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Effect of *Trichilia monadelpha* Stem Bark Extract on the Fatty Acid Composition of Rabbit's Thigh Meat

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Abstract

This study was conducted to evaluate the effects of Trichilia monadelpha stem bark extract on the fatty acid composition of rabbit's thigh meat. A total of 40, 6-7 weeks New Zealand white × Chinchilla crossbred rabbits with an average weight of 490 ± 4.40 were randomly divided to 4 groups with 5 replications consisting of 2 animals each in a completely randomized design. Rabbits in treatment 1 (T1) was fed basal diet with no Trichilia monadelpha stem bark extract (TMSB), T2, T3 and T4 were fed basal diet with 3mL, 6mL and 9mL TMSB per rabbit/day. Phytochemical analysis of TMSB revealed the presence of tannins (10.95 mg/g), alkaloids (9.22 mg/g), saponins (4.75 mg/g), oxalates (3.10 mg/g), flavonoids (15.88 mg/g), phenols (18.46 mg/g), terpenoids (8.62 mg/g), glycosides (7.11 mg/g) and 2-diphenyl 1-piccrlhydrazyhydrate (430.8 mg/g). Concentrations of vitamins identified in the extract are; vitamin A (2.190 mg/100g), vitamin B1 (0.567 mg/100g), vitamin B2 (0.301 mg/100g), vitamin B3 (0.227 mg/100g), vitamin B9 (0.080 mg/100g), vitamin B12 (0.209 mg/100g) and vitamin C (5.680 mg/100g). Composition of saturated fatty acid (TSFA) decrease with a significant increase in monosaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) ($P<0.05$) across the treatments. It was found that TMSB significantly ($P<0.05$) influenced the concentration of total unsaturated fatty acid (TSFA). Therefore, it can be concluded that TMSB is capable of modulating the fatty acid and improving the quality of meat from rabbit without causing any deleterious effect on the performance of the animal.

1. Introduction

The use of plant extracts or phytogenics have been gaining increasing attention in the feed industry due to their beneficial effect on livestock performance and food safety (IDT, 2000). Phytogenic feed additives (PFAD) comprise of a wide range of plants like herbs, spices and plant derived essential oils with marked pharmacological functions (IPP, 2011; Agubosi *et al*., 2021). The chemical composition of PFAD underlies a certain variation due to their bioactive compounds and other factors like anti-nutrients, species, location, harvesting and storage conditions (Agubosi *et al*., 2022). Extracts from plants contain secondary metabolites or phytochemicals which performs several therapeutic activities such as: antimicrobial against bacteria (gram-positive and gram-negative), antioxidants (scavenging free radicals), immune-modulatory, hypolipidemic, cytotoxic antiviral, anti-plasmodial, anti-trypanosomal and hepato-protective (Mota *et al*., 1985; Kamanzi *et al*., 2004). The medicinal use of *Trichilia monadelpha* can never be overemphasized as phytochemical screening revealed the presence of terpenoids, saponins, alkaloids, flavonoids, tannins, oxalates and glycosides (Buzzini *et al*., 2008; Savithramma *et al*., 2012). The plant belongs to the family Meliaceae with over 90 species and widely distributed in several parts of Asia and Africa (Savithramma *et al*., 2012). Aqueous extract of the leaves, stem bark and root are used in traditional medicine for the treatment of gastro-intestinal disease, sexually

transmitted disease, malaria, pneumonia and other respiratory disease (Woode *et al*., 2012). Many studies have shown the antibacterial, antifungal, anti-proliferative, antiviral, anti-helminthic, cytotoxic, antioxidant, anti-inflammatory, antitumor, antioxidant, anti-depressant, angelsics and antipyretic properties of both aqueous, methanolic and ethanolic stem bark extract (Ivo *et al*., 2014; Aladesanmi and Odediran, 2000). The antimicrobial effect of *Trichilia monadelpha* stem bark extract against *Escherichia coli*, *Staphyllococcus aureus*, *Staphyllococcus pyogenes*, *Bacillus aereus*, *Pseudomonas spp*, *Aeromonas spp* and *Klebsiella spp* was reported by Germano *et al*. (2007). Recent results from Rababah *et al*. (2006) confirm that animals fed phytogenic feed additives showed higher meat PUFA content. This effect was also correlated with a reduction in the susceptibility of the chicken meat to lipid peroxidation. Sanchez *et al*. (2012) also reported a higher concentration of omega-3 and omega -6 fatty acid in the thigh meat of rabbits fed *Hypericum perforatum* L. extract. For this reason, animal nutrition is currently evolving toward PUFA-enriched diets to improve animal fat healthfulness (food safety) (Bourre, 2005). Therefore, feeding animals with *Trichilia monadelpha* stem bark extract will provide potential benefits to both the animal and consumers due to its abundant potentials.

2. Materials and Methods

2.1 Experimental site and collection of plant material

The experiment was carried out at Sumitra Research Institute India located within with the coastline of 1,600 Km, 23° 13'N 72°41'E in the month of March to July, 2022. *Trichilia monadelpha* stem bark was collected within the premises of Sumitra Research Institute, India and the taxonomic identification was carried out by a certified taxonomist at the Department of Crop Science of the same institute where a voucher specimen (ST/0221H) was submitted.

2.2 Preparation of *Trichilia monadelpha* stem bark and analysis

Trichilia monadelpha stem bark was cut into smaller pieces, washed with running clean water and shade dried for 10 days in an aluminum pan, grinded into powder with an electric blender and transferred into an air tight labelled zip lock bag. 500 g of dried *Trichilia monadelpha* stem bark was extracted with 1000 mL of methanol in a conical flask for 48 hours at a temperature of 25°C and filtered with Whatman No.1 filter paper. Methanol was dried in a rotary evaporator under low pressure at a temperature of 40 °C and the extract (TMSB) was stored in the refrigerator at 4 °C. Sample of *Trichilia monadelpha* stem bark extract (TMSB) was taken to the laboratory and were analyzed for tannins (Ahmad *et al*., 2014), phenols (Bhat *et al*., 2018), terpenoids (Debnath and Vyas, 2015), saponins (Tiwari *et al*., 2011), alkaloids (Jamuna and Paulsamy, 2013), oxalates and glycosides (Sczkowski *et al*., 1998), Terpenoids and flavonoids (Harbone, 1973), vitamin C (Okwu and Ndu, 2006), vitamin A (Okwu, 2004), vitamin B complex (Robert *et al*., 2003) and DPPH (diphenylpicryhydrazyl) radical scavenging activity (Rao *et al*., 2010).

2.3 Animal management and experimental design

A Completely randomized design (CRD) was used in this study. A total of 40, 6-7 weeks New Zealand white × Chinchilla crossbred rabbits with an average weight of 490 ± 3.7 were sourced from a reputable farm in India. The animals were properly inspected against any deformity and transported early in the morning to Sumitra Research Farms. Rabbits were equally divided into 4 dietary treatments with 5 replications consisting of 2 animals each. Before the commencement of the experiment, hutches, watering and feeding troughs, were thoroughly cleaned, disinfected, and sprayed against parasites. Animals are placed on a 14 days adjustment period after balancing the weight and given prophylactic treatment of Oxytrox® L.A (antibiotics) and Ivermectin Injection (endo- and ecto- parasites) adhering strictly to the manufacturers recommendation. Other sanitary and management practices were taken throughout the experimental period which lasted for 84 days. Basal diet was prepared to meet the nutrient requirement of growing rabbits (NRC, 1977). Fresh clean water was provided at all times. The amount of feed consumed per rabbit was determined as the difference between the feed offered and leftover. Body weight gain (BWG) change was calculated as the difference between the final and initial body weight. Feed conversion ratio was determined as total feed intake divided by BWG. The experimental set-up follows the pattern below:

Treatment 1: Basal diet with no *Trichilia monadelpha* stem bark extract (TMSB); Treatment 2: Basal diet plus 3 mL TMSB per rabbit/day; Treatment 3: Basal diet plus 6 mL TMSB per rabbit/day; Treatment 4: Basal diet plus 9 mL TMSB per rabbit/day

2.4 Laboratory analysis

Proximate analysis of the experimental diet was carried out using ProxiMate ^{TM} NIR instrument (India) with dimensions (W×D×H) (260 × 435 × 500 mm), 900 – 1700 nm wave length range, frequency (50/60 Hz), power consumption of 60W and resolution VIS (10 nm). Fatty acid analysis was carried out on 5 randomly selected rabbits using fatty acid analyzer (YL 6500 series) with the following specifications: column: TR-WAX (30m × 25mm ×0.25um), carrier gas: helium, 1.0 ml/min (split ratio 50:1), injector: capillary 270^{o}C, detector: FID 270^{o}C, sample preconditioning: FAME and injector volume: 1.0 ul (liquid).

2.5 Statistical analysis

Data were subjected to a one-way analysis of variance (ANOVA) by using the general linear model procedure of SAS (Version 9.4, SAS Institute Inc., Cary, NC). When the effect was declared significant ($p<0.05$), treatment means were compared using a Duncan's multiple-range test.

Table 1: Gross composition of experimental basal diets

Ingredient	Quantity (Kg)
White corn	35.60
Wheat offal	23.00
Palm kernel meal	14.00
Soy bean meal	15.00
Di-calcium phosphate	5.30
Palm oil	5.00
Salt	0.35
≠Premix	0.25
Toxin binder	0.20
Methionine	0.10
Lysine	0.20
Total	100.0
Calculated analysis (g/kg DM)	
Dry matter	900.46
Crude protein	170.10
Ash	19.11
Crude fibre	150.40
Ether extract	10.88
Metabolizable energy (kcal/kg)	2890.22

≠Each 1 kg contains: 8,500 IU vitamin A, 3000 IU vitamin D_3, 15.6 IU vitamin E, 2.10 mg vitamin K, 8.60 mg calcium pantothenate, 0.02 mg vitamin B_{12}, 0.55 mg folic acid, 300 mg choline chloride, 30.02 mg chlorotetracycline, manganese 150.30 mg, 62.75 mg iron, 44.04mg zinc, 2.7 mg copper, 1.50 mg iodine, 0.34 mg cobalt, 0.11 mg selenium

3. Results And Discussion

3.1 Chemical composition of secondary metabolites in *Trichilia monadelpha* stem bark extract (TMSB)

Examination of the secondary metabolites (phytochemicals) in *Trichilia monadelpha* stem bark extract revealed the presence of eight bioactive compounds at different concentrations (Table 2). Phenols had the highest concentration (18.46 mg/g) followed by flavonoids (15.88 mg/g), tannins (10.97 mg/g), alkaloids (9.22 mg/g), terpenoids (8.62 mg/g), glycosides (7.11 mg/g), saponins (4.75 mg/g) and oxalates (3.10 mg/g) respectively. DPPH (diphenylpicryhydrazyl) radical scavenging activity revealed that TMSB contained (430.8 mg/g). Phytochemicals are bioactive chemicals of plant origin used by plants for growth or defense against pathogens or predators (Saxena *et al*., 2013; Alagbe *et al*., 2020). They are also capable acting as co-factors and inhibitors of enzymatic reactions (Sarker and Nahar, 2007), substrate of biochemical reactions (Balandrin and Klocke, 1998; Alagbe *et al*., 2017), scavengers of free radicals and selective inhibitors of deleterious pathogens (Hyun *et al*., 2018; Cheeke, 2000). All the bioactive compounds recorded in TMSB have a marked pharmacological functions. For instance, phenol which is the most abundant compound contains one benzene ring with hydroxyl groups is effective in the reduction of reactive oxygen species (antioxidants) and promote a healthy gut in animals (Gadde *et al*., 2017), flavonoids and terpenoids play major role in the selective growth of

beneficial bacteria (Lillehoj and Lee, 2013; Musa *et al*., 2020), alkaloids function as antimalarial and analgesics (Akintayo and Alagbe, 2020), tannins possess antibacterial and antiviral activities (Daniyan *et al*., 2010; Adewale *et al*., 2021), saponins have been recommended to be required in antibacterial and anti-inflammatory activities (Abu *et al*., 2016). High concentration of phytochemicals beyond permissible range can be deleterious to the body of animals. According to Chai and Liebman (2004), high oxalate diet can increase the risk of renal calcium absorption and has been implicated as a source of kidney stones. However, all values were within the tolerable level recorded for rabbits by Omokore and Alagbe (2019). DPPH (2, 2 diphenyl-1-picrylhydrazyl) test is used to ascertain the antioxidant properties in TMSB and ability to scavenge free radicals thus preventing diseases and infections. The DPPH in the test material is potent due to the presence of phytochemicals especially phenolic compounds (FAD, 2013).

Table 2: Chemical composition of secondary metabolites in *Trichilia monadelpha* stem bark extract (TMSB)

Constituents	Composition (mg/g)
Alkaloids	9.22
Tannins	10.97
Saponins	4.75
Oxalates	3.10
Flavonoids	15.88
Phenols	18.46
Terpenoids	8.62
Glycosides	7.11
DPPH	430.8

3.2 Vitamin properties of *Trichilia monadelpha* stem bark (TMSB)

Chemical analysis on the vitamin properties of *Trichilia monadelpha* stem bark (TMSB) revealed that it contained vitamin A (retinol) at 2.190 mg/100g, vitamin B1 (thiamin), vitamin B2 (riboflavin), vitamin B3 (niacin), vitamin B9 (cobalamin) and vitamin C (ascorbic acid) at 0.567 mg/100g, 0.301 mg/100g, 0.227 mg/100g, 0.080 mg/100g, 0.209 mg/100g and 5.680 mg/100g respectively. Vitamin C had the highest concentration while vitamin B9 had the lowest concentration. Vitamins are chemical compounds that are essential for body functioning, enzymatic activities and certain biological functions (Chawla and Kaur, 2004). Vitamin C is the most abundant compound in TMSB which is a clear indication that it can act as an antioxidant as well as the formation of iron needed for the driving of oxygen in all parts of the body (Mullis *et al*., 2003). According to (Olkowski *et al*., 1992), vitamin B is responsible for maintaining nerve function, production of red blood cell, synthesis of fats and carbohydrates as well as replication of deoxyribonucleic acid (DNA) while vitamin A helps in improving the immune system, muscle tissues and sharp vision (Campbell *et al*., 2000; Engle *et al*., 2001).

Table 3: Vitamin properties of *Trichilia monadelpha* stem bark (TMSB)

Parameters	Composition (mg/100g)
Vitamin A (Retinol)	2.190
Vitamin B1 (Thiamin)	0.567
Vitamin B2 (Riboflavin)	0.301
Vitamin B3 (Niacin)	0.227
Vitamin B9 (Folate)	0.080
Vitamin B12 (Cobalamin)	0.209
Vitamin C (Ascorbic acid)	5.680

3.3 Fatty acid composition of rabbit thigh meat fed different levels of *Trichilia monadelpha* stem bark extract

Fatty acid composition of rabbit thigh meat fed different levels of *Trichilia monadelpha* stem bark extract revealed the presence of total saturated fatty acid (TSFA), monosaturated fatty acid (MUFA) and polysaturated fatty acid (PUFA) which ranged from 38.18 – 43.80 %, 20.12 – 24.22 % and 21.60 – 41.60 % respectively (Table 4). TSFA, MUFA and PUFA values were significantly ($P<0.05$) influenced by the treatments. Meat samples from T2, T3 and T4 had the highest concentration of total unsaturated fatty acid (PUFA and MUFA) compared to the other treatment. Conversely, T1 had the highest concentration of TSFA compared to the other treatments ($P<0.05$). High PUFA and MUFA level in T2, T3 and T4 could the attributed to the presence of phytochemicals in TMSB which enhanced the absorption or stability of essential nutrients as well as increase in the shelf life of

products (Alagbe *et al*., 2022; Davidson and Naidu, 2000). Increase intake of SFA results in cardiovascular disease in animals (Dawson *et al*., 1995). The result obtained in this experiment is in agreement with the findings of Chouliara *et al*. (2007); Brannan (2008) but contrary to the reports of Anadon *et al*. (2002) this variation could be attributed to differences in the composition of phytochemicals of the test ingredients, method of processing or extraction as well as concentrations. Diet plays an important role in the overall health and performance of an animal. Furthermore, nutrition has a regulatory effect on biological processes in muscle, which can influence the quality of meat and meat products (Anderson *et al*., 2005).

Table 4: Fatty acid composition of rabbit's thigh meat fed different levels of *Trichilia monadelpha* stem bark

Constituents	T1	T2	T3	T4	SEM
C14:0 (Lauric acid)	4.06^{a}	2.17^{b}	2.11^{c}	2.00^{c}	0.06
C16:0 (Palmitic acid)	19.4^{a}	11.3^{b}	10.7^{c}	10.3^{c}	0.42
C18:0 (Stearic acid)	7.18^{a}	5.60^{b}	5.10^{b}	4.00^{c}	0.30
C20:0 (Arachidic acid)	3.46^{a}	2.01^{b}	1.19^{c}	1.15^{c}	0.42
C22:0 (Behenic acid)	0.55^{a}	0.38^{b}	0.18^{c}	0.10^{c}	0.02
C14:1c (Myristic acid)	1.57^{d}	3.01^{c}	4.08^{b}	5.22^{a}	0.07
C16:1c (Palmitoleic acid)	2.09^{c}	3.00^{b}	4.05^{a}	4.11^{a}	0.02
C18:1c (Oleic acid)	10.1^{c}	14.3^{b}	19.6^{a}	20.7^{a}	0.44
C18:1n9t (Linoleic acid)	1.55^{c}	2.03^{b}	3.40^{a}	3.58^{a}	0.01
C18:1n9c (Linolelaidic acid)	1.00^{b}	1.61^{b}	2.08^{a}	2.77^{a}	0.05
C:22:1 (Erucic acid)	0.50^{c}	0.87^{b}	1.00^{a}	1.07^{a}	0.04
C18:2n6 (α-linolenic acid)	18.7^{b}	21.9^{a}	24.6^{a}	25.9^{a}	0.11
C20:5n3 (Arachidonic acid)	0.94^{c}	1.88^{b}	2.02^{a}	2.40^{a}	0.55
C18:3n3 (γ-linoleic acid)	7.18^{c}	10.8^{b}	13.7^{a}	18.4^{a}	0.42
C20:4n6 (Docosanoic acid)	2.05^{b}	2.86^{b}	4.05^{a}	5.71^{a}	0.08
C20:3n6 (Eicosapentanoic acid)	1.34^{b}	2.00^{a}	2.08^{a}	2.11^{a}	0.01
C22:6n3 (Decosahexeoic acid)	1.93^{c}	4.33^{b}	5.84^{a}	6.88^{a}	0.61
TSFA[1]	43.80^{a}	39.80^{b}	39.56^{b}	38.18^{b}	0.12
TUFA[2]	56.20^{b}	60.20^{a}	61.44^{a}	62.82^{a}	0.09
MUFA[3]	20.12^{b}	22.10^{a}	23.38^{a}	24.22^{a}	0.14
PUFA[4]	26.08^{b}	40.10^{a}	40.90^{a}	41.60^{a}	0.47

Means within a row with different letters were significantly different ($P<0.05$); [1]Total saturated fatty acid= C12:0 + C14:0 + C16:0 + C18:0 + C20:0 +C22:0; [2]Unsaturated fatty acid = (3 + 4); [3]Mono unsaturated fatty acid= C14:1C + C16:1$_C$ + C18:1$_C$ + C18:1n9t + C18:1n9c + C22:1; [4]Polyunsaturated fatty acid = C18:2 n6 + C20:5 n3 + C18:3n3 + C20:4n6 + C20:3n6 + C: 22:6n3

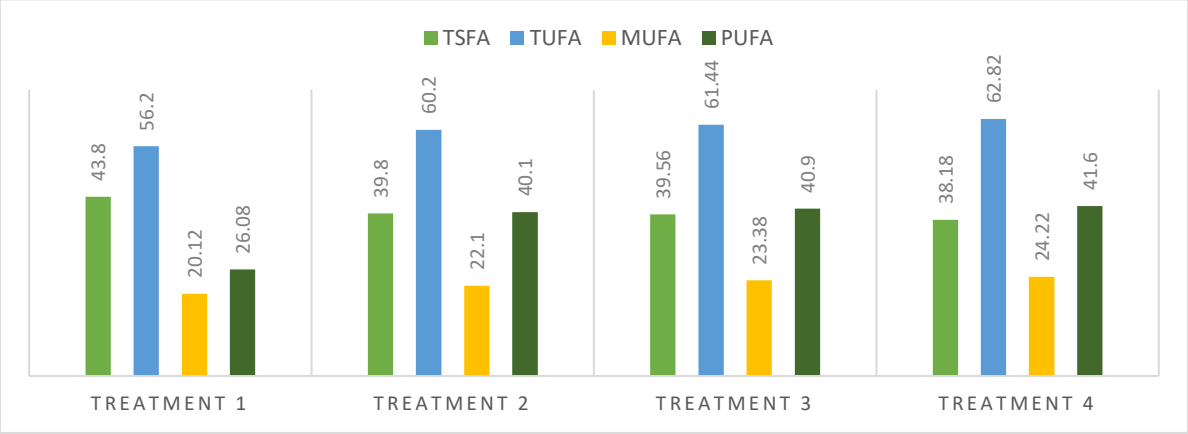

Figure 1: Fatty acid composition of thigh meat across the treatments

4. Conclusion

Results from this study showed that rabbits fed TMSB had a better PUFA and MUFA level with a decrease in TSFA concentration. TMSB contains secondary compounds which exhibit many different biological properties

in animals including modulating the fatty acid composition of meat as well as promoting food safety. It can be concluded that feeding rabbits TMSB up to 9 mL per day had no negative effect on the general performance of animals.

References

Okwu DE. Phytochemical and vitamin content of indigenous spices of South Eastern Nigeria. J. Sustain Agric. Environ., 2004; 6:30-37.

Okwu DE, Ndu CU. Evaluation of the phytonutrient, mineral and vitamin content of some varieties of yam (Discorea spp.). International Journal of Molecular Medicine and Advanced Science, 2006; 2(2): 199-203.

Robert KM, Daryl KG, Peter AM, Victor WR. Harper's Illustrated Biochemistry. In Benders and Mayes Vitamins and Minerals, Lange Medical Books/McGraw-Hill, Medical Publishing Division, New York, 2003; 496.

Sczkowski CP, Kalinowska M, Wojciechowski Z. The 3-O glucosylation of steroidal saponins and alkaloids in eggplant (Solanum melongena); evidence for two separate glycosyl transferences, Phytochemistry, 1998; 48: 1151-1159.

Harborne JB. Phytochemical Methods: A guide to modern techniques of plant analysis. Chapman and Hall, New York. 1973; 2: 88- 185.

Abu, Ngozi E., Ezeomeke, Somadina, Azegba, Promise and Davidson, Gloria (2016). Phytochemical, nutritional and anti-nutritional properties of leaves, stems bark and roots of trees used in popular medicine for the treatment of malaria in South Eastern Nigeria. Journal of Medicinal Plants Research. 10(38): 662-668.

International Poultry Production (2011). Full natural phytogenic support for intestinal resilience in poultry. International Poultry Production Magazine, 30(4): 25-26.

Adewale, A.O., Alagbe, J.O., Adeoye, Adekemi. O. (2021). Dietary Supplementation of *Rauvolfia Vomitoria* Root Extract as A Phytogenic Feed Additive in Growing Rabbit Diets: Haematology and serum biochemical indices. International Journal of Orange Technologies, 3(3): 1-12.

Alagbe, J.O., Shittu, M.D and Ushie, F.T. (2021). GC-MS analysis of methanolic stem bark extract of *Zollingeriana indigofera*. Asian Journal of Advances in Research 11(4): 144-146.

Alagbe, J.O (2021). Dietary Supplementation of *Rauvolfia Vomitoria* Root Extract as A Phytogenic Feed Additive in Growing Rabbit Diets: Growth Performance and Caecal Microbial Population. *Concept in Dairy and Veterinary Sciences*. 4(2):2021.

Alagbe, J.O (2020). Chemical evaluation of proximate, vitamin and amino acid profile of leaf, stem bark and roots of *Indigofera tinctoria*. International Journal on Integrated Education. 3(10): 150-157.

Alagbe, J.O., Ajagbe, A.D., Attama Jeremiah, Philemon, K.C and Bello, Kamoru, A (2020). *Albizia lebbeck* stem bark aqueous extract as alternative to antibiotic feed additives in broiler chicks diets: Haematology, Serum indices and oxidative status. International Journal of Biological, Physical and Chemical Studies, 2(1): 8-15.

Alagbe, J.O (2020). Caecal Microbial Population of Growing Grass Cutters (*Thyronoyms Swinderianus*) Fed *Phyllantus Amarus* and *Pilogstigma Thonngii* Leaf Meal Mixture as Partial Replacement for Soya Bean Meal. Concept of Dairy and Veterinary Sciences. 3(5): 350 – 355.

Alagbe, J.O., Adeoye, Adekemi and Oluwatobi, O.A. (2020). Proximate and mineral analysis of *Delonix regia* leaves and roots. International Journal on Integrated Education. 3(10): 144-149.

Alagbe, J.O., Sharma, R., Eunice Abidemi Ojo, Shittu, M.D and Bello Kamoru Atanda (2020). Chemical evaluation of the proximate, minerals, vitamins and phytochemical analysis of *Daniellia oliveri* stem bark. International Journal of Biological, Physical and Chemical Studies, 2(1):16-22.

Alagbe, J.O and Akintayo-Balogun, O.M. (2020). Effects of dietary supplementation of *Albizia lebbeck* seed oil (ALO) on the fatty acid composition of weaner rabbits. Biochemistry and Biotechnology Research, 8(2): 29-33.

Musa, B., Alagbe, J.O., Adegbite Motunrade Betty, Omokore, E.A. (2020). Growth performance, caeca microbial population and immune response of broiler chicks fed aqueous extract of *Balanites aegyptiaca* and *Alchornea cordifolia* stem bark mixture. United Journal for Research and Technology, 2(2):13-21.

Omokore, E.O and Alagbe, J.O. (2019). Efficacy of dried *Phyllantus amarus* leaf meal as an herbal feed additive on the growth performance, haematology and serum biochemistry of growing rabbits. International Journal of Academic Research and Development. 4(3): 97-104.

Alagbe, J.O. (2019). Haematology, serum biochemistry, relative organ weight and bacteria count of broiler chicken given different levels of *Luffa aegyptiaca* leaf extracts. International Journal of Advanced Biological and Biomedical Research. 7(4):382-392.

Alagbe, J.O and Omokore, E.A. (2019). Effect of replacing soya bean meal with *Indigofera zollingeriana* leaf meal on the performance and carcass characteristics of growing rabbits. International Journal of Multidisciplinary Research and Development. 6(5): 74-77.

Alagbe, J.O., Shittu, M.D and Tanimomo, Babatunde K. (2022). Influence of *Anogeissusleio carpus* stem bark on the fatty acid composition in meat of broiler chickens. European Journal of Life Safety and Stability 14(22): 13-22.

Alagbe, J.O (2022). Use of medicinal plants as a panacea to poultry production and food security: A review. *Gospodarka I Innowacje* 22(2022): 1-12.

Alagbe, J.O., Agubosi, O.C.P., Ajagbe, A.D, Shittu, M.D and Akintayo Balogun, O.M (2020). Performance, haematology and serum biochemical parameters of growing grass cutters fed *Phyllantus amarus* and *Piliostigma thonningii* leaf meal mixture as partial replacement for Soya bean meal. United International Journal for Research and Technology, 2(1): 14-23.

Alagbe, J.O., Shittu, M.D., Bamigboye, S.O and Oluwatobi, A.O. (2020). Proximate and mineral composition of *Pentadiplandra brazzeana* stems bark. Electronic Research Journal of Engineering, Computer and Applied Sciences. 1(2009): 91-99.

Sarker SD, Nahar L. Chemistry for Pharmacy Students General, Organic and Natural Product Chemistry. Indian Journal of Physiology and Pharmacology, 2007; 283-359.

Saxena M, Saxena J, Nema R, Singh D, Gupta, A. Phytochemistry of Medicinal Plants. Journal of Pharmacognosy and Phytochemistry Center for Microbiology and Bio-Technology Research and Training, Bhopal, India. 2013; 8192 (1): 168-182.

Balandrin MF, Klocke JA (1998) Medicinal, Aromatic and Industrials Products from Plants: Biotechn. In Agric. and Forest, 4 (Medicinal and Aromatic plants I). Edited by Y.P.S. Bajaj. Springier-Verlag, Berlin, New York.

Alagbe, J.O., Eimoga, A.A and Alagbe, O.O. (2017). Growth response and carcass characteristics of weaner grass cutters fed diets supplemented with *Polyalthia longifolia* seed oil as a natural growth promoter. Greener Journal of Agricultural Sciences. 7(5): 112-119.

Alagbe, J.O. (2017). Growth performance and blood parameters of weaner pigs fed diets supplemented with turmeric powder. Scholarly Journal of Agricultural Science. 7(2):57-61.

Hyun Lillehoji., Yanhong Liu., Sergio Calsamiglia., Mariano E. Fernandez-Miyakawa., Fang Chi., Ron L. Cravens., Sungtaek Oh and Cyril G. G. (2018). Phytochemicals as antibiotic alternatives to promote growth and enhance host health. Veterinary Research, 2018 (49:46).

Gadde, U., Kim, W.H., Oh, S.T and Lillehoj, H.S. (2017) Alternatives to antibiotics for maximizing growth performance and feed efciency in poultry: a review. Animal Health Research Revision 18:26–45

Lillehoj, H.S and Lee, K.W. (2012) Immune modulation of innate immunity as alternatives-to-antibiotics strategies to mitigate the use of drugs in poultry production. Poultry Science, 91:1286–1291.

Andersen H. A., Oksbjerg N., Young J. F., Therkildsen M. (2005). Feeding and meat quality – a future approach. Meat Science, 70, 543–554.

Agubosi, O.C.P., Imudia, Favour Dumkenechukwu and Alagbe, J.O. (2022). Evaluation of the nutritional value of air dried and sun-dried sweet potato (*Ipomoea batatas*) peels. European Journal of Life Safety and Stability 14(22): 43-51.

Agubosi, O.C.P., Oluwafemi, R.A., and Alagbe, J.O. (2021). Preliminary study on GC-MS analysis of *Prosopis africana* seed (*African mesquite*) oil. Journal of Ethics and Diversity in International Communication 1(4): 18-20.

Akintayo Balogun Omolere. M and Alagbe, J.O (2020). Probiotics and medicinal plants in poultry nutrition: A review. United International Journal for Research and Technology, 2(1): 7-13.

Cheeke, P.R. (2000). Actual and potential applications of Yucca schidigera and Quillaja saponaria saponins in human and animal nutrition, Journal of Animal Science, 77:1-10.

Daniyan, S. Y., Galadima, M., Ijah, U., Odama, L .E, Yusuf, A. Y and Abbas, Y. (2010). In vitro antibacterial screening of *Piliostigma thonningii*(schum) Milne red head leaves extracts against clinical isolates of methicillin resistant and methicillin sensitive *Staphylococcus aureus*. International Journal of pure and Applied Sciences, 4(1): 88-94.

Olkowski, A. A., S. R. Gooneratne, C. G. Rousseaux, and D. A. Christensen. (1992). Role of thiamine status in sulphur induced polioencephalomalacia in sheep. Research in Veterinary Science, 52:78–85.

Chai, W. and Liebman, M. (2004). Assessment of oxalate absorption from Almonds and Black beans with and without the use of an extrinsic label. *Journal of Urology,* 172: 953-957.

Food and Drug Administration (2013) Guidance for Industry #213 new animal drugs and new animal drug combination products adminis- tered in or on medicated feed or drinking water of food- producing animals: recommendations for drug sponsors for voluntarily aligning product use conditions with GFI #209.

Chawla, R., and H. Kaur. (2004). Plasma antioxidant vitamin status of periparturient cows supplemented with alpha-tocopherol and beta-carotene. Animal Feed Science and Technology, 114:279–285.

Mullis, L. A., J. W. Spears, and R. L. Mc Craw. (2003). Estimated copper requirements of Angus and Simmental heifers. Journal of Animal Science, 81:865–873.

Engle, T. E., V. Fellner, and J. W. Spears. (2001). Copper status, serum cholesterol, and milk fatty acid profile in Holstein cows fed varying concentrations of copper. Journal of Dairy Science, 84:2308–2313.

Campbell, J. R., P. R. Greenough, and L. Petrie. (2000). The effects of dietary biotin supplementation on vertical fissures of the claw wall in beef cattle. Canadian Veterinary Journal, 41:690–694.

Davidson H.J.D., Naidu A.S. (2000). "Phyto-phenols," in Natural Food Antimicrobial Systems, ed. A. S. Naidu (Boca Raton, FL: CRC Press), 265–294.

Dawson P.L., Han I.Y., Voller L.M., Clardy C.B., Martinez R.M., Acton J.C. (1995). Film oxygen transmission rate effects in ground chicken meat quality. Poultry Science, 74, 1381-1387.

Chouliara E., Karatapanis A., Savvaidis I. N., Kontominas M. G. (2007). Combined effect of oregano essential oil and modified atmosphere packaging on shelf-life extension of fresh chicken breast meat, stored at 4°C.Food Microbiology, 24, 607– 617.

Anadon H.L.S. (2002). Biological, Nutritional, and Processing Factors Affecting Breast Meat Quality of Broilers. Doctor of Philosophy Thesis in Animal and Poultry Sciences. Virginia Polytechnic Institute and State University. Blacksburg, Virginia. USA.

Brannan R.G. (2008) Effect of grape seed extract on physicochemical properties of ground, salted, chicken thigh meat during refrigerated storage at different relative humidity levels. Journal of Food Science, 73, C36-C40.

International Dairy Topics (2000). The use of plant extracts to support growth in early calfhood. International Journal of Dairy Topics Magazine, 18(5): 11-12.

Rababah T.M., Ereifej K.I., Al-Mahasneh M.A., Al-Rababah M.A. (2006). Effect of plant extract on physicochemical properties of chicken breast meat cooked using conventional electric oven or microwave. Poultry Science, 85:148-154.

Bourre J.M. (2005). Where to find omega-3 fatty acids and how feeding animals with diet enriched in omega-3 fatty acids to increase nutritional value of derived products for human: What is actually useful? The Journal of Nutrition Health and Aging, 9, 232–242.

Savithramma, N.M and Ankanna, S. (2012). Preliminary phytochemical analysis of traditionally used medicinal plants. Research Journal of Pharmacology and Biological Sciences, 3(1): 308-314.

Woode, E., Amoh-Barimah, A.K., Abotsi, W.K., Ainooson, G.K and Owusu, A.K. (2012). Analgesic effects of stem bark extracts of *Trichilla monadelpha*. Indian Journal of Pharmacology, 44(6): 765-773.

Meir,S., Kanner, J., Akiri, B and Hadas, S.P. (1995). Determination and involvement of aqueous reducing compounds in oxidative defense systems of various senescing leaves. Journal of Agriculture and Food Chemistry, 43: 1813-1818.

Kamanzi, A., Schmid, C., Burn, R., Kone, M.W and Traore, D. (2004). Antitrypanosomal and antiplasmodial activity of medicinal plants from Cote d'voire. Journal of Pharmacology, 90(2-3): 221-227.

Ainooson, G.K., Owusu, G., Woode, E., Ansah, C and Anan, K. (2012). *Trichilla monadelpha* bark extracts inhibits Carrageenan-Induced foot oedema in the 7th day old chick and the oedema associated with adjuvants induced arthritis in rats. African Journal of Traditional and Complementary Medicine, 9(1): 8-16.

Ivo, J., Viera, C., Wagner, D.S.T., Milena, D.S.G., Raimundo, B.F. (2014). Novel antimalarial compounds isolated in a survey of self-meditative behavior of wild chimpanzee in Uganda. Antimicrobial Agents Chemotherapy, 48: 3196-3199.

Tsamo, T.A., Mkounga, A.B., Njayou, F.N., Manutou, J., Kirk, M and Philip, G.H. (2013). Rubescins A, B and C new havanensin type limonoids from root bark of *Trichilla monadelpha*. Chemical Pharmacology Bulletin, 61: 1178-1183.

Aladesanmi, A.J and Odediran, S.A. (2000). Antimicrobial activity of *Trichilla monadelpha* leaves. Fitoterapia, 71: 179-182.

Germano, M.P., Angelo, V.D., Sanogo, R., Catania, S., Aima, S., De Pasquale, R and Bisignano, G. (2005). Hepatoprotective and antibacterial effects of extracts from *Trichilla monadelpha*. Journal of Ethno pharmacology, 96: 227-232.