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Evaluation of Chili Pepper (Capsicum Annuum), Tiger nuts (Cyperus Esculentus), and Turmeric (Curcuma Longa) as Sources of Antioxidant Compounds for the Potential of AntiAging-like Activity

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EVALUATION OF CHILI PEPPER (*CAPISICUM ANNUUM*), TIGER NUTS (*CYPERUS ESCULENTUS*), AND TURMERIC (*CURCUMA LONGA*) AS SOURCES OF ANTIOXIDANT COMPOUNDS FOR THE POTENTIAL OF ANTIAGING-LIKE ACTIVITY

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ABSTRACT

Aging is a natural process that living organisms go through as they become older. In humans and other animals, aging is accompanied by several morphological changes, including the formation of wrinkles. Wrinkles are also caused by various environmental factors such as excessive exposure to sun or pollution, and continuous sleep deprivation. These environmental factors cause oxidation of skin cells and the degradation of subcutaneous fatty acids, leading to the formation of wrinkles. Skin care and wrinkle treatment products are part of a multimillion-dollar industry. Plant-based products are an alternative method for treating wrinkles and premature aging. Several antioxidants naturally found in plants have been associated with slowing down or preventing wrinkle formation.

The objective of this study is to determine the antioxidant capacity of tiger nut bulbs *(Cyperus esculentus),* chili pepper *(Capsicum annuum),* and turmeric *(Curcuma longa)* by analyzing their vitamin A, C, and E contents. Tiger nut, chili pepper, and turmeric constituents were extracted in distilled water. To examine vitamin C content, a spectrophotometric method using potassium permanganate ($KMnO_4$ in 0.1-M sulfuric acid (H_2SO_4)) was used to test the extracted samples. Similar techniques were used to test vitamin E contents of the samples using spectrophotometric methods bathophenanthroline, iron (III) chloride ($FeCl_3$), and phosphoric acid (H_3PO_4). For

vitamin A testing, spectrophotometric methods using potassium hydroxide (KOH) and xylene were conducted on the extracted samples. The samples were also measured against the standard curves for vitamins C and E. Results indicated that tiger nut contains more vitamin A and E than chili pepper but less vitamin C. Future uses of these plants can possibly help aid in not only antiaging possibilities, but also within general skincare health.

ACKOWLEDGMENTS

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I would also like to thank my committee members Dr. James Rayburn and Dr. Triplett for collaborating and giving me advice while I selected samples for this experiment.

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Chelsea Blair Toyer

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INTRODUCTION

As society continues to live longer, many people want to turn back the clock to achieve a more youthful appearance, and thus turn to alternative methods. Cosmetic surgery and skincare is huge in America currently. In 2016, Americans spent around $16 billion on cosmetic and minimally invasive procedures [13, 26, 33]. In 2019, The American Society of Plastic Surgeons reported that Americans spent $16.7 billion on non-invasive procedures and it is expected to continue to rise. The top-five minimally invasive cosmetic procedures from 2019 include Botox, fillers, chemical peels, and intense pulsed light treatment. All the procedures have their advantages and disadvantages. The most concerning is that many medical professionals do not know overall how these procedures will affect younger patients. Younger people are opting into cosmetic surgery as a quick fix or as a preventive measure to stop the appearance of aging. Although cosmetic surgery is a growing trend, many people are slowly turning toward more natural remedies to help their skin combat the several factors that lead to premature aging. Many of these remedies include medicinal uses of plants[15].

Premature aging can be genetic or caused by various environmental factors and is commonly associated with wrinkle formation. Some of the leading environmental causes of wrinkles include excessive exposure to sun, air pollution, continuous sleep deprivation, and smoking. These environmental factors and social activities cause oxidation of skin cells and degradation of subcutaneous fatty acids, leading to wrinkles[36]. Aging is a natural part of life, but these factors can help speed up the process. Our skin cells

naturally produce reactive oxygen (ROS) and reactive nitrogen (RNS) species. Both of these free radicals play an important role in cell proliferation, differentiation, and apoptosis. The group of endogenous antioxidants help keep homeostasis by making sure the free radicals do not damage the cells by neutralizing the free radicals. If there is an unbalance of the free radicals and endogenous antioxidants, then oxidative stress will occur [33]. The free radicals cause damage due to them having an unpaired electron. When the free radicals seek to fulfill their outer ring by taking electrons from nearby structures such as DNA, cytoskeleton, and cell membranes, the free radicals can cause damage on a cellular level. Antioxidants can help lessen the damages the cells endure by contributing an electron to the free radical thus disarming it. [33]. Our skin naturally has antioxidants within the extracellular space in the epidermis and dermis such as ascorbic acid. Vitamin E is also seen to be present in the epidermis. Vitamin C and α-tocopherol have been shown to be in the cornified layer of the epidermis and the deepest cornified layers have a higher concentration [33]. To combat the oxidative stress and to contribute in aiding the naturally antioxidants found within our skin, medicinal uses of plants that have antiaging-like properties can be of good use.

Plant-based products provide alternative methods for treating wrinkles and premature aging. Several antioxidants naturally found in plants have been associated with slowing down or preventing wrinkles and premature skin aging [24, 26, 28]. These compounds include vitamins and enzymes. In popular folk medicine, several plants have been mentioned to play a role in slowing down aging [5, 12, 30]. Tiger nut (*Cyperus esculentus* L.), chili pepper

(*Capsicum annuum* L.), and Turmeric (*Curcuma longa* L.) are only a few of the numerous plants mentioned in folk medicine to contain several vitamins and enzymes necessary for skin care.

Cyperus esculentus is a plant species belonging to the Sedge family, Cyperaceae. Although these plants are referred to as tiger nuts, the edible portion of the plant is not fruits but the tubers. Tiger nuts get their name from the stripes on the exterior portion of the tubers [1, 8, 31, 35]. Tiger nuts are also known as the earth almond and yellow nutsedge. This species is widely cultivated across the globe, especially in Africa, the Middle East and the Indian Subcontinent. The majority of these areas are temperate, tropical and subtropical environments. The earliest record of the *C. esculentus*, under the name "earth almond" extend to ancient Egypt where they were entombed with Egyptians [8]. Many contemporary farmers do not like tiger nuts because the plants are highly invasive when cultivated in non-native environments. Due to their unique root system, tiger nuts have a stratified and layered root system, where the tubers and roots are interconnected [21]. The roots are fibrous and will grow through surrounding plants that try to compete for water and nutrients in the soil.

Tiger nuts prefer a humid climate and soil that is sand or heavy clay for their unique root system. Tiger nuts can reach up to 90 cm, potentially blocking sunlight from any nearby plants. They are typically planted during the months of March to April and harvested between November and December, requiring weeklong irrigation during the growing

season[22]. Once harvested, the tubers are pulled from the ground and put through the washing and drying process. The drying process usually will be three months to help with the shelf life [1, 21]. The drying process also helps with the nutrition level[32, 35].

The tuberous rhizomes can be used for a diversity of drinks and dishes. Tiger nuts can be roasted, baked, made into milk or oil, and eaten raw. A popular drink in Nigeria and Mali called *kunnu aya* uses tiger nut and is and tiger nut milk called *nonon aya*. In Spain, tiger nuts are called chufa and they are used to make horchata de chufa [4]. Tiger nut is such a popular food source in many countries due to their high nutritional value [22, 23]. Tiger nut contains magnesium, iron, vitamin E, vitamin C, and fiber. One serving of tiger nuts contain 10 grams of fiber, which is half of our daily intake. Tiger nuts have been used for diarrhea, colic, and as an ointment 4 [32, 35]. The antioxidants within tiger nut [9], specifically the vitamin E, vitamin C, and oleic acid, can play a potential role in protecting the skin from free radicals[9].

Chili pepper (*Capsicum annuum*) is an evergreen perennial plant in the nightshade family, Solanaceae. They are related to tomatoes, potatoes, and eggplants, and the edible fruits are harvested and used in various stages of maturation [16]. Chili peppers are one of the oldest native crops in Central and South America. They are grown in the temperate, tropical, and subtropical parts of the world. The plant has a shrubby appearance and can grow to 2 feet or more in height. *Capsicum annuum* represents one of five major species of cultivated *Capsicum*, and includes jalapenos, bell, and cayenne peppers [16]. These

peppers come in a variety of colors ranging from green, red, yellow, and orange. The intensity of their flavor encompasses sweet, neutral, and hot varieties of peppers. The hot peppers get their spiciness from the capsaicin. The growing conditions of the plants determine the intensity of the heat. For example, when peppers are water-stressed, the capsaicin will have more intensity than the peppers that were not water-stressed [16, 17, 34]. This is due to the plant absorbing low levels of water during the growth phases. Hotter weather and drier soil can also contribute to the peppers' intensity levels [16, 17, 34]. Capsaicin's are secondary metabolites that protect the plants from predators and pathogens. Days to harvest ranges from 60 to 90 for sweet peppers and 150 days (about 5 months) for the hotter peppers. Chili peppers can be eaten raw, dried, cooked, or used as a powder in a diversity of dishes. Chili peppers have also been used for traditional medicines. The Mayans used chili pepper to help treat asthma, sore throats, and coughs. The Aztecs even used the peppers to help with toothaches [34]. Capsaicin has been used in topical creams to alleviate pain associated with post-herpetic neuralgia, diabetic neuropathy, and other chronic pain symptoms [34,35]. Chili pepper also have anticarcinogenic and antidiabetic properties[37]. Moreover, the fruits are a major source of antioxidants such as vitamins C and E. Antioxidants have been shown to help with age-related diseased by preventing or reducing the symptoms [34].

Turmeric, *Curcuma longa*, is a plant species belonging to the ginger family, Zingiberaceae, and grown for its underground rhizome. Turmeric is native to India and China. The plant prefers a warmer climate, with plentiful rainfall and soil that is sandy or

clay-like [6, 39]. The plant reaches maturity 7 to 9 months after planting, when the rhizomes can be harvested. The rhizomes then go through a process called curing, in which they are boiled and then sun-dried[38]. The outer surface is polished by manual or mechanical rubbing to help with their appearance [6, 39]. Turmeric is used in many African and Asian dishes such as curry and it is also used for medicinal purposes. In traditional Ayurvedics, turmeric is used as an anti-inflammatory, anticoagulant, antifungal, and antioxidant as well as treat skin irritation [6, 39, 40]. The active compound in turmeric is polyphenol curcumin. Curcumin, also known as diferuloylmethane, gives turmeric its man health benefits. Studies have shown that curcumin targets signaling molecules while also demonstrating activity at the cellular level to aid in turmeric's health properties [11].

Vitamin A belongs to a group of unsaturated organic molecules, important in the growth and development of humans [12]. There are two types of vitamin A: the preformed vitamin A (retinyl acetate or retinyl palmitate, retinol) found in animal products such as meat, fish, poultry, and dairy foods; and the provitamin A, such as the carotenoids, found in plant-based foods [12, 25]. Vitamin A is recognized in the cosmetics industry as a wrinkle-reducer. Topical application of products containing retinoid (a synthetic form of a vitamin A) can help treat acne and psoriasis. When applied to the skin, vitamin A is known to promote collagen synthesis [31, 41].

Vitamin C is commonly associated with its ability to strengthen the immune system and ward off the common cold. It is a water-soluble antioxidant, which helps to fade brown

spots on the skin [2, 29]. Other roles of vitamin C include tissue regrowth, collagen formation, wound healing, as well as the maintenance of healthy bones, teeth, and gums. It is one of the most efficient free-radical scavengers of all the vitamins [2, 20, 24, 27].

Vitamin E is recognized as the dry-skin defender. Topically, Vitamin E is a powerful fat-soluble antioxidant that protects lipids from oxidizing, which helps skin retain its natural moisturizers [18, 30].

The objectives of the study are to isolate and determine the vitamins A, C, E contents of tiger nut bulbs, chili pepper fruits, and turmeric powder, and compare with the values of marketed turmeric.

PROCEDURES

Before beginning the experiment, the tiger nut bulbs were purchased from an online store and the turmeric were bought from a local store. The chili peppers were grown fresh in the Science Department green house at Jacksonville State University.

To prepare samples for extraction and analyses, tiger nut and turmeric powder were processed separately but by the same method. In both cases, 2.0 g of the powder was homogenized in 5-mL of distilled water and then gradually added 5-mL water four times for a total volume of 20-mL/homogenate. Homogenates were stirred several times over 5 minutes and then filtered through two layers of cheesecloth each into a beaker, and then filtered again through four-layers of cheesecloth. The volume of each filtrate was adjusted to 40-mL using distilled water and stored on ice. Serial dilutions of tiger nut and turmeric extracts were subsequently made in 15-mL plastic tubes and used for spectrophotometric analyses.

Chili pepper extracts were prepared using fresh fruits to make a paste. The 2.0 g of chili pepper paste was homogenized in 5-mL of distilled water and then added 5-mL distilled water four times gradually for a total volume of 20-mL/homogenate, and then processed as above to prepare for spectrophotometric analyses.

Spectrophotometric Determination of Vitamin A Content

The vitamin A contents of the extracts were determined using the method of Rutkowsi et al. [32]. The procedure consisted of reacting 2-mL of each extract with 1-mL of 1-M solution of potassium hydroxide (KOH) in 90% ethanol to deplete the proteins from the reaction mixture. Parafilm was used to cover the tubes, which was then shaken from side to side for 1 minute by hand. Parafilm was then removed and tubes were placed in a 60°C water bath for 20 minutes, then placed into a beaker of cold water for 5 minutes to cool. To reduce the viscosity and facilitate the extractions, 1-mL of xylene was added to each tube. The tubes were covered separately with parafilm and shaken side to side to mix the contents for 1 minute. Samples were then transferred into 15-mL centrifuge tubes and centrifuged for 10 minutes. Following a total of 1600 microliters was taken from the middle section of each sample and placed into separate 4-mL cuvettes.

Absorbencies were recorded at 335 nanometers using xylene as blank and labeled as A1s to denote the first absorbencies. The cuvettes were then placed 6 inches away from UV

lamp at 250–300 nm for 30 minutes. Absorbencies were then recorded at 335 nm and labeled as A2s. The concentration of vitamin A (Cu) of each sample was calculated using the formula Cu = (A1-A2)*22,23 (Rutkowski et al. [32]). The multiplier 22.23 was applied due to basis of the absorption coefficient being 1% vitamin A solution in xylene. The absorbency of the samples was taken at 335 nm when measuring in a cuvette with a thickness of 1 cm. A1 was the first absorbency taken from the homogenized samples before being put in front of the UV lamp. A2 was the second absorbency taken after the samples were exposed to the UV lamp. The absorbencies were plugged in the formula and the multiplier was applied. The procedure was repeated three times for each sample.

Spectrophotometric Determination of Vitamin C Content

The vitamin C contents of tiger nut, chili pepper, and turmeric extracts were determined spectrophotometrically using the potassium permanganate method according to Lenghor et al [19]. To prepare the stock solution, 2 mg potassium permanganate ($KMnO_4$) was added to 50-mL 0.1-M Sulfuric Acid (H_2SO_4) in a glass jar and slowly shaken side to side. A 2

mg/mL stock solution of ascorbic acid was prepared by dissolving 2 mg ascorbic acid in 20-mL distilled water. A series of five diluted vitamin C standards were made as follows: 10-mL distilled water was added separately to 4 plastic tubes. In each of the four tubes, a specific amount of distilled water was removed and replaced with the ascorbic acid stock. In tube 0, no distilled water was taken out. In tube 1, 0.25-mL distilled water was removed and replaced with 0.5-mL ascorbic acid stock. In tube 3, 0.75-mL of distilled water was removed and replaced with 0.75-mL ascorbic acid stock. In tube 4, 1-mL of distilled was removed and replaced with 0.75-mL ascorbic acid stock. In tube 4, 1-mL of distilled water and replaced with 1-mL ascorbic acid stock. This constitutes a standard dilution series to be used for determination of vitamin C contents of the 3 homogenized extracts, chili pepper, tiger nut, and turmeric, with tube 0 as a blank for this series.

Two milliliters of each sample were placed in separate cuvettes. Two milliliters of $KMnO_4$ in 0.1 M of H_2SO_4 was added to each sample for ascorbic acid redox reaction. The permanganate ion serves as a color indicator to help monitor the absorbance at 525

nm, while sulfuric acid prevents the conversion of permanganate to manganese dioxide precipitate. Parafilm was placed over the opening of each glass tube and cuvettes were shaken one at a time side by side to mix. After mixing, the absorbency of each sample and of the series of standard solutions were measured at 525 nm using Genesis spectrophotometer, using distilled water as blank. A standard curve was generated using the values of the standard series and the concentrations of vitamin C deduced from the curve. To obtain this data, the formula C1V1=C2V2 was used to determine the diluted extract of each sample in cuvettes.

Spectrophotometric Determination of Vitamin E Content

Vitamin E contents were determined spectrophotometrically according to the combined methods of Kayden et al. [10, 14] and Rutkowski et al.[32]. To prepare a reference vitamin E stock solution, bathophenanthroline was weighed on the scale and then placed in a 50-mL plastic tube. A series of dilutions was made from the reference vitamin E stock

containing 0 µg/mL, 1 µg/mL, 5 µg/mL, 10 µg/ml. The 100% ethanol was added to the 50-mL tube containing the bathophenanthroline. The contents were mixed using the vortex mixer and a solution of 1-mM FeCl3 in 100% Ethanol was prepared. Bathophenanthroline, $FeCl_3$, and H_3PO_4 were all used in the vitamin E test to allow for a color reaction to occur. This increased the stability of the color change and allowed for better absorbency at 534 nm.

For spectral analyses, each sample and the standards were reacted the same way: five glass test tubes containing 1-mL of 100%-ethanol were used to run the standard series alongside the samples. Three tubes were used for experimental samples. A series of five vitamin E standards were analyzed as follows: Tube 1 received 1-mL from Series 0 µg/mL, Tube 2 received 1-mL from Series 1 µg/mL, Tube 3 received 1-mL from Series 5 µg/mL, and Tube 4 received 1-mL from Series 10 µg/mL. To mix the contents separately, parafilm was placed on top of each glass tube before being mixed. Using a micropipette, 0.2-mL of 0.2% bathophenanthroline in 100%-ethanol was then added to

each of the five series then mixed. Each tube was quickly given 0.2-mL of the 1-mM $FeCl_2$ then mixed before 0.2-mL of 1-mM solution of phosphoric acid (H_3PO_4) in 100%-ethanol was micropipette into each of the standard series. The final volume for each of the series being tested is 2.6-mL. Each of the series were placed into 4-mL cuvette before the absorbencies were taken using a spectrophotometer at 534 nm and recorded the data. A standard curve was generated using the values of the standard series and the concentrations of vitamin E were deduced from the curve. The homogenized samples, tiger nut, chili pepper, and turmeric were all tested using the corresponding vitamin E methods conducted on the vitamin E standard series.

RESULTS

Vitamin A Results

In this research Rutkowski et al [32]. method was used to determine the concentration of vitamin A in tiger nut, chili pepper, and turmeric extracts. The results were shown in Table 1 and Figure 1. Tiger nut exhibited a higher average of vitamin A contents than chili pepper. Tiger nut averaged 41.79 mg/g, while chili pepper averaged 35.56 mg/g. Turmeric averaged 40.73 mg/g and in previous studies turmeric has already been reported to have strong antioxidant activities. These results indicated that tiger nut has the presence of vitamin A contents that may have the potential to have antioxidant activity in comparison to those of turmeric. When compared with published data, the results of this research were comfortable of those in previous published literature [3].

TABLE 1: Compound Data for vitamin A (sample averages in mg/g)

n	CP	TN	TU
1	34.66	24.88	43.56
2	38.24	33.79	43.78
3	33.78	66.69	34.86
Average	35.56	41.79	40.73
Standard dev.	1.167	11.54	2.45

n = number of Tests. CP = chili pepper, TN = tiger nut, and TU = turmeric. Table depicts the absorbency for the Vitamin A tests for each homogenized samples.

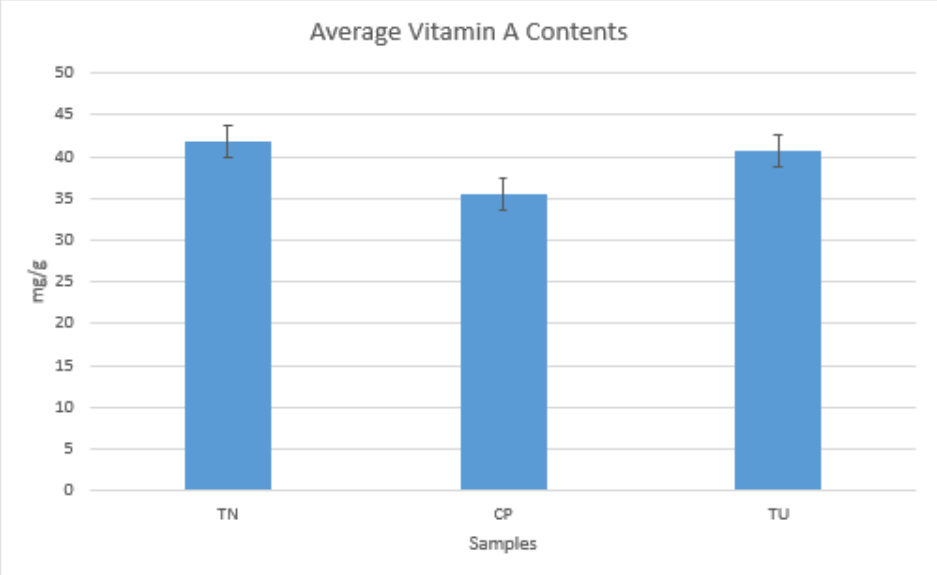

Figure 1. Graph showing averages of vitamin A. Average vitamin A contents. The average of each (n = 3 Table 1.) samples vitamin A concentration at mg/g. TN = tiger nut, CP = chili pepper, and TU = turmeric. Tiger nut is shown to have more vitamin A concentration than Chili Pepper. Turmeric is on the market and comapring tiger nut to it we can see they have relatively close amounts of Vitamin A regarding this data sample.

Vitamin C Results

The method of Lenghor et al.[19] was used to determine the concentration of vitamin C in tiger nut, chili pepper and turmeric extracts. The results were shown in Table 2 and Figure 3, chili pepper was shown to have a higher vitamin C concentration than tiger nut and turmeric. Chili Pepper is shown to have a higher vitamin C concentration than tiger nut and turmeric. Chili Pepper is shown to have averaged 40.87 mg/g, while tiger but average was 10.217 mg/g. Turmeric vitamin C concentration average was recorded having 17.145 mg/g. The results showed that there are high levels of vitamin C contents in chili pepper and that there is a potential of antioxidant activity. Previous studies have shown that peppers have a high content of vitamin C as well [7].

TABLE 2: Compound Data for vitamin C (sample averages in mg/g)

n	CP	TN	TU
1	66.819	15.64	29.32
2	31.272	10.851	14.518
3	31.792	8.517	13.448
4	33.64	5.86	11.286
Average	40.8775	10.217	17.145
Standard dev.	15.218	3.595	7.375

n = number of Tests. CP= chili pepper, TN = tiger nut, and TU = turmeric. Table depicts the fruits amount of fruit in mg/g in each samples cuvette while running the experiment.

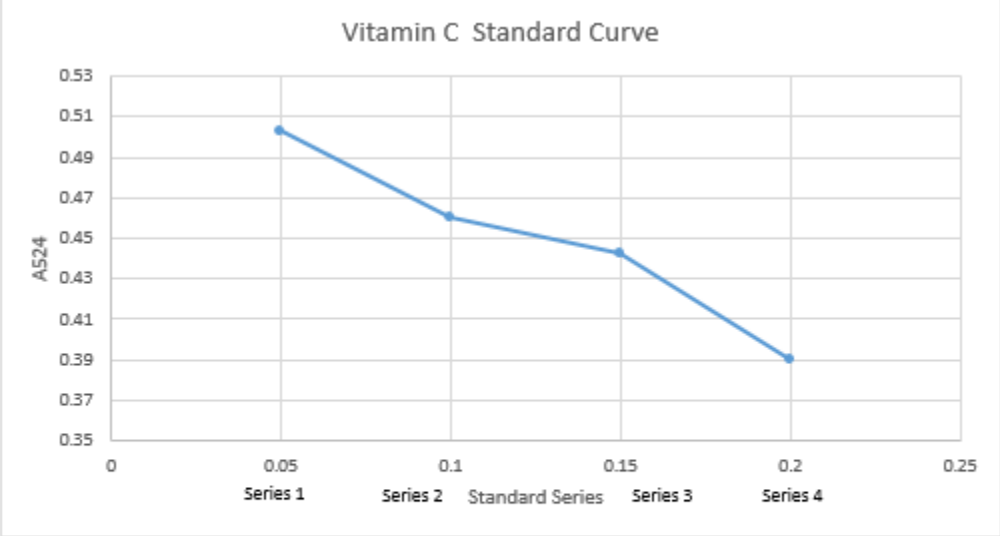

Figure 2. Graph of vitamin C standard series. The Standards Series had known Vitamin C concentrations graphed to compare to samples unknown Vitamin C concentrations. Series 1 with 0.25mL of the diluted Ascorbic Acid. Series 2 with 0.5 mL of the diluted Ascorbic Acid. Series 3 with 0.75 mL of the diluted Ascorbic Acid. Series 4 with 1mL of diluted Ascorbic Acid. A524 is the absorbency range used to detect Vitamin C concentrations on the Spectrophotometer.

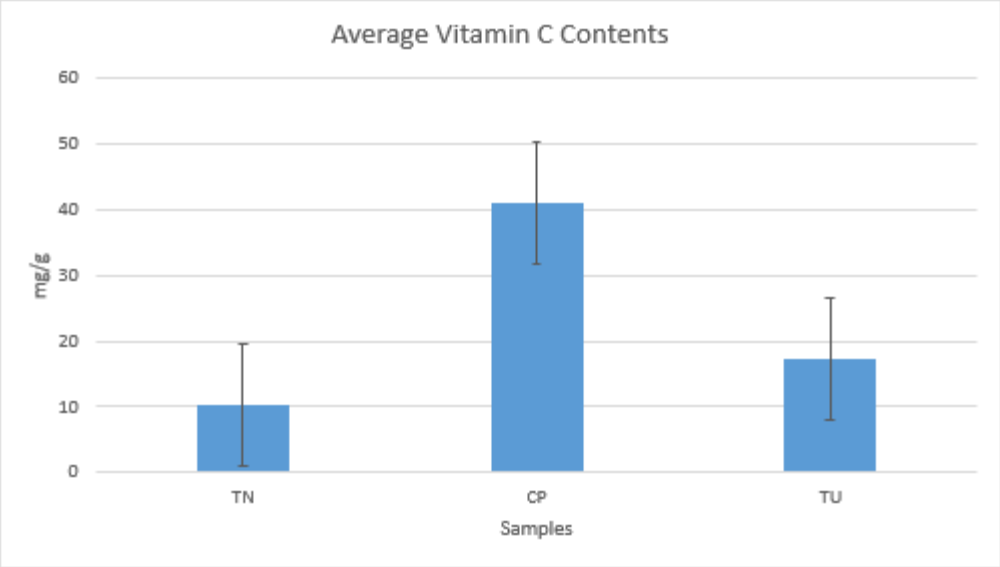

Figure 3. Graph showing averages of vitamin C contents. The average of each (n = 3 Table 2) samples vitamin C concentration in the cuvette. TN = tiger nut, CP = chili pepper, and TU = turmeric. Chili Pepper is shown to have more vitamin A contents than tigernut and turmeric. Tiger nut and turmeric have relatively close amounts of Vitamin C contents.

Vitamin E Results

The methods of Kayden et al. [10, 14] and of Rutkowski et al[32] were used to determine the vitamin E concentrations in tiger nut, chili pepper, and turmeric extracts. Tiger nut was shown to have a higher vitamin E content than chili pepper. In Table 3 and Figure 5, tiger nut was shown to have a higher vitamin E content than chili pepper. In Table 3 and Figure 5, tiger nut had an average of 36.19 mg/g. Chili Pepper had an average of 32.863 mg/g for its vitamin E contents. The results for vitamin E testing indicated that tiger nut had high levels of vitamin E and that tiger nut has the potential to have antioxidant activity occurring.

TABLE 3: Compound Data for vitamin E (sample averages in mg/g)

n	CP	TN
1	53.02	9.022
2	18.964	34.632
3	24.814	48.022
4	34.648	54.798
Average	32.863	36.619
Standard dev.	6.459	8.736

n=number of Tests. CP = chili pepper and TN= tiger nut. The table is showing the amount of fruit in mg/g in each of the samples cuvette while testing.

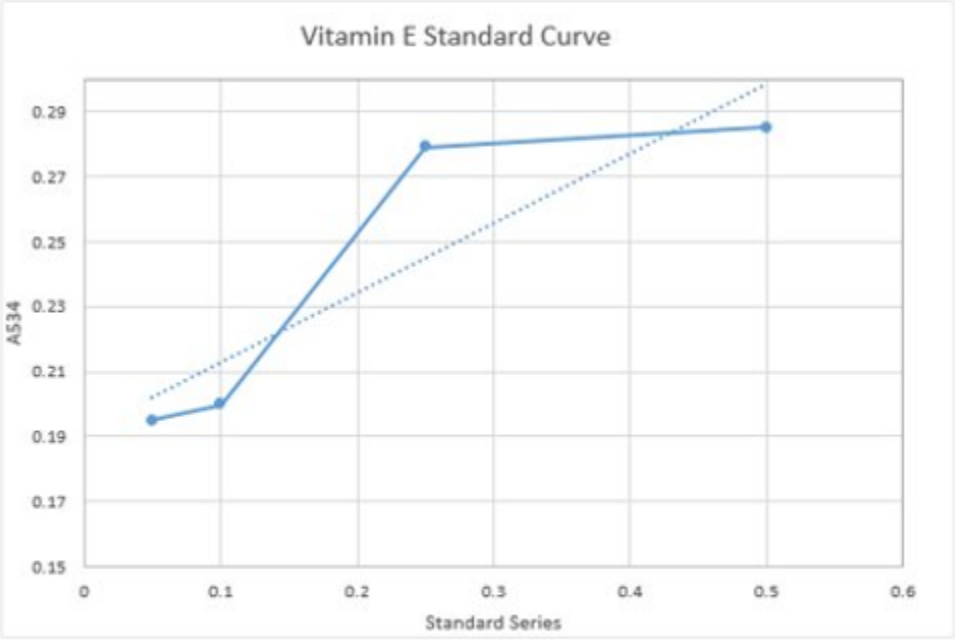

Figure 4. Graph of vitamin E standard series. The standards series had known vitamin E concentrations graphed to compare to samples' uknown Vitamin E concentrations. A534 is the absorbency range used to detect vitamin E concentrations on the spectrophotometer.

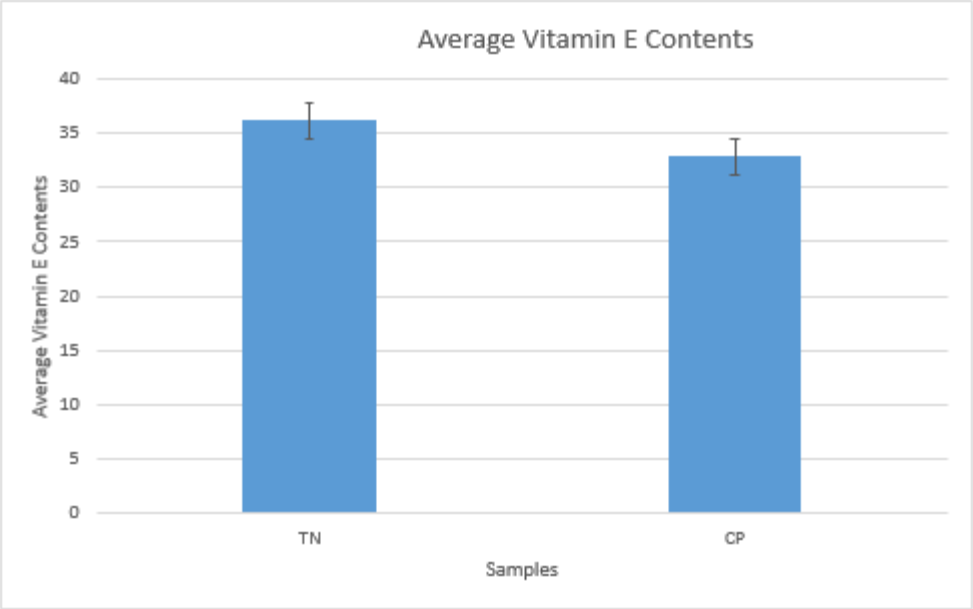

Figure 5. Graph showing averages vitamin E concentration. The average of each sample's vitamin E concentration at mg/g. TN = tiger nut and CP = chili pepper. Here the graph shows that Tigernut has slighlty more Vitamin E contents than Chili Pepper.

CONCLUSION

With demands of antiaging products in cosmetics, performing these types of experiments allows us to be able to find alternative natural remedies. Conducting this research we are able to observe the victim contents of tiger nut, chili pepper, and turmeric for their potential of having antiaging-like properties. Vitamins A, C, and E concentrations for tiger nut, chili pepper, and turmeric was studied using spectrophotometric methods and different vitamin assays. Tiger nut had a high concentration of both vitamin A and E. Chili Pepper had a higher concentration of vitamin C. Tiger nut overall showed that it had a higher antioxidant potential. These results from tiger nut indicate that they can be a resourceful alternative for medicinal uses.

For future studies, more testing needs to be done. Having more tests per sample we will see a wider range of vitamin A, C, and E concentrations from each sample group. Also comparing the sample results to those of products on the market that claim to have vitamin A, C, or E from fruits extracts in them, could be a future experiment. Testing

fresh live samples would be interesting as well. Using fresh samples in the experiments we will watch for any oxidative stress that occurs in a model organism and see if the antiaging-like properties could possibly help reduce the oxidation. These tests can all help lead us to potentially use the samples in this experiments be used medicinally.

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