STUDIES ON AGRICULTURAL AND INDUSTRIAL BY-PRODUCTS IN ANIMAL NUTRITION

BY

AHMED AHMED OSMAN MOHAMED

B.Sc. Agric.,(Animal Production) Suez Canal University 1983

M.Sc. Animal Production (Animal nutrition) 1992

Thesis

Submitted in Partial fulfilment of
the Requirement for the Degree of

DOCTOR of PHILOSOPHY (Ph.D)

IN

Agriculture Science

Animal production

(Animal nutrition)

Supervision Committee

Prof. Dr. F. Z. Swidan
Prof. of Animal nutrition
Faculty of Agriculture
Suez Canal University
Ismailia, Egypt

Dr. Ioan Ap Dewi
School of Agricultural
and Forest Science
University of Wales
Wales, United Kingdom

Dr. H. Omed
School of Agricultural
and Forest Science
University of Wales
Wales, United Kingdom

Department of Animal Production
Faculty of Agriculture
Suez Canal University

1998

APPROVAL SHEET

Title : ***STUDIES ON AGRICULTURAL AND INDUSTRIAL BY-PRODUCTS IN ANIMAL NUTRITION***

Name : **AHMED AHMED OSMAN MOHAMED**

This thesis for **the Ph.D. degree** has been approved by :

Prof. Dr. .....

Prof. Dr. .....

Prof. Dr. .....

Committee in charge

Date: 11 / 7 / 1998

ACKNOWLEDGMENTS

I am greatly indebted to Dr. **F. Z. Swidan**, Prof. of Animal Nutrition, Animal Production Department, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt, for suggesting the problem, Keen supervision and continuos encouragement.

Deep thanks to Dr. **Ioan Ap Dewi**, School of Agricultural and forest science, University of Wales, Bangor, North Wales, United Kingdom, for providing the facilities needed for the work and for his statistical advice.

I am also grateful to Dr. **H. Omed**, School of Agricultural and forest science, University of Wales, Bangor, North Wales, United Kingdom, for his valuable help and constructive criticism throughout the work in Bangor.

I would like to thank Prof. Dr. **J. B. Owen** Professor of Agriculture, School of Agricultural and forest science, University of Wales, Bangor, North Wales, United Kingdom, for his encouragement and valuable advice.

My thanks extend to the staff at the College Farm, School of Agricultural and forest science, University of Wales, Bangor, North Wales, United Kingdom and also to the staff at the Farm of the Animal Production Department, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt, for their frankly help.

CONTENTS

PAGE

LIST OF TABLES

TABLE **PAGE**

CHAPTER 1

INTRODUCTION

In the subtropical developing countries, like Egypt, The gap between available and required animal feeds is great .

About 6, 1.2 and 2 million Tons of TDN are available as animal feeds from clover, concentrates and crop residues, respectively, the requirements of the animal population are about 14 million Tons of TDN. There is a shortage of animal feeds of about 4 million Tons of TDN (Mohamed ,1993).

Moreover, the competition between humans and livestock for concentrates is obvious. Feed shortages are particularly acute with regard to protein. As the pressure on land in Egypt is greater than any other part of the world, feeding high quality protein sources such as soya bean meal and fish meal to animals is unjustifiable. In order to correct the feed balance in Egypt, all potential agricultural by-products must be utilized in animal feeding. Furthermore, ways to improve the nutritive value of these by-products have to be found.

Ruminants have a unique digestive system that allows them to use waste and other types of by- products as sources of dietary nutrients . One by-product which can be used as a ruminant feed is poultry litter . It has been used mainly as a fertilizer, but this use has lately been a cause for concern where broiler chickens are intensively produced and the litter is distributed over too small area, broiler litter can contaminate the groundwater with excess nutrients. This

problem will only intensify in the future as the poultry industry continues to grow (Ruffin and McCaskey 1996).

The use of by-products for animal feeding, in addition to reducing feed shortages, decreases the cost of feeding and consequently the sale price of animal products . The use of by-products can also alleviate pollution problems especially with the intensification of farming that has taken place with increasing public awareness of environmental pollution and pressures, and restrictions on farming. The manure disposal problem can be expected to worsen rather than improve.

Numerous investigations have indicated that feeding sheep on rations containing by- products (brewer's grains, pea pods and orange wastes) had no significant effect on rumen pH , ammonia , total volatile fatty acids and molar proportion of volatile fatty acids (Salem, 1989).

Poultry litter can be incorporated in amounts up to 30% in concentrate supplements in the diets of sheep and goats (Murthy ***et al***, 1996).

The present research was conducted to study the possibility of using alternative sources of protein such as urea or poultry litter. The study included in vitro techniques to predict the digestibility of ration containing by products; improving the feed quality of poultry litter by acids or formalin treatment; evaluation of poultry litter treated with acids or formalin incorporated in sheep diet and evaluation of silages containing poultry litter.

CHAPTER 2

REVIEW OF LITERATURE

2.1- LIVESTOCK AND PRODUCTION SYSTEMS IN EGYPT

The main livestock in Egypt are buffaloes, cows, sheep and goats. Buffalo is the most important animal to the small farmer, under the local prices of liquid milk that buffalo milk gives greater return as a result of its higher fat content than cattle milk. Cow has been used for work and meat production but sheep and goats are raised by small holders to be used for meat production especially as sacrifices.

A census of livestock in Egypt in 1994 showed that there were 3.76 million cows, 2,59 million buffaloes, 4.67 million sheep, 5.49 million goats, 245 thousand camels and 134 thousand pigs. Relevant estimates obtained for poultry were 36.64 million chickens, 7.90 million ducks, 6.46 million geese, 11.29 million pigeons, 7.36 million rabbits and 1.428 million turkeys.

More than 90% of the total cattle and buffalo in Egypt are raised by small holders who own on average 1-3 animals each, these animals are mainly fed on Egyptian clover (berseem) during winter and on straw, hay and green maize plants in summer. In year 1955 -1956 the Tahreer province -a great agricultural project- imported great numbers of Friesian cattle (males and

females) from Holland as a fundamental herd in Egypt (Ragab and Abdel - Aziz 1961) .

There were about 4.8 million goats in Egypt in 1992, representing 6% of the total number of livestock units and providing 7% of the red meat consumed. 84% of the goats population is found in the Nile valley, and around 90% of these goats are bred on smallholdings of 0.2 - 2.0 hectares, each containing up to 3 cattle or buffaloes and 5 small ruminants. Other production systems used are sedentary and transhumant commercial system and intensive dairy production system by using imported breeds. Details are given of reproduction and management of extensively managed goats in the north-western coastal range, Sinai and the red sea coast.(Galal ***et al*** 1995).

Table 2-1: livestock population in Egypt during the period 1989 - 1994

Thousand head, except percent.

Type of Livestock	Year						Percent of Change 1990-1994
	1989	1990	1991	1992	1993	1994	%
Buffaloes	2485	2506	2527	2548	2570	2592	3.4
Cows	3389	3463	3537	3612	3688	3764	8.7
Sheep	4025	4146	4270	4398	4530	4666	12.5
Goats	4200	4442	4692	5020	5373	5492	23.6
Camels	188	179	208	220	232	245	24.4
Pigs	95	102	109	117	125	134	31.4

Central Agency For Public Mobilisation and Statistics 1995

2.1.1- MEAT PRODUCTION

The data shown in Table 2.2, presented numbers of slaughtered livestock to be a matter of 92 thousand head buffaloes, 454 thousand head calves, 191 thousand head cows 497 thousand head veals, 506 thousand head sheep, and 44 thousand head goat in 1994.

Conventionally meat production from cattle and buffalo has been inconsequential compared to their work and milk production. The male offspring of indigenous cows had a low birth weight (average 30 Kg) and

moderate ability for growth during the suckling period (4-6 months). The normal procedure is to rear the calves till they are weaned at an average live weight of 90 Kg. The newly weaned calves usually face the shortage of good quality hay or green fodder during the summer months and consequently growth and maturity as a feeder calf are delayed (Shabana, 1984)

Table 2-2 : Number of slaughtered livestock, by type of livestock and year

Thousand head, except percent

Type of Livestock	Year							Percent of Change 1990-1994
	1952	1989	1990	1991	1992	1993	1994	%
Buffaloes	75	79	96	135	163	113	92	-4.2
Calves	207	457	486	511	555	551	454	-6.6
Cows	40	32	52	74	76	75	191	267.3
Veal	256	481	621	718	707	478	497	-20,0
Sheep	534	485	526	561	553	479	506	-3.8
Goats	17	39	53	64	78	45	44	-17.0
Camels	31	80	74	90	90	62	83	12.2
Oxen	60	2	1	1	2	2	5	400.0
Pigs	22	54	59	61	67	67	64	8.5

Central Agency For Public Mobilisation and Statistics 1995

There are a few medium and large scale farms, mostly combined with dairy farms which rear, grow and fatten their male offsprings. Some of these farms also purchase male calves of over 90 Kg, preferably at 150 Kg live weight, for growing and fattening. In addition, a number of small to medium scale beef producers buy male feeder calves at age of 12-14 months and average of 250 Kg live weight to fatten on concentrates for a period of six month, the animal reaching 350 Kg live weight at slaughtering (Shabana, 1984).

As far as the suckling buffalo male is concerned, and due to heavier body live weight at birth and growing ability, most male buffalo calves are sold for veal when only a few weeks old (average 4 weeks, 60 kg live weight).. It is obvious under the local prices of liquid milk that buffalo milk given greater return to the producers as a result of its higher fat content than cattle milk. So, raising young buffalo calves on natural buffalo milk is considered very expensive. Therefore, about 600 thousand calves mainly males are slaughtered yearly in Egypt at about 40 days of age.

The majority of small farmers prefers this for several reasons such as cash flow from sale of milk, avoiding higher mortality rates, feed shortages and difficulty of using the buffalo bull for draught purposes (Shabana, 1984).

2.1.2- MILK PRODUCTION

The milk production in 1993 as shown in table 2.3 was in the order of 2284 thousand ton as a total, being 1034 thousand ton cow milk and 1230 thousand ton buffaloes milk.

Table 2-3 : Milk production estimates

Thousand ton

Year					
Source	1989	1990	1991	1992	1993
Total	2178	2204	2231	2258	2284
Cows	954	974	994	1014	1034
Buffaloes	1208	1213	1219	1225	1230
Goats	16	17	18	19	20

Central Agency For Public Mobilisation and Statistics 1995

Consumption of milk and dairy products in Egypt per capita in 1983, were estimated to be 40 Kg. This low consumption is about 25% of the 150 Kg recommended by the international organisations as the minimum requirement per person. The low milk production is due to the fact that animals are kept by farmers primarily as working animals on the farm, and therefore their ability for

milk production is very low. However, experiments have shown that if the animals are relieved from work and raised only for milk production, milk yield can be easily doubled. They also respond to better management and feeding (Shabana, 1984).

2.2- LIVESTOCK FEEDS IN EGYPT

In Egypt, there are two periods of feeding animals in general, the winter and summer, and the feeding regimes are quite different during each season. In other words, there is an heterogeneous distribution of feed supply around the year. In winter the animals are generally over-fed but are under-fed in summer. During summer there is a deficiency of about 1.5 million tons of Starch Value units assuming that all milk is produced during the winter period. Such deficiency would be more if a fraction of milk is produced during the summer time, causing a serious decrease in animal production. More efforts should be directed to increase the available feeds especially during summer (Shalaby ***et al*** 1984).

The production of animal feeds in Egypt depends on cultivation of berseem (clover) *Trifolium alexandrinum L.*, its supplies about 4.8 million tons of feed units as starch value, representing 69% from the whole nutritive value of the Egyptian feed stuffs (shalaby ***et al*** 1984)

The main feed source for livestock green clover is consumed during winter (December to May), It has been repeatedly recommended to preserve suitable amounts of green clover as silage or hay to be use in summer feeding to reduce the problem of feed shortage in such season (Gabra 1984).

Table 2-4 Cultivated area of main winter crops, by type of crop and year

Thousand acre, except percent

Type of Crops	Year		Percent of Change 1990-1994	
	1952	1990	1994	%
Total	**4364**	**5593**	**5932**	**6.1**
Barley	137	127	148	16.5
Beet	-	34	42	23.5
Bean	355	345	374	8.4
Chickpeas	15	13	17	30.8
Clover	**2202**	**2620**	**2686**	**2.5**
Fenugreek	54	16	20	25
Lentil	58	14	16	14.3
Linen	13	31	28	-9.7
Lupine	11	8	9	12.5
Garlic	9	15	12	-20.0
Onion	26	25	26	4.0
Vegetable	63	344	366	6.4
Wheat	1402	1955	2111	8.5
Others	19	46	77	67.4

Central Agency For Public Mobilisation and Statistics 1995

Table 2-5 : Cultivated area of main summer crops, by type of crop and year

Thousand acre, except percent

Type of Crops	Year			Percent of Change 1990-1994
	1952	1990	1994	%
Total	3026	5055	N.A	-
Cotton	1967	993	N.A	-
Maize	**27**	**1547**	**1740**	**12.5**
Millet	378	312	367	17.6
Peanut	26	29	161	455.2
Potato	-	70	58	-17.1
Rice	**362**	**1036**	**1378**	**33.0**
Sesame	42	42	61	45.2
Soy bean	-	99	56	-43.4
Sugar cane	92	274	278	1.5
Vegetables	118	437	488	11.7
others	14	216	291	34.7

Central Agency For Public Mobilisation and Statistics 1995

2.3- ALTERNATIVE FEEDS FOR LIVESTOCK IN EGYPT

2.3.1- FODDER BEET

Fodder beet is a winter crop, which may participate in solving the animal feeding problem if stored under good conditions to be used during summer season (Shalaby ***et al*** 1989a) The plant could be sown at October and harvested at May (Gabra ***et al*** 1987). Fodder beet is characterised with its great number of varieties which seems suitable for a wide range of soils (Rammah ***et al*** 1984). The chemical composition of fodder beet ranged from 15.5 - 28.4% DM, 59.4 -

68.2%, NFE 1.26 - 1.92% N and 5.8 - 7.3% CF and Crude Protein digestibility ranged between 53.5 - 72.3% and CF digestibility averaged 86.0%, when it was used in sheep feeding (Demarquilly, 1972). The fodder beet roots were replaced successfully 50% of pelleted concentrate mixture in lambs diets (Osman, 1991). Fodder beet also tended to increase milk yield, and yield of constituents, but the effect was statistically significant for milk protein content only ($P<0.01$). There was a significant interaction between fodder beet and concentrate CP content for milk protein yield ($P<0.001$) (Fisher *et al* 1994)

Fodder beet can be ensiled and produces a good quality silage of high nutritive value. Silage of fodder beet root can participate in solving feed stuffs shortage during summer (Shalaby *et al* 1989). Furthermore, adding some agricultural by-products such as peanut hulls and corn stalks to fodder root is important in making silage to absorb considerable amount of water from the high moisture roots and to produce a good quality silage (Abdal Aziz ***et al*** 1989). Ensiling in mixtures solves some of the problems of storage and feeding fodder beet, but some of the high nutritive value of fresh beet is lost (Gruber 1992). Otherwise, there is limit to use fodder beet. On the other hand it should be noticed that milk yield decreased by up to 21% with increasing intake of fodder beet. However, milk fat content increased so that the daily milk fat yield was unaffected by beet intake. Inclusion of beet increased digestibility of DM

and energy in the total diet, while digestibility of crude fibre remained unchanged. Then, efficiency of utilization of metabolizable energy (ME) in the total diet for milk and energy deposition was lower by 6.4 percentage points for beet 22 kg and by 8.4 percentage points for beet 44 kg (Muller ***et al*** 1994). Also, increasing the intake from fodder beet silage, increased rumen volatile fatty acid concentration. As a molar percentage of total VFAs, acetate was highest in diet of grass silage and hay plus barley, propionate in diet with half of the energy from barley replaced by fodder beet and butyrate in diet with all of the energy from barley replaced by fodder beet (Zitnan, R.1993) It was concluded that the highest level of rumen propionate was very effective with fattening animals. In that case, calves fed fodder beet had the highest daily gain compared with other diets (Zitnan, R.1993). Intake of fodder beet should not exceed 20 to 50 kg, depending on its sugar content, to avoid rumen acidosis. (Salewski 1991).

2.3.2- CASSAVA

Cassava leaves have been reported to be one of the notable sources of essential amino acids (Hall ***et al*** 1975) beside a high carotene content (Oke 1973). Moreover several reports demonstrated that the cassava roots can replace cereals or other carbohydrate sources without any loss in performance

especially for dairy and beef cattle with attendant reduced cost of feeding (Compos and Silva 1978 and Tudor and Norton 1982). However, in Egypt, Abd El-Baki ***et al*** (1986) evaluated different complete feeds for ruminants which contained different levels of dried cassava roots and leaves. Also, Abd El-Baki ***et al*** (1989)studied cassava plant as a new animal feed in Egypt and evaluated their products by sheep. They reported that cassava leaves are potentially variable as a source of protein and roots represent an important supply of energy for feeding livestock. Hence it is an attractive substitute to traditional protein and energy sources.

Smith ***et al*** (1992) reported that cassava tubers and peel are good energy sources, which when supplemented with nitrogen, minerals, vitamins and roughage promote good performance in dairy and beef cattle, sheep and goats. On the other hand, total substitution of maize meal with cassava had no significant effect on digestibility of DM or organic matter, and was economical, reducing feed costs (Sanda ***et al*** 1992).

2.3.3- NAPIER GRASS

Since Napier grass is mainly a summer forage, it could participate in solving the problem of feeding the national herds during the summer season. The fodder leaves were not recommended to be ensiled with the roots. Leaves

could be conserved as hay and should be mixed with some legume forage crops to improve the feeding quality of this hay. Such hay can cover the maintenance requirements of sheep from energy and protein with surplus remaining for production (Shalaby ***et al*** 1989).

Kariuki ***et al*** (1993) reported that the half life of napeir grass was highly correlated to in vitro digestibility (r = 0.9). It is concluded that between 4 and 8 weeks of growth. Napier grass (Pennisetum purpureum) can be offered as sole feed for sheep (Devasena ***et al*** 1993) and also for dairy goats (Yokota ***et al*** 1994)

2.3.4 - AGRICULTURAL BY-PRODUCTS

In Egypt there are more than 14 million tons (per annum) of low quality roughage including wheat and rice straw, corn stover, corn cobs, sugar cane bagasse and pith, rice hulls, cotton stalks with the exception of the latter two ingredients. The TDN values of these products are in order of 45% or higher. These values can be improved to up to 20% by single grinding and supplementing with urea, molasses and minerals (EL Shazly 1983). Rice straw is by far the largest fibrous crop residue available for the farm feeding of livestock. It has been utilized in many countries as a staple feed for ruminant animal for many years. Although of poor quality, rice straw forms a good

roughage when supplemented with feeds rich in protein and energy fortified with minerals and vitamin A. To be effectively utilized for feeding animals, various physical, chemical and microbial treatments have been suggested in many part of the world (Ranjhan and Chadhokar 1984). Other ingredients which would be used are sunflower straw and maize stover as they are good roughage resources for sheep feeding (Rao ***et al*** 1994). Groundnut hulls and cotton straw were ranked as poor roughage sources for direct feeding to goats (Rao ***et al*** 1995). Although some of those ingredients classified as nutritionally poor by-products But when they were prepared as silage or hay, CP and crude fibre are increased (Ceron Madrigal ***et al*** 1995).

Furthermore, fresh olive tree leaves or ammonia treated olive tree leaves were used successfully as they replaced lucerne hay in lactating ewes diets (Fegeros ***et al*** 1995). Numerous efforts have been made to improve the nutritive value of fibrous crop residues by chemical, physical and microbial methods; such as research on chemical treatment of various crop residues; the influence of physical treatments such as chopping, grinding, pelleting and compacting of fibrous residues (Sharma ***et al*** 1993).Moreover, the physico-chemical treatments (high temperature steam and dilute acid) had been used to improve potentially high lignocellulosic by-products for ruminant utilization (Castro ***et al*** 1993). Finally, the biodegradation of sugarcane bagasse and its components

by different strains of white rot fungi, made it possible to improve the nutrient availability from sugarcane bagasse (Kewalramani ***et al*** 1993).

Ammoniation of rice straw and addition of blotong (filter cake from sugarcane processing) were increased DM and organic matter digestibility and total protein content (Rahmadi ***et al*** 1994).

2.3.5- INDUSTRIAL BY-PRODUCTS

These by-products show considerable potential as non conventional substitutes for expensive feed ingredients. The livestock industry would gain much benefits due to the availability of good quality and relatively inexpensive feed ingredients for the formulation of compound livestock feeds.

Great number of by-products have been evaluated as livestock ingredients such as roughages (sorghum silage, groundnut straw and leaves, Panicum maximum hay and straw, maize stover and leaves, Acacia albida siliquae), energy concentrates (white sorghum meal, red sorghum meal, millet meal, wheat meal), protein feeds (whole cottonseeds, cottonseed oil meal, palm kernel cake, groundnut oil meal) and other industrial by-products (millet bran, rice bran and hulls, dried brewers' grains). Composition of the roughages was very variable. Panicum maximum hay was practically a straw, very high in fibre and low in digestible organic matter. Sorghum silage was similar in nutritive

value to silage obtained at temperate climates. Dried groundnut straw and leaves were quite a good forage, but varied significantly in fibre and silica content. Energy concentrate feeds showed chemical composition and nutritive value similar to those obtained at temperate climates. Millet, white sorghum and red sorghum meal had lower DM solubility and degradation rate than wheat meal. Rumen degradabilities were high in groundnut meal and cottonseed meal and low in palm kernel cake. Among by-products, chemical composition and nutritive value of rice bran were negatively affected by high levels of silica and acid detergent lignin, due to a high proportion of hulls (Parigi-Bini ***et al*** 1995),

The palm kernel meal diets were reflected in higher lamb weights at slaughter and cost of the diets decreased with increasing level of palm kernel meal making it economically attractive to use palm kernel meal in the diet of sheep (Umunna ***et al*** 1994).

Dairy ewes fed on diets containing citrus pulp had similar milk yields and milk compositions to those fed on control diets (Fegeros ***et al*** 1995). Also it can be used in mixtures formula pellet for sheep. The moisture content of a well-balanced pellet feed before drying was 48.8% when the ratio of citrus pulp to formula feed was 30 to 70. This ratio produced the best quality pellets. Drying pellets to a moisture content to 13% required about 8 h with artificial heat and about 22 h by sunlight for mixtures of citrus pulp and formula feed,

wheat bran, barley bran or oat grain. Drying times for citrus pulp + lucerne hay pellet were slightly less. Digestible crude protein (DCP) and TDN of the pelleted mixtures ranged from 7.5 to 11.4% and from 55.1 to 71.5% respectively; DCP was highest in citrus pulp + lucerne hay pellets and TDN was highest in citrus pulp + oat grain pellets (Kang ***et al*** 1994).

Bhattacharrya and harb (1973) replaced corn in wether lambs diets (which contain 60% corn) by citrus pulp with the ration 33,66.and 100% concluded that the crude fibre digestibility of the rations increased at each increase in the level of citrus pulp while the energy digestibility was significantly lower 60 % level of pulp incorporation . They also added that the average total digestible nutrient and digestible energy of citrus pulp calculated by difference was approximately 80% and 3.503 kcal/kg respectively .On the other hand , Baired ***et al***. (1974) concluded that the digestible energy (DE) metabolizable energy (ME) and metabolizable energy for maintenance were 3357,3194 and 3118 kcal/Kg , respectively. Apparent digestibility of protein in ration of maize alone ,with 1/3 or 2/3 citrus pulp and citrus pulp alone were found to be 69.1.69.1,69.8 and 69.5, respectively. The corresponding energy digestibility values were 62.4, 69.1 75.1 and 74.9% respectively.

Schaibly and Wing (1971) studied the effects of citrus pulp on rumen fermentation patterns and concluded that as citrus pulp varied form 100 to

67,33 and 0% of the ration molar percentages of acetic, propionic and butyric acids measured at 2hr after feeding varied , respectively as follow 65.1 13.9 , 21.6 ; 68.8 , 13.5 , 16.8 , 62.1 , 12.8 , 23.5; 70.8 ,11.5, 16.3. They were also added that the only significant difference among treatments between the acetic to propionic rations in rumen liquor of animals receiving 67% or 100% citrus pulp at 2 and 4hr after feeding where the acetic/propionic ratio of the 100% ration increased and that of 67% ration decreased during both intervals. Otherwise, citrus pulp can be mixed with poultry litter to produced a good quality silage (Osman, 1991).

Tag-Eldin ***et al.*** (1982) used a control diet composed of 48% cotton seed cake, 7% rice bran, 19% wheat bran, 20%yellow maize, 3% molasses ,2% calcium carbonate and 1% sodium chloride. They substituted this concentrate mixture by a silage composed of orange wastes and pea-pods (1:1) at level 0.00,50.0 , 100.0%. Data revealed that there were significant differences between the nutritive value and N balance of the three tested diets. The authors also showed that higher values of digestibility of rations containing silage were obtained.

Yang and Chaug (1986) fed rams fitted with stomach fistula 5 diets contained a 1:1 mixture of hay and either citrus pulp silage (DM 17.6%)as such or pre wilted (DW 23.4%) or citrus peel silage similarly (DM 18.9 and 23.6%).

They showed the DM digestibility were higher the mixed diets than in control and the mean DM digestibility for pulp silage was higher than for peel silage and pre-wilting of both increased DM digestibility.

Nour ***et al.***(1987) studied the effect of fresh cattle manure on the quality of the orange waste silage and found that increasing levels of fresh cattle manure to orange waste silage increased dry matter , crude protein , ether extract, ash ,silica, minerals (Ca, P, Cu, Fe, Mg, Zn, and Mn) and decreased the NFE of the silage . They also added that increasing the level of fresh cattle manure increased VFA's concentration and decreased lactic acid ,ethanol and dry matter digestibility .

2.4- POULTRY LITTER

The use of poultry waste as a feed ingredient will not only reduce waste disposal and cost environmental pollution, but will also provide inexpensive feed components for ruminants (Chaudhry, ***et al*** 1993).

2.4.1- CHEMICAL COMPOSTION AND NUTRITIVE VALUE

The chemical composition and quality of poultry litter can vary considerably from one producer to another. Because the amount and kind of bedding material are not standardized or regulated. Other factors such as broiler

house management and moisture can add to the variation in litter composition and quality. Monteny, 1994 reported that by lowering pH of slurry the equilibrium between ammonia (NH_3) and ammonium (NH_4) is changed, so that very little volatile ammonia is present in the slurry and he also added about 40L of nitric acid (HNO_3) per m^3 slurry (57% HNO_3 by volume) is required to reduce slurry pH to 4.5. Ammonia emission was reduced by 35% following this treatment. For cattle, urea in the urine is converted into ammonia as soon as the urine and faeces come into contact. However, the conversion of uric acid from poultry droppings, into urea and then to ammonia takes one or more days (Groot Koerkamp, 1990). Nutrient analysis of the litter has been done by numerous investigators. Blair and Knight, 1973 found that poultry litter contained 25.3% crude protein, 13.84% crude fibre, 2.3% ether extract, 2.5% calcium, and 1.6% phosphorus. While, McClure and Fontenat, 1983, reported that broiler litter contained 30.9% crude protein as dry matter basis. Recently, Pugh, *et al*, (1994), indicated that broiler litter contained 24.9% crude protein, 23.6 crude fibre, 24.7% ash, 2.3% calcium and 1.6% phosphorus. Finally, the average nutrient content of 106 samples of broiler litter collected from across Alabama - Where the bedding materials used in broiler houses are wood shavings, sawdust, peanut hulls, and some shredded paper products - were moisture 19.5%, crude protein 24.9%, crude fibre 23.6%, ash 24.7%, calcium

2.3%, phosphorus 1.6%, potassium 2.3%, magnesium 0.52%, sulfur 0.50%, copper 473 PPM, Iron 2,377 PPM, manganese 348 PPM and zinc 315 PPM (Ruffin and McCaskey, 1991). It has been shown that animal excreta, including bedding and associated materials, are more valuable as a feed ingredient for ruminant animal.

However, two serious obstacles to the feeding of poultry litter to livestock exist, namely, pathogenic organisms and medicinal drugs. Research work (Caswell, ***et al***, 1975)has shown that poultry waste can be rendered free of pathogens by autoclaving, fumigation and dry heat alone or in combination with para-formaldehyde. Also, litter can be heat treated as would occur during mechanical drying or pelleting of feed (Ruffin and McCaskey, 1991 and Osman 1991). Other methods of processing such as ensiling (Caswell, ***et al***, 1977)and deep stacking (Strickler, 1977 and Rude ***et al*** 1994) have also been proposed.

Poultry litter can be mixed with other feed ingredients and ensiled to encourage acid production or can be directly acidified to achieve essentially the same effect (Ruffin and McCaskey, 1991). To minimize risks from drug residues in the tissues of animal that are fed litter , all litter feeding should be discontinued 15 days before the animals are marketed for slaughter (Ruffin and McCaskey, 1991).

The nutritive value of poultry litter has been evaluated as mixed in concentrate diet or as ensiled with other materials. Furthermore, two groups of Awassi ewes were fed on a control diet or a diet containing 30% poultry litter from laying birds. Differences in breeding and lactation performance, between ewes given the control and those given the poultry litter diet, were small for all data obtained on performance. Also, there was no disease problem related to the use of poultry litter. Milk and cheese from ewes given poultry litter were just as acceptable as those from ewes given the control diet (Muwalla, ***et al***. 1995). Moreover, the apparent digestibility of organic matter, crude protein, crude fibre and nitrogen-free extract of poultry litter estimated by sheep was 69.8, 82.8, 49.7 and 71.4%, respectively. For ewes which were grazing daily and given no supplement or supplemented with poultry litter. Intake of poultry litter averaged 0.06 kg/day for ewes. Poultry litter increased daily gain (Flachowsky, 1992). Low cost concentrate supplements containing 30% poultry droppings (PD), 22.7% PD + 7.5% poultry litter (PL) or 15% PD + 15% PL were processed into pellets and fed to rams and goats along with chopped sorghum straw. The digestibilities of all nutrients except ether extract were comparable in all 3 diets. Goats had higher digestibilities of all nutrients except CP, ether extract and energy than sheep. Goats and sheep had positive nitrogen, calcium and phosphorus balances. Digestible protein and TDN contents were

comparable across diets. The nutritive value was similar for all supplements and between species (Murthy, ***et al*** 1996).

Poultry litter can be ensiled with other by-products such as citrus pulp to produce good quality silage containing nitrogen and energy source. Silage composed of about 4 to 5 parts of citrus pulp and 1 part poultry litter was fed to heifers, lambs and kids, silage posed no problems regarding disease (Hadjipanayiotou, 1993). Similarly, the poultry manure silage (PMS) was prepared using 6 litres water, 2 litres molasses and 21 lbs poultry manure; (30.4% protein and 7% crude fibre) to replace part of lambs concentrate feed. The results suggest that PMS can be used to replace half the concentrate feed in growing lambs fed to appetite without significantly influencing growth rate (Griffith, 1993).

Digestibilities of DM, CP, ether extract and organic matter were higher ($P<0.05$) in sheep fed on silages containing broiler litter than in those fed on maize silage alone. The results indicated that the broiler litter is a good source of protein and can be mixed with low-protein forages. Moreover, ensiling of broiler litter was effective for the destruction of pathogenic organisms, and no ill health effect was observed in sheep.

2.4.2 -USE OF POULTRY LITTER AS A FERTILIZER

Broiler litter can be used as a fertilizer for grass pastures and other long

season crops. Annual applications of broiler litter are possible and practical because of the slow release of nutrients from the litter, particularly nitrogen and this slow release tends to work well in long season (Bagley ***et al*** 1994).

Broiler litter has been used mainly as a fertilizer but does not make the most efficient use of broiler litter, the economic value of excreta products as feed components in balanced diets for several classes of ruminants is three to ten times greater than their value as nutrients for plant (Smith and wheeler, 1979). It is as four times more efficient as a ruminant feed ingredient than as fertilizer (Ruffin and McCaskey, 1991). In addition to offering an economic advantage, using broiler litter in feed also helps to conserve plant nutrients. These nutrients, nitrogen, potassium, and other mineral elements are distributed on pasture land as manure by the animal consuming the litter (Ruffin and McCaskey, 1991).

2.4.3- USE OF POULTRY LITTER AS A FEED

Although broiler litter can be used efficiently and effectively as a fertilizer, its greatest potential economic impact is as feed source for ruminant animal. Broiler litter has been used as a cattle feed ingredient for over 35 years without harmful effects to humans who have consumed products of these animals (Ruffin and McCaskey, 1991). Good quality broiler litter is

approximately equal to good quality of alfalfa hay.(Bagley ***et al*** 1994) To make broiler litter diets more palatable in order to increase consumption, corn or other feeds are added. Fontenot, 1978, estimated that broiler litter as a feed is worth two to three times more than its value as a fertilizer for pastures.

2.4.4 - IMPROVING THE NUTRITIVE VALUE OF BROILER LITTER

Broiler litter fed to ruminants is usually mixed with a more palatable feed, such as maize. Any number of palatable feeds in addition to corn can be used to mix with the broiler litter, such as wheat, commercial grain mixes, soybean hulls (Bagley ***et al*** 1994) and citrus pulp when it is used as silage.

Diets containing broiler litter can produce acceptable levels of performance by ruminants. However, raw broiler litter needs to be processed to ensure its safety from potentially harmful pathogens. Processing can be achieved by moderate heat, either during the ensiling process or by deep stacking or pelleting the broiler litter (Bagley ***et al*** 1994). Broiler litter contains very low or no vitamin A, so the supplement fed to animals consuming broiler litter diets should contain vitamin A, fresh forages are very high in vitamin A precursor, and the animal can store relatively large quantities of vitamin A in the liver. However, vitamin A is a relatively inexpensive feed additive, (Bagley ***et al*** 1994).

Good quality broiler litter should contain 20 - 30 percent crude protein . Litter can be low in crude protein because of either a very high ash content or because of excess volatilization of nitrogen in the poultry house. High temperatures and excess moisture in the poultry house leads to nitrogen volatilization. If crude protein values are below 18%, the litter should be used as a fertilizer and not as a feed source (Bagley ***et al*** 1994).Moreover, ash in litter is made up of minerals from feed, broiler excrement, bedding material, and soil. Ash content is one of the important measures of the quality of litter. So, ash contents of over 28% are too high and should not be fed to the animal (Ruffin and McCaskey, 1991).recently, Hays reported in 1994 some pilot studies showing that certain experimental chemical can be added to bedding material in poultry houses that may prevent volatilization of nitrogen and solubilization of protein.

2.5- IN-VITRO ESTMATES OF DIGESTIBILITY

An important concept to take into consideration about feedstuffs is its nutritive value. One of the most useful measures of the nutritional value of a feedstuff is its apparent dry matter digestibility. This can only be measured in vivo but in vivo digestibilities are very expensive, require a long time and large amounts of feedstuffs. So, there is an increasing interest in doing digestibility

predictions through laboratory tests of low cost and simple procedure. Several laboratory methods have been proposed for its estimation. These methods rely either on measuring cell wall fractions or on in vitro techniques that simulate the natural ruminant digestive processes (Omed *et al* ,1989). Many artificial rumen procedures have been proposed, the two stage technique based on the use of rumen liquor followed by acid pepsin developed by Tilly *et al* (1960)and Tilley &Terry (1963) being the most extensively used. The rumen liquor can be obtained by stomach tube, but is more easily collected from sheep or cattle if they are fitted with permanent rumen fistulae. An alternative method has been devised by Omed *et al* (1989) to avoid the dependence on rumen liquor. This technique based on the use of the faecal micro-organisms contained in a filtered suspension of sheep faeces and pepsin.

Several authors have been studied the correlation between in vivo and in vitro results. Lately, as reported by Borba and Ribeiro, (1996) the results for the prediction of in vitro digestibility were obtained using the method of rumen fluid from fistulated sheep compared with two alternative methods, one using rumen fluid from slaughtered cattle and another, a sheep faeces suspension as inocula sources. It was concluded that the method using rumen fluid from slaughtered cattle is a valid alternative to the method using rumen fluid from fistulated sheep.

CHAPTER 3

GENERAL MATERIALS AND METHODS

3.1 - ANIMALS

Two breeds were used in study, the first one Rahmani, a local breed in Egypt and Cambridge a local breed in United kingdom. Twenty yearling Rahmani male lambs with an average initial live body weight of 44 Kg were used in feeding and digestibility trials. In addition, Seven Rahmani male lambs aged 7 - 8 months of 26 Kg average body weight. Eight yearling Cambridge female with average initial live body weight of 49 Kg were also used in this study.

3.2 - FEEDING TRIALS

The animals were housed during the course of experimental period, animals were fed twice daily and fresh water was always available . Records for biweekly live body weight were kept for individuals of each groups.

3.3 - DIGESTION TRIALS

3.3.1 - IN-VIVO DIGESTIBILITY

The animals were housed in metabolism crates . Following a preliminary adjustment period of 10 days data was collected for a period of 7 days . The metabolism crates were fitted with mesh floors and sloped netted

separators to accurately collect and separate faeces from urine . Daily feed consumption and faecal output were recorded and samples of diets and faeces were collected for chemical analysis .

3.3.2 - IN-VITRO DIGESTIBILITY

In vitro digestibility was estimated by a two stage technique based on the use of rumen liquor followed by acid pepsin developed by Tilley ***et al.*** (1960) and Tilley & Terry (1963) and using faecal micro-organisms contained in a filtered suspension of sheep faeces and pepsin, this technique is simple, cheap and needs no modified animals (EL Shaer ***et al.*** 1987).

Triplicate samples, each 180 mg of air dried ,ground to pass a 1 mm screen, were used in the analysis. These, together with additional samples used to determine the dry matter content, were weighed accurately into pre-weighed McCartney bottles which had previously been oven dried at 105°C for several days to constant weight.

A total of 60 g wet weight of sheep faeces were collected within 1 h of voiding from sheep. The faeces was mixed with 50 ml of synthetic saliva (McDougal, 1948) which had previously been saturated with carbon dioxide. The mixture was filtered through a double layer of muslin which was then wrung out and rinsed again to recover as much liquid as possible before being made up to 1000 ml with artificial saliva . The pH was checked, and adjusted if necessary to pH 6.8. The filtrate was stirred and 18 ml were added to each

McCartney bottle and also to five control bottles. The bottles were incubated at 38°C in incubator for 48 h , being also shaken manually three times daily during the incubation period. At the end of incubation period the bottles were centrifuged at 2000 rounds/hour for 30 min. The supernatant liquid was poured off and 18 ml of a freshly prepared solution of 4 g/l pepsin in 0.1 N HCl were added. The bottles were then incubated for a further 48 h, being shaken after the first 10 min to resuspend the feeding stuff residues. At the end of the pepsin digestion period the bottles were again centrifuged and the supernatant poured off. The residues in the bottles were rinsed with distilled water and recentrifuged before being placed to dry in an oven at 105° C together with the samples reserved for the dry matter determination. After 48 h in the oven the bottles were cooled in a desiccator and weighed. To ensure that drying was complete the bottles were returned to the oven for a further 24 h and the weighing repeated. The proportion of dry weight lost by each sample was calculated taking into account the residual weight of faeces in the control bottles. The mean proportional weight loss of the three replicates for each sample was recorded as the in vitro digestibility.

3.4 - CHEMICAL ANALYSIS

A proximate chemical analysis of feeds and faeces was carried out according to official methods of analysis (A.O.A.C., 1990).

3.4.1 - DETERMINATION OF THE MOISTURE

Moisture of fresh feeds, ensiled feeds and faeces was determined by drying in two stages, at 60 °c overnight then at 105 °c for 3 hrs . All the samples were ground by hammer mill fitted with a 1 mm mesh sieve. The dried and ground samples were stored away from direct sunlight in sealed polyethylene packs.

3.4.2 - DETERMINATION OF THE NITROGEN CONTENT

Nitrogen content (N) was determined by the kjeldahl procedure, it is a two stage process, consisting of:

a) Acid digestion

b) Titration

a) Acid digestion

Reagents: sulphuric acid (98%)

Kjeldahl tablet contained 3.5 00 g K_2SO_4

0.105 g $CuSO_4$

0.105 g SiO_2

Procedure :

Duplicate samples each of 200 mg of milled and dried samples were transferred into a micro - digestion tube, and half of one kjeldahl catalyst tablet was added and also 5 ml of sulphuric acid was added to each tube. The tubes were inserted into a preheated (450 °C) heater contained within the fume

cupboard. Digestion was completed when the acid mixture turns to the characteristic green colour.

b) Titration

Reagents : Sodium hydroxide (NaOH) 40%, Boric acid 1% with bromo cresol green / methyl red indicator (100 g to boric acid in 10 L distilled water) 100 ml bromo cresol green (100 mg in 100 ml methanol) 70 ml methyl red (100 mg in 100 ml methanol) 5 ml sodium hydroxide (4%) to give a positive blank and hydrochloric acid (HCl) 0.5 M

Procedure :

A kjeltec Auto 1030 analyser was used for titration. Three samples of distilled water (blanks)were titrated prior to running a batch of samples . The ammonia produced from the breakdown of nitrogenous components (except $NO^-_3 + NO^-_2$) during the acid digestion stage was released by an automated addition of 25 ml of sodium hydroxide and constant passage of steam through the resulting mixture . The ammonia was distilled off and collected in the receiver solution. The result was calculated from the amount of titrant (HCl) required to reach the required end point of the receiver solution (rose) . If the results of duplicates did not agree within 5% they were repeated.

3.4.3 - DETERMINATION OF CRUDE FIBRE

Crude Fibre (CF) was determined using 1.25 % sulphuric acid and 1.25 % Potassium hydroxide. The fibertec system (Tecator 1020) was used for determination.

Reagents :

Sulphuric acid 0.128 M (12.5 g of H_2SO_4 diluted to 1 L with distilled water), Potassium hydroxide 0.223 M (12.5 g of KOH dissolved in deionized water and diluted to 1L), n-Octanol and Acetone.

Procedure :

One gram of milled and dried sample after being oil-free was transferred into a Pyrex filter crucible. The crucibles were inserted into the fibertec system and 100 ml of 0.128 M sulphuric acid (measured at room temperature) was added to each crucible brought to boiling point. One to two drops of n-octanol was added to reduce excessive foaming. The crucibles were boiled gently for 30 min. and filtrated. The residues were Washed with warm water and 100 ml of potassium hydroxide 0.223 M (measured at room temperature) was added to each crucible and brought to boiling point. One to two drops of n-octanol was added to reduce excessive foaming. The crucibles were Boiled gently for 30 min. and filtrated. The residues were washed with warm water 3 times and also with acetone 3 times (25 ml for each). The crucibles and its contents were placed to dry in an oven at 130° C overnight. The crucibles were cooled in a

desiccator and weighed, then the crucibles were placed in a cool muffle furnace and the temperature was increased to 500° C. The crucibles removed from the muffle furnace, cooled in a desiccator and weighed. The difference in weight is the amount of crude fibre in the sample .

3.4.4 - DETERMINATION OF ETHER EXTRACT

Soxhlet apparatus was used to determine Ether Extract (EE) using petroleum ether (40 -60 °c) as a solvent .This fraction consists of fats and oils plus other substance, soluble in non-polar solvents, such as sterols and vitamins A and K .

Reagents :

- Petroleum ether 40 - 60° C

Procedure :

Two gram of the milled and dried sample was weighed and placed in an extraction thimble. The thimbles were placed in a Soxhlet extractor fitted with a weighed flask. Sufficient 40 - 60 °C petroleum ether was poured into the extractor to start the siphon, then sufficient ether was added to half fill the extractor again. The samples were condensered and extracted for 6 hours . The thimbles were removed, the petroleum ether in the extractor was collected and distilled off the remainder of the solvent in the flask .The flask was dried in an oven at 105 °C for approximately 1 hour and weighed with its contents. The difference in weight is the amount of the ether extract in the sample .

3.4.5 - DETERMINATION OF ASH AND ASH SOLUTION

Ash content was determined at 500 °c for 3 hrs in a muffle furnace.

Procedure :

Two gram of dried and ground sample was transferred into the basin and the basin was placed in a cool muffle furnace. The temperature of the muffle furnace was increased to 500 °C until a whitish grey ash remained. The basin was Placed in a desiccator to cool and weight, and prepared ash solution by hydrochloric acid (6 M approximately) and transferred to volumetric flask 50 ml . The sample solution was stored in a polythene bottle. The concentration of phosphorus in the solution was determined spectrophotometrically as the yellow phospho-vando-molybdate complex . The other elements in the ash solution (calcium, copper and zinc) was determined individually by atomic absorption .

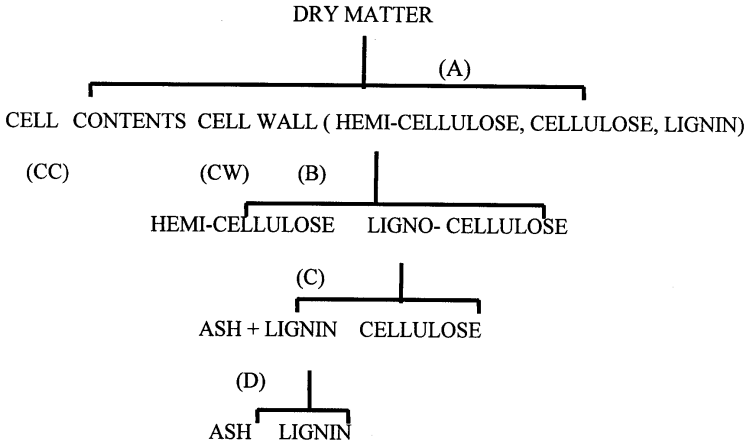
3.4.6 - DETERMINATION OF THE NITROGEN FREE EXTRACT

Nitrogen free extract (NFE) was calculated by difference .

3.4.7 - DETERMINATION OF THE FIBRE FRACTIONS

Fibre fractions were determined following Van Soest method (Van Soest, 1967).

Figure 1 Scheme of Fibre Fractions Analysis



A = Neutral detergent fibre

B = Acid detergent fibre

C = 72 % sulphuric acid

D = Muffle furnace at 550° C

A - Neutral Detergent Fibre

Reagents :

- 37.2 g disodium EDTA and 13.6 g disodium tetra borate and 60 g of sodium lauryl sulphate were dissolved in approximately 1 L of warm water. 20 ml of 2-ethoxyethanol was added to about 500 ml warm water, and 9.12 g of disodium hydrogen phosphate (anhydrous)was dissolved. Two solutions were mixed and completed to 2 litres. pH was Checked and adjusted to 6.9 - 7.1 with (conc. HCl). Sodium sulphite (anhydrous) and acetone

Procedure :

Empty and dry crucible was weighed, then weighed again after addition of 1 g of milled and dried sample, approximately 0.25 g of sodium sulphite was added to each crucible (a bit on the end of a spatula), the crucibles were placed into the fibertic system and approximately 100 ml of NDF reagent was added to each crucible. Excessive foaming was Reduced by addition of 1 - 2 drops of n-octanol. The crucibles were Boiled gently for 1 hour and filtrated. The residues were Washed with warm water 3 times and also with acetone 3 times (25 ml for each). The crucibles and its contents were placed to dry in an oven at 130° C overnight, then the crucibles were cooled in a desiccator and reweighted.

B - Acid Detergent Fibre

Reagent :

Twenty gram of cetyltrimethylammonium bromide (CTAB) was dissolved in 2 litres of 0.5 M H_2SO_4. Sulphuric acid 0.5 M was prepared by adding 53.5 ml to 1.5 L water and made up to 2 litres .

Procedure :

The crucibles with NDF residues were placed into the fibertic system. Approximately 100 ml of ADF reagent was added to each crucible. Excessive foaming was Reduced by addition of 1 - 2 drops of n-octanol. The crucibles were Boiled gently for 1 hour and filtrated. The residues were Washed with

warm water 3 times and also with acetone 3 times (25 ml for each). The crucibles and its contents were placed to dry in an oven at 130° C overnight, then the crucibles were cooled in a desiccator and reweighted.

C- 72 % Sulphuric acid

Reagent :

Sulphuric acid 72% was prepared by adding 403 ml of conc. H_2SO_4 to 274 ml of water. For 2 litres were used 1190 ml of conc. H_2SO_4 and 809 ml of water .

Procedure :

50 ml of sulphuric acid was added to the crucibles with ADF residues. The crucibles were placed in position and Incubated 3 hours at 25° C. The residues were washed very well with cold water, then acetone. The crucibles and its contents were placed to dry in an oven at 130° C overnight, then the crucibles were cooled in a desiccator and reweighted. The crucibles were placed in muffle furnace at 550° C. The crucibles were cooled in a desiccator and reweighted.

3.4.8 - DETERMINATION OF SILAGE QUALITY

Silage quality was evaluated through chemical determination of aqueous extract of the silage material. The pH was determined by using pH metre, total

volatile fatty acids (VFA's) acetic , propionic and butyric were determined by using gas liquid chromatography (GLC); total acidity was determined by volumetric titration, and ammonia was determined by titrimetrically.

3.5 - STATISTICAL ANALYSIS

The sample complete randomized design applied to analysis of variance . The observation are down at randomized from normally distributed , treatment and environmental effects are additive and homogeny of error variance .

The digestibility data was also analysed by the ANOVA procedure, utilizing the statistical package (Minitab) program , on the university college of north Wales computer system.

CHAPTER 4

TREATMENT OF POULTRY LITTER BY ACID IN BROILER HOUSE

4.1- INTRODUCTION

Due to the shortage of animal feed in Egypt and to reduce the production costs by reducing the feed cost we have to look for alternative sources to ruminant feed. The industry seeking ways to better capture the potential value of poultry litter as a source of nitrogen, minerals and energy.

As economic pressure increases on the animal production, producers will look for ways to reduce feed costs, of all the alternative feeds available, poultry litter has the greatest feeding value for its cost.

Chemical treatment can be added to the bedding material in poultry litter houses that may prevent volatilization of nitrogen and solubilization of protein (Hay, 1994) and also can improve the feeding quality of bedding material particularly, straw. However, nitric acid can be used to reduce ammonia emission by lowering pH of slurry to 4.5 (Monteny, 1994). Also, broiler litter can be directly acidified to lower pH and reduce ammonia volatilization by using acid treatment. This work has been done to reach that aim by treating poultry litter with acids.

4.2- DESIGN

Figure 4-1 Treatment design as shown in broiler house

SECTOR 4 1 APPLICATION	**HCl**	**No Acid**	**Acetic Acid**
SECTOR 3 2 APPLICATIONS	**HCl**	**No Acid**	**Acetic Acid**
SECTOR 2 3 APPLICATIONS	**HCl**	**No Acid**	**Acetic Acid**
SECTOR 1 4 APPLICATIONS (Birds begin here)	**HCl**	**No Acid**	**Acetic Acid**

This experiment was conducted on the college farm where broilers are produced on commercial basis. Broiler house factorial design was followed with 2 factors : Factor 1, Acid treatment This factor had three levels, hydrochloric, no acid and acetic acid. Factor 2, Sector This factor had four levels; 1, 2, 3 and 4 With birds starting in sector 1. Sectors 1, 2, 3 and 4 were treated with acid four times, three times, twice and once respectively. This resulted in a total of 12 experimental locations (3 columns X 4 rows). In which straw was used for bedding and each locations was weighted 120 kg approximately dried straw. The animal house was divided into 4 equal sectors.

At the start of the treatment the chicken were placed in the 1st sector of the house for 2 week. At the end of this period this sector was subdivided in to 3 equal parallel strips area, 2 of which were treated with either HCl or acetic acid treatment. The third strip area was kept as an untreated control. Following this the chicken were allowed further space (2nd sector) for another 2 weeks. At the end of this period this sector was also subdivided in to 3 strips and added to previous area and treated together with HCl or acetic acid treatment as for strip 1. A further area (sector 3) was added to the previous area after another 2 weeks this area was also subdivided in to another 3 parallel strips and treated in similar way as descried above. The final sector (sector 4) was last added and subdivided after 2 weeks to 3 strips and treated as described earlier. The percentage of acid treatment was 3% as dry matter of bedding weight. Commercial HCl of 37% and acetic acid of 85% were used in the treatments. The chicken taken space every two weeks and marketed at 8 weeks age, so, sector 1 was treated with acid four times (0.9 L x 4), sector 2 treated with acid three times (1.2 L x 3) , sector 3 treated with acid twice (1.8 L x 2), and sector 4 treated with acid once (3.6 L). The total quantity of acids were the same for all experimental locations (3.6 L).

Three samples for chemical analysis were taken at random from each experimental location. Separate chemical analysis such as crude protein, crude fibre, ether extract and ash were performed for each sample. This work was carried out during the summer and repeated again during the winter.

4.3- INTERPRETATION

4.3.1- MAIN EFFECTS

The two factors, acid treatment and sector, were in columns and rows. The columns and rows were not replicated. These two factors were confounded with environmental in the building and the behaviour and distribution of birds but their effects were small because the temperature and humidity in the building were under control by thermometers and hygrometers in all the building and using the heater, ventilator or open the window to its adjustment.

4.3.1.1-FACTOR : ACID TREATMENT

The acid treatment factor included acetic acid and HCl acid for whole broiler house. However, the acid applications were changed through the sectors. While, sector 2 was treated with acid for first time, it was second time for sector 1. As well the first treated for sector 3, it was second for sector 2 and third for sector 1and finally first treated for sector 4, it was second for sector 3, third for sector 2 and forth for sector 1.

4.3.1.2- FACTOR SECTOR

The factor sector included the number of acid applications while the acid application were 4, 3, 2 and 1 for sector 1, 2, 3 and 4 respectively and also includes changes in the litter; in depth, weight or density and because of changes in manure as birds become older. Therefore the results obtained for each sector depend on two factors, not number of applications only.

4.3.2- INTERACTION BETWEEN MAIN EFFECTS

The interaction between main effects produces 12 mean values, for each combination of acid treatment and sector. The sectors were reflected changes in the litter such as depth, weight or density, but each sector had the same litter and the same acid application. So, the difference will be between the acid treatments. This means the difference between HCl , no acid and acetic acid treatment when the number of application were once, twice, three times or four times.

4.4- STATISTICAL ANALYSIS

The chemical analysis data were analysed by analysis of variance (ANOVA) includes the effects of sector and treatments. The replicates not included as a factor in the analysis because all sample were taken at random, the variance between replicates were similar. If replicate is included in analysis, it will reduce both the degree of freedom and error SS and will decrease the F value of treatments. Means were compared using Fisher's multiple comparison procedure (Dowdy & Wearden, 1983). Due to that each sector produced different quantities of litter, the weighted analysis of variance was used. Moreover, each experimental blocks were weighted, the mean for each sector was calculated. The relative weight for each sector was calculated as following equation

relative weight of sector = mean sector / total weight

The overall differences among treatments were calculated as true mean based on the results in the four sectors. The true mean is related to the weight of litter produced in each sector for each treatment.

Arithmetic mean = (mean sector 1 + mean sector 2 +mean sector 3 + mean sector 4)/ 4

True mean = [mean sector 1 x (weight sector 1 / total weight) + mean sector 2 x (weight sector 2 / total weight) + mean sector 3 x (weight sector 3 / total weight) + mean sector 4 x (weight sector 4 / total weight)]

Finally the true means for treatments were calculated by weighted analysis of variance.

4.5- RESULTS

4.5.1- TRIAL A

This treatment was carried out through summer. Table 4-1 shows the mean values for crude protein for sectors and acid treatments. Statistical analysis clearly showed that acetic acid treatment was significantly higher than HCl treatment or control ($P<0.05$) and also, HCl treatment was significantly higher than control ($P<0.05$). The differences among sectors which included acid applications were not statistically significant ($P<0.05$).

Table 4-1 Crude protein content for each experimental location

	HCl treatment	**Control**	**Acetic acid treatment**	**Means**
Sector 4	15.40	13.37	17.75	15.51 a
Sector 3	15.55	14.71	17.54	15.93 a
Sector 2	14.94	15.72	17.59	16.08 a
Sector 1	16.74	14.22	18.03	16.33 a
Means	15.66 b	14.51 c	17.73 a	

It also appeared that there were statistically significant differences ($P<0.05$) among all treatment in crude fibre content in litter. Variation among sectors approached high significant ($P<0.05$) but only there was no significant between sector 3 and sector 4 in crude fibre as showed in table 4-2.

Table 4-2 Crude fibre content for each experimental location

	HCl treatment	Control	Acetic acid treatment	Means
Sector 4	22.42	24.33	20.31	22.35 a
Sector 3	22.61	25.95	20.86	23.14 a
Sector 2	18.86	20.21	15.52	18.20 b
Sector 1	15.77	19.97	14.17	16.64 c
Means	19.92 b	22.62 a	17.72 c	

It could also be noticed that there were no statistically significant differences among either treatments or sectors in ether extract as shown in table 4-3.

Table 4-3 Ether extract content for each experimental location

	HCl treatment	Control	Acetic acid treatment	Means
Sector 4	3.45	3.39	3.13	3.32 a
Sector 3	2.56	3.31	2.44	2.77 a
Sector 2	2.77	3.47	2.83	3.02 a
Sector 1	2.41	3.06	3.16	2.88 a
Means	2.80 a	3.31 a	2.89 a	

Variation in nitrogen free extract approached high significant differences between control and either HCl treatment or acetic acid treatment ($P<0.05$), but

there was no significant differences between HCl and acetic acid treatment. Also the results indicated that there were significant differences among all sectors in nitrogen free extract ($P<0.05$) as shown in table 4-4.

Table 4-4 Nitrogen free extract content for each experimental location

	HCl treatment	Control	Acetic acid treatment	Means
Sector 4	44.46	42.18	44.45	43.70 a
Sector 3	42.72	40.34	43.73	42.26 b
Sector 2	46.91	44.22	47.42	46.18 c
Sector 1	47.84	46.95	48.58	47.80 d
Means	45.48 b	43.42 c	46.05 a	

It also appeared that there were no significant differences among HCl, acetic acid or control in ash contents and also there were no significant differences among all sectors as shown in table 4-5.

Table 4-5 Ash content for each experimental locations

	HCl treatment	Control	Acetic acid treatment	Means
Sector 4	14.27	16.72	14.37	15.12 a
Sector 3	16.54	15.69	15.44	15.89 a
Sector 2	16.53	16.38	15.64	16.18 a
Sector 1	17.25	15.10	16.06	16.14 a
Means	16.15 a	15.97 a	15.38 a	

4.5.2- TRIAL B

This trial was carried out through the winter to find out season effect -if any- on chemical composition of the litter. The results are presented in Table 4-6, which shows that there were significant differences between control and both of HCl and acetic acid treatment but there was no significant differences ($P<0.05$) between HCl or acetic acid in crude protein. The differences among the sectors were significant but only between sector 3 and sector 2, there was no significant differences ($P<0.05$).

Table 4-6 **Crude protein** content for each experimental location

	HCl treatment	**Control**	**Acetic acid treatment**	**Means**
Sector 4	14.56	13.52	15.60	14.56 c
Sector 3	21.03	20.30	19.67	20.33 b
Sector 2	21.83	19.21	21.12	20.72 b
Sector 1	22.98	20.75	23.84	22.52 a
Means	20.01 a	18.45 b	20.06 a	

Meanwhile, the crude fibre results are presented in Table 4-7 showing no significant difference among all sectors($P<0.05$). There were significant difference ($P<0.05$) between control and either of HCl or acetic acid treatment but there was no significant difference within the acid treatment($P<0.05$).

Table 4-7 **Crude fibre** content for each experimental locations

	HCl treatment	Control	Acetic acid treatment	Means
Sector 4	17.08	17.99	16.96	17.34 a
Sector 3	15.19	16.51	14.48	15.06 a
Sector 2	16.93	17.86	14.24	16.34 a
Sector 1	14.19	18.40	15.32	16.30 a
Means	15.85 a b	17.69 a	15.25 b	

On the other hand, the ether extract results indicated that there were no significant difference among different sectors ($P<0.05$). Also there was no significant difference between HCl and control but there was significant difference between any of them and acetic acid treatment as shown in table 4-8.

Table 4-8 **Ether extract** content for each experimental location

	HCl treatment	Control	Acetic acid treatment	Means
Sector 4	2.79	2.77	2.17	2.58 a
Sector 3	2.48	2.47	1.99	2.31 a
Sector 2	2.15	2.17	1.67	2.00 a
Sector 1	1.97	2.42	1.79	2.06 a
Means	2.35 a	2.46 a	1.91 b	

However, the results presented in Table 4-9 show that there were no significant differences ($P<0.05$) among the treatments in nitrogen free extract.

Also, there were no significant difference among sector3, sector 2 and sector 1 but there were significant differences between any of them and sector 4 ($P<0.05$).

Table 4-9 **Nitrogen free extract** content for each experimental location

	HCl treatment	Control	Acetic acid treatment	Means
Sector 4	50.13	52.83	52.81	51.98 a
Sector 3	46.37	46.05	49.86	47.43 b
Sector 2	44.01	46.82	47.50	46.11 b
Sector 1	46.05	43.87	43.73	44.54 b
Means	46.69 a	47.38 a	48.48 a	

Results are presented in Table 4-10 show that there were no significant difference among either sectors or treatments in ash content.

Table 4- 10 Ash content for each experimental locations

	HCl treatment	Control	Acetic acid treatment	Means
Sector 4	15.26	12.89	12.46	13.54 a
Sector 3	14.93	14.67	14.00	14.37 a
Sector 2	15.08	13.44	15.47	14.83 a
Sector 1	14.81	13.56	15.32	14.56 a
Means	14.90 a	13.60 a	14.48 a	

4.6- DISCUSSION

The acid treatments improved the poultry litter quality by increasing the crude protein content from 14.5% for no acid treatment to 15.7% for HCl treatment and to 17.7% for acetic acid treatment during summer (trial A) and

from 18.45% where no acids was used up to 20.01% or 20.06% as a result of HCl or acetic acid treatment during winter (trial B). This is in general agreement with findings reported by Hays 1994 where certain experimental chemicals added to bedding material in poultry houses prevented volatilization of nitrogen. Lowering pH (4 - 4.5) by added acid changed the equilibrium between ammonia (NH_3) and ammonium (NH_4) so that very little volatile ammonia is present (Monteny, 1994).

It also appeared that there were statistically significant differences between treatments in crude fibre due to the effect of acid treatments on the lignocellulose in the bedding material. These results are in agreement with those obtained by Castro ***et al*** 1993 who found that the dilute acid treatment can improve potential lignocellulosic by-products.

It could also be noticed that there were significant differences between sectors, this was expected because of included variations in the litter such as depth, weight or density. On the other hand, there were no differences between either sector3 and sector 4 or sector 1 and sector 2 and this may be due to increased manure production during the last 2-3 weeks of the fattening periods (Monteny, 1994).

The same trends were obtained by data collected at winter. These results may be due to the temperature and humidity in the broiler house were the same.

Crude protein content was higher in winter than in summer, obviously,

because of more feed consumption during winter and expectedly more manure portion on the bedding.

All the poultry litter were produced through this treatment had good quality as animal feed. This is in close agreement with many investigators (Blair and Knight, 1973; McClure and Fontenat, 1983 and Pugh, ***et al*** 1994).

The poultry litter produced in sector 1 were incorporated in sheep diets and its feeding value will be presented in the following chapter.

CHAPTER 5

NUTRITIONAL EVALUATION OF POULTRY LITTER TREATED WITH ACID AND INCORPORATED IN SHEEP DIETS

5.1- INTRODUCTION

The practice of using non-protein nitrogen in ruminant rations is becoming more common. The principal compound used in this manner has been urea, but various other nitrogenous salts have been fed successfully. Belasco, 1954 has since reported that rumen organisms are capable of utilizing uric acid, the principal nitrogen excretory product of chickens as a source of nitrogen. Due to the unique ability of ruminant animals to digest forages, other fibrous material, and inorganic nitrogen such as urea , there is a world wide awareness that by-products of agriculture and the food processing industry can serve as low cost feedstuff alternatives (Wilkinson 1988). Broiler litter is a poultry industry by-product that must be disposed of in an environmentally sound and economically efficient manner.

The use of broiler litter as a feed source for ruminant animal is environmentally and economically efficient if proper precautions are taken (Flachowsky and Henning, 1990). The purpose of this study was to determine the digestibility and nutritive value of poultry litter when treated with HCl or acetic acid and fed to lambs.

5.2- MATERIAL AND METHODS

5.2.1- ANIMALS

Twenty yearling Rahmani lambs with an average weight of 44 Kg were randomly allotted to four groups of five. The animals were housed in individual pens. All animals had access to small outdoor yard but feeding was done inside a shelter.

5.2.2- FEEDS

Poultry litter was treated with HCl or acetic acid while on the broiler house floor. It was later collected and stacked in several layers in an open sunny area to dry. Sun dried litter was incorporated in lamb diets. This litter was composed of rice straw as bedding material and, broiler dropping where acid treatment was applied four times. Four diets were used in this study; a control diet, diet mix containing untreated poultry litter, diet mix containing poultry litter treated with HCl and diet mix containing poultry litter treated with acetic acid. The chemical composition of all ingredients used are presented in Table 5-1. Formulation and chemical composition of the experimental diets are presented in table 5-2 and also contribution of nitrogen sources in each diet is exhibited in Table 5-3. The control diet consisted of 48% maize, 40% wheat bran, 10% sun flower seed meal, 1.5% limestone and 0.5% salt. In the other three diets the sun flower seed meal was replaced with untreated poultry litter , poultry litter treated with HCl or poultry litter treated with acetic acid respectively. The basis of replacement was to test poultry litter as a source of

nitrogen in practical diets. The four diets were manufactured in a commercial feed mill. All ingredients were ground to a maximum size of 6 mm. A steam press unit was used for pelleting the feed into 8 mm diameter pellets. Temperature of the pelleted product was in the order of 98°C before it was transferred to a cooler and drier unit.

Table 5-1 Chemical composition of the ingredients used in the experimental diets

percentage %	Maize	Wheat bran	Sun flower seed meal	PL treated with HCl	PL treated with Acetic	PL untreated
Moisture %	11.85	10.99	6.29	13.87	13.16	14.33
On Dry Matter Basis %						
Crude Protein	9.73	16.34	30.29	22.98	23.84	20.75
Crude Fibre	3.63	9.57	24.30	14.19	15.32	19.40
Ether Extract	5.00	4.49	1.94	1.97	1.79	2.42
Nitrogen Free Extract	80.39	64.82	35.85	46.05	43.73	43.87
Ash	1.25	4.78	7.62	14.81	15.32	13.56
Dry Matter % Hemicellulose	13.6	31.6	12.7	29.1	33.5	29.8
Cellulose	1.5	2.8	6.2	4.3	5.4	3.6
Lignin	0.7	7.2	1.7	8.8	11.2	17.0
Cell Contents	83.5	57.1	57.1	55.4	45.7	47.6

Table 5-2 Chemical composition for the experimental diets used in the feeding trial

Diets: / Ingredients:	Control	PL HCl	PL Acetic	PL untreated
Maize	**48**	**48**	**48**	**48**
Wheat bran	**40**	**40**	**40**	**40**
Sun flower seed meal	**10**	-	-	-
PL treated with HCl	-	**10**	-	-
PL treated with acetic	-	-	**10**	-
PL without treated	-	-	-	**10**
Limestone	**1.5**	**1.5**	**1.5**	**1.5**
Salt	**0.5**	**0.5**	**0.5**	**0.5**
Proximate Analysis:				
Dry Matter	89.08	88.79	89.69	90.01
Crude Protein	14.32	13.61	13.72	13.35
Crude Fibre	7.78	8.04	8.21	8.20
Ether Extract	6.64	4.90	4.34	4.28
Nitrogen Free Extracts	63.86	66.30	66.45	67.03
Ash	7.40	7.15	7.28	7.14
Fiber Fractions:				
Hemicellulose	17.0	18.2	19.4	19.7
cellulose	2.3	1.9	3.1	1.9
Lignin	6.6	4.5	1.9	4.9
Cell contents	73.2	74.6	74.0	72.6
Minerals:				
P g/kg	6.3	6.7	6.3	6.3
Ca g/kg	6.8	6.4	7.4	7.4
Cu mg/kg	4.0	4.0	4.0	4.0
Zn mg/kg	14.0	17.0	14.0	17.0

Table 5-3 The contribution of Crude Protein sources in each diet as a percentage of total dietary Crude protein

Source of nitrogen	in the diet	CP contributed %	total dietary CP %	Exp. Source of nitrogen
Sun flower seed meal	10	3.03	14.32	21.2
PL treated with HCl	10	2.30	13.61	16.90
PL treated with acetic	10	2.38	13.72	17.35
PL untreated	10	2.08	13.35	15.58

5.2.3- FEEDING TRIAL

The experimental diets were used in a feeding trial by using four animal groups, each of five lambs. Experimental Diets were offered to the lamb groups over a period of 117 days. Daily allowances were one Kg of the experimental diet + 2 Kg of Egyptian Clover / head.

The first two weeks were considered a standardization period. The experimental lambs were weighted biweekly. The total gain in liveweight was calculated by the difference between initial and final weight.

5.2.4- DIGESTION TRIALS

During the feeding trial, four animals, one from each group were transferred to individual metabolic cages. The four animals were of almost similar liveweight. This trial was repeated three times with different animal

from each group. Three animals were used, therefore, to determine nutrient digestibility and the feeding value of each experimental diet in terms of total digestible nutrients. Each trial consisted of 10 -day- preliminary period followed by 7 -day- collection period.

Faeces were collected daily in nylon bags, mixed thoroughly, weighed, and 10% of each day collection was used for dry matter determination. Samples from each animal were taken over the whole collection period , pooled together, ground and kept in tightly closed containers for chemical analysis. Digestibility coefficients were calculated by expressing the weight of nutrients digested as proportions of the weights consumed. The general formula for the calculation of digestibility coefficients

is: $$\frac{\text{Nutrient consumed - Nutrient in faeces}}{\text{Nutrient consumed}}$$

5.2.5- CHEMICAL ANALYSIS

Analysis of feedstuffs and faeces were carried out by the methods described in chapter 3.

5.2.6- STATISTICAL ANALYSIS

The data were subjected to analysis of variance (ANOVA) for the effect of treatments was carried out by using completely randamized block design. The animals were distributed into blocks according to the weight and the treatments were randomly distributed into each block. Means were

compared using Fisher's multiple comparison procedure whenever the results of the ANOVA indicated significance (Dowdy & Wearden, 1983).

5.3- RESULTS

Table 5-4 shows the coefficients of digestibility and nutritive value of diets used in this experiment. Inspection of digestibility data reveal that there is no significant improvement in the digestion of dry and organic matter, crude fibers and their fraction of cellulose and hemicellulose. This is possibly due to the inclusion of poultry litter - whether treated or untreated - instead of sun flower meal in the diets given to lambs. It should be noticed also that improvement was most remarkable in crude fibers. Moreover, treatment of PL by acetic acid has led to significant improvement in digestibility of hemicellulose and cellulose over the HCl treated or untreated PL. On the other hand, digestibility of crude protein or nitrogen free extractives were not affected by the inclusion of treated or untreated PL or sun flower meal. The nutritive value of the litter diets expressed as TDN, SV or DCP were statistically significant different especially where the litter was treated by acetic acid.

Table 5-4 Average of digestibility coefficients and Nutritive value for the experimental diets used in the feeding trial

Digestibility Coefficient %	Basic diet	PL- HCl diet	PL - acetic diet	PL untreated diet
Dry Matter	71.71 b	75.50 a	78.59 a	79.12 a
Organic Matter	73.05 b	78.33 a	81.33 a	81.73 a
Crude Protein	71.97 a	72.34 a	73.86 a	72.98 a
Crude Fibre	48.63 a	64.56 b	72.03 b	70.61 b
Ether Extract	64.94 b	69.53 b	82.84 a	82.97 a
Nitrogen Free Extract	84.44 a	82.81 a	85.00 a	84.76 a
Ash	-	-	-	-
Hemicellulose	45.47 c	52.93 b	70.53 a	64.53 a
cellulose	32.87 c	50.37 b	59.71 a	48.6 b
Cell contents	84.52 a	86.4 a	88.04 a	88.77 a
Nutritive value:				
AS Fed				
TDN	68.91 c	71.72 a	72.31 b	72.31 b
SV	68.00 c	70.67 a	71.34 b	71.36 b
DCP	8.75 b	9.18 a	9.09 a	8.77 b
On Dry Matter basis				
TDN	77.61	80.51	80.62	80.33
SV	76.58	79.33	79.54	79.28
DCP	9.85	10.31	10.13	9.74

Means with different character within row are significantly ($P<0.05$) different

The daily feed intake, average of body weight, the rate of gain and feed conversion in the four groups during the experimental periods are shown in table 5-5. Statistical analysis showed that there were no significance differences among all groups in initial body weight and also there were no significance differences in daily feed intake.

The results are presented in table 5-5 show that the highest rate of gain and the highest feed conversion were achieved in the group fed on diet containing PL treated with acetic acid.

Table 5-5 Daily feed intake , Feeding value and average gain in liveweight over experimental period (117 days)

	Basic diet	PL treated with HCl diet	PL treated with Acetic diet	PL untreated diet
Feeding Value %				
TDN	77.61	80.51	80.62	80.33
SV	76.58	79.33	79.54	79.28
DCP	9.85	10.31	10.13	9.74
Daily Intake Kg				
Dry Matter	0.89	0.89	0.90	0.90
TDN	0.691	0.717	0.726	0.723
DCP	0.088	0.092	0.091	0.088
Gain Kg				
Average initial weight	43.5	43.4	43.3	45.5
Average final weight	57.2	59.0	64.5	62.0
Total gain in weight	13.7	15.6	21.2	16.5
Average daily gain (g)	117.1 c	133.3 b	181.2 a	141.0 b
Feed conversion	7.6	6.7	4.97	6.4

5.4- DISCUSSION

Using poultry litter in experimental diets, as shown in Table 5-4, resulted in increase the crude protein, crude fibre, hemicelluose and cellulose digestibilities. This may be due to the energy (TDN) contains in the diets containing poultry litter table 5-4. The inclusion of readily available source of carbohydrates in formulating poultry litter diets was assumed to improve its feeding quality. Bagley ***et al*** 1994 reported that, to make broiler litter more palatable in order to increase consumption, corn or other feeds are added.

Treating poultry litter with HCl or acetic acid are improved the bedding quality. This results are in agreement with those obtained by Castro ***et al*** 1993 who found that the dilute acid treatment can be improve potential lignocellulosic by-products. Furthermore, acetic acid treatment tend to be better than HCl treatment. This may be due to the acetic acid in addition to improve the quality of bedding material is played as a source of energy which provide a good source of energy and stimulate fermentation and digestion of the non protein nitrogen.

Daily feed intake, rate of gain and feed conversion are presented in table 5-5. The results indicate that the diets containing poultry litter treated with acetic acid is statistically higher than other three diets in rate of gain and feed conversion. This results may be due to this diet contained high quantity of digestible crude protein , in addition to the effect of acetic acid on the bedding material and as a source of energy.

CHAPTER 6

VOLUNTARY INTAKE AND DIGESTIBLITIY OF POULTRY LITTER-CITRUS PULP SILAGE FED TO GROWING LAMBS

6.1- INDRODUCTION

Poultry litter can be rendered free of pathogens by different methods of processing such as ensiling (Caswell, *et al* 1977). However, it can be ensiled in mixtures with other feed ingredients and ensiled to encourage acid production. Poultry waste is generally high in crude protein; 25% out of which more than 50% is non protein nitrogen (NPN) (Bhattacharya and Fontenot, 1966). In contrast, citrus pulp is generally high in energy where nitrogen free extracts furnish 70% or more of its chemical composition. Consequently, poultry litter can be ensiled with other by-products such as citrus pulp to produce a good quality silage of fair nitrogen and energy lenient (Hadjipanayiotou, 1993).

The purpose of this study was to determine the voluntary feed intake of poultry litter ensiled with citrus pulp and to assess its nutrient digestibility when fed to lambs.

6.2- MATERIALS AND METHODS

6.2.1- SILAGE PROCESSING

Poultry litter collected from commercial broiler houses was mixed with citrus pulp in a ratio of 20:80 as fresh matter, respectively. The mixture was

properly pressed into a trench and tightly covered by plastic sheet. The trench was opened five months later, and the silage was sampled for quality measurement and dry matter determination. Dry matter content was determined by placing the sample in a 60 °C oven. Water extracts of the silage were prepared by homogenizing 25 g wet material with 100 ml water in a blender for 2 minutes. The homogenate was filtered and used for measurement of silage quality and volatile fatty acids. Silage material was analysed for proximate chemical composition before and after ensiling.

6.2.2- ANIMALS

A total number of 7 male rahmani lambs with an average weight of 25 kg were used throughout the course of the study.

6.3- VOLUNTARY FEED INTAKE

The silage was allowed to air dry for one day before being offered to 7 lambs. The silage and a concentrate mixture (60% wheat bran, 25% maize,12% sun flower seed cake, 2.5% limestone and 0.5% salt) were used in feeding the lambs for period of 18 days to measure voluntary intake. The lambs were offered gradually increasing amount of silage and a decreasing amount of concentrate mixture. They were fed twice daily and always had free access to fresh water.

6.4- DIGESTIBILITY TRIAL

Four lambs were used to determine digestibility coefficients for ensiled poultry litter-citrus pulp. This trial was conducted on two stages; preliminary for 14 days and collection for 7 days. Daily feed consumption and faecal output were recorded in the 7 day collection period and samples of feed and faeces were taken for chemical analysis.

6.5- CHEMICAL ANALYSIS

Proximate chemical analysis of feeds and faeces were carried out according to official methods of analysis (A.O.A.C., 1990). Silage quality was measured by the methods described in Chapter 3.

6.6- RESULTS

Table 6-1 shows the chemical composition of citrus pulp, poultry litter and their mixture before ensiling. Data presented show that on dry matter basis citrus pulp was much higher in NFE (75%) than poultry litter (47%), Poultry litter was much higher in crude protein (25%) than citrus pulp (7%). The poultry litter-citrus pulp mixture (20:80) contained proper level of moisture for making silage.

Table 6-3 shows the chemical composition of poultry litter-citrus pulp mixture before and after ensiling, digestibility coefficients of nutrients, and

nutritive values for the silage produced. It appeared that differences in dry matter and organic matter percentages were miner, while values of CP,CF, EE, and ash tended to be higher in the silage produced than in the mixture. It seems that this was at the expense of NFE which was remarkably lower after ensilage.

The average digestibility coefficients and nutritive value of ensiled poultry litter-citrus pulp are also presented in table 6-3. Values of digestibility for DM, OM, CP, CF, EE were 52.2, 55.6, 48.2, 48.0, 52.7, respectively and as high as 73% for NFE. In addition, the nutritive value expressed as TDN or SV and DCP were; 55% or 54% and 9%, respectively .

Voluntary feed intake is presented in table 6-4 as amounts consumed from amounts offered of silage or concentrate mixture over a period of 18 days. Daily consumption exceeded 1 Kg silage/head which indicate no problem of palatability. These results are in agreement with those reported by Hadjipanayiotou 1993 for ensiled poultry litter-grapefruit on sheep.

Table 6-1 Chemical composition of citrus pulp, poultry litter and their mixture (80 % CP + 20 % PL) before ensiling

Chemical Composition	Citrus pulp (CP)	Poultry litter (PL)	Mixture before ensiling
Moisture	80.85	17.85	69.34
DM Basis			
Crude Protein	6.67	25.20	17.95
Crude Fiber	9.62	13.25	10.00
Ether Extract	3.88	0.97	2.45
Nitrogen Free Extract	74.89	47.28	56.87
Ash	4.94	13.30	12.73
Fiber Fraction:			
Cellulose	1.90	5.50	7.10
Hemicellulose	6.40	26.50	15.50
Lignin	9.10	19.40	10.50
Cell Contents	81.80	45.80	61.40
Minerals:			
P g/Kg	1.00	11.3	6.0
Ca g/Kg	40.0	6.6	11.4
Cu mg/Kg	3.0	4.0	4.0
Zn mg/Kg	48.0	34.0	27.0

Table 6-2 Silage quality for silage produced

pH	Lactic acid %	NH3-N (mg/100g)	VFA's (mg/100g)	*Acetic	Propionic	Butyric
4.8	0.74	510	38.16	52.18	18.34	9.25

As a percent from VFA's

Table 6-3 Chemical composition of citrus pulp and poultry litter mixture (80 %CP + 20 % PL)before and after ensiling and silage digestibility coefficient

%	Before ensiling	After ensiling	Digestibility coefficient
Dry matter	30.66	29.28	52.20
Organic matter	87.27	84.12	55.62
Crude protein	17.95	18.78	48.24
Crude fiber	10.00	11.49	48.05
Ether extract	2.45	2.77	52.74
Nitrogen free extract	56.87	51.08	73.26
Ash	12.73	15.88	-
Minerals			
P g/Kg	6.0	14.0	-
Ca g/Kg	11.4	46.0	-
Cu mg/Kg	4.0	6.0	-
Zn mg/Kg	27.0	46.0	-
Fiber Fraction			
Cellulose	7.10	15.3	42.00
Hemicellulose	15.50	9.30	27.80
Lignin	10.50	3.10	-
Cell contents	61.40	60.10	66.94
Nutritive Value	**TDN**	**SV**	**DCP**
as fed	16.19	15.98	2.65
on DM Basis	55.29	54.65	9.06

Table 6-4 Voluntary feed intakes (g/head/days)of citrus pulp and poultry litter ensiled mixed with farm diet*

Diets / Days	silage (gm) Offered	silage (gm) Consumed	farm diet * (gm) Offered	farm diet * (gm) Consumed	Consumed from mixture of silage and farm diet (gm)
1	286	211	407	382	593
2	286	267	407	387	650
3	428	403	357	347	750
4	570	553	314	304	857
5	570	555	314	302	857
6	857	452	315	305	757
7	857	468	315	305	793
8	857	453	315	304	757
9	857	390	315	303	693
10	857	453	315	304	757
11	857	581	315	305	886
12	857	737	315	304	1041
13	857	726	315	315	1041
14	1071	593	143	143	736
15	1071	686	143	143	829
16	1071	707	143	143	850
17	1071	1047	143	143	1190
18	1071	1057	143	143	1200

* Farm diet contain 60% wheat bran, 25% maize,12% sun flower seed cake, 2.5% limestone and 0.5% salt

6.7- DISCUSSION

6.7.1- CHEMICAL COMPOSITION

While crude protein is high in poultry litter (25.2%) and low in citrus pulp (6.7%), NFE is low in the former (47.3%) and high in the latter (74.9%). These values are generally in agreement with those reported by numerous investigators Sancliaz-Vizcaino, ***et al*** 1971 and Bhattacharya and Harb, 1973 for citrus pulp and Blair and Kinght, 1973 and Silva ***et al*** 1976 for poultry litter. Chemical composition of citrus pulp and poultry litter might indicate that they compliment each other when mixed and ensiled to produce a good diet for ruminants.

6.7.2- FERMINTATIVE CHANGES AND QUALITY MEASURES

The differences between the mixture of poultry litter-citrus pulp before and after ensiling as shown in Table 6-3 indicate that most of nutrient values tended to be higher in silage than before. However, the nitrogen free extract was remarkably lower after ensiling as most of the energy required by fermentation process is drown from soluble carbohydrate (Watson and Smith, 1965 and Watson and Nash, 1960). Therefore, differences in before and after ensiling percentages for CP, CF, EE and Ash are presumably relative rather

than actual values. In other words, the actual major change seems to have taken place in the NFE fractions. Similar findings were reported by El-Gaafary, 1981 in citrus pulp ensiled with rice hulls and orange waste silage by Nour *et al* 1987. The crude fiber and ash percentages followed similar trends.

The silage produced had a natural yellowish colour, a pleasant mild aroma and soft consistency. Such observations agree well with those reported for ensiled citrus pulp by Becker ***et al*** 1946 and Hadjipanayiotou, 1993. Ensiling quality measures as pH, lactic acid, ammonia, total and individual volatile fatty acids are comparable with values reported for ensiled citrus pulp by numerous investigators, Abdel-Razik 1979. However remarkably higher VFA's and lower lactic acid do not indicate desirable course of fermentation or high quality product. Palatability, however, seems not to be much affected.

6.7.3- DIGESTIBILITY COEFFICIENTS AND NUTRITIVE VALUE

Average values for DM, OM, CP, CF, EE and NFE were 52.20, 55.62 48.24, 48.05, 52.74 and 73.26, respectively. Results of nutritive value as TDN or SV and DCP were 55.29 or 54.65 and 9.06, respectively. Values obtained here for digestibility coefficients of poultry litter-citrus pulp silage are generally lower than those reported by Tag-Eldin ***et al*** 1982 and Yang and Choug 1986. In this work the digestibilities were lower than the others. This could be

attributed to relatively higher values for volatile fatty acids and lower value for lactic acid which might have negatively affected digestibility. However the nutritive value of this silage is almost 150% better than that for Egyptian clover or its good quality hay.

CHAPTER 7

REPLACEMENT OF PROTEIN SOURCES IN HIGH FIBRE DIETS WITH NON PROTEIN NITROGEN

7.1- INTRODUCTION

For the past two decades there has been a global search for alternative feed resources for sustainable animal productivity (Owen and Jayasuriya, 1989) . The importance of crop residues as feeds for ruminants , especially during the dry season , has been recognized by farmers who face a number of constraints on their appropriate improvement and utilization (Wanapat, 1990). The main nutritional constraints on rice straw as an animal feed are its slow rate of digestion and low nitrogen (N) content. Urea treatment increase N content as well as intake (Tuen *et al.*, 1991) and rate and extent of digestion (Ibrahim *et al.*, 1989). Feeding trials with sheep have shown that animals fed urea-treated and urea-supplemented rice straw ate more and grew faster than animals receiving untreated straw (Djajanegara and Doyle, 1989).

Formalin was successfully applied to limit the breakdown of water-soluble carbohydrates and protein (Wilkins *et al.*, 1974) during ensilage. An application rate of 3-5 g formaldehyde per 100 g crude protein (CP) for grass silage, was suggested to be safe for ruminants (Wilkinson *et al.*, 1976). Additives, and especially formaldehyde, or mixtures of acids and formaldehyde, decrease protein breakdown in the ensiling process as well as in

the rumen and therefore influence positively the productivity of animals (Orda, 1984; Skultety, 1985).

Feeding poultry wastes, particularly poultry litter, to fatten is well documented in the technical literature throughout the world and is widely practised (Murthy, ***et al*** 1996; Griffith, 1993 and Flachowsky, 1992). The fact that it can dramatically reduce the cost of finishing is the determining factor in choosing a feeding system. In many developing countries, when pastures are inadequate in both quantity and quality, it is economical to finish lambs on cheap complete rations. When these rations are high in energy and low in volume the lambs' intake is greatly increased and their finishing time is satisfactorly reduced. The aim of this study was to compare the effect of chemically treated poultry litter (formaldehyde) and untreated poultry litter and, barley straw (urea) as a sources of nitrogen instead of soyabean meal.

7.2- MATERIAL AND METHODES

Work reported in this chapter was carried out in Bangor, North Wales, UK. Because of some limitations in animal numbers, eight yearling Cambridge ewes with an average weight of 49Kg were randomly distributed into four groups to run digestibility trials on four experimental diets.

7.2.1- PREPARATION OF TREATMENTS

Urea treated barley straw (UBS) was prepared by chopping using cutting machine, spread on cement floor and sprayed by 3.5% urea solution. Urea was completely dissolved in water at rate of 3.5 Kg in 100 litter to be sprayed on 100 Kg barley straw. After thoroughly mixed, barley straw was stored tightly in a silage bag for a reaction period of 30 days.

Poultry litter was collected from a commercial broiler house where wheat straw was used as a bedding material. The litter was spread on cement floor and sprayed by 3% formaldehyde (40 %). After thoroughly mixing and dried for 3 days. Formalin treated poultry litter (FPL) was stored in bags.

7.2.2- EXPRIMENTAL DIETS

Chemical analysis of ingredients was observed in formulating the experimental diets in order to get their chemical composition as close as possible. Ingredients used in the formulation of experimental diets were barley straw; (BS), urea treated barley straw; (UBS), poultry litter; (PL), formalin treated poultry litter; (FPL), barley; (B), and soyabean meal; (SBM). Chemical composition for all ingredients are presented in Table 7-1. The four diets offered were made up of :

BS + B + SBM, Diet 1 (control)
only B + UBS, Diet 2
BS + B + PL, Diet 3
BS + B + FPL, Diet 4

In other words SBM of the control diet was replaced by urea treated barley straw, poultry litter or by formalin treated poultry litter in diets 2,3 or 4, respectively. Table 7-2 presents chemical composition of all diets.

7.2.3- DIGESTION TRIAL

Animals were transferred to individual metabolic cages to determine coefficients of digestibility and nutritive value in terms of total digestible nutrients for each diet. The trial consisted of a 10-day- preliminary period followed by 7 -day- collection period and they were repeated twice. Faeces were collected daily in nylon bags and were mixed thoroughly, weighed and 10% of each day collection was used for dry matter determination. Samples from each animal were taken over the whole collection period, pooled together, ground and kept in tightly closed containers for chemical analysis. Chemical analysis of feedstuffs and faeces were carried out by the methods described in chapter 3.

7.2.4- STATISTICAL ANALYSIS

Data was analysed by analysis of variance (ANOVA) for the effect of treatments was carried out by using complete randamized block design and repeated twice. The animals were distributed into blocks according to the weight and the treatments were randomly distributed into each block. Means were compared using Fisher's multiple comparison procedure whenever the results of the ANOVA indicated significance (Dowdy & Wearden, 1983).

7.3- RESULTS

The effect of treatment on the chemical composition of barley straw or poultry litter as treated by urea or formalin, respectively, are shown in table 7-1.

Urea treatment increased crude protein content of barley straw from 4.01% to 6.2 % or well above 50% improvement on DM basis. Also chemical composition of the straw fibers was affected by urea treatment as their are remarkable increases in NDF, ADF and Cellulose and slight decrease in hemicellulose with no appreciable effect on ADL.

Changes were also remarkable in Chemical composition of fiber NDF, ADF, hemicelluose and cellulose due to formalin treatment on poultry litter. Other chemical analysis showed little or no difference between untreated and formalin treated poultry litter.

Daily feed allowances expressed as DM given per head in the four groups and chemical composition of the four experimental diets are presented in Table 7-2.

Data shown on chemical composition indicate minute differences -if any- in the proximate analysis of all diets on dry matter basis. Fiber components, however, showed relatively wider variations among diets with highest values for NDF,ADF and cellulose in the urea treated barley straw diet. No differences were observed between poultry litter or formalin treated poultry litter diets.

Results obtained on nutrient digestibility coefficients and nutritive value for the experimental diets are exhibited in table 7-3.

No differences existed between digestibility coefficients of DM, OM, CP, NFE of the control and urea treated barley straw diets. However, digestion of crude fiber, cellulose and ether extract was significantly better in the control diet (SBM) while hemicellulose of the UBS diet was more digestible. On the other hand digestibility coefficients of all nutrients in poultry litter diet were not significantly different from those in the formalin treated poultry litter diet. Besides they were of lower value when compared to the control or the urea treated straw diets with one exception where digestibility value of CP was significantly -though slightly- better.

It is also indicated in Table 7-3 that nutritive values of the control and UBS diets were almost similar. But TDN or SV for any of them was higher than any of the poultry litter diets whether treated or not.

Taking these findings into consideration, it is worthwhile to note that animals on the four diets suffered from a liveweight loss which ranged from 2.5 Kg on the control diet to 3.7 Kg on the UBS diet. Losses on the poultry litter diet where intermediate.

Table 7-1 Chemical composition of the ingredients used in the experimental diets

Proximate Analysis:	Barley straw (BS)	Urea treated Barley straw (UBS)	Poultry litter (PL)	formalin treated Poultry litter (FPL)	Ground Barley (B)	Soyabean oil meal (SBM)
Dry Matter	90.00	48.3	88.4	90.63	86.6	89.85
Crude Protein	4.01	6.20	27.04	27.98	11.18	48.67
Crude Fibre	40.10	42.80	15.30	16.40	5.30	6.80
Ether Extract	1.98	1.84	2.1	2.2	1.7	3.70
Nitrogen Free Extract	48.10	43.94	40.71	38.88	75.21	32.59
Ash	5.81	5.22	14.85	14.54	6.61	8.24
Fiber Fractions:						
NDF	68.77	77.78	53.88	63.26	16.77	12.87
ADF	35.99	49.32	20.48	23.84	2.6	4.31
Hemicellulose	32.78	28.46	33.4	39.42	14.17	8.56
Cellulose	34.63	48.43	19.52	22.07	0.68	3.02
Lignin	1.06	0.89	1.69	1.77	1.91	1.29
Minerals:						
P g/kg	1.1	0.75	4.18	5.07	3.14	6.8
Ca g/kg	3.4	4.6	4.3	4.3	2.7	3.1
Cu mg/kg	1.4	1.6	6.1	6.6	1.4	2.2
Zn mg/kg	3.9	4.0	2.6	2.9	3.6	3.3
Mg mg/Kg	5.2	5.3	1.6	1.6	0.8	1.2

Table 7-2 Chemical composition for the experimental diet used in the feeding trial (DM basis)

	1 (control)	2	3	4
Ingredients :	**Consumed : gm / head**			
Barley Straw	**500**	**-**	**500**	**500**
Urea Treated Barley Straw	**-**	**500**	**-**	**-**
Barley	**270**	**300**	**222**	**233**
Soyabean Meal	**30**	**-**	**-**	**-**
Poultry Litter	**-**	**-**	**78**	**-**
Formalin Treated Poultry Litter	**-**	**-**	**-**	**67**
Proximate analysis:	**Chemical composition %**			
Dry Matter	88.85	62.66	88.90	89.06
Crude Protein	8.10	8.07	8.25	8.11
Crude Fibre	27.11	28.74	28.03	27.98
Ether Extract	1.95	1.79	1.91	1.92
Nitrogen Free Extract	56.67	55.67	54.90	55.22
Ash	6.17	5.74	6.91	6.77
Fiber Fractions:				
NDF	49.12	54.90	52.89	53.16
ADF	23.53	31.80	25.21	25.25
Hemicellulose	25.59	23.10	27.68	27.92
cellulose	21.99	30.52	23.74	23.69
Lignin	1.36	1.27	1.36	1.37
Minerals:				
P g/kg	2.00	1.65	1.97	2.03
Ca g/kg	3.15	3.89	3.29	3.27
Mg mg/kg	1.43	1.53	1.86	1.84
Cu mg/kg	3.78	3.85	3.69	3.73
Zn mg/kg	3.57	3.61	3.63	3.62

Table 7-3 Digestibility coefficient and Nutritive value for the experimental diets

Digestibility Coefficient %	Diet 1 Control	Diet 2 UBS	Diet 3 PL	Diet 4 FPL
Dry Matter	52.30 a	52.95 a	50.50 b	50.50 b
Organic Matter	56.30 a	56.80 a	55.00 b	54.90 b
Crude Protein	56.00 a	55.00 a	57.34 b	57.90 b
Crude Fibre	60.31 a	53.3 a	49.4 c	50.00 c
Ether Extract	59.50 a	57.95 b	52.90 c	53.60 c
Nitrogen Free Extract	71.90 a	72.10 b	68.60 b	69.70 b
Hemicellulose	64.79 b	68.14 a	43.52 d	47.42 c
cellulose	62.00 a	56.79 b	45.43 c	45.35 c
Nutritive value % DM basis				
loss of weight Kg	2.5	3.7	3.3	2.7
TDN	64.24	62.22	58.51	59.49
SV	55.96	53.49	49.97	50.96
DCP	4.5	4.4	4.7	4.7

Means with different character within row are significantly ($P<0.05$) different

7.4- DISCUSSION

Results obtained for chemical composition and digestibility of urea treated barley straw are generally comparable to those reported for rice straw by Ibrahim ***et al.***(1989) on sheep, and Tuen ***et al.*** (1991) and Mgheni ***et al.*** (1993) on goats.

The similarity of DM, OM, CP, and NFD digestibility in the control and UBS diets and their TDN, SV and DCP values indicate that source of dietary

nitrogen is possibly of minor importance at least when diets are given at maintenance level or nearly so.

In the meantime the improvement of crude fiber and cellulose digestibility of control diet over those of other diets might be attributed to the relatively slow degradability of SBM protein compared to that of urea in the UBS diet or the uric acid or other sources of NPN in the PL diets. It is well established that such nitrogen sources are rapidly degraded in the rumen into ammonia which is readily absorbed giving just a short period of time to be efficiently utilized by the cellulolytic bacteria of the rumen Djajanegara and Doyle (1989).

With the poultry litter diets it seems that the absence of significant differences between digestibility of nutrients clearly indicate that treatment of the PL by formalin did not affect the activities of rumen microflora and did not -in particular- affect utilization of different N sources of the litter. Yet, the only improvement in hemicellulose digestibility seems unexplainable within data of the present work. Significantly lower digestibility values for all nutrients - except CP- in the PL diets might be -at least in part of it- due to that the bedding material used in the houses where litter was collected from was wheat straw instead of barley straw.

CHAPTER 8

USE OF FAECAL ORGANISMS FROM SHEEP FOR THE *IN VITRO* DETERMINATION OF DIGESTIBILITY FOR THE DIETS CONTAINING POULTRY LITTER

8.1- INTRODUCTION

One of the most useful measures of the nutritional value of a feedstuff is its apparent dry matter digestibility. This can only be measured *in vivo* but, since the *in vivo* determination of digestibility is laborious and consumes large amounts of feedstuffs, several laboratory methods have been proposed for its estimation. These methods rely either on measuring cell wall fractions or on *in vitro* techniques that simulate the natural ruminant digestive processes. Many artificial rumen procedures have been proposed, the two-stage technique based on the use of rumen liquor followed by acid pepsin developed by Tilley *et al.* (1960) and Tilley & Terry (1963) being the one most extensively used. This method is reliable, accurate and precise for the prediction of *in vivo* digestibility of a wide range of forages. However, its application has the disadvantage that surgically modified animals are needed to provide the rumen liquor.

With increasing concern for animal welfare, there is a need for an alternative to the Tilley and Terry (1963) method, which requires rumen liquor from fistulated animals. El Shaer *et al.* (1987) described a method which uses ovine faeces micro-organisms inoculum instead of the rumen liquor. The method was developed on the principle that micro-organism species present in the rumen are also present in the hind gut and that a proportion of these micro-organisms are passed in the faeces (Van Soest, 1982). This technique is simple, cheap and needs no modified animals. The aim of this study was to test this technique for the prediction of the dry matter, crude protein and crude fibre digestibility of the diets containing poultry litter.

8.2- MATERIALS AND METHODES

Twenty eight samples of the diets where most of them were containing poultry litter either silage or not of known *in vivo* digestibility, obtained from the present studies in previous chapters were subjected to this study.

Triplicate samples, each of 180 mg of air dried ,ground to pass a 1 mm screen, were used in the analysis. These, together with additional samples used to determine the dry matter content, were weighed accurately into pre-weighed McCartney bottles which had previously been oven dried at 105°C for several days to constant weight.

A total of 60 g wet weight of sheep faeces were collected within 1 h of

voiding from sheep. The faeces mixed with 50 ml of artificial saliva (McDougal, 1948) which had previously been saturated with carbon dioxide. The mixture was filtered through a double layer of muslin which was then wrung out and rinsed again to recover as much liquid as possible before being made up to 1000 ml with artificial saliva . The pH was checked, and adjusted if necessary to pH 6.8. The filtrate was stirred and 18 ml were added to each McCartney bottle and also to five control bottles. The bottles were incubated at 38°C in incubator for 48 h , being also shaken manually three times daily during the incubation period. At the end of incubation period the bottles were centrifuged at 2000 g for 30 min. The supernatant liquid was poured off and 18 ml of a freshly prepared solution of 4 g/l pepsin in 0.1 N HCl were added. The bottles were then incubated for a further 48 h, being shaken after the first 10 min to resuspend the feedstuff residues. At the end of the pepsin digestion period the bottles were again centrifuged and the supernatant was poured off. The residues in the bottles were rinsed with distilled water and recentrifuged before being placed to dry in an oven at 105° C together with the samples reserved for the dry matter determination. After 48 h in the oven the bottles were cooled in a desiccator and weighed. To ensure that drying was complete the bottles were returned to the oven for a further 24 h and the weighing repeated. The proportion of dry weight lost by each sample was calculated taking into account the residual weight of faeces in the control bottles. The

mean proportional weight loss of the three replicates for each sample was recorded as the *in vitro* digestibility.

8.3- RESULTS

The result of applying this procedure to 28 samples of known *iv vivo* digestibility is illustrated in Fig.4 . The relationships between *in vivo* digestibility (y) and in vitro digestibility (x) were calculated separately for the dry matter (10 samples), crude protein (9 samples) and crude fibre (9 samples). They were :

$y = 8.2 (\pm 1.9) + 0.91 (\pm 0.029)x$ for dry matter

R. square was 99.2% and correlation coefficient was 0.99

$y = 13.6 (\pm 4.5) + 0.84 (\pm 0.069) x$ for crude protein

R. square was 95.5 % and correlation coefficient was 0.97

$y = 9.16 (\pm 4.28) + 0.91 (\pm 0.073) x$ for crude fibre

R. square was 95.7 % and correlation coefficient was 0.97

and were indistinguishable at the 5% level of probability. Data for these 28 samples were therefore pooled and the relationship between the digestibility estimates was found to be represented by the equation :

$y = 10.6 (\pm 1.9) + 0.88 (\pm 0.03) x$

R. square was 97.0 % and correlation coefficient was 0.98

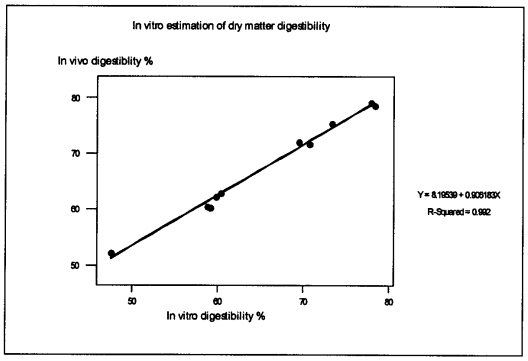


Figure 1

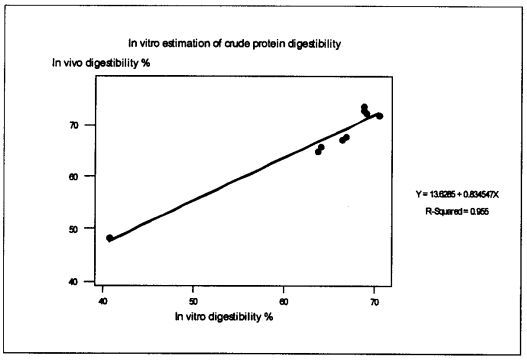


Figure 2

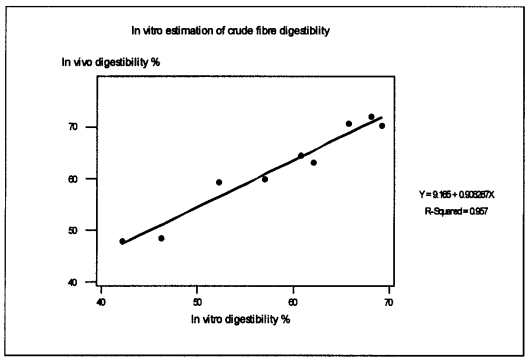


Figure 3

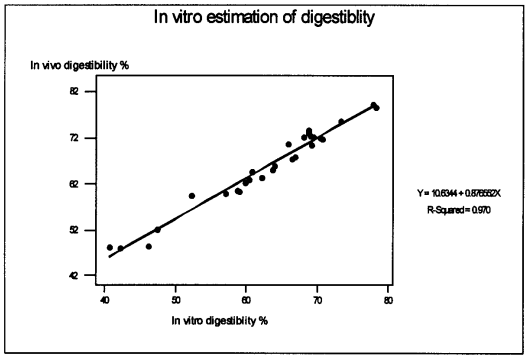


Figure 4

8.4- DISCUSSION

The fermentative organisms contained in the faeces samples were capable of degrading diets containing poultry litter. The *in vitro* digestibilities calculated for the diets were acceptably close to the apparent digestibilities *in vivo*. El Shaer *et al* (1987) found a high correlation between *in vitro* and *in vivo* digestibility. The relationship was represented by the equation $y = 1.003 (\pm 0.004) x$ with a correlation coefficient of 0.98 and a residual standard deviation of 1.54. When compared with enzymatic and the Tilly and Terry method (Omed *et al* 1989) it was concluded that suspension of micro-organisms derived from sheep faeces were as rumen liquor for digesting ruminant feedstuffs *in vitro*. Since sheep faeces are much more easily obtained than rumen liquor , the faeces liquor method would seem to have a distinct advantage may be of special value in countries where regular supplies of cellulase are unobtainable.

SUMMARY

This work was carried out through the channel system between Suez Canal University, Ismailia, Egypt and University of Wales, Bangor, North Wales, United Kingdom.

Some of the agro-industrial by-products are looked at as environmental pollutants. In the present work some of them, namely; poultry litter, citrus pulp and barley straw as a high fiber roughage were chosen to investigate how they can be utilized, safely and efficiently in ruminant feeding. This objective, therefore, was approached through application of some treatments to render such by-products secure and uncostly feeds when incorporated in ruminant rations.

Treatments and results obtained are summarized as follow.

Acid treatments of poultry litter

1-Chemical composition

In the commercial broiler house floor bedding of wheat straw was biweekly sprayed by HCl or acetic acid or not sprayed and left to serve as control. Acids were sprayed (3% of the bedding DM) for one, two, three or four times over the 8 wk production cycle.

Results obtained on the chemical composition of the poultry litter revealed that acid treatments significantly raised CP and lowered CF content of litter and these changes were more pronounced with acetic acid specially during summer.

However, NFE, EE or ash content of the litter were not significantly affected by any of the treatments.

2- Nutrient digestibility and growth performance of lambs

Poultry litter, treated with HCl , acetic or untreated replaced sun flower seed meal incorporated in a control diet at the level of 10%.

Digestibility of dry, organic matter, crude fibers and their fractions of cellulose and himicellulose in litter diets were improved significantly over the control one. Remarkably and significant improvement in crude fibers, cellulose and hemicellulose digestibility were attained in the acetic acid - treated – poultry litter – diet.

Crude protein and NFE digestibility were not affected by the replacement.

Nutritive value was consistently better in the litter diets whether the litter was treated or not.

Daily feed intake did not differ significantly on the four diets. Lambs on the acetic acid treated litter diet significantly out gained lambs on the other litter diet which also performed better than those on the control diet.

Ensiling poultry litter with citrus pulp

A mixture of poultry litter and citrus pulp in a ratio of 20:80, respectively, was ensiled in a trench for 5 months.

Voluntary feed intake of the silage as measured by lambs indicate no problem of palatability although the product was not of high quality.

Digestibility coefficients of all the silage nutrients were around 50% except NFE digestibility which was about 73%. However, nutritive value of the silage was 16.2 and 2.7 in terms of TDN and DCP, respectively, or almost 150% better than the Egyptian clover.

Use of different nitrogen sources in high fiber diets

Four experimental diets were formulated to have similar chemical composition. Average CP% was very close to 8% but was furnished from:

Barley straw + ground barley +soyabean meal (the control diet)

Urea treated barley straw + + ground barley (UBS diet)

Barley straw + ground barley + poultry litter (PL diet)

or Barley straw + ground barley + formalin treated poultry litter (FPL diet).

No differences existed between digestibility of nutrients or nutritive value of the control or UBS diet indicating that source of dietary protein was of minor importance particularly at levels around maintenance.

Crude fiber and cellulose digestibility were digested better in the control diet compared to any of the others; possibly due to the slowly degradable protein of SBM.

Formalin treatment did not affect nutrient digestibility. Poultry litter diets (treated or not) were generally lower in there nutrient digestibility – except crude protein. Perhaps, this could be attributed to the lower amount of ground barley – the major energy source- incorporated in the litter diets and the lower NFE percentage of poultry litter in the meantime.

Use of faecal organisms from sheep for the *in vitro* determination of digestibility for the diets containing poultry litter

Twenty eight samples of the diets, most of them were those containing poultry litter and of known *in vivo* digestibility, reported in previous chapters of this work were subjected to this study.

The objective of this part was to test validity of the faecal liquor method to determine *In vitro* digestibility of feeds or diets containing poultry litter. As described by EL-Shaer ***et al*** 1987, this method rely on the use of ovine faecal micro-organisms inoculum instead of rumen liquor.

The relationships between *in vivo* digestibility (y) and in vitro digestibility (x) were calculated separately for the dry matter (10 samples), crude protein (9 samples) and crude fibre (9 samples).

for dry matter :

$y = 8.2 (\pm 1.9) + 0.91 (\pm 0.029)x$ and correlation coefficient was 0.99

for crude protein :

$y = 13.6 (\pm 4.5) + 0.84 (\pm 0.069)\ x$ and correlation coefficient was 0.97

and for crude fibre:

$y = 9.16 (\pm 4.28) + 0.91 (\pm 0.073)\ x$ and correlation coefficient was 0.97

There were indistinguishable differences at the 5% level of probability. Data for these 28 samples therefore was pooled and the relationship between the digestibility estimates was found to be represented by the equation :

$y = 10.6 (\pm 1.9) + 0.88 (\pm 0.03) x$ and correlation coefficient was 0.98

The results correlated closely with the *in vivo* digestibilities.

REFERENCES

Abd El-Aziz G.M. , Rammah A.M. , Shalaby A.S. ,and Beshay M.G., (1989).Evaluation of Jar Made Silage from DifferentFodder Beet Varities either alone or with some Roughages.Third Egyption - British Conferance On Animal ,Fish and Poultryb Production. Faculty of Agriculture Alexandria University , Alexandria- Egypt. 7-10 October (1989).

Abd EL-Baki. S.M. ; Hrssonn. E. M. ; Shoukry, M. M. ; Bassiuny. S.M. and Hilorl.F. (1989): Chemical treatments of some poor quality roughages (6) minerals studies. 3rd Egyption British Conf. OnAnimal,Fish and poultry production , Fac. Of Agric. ,Alex. Univ.(1989). Vol (1) ; P. 217-257.

Abd-EL-Baki, S.M. Nowar, M.S. ,Hassona, E.M. and Soliman, E.S. (1986) .Rice hull with cassava and urea in complete ration for ruminants. Third International Conference on Rice, 22-25, September, Alexanddria.

Abdel-Raziek, S.S. (1979) . Utilization of some by - products in the feeding of ruminants. M.Sc .Thesis , Faculty of Agriculture, Alex . Univerity.

A.O.A.C. Association of Official Analysis Chemists. 1990. Official Methods of analysis. 13th Ed. Washington, D.C.

Bagely C. P. ,Burdine W.B. , Jr . , and Evans R.R .(1994) . Intake and performance of beef heifers feed broiler litter and soybean hull supplements. J. Anim .Sci 77 (Suppl. 1) : 381.

Baird ,D.M. , Allison ,J. R. and Heaton ,E .K. (1974) . The energy value for and influence of citrus pulp in finishing diets for swine .J. Anim. Sci., 38: 545-553.

Becker , R.B.; Davis ,G.K. ; Kirk, W.G. ; Arnold ,P.T. ; and Hyman, W.P. (1946) . Citrus pulp silage . Florida university, Agric. Expt . Sta. ,Bull. 423. (C.F. EL- Gaafary , N.M. 1981).

Belasco, I. J. 1954. New nitrogen feed compounds for ruminants - A laboratory evaluation. Journal of animal science 13:601.

Benghedalia.D.,Miron.J.,Yosef.E. 1996. Apparent digestibility of minerals by lactating cows from a total mixed ration supplemented with poultry litter. Journal of dairy science, Vol. 79, No.3, PP.454-458.

Bhattacharya, A.N. and Harb , M.(1973) . Dried citrus pulp as a grain replacement for Awasi Lambs .J.Anim. Sci. ,36:1175- 1180

Bhattacharya ,A.N. ,and Fontenot , J. P. (1966). Protein and energy value of peanut hull and wood shaving polutry litters .J. Anim . Sci., 25:367.

Blair,R. and Knight,D.W.(1973). Recycling Animal Wastes part 1 The problems of disposal and regulatory aspects of recycled manures. Feedstuffs (Minneap), 45(10):32.

Borba, A.E.S.; Ribeiro, J.M.C.R.(1996) A comparison of alternative sources of inocula in an in vitro digestibility technique. Annales de Zootechnie. 1996, 45: 1, 89-95; 12 ref.

Boucque, C. V. ; Fiems, L. O. ; Cottyn, B. G. 1994. Beet fed as such or ensiled with maize and fresh potatoes in diets for finishing bulls. Archives of Animal Nutrition. 1994, 46: 1, 93-101.Belgium.

Brabander, D. 1993. Quality of herbage products and of pressed pulps. Betteravier-Bruxelles. 1993, 27: 282, 10-11. Belgium.

Brzoska, F.; Wiewiora, W.; Brzoska, B. 1992. The effect of feed phosphate particle size on phosphorus utilization and mineral balance in sheep. Roczniki Naukowe Zootechniki. 1992, 19: 1, 125-134; 20 ref. Poland.

Bulatov, A. P.; Kakhikalo, V. G. 1994. Rearing Holstein crossbred heifers on single-type diets. Zootekhniya. 1994, 33: 4, 20. Kurgan, Russia.

Castro -F.B. , .Hotten - P.M. ,Orskov E.R . , (1993) The potential of dilute -acid hydrolysis as a treatment for improving the nutritional quality of industrial lignocellulosic by -products. Animal Feed Science- and- Technology ,1993, 42: 1-2, 39-53;25 ref.

Caswell L.F. , Fontenot J.P. and Webb K.E. (1975). Effect of processing method on pasteurization and nitrogen components of broiler litter and nitrogen utilization by sheep. J. Anim. Sci. 40:750.

Caswell L.F. , Webb K.E. and Fontenot J.P. (1977). Fermentation, nitrogen utilization, palatability of broiler litter ensiled with high moisture corn grain. J. Anim. Sci. (C.F. Caswell ***et al*** 1978)

Caswell L.F. , Fontenot J.P. and Webb K.E. (1978) Fermentation and utilization of broiler litter ensiled at different mosture levels . Journal of Animal Science, Vol. 46, No.2

Central Agency For Public Mobilisation and Statistics. 1995. Statistical year book. Arab Republic of Egypt. June 1995.

Ceron-Madrigal,J.J.;Hernandez-Ruiperez,F.;Bernal-Gambin, L.J.(1995).Contributions to the study of carnation (Dianthus caryophyllus) byproduct in animal feeding.Avances-en-Alimentacion-y-Mejora-Animal. 1995, 35: 1, 11-14; 15 ref. Murcia, Spain.

Chaudhry, S. M.; Naseer Z. ; and Chaudhry, D. M. 1993. Fermentation characteristics and nutritive value of broiler litter ensiled with corn forage.Food Chemistry. 1993, 48: 1, 51-55; 32 ref.

Compos, A.F. et Silva ,J.F. CDA (1978) Detrminanccao de valor nutritivo da raspa de mandiocaeda crueira, para ruminantes . Seiva (Brasil), 36:6

Demarquilly ,C. (1973). Digestiblity, nutritive value and intake of beet with various dry matter content .Herb. Abst. , 45:4604.

Devasena, B.; Krishna, N.; Prasad, J.R.; Reddy, D.V. (1993). Chemical composition and nutritive value of Brasilian napier grass. Indian Journal of Animal Sciences. 1993, 63: 7, 776-777; 5 ref.

Djajanegara, A. and Doyle, P. T., 1989. Urea as supplementation compared with pre-treatment. 1. Effect on intake, digestion and liveweight change by sheep fed a rice straw. Anim. Feed Sci. Technol., 27:17-30.

Doberschutz, K. D.; Lusky, K.; Stoyke, M.; Lippert, A. 1993. Occurrence of cadmium, lead and mercury in forage plants and animal organs from areas with different contamination.

Doctorian, D.S.,and Evers,G.W. (1996). Utilizing broiler litter as a protein and mineral supplement for beef cows. Rton / Forage - livestock.1996/litutil.

Dowdy, S. and Wearden, S., 1983. Statistics for Research. Wiley Inter Science.

EL -Gaafary ,M.N.(1981) The possibility of making silage from citrus pulp and rice hulls . M.Sc. Thesis , Faculty of Agric., Zagazig University.

EL-Sabban ,F.F., Bratzler, J.W., Long, T.A., Frear, D.E.H. and Gentry, R.F. 1970. Value of processed poultry waste as a feed for ruminants. Anim. Sci., 31:107.

EL-Sabban,F.F.,Bratzler,J.W.,Long,T.A.,Frear,D.E.H. and Gentry,R.F.(1970). Value of processed poultry waste as a feed for ruminants. Anim. Sci.,31:107.

EL-Saify, M. M., Soliman, S. M., Shehata, M. N.and Borhami, B. E. 1983. An economic view of agricultural by-products as animal feed in Egypt . Proceeding of workshop on applied research. 14 - 17 March Alex., Egypt

EL- Shaer H. M. , Omed H.M. , Chamberlain A.G. and Oxford R.F.E. ,(1987) . Faecal organisms from sheep for the *in vitro* determination of digestibility. J. agric . Sci., Camb.(1987),109, 257-259.

EL-Shazley ,k.m.(1983) . Opening address. 2nd workshop on utilization of low quality roughages with special reference to developing countries . 14-17 March. Alexandria, Egypt.

Fegeros K. ;Zervas G. ;Apsokardos F. ; Vastardis J. ; Apostolaki E. (1995) Nutritive evaluation of ammonia treated olive tree leaves for lactating sheep. Small -Ruminant- Research. 1995, 17:1, 9-15;35ref

Fiems, L. O.; Cottyn, B. G.; Vanacker, J. M.; Boucque, C. V.; Brabander, D. L.; Production and utilization of mixed fodder beet silages in alpine regions. 2. Utilization of mixed fodder beet silages for feeding dairy cows. Wirtschaftseigene Futter. 1992, 38: 3, 155-178; 25 ref.Irdning, Austria.

Fisher, G.E.J.; Sabri, M.S.; Roberts, D.J.1994. Effects of feeding fodder beet and concentrates with different protein contents on dairy cows offered silage ad libitum. Grass and Forage Science, 49: 1, 34-41.

Flachowsky, G. and Hennig, A. 1990. Composition and digestibility of untreated and chemically treated animal excreta for ruminants. A review. Biol. Wastes, 31:17-36.

Flachowsky,G 1992 Feeding poultry litter to cattle and sheep.Cattle-Research-Network-Newsletter. 1992, No. 6, 6-9; 5 ref.

Fontenot, J.P. (1978) . Poultry litter as a feed ingredient for cattle and sheep VPI and SU Spec. Rep

Gabra, M. A. 1984. Studies on the productivity and feeding qualities of some annual and perennial forages as affected by some agronomic practices fed to sheep in metabolism trials including nutritional balances. Ph.D. thesis, faculty of agriculture, Cairo university

Gabra, M.A. ; El -Kholy , N.M. ; Sherif, s.y. andSoliman ,I.M. (1987) . Chemical composition and feeding value of fooder beet (Beta VulgarisL.). Proc. 1st Conf. Agric . Develop. Res., Vol. 1,92-100.

Galal,E. S. E.; EL-Aich, A.; Landau, s.; Bourbouze, a.;Rubino, R. And Morand,F. P. 1995. Goat production system in Egypt. Goat production system in Mediterranean, 161-165; EAAP.

Gomez, V.; Vidal, J.A. 1992. Grazing of maize, sunflower, sudan/sorghum hybrid pasture and fodder beet by goats in irrigated regions of Albacete. Actas de las XVI Jornadas Cientificas, Sociedad Espanola de Ovinotecnia y Caprinotecnia, Pamplona, Spain, September 1991. 1992, 240-241.

Griffith,D.L.V. 1993. A trial to investigate the use of ensiled broiler chicken litter manure in diets for fattening lambs. Proceedings: Eleventh Annual Conference, Barbados Society of Technologists in Agriculture, Caribbean Development Bank Barbados, December 4, 1994. 1993, 58-71.

Groot Koerkamp, P.W.G., 1990. Naar stallen met beperkte ammoniakuitstoot : deelrapport pluimvee. Onderzoek inzake de mest-en ammoniakproblematiek in de veehouderij 8D. DLO, Wagningen. (cited from Monteny, 1994).

Gruber, L. 1992. Utilization of fodder beet by dairy cows. Veroffentlichungen Bundesanstalt fur Alpenlandische Landwirstschaft Gumpenstein. 1992, No. 16, 13-42; 48 ref. Irdning, Austria.

Gruber, L. 1993. Utilization of fodder beet by dairy cows. Bericht Bundesanstalt fur Alpenlandische Landwirtschaft. 1993, No. 20, 21-49; 48 ref. Irding, Austria.Gruber, L.; Steinwender, R.; Hausler, J.; Krautzer, B.1992.

Hadjipanayiotou, M. 1993 Voluntary intake of citrus pulp-poultry litter silage by growing female Friesian calves, Chios lambs and Damascus kids.Technical Bulletin Cyprus Agricultural Research Institute. 1993, No. 155, 6 pp.; 9 ref.

Hall ,N.T., Nagy, S. and Barry , R.E. (1975). Leaves for food : Protein and amino acid contents of leaves from 23 tropical and sub- tropical plants .Proc.Florida state Hort.Soc.,88:486

Hays ,S.M. (1994). Acleanup of poultry litter ,Highlightis of Alabama Agric Res. 42(5): 10.

Ibrahim, M.N.M., Tamminga, S. and Zemmelink, G., 1989. Effect of urea treatment on rumen degradation characteristics of rice straws. Anim. Feed Sci. Technol., 24:83-95.

Janetschek, H. 1993. Economic aspects of fodder beet as roughage in dairy farming. Bericht Bundesanstalt fur Alpenlandische Landwirtschaft. 1993, No. 20, 51-59; 14 ref. Vienna, Austria.

Jans, F. 1991. Milk production potential of roughage.
Bericht Bundesanstalt fur Alpenlandische Landwirtschaft. 1991, 18: 31-37; 4 ref. Switzerland.

Kang, S. W.,Lee, W.S.; Jin, S. H. ;Oh,W.Y.;Kang, T.H. 1994. Effect of level of inclusion of citrus pulp on pelleting conditions. Journal of Agricultural science livestock. 36:1 , 512-516 ;10 ref.

Kariuki, J.N.; Wanyoike, M.M.; Abate, A. (1993) Dry matter degradability of Napier grass (Pennisetum purpureum) in the rumen. Bulletin of Animal Health and Production in Africa. 1993, 41: 3, 239-244; 20 ref.

Kewalramani, N.; Lall, D.;Pathak, N. N.1993. Biodelignification and changes in in vitro digestibility of sugarcane bagasse treated with white rot fungi. Journal of Applied Animal Research. 1993, 4: 2, 133-140; 11 ref.

Kongressband 1993 Hamburg. Vortrage zum Generalthema des 105. VDLUFA-Kongresses vom 20.-25.9.1993 in Hamburg: Qualitat und Hygiene von Lebensmitteln in Produktion und Verarbeitung. 1993, 393-396.

Kraszewski, J.; Wawrzynczak, S.; Blaziak, S.; Mandecki, A. 1992. Usefulness of salt licks containing avoparcin in feeding high yielding dairy cows. Roczniki Naukowe Zootechniki, Monografie i Rozprawy. 1992, No. 31, 23-30; 13 ref.Poland.

Lehmann, E.; Jans, F.; Charriere, J. D. 1993. Whey may also be used for rearing and fattening cattle. Revue Suisse d'Agriculture. 1993, 25: 4, 205-208; 4 ref.

McClure, W.H. and Fontenot ,J.P.(1983). Broiler litter deep stacked or ensiled with corn forage for finishing heifers . Anim. Sci., 51(Supplement1): 132.

McDougal, E. I. 1948. Studies on ruminant saliva. 1. The compostion and output of sheep's saliva. Biochemical Journal 43, 99-100.

Mgheni, D. M.; Kimambo, A. E.; Sundstol, F. and Madsen, J. 1993. Influence of urea treatment or supplementation on degradation, intake and growth performance of goats fed rice straw diets. Animal feed science and technology, 44:209-220.

Mohamed, A., H., 1993. Improvement of ruminants feeding on agriculture by products. Ph.D. Thesis, Department of Animal Production, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.

Monteny, G.J. 1994. Reduction of ammonia emission from dutch agriculture: Technical solutions. Pollution in livestock production system. (Text book) Edited by I. AP Dewi; R.F.E. Axford; I. Fayez M. Marai and H. M. Omed. CAB international.

Muller,H. L.; Birkenmaier, F.; Schwarz, F. J.; Kirchgessner, M. 1994. Energy utilization of fodder beets in lactating dairy cows. Journal of Animal Physiology and Animal Nutrition. 71: 4-5, 234-246; 34 ref.

Murthy, K.S.; Reddy, M.R.; Reddy, G.V.N., 1996. Nutritive value of supplements containing poultry droppings/litter for sheep and goats. Small Ruminant Research. 1996, 21: 2, 71-75; 17 ref.

Murthy,K.S.,Reddy.M.R.,Reddy.G.V.N. 1996. Nutritive value of supplements containing poultry droppings/litter for sheep and goats. Small ruminant research,Vol.21,No.2,PP.71-75.

Muwalla, M.M.; Abo-Shehada, M.N.; Tawfeek, F.; Abuirmeileh, N.M.; Hill, R. 1995.Use of dried poultry litter in the diet of pregnant and lactating Awassi ewes. Tropical Animal Health and Production. 1995, 27: 2, 106-112; 15 ref.

Nour ,A.M. ; Tag Eldin ,A.E. and EL-Shazly, K.(1987) . Evaluation of silage from some Agro-industrilal by - products in vitro . Alex .J. Agric. Res., 32(3): 49-61.

Oke, O.l. (1973).Leaf protein research in Nigeria. A review. Trop. Sci. ,15:139.

Omed, H. M., Axford, R. F. E., Chamberlain, A.G.and Givens, D. I. 1989. A comparisn of three laboratory techniques for the estimation of the digestibility of feedstuffs for ruminants. Journal of Agricultural science, Cambridge 113, 35-39.

Orda, J., 1984. Wplyw podsuszania oraz dodatku kwasu z formalina przy kiszeniu traw I lucerny na ich wartosc pokarmowa. Wroclaw , 26: 89-109.

Osman, A. A., 1991 Studies on the nutritional value of some feedstuffs produced within Ismailia province. M.Sc. Thesis, Department of Animal Production, Faculty of Agriculture, Suez Canal University, Ismailia, Egypt.

Owen, E. and Jayasuriya, M.C.N., 1989. Use of crop residues as animal feeds in developing countries. Res. Dev. Agri., 6(3): 129-138.

Parigi, Bini, R; Xiccato, G; Carazzolo, A; Guzzinati, R; Pafou, G.G.1995. Composition and ruminal degradability of tropical feedstuffs for ruminants. Second experimental contribution.
Composizione e degradabilita ruminale di alimenti zootecnici di provenienza tropicale (Senegal). Secondo contributo sperimentale.
Zootecnica e Nutrizione Animale. Italy 1995, 21: 4, 187-199; 21 ref.

Phipps, R.H.; Sutton, J. D.; Jones,B. A. 1995. Forage mixtures for dairy cows: the effect on dry-matter intake and milk production of incorporating either fermented or urea treated whole crop wheat, brewers' grains, fodder beet or maize silage into diets based on grass silage. Animal Science. 1995, 61: 3, 491-496; 22 ref.

Pugh,D.G., Rankins,D.L., Powe,T., Dandrea,G. 1994. Feeding broiler litter to beef cattle. Veterinary medicine, vol.89, No.7, PP. 661-664.

Ragab, M. T. ; Abdel - Aziz, A. S. . 1961 The effect of some environmental factors on body weight and relative growth rate in friesin calves of Tahreer province. Journal of animal production of the United Arab Repuplic , Vol. 1, No. 2 , 107 - 119.

Rahmadi, D.; Soenarso; Noviatno, D. S.; Erlin, C. I.; Djajanegara, A.; Sukmawati, A. 1994. The utilization of solid byproduct of sugarcane industry (blotong) as feed for ruminant animal. Sustainable animal production and the environment. Proceedings of the 7th AAAP Animal Science Congress, Bali, Indonesia, 11-16 July, 1994. Volume 2: contributed papers. 1994, 467-468; 4 ref.

Rammah,A.M., Ali, F.M. and Hassan , M.T.C. (1984). Evaluation of fodder deet cultivars for different location and years .
EMCIP publication ,1:215. (Cited from Shalaby et al. 1989)

Ranjhan, S. K. and Chadhokar, P. A. 1984 Effective utilization of agro-industrial by-products for animal feeding in Sri Lanka. World Animal Review. April - June 1984, pp 45-51.

Rao,S.B.N.; Krishna,N.; Prasad,J.R.; Raghavan,G.V. (1995)
Evaluation of nutritional quality of some fibrous resources by in vitro and nylon bag techniques in goats.
Indian-Journal-of-Animal-Nutrition. 1995, 12: 2, 85-90; 14 ref.

Remond, B.; Rouel, J.; Ollier, A. 1991. Effect of glycerol supplementation of the diet of dairy cows on milk production and some digestive and metabolic parameters. Annales de Zootechnie. 1991, 40: 2, 59-66; 14 ref. France.

Rousselot, M. C.1994. Improving milk composition with concentrates. Chevre. 1994, No. 203, 22-24.French

Rude.B.J.,Rankins,D.L.,Dozier,W.A. 1994. Nitrogen and energy metabolism and serum constituents in lambs given broiler poultry litter processed by 3 deep stacking methods. Animal production,Vol.58,No.Pt1,PP.95-101.

Ruffin,B.G. and McCaskey,T.A.(1996). Feeding broiler litter to beef cattle. Alabama Cooperative Extension Service. Circular ANR 557.

Salem,O.A., M. A. Hanafy, I. Abd EL-Moty, Amal EL-Mola and G. M. Rakha.1989. Effect of using agro-industrial by-products on sheep performance. O.A.I. Third Egyptian British Conference on Animal, Fish and Poultry Production, 7-10 October. Alex. Egypt.

Salewski,A. 1991. Fodder beet for dairy cows. Milch Praxis. 1991, 29: 1, 63-64; 7 ref.Bingen, Germany.

Sanchez-Vizcaino, Hemandez, E; Smilg, R. C. (1971). Vegetable by-products of canning industry in animal nutrition. Revistra de Nut. Anim. 9:197. (C.F. Nut. Abs. Rev., 1972, 42:9468).

Sanda,I.A.; Methu,J.N.; Hahn, S.K.; Reynolds, L.; Egbunike, G.N. (1992). Evaluation of cassava as energy source in dairy cow concentrate feeds in Kenya. Cassava as livestock feed in Africa: proceedings of the IITA-ILCA-University of Ibadan workshop on the potential utilization of cassava as livestock feed in Africa, 14-18 November 1988, Ibadan, Nigeria. 1992, 127-134; 13 ref.

Schaibly ,G.E. and Wing, J.M. (1971) . Digestibility and rumen fermentation of corn silage and citrus pulp. J.Dairy Sci., 54:773,Abstr.

Schwarz, F. J.; Kirchgessner, M. 1990. Feeding of fodder beet silages to fattening bulls. Bayerisches Landwirtschaftliches Jahrbuch. 1990, 67: 7, 751-760; 19 ref. Germany.

Shabana, A. 1984. Proposals for animal production development policies in Egypt. First Egyptian British conference on animal and poultry production, Sep. 11-13, Zagazig, Egypt.

Shalaby, A. S., A. K. Abou-Raya, Y. I. EL-Talty, and M. A. Gabra 1984. Effect of stand density and growth stage on the yield and nutritive qualities of Napier grass *Penniestim purpureum*. First Egyptian British conference on animal and poultry production, Sep. 11-13, Zagazig, Egypt.

Shalaby, A. S., A. K. Abou-Raya, Y. I. EL-Talty, and M. A. Gabra 1984. Studies on the productivity and feeding qualities of Egyptian clover as affected by some agronomic practices fed to sheep in metabolism trials. First Egyptian British conference on animal and poultry production, Sep. 11-13, Zagazig, Egypt.

Shalaby ,A.S. ;Abdul-Aziz, G.M. , Rammah, A.M. ;and Beshay, M.G. (1986). Fooder beet ,a new forage in Egypt 1- Productivity and the chmeical analysis of some fooder beet (*Beta Vulgaris l.)* **Cultivarsd Sown** at different location in Egypt . The third Egyption British Conference on Animals ,Fish and poultry production, Alexandria ,7-10October, 1989.

Shalaby ,A.S. , Abdul -Aziz ,G.M. ; Rammah A.M. and Beshay ,(1989). Fooder beet, a new forage in Egypt 2- Nutritional evaluation of Fresh fooder beet (*Betaaaa vulgaris L.)* and its silages ,with or without roughages ,The thrid Egyption -British conference on Animals, Fish and poultry production ,Alexandria,7-10 October ,1989.

Sharma,S.;Sehgal,H.S.; Simmi,Sharma (1993) A note on evaluation of some wastes and by-products from agriculture and animal husbandry as feed ingredients for Cirrhina mirigala (Ham.). Fisheries Research Complex, Department of Zoology, Punjab Agricultural University, Ludhiana 141 004, India. Biorescource Technology. 1993, 44: 1, 9-11; 10 ref.

Silva ,L.A. ; Van Horn, H.H.; Olaloku, E.A. ;Wilcox, C.J. and Harris B.(1976) Complete rations for dairy cattle VII.Dried poultry waste for lactating cows .Dairy Sci.,59(12):2071.

Skultety, M., 1985. Vpiyv konservacnych pripravkov na base formalehydu na akost a vyzivni hodmotu lucerny siatej. Agrochemia, 25 (11) : 345-347.

Smith, L. W.; Wheeler, W. E. (1979). Nutritional and economic value of animal excreta. J. Anim. Sci., 48: 144-156.

Smith,O.B.; Hahn,S.K.; Reynolds, L. ; Egbunike, G.N.(1992) A review of ruminant responses to cassava-based diets. Cassava as livestock feed in Africa: proceedings of the IITA-ILCA-University of Ibadan workshop on the potential utilization of cassava as livestock feed in Africa, 14-18 November 1988, Ibadan, Nigeria. 1992, 39-53; 48 ref.

Snyman, L. D., 1993. Effect of exposure on the chemical composition and in vitro dry matter digestibility of untreated and formalin treated green chop. Animal feed science and technology, 44:275-280.

Steinwender, R. 1991. Fodder beet and mixed sugar beet top silage an energy rich roughage for dairy cows. Energieversorgung uber das wirtschaftseigene Grundfutter. 18. Tierzuchttagung, Gumpenstein, Austria, 15. Mai 1991. 1991, 17-24; 21 ref. Irdning, Austria.

Strickler, R. H. (1977). Deep stacking broiler as a means of storage for use in feeding beef cows. In alternate nitrogen sources for ruminants. P. 56-57. Conf. 9-11 November 1977, Atlanta, Georgia.

Tag Eldin ,A.S., Nour,A.M.; El Shazly,K.; Aboza,M.A. ;Borhami ,B.E. and Naga, M.A. (1982). Orange - peel and pea pods silage as a feed for lactating cattle and buffaloes .Alex .,J.Agric., Res., 30(1) :71-83.

Tilley, J. M. A., Deriaz, R. E. and Terry, R. A. 1960. The in vitro measurement of herbage digestibility and assessment of nutritive value. Proceedings of the 8th International grassland congress, Reading, Berks, PP.533-537. British Grassland Society.

Tilley,J. M.A.and Terry,R.A. 1963. A two stage technique for the in vitro digestion of forage crops. Journal of the British Grassland society 18, 104-111.

Tudor, G.D. and Norton ,B.W. (1982). The nutritive value of cassava for cattle .Proc. Aust. Soc. Anim. Prod., 14:599.

Tuen, A. A., Dahan, M. M., Young, B. A. and Vijchulata, P., 1991. Intake and digestion of urea-treated, urea-supplemented and untreated rice straw by goats. Anim. Feed Sci. Technol., 32: 333-340.

Umunna, N.N.; Magaji, I.Y.; Adu, I.F.; Njoku, P.C.; Balogun, T.F.; Alawa, J.P.; Iji,P.A. (1994) Utilization of palm kernel meal by sheep. Journal of Applied Animal Research. 1994, 5: 1, 1-11; 20 ref.

Van Soest, P. J. 1967. Development of a comperhensive system of feed analysis and its application to forages. J. Anim. Sci. 26: 119-128.

Van Soest, P. J. 1982. Nutritional Ecology of the Ruminant. Oregon: O & B Books.

Van Soest,P. J. and Wine, R.H.1967. Use of detergents in the analysis of fibrous feeds. J. O. A. C. 50: 50-55.

Vlaemynck, G.; De-Brabander,D.L.1992.Preservation, chemical composition and digestibility of mixed silages with maize and beet. Revue de l'Agriculture. 1992, 45: 5, 899-908; 21 ref.Belgium

Wanapat, M., 1990. Nutritional aspects of ruminant production in south east Asia with special reference to Thailand. Funny Press, Bangkok, pp. 25-40.

Watson ,S.J. (1960) .The conservation of grass and forage crops .2nd Ed_.pub . Oliver and Boyed .(C.F.EL- Gaafary 1981) .

Waston, S.J. and Smith, A.M. (1956).Silage . 2nd Ed. Crosby look wood and son Ltd., London . (C.F. EL-Gaafary 1981).

Wilkins, R. J., Wilson, R.F. and Cook, J.E., 1974. Restriction of fermentation during ensilage: the nutritive value of silages made with the addition of formaldehyde. Proc. 12th International Grassland Congress, Moscow, 1974, pp. 675-690.

Wilkinson, J. M. 1988. The feed value of by-products and wastes. In Feed Science: World Animal Science, pp. 313-327. Amsterdam: Elsevier Science Publishers.

Wilkinson, J.M., Wilson, R.F. and Barry, T.N., 1976. Factors affecting the nutritive value of silage. Outlook Agric., 9: 3-8.

Wojtasik, J.; Soroka, T.; Matras, J.; Wojcik, S. 1994. Fodder beet and sweet lupin seeds as feeds for dairy cows. Annales Universitatis Mariae Curie Sklodowska. Sectio EE Zootechnica. 1994, 12: 211-215; 5 ref.Lublin, Poland.

Yang, S. j. and Choung ,c.c. (1986). Studies on the utilization of citrus by-products as livestock feeds .5. Digestibility of citrus by - products silages fed to sheep, and total VFA concentration and pH change in rumen Liqour. Korean,J. Anim. Sci., 28(2) :81-85.

Yokota, H; Ohshima, M.; Okajima,T.; Djajanegara, A.; Sukmawati, A. (1994) Sustainable animal production and the environment. Proceedings of the 7th AAAP Animal Science Congress, Bali, Indonesia, 11-16 July, 1994. Volume 3: poster papers. 1994, 205-206; 3 ref.

Zitnan, R. 1993. Level of rumen fermentation in fattening cattle during replacement of concentrates with fodder beet. Journal of Farm Animal Science. 1993, 26: 131-134; 8 ref. Kosice, Slovakia.

دراسات على استخدام المخلفات الزراعية و الصناعية في تغذية الحيوان

رسالة مقدمة من

احمد احمد عثمان محمد

بكالوريوس في الإنتاج الحيواني جامعة قناة السويس1983

ماجستير في الإنتاج الحيواني (تغذية حيوان) جامعة قناة السويس 1992

للحصول على

درجة دكتوراه الفلسفة في العلوم الزراعية

إنتاج حيواني

(تغذية حيوان)

لجنة الإشراف

ا.د / فهمي زكى سويدان

أستاذ تغذية الحيوان –قسم الإنتاج الحيواني

كلية الزراعة – جامعة قناة السويس

الإسماعيلية – مصر

Dr. Ioan Ap Dewi
School of Agricultural and Forest Science
University of Wales
Wales, United Kingdom

Dr. H. Omed
School of Agricultural and Forest Science
University of Wales
Wales, United Kingdom

قسم الإنتاج الحيواني – كلية الزراعة

جامعة قناة السويس

1998

الملخص العربى

تمت هذة الدراسة من خلال نظام الاشراف المشترك بين جامعة قناة السويس- الاسماعيلية - مصر و University of Wales , Bangor, North Wales, United Kingdom

و الهدف من هذة الدراسة كان استخدام المخلفات الزراعية و الصناعية فى تغذيـــة الاغنـام بهدف خفض تكاليف التغذية. وتلخصت النتائج فى الاتى:-

1- معاملة فرشة الدواجن بحامض HCl او حامض الخليك

تمت هذة المعاملة فى عنبر دجاج التسمين اثناء وجود الكتاكيت و كانت نسبة الحـامض 3 % على اساس المادة الجافة للفرشة. و كان الهدف من هذة المعاملة هو رفع القيمة الغذائية لفرشة الدواجن فحامض HCl بالاضافة الى تاثيرة على رفع القيمة الهضمية للالياف الا انـة ايضـا يؤثر على تثبيت الامونيا فى الفرشة و كذلك حامض الخليك بالاضافة الى تاثيرة على تثبيـت النتروجين الا انة ايضا مصدر من مصادر الطاقة .

التحليل الاحصائى اوضح ان الفرشة المعاملة بحامض الخليك كانت اعلى من الفرشة المعاملة بحامض HCl بفروق معنوية فى معظم المكونات الغذائية وكذلـك كـانت الفرشـة المعاملـة بحامض HCl اعلى بفروق معنوية من الفرشة الغير معاملة (الكنترول) .

حيث ان نسبة البروتين قد ارتفعت من 14.5 % فى الفرشة الغير معاملة الـى 15.5 % فـى الفرشة المعاملة بحامض HCl و الى 17.7 % فى الفرشة المعاملة بحامض الخليـك . كذلـك كانت نتيجة المعاملة على محتوى الالياف هو 19.5 % للفرشة المعاملة بحـامض HCl و 17.7 % للفرشة المعاملة بحامض الخليك و 22.6 % فى الفرشة الغير معاملة .

2- تاثير استخدام فرشة الدواجن المعاملة بالاحماض و المضافة الى علائق الاغنام على القيم الهضمية و معدل النمو

استخدمت فى هذة التجربة اربع علائق الاولى كنترول وتتكون من 48 % ذرة و 40 % ردة و 10 % كسب عباد الشمس و 1.5 % حجر جير و 0.5 % ملح طعام و فى الثلاث علائق الاخرى تم استبدال كسب عباد الشمس بفرشة الدواجن غير المعاملة او فرشة الدواجن المعاملة بحامض HCl او فرشة الدواجن المعاملة بحامض الخليك على التوالى.

وكانت نتيجة استخدام هذة العلائق هو ارتفاع معامل هضم البروتين حيث كان 71.97 % و 72.34 % و 73.86 % و 72.98 % كذلك ارتفاع معامل هضم الالياف حيث كان 48.63 % و 64.56 % و 72.03 % و 70.1 % وهيميسيليلوزكان 45.47 % و 52.93 % و 70.53 % و 64.53 % وكان السيليلوز 32.87 %

و 50.37 % و 59.71 % و 48.6 % لكل من الكنترول و العليقة المحتوية على فرشة معاملة بحامض HCl والعليقة المحتوية على فرشة معاملة بحامض الخليك و العليقة المحتوية على فرشة غير معاملة على الترتيب.

كذلك اوضحت النتائج ان معدلات النمو للعليقة المحتوية على فرشة معاملة بحامض الخليك اعلى احصائيا من باقى الثلاث معاملات الاخرى حيث كان 117.1 جرام / يوم للعليقة الكنترول و 133.3 جرام / يوم للعليقة المحتوية على فرشة معاملة بحامض HCl و 181.2 جرام / يوم للعليقة و 141 جرام / يوم للعليقة المحتوية على فرشة غير معاملة. اما بالنسبة الى كفاءة التحويل الغذائى فقد كان معامل التحويل الغذائى هو 7.6 و 6.7 و 4.97 و 6.4 لكل من الكنترول و العليقة المحتوية على فرشة معاملة بحامض HCl والعليقة المحتوية على فرشة معاملة بحامض الخليك و العليقة المحتوية على فرشة غير معاملة على الترتيب.

3- تقدير الماكول و معامل الهضم للسيلاج المصنوع من فرشة الدواجن و مخلفات عصير البرتقالعند تغذيتها للحملان النامية

تم تصنيع سيلاج بنسبة 20 % فرشة دواجن و 80 % مخلفات عصير البرتقال على اساس الوزن الطازج . و كان السيلاج يعرض للهواء الجوى لمدة يوم واحد قبل تقديمة للحملان . تم خلط السيلاج مع مخلوط علف مكون من 60 % ردة و 25 % ذرة و 12 % كسب عباد الشمس و 2.5 % حجر جير و 0.5 % ملح طعام حيث تم الخلط بالتدريج لتقدير الكمية الماكولة من السيلاج مع المخلوط .

و كانت نتيجة التحليل الغذائى ان الفرشة محتوية على 25 % بروتين خام و 47 % كربوهيدرات ذائبة اى انها مصدر للنتروجين بينما كان محتوىمخلفات عصير البرتقال 7% بروتين خام و75% كربوهيدرات ذائبة اى انها مصدر للكربوهيدرات.

ونتيجة تجربة الهضم كان معاملات الهضم 52.2 % و 48.2 % و 48 % و 52.7 % و 73 % لكل من المادة الجافة و البروتين الخام و الالياف الخام و الدهن الخام و المستخلص الخالى من النتروجين على الترتيب بينما كانت القيمة الغذائية 55 % TDN و 9 % بروتين خام مهضوم . و كان الماكول من المادة الجافة محسوب بالجرام لكل وحدة وزن تمثيلى 23.45 جرام مادة جافة.

4- احلال مصادر نتروجين غير بروتينى محل مصدر بروتينى فى علائق الاغنام المحتوية على نسبة عالية من الالياف

تمت هذة التجربة فى المملكة المتحدة باستخدام اربع علائق متساوية فى محتوى النتروجين العليقة الكنترول مكونة من قش الشعير و حبوب الشعير و كسب فول الصويا كمصدر

للنتروجين و فى الثلاث علائق الاخرى تم استبدال كسب فول الصويا بقش شعير معامل بالامونيا او فرشة دواجن معاملة بالفورما لين او فرشة دواجن غير معاملة على الترتيب.

اوضحت النتائج ان معاملة القش بالامونيا قد رفع محتوى النتروجين من 4.01 % فى القش الغير معامل الى 6.2 % فى القش المعامل كذلك رفع نسبة NDF من 68.77 % الى 77.78 % و ايضا رفع نسبة ADF من 35.99 % الى 49.32 % و السيليلوز من 34.63 % الى 48.43 % مع انخفاض فى نسبة الهميسيليلوز من 32.78 % الى 28.46 % .

اما عن تاثير المعاملة بالفورما لين على فرشة الدواجن فقد وجد زيادة طفيفة فى محتوى النتروجين من 27.04 % الى 27.98 % و كذلك زيادة فى NDF من 53.88 % الى 63.26 % و فى نسبة ADF من 20.48 % الى 23.84 % و السيليلوز من 19.52 % الى 22.07 % و الهيميسيليلوز من 33.4 % الى 39.42 % .

اما عن التاثير على معاملات الهضم اوضحت النتائج انة لاتوجد فروق معنوية بين العليقة المحتوية على قش معامل بالامونيا و العليقة الكنترول فى كل من المادة الجافة و المادة العضوية و البروتين الخام و المستخلص الخالى من النتروجين . و كذلك لا توجد فروق معنوية بين كل من العليقة المحتوية على فرشة دواجن معاملة او فرشة دواجن غير معاملة فى معظم المكونات الغذائية . بينما كان هناك اختلافات معنوية بين العليقتين المحتويتين على فرشة الدواجن سواء معاملة او غير معاملة و بين العليقتين الاخريين .

كما اوضحت نتائج هذة التجربة ان تاثير معاملة القش بالامونيا قد حسن من القيمة الهضمية لمكونات القش كذلك المعاملة بالفورمالين حسنت من كفاءة إستخدام النتروجين الموجود فى فرشة الدواجن.

5- تقدير القيمة الهضمية للعلائق المحتوية على فرشة الدواجن معمليا بواسطة إستخدام الكائنات الدقيقة من روث الأغنام

إستخدمت فى هذه الدراسة كل العلائق السابق إستخدامها فى هذه الدراسة والمعروف معامل الهضم لها لإيجاد العلاقة بين هذه القيم والقيم المعملية بإستخدام مستخلص روث الأغنام.

وكانت العلاقة بين معامل الهضم المعلوم (y) والقيمة المقدرة لمعامل الهضم فى المعمل وقد وضحت هذه النتائج من المعادلات التالية

بالنسبة للمادة الجافة (10 عينات) كانت المعادلة $y = 8.2 (\pm 1.9) + 0.91 (\pm 0.029)x$

وكان معامل الأرتباط 0.99

بالنسبة للبروتين الخام (9 عينات) كانت المعادلة $y = 13.6 (\pm 4.5) + 0.84 (\pm 0.069) x$

وكان معامل الأرتباط 0.97

وبالنسبة للألياف الخام كانت المعادلة $y = 9.16 (\pm 4.28) + 0.91 (\pm 0.073) x$

وكان معامل الأرتباط0.97

وقد تم تجميع كل النتائج فى معادلة واحدة (28) عينة وكانت المعادلة كالأتى:

$y = 10.6 (\pm 1.9) + 0.88 (\pm 0.03) x$

وكان معامل الأرتباط 0.98