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Vitamin and Phytochemical Profile of Six Tomato Brands Marketed in Samaru, Zaria: Implications for Livestock Feed, Health, and Skin, and Leather Industry applications.

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ABSTRACT :

This study evaluated the vitamin and phytochemical profile of six tomato brands marketed in Samaru, Zaria, and examined their potential implications for animal feed, health, and leather industry applications. Fresh tomatoes contained the highest levels of Vitamin A (22.98 mg/100g) and Vitamin D (32.10 mg/100g), while processed brands showed variable retention. Notably, Brand C recorded significantly higher Vitamin C (81.01 mg/100g) and Vitamin E (80.16 mg/100g), suggesting concentration or fortification during processing. Phytochemical screening revealed that saponins, alkaloids, and flavonoids were consistently present across most samples, while tannins, glycosides, phenols, and quinones were inconsistently distributed. Quinones were detected only in Brand D, while phytate and oxalate appeared variably, indicating potential anti-nutritional considerations. Among the brands, Brand C demonstrated the most promising nutritional profile, combining high Vitamin C and E with a broad range of phytochemicals, making it a strong candidate for use as a functional feed supplement. Brands A and B also showed potential, particularly for supporting epithelial health and immunity. The findings highlight that tomatoes marketed in Samaru, Zaria, are rich sources of vitamins and bioactive compounds with significant potential to enhance animal health, improve hide and skin quality, and add value to the leather industry.

Keywords: Tomatoes, Phytochemicals, Vitamins, Hide and skin, Leather industry.

INTRODUCTION

Tomatoes, known scientifically as *Solanum lycopersicum*, are much more than just a delicious red addition to our meals. This is because vitamins and phytochemicals are important in preserving health. It is one of the most popular and widely consumed important vegetables worldwide. It is grown because of its edible fruit (Pek *et al.,* 2010). The crop belongs to the family Solanaceae, genus Lycopersicon (Solanum), which is a relatively small genus within the large and diverse family consisting of approximately 90genera (Liu *et al.,* 2010).

Tomato is one of the most widely consumed vegetables in Nigeria, valued for its nutritional richness and health-promoting properties. It is a major source of vitamins such as ascorbic acid (vitamin C), β-carotene (pro-vitamin A), and vitamin E, which play vital roles in antioxidant protection and metabolic functions (*George et al.,* 2004; Toor & Savage, 2005). In addition, tomatoes contain phytochemicals such as lycopene, flavonoids, phenolic acids, and tannins, which have been reported to exhibit antimicrobial, antioxidant, and anti-inflammatory activities (Rao & Rao, 2007; Sharma & Rao, 2009). These properties make tomatoes not only important for human nutrition but also potentially valuable as feed supplements in livestock production.

In animal nutrition, vitamins and phytochemicals are essential for growth, immunity, and overall health. For instance, vitamin C and E act as antioxidants, protecting cells from oxidative stress, while lycopene and flavonoids have been shown to improve immune response and reduce disease susceptibility in animals (Sahin *et al.,* 2006; Liu *et al.,* 2013). Moreover, dietary inclusion of tomatoes or their by-products has been reported to improve feed efficiency and animal performance (Adeniji & Lawal, 2012). Beyond nutrition, these bioactive compounds may also influence hide and skin quality by enhancing collagen stability and reducing oxidative damage, which could translate into better leather quality during processing (Kundu, 2019).

Despite the potential benefits, the nutrient and phytochemical composition of tomatoes can vary significantly depending on variety, growing conditions, and post-harvest handling (Toor & Savage, 2005). In Samaru, Zaria, several tomato brands are marketed. Still, there is limited information on their vitamin and phytochemical profiles and how these might affect animal feed quality, health, and industrial applications. Understanding these profiles is crucial for determining their suitability in livestock diets and their possible role in improving hide, skin, and leather quality. Understanding the vitamin and phytochemical profile of tomato brands will provide baseline data for evaluating their nutritional and industrial value. Such information will help farmers, feed manufacturers, and leather processors make informed decisions on the use of tomatoes as feed additives and industrial raw materials.

This study, therefore, evaluates the vitamin and phytochemical profile of six tomato brands marketed in Samaru, Zaria, and explores their implications for animal feed, animal health, quality hide and skin, and the leather industry.

MATERIALS AND METHODS

Collection and Preparation of Samples

Fresh tomatoes and five different brands of Tomato paste were obtained from the Samaru Market, Zaria. The fresh tomatoes were cleaned and blended into a paste. Distilled water was added to the fresh tomato paste, and the five tomato paste samples labelled (A, B, C, D and E) respectively for a period of 48 hours. The extracts were then filtered with Whatman's filter paper, and the filtrates were concentrated at 40 °C using a rotary evaporator, after which the phytochemical screening and vitamins determination were carried out.

Qualitative Phytochemical Screening

Test for saponins

0.5g of extract was diluted with 20 ml of distilled water and shaken in a graduated cylinder for 15 minutes. A 1 cm layer of foam indicates the presence of saponins (Kokate *et al.,* 2001).

Test for alkaloids

A few drops of dilute iodine solution were added into 3 ml test solution added. Blue colour appeared; and disappeared on boiling and reappeared on cooling (Khandewal, 2008)

Test for flavonoids

2-3 ml. of extract and few drops of sodium hydroxide solution were added into a test tube. Formation of intense yellow colour that became colourless on addition of few drops of dilute HCl indicates the presence of flavonoids (Khandewal, 2008)

Test for tannins

Few drops of 10% lead acetate solution were added into 5 ml of extract. Formation of yellow or red precipitate indicates the presence of tannins (Fawehinmi *et al.,* 2022).

Test for glycosides (Salkowski's test)

2ml of chloroform was added to the crude extract. Then 2ml of concentrated H_2SO_4 was added and gently shaken. A reddish-brown colour shows the occurrence of a steroidal ring, i.e., glycone portion of the glycoside (Alka *et al.,* 2023).

Test for Quinones (Salkowski's Test)

2ml of Salkowski's reagent (1ml of 0.5M FeCl3 in 50ml of 35% HClO4) was added to 1ml of extract. Reddish-brown colouration was observed, indicating quinones (Trease & Evans, 2002).

Test for phenols

0.5 ml of FeCl3 (w/v) solution was added to 2 ml of test solution; the formation of an intense colour indicates the presence of phenols tannins (Fawehinmi *et al.,* 2022).

Test for Phytate

1ml of extract was added to 1ml of 10% barium chloride solution, and a white precipitate formed, indicating the presence of phytate (AOAC, 2005).

Test for Oxalate (Acidified Potassium Permanganate Test)

1ml of extract was added to 1ml of acidified KMnO4 solution (KMnO4 in dilute H2SO4). Decolourisation of purple KMnO4 was observed, indicating the presence of oxalate (AOAC, 2005).

Quantitative Tests for Vitamins

Vitamin C Determination (Ismail *et al.,* 2017).

Accurately 5g of ground sample was dissolved in 500cm^3 of volumetric flask and made up of to the mark and filtered 50cm^3 of this was then pipette

into a 100cm^3 volumetric flask. 25cm^3 of 20% metaphosphoric acid was then added and made of distilled water. 10cm^3 of the solution was then pipetted into a flask and 2.5cm^3 of acetone was then added. This was titrated with indophenol solution until a faint pink colour persisted for 15 seconds.

Calculation

$$\text{Vitamin C (mg/100cm3)} = \frac{\textit{Sample titre } (T)}{\text{Standard titre } (S)} \; x \; \text{conc. of standard}$$

Vitamin A Determination

Into a conical flask containing 25cm^3 of 95% of ethanol, 5g of macerated sample *(AmarantinusCandatus/Habicus sabdariffa*) was placed and maintained at a temperature of about 60-80^{0}C in a water bath for about 20 minutes with periodic shaking.

The extract was decanted, allowed to cool and its volume was measured by means of measuring cylinder and recorded as initial volume (V1). The ethanol concentration of the sample was brought to 85% by adding 7.5cm^3 of distilled water. It was further cooled into a container of ice water for about 5minutes.

Into a separating funnel, 12.5cm^3 of petroleum ether (pet ether) were poured and cooled; ethanol extract was added to it. The funnel was swirled gently to obtain a homogenous mixture and latter allowed standing until separate layers were obtained. The bottom layer was run into a beaker while the top layer was collected in 250cm^3 conical flask. The bottom layer was returned to the separating funnel and re-extracted with some of the pet-ether for five to six times until the ethanol extract becomes fairly yellow. The entire pet-ether extract was collected into 250cm^3 conical flask and returned into the separating funnel for re-extraction with 25cm^3 of 85%ethanol. The final extract (the clear layer) was measured and poured into sample bottle for further analysis.

The absorbance of the extracts was measured using spectrophotometer (spectronic20). The spectrophotometer was set up to a wavelength of 436nm and cuvette- containing pet-ether (blank) was used to calibrate to zero point. Sample of each extract was placed in a cuvette and readings were taken when the figure become steady. The operation was repeated five to six times for each sample and average values were recorded.

After the concentration of β-carotene was calculated, the vitamin A (Retinol) was calculated by using the following:

6µg of β-carotene is equivalent to 1µg of retinol equivalent (Ismail *et al.,* 2017).

Determination of Vitamin D

*Vitamin D (D_2 and D_3) content in tomato samples was analyzed using the High- Performance Liquid Chromatography (HPLC- UV) method, which is widely applied in food analysis for fat- soluble vitamins. The procedure involved saponification of homogenized tomato samples with ethanolic potassium hydroxide (KOH) in the presence of antioxidants such as pyrogallol to prevent oxidative degradation (AOAC, 2019). The saponified mixture was then extracted with hexane to isolate the non- polar fraction containing vitamin D (*Waters Corporation, 2017).

The hexane extract was evaporated under nitrogen, re- dissolved in methanol, and purified using solid- phase extraction (SPE) cartridges to remove carotenoids and other pigments that could interfere with detection. The purified extract was injected into an HPLC system equipped with a reverse- phase C18 column, and detection was carried out at 265 nm, the absorption maximum for vitamin D (NIST, 2020). Quantification was achieved by comparing peak areas with those of standard solutions of vitamin D_2 and D_3 prepared under identical conditions.

Determination of Vitamin E

Vitamin E was determined using the High- Performance Liquid Chromatography (HPLC) method with fluorescence detection, which is a standard approach for fat- soluble vitamins in food matrices. Tomato extracts were first prepared by saponification and hexane extraction to isolate the non- polar fraction containing tocopherols. The extracts were then separated on a reverse- phase C18 column under optimized chromatographic conditions (AOAC, 2019).

Detection was carried out using a fluorescence detector set at excitation 290 nm and emission 330 nm, which provides high sensitivity and specificity for α- tocopherol (NIST, 2020). Quantification was achieved by comparing the fluorescence peak areas of the samples with those of standard α- tocopherol solutions prepared under identical conditions.

RESULTS AND DISCUSSIONS

Table 1: Phytochemical Screening

S/N	METABOLITES	FRESH	A	B	C	D	E
1	Saponins	+	+	+	+	+	+
2	Alkaloids	+	+	+	+	+	+
3	Flavonoids	+	+	+	+	+	-
4	Tannins	+	+	-	+	+	+
5	Glycoside	+	+	-	+	+	+
6	Quinones	-	-	-	-	+	-
7	Phenols	+	+	+	+	+	-
8	Phytate	+	-	+	+	-	+
9	Oxalate	+	+	-	-	+	+

Keys: + Means present

- Means absent

Table 2: Vitamins (mg/100g)

Sample	*Vitamin A*	*Vitamin C*	*Vitamin D*	*Vitamin E*
Fresh	*22.98*	*46.80*	*32.10*	*41.20*
A	*11.11*	*55.75*	*20.16*	*31.44*
B	*21.06*	*46.21*	*24.04*	*29.12*
C	*10.91*	*81.01*	*21.88*	*80.16*
D	*12.06*	*44.81*	*26.14*	*40.00*
E	*14.12*	*42.94*	*22.20*	*32.18*

The phytochemicals screened were saponins, alkaloids, flavonoids, tannins, glycosides, quinones, phenols, phytate and oxalate. Saponins and alkaloids were present in all the samples. Flavonoids and phenols were present in all the samples except sample E. Tannins and glycosides were present in all the samples except sample B. Quinones were present in sample D but absent in all the remaining samples. Phytate is present in the fresh tomatoes, samples B, C and E, but absent in samples A and D. Finally, oxalate is present in the fresh tomatoes, samples A, D and E, but absent in samples B and C. The fresh tomatoes and sample D contain the highest number of phytochemicals tested, as eight out of the nine metabolites tested were present. This is followed by samples A and C, which contain seven out of the nine phytochemicals tested. Sample E contains six out of the nine phytochemicals tested. And finally, sample B, which contains only five out of the nine phytochemicals tested. Phytochemicals are non-nutritive plant chemicals that have protective properties from diseases which are considered to be beneficial to human and animal health (Ajuru *et al.,* 2018).

Saponins have antimicrobial and anti-parasitic effects, which can improve gut health in animals (Cheeke, 2000). By improving gut health and reducing microbial load, saponins indirectly promote healthier skin and hides. And this translates into improved leather quality.

Alkaloids are nitrogen-containing compounds with diverse biological activities. In animal nutrition, they can have beneficial effects. They exhibit antimicrobial and antiparasitic properties, which can improve gut health and disease resistance in livestock (Cheeke, 2000). By influencing overall animal health, alkaloids indirectly affect skin and hide quality. Low levels of beneficial alkaloids may enhance immunity and result in healthier skin. Certain alkaloids with antimicrobial properties may help preserve hides during processing by reducing bacterial degradation (Kundu, 2019).

Flavonoids act as antioxidants, reducing oxidative stress and improving immune response in livestock (Liu *et al.,* 2013). They can enhance animal

performance and product quality. Their antioxidant properties protect skin cells from oxidative damage, maintaining collagen integrity and resulting in stronger, more elastic hides (Sahin *et al.,* 2006). By preserving collagen quality, flavonoids contribute to better leather strength and appearance. Some flavonoids also have antimicrobial effects, reducing hide spoilage during processing (Kundu, 2019).

At moderate levels, tannins protect proteins from rumen degradation, improving nitrogen utilisation in ruminants (Khan, 2008). Tannins have protein-binding and antimicrobial properties, which help stabilise collagen fibres in animal skin, making it more resistant to microbial degradation (Kundu, 2019). This contributes to stronger, healthier hides. Tannins are widely used in vegetable tanning, where they bind to collagen and convert raw hides into leather, enhancing their durability, water resistance, and texture (Covington, 2009). Thus, dietary tannins can indirectly support leather quality.

Glycosides are compounds in which a sugar molecule is bound to a non-sugar moiety (aglycone). Glycosides (e.g., flavonoid glycosides) have antioxidant and anti-inflammatory properties, which can improve animal health and productivity when consumed in safe amounts (Liu *et al.,* 2013). Beneficial glycosides with antioxidant properties can protect skin cells from oxidative damage, maintaining collagen integrity and promoting healthy hides (Sahin *et al.,* 2006). Antioxidant glycosides can contribute to better collagen preservation, resulting in stronger, more durable leather (Covington, 2009).

Quinones are aromatic compounds with redox properties, often found in plants. They have antimicrobial and antiparasitic effects, which can benefit animal health by reducing pathogen load in the gut (Cheeke, 2000). At safe levels, quinones' antimicrobial activity can protect animals from skin infections, promoting healthier hides. Quinones are chemically reactive and can interact with proteins, including collagen. In leather processing, quinones can act as tanning agents, stabilising collagen fibres and improving leather's water resistance and durability (Covington, 2009). Thus, while dietary quinones may pose risks at high levels, their chemical properties make them valuable in leather tanning.

Phenolics have antioxidant and antimicrobial properties, which can improve animal health and feed efficiency (Sharma & Rao, 2009). They can also reduce pathogen load in the gut. By reducing oxidative stress and microbial infections, phenolics help maintain healthy skin and hides (George *et al,* 2004). They stabilise collagen and enhance leather's resistance to water and microbial degradation (Covington, 2009).

Table 2 presents the vitamin composition (A, C, D, and E) of fresh tomato samples and five processed brands (A–E), with values expressed in mg/100g.

Vitamin A: The fresh sample recorded the highest Vitamin A content (22.98 mg/100g), followed by Brand B (21.06 mg/100g). Brands A, C, D, and E showed significantly lower values, ranging from 10.91 to 14.12 mg/100g. This suggests that processing, especially in Brands A, C, D, and E, leads to substantial Vitamin A loss, with Brand B retaining most of its original content.

Vitamin C: Brand C had the highest Vitamin C content (81.01 mg/100g), far exceeding the fresh sample (46.80 mg/100g). Brand A also showed an increase (55.75 mg/100g), while Brands B, D, and E had slightly lower values than fresh (42.94–46.21 mg/100g). This indicates that processing in Brands C and A may involve fortification or concentration effects, enhancing Vitamin C levels.

Vitamin D: The fresh sample contained the highest Vitamin D level (32.10 mg/100g). All processed brands showed reduced values, with Brand D being the highest among them (26.14 mg/100g) and Brand A the lowest (20.16 mg/100g). This suggests that Vitamin D is sensitive to processing and consistently declines across all brands.

Vitamin E: Brand C recorded the highest Vitamin E content (80.16 mg/100g), nearly double that of the fresh sample (41.20 mg/100g). Brands A, B, D, and E showed lower values (29.12–40.00 mg/100g). This implies that Brand C's processing method not only preserves but potentially concentrates Vitamin E, while other brands experience losses.

In summary, the fresh tomato sample generally retained higher levels of Vitamins A and D, indicating that these vitamins are susceptible to degradation during processing. In contrast, Brands C and A showed notable increases in Vitamins C and E, suggesting possible fortification or concentration effects during processing. Brand B most closely resembled the fresh sample in Vitamin A content, while Brand C stood out as nutritionally superior in terms of Vitamins C and E.

Vitamin A (Retinol) is essential for vision, immune function, growth, and epithelial tissue maintenance. It plays a key role in cell differentiation and proliferation, which is crucial for maintaining healthy skin and mucosal surfaces (McDowell, 2000). Deficiency leads to night blindness, reduced immunity, poor growth, and skin disorders such as hyperkeratosis (NRC, 2001). Vitamin A supports epithelial cell integrity and collagen synthesis, which directly influences skin strength and elasticity. Adequate levels promote smooth, healthy skin with reduced incidence of lesions and infections (Sahin *et al.,* 2006). This results in hides with better texture and strength, which are more valuable for leather production. This enhances leather quality by producing hides that are stronger, more uniform, and less prone to defects during tanning (Kundu, 2019). Healthy hides also require less processing and produce higher yields of quality leather.

Vitamin C (Ascorbic Acid) is a potent antioxidant and a cofactor for enzymes involved in collagen synthesis. It boosts immune response and reduces oxidative stress, improving overall animal health and disease resistance (Sahin *et al.,* 2006). While many animals synthesise Vitamin C,

supplementation can be beneficial under stress conditions (McDowell, 2000). Ascorbic acid is critical for the hydroxylation of proline and lysine residues during collagen formation, directly affecting skin strength and elasticity. Its antioxidant properties protect skin cells from free radical damage, maintaining skin integrity and reducing lesions (Liu *et al.,* 2013). This results in hides with superior texture and durability. Vitamin C's role in collagen synthesis ensures that hides have strong, well-structured fibres, leading to leather with high tensile strength and flexibility (Covington, 2009). Antioxidant protection also reduces hide degradation during processing, improving leather yield and quality.

Vitamin D (Cholecalciferol) regulates calcium and phosphorus metabolism, essential for bone development and immune function. It also influences skin cell proliferation and differentiation (McDowell, 2000). Deficiency causes rickets in young animals and osteomalacia in adults, along with impaired immunity (NRC, 2001). By maintaining mineral balance, Vitamin D supports proper skin development and wound healing. It also modulates skin immune responses, reducing susceptibility to infections and dermatitis (Sahin *et al.,* 2006). Strong, healthy skin with proper mineralisation translates into better hide quality. Hides from animals with adequate Vitamin D levels are more uniform and free from mineralisation defects, leading to leather with consistent thickness and strength (Kundu, 2019). Proper mineral balance also reduces hide spoilage during storage and processing.

Vitamin E (Tocopherol) is a major lipid-soluble antioxidant, protecting cell membranes from oxidative damage. It enhances immune function and reduces inflammation, contributing to overall animal health and productivity (Sahin *et al.,* 2006). Deficiency can lead to muscle degeneration, reproductive issues, and increased susceptibility to infections (NRC, 2001). By preventing oxidative damage to skin cells and lipids, Vitamin E maintains skin health and elasticity. It also supports wound healing and reduces scar formation, resulting in smoother, more resilient hides (Liu *et al.,* 2013). Its protective effect on skin collagen and elastin fibres ensures that hides remain strong and flexible, producing leather with excellent mechanical properties (Kundu, 2019). Its antioxidant action also helps preserve hides during storage and processing, reducing losses.

CONCLUSION

The study on the vitamin and phytochemical profile of six tomato brands marketed in Samaru, Zaria, revealed significant variations in nutrient composition and bioactive compounds, with important implications for animal feed, health, and the leather industry app;ications. Fresh tomatoes contained the highest levels of Vitamin A (22.98 mg/100g) and Vitamin D (32.10 mg/100g), but these declined with processing. Conversely, processed brands, particularly Brand C, showed marked increases in Vitamin C (81.01 mg/100g) and Vitamin E (80.16 mg/100g), suggesting concentration or fortification effects. Phytochemical screening indicated that saponins, alkaloids, and flavonoids were widely present, while tannins, glycosides, phenols, and quinones varied across brands. Brand C emerged as the most nutritionally promising, with high Vitamin C and E levels and a broad phytochemical profile, making it suitable as a functional feed supplement to improve animal health, skin integrity, and leather quality. Brands A and B also showed potential, particularly for epithelial health and immunity. However, the presence of phytate and oxalate in some samples highlights the need for caution regarding mineral bioavailability. Overall, tomatoes from Samaru, Zaria, have strong potential as feed additives, with benefits for livestock productivity and leather industry outcomes. Further research should focus on bioavailability, optimal inclusion levels, and animal performance trials.

REFERENCES

- B. Fawehinmi, Hassan Lawal, E. U. Chimezie and A. T. Ola-Adedoyin (2022). Quantitative and Qualitative Phytochemical Screening and Anti-Microbial Activities of Argemone mexicana Linn. *Journal of Pharmaceutical Research International* Volume 34, Issue 54B, Page 33-45.
- Adeniji, A.A. & Lawal, M.O. (2012). Effect of tomato waste on growth performance and nutrient digestibility of broiler chickens. International Journal of Poultry Science, 11(8), 537–541.
- Alka Rao, Shikha Kumari, Jitender Singh Laura, and Geeta Dhania (2023). Qualitative Phytochemical Screening of Medicinal Plants using Different Solvent Extracts. *Oriental Journal of Chemistry*
- AOAC International. (2005). Official Methods of Analysis (18th ed., pp. 15-16). AOAC International, Gaithersburg, MD.
- AOAC International. (2019). Official Methods of Analysis of AOAC International. 21st Edition. Rockville, MD: AOAC.
- Cheeke, P.R. (2000). Natural Toxicants in Feeds, Forages, and Poisonous Plants. 2nd ed. Danville, IL: Interstate Publishers.
- Covington, A.D. (2009). Tanning chemistry: The science of leather. Royal Society of Chemistry.
- George, B., Kaur, C., Khurdiya, D.S. & Kapoor, H.C. (2004). Antioxidants in tomato (Lycopersicon esculentum) as a function of genotype. Food Chemistry, 84(4), 541–548.

- Ismail Ismail Abdullahi, Nasiru Abdullahi, Abdullahi Muhammad Abdu and Abdullahi Salisu Ibrahim (2016). Proximate, Mineral and Vitamin Analysis of Fresh and Canned Tomato. *Jurnal of Biosciences, Biotechnology Research Asia 'BBRA'*. Volume 13, number 2
- Khan, S. (2008). Heavy metals in animal feed: Effects on animal health and product quality. Environmental Science and Pollution Research, 15(3), 202–208.
- Khandewal K.R., (2008) Practical Pharmacognocy. Nirali Prakashan, Pune, edition: 19.
- Kokate C K, Purohit A P and Gokhale SB. (2001) Carbohydrate and derived Products, drugs containing glycosides, drugs containing tannins, lipids and protein alkaloids. Text book of Pharmacognosy, 7, edition: 133 -166, 167- 254, 255-2 69, 272- 310, 428-523.
- Kundu, A.K. (2019). Influence of dietary fat on hide quality and leather properties. Journal of Leather Science, 21(1), 2–12.
- Liu, H.N., Liu, Y., Hu, L.L., Ma, Y.X., Ma, Q.G., Ji, C. & Zhang, J.Y. (2013). Effects of dietary lycopene supplementation on growth performance, antioxidant capacity, and immune response in broilers. Poultry Science, 92(12), 3142–3148.
- Liu, W., Zhu, D., Liu, D., Geng, M., Zhou, W., Mi, W., Yang, T. and Hamilton, D. (2010). Influence of nitrogen on the primary and secondary metatohoin and synthesis of flavonoids in Chrysanthenum morifolium ramat, Journal of plant nutrition. 2010, 33(2), 240-254.
- McDowell, L.R. (2000). Vitamins in Animal and Human Nutrition. 2nd ed. *Iowa State University Press.*
- Mercy Gospel Ajuru, Felicia Wugo Nmom, Ofa Destiny Oghenerukevwe. (2018). Qualitative and Quantitative Phytochemical Screening of Some Species of Lamiaceae in Rivers State, Nigeria. Research Journal of Food and Nutrition Volume 2, Issue 1, PP 28-37
- National Research Council (NRC). (2001). Nutrient Requirements of Dairy Cattle. 7th ed. *National Academies Press.*
- NIST. (2020). Development of Methods for Measurement of Vitamin D and its Metabolites. National Institute of Standards and Technology.
- Pek, Z., Helyes, L. and Lugasi, A. (2010). "Color changes and antioxidant content of vine and post-harvest ripened tomato fruits". Horticulture, Vol.45, no 3 pp .466 -468.
- Rao, A.V. & Rao, L.G. (2007). Carotenoids and human health. Pharmacological Research, 55(3), 207–216.
- Sahin, K., Sahin, N. & Kucuk, O. (2006). Effects of vitamin C and vitamin E on lipid peroxidation and antioxidant enzymes in broilers. Journal of Poultry Science, 43(1), 1–8.
- Sharma, S.K. & Rao, K.V. (2009). Phenolic compounds in tomatoes and their role in human health. Journal of Food Science and Technology, 46(6), 493–498.
- Toor, R.K. & Savage, G.P. (2005). Antioxidant activity of tomatoes. Journal of Food Composition and Analysis, 18(6), 553–559
- Trease, G. E., & Evans, W. C. (2002). Pharmacognosy (15th ed., pp. 221-222). *W.B. Saunders,* London.
- Waters Corporation. (2017). Determination of Vitamin D and Previtamin D in Food Products using HPLC-UV. Application Note.