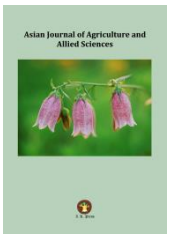

Asian Journal of Agriculture and Allied Sciences

Volume 6, Issue 1, Page 95-103, 2023; Article no.AJAAS.12013

Unconventional Homogenized Vegetable Meal (HVM) Feed Ingredients on Skin Pigmentation and Weight Gain of Broiler Chickens

U.D.E. Ogbuokiri [a*], G.E. Omorodion [a], U. A. Agugo [b], Maxwell Edih [a], C.C. Olueze [a] and H.C. Nwaereka [a]

[a] Department of Animal Production and Health Technology, Imo State Polytechnic Umuagwo, Ohaji, Owerri, Nigeria.
[b] Department of Human Nutrition and Dietetics, Ambrose Alli University, Ekpoma, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author UDEO designed the study. Author UAA wrote the first draft of the manuscript and managed the literature search. Authors GEO and CCO managed the data collection and analyses of the study. All authors read and approved the final manuscript.

Original Research Article

Received: 25/10/2023
Accepted: 29/12/2023
Published: 30/12/2023

ABSTRACT

A feeding trial was undertaken to investigate the effects of unconventional homogenized (HVM) feed ingredients on skin pigmentation and weight gain of broiler chickens. A total of one hundred and twenty (120) Arbor Acres day – old- chicks (DOCs) of straight – run were used for this study. They were reared to one week of age following standard procedures and strict bio-security measures, using commercial feed before placing them on experimental diets. Birds were randomly assigned to five treatments with twenty-four (24) birds per treatment in a Completely Randomized Design (CRD). Each treatment was further replicated four times with six birds per replicate. Eachreplicate was housed in a 2 x 3 m pen on a deep litter. The birds received water and feed ad libitum starting from 7.00 am daily for 56 days of feeding trial. The treatment groups were assigned to the different treatment diets so that the control group received a diet containing zero HVM, while

**Corresponding author: E-mail: samdoles@yahoo.com;*

others received the corresponding HVM inclusion levels consisting of 2.5%, 5%, 7.5% and 10% proportions. The result of broiler birds fed homogenized unconventional feed ingredients (HVM) on the shank (skin) pigmentation score recorded no significant difference (P>.05) between treatment T1 and T2 (HVM=0% and HVM= 2.5%). However, differences among treatments T3, T4 and T5 (HVM= 5%, HVM=7.5% and HVM=10%) were significantly better (P=.05) than birds on T1 and T2. The result equally shows no significant difference (P>.05) on the mean change in life weight of birds across all treatments. However, the mean weight gain increases as the inclusion of HVM increases across the treatments, except in treatment 3. Results of feed intake and feed conversion ratio (FCR) showed no significant difference (P>.05) across all treatment. This finding indicates that the increase in the inclusion rate of HVM increases the weight gain.

Keywords: Homogenized; unconventional; feed ingredients; skin pigmentation; weight gain; broiler; chickens.

1. INTRODUCTION

"The world would need 73% more meat and 58% more milk in 2050 as postulated by FAO and Thieme and Makkar" [1, 2]. "To meet the above demands, a huge quantity of feed resources will be required. Given the central importance of broiler production in bridging the animal protein gap in Nigeria, it becomes very necessary to exploit feed ingredients of lower cost and sound biological values that can help supplement the costly conventional protein sources. Leaf meal supplementation has been included into the diet of poultry as means of reducing the high cost of conventional protein source and to improve profit margin" [3-7]. "The incorporation of protein from leaf sources in the diet for broiler is fast gaining grounds because of its availability, abundance and relatively low cost. Leaf meal does not only serve as a protein source but also provide some necessary vitamins, minerals and also oxycarotenoids which cause the yellow colour of broiler skin, shank and egg yolk" [3-7]. "The fibre content of leaf meals may equal to or exceed crude protein concentrations. Consequently, digestibility of the crude protein fraction of many leaf meals is low which tends to depress overall crude protein digestibility when leaf meals constitute a significant proportion of the diet" [8]. The use in mono-gastric nutrition may also be limited by their low contents of metabolizable energy (ME) and sulphur amino acids and by the increased bulkiness of these products.

"In Nigeria, attempts to expand the livestock sub-sector have been hampered by the perennial rise in costs of production and chronic shortages of the main energy sources, cereals, especially maize where animals are in direct competition with man and food industries for its consumption and use. Cereal grains constitute a large proportion (>50%) of poultry diets and contribute largely carbohydrates and to some extent proteins" [9]. "They are mainly a dietary source of energy but can vary widely between grain types and animal species" [9]. "As feed constitutes 60-70% of the total cost of production, any attempt to reduce the feed costs may lead to a considerable reduction in the total cost of poultry production" [10]. In this regard, there exists a wide range of agricultural by-products, some of them are available in large quantities, are even wasted and do have considerable nutritional potentials. Cassava (*Manihot esculenta,* Crantz), cabbage (*Brassica oleracea, var. capitata)* and pawpaw (*Carica Papaya*, Linn.) leaves are within some of the categories of these unrealized potentials.

"In Nigeria, a considerable amount of cassava leaves are generated annually and readily available as a by-product at the time of harvesting the roots. Lots of the generated cassava leaves are wasted. Cassava leaves are a significant source of potential alternative protein resource for both humans and animals" [11]. "The leaves, depending on the varieties, are rich in minerals, proteins, vitamin and carotenes" [11]. Equally, cassava foliage meal has vitamin A in significant levels in the pigmentation of egg yolk and skin of poultry, especially broilers [12, 3] and it can be a substitute for all the alfalfa in the diet of laying hens [12]. According to Ogbuokiri [3], low inclusion levels (6 and 8%) of cassava leaf meal, had a significant effect on the pigmentation score of starter broilers.

"Pawpaw (*Carica papaya,* Linn) is a plant native to tropical America. The leaves have become increasingly important as a source of protein for monogastric and ruminant animals" [13]. "The leaf protein is reported to be limiting in methionine and tryptophan but rich in lysine, with an overall biological value of 49-57%" [13]. "Pawpaw leaves are rich in vitamin C, folate, and

potassium; they are also good sources of fibre, vitamin A, vitamin E, eye-saving carotenoids, lutein and zeaxanthrin and lycopene. Pawpaw has a lycopene level of about 2,000 ug per 100g and the fruits have 33% more vitamin C and 50% more potassium than oranges, with fewer calories. It has 13 times more vitamin C and more than twice potassium than apple" [13].

"Cabbage (*Brassica oleracea, var. capitata)*) is a leafy green, red, or white biennial vegetable that grows annually. It is largely grown during the winter and early spring, (Wikipedia). It has been estimated that about 30% of total cabbage production is discarded as waste, which consists mostly of leaves, (Wikipedia). Cabbage waste is a good source of protein (Wikipedia) and can also be used for feeding poultry. Cabbage is a very good source of dietary fiber, calcium, magnesium, and potassium. As per the United States Development Agency (USDA) nutrient database, it also contains various vitamins like vitamin C, thiamine, niacin, and folate. It is also high in antioxidant including flavonoids, zeaxanthin, lutein, choline, and beta-carotene". [14]

"Vegetables are rich nutrient sources, potentially good for supplying essential amino acids, minerals and antioxidants to the birds, comparatively inexpensive, easily available and easy to process and pose less risk of disease contamination" [15]. "Consumers prefer the meat of broilers exclusively fed with vegetable sources as they feel it is more tasty, juicy, and tender". [16] "However, it should be also considered that vegetable sources contain numerous anti-nutritive factors (ANF), lower protein quality, lower digestibility and lower biological value compared with animal sources and can affect meat quality". [17] "Chicken meat is rich in polyunsaturated fatty acids (PUFA), which are more sensitive to free-radical attack, leading to oxidative damage" [18]. "Meat quality is negatively affected when free radicals initiate the oxidation reaction and destroy the normal muscle fiber, accumulating harmful byproducts in the muscle" [19]. "Meat discoloration post mortem is predominantly caused by the oxidation of myoglobin" [20]. "It is assumed that vegetables/green leafy plants fed to broilers may improve the antioxidant status of meat and reduce the harmful effects of oxidative damage" [20].

The shelf life of broiler meat is the length of time that the meat may be stored without becoming unfit for use, the shelf life of the carcass has a long way to determine the rate of consumers demand and consumption. According to the United States Department of Agriculture (USDA), raw chicken, raw turkey and other poultry [14] can be kept in the fridge approximately 1-2 days. The present study is designed to investigate the effects of dietary supplementation with some unconventional feed ingredients (cassava, pawpaw and cabbage leaves) on skin pigmentation and weight gain of broiler chickens as an alternative to existing conventional animal feed protein sources, intended to force down the escalating feed prices as well as the costs of broiler production.

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was carried out at the Poultry Unit of the Imo State Polytechnic Teaching and Research Farm, Umuagwo, Ohaji, Imo State, Nigeria. The site has the coordinates of Latitude 5o 29'0" North and Longitude 7o 2' 0" East of Greenwich Meridian, Altitude of 156 m (511 ft) and 12 km south from the Owerri capital territory. The annual relative humidity is 75%, with humidity reaching 90% in the rainy season. "It has an average yearly rainfall of 172 - 190 mm, which is uniformly distributed. The area experiences maximum and minimum temperatures of 340C and 180C respectively. The dry season experiences two months of Harmattan from late December to February. The hottest months are between January and March. The experimental site is located within the tropical evergreen rain forest belt Southeastern Nigeria" [21].

2.2 Preparation of Homogenized Vegetable Meal (HVM)

The unconventional leaves of cassava leaf (*Manihot esculenta,* Crantz), pawpaw leaf (*Carica papaya*, Linn.) and cabbage leaf *(Brassica oleracea var. capitata)* were gathered around the premises of Animal Production and Health Technology Department of Imo State Polytechnic, Umuagwo, Ohaji, Owerri, Imo State. The leaves were washed, dried under the shade for about seven (7) days on the concrete floor until they are crispy, stored in polyethylene bags and later milled to produce a homogenized vegetable meal (HVM). Red oil (about 10ml/200g cassava) was

added to help eliminate the cyanide in the cassava leaves. The HVM was subjected to standard proximate analysis [22] to determine the crude protein, moisture, crude protein, ash, ether extract and nitrogen-free extract (NFE).

2.3 Experimental Birds and Design

"One hundred and twenty (120) Arbor Acres broiler day- old- chicks (DOCs) of mixed sexes were used for this study. They were reared to one week of age following standard procedures and strict bio-security measures, using commercial feed before placing them on experimental diets". [23] The one hundred and twenty (120) birds, selected from a pool of 200 birds, were randomly assigned to five treatments with twenty-four (24) birds per treatment in a Completely Randomized Design (CRD). Each treatment was further replicated four times with six birds per replicate. Each replicate was housed in a 2 x 3 m pen on a deep litter. The birds receive water and feed *ad libitum* starting from 7.00 am daily for 56 days of feeding trial. The treatment groups were assigned to the different treatment diets so that the control group received a diet containing zero HVM, while others received the corresponding HVM inclusion levels.

2.4 Test Diets

Five experimental test diets were formulated. The HVM was incorporated into the diets at 0, 2.5, 5, 7.5 and 10 % to represent treatments 1, 2, 3, 4 and 5, respectively. Treatment 1 served as control.

2.5 Data Collection

Bodyweight and shank pigmentation scores were recorded at the beginning of the experiment (D+0, D = Day experimental feed was introduced) and thereafter, weekly. Feed intake was recorded weekly. Mortality was recorded daily throughout the experiment. The shank pigmentation scores were measured weekly using the Roche Yolk colour (RYC) scale [24]. At the end of the experiment, 56 days, 50% of the birds were killed using an automatic killing machine after proper stunning to enable the majority of the blood to be pumped out during the first 15 seconds. This allows for rapid subjection to scalding. A semi- scald temperature of 51-54^{o}C for 90 to 120 seconds was used to keep the epidermal skin layer on the bird (yellow colour). Later, the birds were de-feathered (picked) using a drum-type de-feathering machine rotating perpendicularly counter to the rubber fingers to bird movement. Other cores like pinning, singeing, washing off feathers with water and removal of shanks and oil glands and evisceration were performed. Broilers from different treatments were processed and stored in a freezer at different (2^0C- 4^0C) temperatures for 14 days after the first sample was collected. The microbial growth count and the effect of skin pigmentation were evaluated weekly to determine the best storage time. The aspect of microbial and sensory evaluation of chicken meat have been published [25].

2.6 Data Analysis

Data obtained from the response variables were subjected to a one-way analysis of variance (ANOVA) according to the procedure of Bevans, [26]. Significantly different means were separated using Duncan Multiple Range Test as described by De Mendiburu [27]. Data generated from the microbial growth count were expressed in an excel spreadsheet and summarized in a Table 1.

Table 1. Proximate composition of homogenized vegetable meal (HVM) of cabbage, pawpaw and cassava leaves

Component	Percentage
Crude protein	26.23
Fat	4.70
Moisture	8.27
Ash	8.85
NFE	-
Crude fiber	8.78
Energy (kcal/kg)	2043.04

Source: animal care service consult (Nigeria) Ltd. Feed and quality control laboratory Asaba, Delta state, Nigeria

3. RESULTS AND DISCUSSION

3.1 Mean Change in Live Weight

The result on mean weight gain is presented in Table 3. The result shows that the mean change in the live weight of the birds was significant (P=.05). The mean change in life weight increased as the inclusion of HVM increases

across the treatments, except in treatment 3. The mean change in live weight of birds for T1-T5 was 2297g, 2490g, 2425g, 2533g and 2584g, respectively. This result is in harmony with Revidran et al[28] that found that cassava leaf meal can be included up to 15%-20% in broilers diet without any negative impact on performance. This finding is also in agreement with the submission of Nworgu and Fasogbon [29] that observed a significant (P=.05) increase on average daily weight gain of 13.21gram as against the control diet of 12.48g when fed 20% dietary level of *Centrosema pubescence* leaf meal to growing pullets. The increase in the mean change in the live weight of the birds could be as a result of the high protein in the cassava leaf. According to Ngiki et al.[30] observed high protein and nutritional factors in cassava leave ranging from 16.6%-39.9% and mineral level levels, as well as being an available source of vitamin B1, B2 and C and carotenes. This result also agrees with Adesina and Toya [31] that reported that birds fed 30% cabbage produced significant higher body weight after 4 weeks.

3.2 Mean Feed Intake

The mean feed intake is shown in Table 3; the result shows that no significant difference (P>0.05) was recorded in the feed intake across all treatments with values of 1528g, 1880g, 1988g, 1749g and 2152g respectively. However, there was progressive improvement in the feed intake of birds across the treatments, except in treatment 4. As reported by [32], this could be a result of the presence of the micronutrient like vitamin A, Riboflavin, and Iron present in cabbage leaf which helps to boost the health of the chicken.

Table 2. Percentage composition of the Experimental diet (%)

Ingredients	**Treatment diets**				
	1(0%)	**2(2.5%)**	**3(5%)**	**4(7.5%)**	**5(10%)**
Maize	60.75	58.65	55.95	55.45	54.45
HVM[1]	0	2.5	5	7.5	10
Soya bean meal	30	30	30	28	26.5
Oil	3	3	3	3	3
Bone meal	2	1.6	1.6	1.6	1.6
Limestone	1.2`	1.2	1.4	1.4	1.4
Fish meal	2	2	2	2	2
Salt	0.3	0.25	0.3	0.3	0.3
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**
Calculated Analysis					
Protein (%)	20	20	21	21	21
Energy (ME Kcal/kg)	3198	3198	3200	3200	3198
Oil (%)	5.9	5.9	6.0	5.9	6.0
Crude fiber (%)	3.4	3.5	3.69	3.77	3.9
Lysine (%)	1.3	1.3	1.3	1.3	1.2
Methionine (%)	0.57	0.57	0.57	0.56	0.55
Calcium (%)	1.5	1.4	1.5	1.5	1.4
Avail. Phosphorus (%)	0.59	0.53	0.53	0.52	0.52

HVM[1] = Cabbage, pawpaw and cassava leaves

Vitamin A: 12,000,000 IU, Vitamin. D3: 2,500,000 IU, Vitamin E: 20, 0000 mg, Vitamin K3: 2,000 mg, Vitamin B1: 2,000 mg, Vitamin. B2:5,000 mg, Niacin: 30,000 mg, Pantothenic Acid: 11,000 mg, Vitamin. B6: 4000mg, Vitamin. B12: 15mg, folic Acid: 1,500 mg, Biotin H2: 60mg, Choline chloride: 220, 000mg, Cobalt: 200mg: Copper 3,000mg, Iron: 20,000 mg, Manganese: 50,000mg, Selenium: 1,000mg, Zinc: 40,000mg and antioxidant: 1,250mg

Table 3. Effect of graded level of homogenized feed ingredients on the performance of broiler birds

Ingredients	Treatment Diets				
	1(0%)	2(2.5%)	3(5%)	4(7.5%)	5(10%)
Protein	20	20	21	21	21+
Energy (ME kcal/kg)3198	3198	3198	3200	3200	3198+
Calorie/protein Ratio	160	160	152	152	152+
Lysine/methionine Ratio	2	2	2	2	2+
Mean initial live weight (g)	78.7	78.7	78.7	78.7	78.7+
Mortality	0	0	0	0	0+
Mean final live weight (g)	2376	2569	2504	2612	2663
Mean live weight gain (g)	2297^{a}	2490^{b}	2425^{c}	2433^{d}	2584^{e}
Mean daily weight gain/bird (g	41^{a}	44^{a}	43^{a}	45^{a}	46^{a}
Mean feed intake (g)	1528^{a}	1880^{a}	1988^{a}	1749^{a}	2152^{a}
Mean daily feed intake/Bird (g)	203^{a}	250^{a}	265^{a}	233^{a}	285^{a}
Shark pigmentation	1.0^{b}	1.03^{b}	1.35^{ab}	1.44^{a}	1.50^{a}
Feed conversion Ratio	1.3^{ab}	1.5^{a}	1.7^{a}	1.3^{ab}	1.6^{a}

Means on the same Row Bearing different superscript differ significantly (P<0.05),
+ Not subjected to statistical analysis.

3.3 Mean Daily Feed Intake Per Bird (g)

The performance indices of the birds are shown in Table 3. The mean daily feed intake of birds in treatment 5 was numerically better than those of the other treatments different. The respective numerical values were 203, 250, 265, 233 and 285 g for treatments 1, 2, 3, 4, and 5, respectively.

The different levels of consumption among the diet could be as a result of certain factors that influence the rate of feed consumption which include the consumption of other nutrients in the diet. The relatively high level of consumption of diet could be as a result of the texture of the feed since the fibre levels are relatively high thus making the feed bulky. This agrees with the findings of Homer and Schaible [33] that feed intake in poultry is determined largely by energy concentration, provided the diet is adequate. The texture of the feed may have contributed to the different voluntary levels of consumption among the treatments, a finding that agrees with Feltwell [34].

3.4 Mean Daily Weight Gain per Bird (g)

The data on mean daily weight gain per bird are also shown in Table 3. Birds on treatment 2, 4 and 5 recorded numerically higher weight gain than treatments 1 and 3. The respective values were 41, 44, 43, 45 and 46 g. The average daily weight gain in treatments 3, 4 and 5 is reflected on the daily feed intake as the birds on treatment 3, 4 and 5 recorded the highest feed intake. This view is in accordance with the findings of Feltwell and Fox [35] that growth may be regarded as a function of food consumption since the live weight of birds increases in proportion to the amount of food consumption above that needed for maintenance. And contrary to the lower live weight gain of broilers feed with feed ingredients supplemented with vegetable waste, as reported by Raza *et al*. [36]. The variation could be attributed to the nature and nutrient composition of the vegetable waste since the experiment was conducted in Pakistan.

3.5 Shank Pigmentation Score

Shank pigmentation score was monitored with Roche colour fan [37] and shown in table 3. No significant differences (P>0.05) were recorded in the average mean of the shank colour between treatment 1 and treatment 2 with 1.0 and 1.03 figures, respectively. However, treatments T3, T4 and T5 with mean respective values of 1.35, 1.44, and 1.50 were significantly (P=0.05) better than T1 and T2, without themselves being significantly different (P>0.05).

There was an increase in the shank pigmentation as the HVM increases across the treatments. This is in harmony with [4] that showed that the inclusions of the homogenized vegetable waste meal (HVWM) of onions, sweet potato vine, sweet orange fruit peel, ugu leaf or fluted pumpkin leaf, green leaf and carrot leaf up to 25% in broiler starter diet improved the shank pigmentation in starter broilers. The result is not in agreement with Tewe et al., [37]and work of Ogbuokiri et al.[3] that recorded no significant effect on broilers starter birds fed 6-8% inclusion

cassava leaf meal, properly dried and further detoxified by the addition of 0.15-0.30% methionine and 20% red oil. The improved skin colour could be a result of the carotenoid in the feed [38].

3.6 Feed Conversion Ratio

The feed conversion ratio is presented in Table 3; the result shows the FCR followed the same pattern as body weight gain. This is expected since increase in weight gain is an indication of better feed utilization. However, the FCR values for treatment 2, treatment 3 and treatment 5 with the value of 1.5, 1.7, and 1.6, respectively, were numerically better than treatment 1 and treatment 4. Although the FCR obtained in this study did not fall within the range recommended in the humid tropics as reported by Obioha [39] and Ogbuokiri [40], the ratios posted showed that the management coverts 1.3kg to 1.7kg of feed into 1kg of meat which is also good in broilers products.

4. CONCLUSION

The result of this study shows that the inclusion of some homogenized vegetable meal, (cabbage, pawpaw and cassava leaves) in the feed of broiler birds did not affect the palatability, nutrient utilization or growth of broilers as well as the shelf life of the meat negatively. The result also shows that incorporating HVM into the feed of broilers finishers diet also have a good effect on the performance as measured by shank pigmentation, feed intake and growth rate.

5. RECOMMENDATION

The authors therefore, recommend the use of HVM (cabbage, cassava and pawpaw leaves) at the rate of 2.5%-10% inclusion in broiler feed without any adverse effect on performance, shelf life and skin pigmentation. The practice is recommended in growing broilers for personal and commercial purpose.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Food and Agriculture Organisation of the United Nations FAO; 2011.
2. Thieme O,Makkar HPS.Utilization of loss and waste during the food production cycle as livestock feed. Anim. Prod. Sci.2017;57:601–607.
3. Ogbuokiri UDE Effect of total replacement of maize with cassava and cassava products on the skin pigmentation of broiler chickens. Anim. Prod. Res. Adv. 2011;8(1):20-24.
4. Ogbuokiri UDE, Anyanwu NE, Edih MC,Izuazu V, Jiribeako V, Ibe C, Eke, CC. Performance Evaluation of Starter Broiler Chicks Fed Some Recycled Vegetable Wastes. Animal Production Research Advances. 2014;10(1):22 – 28
5. Ogbuokiri UDE, Iheanacho A, Osuji AL, Okoli IC,Ekenyem BU. Effect of Pawpaw Leaf (*Carica Papaya*, Linn.) Meal on Some Performance Attributes of Starter Broiler Chicks. J Anim. Sci. Adv. 22014;4(5):826-832:4(5):826-832.
6. Ogbuokiri UDE, Taiwo OO, Paul PN,Ogonnaya, PO. Effect of pawpaw leaf (*Carica papaya, Linn)* meal on growth performance and hematology of finisher broiler chicks. International Journal of Tropical Agriculture and Food Systems. 2016;10:1 – 7.
7. IzuazuV, Ogbuokiri UDE, Olueze CC, NwoguCM, Eke CC, Ibe C. Economic analysis, Egg quality characteristics and growth parameters of pullets fed graded levels of recycled vegetable wastes. Annals of Agric. Sci., Moshtohor. 2018;56(4):1013 – 1020.
8. Dessimoni GV, Dalolio FS, Moreira J, Teixeira LV, Bertechini, AG, Hermes RG. Protease supplementation under amino acid reduction in diets formulated with different nutritional requirements for broilers. Brazilian J. Poult. Sci. 2019;21(1):1-8.
9. Black JL. Variation in nutritional value of cereal grains across livestock species. Proceedings of Australian Poultry Science Symposium. 2001;13:22-29.
10. Swain BK.Low cost feed formulation for rural poultry production. In book: Empowering farm women thru livestock and poultry intervention. ICAR-Central Institute for Women in Agriculture, Editors: A.K. Panda, Anil Kumar, B. Sahoo and Tanuja, S. 2016;186-194.
11. Dresden, D What to know about cassava: Nutrition and toxicity. Medical News Today; 2021.

Available:https://www.medicalnewstoday.com/articles/322220. Retrieved 10/10/2021
12. Tewe, O. O. (2004). Cassava for livestock feed in sub-Saharan Africa, University of Ibadan Press, Ibadan, Nigeria.
13. Bunea, A, Lujerdean, A, Pintea, A, Andrei, S, Bunea, C Bele, Constantin. Using Cellulases and Pectinases to Improve Better Extraction of Carotenoids from the Marigold Flowers (*Tagetes erecta* L.). Bulletin UASVM Animal Science and Biotechnologies. 2010;67(1-2).
14. United State Department of Agriculture,Refrigeration and Food Safety. St Laurent Boulevard, Ottawa, Ontario K1G 4J8, 2008. Food safety at home. 2010;13(9):783-784.
15. Omenka RO, Anyasor GN. Vegetable-based feed formulation on poultry meat quality, African Journal of Food, Agriculture, Nutrition and Development. 2010;10(1):2001-2010.
16. Raza A, Hussain J, Hussnain F, Zahra F, Mehmood S, Mahmud ZB, AmjadMT, Khan M, Asif U, Ali IH, Badar MN Vegetable waste inclusion in broiler diets and its effect on growth performance, Blood metabolites, immunity, meat mineral content and lipid oxidation status. Braz. J. Poult. Sci. 2019; 21(01).
17. Ram H, Jat GS, Devi SL. Antinutritional factors in Vegetables. Indian Agric. Res. Institute. Biotech Articles; 2016.
18. Arshad MS, Anjum FM, Asghar A, Khan, MI, Yasin M, Shahid M. Lipid stability and antioxidant profile of microsomal fraction of broiler meat enriched with α-lipoic acid and α-tocopherol acetate, Journal of Agricultural and Food Chemistry. 2011; 59(13):7346−7352.
19. Brenes A, Viveros A, Goni I, Centeno C, Sayago-Ayerdy SG, Arija I. Effect of grape pomace concentrate and vitamin E on digestibility of polyphenols and antioxidant activity in chickens, Poultry Science. 2008;87(2):307–316.
20. Faustman C, Sun Q, Mancini R, Suma SP Myoglobin and lipid oxidation interaction: Mechanistic bases and control. Meat Science. 2010;86(1):86-94.
21. AreolaO, Ahmed K, Irueghe OI, Adeleke BO, Leong GC. Certificate physical and human geography for senior secondary schools. New Impression, University Press PLC, Ibadan, Nigeria; 2002.
22. Vuilleumier JP. The Roche Yolk Colour Fan – An instrument for measuring yolk colour. Poultry Sci.1969;48:767 – 779
23. Ogbuokiri UD. Effects of Palm Oil Sludge Supplementation in Starter Diets of Broiler Chickens on Growth Performance, Economic Analysis, Feed Conversion and Skin Pigmentation. Annals of Agricultural Science, Moshtohor. 2018;56(4):1005-12.
24. AOAC. Official methods of Analysis, 21st ed., Association of Official Analytical Chemists, Washington DC, USA; 2019.
25. Agugo UA, Ogbuokiri UDE, Anozie L, Emereonye KR, Anyanwu HO,UchegbulamANP..Unconventional Composite Feed Ingredients on Storage and Sensory Attributes of Chicken Meat, Asian Food Sci. J. 2021;20(9):169-174
26. Bevans R, An introduction to the one-way ANOVA**.** 1017AZ Amsterdam. The Netherlands; 2020. Available:https://online210.psych.wisc.edu/wp-content/uploads/PSY-210_Unit_Materials/PSY-210_Unit12_Materials/Bevans_ANOVA_2020.pdf. Retrieved 20/10/2021
27. De Mendiburu F. Duncan's new multiple range test. In agricolae: Statistica Procedures for Agricultural Research. CRAN Packages; 2020.
28. Ravindran V, Kornegay BT, Kajaguru ASB, Potter, LM, Cherry, JA. Cassava leaf meal as a replacement for coconut oil meal in broiler diets. Poult. Sci.1986;65:1720–1727.
29. Nworgu FC, Fasogbon FO. Centrosema (*Centrosemapubescens*) leaf meal as protein supplement for pullet chicks and growing pullets. International Journal of Poultry Science. 2007;6(4):255-260.
30. Ngiki YU, Igwebuike JU, Moruppa SM.Utilisation of cassava products for poultry feeding: A review. Int J Sci Tech. 2014;2(6):48-59.
31. Adesina OO, Toye, AA. (2014). Nutritive Effect of Cabbage (*Brassica oleracea, var. capitata*) on growth, obesity, lipidaemia and haematology in broiler and pullet chickens. Global J of Agric. Sci. 2014; 13:11-25
32. Ogbede, SC, Saidu AN, Kabiru, AY, Busari MB, Nutrient and Anti-Nutrient compositions of *Brassica oleracea, var. capitata)*. 2015;19-25.
33. Homer P, Schaible PJ. Poultry: Feeds and nutrition. Westport, CT: AVI Publishing; 1980.

34. Feltwell R. Poultry keeping, 1st Ed. Faber and Faber Ltd, London; 1980.
35. Feltwell R, Fox S Practical poultry feeding, ELBS 1 st Ed. Faber and Faber Ltd, London; 1979.
36. Raza A, Hussain J, Hussnain F, Zahra F, Mehmood S, Mahmud A, Amjad ZB, Khan MT, Asif M, Ali U, Badar IH, Nadeem M. Vegetable Waste Inclusion in Broiler Diets and its Effect on Growth Performance, Blood Metabolites, Immunity, Meat Mineral Content and Lipid Oxidation Status, Brazilian Journal of Poultry Science. 2019; 21(1):01-08
37. Tewe OO, Gomez, G, Maner G. Effect of extraneous linamarase on the hydrocyanic acid content of some tropical cassava varieties. Nig. Jour. Nutr. Sci.1980;1:27-32.
38. Perez-Vendrell AM, Hernandez J, LlauradoM, SchierleL, Brufau J. J. Influence of source and ratio of xanthophylls pigments on broiler chicken pigmentation and performance. Poult. Sci. 2001;80:320–326.
39. Obioha C. A guide to poultry production in the tropics. Acena Publishing. Enugu, Nigeria; 1992.
40. Ogbuokiri, U.D.E. (2012). Effect of total replacement of maize with cassava and cassava production on the skin pigmentation of broiler chickens. Anim. Prod. Res. Adv. 2012;8(1):20-24.