10.8 | 15.2 | 26.8 | 42.0 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained Firm | Crumbly | Possible no. slices | Slices obtained Firm % | Crumbly % | Total % |
|---|---|---|---|---|---|---|---|
| PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued) | | | | | | | |
| **Lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 169 | 3 | 7 | 10 | 30.0 | 70.0 | 100.0 |
| VII | 194 | 0 | 6 | 10 | 0 | 60.0 | 60.0 |
| VIII | 216 | 1 | 4 | 12 | 8.3 | 33.3 | 41.6 |
| Av. (3 animals) | | 1.3 | 5.7 | 10.7 | 12.8 | 54.4 | 67.2 |
| IX | 241 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| X | 266 | 7 | 2 | 12 | 58.3 | 16.7 | 75.0 |
| Av. (5 animals) | | 2.2 | 4.4 | 11.0 | 19.3 | 41.5 | 60.8 |
| Injected samples | | | | | | | |
| VI | 169 | 0 | 8 | 10 | 0 | 80.0 | 80.0 |
| VII | 194 | 0 | 1 | 10 | 0 | 10.0 | 10.0 |
| VIII | 216 | 0 | 2 | 11 | 0 | 18.2 | 18.2 |
| Av. (3 animals) | | 0 | 3.7 | 10.3 | 0 | 36.1 | 36.1 |
| IX | 241 | 0 | 2 | 9 | 0 | 22.2 | 22.2 |
| X | 266 | 5 | 4 | 11 | 45.4 | 36.4 | 81.8 |
| Av. (5 animals) | | 1.0 | 3.4 | 10.2 | 9.1 | 33.4 | 42.4 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued) | | | | | | | |
| Sodium chloride and lactic acid injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 170 | 3 | 6 | 10 | 30.0 | 60.0 | 90.0 |
| VII | 192 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| VIII | 217 | 0 | 7 | 12 | 0 | 58.3 | 58.3 |
| Av. (3 animals) | | 1.0 | 5.3 | 11.0 | 10.0 | 48.5 | 58.5 |
| IX | 242 | 2 | 3 | 9 | 22.2 | 33.3 | 55.5 |
| X | 264 | 0 | 4 | 12 | 0 | 33.3 | 33.3 |
| Av. (5 animals) | | 1.0 | 4.6 | 10.8 | 10.4 | 42.4 | 52.9 |
| Injected samples | | | | | | | |
| VI | 170 | 0 | 8 | 10 | 0 | 80.0 | 80.0 |
| VII | 192 | 0 | 2 | 10 | 0 | 20.0 | 20.0 |
| VIII | 217 | 1 | 5 | 10 | 10.0 | 50.0 | 60.0 |
| Av. (3 animals) | | 0.3 | 5.0 | 10.0 | 3.3 | 50.0 | 53.3 |
| IX | 242 | 0 | 2 | 10 | 0 | 20.0 | 20.0 |
| X | 264 | 0 | 6 | 11 | 0 | 54.5 | 54.5 |
| Av. (5 animals) | | 0.2 | 4.6 | 10.2 | 2.0 | 44.9 | 46.9 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| **SEMITENDINOSUS MUSCLE** | | | | | | | |
| Sodium chloride injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 172 | 8 | 1 | 10 | 80.0 | 10.0 | 90.0 |
| VII | 197 | 11 | 1 | 12 | 91.7 | 8.3 | 100.0 |
| VIII | 219 | 10 | 0 | 10 | 100.0 | 0 | 100.0 |
| Av. (3 animals) | | 9.7 | 0.7 | 10.7 | 90.6 | 6.1 | 96.7 |
| IX | 244 | 8 | 1 | 10 | 80.0 | 10.0 | 90.0 |
| X | 269 | 11 | 1 | 12 | 91.7 | 8.3 | 100.0 |
| Av. (5 animals) | | 9.6 | 0.8 | 10.8 | 88.7 | 7.3 | 96.0 |
| Injected samples | | | | | | | |
| VI | 172 | 9 | 0 | 9 | 100.0 | 0 | 100.0 |
| VII | 197 | 9 | 3 | 12 | 75.0 | 25.0 | 100.0 |
| VIII | 219 | 10 | 0 | 10 | 100.0 | 0 | 100.0 |
| Av. (3 animals) | | 9.3 | 1.0 | 10.3 | 91.7 | 8.3 | 100.0 |
| IX | 244 | 8 | 1 | 9 | 88.9 | 11.1 | 100.0 |
| X | 269 | 11 | 1 | 12 | 91.7 | 8.3 | 100.0 |
| Av. (5 animals) | | 9.4 | 1.0 | 10.4 | 91.1 | 8.9 | 100.0 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| SEMITENDINOSUS MUSCLE (continued) | | | | | | | |
| **Lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 173 | 6 | 0 | 10 | 60.0 | 0 | 60.0 |
| VII | 195 | 11 | 0 | 11 | 100.0 | 0 | 100.0 |
| VIII | 220 | 10 | 0 | 10 | 100.0 | 0 | 100.0 |
| Av. (3 animals) | | 9.0 | 0 | 10.3 | 86.7 | 0 | 86.7 |
| IX | 245 | 8 | 1 | 10 | 80.0 | 10.0 | 90.0 |
| X | 267 | 12 | 0 | 12 | 100.0 | 0 | 100.0 |
| Av. (5 animals) | | 9.4 | 0.2 | 10.6 | 88.0 | 2.0 | 90.0 |
| Injected samples | | | | | | | |
| VI | 173 | 6 | 0 | 11 | 54.5 | 0 | 54.5 |
| VII | 195 | 9 | 2 | 11 | 81.8 | 18.2 | 100.0 |
| VIII | 220 | 10 | 0 | 10 | 100.0 | 0 | 100.0 |
| Av. (3 animals) | | 8.3 | 0.7 | 10.7 | 78.8 | 6.1 | 84.8 |
| IX | 245 | 7 | 3 | 10 | 70.0 | 30.0 | 100.0 |
| X | 267 | 12 | 0 | 12 | 100.0 | 0 | 100.0 |
| Av. (5 animals) | | 8.8 | 1.0 | 10.8 | 81.3 | 9.6 | 90.9 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| | | | | SEMITENDINOSUS MUSCLE (continued) | | | |
| **Sodium chloride and lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 171 | 9 | 2 | 11 | 81.8 | 18.2 | 100.0 |
| VII | 196 | 11 | 0 | 11 | 100.0 | 0 | 100.0 |
| VIII | 221 | 10 | 0 | 10 | 100.0 | 0 | 100.0 |
| Av. (3 animals) | | 10.0 | 0.7 | 10.7 | 93.9 | 6.1 | 100.0 |
| IX | 243 | 9 | 1 | 10 | 90.0 | 10.0 | 100.0 |
| X | 268 | 12 | 0 | 12 | 100.0 | 0 | 100.0 |
| Av. (5 animals) | | 10.2 | 0.6 | 10.8 | 94.4 | 5.6 | 100.0 |
| Injected samples | | | | | | | |
| VI | 171 | 9 | 1 | 10 | 90.0 | 10.0 | 100.0 |
| VII | 196 | 10 | 0 | 10 | 100.0 | 0 | 100.0 |
| VIII | 221 | 10 | 0 | 10 | 100.0 | 0 | 100.0 |
| Av. (3 animals) | | 9.7 | 0.3 | 10.0 | 96.7 | 3.3 | 100.0 |
| IX | 243 | 6 | 2 | 9 | 66.7 | 22.2 | 88.9 |
| X | 268 | 11 | 1 | 12 | 91.7 | 8.3 | 100.0 |
| Av. (5 animals) | | 9.2 | 0.8 | 10.2 | 89.7 | 8.1 | 97.8 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| SEMIMEMBRANOSUS MUSCLE | | | | | | | |
| Sodium chloride injection | | | | | | | |
| Control samples | | | | | | | |
| VI | 177 | 2 | 5 | 11 | 18.2 | 45.4 | 63.6 |
| | 179 | 0 | 5 | 10 | 0 | 50.0 | 50.0 |
| Av. | | 1.0 | 5.0 | 10.5 | 9.1 | 47.7 | 56.8 |
| VII | 199 | 0 | 2 | 12 | 0 | 16.7 | 16.7 |
| | 200 | 4 | 5 | 11 | 36.4 | 45.4 | 81.8 |
| Av. | | 2.0 | 3.5 | 11.5 | 18.2 | 31.0 | 49.2 |
| VIII | 222 | 0 | 7 | 11 | 0 | 63.6 | 63.6 |
| | 226 | 2 | 5 | 11 | 18.2 | 45.4 | 63.6 |
| Av. | | 1.0 | 6.0 | 11.0 | 9.1 | 54.5 | 63.6 |
| Av. (3 animals) | | 1.3 | 4.8 | 11.0 | 12.1 | 44.4 | 56.5 |
| IX | 249 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| | 251 | 2 | 4 | 11 | 18.2 | 36.4 | 54.6 |
| Av. | | 1.0 | 3.5 | 11.0 | 9.1 | 31.8 | 41.0 |
| X | 271 | 2 | 7 | 12 | 16.7 | 58.3 | 75.0 |
| | 272 | 7 | 4 | 12 | 58.3 | 33.3 | 91.6 |
| Av. | | 4.5 | 5.5 | 12.0 | 37.5 | 45.8 | 83.3 |
| Av. (5 animals) | | 1.9 | 4.7 | 11.2 | 16.6 | 42.2 | 58.8 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | | |
| <u>Sodium chloride injection</u> (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 177 | 6 | 4 | 11 | 54.5 | 36.4 | 90.9 |
| | 179 | 0 | 6 | 11 | 0 | 54.5 | 54.5 |
| Av. | | 3.0 | 5.0 | 11.0 | 27.2 | 45.4 | 72.7 |
| VII | 199 | 4 | 5 | 12 | 33.3 | 41.7 | 75.0 |
| | 200 | 2 | 7 | 10 | 20.0 | 70.0 | 90.0 |
| Av. | | 3.0 | 6.0 | 11.0 | 26.6 | 55.8 | 82.5 |
| VIII | 222 | 0 | 8 | 12 | 0 | 66.7 | 66.7 |
| | 226 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| Av. | | 0 | 5.5 | 11.5 | 0 | 47.0 | 47.0 |
| Av. (3 animals) | | 2.0 | 5.5 | 11.2 | 17.9 | 49.4 | 67.4 |
| IX | 249 | 0 | 0 | 11 | 0 | 0 | 0 |
| | 251 | 0 | 2 | 11 | 0 | 18.2 | 18.2 |
| Av. | | 0 | 1.0 | 11.0 | 0 | 9.1 | 9.1 |
| X | 271 | 5 | 4 | 12 | 41.7 | 33.3 | 75.0 |
| | 272 | 0 | 8 | 11 | 0 | 72.7 | 72.7 |
| Av. | | 2.5 | 6.0 | 11.5 | 20.8 | 53.0 | 73.8 |
| Av. (5 animals) | | 1.7 | 4.7 | 11.2 | 14.9 | 42.1 | 57.0 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | | |
| **Lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 175 | 1 | 3 | 10 | 10.0 | 30.0 | 40.0 |
| | 176 | 8 | 3 | 12 | 66.7 | 25.0 | 91.7 |
| Av. | | 4.5 | 3.0 | 11.0 | 38.4 | 27.5 | 65.8 |
| VII | 198 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| | 202 | 1 | 6 | 11 | 9.1 | 54.5 | 63.6 |
| Av. | | 0.5 | 4.5 | 11.0 | 4.6 | 40.9 | 45.4 |
| VIII | 225 | 0 | 4 | 11 | 0 | 36.4 | 36.4 |
| | 227 | 0 | 1 | 12 | 0 | 8.3 | 8.3 |
| Av. | | 0 | 2.5 | 11.5 | 0 | 22.4 | 22.4 |
| Av. (3 animals) | | 1.7 | 3.3 | 11.2 | 14.3 | 30.3 | 44.5 |
| IX | 247 | 0 | 4 | 11 | 0 | 36.4 | 36.4 |
| | 248 | 0 | 1 | 11 | 0 | 9.1 | 9.1 |
| Av. | | 0 | 2.5 | 11.0 | 0 | 22.8 | 22.8 |
| X | 270 | 2 | 8 | 11 | 18.2 | 72.7 | 90.9 |
| | 274 | 6 | 2 | 11 | 54.5 | 18.2 | 72.7 |
| Av. | | 4.0 | 5.0 | 11.0 | 36.4 | 45.4 | 81.8 |
| Av. (5 animals) | | 1.8 | 3.5 | 11.1 | 15.9 | 31.8 | 47.6 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained Firm | No. slices obtained Crumbly | Possible no. slices | Slices obtained Firm | Slices obtained Crumbly | Slices obtained Total |
|---|---|---|---|---|---|---|---|
| | | | | | % | % | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | | |
| Lactic acid injection (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 175 | 2 | 6 | 11 | 18.2 | 54.5 | 72.7 |
| | 176 | 3 | 5 | 11 | 27.3 | 45.4 | 72.7 |
| Av. | | 2.5 | 5.5 | 11.0 | 22.8 | 50.0 | 72.7 |
| VII | 198 | 0 | 4 | 10 | 0 | 40.0 | 40.0 |
| | 202 | 10 | 1 | 12 | 83.3 | 8.3 | 91.6 |
| Av. | | 5.0 | 2.5 | 11.0 | 41.6 | 24.2 | 65.8 |
| VIII | 225 | 5 | 3 | 12 | 41.7 | 25.0 | 66.7 |
| | 227 | 2 | 5 | 12 | 16.7 | 41.7 | 58.4 |
| Av. | | 3.5 | 4.0 | 12.0 | 29.2 | 33.4 | 62.6 |
| Av. (3 animals) | | 3.7 | 4.0 | 11.3 | 31.2 | 35.9 | 67.0 |
| IX | 247 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| | 248 | 0 | 0 | 11 | 0 | 0 | 0 |
| Av. | | 0 | 1.5 | 11.0 | 0 | 13.6 | 13.6 |
| X | 270 | 0 | 9 | 12 | 0 | 75.0 | 75.0 |
| | 274 | 4 | 4 | 11 | 36.4 | 36.4 | 72.8 |
| Av. | | 2.0 | 6.5 | 11.5 | 18.2 | 55.7 | 73.9 |
| Av. (5 animals) | | 2.6 | 4.0 | 11.3 | 22.4 | 35.4 | 57.7 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained Firm | No. slices obtained Crumbly | Possible no. slices | Slices obtained Firm | Slices obtained Crumbly | Total |
|---|---|---|---|---|---|---|---|
| | | | | | % | % | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | | |
| <u>Sodium chloride and lactic acid injection</u> | | | | | | | |
| Control samples | | | | | | | |
| VI | 174 | 0 | 8 | 10 | 0 | 80.0 | 80.0 |
| | 178 | 5 | 5 | 12 | 41.7 | 41.7 | 83.4 |
| Av. | | 2.5 | 6.5 | 11.0 | 20.8 | 60.8 | 81.7 |
| VII | 201 | 0 | 8 | 12 | 0 | 66.7 | 66.7 |
| | 203 | 2 | 7 | 12 | 16.7 | 58.3 | 75.0 |
| Av. | | 1.0 | 7.5 | 12.0 | 8.4 | 62.5 | 70.8 |
| VIII | 223 | 0 | 7 | 12 | 0 | 58.3 | 58.3 |
| | 224 | 3 | 6 | 11 | 27.3 | 54.5 | 81.8 |
| Av. | | 1.5 | 6.5 | 11.5 | 13.6 | 56.4 | 70.0 |
| Av. (3 animals) | | 1.7 | 6.8 | 11.5 | 14.3 | 59.9 | 74.2 |
| IX | 246 | 0 | 2 | 11 | 0 | 18.2 | 18.2 |
| | 250 | 2 | 2 | 12 | 16.7 | 16.7 | 33.4 |
| Av. | | 1.0 | 2.0 | 11.5 | 8.4 | 17.4 | 25.8 |
| X | 273 | 7 | 4 | 12 | 58.3 | 33.3 | 91.6 |
| | 275 | 0 | 6 | 12 | 0 | 50.0 | 50.0 |
| Av. | | 3.5 | 5.0 | 12.0 | 29.2 | 41.6 | 70.8 |
| Av. (5 animals) | | 1.9 | 5.5 | 11.6 | 16.1 | 47.7 | 63.8 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained Firm | Crumbly | Possible no. slices | Slices obtained Firm | Crumbly | Total |
|---|---|---|---|---|---|---|---|
| | | | | | % | % | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | | |
| Sodium chloride and lactic acid injection (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 174 | 7 | 2 | 11 | 63.6 | 18.2 | 81.8 |
| | 178 | 0 | 7 | 10 | 0 | 70.0 | 70.0 |
| Av. | | 3.5 | 4.5 | 10.5 | 31.8 | 44.1 | 75.9 |
| VII | 201 | 1 | 8 | 10 | 10.0 | 80.0 | 90.0 |
| | 203 | 0 | 7 | 12 | 0 | 58.3 | 58.3 |
| Av. | | 0.5 | 7.5 | 11.0 | 5.0 | 69.2 | 74.2 |
| VIII | 223 | 5 | 4 | 12 | 41.7 | 33.3 | 75.0 |
| | 224 | 1 | 5 | 11 | 9.1 | 45.4 | 54.5 |
| Av. | | 3.0 | 4.5 | 11.5 | 25.4 | 39.4 | 64.8 |
| Av. (3 animals) | | 2.3 | 5.5 | 11.0 | 20.7 | 50.9 | 71.6 |
| IX | 246 | 0 | 4 | 10 | 0 | 40.0 | 40.0 |
| | 250 | 3 | 4 | 11 | 27.3 | 36.4 | 63.7 |
| Av. | | 1.5 | 4.0 | 10.5 | 13.6 | 38.2 | 51.8 |
| X | 273 | 3 | 5 | 11 | 27.3 | 45.4 | 72.7 |
| | 275 | 0 | 6 | 12 | 0 | 50.0 | 50.0 |
| Av. | | 1.5 | 5.5 | 11.5 | 13.6 | 47.7 | 61.3 |
| Av. (5 animals) | | 2.0 | 5.2 | 11.0 | 17.9 | 47.7 | 65.6 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| | | | | BICEPS FEMORIS MUSCLE | | | |
| **Sodium chloride injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 184 | 3 | 8 | 12 | 25.0 | 66.7 | 91.7 |
| | 185 | 7 | 3 | 13 | 53.8 | 23.1 | 76.9 |
| Av. | | 5.0 | 5.5 | 12.5 | 39.4 | 44.9 | 84.3 |
| VII | 205 | 8 | 2 | 11 | 72.7 | 18.2 | 90.9 |
| | 207 | 9 | 2 | 12 | 75.0 | 16.7 | 91.7 |
| Av. | | 8.5 | 2.0 | 11.5 | 73.8 | 17.4 | 91.3 |
| VIII | 228 | 5 | 2 | 13 | 38.5 | 15.4 | 53.9 |
| | 230 | 6 | 4 | 11 | 54.5 | 36.4 | 90.9 |
| Av. | | 5.5 | 3.0 | 12.0 | 46.5 | 25.9 | 72.4 |
| Av. (3 animals) | | 6.3 | 3.5 | 12.0 | 53.2 | 29.4 | 82.7 |
| IX | 256 | 0 | 3 | 12 | 0 | 25.0 | 25.0 |
| | 257 | 6 | 5 | 11 | 54.5 | 45.4 | 99.9 |
| Av. | | 3.0 | 4.0 | 11.5 | 27.2 | 35.2 | 62.4 |
| X | 277 | 10 | 1 | 12 | 83.3 | 8.3 | 91.6 |
| | 279 | 11 | 0 | 11 | 100.0 | 0 | 100.0 |
| Av. | | 10.5 | 0.5 | 11.5 | 91.6 | 4.2 | 95.8 |
| Av. (5 animals) | | 6.5 | 3.0 | 11.8 | 55.7 | 25.5 | 81.2 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained Firm | No. slices obtained Crumbly | Possible no. slices | Slices obtained Firm | Slices obtained Crumbly | Slices obtained Total |
|---|---|---|---|---|---|---|---|
| | | | | | % | % | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | | |
| Sodium chloride injection (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 184 | 9 | 2 | 11 | 81.8 | 18.2 | 100.0 |
| | 185 | 11 | 1 | 12 | 91.7 | 8.3 | 100.0 |
| Av. | | 10.0 | 1.5 | 11.5 | 86.8 | 13.2 | 100.0 |
| VII | 205 | 10 | 2 | 12 | 83.3 | 16.7 | 100.0 |
| | 207 | 8 | 4 | 12 | 66.7 | 33.3 | 100.0 |
| Av. | | 9.0 | 3.0 | 12.0 | 75.0 | 25.0 | 100.0 |
| VIII | 228 | 6 | 2 | 11 | 54.5 | 18.2 | 72.7 |
| | 230 | 4 | 6 | 11 | 36.4 | 54.5 | 90.9 |
| Av. | | 5.0 | 4.0 | 11.0 | 45.4 | 36.4 | 81.8 |
| Av. (3 animals) | | 8.0 | 2.8 | 11.5 | 69.1 | 24.9 | 93.9 |
| IX | 256 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| | 257 | 6 | 6 | 12 | 50.0 | 50.0 | 100.0 |
| Av. | | 3.0 | 4.5 | 11.5 | 25.0 | 38.6 | 63.6 |
| X | 277 | 6 | 5 | 11 | 54.5 | 45.4 | 99.9 |
| | 279 | 11 | 2 | 13 | 84.6 | 15.4 | 100.0 |
| Av. | | 8.5 | 3.5 | 12.0 | 69.6 | 30.4 | 100.0 |
| Av. (5 animals) | | 7.1 | 3.3 | 11.6 | 60.4 | 28.7 | 89.1 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | | |
| __Lactic acid injection__ | | | | | | | |
| Control samples | | | | | | | |
| VI | 181 | 11 | 0 | 11 | 100.0 | 0 | 100.0 |
| | 183 | 10 | 2 | 12 | 83.3 | 16.7 | 100.0 |
| Av. | | 10.5 | 1.0 | 11.5 | 91.6 | 8.4 | 100.0 |
| VII | 204 | 4 | 3 | 13 | 30.8 | 23.1 | 53.9 |
| | 206 | 10 | 2 | 12 | 83.3 | 16.7 | 100.0 |
| Av. | | 7.0 | 2.5 | 12.5 | 57.0 | 19.9 | 77.0 |
| VIII | 232 | 11 | 2 | 13 | 84.6 | 15.4 | 100.0 |
| | 233 | 0 | 9 | 12 | 0 | 75.0 | 75.0 |
| Av. | | 5.5 | 5.5 | 12.5 | 42.3 | 45.2 | 87.5 |
| Av. (3 animals) | | 7.7 | 3.0 | 12.2 | 63.6 | 24.5 | 88.2 |
| IX | 253 | 0 | 1 | 10 | 0 | 10.0 | 10.0 |
| | 255 | 0 | 3 | 11 | 0 | 27.3 | 27.3 |
| Av. | | 0 | 2.0 | 10.5 | 0 | 18.6 | 18.6 |
| X | 276 | 2 | 4 | 12 | 16.7 | 33.3 | 50.0 |
| | 278 | 10 | 1 | 11 | 90.9 | 9.1 | 100.0 |
| Av. | | 6.0 | 2.5 | 11.5 | 53.8 | 21.2 | 75.0 |
| Av. (5 animals) | | 5.8 | 2.7 | 11.7 | 48.9 | 22.7 | 71.6 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | | |
| Lactic acid injection (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 181 | 11 | 0 | 11 | 100.0 | 0 | 100.0 |
| | 183 | 7 | 5 | 12 | 58.3 | 41.7 | 100.0 |
| Av. | | 9.0 | 2.5 | 11.5 | 79.2 | 20.8 | 100.0 |
| VII | 204 | 3 | 3 | 12 | 25.0 | 25.0 | 50.0 |
| | 206 | 8 | 2 | 11 | 72.7 | 18.2 | 90.9 |
| Av. | | 5.5 | 2.5 | 11.5 | 48.8 | 21.6 | 70.4 |
| VIII | 232 | 11 | 1 | 12 | 91.7 | 8.3 | 100.0 |
| | 233 | 8 | 2 | 11 | 72.7 | 18.2 | 90.9 |
| Av. | | 9.5 | 1.5 | 11.5 | 82.2 | 13.2 | 95.4 |
| Av. (3 animals) | | 8.0 | 2.2 | 11.5 | 70.1 | 18.5 | 88.6 |
| IX | 253 | 0 | 2 | 10 | 0 | 20.0 | 20.0 |
| | 255 | 0 | 4 | 11 | 0 | 36.4 | 36.4 |
| Av. | | 0 | 3.0 | 10.5 | 0 | 28.2 | 28.2 |
| X | 276 | 5 | 5 | 12 | 41.7 | 41.7 | 83.4 |
| | 278 | 9 | 1 | 11 | 81.8 | 9.1 | 90.9 |
| Av. | | 7.0 | 3.0 | 11.5 | 61.8 | 25.4 | 87.2 |
| Av. (5 animals) | | 6.2 | 2.5 | 11.3 | 54.4 | 21.8 | 76.2 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| **BICEPS FEMORIS MUSCLE (continued)** | | | | | | | |
| **Sodium chloride and lactic acid injection** | | | | | | | |
| Control samples | | | | | | | |
| VI | 180 | 3 | 3 | 9 | 33.3 | 33.3 | 66.6 |
| | 182 | 12 | 0 | 12 | 100.0 | 0 | 100.0 |
| Av. | | 7.5 | 1.5 | 10.5 | 66.6 | 16.6 | 83.3 |
| VII | 208 | 4 | 5 | 12 | 33.3 | 41.7 | 75.0 |
| | 209 | 11 | 1 | 12 | 91.7 | 8.3 | 100.0 |
| Av. | | 7.5 | 3.0 | 12.0 | 62.5 | 25.0 | 87.5 |
| VIII | 229 | 7 | 2 | 11 | 63.6 | 18.2 | 81.8 |
| | 231 | 5 | 6 | 12 | 41.7 | 50.0 | 91.7 |
| Av. | | 6.0 | 4.0 | 11.5 | 52.6 | 34.1 | 86.8 |
| Av. (3 animals) | | 7.0 | 2.8 | 11.3 | 60.6 | 25.2 | 85.9 |
| IX | 252 | 0 | 0 | 11 | 0 | 0 | 0 |
| | 254 | 0 | 9 | 11 | 0 | 81.8 | 81.8 |
| Av. | | 0 | 4.5 | 11.0 | 0 | 40.9 | 40.9 |
| X | 280 | 9 | 1 | 11 | 81.8 | 9.1 | 90.9 |
| | 281 | 12 | 0 | 12 | 100.0 | 0 | 100.0 |
| Av. | | 10.5 | 0.5 | 11.5 | 90.9 | 4.6 | 95.4 |
| Av. (5 animals) | | 6.3 | 2.7 | 11.3 | 54.5 | 24.2 | 78.8 |

(continued)

Table 2 (continued)

| Animal no. | Sample no. | No. slices obtained | | Possible no. slices | Slices obtained | | |
|---|---|---|---|---|---|---|---|
| | | Firm | Crumbly | | Firm | Crumbly | Total |
| | | | | | % | % | % |
| **BICEPS FEMORIS MUSCLE (continued)** | | | | | | | |
| Sodium chloride and lactic acid injection (continued) | | | | | | | |
| Injected samples | | | | | | | |
| VI | 180 | 0 | 5 | 11 | 0 | 45.4 | 45.4 |
| | 182 | 11 | 0 | 11 | 100.0 | 0 | 100.0 |
| Av. | | 5.5 | 2.5 | 11.0 | 50.0 | 22.7 | 72.7 |
| VII | 208 | 2 | 6 | 12 | 16.7 | 50.0 | 66.7 |
| | 209 | 12 | 0 | 12 | 100.0 | 0 | 100.0 |
| Av. | | 7.0 | 3.0 | 12.0 | 58.4 | 25.0 | 83.4 |
| VIII | 229 | 5 | 6 | 11 | 45.4 | 54.5 | 99.9 |
| | 231 | 4 | 9 | 13 | 30.8 | 69.2 | 100.0 |
| Av. | | 4.5 | 7.5 | 12.0 | 38.1 | 61.8 | 100.0 |
| Av. (3 animals) | | 5.7 | 4.3 | 11.7 | 48.8 | 36.5 | 85.4 |
| IX | 252 | 0 | 4 | 11 | 0 | 36.4 | 36.4 |
| | 254 | 0 | 9 | 11 | 0 | 81.8 | 81.8 |
| Av. | | 0 | 6.5 | 11.0 | 0 | 59.1 | 59.1 |
| X | 280 | 10 | 2 | 13 | 76.9 | 15.4 | 92.3 |
| | 281 | 10 | 1 | 11 | 90.9 | 9.1 | 100.0 |
| Av. | | 10.0 | 1.5 | 12.0 | 83.9 | 12.2 | 96.2 |
| Av. (5 animals) | | 5.4 | 4.2 | 11.6 | 46.1 | 36.2 | 82.3 |

Table 3. Slicing Quality of Canned Beef. Judges' ratings of sliceability (from sample used in scoring) and the sliceability calculated by difference between weight of the canned beef and the unsliceable portion. The range for sliceability scores is 10 for extremely good slicing quality to 1 for extremely poor quality.

| Animal* no. | Sample no. | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION | | | | | | |
| Sodium chloride injection | | | | | | |
| Control samples | | | | | | |
| VI | 162 | 6.7 | 379 | 59 | 320 | 84.4 |
| VII | 188 | 6.3 | 392 | 230 | 162 | 41.3 |
| VIII | 211 | 7.7 | 364 | 145 | 219 | 60.2 |
| Av. (3 animals) | | 6.9 | 378 | 145 | 234 | 62.0 |
| IX | 234 | 4.7 | 376 | 248 | 128 | 34.0 |
| X | 260 | 4.0 | 373 | 165 | 208 | 55.8 |
| Av. (5 animals) | | 5.9 | 377 | 169 | 207 | 55.1 |
| Injected samples | | | | | | |
| VI | 162 | 5.7 | 376 | 81 | 295 | 78.4 |
| VII | 188 | 2.7 | 408 | 240 | 168 | 41.2 |
| VIII | 211 | 2.7 | 362 | 276 | 86 | 23.8 |
| Av. (3 animals) | | 3.7 | 382 | 199 | 183 | 47.8 |
| IX | 234 | 3.3 | 360 | 326 | 34 | 9.4 |
| X | 260 | 9.3 | 406 | 73 | 333 | 82.0 |
| Av. (5 animals) | | 4.7 | 382 | 199 | 183 | 47.0 |

(continued)

*Animals VI, VII, and VIII were steers, carcass grade Commercial, processed 65 minutes; Animal IX was a steer, carcass grade Commercial, processed 90 minutes; Animal X was a cow, carcass grade Cutter, processed 90 minutes.

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | | | |
| <u>Lactic acid injection</u> | | | | | | |
| Control samples | | | | | | |
| VI | 164 | 9.3 | 391 | 26 | 365 | 93.4 |
| VII | 187 | 2.0 | 394 | 359 | 35 | 8.9 |
| VIII | 210 | 3.0 | 363 | 331 | 32 | 8.8 |
| Av. (3 animals) | | 4.8 | 383 | 239 | 144 | 37.0 |
| IX | 236 | 4.0 | 378 | 279 | 99 | 26.2 |
| X | 259 | 2.3 | 378 | 334 | 44 | 11.6 |
| Av. (5 animals) | | 4.1 | 381 | 266 | 115 | 29.8 |
| Injected samples | | | | | | |
| VI | 164 | 7.7 | 380 | 52 | 328 | 86.3 |
| VII | 187 | 6.0 | 383 | 157 | 226 | 59.0 |
| VIII | 210 | 6.3 | 354 | 62 | 292 | 82.5 |
| Av. (3 animals) | | 6.7 | 372 | 90 | 282 | 75.6 |
| IX | 236 | 3.0 | 365 | 254 | 111 | 30.4 |
| X | 259 | 5.7 | 364 | 134 | 230 | 63.2 |
| Av. (5 animals) | | 5.7 | 369 | 132 | 237 | 64.3 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| **LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued)** | | | | | | |
| Sodium chloride and lactic acid injection | | | | | | |
| Control samples | | | | | | |
| VI | 163 | 5.3 | 387 | 126 | 261 | 67.4 |
| VII | 186 | 7.0 | 390 | 73 | 317 | 81.3 |
| VIII | 212 | 5.3 | 364 | 189 | 175 | 48.1 |
| Av. (3 animals) | | 5.9 | 380 | 129 | 251 | 65.6 |
| IX | 235 | 2.3 | 366 | 332 | 34 | 9.3 |
| X | 258 | 8.0 | 372 | 76 | 296 | 79.6 |
| Av. (5 animals) | | 5.6 | 376 | 159 | 217 | 57.1 |
| Injected samples | | | | | | |
| VI | 163 | 9.3 | 385 | 58 | 327 | 84.9 |
| VII | 186 | 3.7 | 384 | 240 | 144 | 37.5 |
| VIII | 212 | 7.0 | 353 | 70 | 283 | 80.2 |
| Av. (3 animals) | | 6.7 | 374 | 123 | 251 | 67.5 |
| IX | 235 | 3.0 | 355 | 327 | 28 | 7.9 |
| X | 258 | 6.3 | 395 | 80 | 315 | 79.7 |
| Av. (5 animals) | | 5.9 | 374 | 155 | 219 | 58.0 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION | | | | | | |
| **Sodium chloride injection** | | | | | | |
| Control samples | | | | | | |
| VI | 167 | 9.3 | 372 | 0 | 372 | 100.0 |
| VII | 189 | 8.0 | 391 | 85 | 306 | 78.3 |
| VIII | 214 | 7.0 | 378 | 49 | 329 | 87.0 |
| Av. (3 animals) | | 8.1 | 380 | 45 | 336 | 88.4 |
| IX | 239 | 8.7 | 375 | 22 | 353 | 94.1 |
| X | 261 | 8.0 | 356 | 99 | 257 | 72.2 |
| Av. (5 animals) | | 8.2 | 374 | 51 | 323 | 86.3 |
| Injected samples | | | | | | |
| VI | 167 | 9.3 | 384 | 33 | 351 | 91.4 |
| VII | 189 | 6.7 | 384 | 173 | 211 | 54.9 |
| VIII | 214 | 8.0 | 357 | 66 | 291 | 81.5 |
| Av. (3 animals) | | 8.0 | 375 | 91 | 284 | 75.9 |
| IX | 239 | 5.0 | 368 | 109 | 259 | 70.4 |
| X | 261 | 8.0 | 356 | 82 | 274 | 77.0 |
| Av. (5 animals) | | 7.4 | 370 | 93 | 277 | 75.0 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | | | |
| **Lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 165 | 6.3 | 368 | 81 | 287 | 78.0 |
| VII | 190 | 8.3 | 424 | 0 | 424 | 100.0 |
| VIII | 215 | 9.0 | 379 | 35 | 344 | 90.8 |
| Av. (3 animals) | | 7.9 | 390 | 39 | 352 | 89.6 |
| IX | 237 | 8.3 | 364 | 45 | 319 | 87.6 |
| X | 262 | 8.7 | 383 | 58 | 325 | 84.8 |
| Av. (5 animals) | | 8.1 | 384 | 44 | 340 | 88.2 |
| Injected samples | | | | | | |
| VI | 165 | 4.7 | 363 | 183 | 180 | 49.6 |
| VII | 190 | 7.3 | 390 | 0 | 390 | 100.0 |
| VIII | 215 | 8.7 | 359 | 0 | 359 | 100.0 |
| Av. (3 animals) | | 6.9 | 371 | 61 | 310 | 83.2 |
| IX | 237 | 5.7 | 343 | 66 | 277 | 80.8 |
| X | 262 | 9.0 | 363 | 35 | 328 | 90.4 |
| Av. (5 animals) | | 7.1 | 364 | 57 | 307 | 84.2 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | | | |
| **Sodium chloride and lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 166 | 7.0 | 378 | 145 | 233 | 61.6 |
| VII | 191 | 9.0 | 387 | 27 | 360 | 93.0 |
| VIII | 213 | 7.0 | 383 | 20 | 363 | 94.8 |
| Av. (3 animals) | | 7.7 | 383 | 64 | 319 | 83.1 |
| IX | 238 | 3.3 | 374 | 266 | 108 | 28.9 |
| X | 263 | 3.7 | 378 | 320 | 58 | 15.3 |
| Av. (5 animals) | | 6.0 | 380 | 156 | 224 | 58.7 |
| Injected samples | | | | | | |
| VI | 166 | 7.3 | 388 | 62 | 326 | 84.0 |
| VII | 191 | 6.3 | 394 | 36 | 358 | 90.9 |
| VIII | 213 | 6.3 | 359 | 26 | 333 | 92.8 |
| Av. (3 animals) | | 6.6 | 380 | 41 | 339 | 89.2 |
| IX | 238 | 5.3 | 356 | 256 | 100 | 28.1 |
| X | 263 | 8.3 | 385 | 83 | 302 | 78.4 |
| Av. (5 animals) | | 6.7 | 376 | 93 | 284 | 74.8 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| **PSOAS MAJOR AND PSOAS MINOR MUSCLES** | | | | | | |
| <u>Sodium chloride injection</u> | | | | | | |
| Control samples | | | | | | |
| VI | 168 | 5.3 | 414 | 0 | 414 | 100.0 |
| VII | 193 | 7.0 | 425 | 149 | 276 | 64.9 |
| VIII | 218 | 9.0 | 379 | 51 | 328 | 86.5 |
| Av. (3 animals) | | 7.1 | 406 | 67 | 339 | 83.8 |
| IX | 240 | 5.7 | 422 | 189 | 233 | 55.2 |
| X | 265 | 4.7 | 373 | 94 | 279 | 74.8 |
| Av. (5 animals) | | 6.3 | 403 | 97 | 306 | 76.3 |
| Injected samples | | | | | | |
| VI | 168 | 3.7 | 388 | 75 | 313 | 80.7 |
| VII | 193 | 4.7 | 423 | 289 | 134 | 31.7 |
| VIII | 218 | 6.3 | 359 | 226 | 133 | 37.0 |
| Av. (3 animals) | | 4.9 | 390 | 197 | 193 | 49.8 |
| IX | 240 | 2.7 | 387 | 348 | 39 | 10.1 |
| X | 265 | 6.7 | 362 | 58 | 304 | 84.0 |
| Av. (5 animals) | | 4.8 | 384 | 199 | 185 | 48.7 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued) | | | | | | |
| **Lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 169 | 6.7 | 418 | 0 | 418 | 100.0 |
| VII | 194 | 5.7 | 436 | 147 | 289 | 66.3 |
| VIII | 216 | 5.0 | 413 | 207 | 206 | 49.9 |
| Av. (3 animals) | | 5.8 | 422 | 118 | 304 | 72.1 |
| IX | 241 | 5.0 | 408 | 272 | 136 | 33.3 |
| X | 266 | 7.3 | 383 | 86 | 297 | 77.5 |
| Av. (5 animals) | | 5.9 | 412 | 142 | 269 | 65.4 |
| Injected samples | | | | | | |
| VI | 169 | 6.7 | 379 | 50 | 329 | 86.8 |
| VII | 194 | 3.7 | 369 | 295 | 74 | 20.0 |
| VIII | 216 | 4.7 | 380 | 231 | 149 | 39.2 |
| Av. (3 animals) | | 5.0 | 376 | 192 | 184 | 48.7 |
| IX | 241 | 4.7 | 385 | 284 | 101 | 26.2 |
| X | 266 | 6.0 | 353 | 55 | 298 | 84.4 |
| Av. (5 animals) | | 5.2 | 373 | 183 | 190 | 51.3 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| **PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued)** | | | | | | |
| **Sodium chloride and lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 170 | 8.7 | 396 | 25 | 371 | 93.7 |
| VII | 192 | 5.3 | 415 | 260 | 155 | 37.3 |
| VIII | 217 | 5.3 | 403 | 129 | 274 | 68.0 |
| Av. (3 animals) | | 6.4 | 405 | 138 | 267 | 66.3 |
| IX | 242 | 8.0 | 382 | 126 | 256 | 67.0 |
| X | 264 | 5.3 | 393 | 264 | 129 | 32.8 |
| Av. (5 animals) | | 6.5 | 398 | 161 | 237 | 59.8 |
| Injected samples | | | | | | |
| VI | 170 | 8.0 | 391 | 44 | 347 | 88.7 |
| VII | 192 | 3.3 | 414 | 277 | 137 | 33.1 |
| VIII | 217 | 6.7 | 380 | 138 | 242 | 63.7 |
| Av. (3 animals) | | 6.0 | 395 | 153 | 242 | 61.8 |
| IX | 242 | 4.0 | 373 | 282 | 91 | 24.4 |
| X | 264 | 7.0 | 363 | 133 | 230 | 63.4 |
| Av. (5 animals) | | 5.8 | 384 | 175 | 209 | 54.7 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| | | | SEMITENDINOSUS MUSCLE | | | |
| **Sodium chloride injection** | | | | | | |
| Control samples | | | | | | |
| VI | 172 | 10.0 | 369 | 39 | 330 | 89.4 |
| VII | 197 | 9.3 | 405 | 0 | 405 | 100.0 |
| VIII | 219 | 10.0 | 371 | 0 | 371 | 100.0 |
| Av. (3 animals) | | 9.8 | 382 | 13 | 369 | 96.5 |
| IX | 244 | 9.0 | 369 | 37 | 332 | 90.0 |
| X | 269 | 10.0 | 363 | 0 | 363 | 100.0 |
| Av. (5 animals) | | 9.7 | 375 | 15 | 360 | 95.9 |
| Injected samples | | | | | | |
| VI | 172 | 10.0 | 358 | 0 | 358 | 100.0 |
| VII | 197 | 9.7 | 384 | 0 | 384 | 100.0 |
| VIII | 219 | 9.7 | 374 | 0 | 374 | 100.0 |
| Av. (3 animals) | | 9.8 | 372 | 0 | 372 | 100.0 |
| IX | 244 | 9.7 | 360 | 0 | 360 | 100.0 |
| X | 269 | 10.0 | 377 | 0 | 377 | 100.0 |
| Av. (5 animals) | | 9.8 | 371 | 0 | 371 | 100.0 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| SEMITENDINOSUS MUSCLE (continued) | | | | | | |
| Lactic acid injection | | | | | | |
| Control samples | | | | | | |
| VI | 173 | 10.0 | 363 | 121 | 242 | 66.7 |
| VII | 195 | 9.3 | 375 | 0 | 375 | 100.0 |
| VIII | 220 | 10.0 | 362 | 0 | 362 | 100.0 |
| Av. (3 animals) | | 9.8 | 367 | 40 | 326 | 88.9 |
| IX | 245 | 8.7 | 377 | 38 | 339 | 89.9 |
| X | 267 | 10.0 | 362 | 0 | 362 | 100.0 |
| Av. (5 animals) | | 9.6 | 368 | 32 | 336 | 91.3 |
| Injected samples | | | | | | |
| VI | 173 | 10.0 | 401 | 141 | 260 | 64.8 |
| VII | 195 | 10.0 | 372 | 0 | 372 | 100.0 |
| VIII | 220 | 9.7 | 360 | 0 | 360 | 100.0 |
| Av. (3 animals) | | 9.9 | 378 | 47 | 331 | 88.3 |
| IX | 245 | 9.3 | 366 | 0 | 366 | 100.0 |
| X | 267 | 10.0 | 347 | 0 | 347 | 100.0 |
| Av. (5 animals) | | 9.8 | 369 | 28 | 341 | 93.0 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| | | | SEMITENDINOSUS MUSCLE (continued) | | | |
| **Sodium chloride and lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 171 | 9.7 | 372 | 0 | 372 | 100.0 |
| VII | 196 | 10.0 | 380 | 0 | 380 | 100.0 |
| VIII | 221 | 10.0 | 369 | 0 | 369 | 100.0 |
| Av. (3 animals) | | 9.9 | 374 | 0 | 374 | 100.0 |
| IX | 243 | 8.7 | 364 | 0 | 364 | 100.0 |
| X | 268 | 10.0 | 365 | 0 | 365 | 100.0 |
| Av. (5 animals) | | 9.7 | 370 | 0 | 370 | 100.0 |
| Injected samples | | | | | | |
| VI | 171 | 10.0 | 370 | 0 | 370 | 100.0 |
| VII | 196 | 9.7 | 365 | 0 | 365 | 100.0 |
| VIII | 221 | 10.0 | 355 | 0 | 355 | 100.0 |
| Av. (3 animals) | | 9.9 | 363 | 0 | 363 | 100.0 |
| IX | 243 | 9.0 | 370 | 36 | 334 | 90.3 |
| X | 268 | 10.0 | 359 | 0 | 359 | 100.0 |
| Av. (5 animals) | | 9.7 | 364 | 7 | 357 | 98.1 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability source | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| | | | SEMIMEMBRANOSUS MUSCLE | | | |
| Sodium chloride injection | | | | | | |
| Control samples | | | | | | |
| VI | 177 | 4.7 | 363 | 119 | 244 | 67.2 |
| | 179 | 5.3 | 374 | 147 | 227 | 60.7 |
| Av. | | 5.0 | 368 | 133 | 236 | 64.0 |
| VII | 199 | 4.7 | 355 | 283 | 72 | 20.3 |
| | 200 | 7.7 | 360 | 60 | 300 | 83.3 |
| Av. | | 6.2 | 358 | 172 | 186 | 51.8 |
| VIII | 222 | 7.3 | 367 | 124 | 243 | 66.2 |
| | 226 | 7.7 | 355 | 121 | 234 | 65.9 |
| Av. | | 7.5 | 361 | 122 | 238 | 66.0 |
| Av. (3 animals) | | 6.2 | 362 | 142 | 220 | 60.6 |
| IX | 249 | 5.0 | 355 | 226 | 129 | 36.3 |
| | 251 | 7.3 | 367 | 166 | 201 | 54.8 |
| Av. | | 6.2 | 361 | 196 | 165 | 45.6 |
| X | 271 | 8.0 | 327 | 64 | 263 | 80.4 |
| | 272 | 6.3 | 330 | 23 | 307 | 93.0 |
| Av. | | 7.2 | 328 | 44 | 285 | 86.7 |
| Av. (5 animals) | | 6.4 | 355 | 133 | 222 | 62.8 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | |
| **Sodium chloride injection** (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 177 | 8.0 | 345 | 36 | 309 | 89.6 |
| | 179 | 6.3 | 352 | 127 | 225 | 63.9 |
| Av. | | 7.2 | 348 | 82 | 267 | 76.8 |
| VII | 199 | 8.7 | 346 | 78 | 268 | 77.4 |
| | 200 | 7.3 | 350 | 20 | 330 | 94.3 |
| Av. | | 8.0 | 348 | 49 | 299 | 85.8 |
| VIII | 222 | 5.3 | 350 | 101 | 249 | 71.1 |
| | 226 | 5.3 | 330 | 174 | 156 | 47.3 |
| Av. | | 5.3 | 340 | 138 | 202 | 59.2 |
| Av. (3 animals) | | 6.8 | 345 | 90 | 256 | 73.9 |
| IX | 249 | 1.7 | 342 | 313 | 29 | 8.5 |
| | 251 | 3.3 | 345 | 261 | 84 | 24.3 |
| Av. | | 2.5 | 344 | 287 | 56 | 16.4 |
| X | 271 | 7.3 | 344 | 75 | 269 | 78.2 |
| | 272 | 5.7 | 324 | 63 | 261 | 80.6 |
| Av. | | 6.5 | 334 | 69 | 265 | 79.4 |
| Av. (5 animals) | | 5.9 | 343 | 125 | 218 | 63.5 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability scores | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | |
| <u>Lactic acid injection</u> | | | | | | |
| Control samples | | | | | | |
| VI | 175 | 6.7 | 374 | 201 | 173 | 46.2 |
| | 176 | 8.0 | 358 | 29 | 329 | 91.9 |
| Av. | | 7.4 | 366 | 115 | 251 | 69.0 |
| VII | 198 | 4.7 | 364 | 228 | 136 | 37.4 |
| | 202 | 6.0 | 362 | 106 | 256 | 70.7 |
| Av. | | 5.4 | 363 | 167 | 196 | 54.0 |
| VIII | 225 | 4.3 | 345 | 221 | 124 | 35.9 |
| | 227 | 4.3 | 358 | 307 | 51 | 14.2 |
| Av. | | 4.3 | 352 | 264 | 88 | 25.0 |
| Av. (3 animals) | | 5.7 | 360 | 182 | 178 | 49.3 |
| IX | 247 | 6.0 | 348 | 206 | 142 | 40.8 |
| | 248 | 3.3 | 359 | 301 | 58 | 16.2 |
| Av. | | 4.6 | 354 | 254 | 100 | 28.5 |
| X | 270 | 7.0 | 318 | 31 | 287 | 90.2 |
| | 274 | 9.0 | 328 | 65 | 263 | 80.2 |
| Av. | | 8.0 | 323 | 48 | 275 | 85.2 |
| Av. (5 animals) | | 5.9 | 352 | 170 | 182 | 52.3 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | |
| Lactic acid injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 175 | 7.3 | 376 | 85 | 291 | 77.4 |
| | 176 | 7.3 | 350 | 68 | 282 | 80.6 |
| Av. | | 7.3 | 363 | 76 | 286 | 79.0 |
| VII | 198 | 4.7 | 342 | 164 | 178 | 52.0 |
| | 202 | 9.3 | 358 | 30 | 328 | 91.6 |
| Av. | | 7.0 | 350 | 97 | 253 | 71.8 |
| VIII | 225 | 6.7 | 333 | 81 | 252 | 75.7 |
| | 227 | 4.7 | 351 | 134 | 217 | 61.8 |
| Av. | | 5.7 | 342 | 108 | 234 | 68.8 |
| Av. (3 animals) | | 6.7 | 352 | 94 | 258 | 73.2 |
| IX | 247 | 3.7 | 343 | 229 | 114 | 33.2 |
| | 248 | 3.3 | 342 | 316 | 26 | 7.6 |
| Av. | | 3.5 | 342 | 272 | 70 | 20.4 |
| X | 270 | 6.7 | 302 | 70 | 232 | 76.8 |
| | 274 | 5.0 | 316 | 73 | 243 | 76.9 |
| Av. | | 5.8 | 309 | 72 | 238 | 76.8 |
| Av. (5 animals) | | 5.9 | 341 | 125 | 216 | 63.4 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| | | | **SEMIMEMBRANOSUS MUSCLE (continued)** | | | |
| **Sodium chloride and lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 174 | 6.7 | 368 | 77 | 291 | 79.1 |
| | 178 | 7.3 | 363 | 54 | 309 | 85.1 |
| Av. | | 7.0 | 366 | 66 | 300 | 82.1 |
| VII | 201 | 4.3 | 363 | 104 | 259 | 71.3 |
| | 203 | 7.0 | 368 | 71 | 297 | 80.7 |
| Av. | | 5.6 | 366 | 88 | 278 | 76.0 |
| VIII | 223 | 5.7 | 352 | 124 | 228 | 64.8 |
| | 224 | 7.3 | 347 | 63 | 284 | 81.8 |
| Av. | | 6.5 | 350 | 94 | 256 | 73.3 |
| Av. (3 animals) | | 6.4 | 361 | 83 | 278 | 77.1 |
| IX | 246 | 2.0 | 364 | 275 | 89 | 24.4 |
| | 250 | 7.3 | 355 | 214 | 141 | 39.7 |
| Av. | | 4.6 | 360 | 244 | 115 | 32.0 |
| X | 273 | 9.3 | 332 | 20 | 312 | 94.0 |
| | 275 | 6.7 | 336 | 117 | 219 | 65.2 |
| Av. | | 8.0 | 334 | 68 | 266 | 79.6 |
| Av. (5 animals) | | 6.3 | 355 | 112 | 243 | 68.6 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | |
| Sodium chloride and lactic acid injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 174 | 8.7 | 366 | 51 | 315 | 86.1 |
| | 178 | 6.3 | 344 | 97 | 247 | 71.8 |
| Av. | | 7.5 | 355 | 74 | 281 | 79.0 |
| VII | 201 | 7.7 | 352 | 30 | 322 | 91.5 |
| | 203 | 5.3 | 375 | 110 | 265 | 70.7 |
| Av. | | 6.5 | 364 | 70 | 294 | 81.1 |
| VIII | 223 | 7.3 | 345 | 70 | 275 | 79.7 |
| | 224 | 7.0 | 336 | 138 | 198 | 58.9 |
| Av. | | 7.2 | 340 | 104 | 236 | 69.3 |
| Av. (3 animals) | | 7.1 | 353 | 83 | 270 | 76.5 |
| IX | 246 | 6.7 | 353 | 175 | 178 | 50.4 |
| | 250 | 9.0 | 346 | 93 | 253 | 73.1 |
| Av. | | 7.8 | 350 | 134 | 216 | 61.8 |
| X | 273 | 7.3 | 326 | 66 | 260 | 79.8 |
| | 275 | 7.0 | 333 | 128 | 205 | 61.6 |
| Av. | | 7.2 | 330 | 97 | 232 | 70.7 |
| Av. (5 animals) | | 7.2 | 348 | 96 | 252 | 72.4 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| | | | BICEPS FEMORIS MUSCLE | | | |
| <u>Sodium chloride injection</u> | | | | | | |
| Control samples | | | | | | |
| VI | 184 | 9.7 | 401 | 20 | 381 | 95.0 |
| | 185 | 9.0 | 394 | 68 | 326 | 82.7 |
| Av. | | 9.4 | 398 | 44 | 354 | 88.8 |
| VII | 205 | 9.0 | 392 | 35 | 357 | 91.1 |
| | 207 | 8.7 | 373 | 28 | 345 | 92.5 |
| Av. | | 8.8 | 382 | 32 | 351 | 91.8 |
| VIII | 228 | 4.0 | 383 | 118 | 265 | 69.2 |
| | 230 | 8.3 | 344 | 22 | 322 | 93.6 |
| Av. | | 6.2 | 364 | 70 | 294 | 81.4 |
| Av. (3 animals) | | 8.1 | 381 | 49 | 333 | 87.3 |
| IX | 256 | 6.3 | 362 | 200 | 162 | 44.8 |
| | 257 | 9.3 | 359 | 0 | 359 | 100.0 |
| Av. | | 7.8 | 360 | 100 | 260 | 72.4 |
| X | 277 | 8.7 | 356 | 26 | 330 | 92.7 |
| | 279 | 10.0 | 345 | 0 | 345 | 100.0 |
| Av. | | 9.4 | 350 | 13 | 338 | 96.4 |
| Av. (5 animals) | | 8.3 | 371 | 52 | 319 | 86.2 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | |
| Sodium chloride injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 184 | 9.0 | 360 | 0 | 360 | 100.0 |
| | 185 | 10.0 | 373 | 0 | 373 | 100.0 |
| Av. | | 9.5 | 366 | 0 | 366 | 100.0 |
| VII | 205 | 9.3 | 367 | 0 | 367 | 100.0 |
| | 207 | 9.0 | 350 | 0 | 350 | 100.0 |
| Av. | | 9.2 | 358 | 0 | 358 | 100.0 |
| VIII | 228 | 9.3 | 347 | 64 | 283 | 81.6 |
| | 230 | 7.3 | 342 | 30 | 312 | 91.2 |
| Av. | | 8.3 | 344 | 47 | 298 | 86.4 |
| Av. (3 animals) | | 9.0 | 356 | 16 | 341 | 95.5 |
| IX | 256 | 4.7 | 366 | 235 | 131 | 35.8 |
| | 257 | 9.3 | 359 | 0 | 359 | 100.0 |
| Av. | | 7.0 | 362 | 118 | 245 | 67.9 |
| X | 277 | 8.7 | 360 | 0 | 360 | 100.0 |
| | 279 | 10.0 | 337 | 0 | 337 | 100.0 |
| Av. | | 9.4 | 348 | 0 | 348 | 100.0 |
| Av. (5 animals) | | 8.7 | 356 | 33 | 323 | 90.9 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. | | | |
|---|---|---|---|---|---|---|
| | | | Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
| | | | gm. | gm. | gm. | % |
| | | | | | | |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | |
| Lactic acid injection | | | | | | |
| Control samples | | | | | | |
| VI | 181 | 9.7 | 372 | 0 | 372 | 100.0 |
| | 183 | 10.0 | 364 | 0 | 364 | 100.0 |
| Av. | | 9.8 | 368 | 0 | 368 | 100.0 |
| VII | 204 | 5.7 | 391 | 138 | 253 | 64.7 |
| | 206 | 7.7 | 379 | 0 | 379 | 100.0 |
| Av. | | 6.7 | 385 | 69 | 316 | 82.4 |
| VIII | 232 | 9.7 | 354 | 0 | 354 | 100.0 |
| | 233 | 7.3 | 357 | 74 | 283 | 79.3 |
| Av. | | 8.5 | 356 | 37 | 318 | 89.6 |
| Av. (3 animals) | | 8.3 | 370 | 35 | 334 | 90.7 |
| IX | 253 | 3.7 | 367 | 316 | 51 | 13.9 |
| | 255 | 5.3 | 364 | 205 | 159 | 43.7 |
| Av. | | 4.5 | 366 | 260 | 105 | 28.8 |
| X | 276 | 5.7 | 375 | 156 | 219 | 58.4 |
| | 278 | 9.3 | 344 | 0 | 344 | 100.0 |
| Av. | | 7.5 | 360 | 78 | 282 | 79.2 |
| Av. (5 animals) | | 7.4 | 367 | 89 | 278 | 76.0 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | |
| Lactic acid injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 181 | 9.7 | 343 | 0 | 343 | 100.0 |
| | 183 | 8.7 | 340 | 0 | 340 | 100.0 |
| Av. | | 9.2 | 342 | 0 | 342 | 100.0 |
| VII | 204 | 7.3 | 370 | 197 | 173 | 46.8 |
| | 206 | 9.0 | 354 | 37 | 317 | 89.5 |
| Av. | | 8.2 | 362 | 117 | 245 | 68.2 |
| VIII | 232 | 9.0 | 348 | 0 | 348 | 100.0 |
| | 233 | 8.3 | 350 | 23 | 327 | 93.4 |
| Av. | | 8.6 | 349 | 12 | 338 | 96.7 |
| Av. (3 animals) | | 8.7 | 351 | 43 | 308 | 88.3 |
| IX | 253 | 4.7 | 345 | 243 | 102 | 29.6 |
| | 255 | 6.7 | 337 | 185 | 152 | 45.1 |
| Av. | | 5.7 | 341 | 214 | 127 | 37.4 |
| X | 276 | 7.7 | 348 | 54 | 294 | 84.5 |
| | 278 | 10.0 | 321 | 22 | 299 | 93.1 |
| Av. | | 8.8 | 334 | 38 | 296 | 88.8 |
| Av. (5 animals) | | 8.1 | 346 | 76 | 270 | 78.2 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | |
| Sodium chloride and lactic acid injection | | | | | | |
| Control samples | | | | | | |
| VI | 180 | 8.0 | 417 | 105 | 312 | 74.8 |
| | 182 | 10.0 | 362 | 0 | 362 | 100.0 |
| Av. | | 9.0 | 390 | 52 | 337 | 87.4 |
| VII | 208 | 6.7 | 382 | 89 | 293 | 76.7 |
| | 209 | 9.7 | 385 | 0 | 385 | 100.0 |
| Av. | | 8.2 | 384 | 45 | 339 | 88.4 |
| VIII | 229 | 9.3 | 358 | 66 | 292 | 81.6 |
| | 231 | 9.0 | 370 | 27 | 343 | 92.7 |
| Av. | | 9.2 | 364 | 46 | 318 | 87.2 |
| Av. (3 animals) | | 8.8 | 379 | 48 | 331 | 87.7 |
| IX | 252 | 3.0 | 376 | 336 | 40 | 10.6 |
| | 254 | 7.3 | 358 | 55 | 303 | 84.6 |
| Av. | | 5.2 | 367 | 196 | 172 | 47.6 |
| X | 280 | 10.0 | 355 | 36 | 319 | 89.8 |
| | 281 | 9.7 | 365 | 0 | 365 | 100.0 |
| Av. | | 9.8 | 360 | 18 | 342 | 94.9 |
| Av. (5 animals) | | 8.3 | 373 | 71 | 302 | 81.1 |

(continued)

Table 3 (continued)

| Animal no. | Sample no. | Slice-ability score | Sliceability on basis of wt. Canned meat | Unslice-able meat | Sliceable meat (by difference) | |
|---|---|---|---|---|---|---|
| | | | gm. | gm. | gm. | % |
| **BICEPS FEMORIS MUSCLE (continued)** | | | | | | |
| Sodium chloride and lactic acid injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 180 | 7.0 | 403 | 198 | 205 | 50.9 |
| | 182 | 9.3 | 368 | 0 | 368 | 100.0 |
| Av. | | 8.2 | 386 | 99 | 286 | 75.4 |
| VII | 208 | 5.0 | 382 | 110 | 272 | 71.2 |
| | 209 | 9.7 | 378 | 0 | 378 | 100.0 |
| Av. | | 7.4 | 380 | 55 | 325 | 85.6 |
| VIII | 229 | 9.3 | 354 | 0 | 354 | 100.0 |
| | 231 | 7.7 | 349 | 0 | 349 | 100.0 |
| Av. | | 8.5 | 352 | 0 | 352 | 100.0 |
| Av. (3 animals) | | 8.0 | 373 | 51 | 321 | 87.0 |
| IX | 252 | 7.0 | 363 | 202 | 161 | 44.4 |
| | 254 | 8.3 | 363 | 65 | 298 | 82.1 |
| Av. | | 7.6 | 363 | 134 | 230 | 63.2 |
| X | 280 | 8.0 | 369 | 25 | 344 | 93.2 |
| | 281 | 9.7 | 364 | 0 | 364 | 100.0 |
| Av. | | 8.8 | 366 | 12 | 354 | 96.6 |
| Av. (5 animals) | | 8.1 | 369 | 60 | 309 | 84.2 |

Table 4. pH of Beef. pH of beef muscles aged one day and before dividing into cuts. Anterior, middle, and posterior positions are represented for muscles of trunk; proximal, middle, and distal positions for muscles of leg. (Left muscles were used for control cuts; right muscles for injected cuts.)

| Animal no. | Position in animal | Position in muscle: Anterior (Proximal) | Middle | Posterior (Distal) | Average |
|---|---|---|---|---|---|
| | | pH | pH | pH | pH |
| | | LONGISSIMUS DORSI MUSCLE, LOIN PORTION | | | |
| VI | Left | 5.35 | 5.35 | 5.35 | 5.35 |
| | Right | 5.35 | 5.35 | 5.40 | 5.37 |
| VII | Left | 5.40 | 5.45 | 5.40 | 5.42 |
| | Right | 5.45 | 5.40 | 5.40 | 5.42 |
| VIII | Left | 5.40 | 5.45 | 5.40 | 5.42 |
| | Right | 5.50 | 5.55 | 5.40 | 5.48 |
| IX | Left | 5.45 | 5.45 | 5.35 | 5.42 |
| | Right | 5.35 | 5.45 | 5.35 | 5.38 |
| X | Left | 5.70 | 5.80 | 5.60 | 5.70 |
| | Right | 5.70 | 5.75 | 5.55 | 5.67 |
| | | LONGISSIMUS DORSI MUSCLE, RIB PORTION | | | |
| VI | Left | 5.40 | 5.40 | 5.40 | 5.40 |
| | Right | 5.45 | 5.40 | 5.40 | 5.42 |
| VII | Left | 5.50 | 5.45 | 5.45 | 5.47 |
| | Right | 5.55 | 5.50 | 5.45 | 5.50 |
| VIII | Left | 5.45 | 5.40 | 5.45 | 5.43 |
| | Right | 5.45 | 5.45 | 5.45 | 5.45 |
| IX | Left | 5.45 | 5.40 | 5.45 | 5.43 |
| | Right | 5.45 | 5.35 | 5.35 | 5.38 |
| X | Left | 5.65 | 5.60 | 5.40 | 5.55 |
| | Right | 5.65 | 5.60 | 5.40 | 5.55 |

(continued)

Table 4 (continued)

| Animal no. | Position in animal | Position in muscle: Anterior (Proximal) | Middle | Posterior (Distal) | Average |
|---|---|---|---|---|---|
| | | pH | pH | pH | pH |
| | | **PSOAS MAJOR AND PSOAS MINOR MUSCLES** | | | |
| VI | Left | 5.35 | 5.40 | 5.50 | 5.42 |
| | Right | 5.35 | 5.40 | 5.50 | 5.42 |
| VII | Left | 5.35 | 5.40 | 5.50 | 5.42 |
| | Right | 5.40 | 5.45 | 5.50 | 5.45 |
| VIII | Left | 5.40 | 5.40 | 5.50 | 5.43 |
| | Right | 5.40 | 5.40 | 5.50 | 5.43 |
| IX | Left | 5.35 | 5.40 | 5.55 | 5.43 |
| | Right | 5.40 | 5.40 | 5.55 | 5.45 |
| X | Left | 5.65 | 5.70 | 5.65 | 5.67 |
| | Right | 5.55 | 5.65 | 5.65 | 5.62 |
| | | **SEMITENDINOSUS MUSCLE** | | | |
| VI | Left | 5.35 | 5.35 | 5.40 | 5.37 |
| | Right | 5.35 | 5.35 | 5.45 | 5.38 |
| VII | Left | 5.35 | 5.35 | 5.40 | 5.37 |
| | Right | 5.40 | 5.40 | 5.50 | 5.43 |
| VIII | Left | 5.35 | 5.40 | 5.45 | 5.40 |
| | Right | 5.35 | 5.40 | 5.40 | 5.38 |
| IX | Left | 5.30 | 5.30 | 5.35 | 5.32 |
| | Right | 5.30 | 5.30 | 5.40 | 5.33 |
| X | Left | 5.50 | 5.50 | 5.60 | 5.53 |
| | Right | 5.50 | 5.50 | 5.60 | 5.53 |

(continued)

Table 4 (continued)

| Animal no. | Position in animal | Position in muscle: Anterior (Proximal) | Middle | Posterior (Distal) | Average |
|---|---|---|---|---|---|
| | | pH | pH | pH | pH |
| | | SEMIMEMBRANOSUS MUSCLE | | | |
| VI | Left | 5.30 | 5.30 | 5.30 | 5.30 |
| | Right | 5.30 | 5.35 | 5.30 | 5.32 |
| VII | Left | 5.35 | 5.30 | 5.35 | 5.33 |
| | Right | 5.35 | 5.30 | 5.35 | 5.33 |
| VIII | Left | 5.40 | 5.30 | 5.35 | 5.35 |
| | Right | 5.40 | 5.30 | 5.35 | 5.35 |
| IX | Left | 5.40 | 5.30 | 5.30 | 5.33 |
| | Right | 5.50 | 5.30 | 5.30 | 5.37 |
| X | Left | 5.55 | 5.50 | 5.55 | 5.53 |
| | Right | 5.55 | 5.50 | 5.60 | 5.55 |
| | | BICEPS FEMORIS MUSCLE | | | |
| VI | Left | 5.45 | 5.40 | 5.40 | 5.42 |
| | Right | 5.45 | 5.35 | 5.45 | 5.42 |
| VII | Left | 5.50 | 5.55 | 5.50 | 5.52 |
| | Right | 5.55 | 5.55 | 5.50 | 5.53 |
| VIII | Left | 5.40 | 5.35 | 5.40 | 5.38 |
| | Right | 5.40 | 5.35 | 5.45 | 5.40 |
| IX | Left | 5.40 | 5.35 | 5.35 | 5.37 |
| | Right | 5.45 | 5.40 | 5.35 | 5.40 |
| X | Left | 5.75 | 5.60 | 5.65 | 5.67 |
| | Right | 5.75 | 5.60 | 5.65 | 5.67 |

Table 5. pH of Beef. pH of beef muscles (average of three determinations) before dividing into cuts but after aging one day; of beef cuts aged eight days (one determination); and of the canned beef (one determination).

| Animal* no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | LONGISSIMUS DORSI MUSCLE, LOIN PORTION | | | |
| Sodium chloride injection | | | | |
| Left muscle | | Control samples | | |
| VI | 5.35 | 162 | 5.45 | 5.75 |
| VII | 5.42 | 188 | 5.40 | 5.60 |
| VIII | 5.42 | 211 | 5.35 | 5.75 |
| Av. (3 animals) | 5.40 | | 5.40 | 5.70 |
| IX | 5.42 | 234 | 5.30 | 5.65 |
| X | 5.70 | 260 | 5.50 | 5.90 |
| Av. (5 animals) | 5.46 | | 5.40 | 5.73 |
| Right muscle | | Injected samples | | |
| VI | 5.37 | 162 | 5.35 | 5.70 |
| VII | 5.42 | 188 | 5.40 | 5.60 |
| VIII | 5.48 | 211 | 5.35 | 5.70 |
| Av. (3 animals) | 5.42 | | 5.37 | 5.65 |
| IX | 5.38 | 234 | 5.40 | 5.65 |
| X | 5.67 | 260 | 5.55 | 5.85 |
| Av. (5 animals) | 5.46 | | 5.41 | 5.70 |

(continued)

*Animals VI, VII, and VIII were steers, carcass grade Commercial, processed 65 minutes; Animal IX was a steer, carcass grade Commercial, processed 90 minutes; Animal X was a cow, carcass grade Cutter, processed 90 minutes.

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | |
| **Lactic acid injection** | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 164 | 5.30 | 5.70 |
| VII | | 187 | 5.45 | 5.60 |
| VIII | | 210 | 5.30 | 5.70 |
| Av. (3 animals) | | | 5.35 | 5.67 |
| IX | | 236 | 5.30 | 5.60 |
| X | | 259 | 5.50 | 5.90 |
| Av. (5 animals) | | | 5.37 | 5.70 |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 164 | 5.40 | 5.70 |
| VII | | 187 | 5.45 | 5.60 |
| VIII | | 210 | 5.30 | 5.70 |
| Av. (3 animals) | | | 5.38 | 5.67 |
| IX | | 236 | 5.30 | 5.60 |
| X | | 259 | 5.50 | 5.90 |
| Av. (5 animals) | | | 5.39 | 5.70 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | |
| Sodium chloride and lactic acid injection | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 163 | 5.40 | 5.70 |
| VII | | 186 | 5.40 | 5.60 |
| VIII | | 212 | 5.30 | 5.65 |
| Av. (3 animals) | | | 5.37 | 5.65 |
| IX | | 235 | 5.35 | 5.60 |
| X | | 258 | 5.55 | 5.85 |
| Av. (5 animals) | | | 5.40 | 5.68 |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 163 | 5.40 | 5.70 |
| VII | | 186 | 5.45 | 5.55 |
| VIII | | 212 | 5.35 | 5.65 |
| Av. (3 animals) | | | 5.40 | 5.63 |
| IX | | 235 | 5.40 | 5.60 |
| X | | 258 | 5.55 | 5.85 |
| Av. (5 animals) | | | 5.43 | 5.67 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION | | | | |
| <u>Sodium chloride injection</u> | | | | |
| Left muscle | | Control samples | | |
| VI | 5.40 | 167 | 5.50 | 5.80 |
| VII | 5.47 | 189 | 5.55 | 5.80 |
| VIII | 5.43 | 214 | 5.40 | 5.75 |
| Av. (3 animals) | 5.43 | | 5.48 | 5.78 |
| IX | 5.43 | 239 | 5.35 | 5.65 |
| X | 5.55 | 261 | 5.55 | 6.00 |
| Av. (5 animals) | 5.46 | | 5.47 | 5.80 |
| Right muscle | | Injected samples | | |
| VI | 5.42 | 167 | 5.50 | 5.75 |
| VII | 5.50 | 189 | 5.65 | 5.75 |
| VIII | 5.45 | 214 | 5.50 | 5.80 |
| Av. (3 animals) | 5.46 | | 5.55 | 5.77 |
| IX | 5.38 | 239 | 5.40 | 5.65 |
| X | 5.55 | 261 | 5.60 | 5.90 |
| Av. (5 animals) | 5.46 | | 5.53 | 5.77 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | |
| **Lactic acid injection** | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 165 | 5.45 | 5.85 |
| VII | | 190 | 5.55 | 5.75 |
| VIII | | 215 | 5.45 | 5.75 |
| Av. (3 animals) | | | 5.48 | 5.78 |
| IX | | 237 | 5.40 | 5.75 |
| X | | 262 | 5.50 | 5.90 |
| Av. (5 animals) | | | 5.47 | 5.80 |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 165 | 5.50 | 6.00 |
| VII | | 190 | 5.60 | 5.75 |
| VIII | | 215 | 5.45 | 5.75 |
| Av. (3 animals) | | | 5.52 | 5.83 |
| IX | | 237 | 5.40 | 5.75 |
| X | | 262 | 5.60 | 5.95 |
| Av. (5 animals) | | | 5.51 | 5.84 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | |
| Sodium chloride and lactic acid injection | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 166 | 5.45 | 5.80 |
| VII | | 191 | 5.50 | 5.70 |
| VIII | | 213 | 5.40 | 5.85 |
| Av. (3 animals) | | | 5.45 | 5.78 |
| IX | | 238 | 5.35 | 5.65 |
| X | | 263 | 5.50 | 5.90 |
| Av. (5 animals) | | | 5.44 | 5.78 |
| Right muscle | (same as for sodium chloride injection | Injected samples | | |
| VI | | 166 | 5.60 | 5.80 |
| VII | | 191 | 5.60 | 5.70 |
| VIII | | 213 | 5.40 | 5.80 |
| Av. (3 animals) | | | 5.53 | 5.77 |
| IX | | 238 | 5.35 | 5.65 |
| X | | 263 | 5.65 | 5.90 |
| Av. (5 animals) | | | 5.52 | 5.77 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | | **PSOAS MAJOR AND PSOAS MINOR MUSCLES** | | |
| Sodium chloride injection | | | | |
| Left muscle | | Control samples | | |
| VI | 5.42 | 168 | 5.50 | 5.85 |
| VII | 5.42 | 193 | 5.40 | 5.65 |
| VIII | 5.43 | 218 | 5.55 | 5.85 |
| Av. (3 animals) | 5.42 | | 5.48 | 5.78 |
| IX | 5.43 | 240 | 5.40 | 5.60 |
| X | 5.67 | 265 | 5.65 | 6.00 |
| Av. (5 animals) | 5.47 | | 5.50 | 5.79 |
| Right muscle | | Injected samples | | |
| VI | 5.42 | 168 | 5.55 | 5.85 |
| VII | 5.45 | 193 | 5.50 | 5.65 |
| VIII | 5.43 | 218 | 5.50 | 5.80 |
| Av. (3 animals) | 5.43 | | 5.52 | 5.77 |
| IX | 5.45 | 240 | 5.45 | 5.60 |
| X | 5.62 | 265 | 5.50 | 5.85 |
| Av. (5 animals) | 5.47 | | 5.50 | 5.75 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued) | | | | |
| Lactic acid injection | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 169 | 5.60 | 5.85 |
| VII | | 194 | 5.55 | 5.75 |
| VIII | | 216 | 5.45 | 5.80 |
| Av. (3 animals) | | | 5.53 | 5.80 |
| IX | | 241 | 5.45 | 5.65 |
| X | | 266 | 5.65 | 6.00 |
| Av. (5 animals) | | | 5.54 | 5.81 |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 169 | 5.65 | 5.80 |
| VII | | 194 | 5.60 | 5.80 |
| VIII | | 216 | 5.40 | 5.75 |
| Av. (3 animals) | | | 5.55 | 5.78 |
| IX | | 241 | 5.45 | 5.65 |
| X | | 266 | 5.65 | 6.05 |
| Av. (5 animals) | | | 5.55 | 5.81 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued) | | | | |
| Sodium chloride and lactic acid injection | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 170 | 5.60 | 5.85 |
| VII | | 192 | 5.40 | 5.65 |
| VIII | | 217 | 5.45 | 5.80 |
| Av. (3 animals) | | | 5.48 | 5.77 |
| IX | | 242 | 5.55 | 5.75 |
| X | | 264 | 5.60 | 6.00 |
| Av. (5 animals) | | | 5.52 | 5.81 |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 170 | 5.60 | 5.85 |
| VII | | 192 | 5.50 | 5.65 |
| VIII | | 217 | 5.45 | 5.75 |
| Av. (3 animals) | | | 5.52 | 5.75 |
| IX | | 242 | 5.55 | 5.75 |
| X | | 264 | 5.60 | 5.90 |
| Av. (5 animals) | | | 5.54 | 5.78 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | | SEMITENDINOSUS MUSCLE | | |
| <u>Sodium chloride injection</u> | | | | |
| Left muscle | | Control samples | | |
| VI | 5.37 | 172 | 5.45 | 5.80 |
| VII | 5.37 | 197 | 5.45 | 5.75 |
| VIII | 5.40 | 219 | 5.35 | 5.75 |
| Av. (3 animals) | 5.38 | | 5.42 | 5.77 |
| IX | 5.32 | 244 | 5.40 | 5.65 |
| X | 5.53 | 269 | 5.55 | 5.90 |
| Av. (5 animals) | 5.40 | | 5.44 | 5.77 |
| Right muscle | | Injected samples | | |
| VI | 5.38 | 172 | 5.40 | 5.80 |
| VII | 5.43 | 197 | 5.50 | 5.70 |
| VIII | 5.38 | 219 | 5.35 | 5.75 |
| Av. (3 animals) | 5.40 | | 5.42 | 5.75 |
| IX | 5.33 | 244 | 5.40 | 5.65 |
| X | 5.53 | 269 | 5.60 | 5.85 |
| Av. (5 animals) | 5.41 | | 5.45 | 5.75 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | | SEMITENDINOSUS MUSCLE (continued) | | |
| **Lactic acid injection** | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 173 | 5.40 | 5.85 |
| VII | | 195 | 5.50 | 5.65 |
| VIII | | 220 | 5.40 | 5.75 |
| Av. (3 animals) | | | 5.43 | 5.75 |
| IX | | 245 | 5.40 | 5.70 |
| X | | 267 | 5.50 | 5.90 |
| Av. (5 animals) | | | 5.44 | 5.77 |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 173 | 5.50 | 5.85 |
| VII | | 195 | 5.40 | 5.65 |
| VIII | | 220 | 5.50 | 5.75 |
| Av. (3 animals) | | | 5.47 | 5.75 |
| IX | | 245 | 5.45 | 5.70 |
| X | | 267 | 5.55 | 5.90 |
| Av. (5 animals) | | | 5.48 | 5.77 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | SEMITENDINOSUS MUSCLE (continued) | | | |
| <u>Sodium chloride and lactic acid injection</u> | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 171 | 5.45 | 5.80 |
| VII | | 196 | 5.40 | 5.65 |
| VIII | | 221 | 5.50 | 5.80 |
| Av. (3 animals) | | | 5.45 | 5.75 |
| IX | | 243 | 5.40 | 5.65 |
| X | | 268 | 5.50 | 5.95 |
| Av. (5 animals) | | | 5.45 | 5.77 |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 171 | 5.40 | 5.75 |
| VII | | 196 | 5.45 | 5.65 |
| VIII | | 221 | 5.45 | 5.75 |
| Av. (3 animals) | | | 5.43 | 5.72 |
| IX | | 243 | 5.40 | 5.65 |
| X | | 268 | 5.60 | 5.85 |
| Av. (5 animals) | | | 5.46 | 5.73 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | | SEMIMEMBRANOSUS MUSCLE | | |
| <u>Sodium chloride injection</u> | | | | |
| Left muscle | | Control samples | | |
| VI | 5.30 | 177 | 5.35 | 5.80 |
| | | 179 | 5.35 | 5.75 |
| Av. | | | 5.35 | 5.78 |
| VII | 5.33 | 199 | 5.45 | 5.60 |
| | | 200 | 5.45 | 5.60 |
| Av. | | | 5.45 | 5.60 |
| VIII | 5.35 | 222 | 5.30 | 5.65 |
| | | 226 | 5.35 | 5.70 |
| Av. | | | 5.32 | 5.68 |
| Av. (3 animals) | 5.33 | | 5.37 | 5.69 |
| IX | 5.33 | 249 | 5.35 | 5.60 |
| | | 251 | 5.40 | 5.60 |
| Av. | | | 5.38 | 5.60 |
| X | 5.53 | 271 | 5.45 | 5.85 |
| | | 272 | 5.50 | 5.90 |
| Av. | | | 5.48 | 5.88 |
| Av. (5 animals) | 5.37 | | 5.40 | 5.71 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | SEMIMEMBRANOSUS MUSCLE (continued) | | | |
| Sodium chloride injection (continued) | | | | |
| Right muscle | | Injected samples | | |
| VI | 5.32 | 177 | 5.40 | 5.75 |
| | | 179 | 5.35 | 5.70 |
| Av. | | | 5.38 | 5.72 |
| VII | 5.33 | 199 | 5.50 | 5.60 |
| | | 200 | 5.45 | 5.60 |
| Av. | | | 5.48 | 5.60 |
| VIII | 5.35 | 222 | 5.35 | 5.65 |
| | | 226 | 5.40 | 5.65 |
| Av. | | | 5.38 | 5.65 |
| Av. (3 animals) | 5.33 | | 5.41 | 5.66 |
| IX | 5.37 | 249 | 5.40 | 5.55 |
| | | 251 | 5.40 | 5.55 |
| Av. | | | 5.40 | 5.55 |
| X | 5.55 | 271 | 5.50 | 5.80 |
| | | 272 | 5.50 | 5.80 |
| Av. | | | 5.50 | 5.80 |
| Av. (5 animals) | 5.38 | | 5.43 | 5.66 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | SEMIMEMBRANOSUS MUSCLE (continued) | | | |
| **Lactic acid injection** | | | | |
| Left muscle | (same as for sodium chloride injections) | Control samples | | |
| VI | | 175 | 5.35 | 5.75 |
| | | 176 | 5.35 | 5.75 |
| Av. | | | 5.35 | 5.75 |
| VII | | 198 | 5.45 | 5.60 |
| | | 202 | 5.40 | 5.60 |
| Av. | | | 5.42 | 5.60 |
| VIII | | 225 | 5.40 | 5.65 |
| | | 227 | 5.35 | 5.65 |
| Av. | | | 5.38 | 5.65 |
| Av. (3 animals) | | | 5.38 | 5.67 |
| IX | | 247 | 5.30 | 5.60 |
| | | 248 | 5.40 | 5.55 |
| Av. | | | 5.35 | 5.58 |
| X | | 270 | 5.45 | 5.80 |
| | | 274 | 5.70 | 5.95 |
| Av. | | | 5.58 | 5.88 |
| Av. (5 animals) | | | 5.42 | 5.69 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | SEMIMEMBRANOSUS MUSCLE (continued) | | | |
| <u>Lactic acid injection</u> (continued) | | | | |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 175 | 5.35 | 5.80 |
| | | 176 | 5.35 | 5.75 |
| Av. | | | 5.35 | 5.78 |
| VII | | 198 | 5.45 | 5.60 |
| | | 202 | 5.40 | 5.60 |
| Av. | | | 5.42 | 5.60 |
| VIII | | 225 | 5.40 | 5.70 |
| | | 227 | 5.35 | 5.65 |
| Av. | | | 5.38 | 5.68 |
| Av. (3 animals) | | | 5.38 | 5.69 |
| IX | | 247 | 5.30 | 5.60 |
| | | 248 | 5.35 | 5.55 |
| Av. | | | 5.32 | 5.58 |
| X | | 270 | 5.45 | 5.80 |
| | | 274 | 5.70 | 6.05 |
| Av. | | | 5.58 | 5.92 |
| Av. (5 animals) | | | 5.41 | 5.71 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | SEMIMEMBRANOSUS MUSCLE (continued) | | | |
| Sodium chloride and lactic acid injection | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 174 | 5.35 | 5.70 |
| | | 178 | 5.35 | 5.85 |
| Av. | | | 5.35 | 5.78 |
| VII | | 201 | 5.45 | 5.60 |
| | | 203 | 5.40 | 5.60 |
| Av. | | | 5.42 | 5.60 |
| VIII | | 223 | 5.35 | 5.65 |
| | | 224 | 5.35 | 5.60 |
| Av. | | | 5.35 | 5.62 |
| Av. (3 animals) | | | 5.37 | 5.67 |
| IX | | 246 | 5.30 | 5.60 |
| | | 250 | 5.35 | 5.55 |
| Av. | | | 5.32 | 5.58 |
| X | | 273 | 5.50 | 5.85 |
| | | 275 | 5.55 | 6.00 |
| Av. | | | 5.52 | 5.92 |
| Av. (5 animals) | | | 5.39 | 5.70 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | SEMIMEMBRANOSUS MUSCLE (continued) | | | |
| <u>Sodium chloride and lactic acid injection</u> (continued) | | | | |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 174 | 5.35 | 5.70 |
| | | 178 | 5.35 | 5.80 |
| Av. | | | 5.35 | 5.75 |
| VII | | 201 | 5.40 | 5.60 |
| | | 203 | 5.40 | 5.60 |
| Av. | | | 5.40 | 5.60 |
| VIII | | 223 | 5.35 | 5.65 |
| | | 224 | 5.40 | 5.60 |
| Av. | | | 5.38 | 5.62 |
| Av. (3 animals) | | | 5.38 | 5.66 |
| IX | | 246 | 5.35 | 5.55 |
| | | 250 | 5.40 | 5.60 |
| Av. | | | 5.38 | 5.58 |
| X | | 273 | 5.55 | 5.85 |
| | | 275 | 5.75 | 5.95 |
| Av. | | | 5.65 | 5.90 |
| Av. (5 animals) | | | 5.43 | 5.69 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | | BICEPS FEMORIS MUSCLE | | |
| Sodium chloride injection | | | | |
| Left muscle | | Control samples | | |
| VI | 5.42 | 184 | 5.40 | 5.80 |
| | | 185 | 5.45 | 5.80 |
| Av. | | | 5.42 | 5.80 |
| VII | 5.52 | 205 | 5.45 | 5.70 |
| | | 207 | 5.40 | 5.60 |
| Av. | | | 5.42 | 5.65 |
| VIII | 5.38 | 228 | 5.35 | 5.75 |
| | | 230 | 5.30 | 5.65 |
| Av. | | | 5.32 | 5.70 |
| Av. (3 animals) | 5.44 | | 5.39 | 5.72 |
| IX | 5.37 | 256 | 5.35 | 5.65 |
| | | 257 | 5.45 | 5.70 |
| Av. | | | 5.40 | 5.68 |
| X | 5.67 | 277 | 5.65 | 5.95 |
| | | 279 | 5.50 | 5.90 |
| Av. | | | 5.58 | 5.92 |
| Av. (5 animals) | 5.47 | | 5.43 | 5.75 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | BICEPS FEMORIS MUSCLE (continued) | | | |
| Sodium chloride injection (continued) | | | | |
| Right muscle | | Injected samples | | |
| VI | 5.42 | 184 | 5.40 | 5.85 |
| | | 185 | 5.45 | 5.80 |
| Av. | | | 5.42 | 5.82 |
| VII | 5.53 | 205 | 5.45 | 5.65 |
| | | 207 | 5.40 | 5.60 |
| Av. | | | 5.42 | 5.62 |
| VIII | 5.40 | 228 | 5.40 | 5.70 |
| | | 230 | 5.35 | 5.65 |
| Av. | | | 5.38 | 5.68 |
| Av. (3 animals) | 5.45 | | 5.41 | 5.71 |
| IX | 5.40 | 256 | 5.40 | 5.60 |
| | | 257 | 5.50 | 5.65 |
| Av. | | | 5.45 | 5.62 |
| X | 5.67 | 277 | 5.55 | 5.95 |
| | | 279 | 5.50 | 5.80 |
| Av. | | | 5.52 | 5.88 |
| Av. (5 animals) | 5.48 | | 5.44 | 5.72 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | BICEPS FEMORIS MUSCLE (continued) | | | |
| Lactic acid injection | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 181 | 5.50 | 5.85 |
| | | 183 | 5.40 | 5.70 |
| Av. | | | 5.45 | 5.78 |
| VII | | 204 | 5.45 | 5.70 |
| | | 206 | 5.40 | 5.65 |
| Av. | | | 5.42 | 5.68 |
| VIII | | 232 | 5.35 | 5.75 |
| | | 233 | 5.45 | 5.75 |
| Av. | | | 5.40 | 5.75 |
| Av. (3 animals) | | | 5.42 | 5.74 |
| IX | | 253 | 5.30 | 5.65 |
| | | 255 | 5.40 | 5.60 |
| Av. | | | 5.35 | 5.62 |
| X | | 276 | 5.60 | 6.00 |
| | | 278 | 5.45 | 5.90 |
| Av. | | | 5.52 | 5.95 |
| Av. (5 animals) | | | 5.43 | 5.76 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day pH | Sample no. | Beef cuts aged eight days pH | Canned beef pH |
|---|---|---|---|---|
| | BICEPS FEMORIS MUSCLE (continued) | | | |
| Lactic acid injection (continued) | | | | |
| Right muscle | (same as for sodium chloride injection) | Injected samples | | |
| VI | | 181 | 5.40 | 5.90 |
| | | 183 | 5.40 | 5.70 |
| Av. | | | 5.40 | 5.80 |
| VII | | 204 | 5.45 | 5.70 |
| | | 206 | 5.40 | 5.60 |
| Av. | | | 5.42 | 5.65 |
| VIII | | 232 | 5.35 | 5.75 |
| | | 233 | 5.50 | 5.75 |
| Av. | | | 5.42 | 5.75 |
| Av. (3 animals) | | | 5.41 | 5.73 |
| IX | | 253 | 5.40 | 5.65 |
| | | 255 | 5.35 | 5.60 |
| Av. | | | 5.38 | 5.62 |
| X | | 276 | 5.50 | 6.00 |
| | | 278 | 5.50 | 5.85 |
| Av. | | | 5.50 | 5.92 |
| Av. (5 animals) | | | 5.42 | 5.75 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | BICEPS FEMORIS MUSCLE (continued) | | | |
| Sodium chloride and lactic acid injection | | | | |
| Left muscle | (same as for sodium chloride injection) | Control samples | | |
| VI | | 180 | 5.50 | 5.85 |
| | | 182 | 5.35 | 5.85 |
| Av. | | | 5.42 | 5.85 |
| VII | | 208 | 5.40 | 5.60 |
| | | 209 | 5.40 | 5.65 |
| Av. | | | 5.40 | 5.62 |
| VIII | | 229 | 5.35 | 5.70 |
| | | 231 | 5.30 | 5.65 |
| Av. | | | 5.32 | 5.68 |
| Av. (3 animals) | | | 5.38 | 5.72 |
| IX | | 252 | 5.45 | 5.70 |
| | | 254 | 5.30 | 5.65 |
| Av. | | | 5.38 | 5.68 |
| X | | 280 | 5.55 | 5.95 |
| | | 281 | 5.45 | 6.00 |
| Av. | | | 5.50 | 5.98 |
| Av. (5 animals) | | | 5.40 | 5.76 |

(continued)

Table 5 (continued)

| Animal no. | Beef muscles (uninjected) aged one day | Sample no. | Beef cuts aged eight days | Canned beef |
|---|---|---|---|---|
| | pH | | pH | pH |
| | BICEPS FEMORIS MUSCLE (continued) | | | |
| <u>Sodium chloride and lactic acid injection</u> (continued) | | | | |
| Right muscle | (same as for sodium chloride injection | Injected samples | | |
| VI | | 180 | 5.50 | 5.80 |
| | | 182 | 5.40 | 5.80 |
| Av. | | | 5.45 | 5.80 |
| VII | | 208 | 5.45 | 5.60 |
| | | 209 | 5.45 | 5.65 |
| Av. | | | 5.45 | 5.62 |
| VIII | | 229 | 5.45 | 5.70 |
| | | 231 | 5.40 | 5.65 |
| Av. | | | 5.42 | 5.68 |
| Av. (3 animals) | | | 5.44 | 5.70 |
| IX | | 252 | 5.45 | 5.65 |
| | | 254 | 5.45 | 5.60 |
| Av. | | | 5.45 | 5.62 |
| X | | 280 | 5.55 | 5.80 |
| | | 281 | 5.50 | 5.85 |
| Av. | | | 5.52 | 5.82 |
| Av. (5 animals) | | | 5.46 | 5.71 |

(continued)

Table 6. Weight Changes of Beef before Canning. Initial weight of beef and weight of beef plus injecting solution one day after slaughter of animal; weight of aged beef eight days after slaughter; percentage weight after aging based on initial weight of sample.

| Animal* no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION | | | | | |
| Sodium chloride injection | | | | | |
| Control samples | | | | | |
| VI | 162 | 606 | | 598 | 98.7 |
| VII | 188 | 601 | | 587 | 97.7 |
| VIII | 211 | 605 | | 595 | 98.3 |
| Av. (3 animals) | | 604 | | 593 | 98.2 |
| IX | 234 | 605 | | 587 | 97.0 |
| X | 260 | 604 | | 593 | 98.2 |
| Av. (5 animals) | | 604 | | 592 | 98.0 |
| Injected samples | | | | | |
| VI | 162 | 608 | 668 | 631 | 103.8 |
| VII | 188 | 602 | 662 | 617 | 102.5 |
| VIII | 211 | 606 | 666 | 593 | 97.8 |
| Av. (3 animals) | | 605 | 665 | 614 | 101.4 |
| IX | 234 | 606 | 666 | 635 | 104.8 |
| X | 260 | 606 | 666 | 634 | 104.6 |
| Av. (5 animals) | | 606 | 666 | 622 | 102.7 |

(continued)

*Animals VI, VII, and VIII were steers, carcass grade Commercial, processed 65 minutes; Animal IX was a steer, carcass grade Commercial, processed 90 minutes; Animal X was a cow, carcass grade Cutter, processed 90 minutes.

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | | |
| <u>Lactic acid injection</u> | | | | | |
| Control samples | | | | | |
| VI | 164 | 604 | | 597 | 98.8 |
| VII | 187 | 604 | | 588 | 97.4 |
| VIII | 210 | 606 | | 597 | 98.5 |
| Av. (3 animals) | | 605 | | 594 | 98.2 |
| IX | 236 | 606 | | 594 | 98.0 |
| X | 259 | 607 | | 598 | 98.5 |
| Av. (5 animals) | | 605 | | 595 | 98.2 |
| Injected samples | | | | | |
| VI | 164 | 606 | 666 | 605 | 99.8 |
| VII | 187 | 608 | 668 | 599 | 98.5 |
| VIII | 210 | 606 | 666 | 602 | 99.3 |
| Av. (3 animals) | | 607 | 667 | 602 | 99.2 |
| IX | 236 | 606 | 666 | 607 | 100.2 |
| X | 259 | 607 | 667 | 633 | 104.3 |
| Av. (5 animals) | | 606 | 666 | 609 | 100.4 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | | |
| <u>Sodium chloride and lactic acid injection</u> | | | | | |
| Control samples | | | | | |
| VI | 163 | 605 | | 590 | 97.5 |
| VII | 186 | 600 | | 588 | 98.0 |
| VIII | 212 | 606 | | 592 | 97.7 |
| Av. (3 animals) | | 604 | | 590 | 97.7 |
| IX | 235 | 600 | | 591 | 98.5 |
| X | 258 | 601 | | 587 | 97.7 |
| Av. (5 animals) | | 602 | | 590 | 97.9 |
| Injected samples | | | | | |
| VI | 163 | 608 | 668 | 630 | 103.6 |
| VII | 186 | 604 | 664 | 622 | 103.0 |
| VIII | 212 | 607 | 667 | 630 | 103.8 |
| Av. (3 animals) | | 606 | 666 | 627 | 103.5 |
| IX | 235 | 605 | 665 | 619 | 102.3 |
| X | 258 | 604 | 664 | 634 | 105.0 |
| Av. (5 animals) | | 606 | 666 | 627 | 103.5 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION | | | | | |
| <u>Sodium chloride injection</u> | | | | | |
| Control samples | | | | | |
| VI | 167 | 605 | | 596 | 98.5 |
| VII | 189 | 601 | | 594 | 98.8 |
| VIII | 214 | 606 | | 603 | 99.5 |
| Av. (3 animals) | | 604 | | 598 | 98.9 |
| IX | 239 | 608 | | 597 | 98.2 |
| X | 261 | 608 | | 603 | 99.2 |
| Av. (5 animals) | | 606 | | 599 | 98.8 |
| Injected samples | | | | | |
| VI | 167 | 600 | 660 | 640 | 106.7 |
| VII | 189 | 608 | 668 | 661 | 108.7 |
| VIII | 214 | 605 | 665 | 643 | 106.3 |
| Av. (3 animals) | | 604 | 664 | 648 | 107.2 |
| IX | 239 | 605 | 665 | 646 | 106.8 |
| X | 261 | 607 | 667 | 661 | 108.9 |
| Av. (5 animals) | | 605 | 665 | 650 | 107.5 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | | |
| <u>Lactic acid injection</u> | | | | | |
| Control samples | | | | | |
| VI | 165 | 607 | | 606 | 99.8 |
| VII | 190 | 603 | | 593 | 98.3 |
| VIII | 215 | 606 | | 598 | 98.7 |
| Av. (3 animals) | | 605 | | 599 | 98.9 |
| IX | 237 | 601 | | 590 | 98.2 |
| X | 262 | 606 | | 600 | 99.0 |
| Av. (5 animals) | | 605 | | 597 | 98.8 |
| Injected samples | | | | | |
| VI | 165 | 605 | 665 | 648 | 107.1 |
| VII | 190 | 602 | 662 | 619 | 102.8 |
| VIII | 215 | 605 | 665 | 616 | 101.8 |
| Av. (3 animals) | | 604 | 664 | 628 | 103.9 |
| IX | 237 | 605 | 665 | 626 | 103.5 |
| X | 262 | 605 | 665 | 645 | 106.6 |
| Av. (5 animals) | | 604 | 664 | 631 | 104.4 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | | |
| <u>Sodium chloride and lactic acid injection</u> | | | | | |
| Control samples | | | | | |
| VI | 166 | 605 | | 599 | 99.0 |
| VII | 191 | 601 | | 589 | 98.0 |
| VIII | 213 | 607 | | 603 | 99.3 |
| Av. (3 animals) | | 604 | | 597 | 98.8 |
| IX | 238 | 604 | | 587 | 97.2 |
| X | 263 | 608 | | 596 | 98.0 |
| Av. (5 animals) | | 605 | | 595 | 98.3 |
| Injected samples | | | | | |
| VI | 166 | 607 | 667 | 642 | 105.8 |
| VII | 191 | 605 | 665 | 622 | 102.8 |
| VIII | 213 | 607 | 667 | 646 | 106.4 |
| Av. (3 animals) | | 606 | 666 | 637 | 105.0 |
| IX | 238 | 608 | 668 | 634 | 104.3 |
| X | 263 | 608 | 668 | 645 | 106.1 |
| Av. (5 animals) | | 607 | 667 | 638 | 105.1 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES | | | | | |
| <u>Sodium chloride injection</u> | | | | | |
| Control samples | | | | | |
| VI | 168 | 608 | | 606 | 99.7 |
| VII | 193 | 604 | | 594 | 98.3 |
| VIII | 218 | 605 | | 597 | 98.7 |
| Av. (3 animals) | | 606 | | 599 | 98.9 |
| IX | 240 | 602 | | 585 | 97.2 |
| X | 265 | 604 | | 600 | 99.3 |
| Av. (5 animals) | | 605 | | 596 | 98.6 |
| Injected samples | | | | | |
| VI | 168 | 606 | 666 | 645 | 106.4 |
| VII | 193 | 605 | 665 | 646 | 106.8 |
| VIII | 218 | 606 | 666 | 650 | 107.3 |
| Av. (3 animals) | | 606 | 666 | 647 | 106.8 |
| IX | 240 | 606 | 666 | 637 | 105.1 |
| X | 265 | 607 | 667 | 648 | 106.8 |
| Av. (5 animals) | | 606 | 666 | 645 | 106.5 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued) | | | | | |
| Lactic acid injection | | | | | |
| Control samples | | | | | |
| VI | 169 | 600 | | 599 | 99.8 |
| VII | 194 | 604 | | 596 | 98.7 |
| VIII | 216 | 606 | | 595 | 98.2 |
| Av. (3 animals) | | 603 | | 597 | 98.9 |
| IX | 241 | 607 | | 601 | 99.0 |
| X | 266 | 602 | | 596 | 99.0 |
| Av. (5 animals) | | 604 | | 597 | 98.9 |
| Injected samples | | | | | |
| VI | 169 | 601 | 661 | 630 | 104.8 |
| VII | 194 | 601 | 661 | 648 | 107.8 |
| VIII | 216 | 606 | 666 | 631 | 104.1 |
| Av. (3 animals) | | 603 | 663 | 636 | 105.5 |
| IX | 241 | 604 | 664 | 639 | 105.8 |
| X | 266 | 605 | 665 | 636 | 105.1 |
| Av. (5 animals) | | 603 | 663 | 637 | 105.5 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued) | | | | | |
| Sodium chloride and lactic acid injection | | | | | |
| Control samples | | | | | |
| VI | 170 | 605 | | 600 | 99.2 |
| VII | 192 | 603 | | 595 | 98.7 |
| VIII | 217 | 606 | | 600 | 99.0 |
| Av. (3 animals) | | 605 | | 598 | 99.0 |
| IX | 242 | 608 | | 599 | 98.5 |
| X | 264 | 605 | | 599 | 99.0 |
| Av. (5 animals) | | 605 | | 599 | 98.9 |
| Injected samples | | | | | |
| VI | 170 | 607 | 667 | 639 | 105.3 |
| VII | 192 | 602 | 662 | 658 | 109.3 |
| VIII | 217 | 606 | 666 | 645 | 106.4 |
| Av. (3 animals) | | 605 | 665 | 647 | 107.0 |
| IX | 242 | 602 | 662 | 636 | 105.6 |
| X | 264 | 605 | 665 | 636 | 105.1 |
| Av. (5 animals) | | 604 | 664 | 643 | 106.3 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | SEMITENDINOSUS MUSCLE | | | |
| Sodium chloride injection | | | | | |
| Control samples | | | | | |
| VI | 172 | 608 | | 605 | 99.5 |
| VII | 197 | 601 | | 594 | 98.8 |
| VIII | 219 | 607 | | 593 | 97.7 |
| Av. (3 animals) | | 605 | | 597 | 98.7 |
| IX | 244 | 605 | | 593 | 98.0 |
| X | 269 | 604 | | 601 | 99.5 |
| Av. (5 animals) | | 605 | | 597 | 98.7 |
| Injected samples | | | | | |
| VI | 172 | 607 | 667 | 634 | 104.4 |
| VII | 197 | 603 | 663 | 644 | 106.8 |
| VIII | 219 | 606 | 666 | 624 | 103.0 |
| Av. (3 animals) | | 605 | 665 | 634 | 104.7 |
| IX | 244 | 604 | 664 | 638 | 105.6 |
| X | 269 | 605 | 665 | 638 | 105.4 |
| Av. (5 animals) | | 605 | 665 | 636 | 105.0 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | SEMITENDINOSUS MUSCLE (continued) | | | |
| **Lactic acid injection** | | | | | |
| Control samples | | | | | |
| VI | 173 | 608 | | 607 | 99.8 |
| VII | 195 | 603 | | 597 | 99.0 |
| VIII | 220 | 608 | | 602 | 99.0 |
| Av. (3 animals) | | 606 | | 602 | 99.3 |
| IX | 245 | 609 | | 602 | 98.8 |
| X | 267 | 604 | | 600 | 99.3 |
| Av. (5 animals) | | 606 | | 602 | 99.2 |
| Injected samples | | | | | |
| VI | 173 | 601 | 661 | 630 | 104.8 |
| VII | 195 | 600 | 660 | 616 | 102.7 |
| VIII | 220 | 607 | 667 | 606 | 99.8 |
| Av. (3 animals) | | 603 | 663 | 617 | 102.4 |
| IX | 245 | 602 | 662 | 600 | 99.7 |
| X | 267 | 608 | 668 | 633 | 104.1 |
| Av. (5 animals) | | 604 | 664 | 617 | 102.2 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | SEMITENDINOSUS MUSCLE (continued) | | | |
| **Sodium chloride and lactic acid injection** | | | | | |
| Control samples | | | | | |
| VI | 171 | 607 | | 600 | 98.8 |
| VII | 196 | 606 | | 604 | 99.7 |
| VIII | 221 | 606 | | 597 | 98.5 |
| Av. (3 animals) | | 606 | | 600 | 99.0 |
| IX | 243 | 604 | | 588 | 97.4 |
| X | 268 | 606 | | 602 | 99.3 |
| Av. (5 animals) | | 606 | | 598 | 98.7 |
| Injected samples | | | | | |
| VI | 171 | 606 | 666 | 636 | 105.0 |
| VII | 196 | 604 | 664 | 635 | 105.1 |
| VIII | 221 | 607 | 667 | 642 | 105.8 |
| Av. (3 animals) | | 606 | 666 | 638 | 105.3 |
| IX | 243 | 604 | 664 | 617 | 102.2 |
| X | 268 | 602 | 662 | 634 | 105.3 |
| Av. (5 animals) | | 605 | 665 | 633 | 104.7 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | SEMIMEMBRANOSUS MUSCLE | | | |
| Sodium chloride injection | | | | | |
| Control samples | | | | | |
| VI | 177 | 604 | | 597 | 98.8 |
| | 179 | 609 | | 597 | 98.0 |
| Av. | | 606 | | 597 | 98.4 |
| VII | 199 | 605 | | 594 | 98.2 |
| | 200 | 600 | | 586 | 97.7 |
| Av. | | 602 | | 590 | 98.0 |
| VIII | 222 | 606 | | 591 | 97.5 |
| | 226 | 606 | | 594 | 98.0 |
| Av. | | 606 | | 592 | 97.8 |
| Av. (3 animals) | | 605 | | 593 | 98.1 |
| IX | 249 | 607 | | 592 | 97.5 |
| | 251 | 600 | | 578 | 96.3 |
| Av. | | 604 | | 585 | 96.9 |
| X | 271 | 606 | | 600 | 99.0 |
| | 272 | 604 | | 596 | 98.7 |
| Av. | | 605 | | 598 | 98.8 |
| Av. (5 animals) | | 605 | | 592 | 98.0 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | |
| <u>Sodium chloride injection</u> (continued) | | | | | |
| Injected samples | | | | | |
| VI | 177 | 604 | 664 | 649 | 107.4 |
| | 179 | 602 | 662 | 625 | 103.8 |
| Av. | | 603 | 663 | 637 | 105.6 |
| VII | 199 | 601 | 661 | 628 | 104.5 |
| | 200 | 606 | 666 | 644 | 106.3 |
| Av. | | 604 | 664 | 636 | 105.4 |
| VIII | 222 | 606 | 666 | 633 | 104.4 |
| | 226 | 606 | 666 | 644 | 106.3 |
| Av. | | 606 | 666 | 638 | 105.4 |
| Av. (3 animals) | | 604 | 664 | 637 | 105.5 |
| IX | 249 | 608 | 668 | 637 | 104.8 |
| | 251 | 608 | 668 | 636 | 104.6 |
| Av. | | 608 | 668 | 636 | 104.7 |
| X | 271 | 606 | 666 | 637 | 105.1 |
| | 272 | 604 | 664 | 635 | 105.1 |
| Av. | | 605 | 665 | 636 | 105.1 |
| Av. (5 animals) | | 605 | 665 | 637 | 105.2 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | | SEMIMEMBRANOSUS MUSCLE (continued) | | |
| Lactic acid injection | | | | | |
| Control samples | | | | | |
| VI | 175 | 600 | | 589 | 98.2 |
| | 176 | 605 | | 596 | 98.5 |
| Av. | | 602 | | 592 | 98.4 |
| VII | 198 | 608 | | 595 | 97.9 |
| | 202 | 605 | | 595 | 98.3 |
| Av. | | 606 | | 595 | 98.1 |
| VIII | 225 | 607 | | 597 | 98.4 |
| | 227 | 606 | | 583 | 96.2 |
| Av. | | 606 | | 590 | 97.3 |
| Av. (3 animals) | | 605 | | 592 | 97.9 |
| IX | 247 | 603 | | 588 | 97.5 |
| | 248 | 607 | | 604 | 99.5 |
| Av. | | 605 | | 596 | 98.5 |
| X | 270 | 605 | | 602 | 99.5 |
| | 274 | 606 | | 599 | 98.8 |
| Av. | | 606 | | 600 | 99.2 |
| Av. (5 animals) | | 605 | | 595 | 98.3 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | |
| <u>Lactic acid injection</u> (continued) | | | | | |
| Injected samples | | | | | |
| VI | 175 | 604 | 664 | 606 | 100.3 |
| | 176 | 605 | 665 | 603 | 99.7 |
| Av. | | 604 | 664 | 604 | 100.0 |
| VII | 198 | 604 | 664 | 625 | 103.5 |
| | 202 | 602 | 662 | 613 | 101.8 |
| Av. | | 603 | 663 | 619 | 102.6 |
| VIII | 225 | 606 | 666 | 612 | 101.0 |
| | 227 | 605 | 665 | 606 | 100.2 |
| Av. | | 606 | 666 | 609 | 100.6 |
| Av. (3 animals) | | 604 | 664 | 611 | 101.1 |
| IX | 247 | 604 | 664 | 604 | 100.0 |
| | 248 | 601 | 661 | 603 | 100.3 |
| Av. | | 602 | 662 | 604 | 100.2 |
| X | 270 | 605 | 665 | 621 | 102.6 |
| | 274 | 606 | 666 | 628 | 103.6 |
| Av. | | 606 | 666 | 625 | 103.1 |
| Av. (5 animals) | | 604 | 664 | 612 | 101.3 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | SEMIMEMBRANOSUS MUSCLE (continued) | | | |
| Sodium chloride and lactic acid injection | | | | | |
| Control samples | | | | | |
| VI | 174 | 606 | | 596 | 98.3 |
| | 178 | 608 | | 594 | 97.7 |
| Av. | | 607 | | 595 | 98.0 |
| VII | 201 | 600 | | 582 | 97.0 |
| | 203 | 606 | | 594 | 98.0 |
| Av. | | 603 | | 588 | 97.5 |
| VIII | 223 | 608 | | 596 | 98.0 |
| | 224 | 608 | | 596 | 98.0 |
| Av. | | 608 | | 596 | 98.0 |
| Av. (3 animals) | | 606 | | 593 | 97.8 |
| IX | 246 | 604 | | 593 | 98.2 |
| | 250 | 600 | | 581 | 96.8 |
| Av. | | 602 | | 587 | 97.5 |
| X | 273 | 605 | | 590 | 97.5 |
| | 275 | 604 | | 600 | 99.3 |
| Av. | | 604 | | 595 | 98.4 |
| Av. (5 animals) | | 605 | | 592 | 97.9 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | |
| Sodium chloride and lactic acid injection (continued) | | | | | |
| Injected samples | | | | | |
| VI | 174 | 600 | 660 | 625 | 104.2 |
| | 178 | 600 | 660 | 622 | 103.7 |
| Av. | | 600 | 660 | 624 | 104.0 |
| VII | 201 | 606 | 666 | 637 | 105.1 |
| | 203 | 602 | 662 | 641 | 106.5 |
| Av. | | 604 | 664 | 639 | 105.8 |
| VIII | 223 | 606 | 666 | 623 | 102.8 |
| | 224 | 607 | 667 | 619 | 102.0 |
| Av. | | 606 | 666 | 621 | 102.4 |
| Av. (3 animals) | | 603 | 663 | 628 | 104.1 |
| IX | 246 | 600 | 660 | 625 | 104.2 |
| | 250 | 608 | 668 | 630 | 103.6 |
| Av. | | 604 | 664 | 628 | 103.9 |
| X | 273 | 605 | 665 | 641 | 106.0 |
| | 275 | 604 | 664 | 645 | 106.8 |
| Av. | | 604 | 664 | 643 | 106.4 |
| Av. (5 animals) | | 604 | 664 | 631 | 104.5 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | | BICEPS FEMORIS MUSCLE | | |
| <u>Sodium chloride injection</u> | | | | | |
| Control samples | | | | | |
| VI | 184 | 605 | | 600 | 99.2 |
| | 185 | 606 | | 601 | 99.2 |
| Av. | | 606 | | 600 | 99.2 |
| VII | 205 | 601 | | 598 | 99.5 |
| | 207 | 607 | | 601 | 99.0 |
| Av. | | 604 | | 600 | 99.2 |
| VIII | 228 | 605 | | 596 | 98.5 |
| | 230 | 606 | | 596 | 98.3 |
| Av. | | 606 | | 596 | 98.4 |
| Av. (3 animals) | | 605 | | 599 | 98.9 |
| IX | 256 | 607 | | 595 | 98.0 |
| | 257 | 603 | | 595 | 98.7 |
| Av. | | 605 | | 595 | 98.4 |
| X | 277 | 603 | | 597 | 99.0 |
| | 279 | 607 | | 600 | 98.8 |
| Av. | | 605 | | 598 | 98.9 |
| Av. (5 animals) | | 605 | | 598 | 98.8 |

(continued)

Table 6 (continued)

| Animal no. | Sample no | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | BICEPS FEMORIS MUSCLE (continued) | | | |
| Sodium chloride injection (continued) | | | | | |
| Injected samples | | | | | |
| VI | 184 | 601 | 661 | 639 | 106.3 |
| | 185 | 606 | 666 | 643 | 106.1 |
| Av. | | 604 | 664 | 641 | 106.2 |
| VII | 205 | 603 | 663 | 652 | 108.3 |
| | 207 | 607 | 667 | 664 | 109.4 |
| Av. | | 605 | 665 | 658 | 108.8 |
| VIII | 228 | 605 | 665 | 638 | 105.4 |
| | 230 | 608 | 668 | 635 | 104.4 |
| Av. | | 606 | 666 | 636 | 104.9 |
| Av. (3 animals) | | 605 | 665 | 645 | 106.6 |
| IX | 256 | 603 | 663 | 635 | 105.3 |
| | 257 | 603 | 663 | 632 | 104.8 |
| Av. | | 603 | 663 | 634 | 105.0 |
| X | 277 | 608 | 668 | 629 | 103.4 |
| | 279 | 600 | 660 | 641 | 106.8 |
| Av. | | 604 | 664 | 635 | 105.1 |
| Av. (5 animals) | | 604 | 664 | 641 | 106.0 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | |
| **Lactic acid injection** | | | | | |
| Control samples | | | | | |
| VI | 181 | 607 | | 604 | 99.5 |
| | 183 | 609 | | 600 | 98.5 |
| Av. | | 608 | | 602 | 99.0 |
| VII | 204 | 606 | | 598 | 98.7 |
| | 206 | 602 | | 595 | 98.8 |
| Av. | | 604 | | 596 | 98.8 |
| VIII | 232 | 605 | | 596 | 98.5 |
| | 233 | 607 | | 602 | 99.2 |
| Av. | | 606 | | 599 | 98.8 |
| Av. (3 animals) | | 606 | | 599 | 98.9 |
| IX | 253 | 608 | | 601 | 98.8 |
| | 255 | 605 | | 592 | 97.8 |
| Av. | | 606 | | 596 | 98.3 |
| X | 276 | 600 | | 591 | 98.5 |
| | 278 | 608 | | 597 | 98.2 |
| Av. | | 604 | | 594 | 98.4 |
| Av. (5 animals) | | 606 | | 597 | 98.7 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | |
| <u>Lactic acid injection</u> (continued) | | | | | |
| Injected samples | | | | | |
| VI | 181 | 603 | 663 | 630 | 104.5 |
| | 183 | 606 | 666 | 620 | 102.3 |
| Av. | | 604 | 664 | 625 | 103.4 |
| VII | 204 | 603 | 663 | 637 | 105.6 |
| | 206 | 600 | 660 | 618 | 103.0 |
| Av. | | 602 | 662 | 628 | 104.3 |
| VIII | 232 | 606 | 666 | 623 | 102.8 |
| | 233 | 605 | 665 | 624 | 103.1 |
| Av. | | 606 | 666 | 624 | 103.0 |
| Av. (3 animals) | | 604 | 664 | 626 | 103.6 |
| IX | 253 | 605 | 665 | 604 | 99.8 |
| | 255 | 607 | 667 | 623 | 102.6 |
| Av. | | 606 | 666 | 614 | 101.2 |
| X | 276 | 605 | 665 | 633 | 104.6 |
| | 278 | 607 | 667 | 625 | 103.0 |
| Av. | | 606 | 666 | 629 | 103.8 |
| Av. (5 animals) | | 605 | 665 | 624 | 103.1 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | |
| Sodium chloride and lactic acid injection | | | | | |
| Control samples | | | | | |
| VI | 180 | 608 | | 603 | 99.2 |
| | 182 | 600 | | 592 | 98.7 |
| Av. | | 604 | | 598 | 99.0 |
| VII | 208 | 601 | | 594 | 98.8 |
| | 209 | 606 | | 602 | 99.3 |
| Av. | | 604 | | 598 | 99.0 |
| VIII | 229 | 606 | | 603 | 99.5 |
| | 231 | 606 | | 590 | 97.4 |
| Av. | | 606 | | 596 | 98.4 |
| Av. (3 animals) | | 605 | | 597 | 98.8 |
| IX | 252 | 603 | | 589 | 97.7 |
| | 254 | 607 | | 598 | 98.5 |
| Av. | | 605 | | 594 | 98.1 |
| X | 280 | 605 | | 601 | 99.3 |
| | 281 | 607 | | 605 | 99.7 |
| Av. | | 606 | | 603 | 99.5 |
| Av. (5 animals) | | 605 | | 598 | 98.8 |

(continued)

Table 6 (continued)

| Animal no. | Sample no. | Initial wt. | Beef plus injecting solution | Wt. beef after aging | |
|---|---|---|---|---|---|
| | | gm. | gm. | gm. | % |
| | | BICEPS FEMORIS MUSCLE (continued) | | | |
| Sodium chloride and lactic acid injection (continued) | | | | | |
| Injected samples | | | | | |
| VI | 180 | 604 | 664 | 656 | 108.6 |
| | 182 | 610 | 670 | 640 | 104.9 |
| Av. | | 607 | 667 | 648 | 106.8 |
| VII | 208 | 603 | 663 | 642 | 106.5 |
| | 209 | 605 | 665 | 633 | 104.6 |
| Av. | | 604 | 664 | 638 | 105.6 |
| VIII | 229 | 607 | 667 | 637 | 104.9 |
| | 231 | 606 | 666 | 632 | 104.3 |
| Av. | | 606 | 666 | 634 | 104.6 |
| Av. (3 animals) | | 606 | 666 | 640 | 105.7 |
| IX | 252 | 604 | 664 | 637 | 105.5 |
| | 254 | 604 | 664 | 629 | 104.1 |
| Av. | | 604 | 664 | 633 | 104.8 |
| X | 280 | 608 | 668 | 648 | 106.6 |
| | 281 | 605 | 665 | 649 | 107.3 |
| Av. | | 606 | 666 | 648 | 107.0 |
| Av. (5 animals) | | 605 | 665 | 640 | 105.8 |

Table 7. Weight of Canned Meat and of Liquid. Weight of beef before processing; weight of meat and of liquid after processing; percentage weight of meat and of liquid based on weight of beef before processing.

| Animal* no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION | | | | | | |
| Sodium chloride injection | | | | | | |
| Control samples | | | | | | |
| VI | 162 | 568 | 379 | 66.7 | 188 | 33.1 |
| VII | 188 | 570 | 392 | 68.8 | 174 | 30.5 |
| VIII | 211 | 568 | 364 | 64.1 | 199 | 35.0 |
| Av. (3 animals) | | 569 | 378 | 66.5 | 187 | 32.9 |
| IX | 234 | 568 | 376 | 66.2 | 188 | 33.1 |
| X | 260 | 569 | 373 | 65.6 | 192 | 33.7 |
| Av. (5 animals) | | 569 | 377 | 66.3 | 188 | 33.1 |
| Injected samples | | | | | | |
| VI | 162 | 570 | 376 | 66.0 | 192 | 33.7 |
| VII | 188 | 572 | 408 | 71.3 | 158 | 27.6 |
| VIII | 211 | 569 | 362 | 63.6 | 203 | 35.7 |
| Av. (3 animals) | | 570 | 382 | 67.0 | 184 | 32.3 |
| IX | 234 | 568 | 360 | 63.4 | 138 | 24.3 |
| X | 260 | 569 | 406 | 71.4 | 146 | 25.6 |
| Av. (5 animals) | | 570 | 382 | 67.1 | 167 | 29.4 |

(continued)

*Animals VI, VII, and VIII were steers, carcass grade Commercial, processed 65 minutes; Animal IX was a steer, carcass grade Commercial, processed 90 minutes; Animal X was a cow, carcass grade Cutter, processed 90 minutes.

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | | | |
| <u>Lactic acid injection</u> | | | | | | |
| Control samples | | | | | | |
| VI | 164 | 568 | 391 | 68.8 | 176 | 31.0 |
| VII | 187 | 570 | 394 | 69.1 | 174 | 30.5 |
| VIII | 210 | 568 | 363 | 63.9 | 197 | 34.7 |
| Av. (3 animals) | | 569 | 383 | 67.3 | 182 | 32.1 |
| IX | 236 | 570 | 378 | 66.3 | 182 | 31.9 |
| X | 259 | 568 | 378 | 66.5 | 189 | 33.3 |
| Av. (5 animals) | | 569 | 381 | 66.9 | 184 | 32.3 |
| Injected samples | | | | | | |
| VI | 164 | 569 | 380 | 66.8 | 188 | 33.0 |
| VII | 187 | 570 | 383 | 67.2 | 186 | 32.6 |
| VIII | 210 | 568 | 354 | 62.3 | 202 | 35.6 |
| Av. (3 animals) | | 569 | 372 | 65.4 | 192 | 33.7 |
| IX | 236 | 568 | 365 | 64.3 | 196 | 34.5 |
| X | 259 | 568 | 364 | 64.1 | 188 | 33.1 |
| Av. (5 animals) | | 569 | 369 | 64.9 | 192 | 33.8 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| LONGISSIMUS DORSI MUSCLE, LOIN PORTION (continued) | | | | | | |
| Sodium chloride and lactic acid injection | | | | | | |
| Control samples | | | | | | |
| VI | 163 | 568 | 387 | 68.1 | 178 | 31.4 |
| VII | 186 | 568 | 390 | 68.7 | 168 | 29.6 |
| VIII | 212 | 570 | 364 | 63.8 | 206 | 36.1 |
| Av. (3 animals) | | 569 | 380 | 66.9 | 184 | 32.4 |
| IX | 235 | 569 | 366 | 64.3 | 194 | 34.1 |
| X | 258 | 568 | 372 | 65.5 | 185 | 32.6 |
| Av. (5 animals) | | 569 | 376 | 66.1 | 186 | 32.8 |
| Injected samples | | | | | | |
| VI | 163 | 569 | 385 | 67.7 | 185 | 32.5 |
| VII | 186 | 569 | 384 | 67.5 | 184 | 32.3 |
| VIII | 212 | 570 | 353 | 61.9 | 202 | 35.4 |
| Av. (3 animals) | | 569 | 374 | 65.7 | 190 | 33.4 |
| IX | 235 | 568 | 355 | 62.5 | 210 | 37.0 |
| X | 258 | 569 | 395 | 69.5 | 156 | 27.4 |
| Av. (5 animals) | | 569 | 374 | 65.8 | 187 | 32.9 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION | | | | | | |
| Sodium chloride injection | | | | | | |
| Control samples | | | | | | |
| VI | 167 | 568 | 372 | 65.5 | 195 | 34.3 |
| VII | 189 | 573 | 391 | 68.2 | 165 | 28.8 |
| VIII | 214 | 570 | 378 | 66.3 | 181 | 31.8 |
| Av. (3 animals) | | 570 | 380 | 66.7 | 180 | 31.6 |
| IX | 239 | 570 | 375 | 65.8 | 193 | 33.8 |
| X | 261 | 568 | 356 | 62.7 | 135 | 23.8 |
| Av. (5 animals) | | 570 | 374 | 65.7 | 174 | 30.5 |
| Injected samples | | | | | | |
| VI | 167 | 571 | 384 | 67.2 | 188 | 32.9 |
| VII | 189 | 573 | 384 | 67.0 | 159 | 27.7 |
| VIII | 214 | 570 | 357 | 62.6 | 209 | 36.7 |
| Av. (3 animals) | | 571 | 375 | 65.6 | 185 | 32.4 |
| IX | 239 | 569 | 368 | 64.7 | 191 | 33.6 |
| X | 261 | 570 | 356 | 62.4 | 191 | 33.5 |
| Av. (5 animals) | | 571 | 370 | 64.8 | 188 | 32.9 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | | | |
| <u>Lactic acid injection</u> | | | | | | |
| Control samples | | | | | | |
| VI | 165 | 570 | 368 | 64.6 | 202 | 35.4 |
| VII | 190 | 571 | 424 | 74.2 | 143 | 25.0 |
| VIII | 215 | 570 | 379 | 66.5 | 192 | 33.7 |
| Av. (3 animals) | | 570 | 390 | 68.4 | 179 | 31.4 |
| IX | 237 | 568 | 364 | 64.1 | 197 | 34.7 |
| X | 262 | 569 | 383 | 67.3 | 172 | 30.2 |
| Av. (5 animals) | | 570 | 384 | 67.3 | 181 | 31.8 |
| Injected samples | | | | | | |
| VI | 165 | 570 | 363 | 63.7 | 200 | 35.1 |
| VII | 190 | 568 | 390 | 68.7 | 168 | 29.6 |
| VIII | 215 | 569 | 359 | 63.1 | 201 | 35.3 |
| Av. (3 animals) | | 569 | 371 | 65.2 | 190 | 33.3 |
| IX | 237 | 569 | 343 | 60.3 | 213 | 37.4 |
| X | 262 | 569 | 363 | 63.8 | 148 | 26.0 |
| Av. (5 animals) | | 569 | 364 | 63.9 | 186 | 32.7 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| LONGISSIMUS DORSI MUSCLE, RIB PORTION (continued) | | | | | | |
| **Sodium chloride and lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 166 | 570 | 378 | 66.3 | 191 | 33.5 |
| VII | 191 | 571 | 387 | 67.8 | 178 | 31.2 |
| VIII | 213 | 570 | 383 | 67.2 | 185 | 32.4 |
| Av. (3 animals) | | 570 | 383 | 67.1 | 185 | 32.4 |
| IX | 238 | 569 | 374 | 65.7 | 187 | 32.9 |
| X | 263 | 570 | 378 | 66.3 | 168 | 29.5 |
| Av. (5 animals) | | 570 | 380 | 66.7 | 182 | 31.9 |
| Injected samples | | | | | | |
| VI | 166 | 570 | 388 | 68.1 | 183 | 32.1 |
| VII | 191 | 571 | 394 | 69.0 | 178 | 31.2 |
| VIII | 213 | 570 | 359 | 63.0 | 208 | 36.5 |
| Av. (3 animals) | | 570 | 380 | 66.7 | 190 | 33.3 |
| IX | 238 | 569 | 356 | 62.6 | 206 | 36.2 |
| X | 263 | 569 | 385 | 67.7 | 153 | 26.9 |
| Av. (5 animals) | | 570 | 376 | 66.1 | 186 | 32.6 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing: Meat | | Weight after processing: Liquid | |
|---|---|---|---|---|---|---|
| | | gm. | gm. | % | gm. | % |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES | | | | | | |
| Sodium chloride injection | | | | | | |
| Control samples | | | | | | |
| VI | 168 | 571 | 414 | 72.5 | 155 | 27.1 |
| VII | 193 | 568 | 425 | 74.8 | 138 | 24.3 |
| VIII | 218 | 568 | 379 | 66.7 | 189 | 33.3 |
| Av. (3 animals) | | 569 | 406 | 71.3 | 161 | 28.2 |
| IX | 240 | 570 | 422 | 74.0 | 143 | 25.1 |
| X | 265 | 570 | 373 | 65.4 | 171 | 30.0 |
| Av. (5 animals) | | 569 | 403 | 70.7 | 159 | 28.0 |
| Injected samples | | | | | | |
| VI | 168 | 572 | 388 | 67.8 | 178 | 31.1 |
| VII | 193 | 569 | 423 | 74.3 | 145 | 25.5 |
| VIII | 218 | 568 | 359 | 63.2 | 207 | 36.4 |
| Av. (3 animals) | | 570 | 390 | 68.4 | 177 | 31.0 |
| IX | 240 | 570 | 387 | 67.9 | 161 | 28.2 |
| X | 265 | 568 | 362 | 63.7 | 162 | 28.5 |
| Av. (5 animals) | | 569 | 384 | 67.4 | 171 | 29.9 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued) | | | | | | |
| **Lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 169 | 571 | 418 | 73.2 | 159 | 27.8 |
| VII | 194 | 568 | 436 | 76.8 | 127 | 22.4 |
| VIII | 216 | 569 | 413 | 72.6 | 151 | 26.5 |
| Av. (3 animals) | | 569 | 422 | 74.2 | 146 | 25.6 |
| IX | 241 | 568 | 408 | 71.8 | 153 | 26.9 |
| X | 266 | 568 | 383 | 67.4 | 238 | 41.9 |
| Av. (5 animals) | | 569 | 412 | 72.4 | 166 | 29.1 |
| Injected samples | | | | | | |
| VI | 169 | 571 | 379 | 66.4 | 186 | 32.6 |
| VII | 194 | 570 | 369 | 64.7 | 189 | 33.2 |
| VIII | 216 | 568 | 380 | 66.9 | 182 | 32.0 |
| Av. (3 animals) | | 570 | 376 | 66.0 | 186 | 32.6 |
| IX | 241 | 568 | 385 | 67.8 | 149 | 26.2 |
| X | 266 | 568 | 353 | 62.1 | 120 | 21.1 |
| Av. (5 animals) | | 569 | 373 | 65.6 | 165 | 29.0 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| PSOAS MAJOR AND PSOAS MINOR MUSCLES (continued) | | | | | | |
| **Sodium chloride and lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 170 | 570 | 396 | 69.5 | 175 | 30.7 |
| VII | 192 | 568 | 415 | 73.2 | 142 | 25.0 |
| VIII | 217 | 570 | 403 | 70.7 | 153 | 26.8 |
| Av. (3 animals) | | 569 | 405 | 71.1 | 157 | 27.5 |
| IX | 242 | 568 | 382 | 67.2 | 151 | 26.6 |
| X | 264 | 570 | 393 | 68.9 | 139 | 24.4 |
| Av. (5 animals) | | 569 | 398 | 69.9 | 152 | 26.7 |
| Injected samples | | | | | | |
| VI | 170 | 572 | 391 | 68.4 | 183 | 32.0 |
| VII | 192 | 571 | 414 | 72.5 | 141 | 24.7 |
| VIII | 217 | 571 | 380 | 66.5 | 175 | 30.6 |
| Av. (3 animals) | | 571 | 395 | 69.1 | 166 | 29.1 |
| IX | 242 | 569 | 373 | 65.6 | 175 | 30.8 |
| X | 264 | 568 | 363 | 63.9 | 180 | 31.7 |
| Av. (5 animals) | | 570 | 384 | 67.4 | 171 | 30.0 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| | | SEMITENDINOSUS MUSCLE | | | | |
| Sodium chloride injection | | | | | | |
| Control samples | | | | | | |
| VI | 172 | 568 | 369 | 65.0 | 198 | 34.8 |
| VII | 197 | 569 | 405 | 71.2 | 162 | 28.5 |
| VIII | 219 | 570 | 371 | 65.1 | 198 | 34.7 |
| Av. (3 animals) | | 569 | 382 | 67.1 | 186 | 32.7 |
| IX | 244 | 570 | 369 | 64.7 | 183 | 32.1 |
| X | 269 | 568 | 363 | 63.9 | 205 | 36.1 |
| Av. (5 animals) | | 569 | 375 | 66.0 | 189 | 33.2 |
| Injected samples | | | | | | |
| VI | 172 | 571 | 358 | 62.7 | 201 | 35.2 |
| VII | 197 | 570 | 384 | 67.4 | 187 | 32.8 |
| VIII | 219 | 570 | 374 | 65.6 | 170 | 29.8 |
| Av. (3 animals) | | 570 | 372 | 65.2 | 186 | 32.6 |
| IX | 244 | 568 | 360 | 63.4 | 177 | 31.2 |
| X | 269 | 568 | 377 | 66.4 | 178 | 31.3 |
| Av. (5 animals) | | 569 | 371 | 65.1 | 183 | 32.1 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| | | SEMITENDINOSUS MUSCLE (continued) | | | | |
| **Lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 173 | 568 | 363 | 63.9 | 186 | 32.7 |
| VII | 195 | 568 | 375 | 66.0 | 187 | 32.9 |
| VIII | 220 | 568 | 362 | 63.7 | 195 | 34.3 |
| Av. (3 animals) | | 568 | 367 | 64.5 | 189 | 33.3 |
| IX | 245 | 568 | 377 | 66.4 | 132 | 23.2 |
| X | 267 | 569 | 362 | 63.6 | 203 | 35.7 |
| Av. (5 animals) | | 568 | 368 | 64.7 | 181 | 31.8 |
| Injected samples | | | | | | |
| VI | 173 | 568 | 401 | 70.6 | 145 | 25.5 |
| VII | 195 | 569 | 372 | 65.4 | 191 | 33.6 |
| VIII | 220 | 568 | 360 | 63.4 | 203 | 35.7 |
| Av. (3 animals) | | 568 | 378 | 66.5 | 180 | 31.6 |
| IX | 245 | 568 | 366 | 64.4 | 179 | 31.5 |
| X | 267 | 568 | 347 | 61.1 | 170 | 29.9 |
| Av. (5 animals) | | 568 | 369 | 65.0 | 178 | 31.2 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| SEMITENDINOSUS MUSCLE (continued) | | | | | | |
| Sodium chloride and lactic acid injection | | | | | | |
| Control samples | | | | | | |
| VI | 171 | 568 | 372 | 65.5 | 193 | 34.0 |
| VII | 196 | 569 | 380 | 66.8 | 189 | 33.2 |
| VIII | 221 | 568 | 369 | 65.0 | 187 | 32.9 |
| Av. (3 animals) | | 568 | 374 | 65.8 | 190 | 33.4 |
| IX | 243 | 569 | 364 | 64.0 | 194 | 34.1 |
| X | 268 | 568 | 365 | 64.3 | 204 | 35.9 |
| Av. (5 animals) | | 568 | 370 | 65.1 | 193 | 34.0 |
| Injected samples | | | | | | |
| VI | 171 | 570 | 370 | 64.9 | 122 | 21.4 |
| VII | 196 | 569 | 365 | 64.1 | 201 | 35.3 |
| VIII | 221 | 568 | 355 | 62.5 | 214 | 37.7 |
| Av. (3 animals) | | 569 | 363 | 63.8 | 179 | 31.5 |
| IX | 243 | 568 | 370 | 65.1 | 170 | 29.9 |
| X | 268 | 570 | 359 | 63.0 | 187 | 32.8 |
| Av. (5 animals) | | 569 | 364 | 63.9 | 179 | 31.4 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing: Meat | | Weight after processing: Liquid | |
|---|---|---|---|---|---|---|
| | | gm. | gm. | % | gm. | % |
| | | SEMIMEMBRANOSUS MUSCLE | | | | |
| Sodium chloride injection | | | | | | |
| Control samples | | | | | | |
| VI | 177 | 570 | 363 | 63.7 | 208 | 36.5 |
| | 179 | 568 | 374 | 65.8 | 198 | 34.8 |
| Av. | | 569 | 368 | 64.8 | 203 | 35.6 |
| VII | 199 | 568 | 355 | 62.5 | 213 | 37.5 |
| | 200 | 569 | 360 | 63.3 | 204 | 35.8 |
| Av. | | 568 | 358 | 62.9 | 208 | 36.6 |
| VIII | 222 | 568 | 367 | 64.6 | 200 | 35.2 |
| | 226 | 571 | 355 | 62.2 | 213 | 37.3 |
| Av. | | 570 | 361 | 63.4 | 206 | 36.2 |
| Av. (3 animals) | | 569 | 362 | 63.7 | 206 | 36.1 |
| IX | 249 | 569 | 355 | 62.4 | 196 | 34.4 |
| | 251 | 568 | 367 | 64.6 | 199 | 35.0 |
| Av. | | 568 | 361 | 63.5 | 198 | 34.7 |
| X | 271 | 568 | 327 | 57.6 | 171 | 30.1 |
| | 272 | 570 | 330 | 57.9 | 238 | 41.8 |
| Av. | | 569 | 328 | 57.8 | 205 | 36.0 |
| Av. (5 animals) | | 569 | 355 | 62.5 | 204 | 35.8 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| | | SEMIMEMBRANOSUS MUSCLE (continued) | | | | |
| Sodium chloride injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 177 | 571 | 345 | 60.4 | 226 | 39.6 |
| | 179 | 568 | 352 | 62.0 | 217 | 38.2 |
| Av. | | 570 | 348 | 61.2 | 222 | 38.9 |
| VII | 199 | 568 | 346 | 60.9 | 220 | 38.7 |
| | 200 | 570 | 350 | 61.4 | 216 | 37.9 |
| Av. | | 569 | 348 | 61.2 | 218 | 38.3 |
| VIII | 222 | 570 | 350 | 61.4 | 221 | 38.8 |
| | 226 | 570 | 330 | 57.9 | 221 | 38.8 |
| Av. | | 570 | 340 | 59.6 | 221 | 38.8 |
| Av. (3 animals) | | 570 | 345 | 60.7 | 220 | 38.7 |
| IX | 249 | 568 | 342 | 60.2 | 209 | 36.8 |
| | 251 | 568 | 345 | 60.7 | 206 | 36.3 |
| Av. | | 568 | 344 | 60.4 | 208 | 36.6 |
| X | 271 | 568 | 344 | 60.6 | 219 | 38.6 |
| | 272 | 570 | 324 | 56.8 | 223 | 39.1 |
| Av. | | 569 | 334 | 58.7 | 221 | 38.8 |
| Av. (5 animals) | | 569 | 343 | 60.2 | 218 | 38.3 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing: Meat | | Liquid | |
|---|---|---|---|---|---|---|
| | | gm. | gm. | % | gm. | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | |
| **Lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 175 | 568 | 374 | 65.8 | 190 | 33.4 |
| | 176 | 570 | 358 | 62.8 | 205 | 36.0 |
| Av. | | 569 | 366 | 64.3 | 198 | 34.7 |
| VII | 198 | 568 | 364 | 64.1 | 200 | 35.2 |
| | 202 | 570 | 362 | 63.5 | 205 | 36.0 |
| Av. | | 569 | 363 | 63.8 | 202 | 35.6 |
| VIII | 225 | 568 | 345 | 60.7 | 223 | 39.3 |
| | 227 | 568 | 358 | 63.0 | 212 | 37.3 |
| Av. | | 568 | 352 | 61.8 | 218 | 38.3 |
| Av. (3 animals) | | 569 | 360 | 63.3 | 206 | 36.2 |
| IX | 247 | 568 | 348 | 61.3 | 215 | 37.8 |
| | 248 | 569 | 359 | 63.1 | 162 | 28.5 |
| Av. | | 568 | 354 | 62.2 | 188 | 33.2 |
| X | 270 | 569 | 318 | 55.9 | 233 | 40.9 |
| | 274 | 569 | 328 | 57.6 | 231 | 40.6 |
| Av. | | 569 | 323 | 56.8 | 232 | 40.8 |
| Av. (5 animals) | | 569 | 352 | 61.8 | 208 | 36.5 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| | | SEMIMEMBRANOSUS MUSCLE (continued) | | | | |
| <u>Lactic acid injection</u> (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 175 | 569 | 376 | 66.1 | 191 | 33.6 |
| | 176 | 568 | 350 | 61.6 | 214 | 37.7 |
| Av. | | 568 | 363 | 63.8 | 202 | 35.6 |
| VII | 198 | 568 | 342 | 60.2 | 217 | 38.2 |
| | 202 | 570 | 358 | 62.8 | 209 | 36.7 |
| Av. | | 569 | 350 | 61.5 | 213 | 37.4 |
| VIII | 225 | 568 | 333 | 58.6 | 231 | 40.7 |
| | 227 | 570 | 351 | 61.6 | 218 | 38.2 |
| Av. | | 569 | 342 | 60.1 | 224 | 39.4 |
| Av. (3 animals) | | 569 | 352 | 61.8 | 213 | 37.5 |
| IX | 247 | 568 | 343 | 60.4 | 215 | 37.8 |
| | 248 | 569 | 342 | 60.1 | 180 | 31.6 |
| Av. | | 568 | 342 | 60.2 | 198 | 34.7 |
| X | 270 | 570 | 302 | 53.0 | 217 | 38.1 |
| | 274 | 570 | 316 | 55.4 | 174 | 30.5 |
| Av. | | 570 | 309 | 54.2 | 196 | 34.3 |
| Av. (5 animals) | | 569 | 341 | 60.0 | 207 | 36.3 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| SEMIMEMBRANOSUS MUSCLE (continued) | | | | | | |
| **Sodium chloride and lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 174 | 570 | 368 | 64.6 | 198 | 34.7 |
| | 178 | 568 | 363 | 63.9 | 208 | 36.6 |
| Av. | | 569 | 366 | 64.2 | 203 | 35.6 |
| VII | 201 | 568 | 363 | 63.9 | 204 | 35.9 |
| | 203 | 568 | 368 | 64.8 | 202 | 35.6 |
| Av. | | 568 | 366 | 64.4 | 203 | 35.8 |
| VIII | 223 | 571 | 352 | 61.6 | 219 | 38.4 |
| | 224 | 570 | 347 | 60.9 | 218 | 38.2 |
| Av. | | 570 | 350 | 61.2 | 218 | 38.3 |
| Av. (3 animals) | | 569 | 361 | 63.3 | 208 | 36.6 |
| IX | 246 | 568 | 364 | 64.1 | 177 | 31.2 |
| | 250 | 568 | 355 | 62.5 | 211 | 37.1 |
| Av. | | 568 | 360 | 63.3 | 194 | 34.2 |
| X | 273 | 568 | 332 | 58.4 | 237 | 41.7 |
| | 275 | 568 | 336 | 59.2 | 209 | 36.8 |
| Av. | | 568 | 334 | 58.8 | 223 | 39.2 |
| Av. (5 animals) | | 569 | 355 | 62.4 | 208 | 36.6 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| | | SEMIMEMBRANOSUS MUSCLE (continued) | | | | |
| Sodium chloride and lactic acid injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 174 | 572 | 366 | 64.0 | 209 | 36.5 |
| | 178 | 568 | 344 | 60.6 | 222 | 39.1 |
| Av. | | 570 | 355 | 62.3 | 216 | 37.8 |
| VII | 201 | 569 | 352 | 61.9 | 216 | 38.0 |
| | 203 | 568 | 375 | 66.0 | 190 | 33.4 |
| Av. | | 568 | 364 | 64.0 | 203 | 35.7 |
| VIII | 223 | 568 | 345 | 60.7 | 219 | 38.6 |
| | 224 | 570 | 336 | 58.9 | 218 | 38.2 |
| Av. | | 569 | 340 | 59.8 | 218 | 38.4 |
| Av. (3 animals) | | 569 | 353 | 62.0 | 212 | 37.3 |
| IX | 246 | 570 | 353 | 61.9 | 170 | 29.8 |
| | 250 | 569 | 346 | 60.8 | 222 | 39.0 |
| Av. | | 570 | 350 | 61.4 | 196 | 34.4 |
| X | 273 | 568 | 326 | 57.4 | 217 | 38.2 |
| | 275 | 569 | 333 | 58.5 | 172 | 30.2 |
| Av. | | 568 | 330 | 58.0 | 194 | 34.2 |
| Av. (5 animals) | | 569 | 348 | 61.1 | 205 | 36.1 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing: Meat | | Liquid | |
|---|---|---|---|---|---|---|
| | | gm. | gm. | % | gm. | % |
| | | BICEPS FEMORIS MUSCLE | | | | |
| **Sodium chloride injection** | | | | | | |
| Control samples | | | | | | |
| VI | 184 | 568 | 401 | 70.6 | 170 | 29.9 |
| | 185 | 569 | 394 | 69.2 | 174 | 30.6 |
| Av. | | 568 | 398 | 69.9 | 172 | 30.2 |
| VII | 205 | 569 | 392 | 68.9 | 180 | 31.6 |
| | 207 | 569 | 373 | 65.6 | 199 | 35.0 |
| Av. | | 569 | 382 | 67.2 | 190 | 33.3 |
| VIII | 228 | 570 | 383 | 67.2 | 187 | 32.8 |
| | 230 | 570 | 344 | 60.4 | 210 | 36.8 |
| Av. | | 570 | 364 | 63.8 | 198 | 34.8 |
| Av. (3 animals) | | 569 | 381 | 67.0 | 187 | 32.8 |
| IX | 256 | 568 | 362 | 63.7 | 200 | 35.2 |
| | 257 | 568 | 359 | 63.2 | 204 | 35.9 |
| Av. | | 568 | 360 | 63.4 | 202 | 35.6 |
| X | 277 | 570 | 356 | 62.4 | 212 | 37.2 |
| | 279 | 570 | 345 | 60.5 | 227 | 39.8 |
| Av. | | 570 | 350 | 61.5 | 220 | 38.5 |
| Av. (5 animals) | | 569 | 371 | 65.2 | 196 | 34.5 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | |
| Sodium chloride injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 184 | 568 | 360 | 63.4 | 205 | 36.1 |
| | 185 | 568 | 373 | 65.7 | 195 | 34.3 |
| Av. | | 568 | 366 | 64.6 | 200 | 35.2 |
| VII | 205 | 569 | 367 | 64.5 | 204 | 35.8 |
| | 207 | 568 | 350 | 61.6 | 221 | 38.9 |
| Av. | | 568 | 358 | 63.0 | 212 | 37.4 |
| VIII | 228 | 570 | 347 | 60.9 | 223 | 39.1 |
| | 230 | 570 | 342 | 60.0 | 227 | 39.8 |
| Av. | | 570 | 344 | 60.4 | 225 | 39.4 |
| Av. (3 animals) | | 569 | 356 | 62.7 | 212 | 37.3 |
| IX | 256 | 569 | 366 | 64.3 | 197 | 34.6 |
| | 257 | 568 | 359 | 63.2 | 207 | 36.4 |
| Av. | | 568 | 363 | 63.8 | 202 | 35.5 |
| X | 277 | 568 | 360 | 63.4 | 180 | 31.7 |
| | 279 | 570 | 337 | 59.1 | 241 | 42.3 |
| Av. | | 569 | 348 | 61.2 | 210 | 37.0 |
| Av. (5 animals) | | 569 | 356 | 62.6 | 210 | 36.9 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| BICEPS FEMORIS MUSCLE (continued) | | | | | | |
| **Lactic acid injection** | | | | | | |
| Control samples | | | | | | |
| VI | 181 | 569 | 372 | 65.4 | 196 | 34.4 |
| | 183 | 570 | 364 | 63.8 | 207 | 36.3 |
| Av. | | 570 | 368 | 64.6 | 202 | 35.4 |
| VII | 204 | 568 | 391 | 68.8 | 178 | 31.3 |
| | 206 | 568 | 379 | 66.7 | 192 | 33.8 |
| Av. | | 568 | 385 | 67.8 | 185 | 32.6 |
| VIII | 232 | 570 | 354 | 62.1 | 207 | 36.3 |
| | 233 | 569 | 357 | 62.7 | 212 | 37.2 |
| Av. | | 570 | 356 | 62.4 | 210 | 36.8 |
| Av. (3 animals) | | 569 | 370 | 64.9 | 199 | 34.9 |
| IX | 253 | 570 | 367 | 64.4 | 188 | 33.0 |
| | 255 | 569 | 364 | 64.0 | 205 | 36.0 |
| Av. | | 570 | 366 | 64.2 | 197 | 34.5 |
| X | 276 | 569 | 375 | 65.9 | 195 | 34.3 |
| | 278 | 570 | 344 | 60.4 | 229 | 40.2 |
| Av. | | 570 | 360 | 63.2 | 212 | 37.2 |
| Av. (5 animals) | | 570 | 367 | 64.4 | 201 | 35.3 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing: Meat | | Liquid | |
|---|---|---|---|---|---|---|
| | | gm. | gm. | % | gm. | % |
| | | BICEPS FEMORIS MUSCLE (continued) | | | | |
| Lactic acid injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 181 | 570 | 343 | 60.2 | 223 | 39.1 |
| | 183 | 568 | 340 | 59.8 | 227 | 40.0 |
| Av. | | 569 | 342 | 60.0 | 225 | 39.6 |
| VII | 204 | 569 | 370 | 65.0 | 196 | 34.4 |
| | 206 | 568 | 354 | 62.3 | 214 | 37.7 |
| Av. | | 568 | 362 | 63.6 | 205 | 36.0 |
| VIII | 232 | 569 | 348 | 61.2 | 220 | 38.7 |
| | 233 | 569 | 350 | 61.5 | 216 | 38.0 |
| Av. | | 569 | 349 | 61.4 | 218 | 38.4 |
| Av. (3 animals) | | 569 | 351 | 61.7 | 216 | 38.0 |
| IX | 253 | 568 | 345 | 60.7 | 208 | 36.6 |
| | 255 | 568 | 337 | 59.3 | 227 | 40.0 |
| Av. | | 568 | 341 | 60.0 | 218 | 38.3 |
| X | 276 | 569 | 348 | 61.2 | 222 | 39.0 |
| | 278 | 569 | 321 | 56.4 | 251 | 44.1 |
| Av. | | 569 | 335 | 58.8 | 236 | 41.6 |
| Av. (5 animals) | | 569 | 346 | 60.8 | 220 | 38.8 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| | | BICEPS FEMORIS MUSCLE (continued) | | | | |
| Sodium chloride and lactic acid injection | | | | | | |
| Control samples | | | | | | |
| VI | 180 | 568 | 417 | 73.4 | 140 | 24.6 |
| | 182 | 569 | 362 | 63.6 | 181 | 31.8 |
| Av. | | 568 | 390 | 68.5 | 160 | 28.2 |
| VII | 208 | 568 | 382 | 67.2 | 194 | 34.2 |
| | 209 | 569 | 385 | 67.7 | 199 | 35.0 |
| Av. | | 568 | 384 | 67.4 | 196 | 34.6 |
| VIII | 229 | 569 | 358 | 62.9 | 210 | 36.9 |
| | 231 | 570 | 370 | 64.9 | 199 | 34.9 |
| Av. | | 570 | 364 | 63.9 | 204 | 35.9 |
| Av. (3 animals) | | 569 | 379 | 66.6 | 187 | 32.9 |
| IX | 252 | 569 | 376 | 66.1 | 187 | 32.9 |
| | 254 | 570 | 358 | 62.8 | 213 | 37.4 |
| Av. | | 570 | 367 | 64.5 | 200 | 35.2 |
| X | 280 | 569 | 355 | 62.4 | 193 | 33.9 |
| | 281 | 568 | 365 | 64.3 | 205 | 36.1 |
| Av. | | 568 | 360 | 63.4 | 199 | 35.0 |
| Av. (5 animals) | | 569 | 373 | 65.5 | 192 | 33.8 |

(continued)

Table 7 (continued)

| Animal no. | Sample no. | Wt. before processing | Weight after processing | | | |
|---|---|---|---|---|---|---|
| | | | Meat | | Liquid | |
| | | gm. | gm. | % | gm. | % |
| | | BICEPS FEMORIS MUSCLE (continued) | | | | |
| Sodium chloride and lactic acid injection (continued) | | | | | | |
| Injected samples | | | | | | |
| VI | 180 | 570 | 403 | 70.7 | 159 | 27.9 |
| | 182 | 570 | 368 | 64.6 | 203 | 35.6 |
| Av. | | 570 | 386 | 67.6 | 181 | 31.8 |
| VII | 208 | 569 | 382 | 67.1 | 186 | 32.7 |
| | 209 | 568 | 378 | 66.5 | 188 | 33.1 |
| Av. | | 568 | 380 | 66.8 | 187 | 32.9 |
| VIII | 229 | 571 | 354 | 62.0 | 220 | 38.5 |
| | 231 | 570 | 349 | 61.2 | 226 | 39.6 |
| Av. | | 570 | 352 | 61.6 | 223 | 39.0 |
| Av. (3 animals) | | 569 | 373 | 65.3 | 197 | 34.6 |
| IX | 252 | 569 | 363 | 63.8 | 185 | 32.5 |
| | 254 | 570 | 363 | 63.7 | 197 | 34.6 |
| Av. | | 570 | 363 | 63.8 | 191 | 33.6 |
| X | 280 | 568 | 369 | 65.0 | 203 | 35.7 |
| | 281 | 569 | 364 | 64.0 | 195 | 34.3 |
| Av. | | 568 | 366 | 64.5 | 199 | 35.0 |
| Av. (5 animals) | | 569 | 369 | 64.9 | 196 | 34.5 |

Table 8. Analysis of Variance of Scores for Flavor of Canned Beef. Sodium chloride injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 111.2222 | |
| Animals | 2 | 2.9305 | 1.4652 |
| Muscles | 5 | 32.2222 | 6.4444 |
| Error (a) | 10 | 26.5695 | 2.6570 |
| Treatments | 1 | 36.0000 | 36.0000** |
| T x M | 5 | 3.0000 | .6000 |
| Error (b) | 12 | 10.5000 | .8750 |
| | ANIMALS IX AND X | | |
| Total | 23 | 388.8333 | |
| Animals | 1 | 273.3750 | 273.3750** |
| Muscles | 5 | 66.9583 | 13.3917 |
| Error (a) | 5 | 17.2500 | 3.4500 |
| Treatments | 1 | 26.0416 | 26.0416** |
| T x M | 5 | 4.0834 | .8167 |
| Error (b) | 6 | 1.1250 | .1875 |

* - Significant.
** - Highly significant.

Table 9. Analysis of Variance of Scores for Flavor of Canned Beef. Sodium chloride and lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 94.2431 | |
| Animals | 2 | .5973 | 0.2986 |
| Muscles | 5 | 22.3681 | 4.4736 |
| Error (a) | 10 | 30.6527 | 3.0653 |
| Treatments | 1 | 25.8403 | 25.8403** |
| T x M | 5 | 10.2014 | 2.0403** |
| Error (b) | 12 | 4.5833 | .3819 |
| | ANIMALS IX AND X | | |
| Total | 23 | 346.8333 | |
| Animals | 1 | 234.3750 | 234.3750** |
| Muscles | 5 | 28.2083 | 5.6417 |
| Error (a) | 5 | 41.5000 | 8.3000 |
| Treatments | 1 | 30.3750 | 30.3750** |
| T x M | 5 | 6.5000 | 1.3000 |
| Error (b) | 6 | 5.8750 | .9792 |

* - Significant.
** - Highly significant.

Table 10. Analysis of Variance of Scores for Flavor of Canned Beef. Lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 59.1875 | |
| Animals | 2 | 0.3750 | 0.1875 |
| Muscles | 5 | 22.8125 | 4.5625 |
| Error (a) | 10 | 17.6250 | 1.7625 |
| Treatments | 1 | 0.1736 | .1736 |
| T x M | 5 | 7.7014 | 1.5403 |
| Error (b) | 12 | 10.5000 | .8750 |
| | ANIMALS IX AND X | | |
| Total | 23 | 350.8333 | |
| Animals | 1 | 247.0416 | 247.0416** |
| Muscles | 5 | 47.2083 | 9.4417 |
| Error (a) | 5 | 44.8334 | 8.9667 |
| Treatments | 1 | .3750 | .3750 |
| T x M | 5 | 3.0000 | .6000 |
| Error (b) | 6 | 8.3750 | 1.3958 |

* - Significant.
** - Highly significant.

Table 11. Analysis of Variance of Scores for Tenderness of Canned Beef. Sodium chloride injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 685.5764 | |
| Animals | 2 | 12.0972 | 6.0486 |
| Muscles | 5 | 355.3681 | 71.0736* |
| Error (a) | 10 | 164.2361 | 16.4236 |
| Treatments | 1 | 79.5070 | 79.5070** |
| T x M | 5 | 26.5346 | 5.3069 |
| Error (b) | 12 | 47.8334 | 3.9861 |
| | ANIMALS IX AND X | | |
| Total | 23 | 251.9062 | |
| Animals | 1 | 5.5104 | 5.5104* |
| Muscles | 5 | 147.9687 | 29.5937** |
| Error (a) | 5 | 2.3021 | .4604 |
| Treatments | 1 | 71.7604 | 71.7604** |
| T x M | 5 | 10.8021 | 2.1604 |
| Error (b) | 6 | 13.5625 | 2.2604 |

* - Significant.
** - Highly significant.

Table 12. Analysis of Variance of Scores for Tenderness of Canned Beef. Sodium chloride and lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 378.3056 | |
| Animals | 2 | 12.1806 | 6.0903 |
| Muscles | 5 | 185.1389 | 37.0278* |
| Error (a) | 10 | 68.7361 | 6.8736 |
| Treatments | 1 | 84.0278 | 84.0278** |
| T x M | 5 | 6.8056 | 1.3611 |
| Error (b) | 12 | 21.4166 | 1.7847 |
| | ANIMALS IX AND X | | |
| Total | 23 | 243.9896 | |
| Animals | 1 | .5104 | .5104 |
| Muscles | 5 | 100.8021 | 20.1604** |
| Error (a) | 5 | 9.0521 | 1.8104 |
| Treatments | 1 | 102.0938 | 102.0938** |
| T x M | 5 | 26.2187 | 5.2437* |
| Error (b) | 6 | 5.3125 | .8854 |

* - Significant.
** - Highly significant.

Table 13. Analysis of Variance of Scores for Tenderness of Canned Beef. Lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 555.7222 | |
| Animals | 2 | 70.6805 | 35.3402** |
| Muscles | 5 | 421.5555 | 84.3111** |
| Error (a) | 10 | 35.7362 | 3.5736 |
| Treatments | 1 | 0.6972 | 0.6972 |
| T x M | 5 | 12.1362 | 2.4272 |
| Error (b) | 12 | 14.9166 | 1.2430 |
| | ANIMALS IX AND X | | |
| Total | 23 | 190.9896 | |
| Animals | 1 | 3.0104 | 3.0104 |
| Muscles | 5 | 142.5521 | 28.5104* |
| Error (a) | 5 | 27.0521 | 5.4104 |
| Treatments | 1 | .5104 | .5104 |
| T x M | 5 | 9.3021 | 1.8604 |
| Error (b) | 6 | 8.5625 | 1.4271 |

* - Significant.
** - Highly significant.

Table 14. Analysis of Variance of Scores for Juiciness of Canned Beef. Sodium chloride injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 257.74 | |
| Animals | 2 | 6.51 | 3.255 |
| Muscles | 5 | 105.53 | 21.106 |
| Error (a) | 10 | 79.20 | 7.920 |
| Treatments | 1 | 29.34 | 29.34** |
| M x T | 5 | 13.37 | 2.674 |
| Error (b) | 12 | 23.79 | 1.983 |
| | ANIMALS IX AND X | | |
| Total | 23 | 126.74 | |
| Animals | 1 | 3.01 | 3.01 |
| Muscles | 5 | 51.80 | 10.360 |
| Error (a) | 5 | 21.31 | 4.262 |
| Treatments | 1 | 19.26 | 19.26 |
| M x T | 5 | 4.56 | 0.912 |
| Error (b) | 6 | 26.80 | 4.467 |

* - Significant.
** - Highly significant.

Table 15. Analysis of Variance of Scores for Juiciness of Canned Beef. Sodium chloride and lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 233.24 | |
| Animals | 2 | 2.05 | 1.025 |
| Muscles | 5 | 132.53 | 26.506** |
| Error (a) | 10 | 34.79 | 3.479 |
| Treatments | 1 | 9.56 | 9.56* |
| M x T | 5 | 37.98 | 7.596** |
| Error (b) | 12 | 16.33 | 1.361 |
| | ANIMALS IX AND X | | |
| Total | 23 | 113.24 | |
| Animals | 1 | 1.26 | 1.26 |
| Muscles | 5 | 33.55 | 6.710 |
| Error (a) | 5 | 32.56 | 6.512 |
| Treatments | 1 | 17.51 | 17.51* |
| M x T | 5 | 11.81 | 2.362 |
| Error (b) | 6 | 16.55 | 2.758 |

* - Significant.
** - Highly significant.

Table 16. Analysis of Variance of Scores for Juiciness of Canned Beef. Lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| ANIMALS VI, VII, AND VIII | | | |
| Total | 35 | 275.22 | |
| Animals | 2 | 25.43 | 12.715 |
| Muscles | 5 | 183.80 | 36.760** |
| Error (a) | 10 | 37.99 | 3.799 |
| Treatment | 1 | 0.25 | 0.25 |
| M x T | 5 | 8.67 | 1.734 |
| Error (b) | 12 | 19.08 | 1.590 |
| ANIMALS IX AND X | | | |
| Total | 23 | 175.33 | |
| Animals | 1 | 2.04 | 2.04 |
| Muscles | 5 | 91.71 | 18.342 |
| Error (a) | 5 | 45.83 | 9.166 |
| Treatments | 1 | 1.04 | 1.04 |
| M x T | 5 | 4.08 | 0.816 |
| Error (b) | 6 | 31.08 | 5.180 |

* - Significant.
** - Highly significant.

Table 17. Analysis of Variance of Scores for Texture of Canned Beef. Sodium chloride injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 681.4722 | |
| Animals | 2 | 11.7222 | 5.8611 |
| Muscles | 5 | 337.1389 | 67.4278* |
| Error (a) | 10 | 138.6111 | 13.8611 |
| Treatments | 1 | 106.7778 | 106.7778** |
| T x M | 5 | 40.8888 | 8.1778 |
| Error (b) | 12 | 46.3334 | 3.8611 |
| | ANIMALS IX AND X | | |
| Total | 23 | 262.4583 | |
| Animals | 1 | 37.5000 | 37.5000* |
| Muscles | 5 | 113.5833 | 22.7167* |
| Error (a) | 5 | 16.1250 | 3.2250 |
| Treatments | 1 | 84.3750 | 84.3750** |
| T x M | 5 | 9.2500 | 1.8500* |
| Error (b) | 6 | 1.6250 | 0.2708 |

* - Significant.
** - Highly significant.

Table 18. Analysis of Variance of Scores for Texture of Canned Beef. Sodium chloride and lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 492.50 | |
| Animals | 2 | 4.50 | 2.25 |
| Muscles | 5 | 263.00 | 52.60** |
| Error (a) | 10 | 74.00 | 7.40 |
| Treatments | 1 | 106.78 | 106.78** |
| T x M | 5 | 18.22 | 3.6440 |
| Error (b) | 12 | 26.00 | 2.1667 |
| | ANIMALS IX AND X | | |
| Total | 23 | 265.4583 | |
| Animals | 1 | 42.6666 | 42.6666** |
| Muscles | 5 | 87.8333 | 17.5667* |
| Error (a) | 5 | 12.7084 | 2.5417 |
| Treatments | 1 | 100.0416 | 100.0416** |
| T x M | 5 | 10.3334 | 2.0667 |
| Error (b) | 6 | 11.8750 | 1.9792 |

* - Significant.
** - Highly significant.

Table 19. Analysis of Variance of Scores for Texture of Canned Beef. Lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 546.7431 | |
| Animals | 2 | 75.3473 | 37.6736** |
| Muscles | 5 | 406.5348 | 81.3070** |
| Error (a) | 10 | 41.2360 | 4.1236 |
| Treatments | 1 | 0.8403 | 0.8403 |
| T x M | 5 | 12.5347 | 2.5069 |
| Error (b) | 12 | 10.2500 | 0.8542 |
| | ANIMALS IX AND X | | |
| Total | 23 | 262.8333 | |
| Animals | 1 | 51.0416 | 51.0416* |
| Muscles | 5 | 154.2083 | 30.8417* |
| Error (a) | 5 | 27.8334 | 5.5667 |
| Treatments | 1 | 3.3750 | 3.3750 |
| T x M | 5 | 2.5000 | .5000 |
| Error (b) | 6 | 23.8750 | 3.9792 |

* - Significant.
** - Highly significant.

Table 20. Analysis of Variance of Scores for Slicing Quality of Canned Beef. Sodium chloride injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 1349.4097 | |
| Animals | 2 | 8.1805 | 4.0902 |
| Muscles | 5 | 790.3680 | 158.0736** |
| Error (a) | 10 | 211.7362 | 21.1736 |
| Treatments | 1 | 37.0069 | 37.0069 |
| T x M | 5 | 185.7015 | 37.1403* |
| Error (b) | 12 | 116.4166 | 9.7014 |
| | ANIMALS IX AND X | | |
| Total | 23 | 1168.24 | |
| Animals | 1 | 162.76 | 162.76** |
| Muscles | 5 | 658.31 | 131.66** |
| Error (a) | 5 | 24.54 | 4.908 |
| Treatments | 1 | 10.01 | 10.01 |
| T x M | 5 | 100.79 | 20.16 |
| Error (b) | 6 | 211.83 | 17.65 |

* - Significant.
** - Highly significant.

Table 21. Analysis of Variance of Scores for Slicing Quality of Canned Beef. Sodium chloride and lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 985.00 | |
| Animals | 2 | 84.50 | 42.24 |
| Muscles | 5 | 557.3333 | 111.4667** |
| Error (a) | 10 | 130.6667 | 13.0667 |
| Treatments | 1 | 1.3611 | 1.3611 |
| T x M | 5 | 37.1389 | 7.4278 |
| Error (b) | 12 | 174.0000 | 14.5000 |
| | ANIMALS IX AND X | | |
| Total | 23 | 1138.41 | |
| Animals | 1 | 207.10 | 207.10* |
| Muscles | 5 | 529.72 | 105.94 |
| Error (a) | 5 | 105.22 | 21.04 |
| Treatments | 1 | 21.10 | 21.10 |
| T x M | 5 | 110.97 | 22.19 |
| Error (b) | 6 | 164.30 | 27.38 |

* - Significant.
** - Highly significant.

Table 22. Analysis of Variance of Scores for Slicing Quality of Canned Beef. Lactic acid injection.

| Source of variation | Degrees of freedom | Sum of squares | Mean square |
|---|---|---|---|
| | ANIMALS VI, VII, AND VIII | | |
| Total | 35 | 1477.0000 | |
| Animals | 2 | 97.1250 | 48.5625 |
| Muscles | 5 | 820.0000 | 164.0000* |
| Error (a) | 10 | 354.1250 | 35.4125 |
| Treatments | 1 | 5.4444 | 5.4444 |
| T x M | 5 | 79.5556 | 15.9111 |
| Error (b) | 12 | 120.7500 | 10.0625 |
| | ANIMALS IX AND X | | |
| Total | 23 | 1093.74 | |
| Animals | 1 | 184.26 | 184.26* |
| Muscles | 5 | 691.57 | 138.31* |
| Error (a) | 5 | 79.04 | 15.81 |
| Treatments | 1 | 1.26 | 1.26 |
| T x M | 5 | 103.29 | 20.66 |
| Error (b) | 6 | 34.32 | 5.72 |

* - Significant.
** - Highly significant.

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Sample No. ____________ Date ____________

# SCORE CARD FOR MEAT

Slicing quality

| Factor | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Extremely good | Very good | Good | Medium plus | Medium | Medium minus | Fair | Poor | Very poor | Extremely poor | Remarks |
| Aroma | | | | | | | | | | | |
| Flavor<br>Liquid | | | | | | | | | | | |
| Lean | | | | | | | | | | | |
| | Extremely tender | Very tender | Tender | Medium plus | Medium | Medium minus | Fair | Tough | Very tough | Extremely tough | |
| Tenderness | | | | | | | | | | | |
| | Extremely juicy | Very juicy | Juicy | Medium plus | Medium | Medium minus | Fair | Dry | Very dry | Extremely dry | |
| Juiciness | | | | | | | | | | | |

Texture

## Descriptive Terms

**Aroma**

1. Mild ----
2. Sharp ----
3. Strong ----
4. Faint ----
5. Foreign ---
6. ______ ----
7. ______ ----
8. ______ ----

**Flavor**

1. Flat ----
2. Mild ----
3. Mellowed ----
4. Rich ----
5. Strong ----
6. Old ----
7. Bitter ----
8. Acid ----
9. Salty ----
10. Sweet ----

**Color of Lean**

1. Light brown ----
2. Dark brown ----
3. Red and brown ----
4. Gray ----
5. Irridescent ----

**Texture**

1. Stringy ----
2. Dense, compact ----
3. ______ ----
4. ______ ----
5. ______ ----

Preference ______________________________ Scorer ______________________
(among samples judged at one time)