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REPLACEMENT OF MAIZE WITH MELON-GROUNDNUT SHELL MEAL ON THE GROWTH PERFORMANCE AND HAEMATOLOGICAL INDICES OF GROWING RABBITS

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Abstract: This experiment was carried out to determine the replacement of maize with melon-groundnut shell meal on the growth performance and some haematological indices of growing rabbits. Fifty- eight weeks old cross breed male growing rabbits with an initial body weight of 406.1 ± 0.60 grams was used for the study. On arrival, animals were quarantined for two weeks and fed basal diet before they were stratified based on their body weights five treatments with ten replicates consisting of one rabbit each in a completely randomized design. Rabbits in treatment one was fed basal diet without melon-groundnut shell meal while melon-groundnut shell meal was used to replace maize at 5 %, 10 %, 15 % and 20 % in treatment two, three, four and five respectively. Feed and clean water was made available at all times and the experiment lasted for 56 days. Proximate analysis of melon-groundnut shell meal (combined in ratio 1:1) showed that it contained dry matter (90.03 %), crude protein (8.46 %), crude fibre (41.51 %), ether extract (2.07 %), ash (10.88 %) and energy (3231.8 Kcal/kg). Average daily weight gain, average daily feed intake and feed conversion ratio values which ranged from 27.75 – 28.10 grams, 105.0 – 105.1 grams and 3.75 – 3.77 were not significantly ($P>0.05$) influenced by the treatment. Similarly, no mortality was recorded throughout the study ($P>0.05$). Haemoglobin, pack cell volume and red blood cell count follow similar trend, values were higher in treatment one and lower in treatment two, three, four and five ($P<0.05$). Total platelet counts and white blood cell count whose values varied from 102.1 – 120.8 ($\times10^9$/L) and 10.42 – 13.40 ($\times10^9$/L) were influenced ($P<0.05$) by the treatment. However, values recorded were within the baseline values for healthy growing rabbits. In conclusion, melon-groundnut shell meal contains some available nutrients and can be used to replace maize up to 20 % without compromising the performance of the animal.
Keywords: Melon shell; Maize; Groundnut shell; Rabbits; Agro-industrial wwaste; Sustainability

1 INTRODUCTION

Energy is the most important and expensive ingredient in animal feed because it is mostly obtained from cereal grains[1]. The importance of dietary energy in animals feeding cannot be overstated, since increasing or reducing dietary energy has been shown to alter feed intake as well as promote or undermine efficient feed utilization and growth rate[2, 3]. The amount of feed energy eaten by an animal could be used to meet its maintenance and production needs[1, 4]. However, intense competition between man and animals for maize, soya beans, and other ingredients frequently results in high prices[5, 6].
Maize (Zea mays) is a key staple food grain around the world, particularly in Africa, Latin America, and Asia[7]. Maize grain is a key feed grain and a staple in animal diets, serving as a source of energy[3, 8]. Other grains are frequently compared to maize for estimating nutritional value, particularly energy content[9, 10]. This situation calls for the assessment of various locally available non-conventional feed resources and the incorporation of promising ones into rabbit feeding[11]. Melon husk and groundnut shell are among the potential agricultural byproducts. Melon, a creeping herbaceous plant from the Cucurbitaceae family, grows in most parts of the world, including India[12, 25]. Melon husks are the shells that are discarded after processing or shelling melon seeds[13]. Ogbe and George found that dried melon husk includes crude protein (19.14%), carbohydrate (61.01%), crude fiber (8.12%), ash (7.73%), crude fat (1.71%), and fatty acid (1.37%). It also contains calcium, magnesium, potassium, sodium, iron, zinc, phosphorus, manganese, and copper[14]. Drying has been discovered as one strategy for lowering anti-nutrients in melon husks, including trypsin inhibitors, oxalate, and cyanide[15]. Melon husk includes phytochemicals (tannins and saponins) that have traditionally been used to treat urinary tract infections, hepatic congestion, intestinal worms, and irregular blood pressure[16].
Groundnut, a leguminous crop from the Fabaceae family, is grown worldwide in both tropical and temperate climates[17]. Groundnut is a high-lysine protein source that can be used to supplement cereal protein. Groundnut shell refers to the fibrous parts of crops that remain after the edible components have been removed[18]. The approximate composition of fresh groundnut seeds revealed that they contain ash (2.4%), crude fat (46.59%), crude protein (19.52%), carbohydrate

(22.00%), and moisture (5.37%)[17]. A phytochemical analysis found that groundnut shell contains alkaloids, saponins, tannins, flavonoids, and steroids[19].
Previous research by Bawa et al.[20] and Osofowora et al. [21] has shown that groundnut shell and cowpea husk may be fed to growing rabbits at up to 10% without affecting their performance. Iyeghe-Erakpotobor and Adeyegun [22] and Etchu et al. [23] discovered that groundnut forage meals can improve the performance of growing rabbits. However, there is little or no information on feeding a melon husk-groundnut shell mixture to growing rabbits instead of corn. This study is crucial since dumping agro-industrial waste creates major environmental damage, and there is an urgent lack of traditional feed ingredients, resulting in low productivity. Utilizing crop leftovers (melon husk and groundnut shell) will improve livestock sustainability, boost animal protein intake, and optimize potential.

2 MATERIALS AND METHODS

2.1 Experiment Location

Livestock unit of Sumitra Research Institute Gujarat was used for the study. It was carried out between October to December, 2023 according to the ethical procedures and guidelines at the Department of Animal Nutrition and Biochemistry (FH/008D/2023). Sumitra Research Institute is situated between 28^{o} 18' N and 70^{o} 35' E India.

2.2 Collection and Processing of Groundnut and Melon Shell

Groundnut shell and melon husk were collected from different dumping sites in Gujarat. The gathered shells were poured separately on a metallic tray to manually remove dirt's and other particles present before it was washed under running tap water and sundried separately for sixteen days until a constant weight was achieved. Dried shells were grinded using a hammer mill and stored in a labeled polythene bag before it was transferred to Sumitra Research laboratory for further analysis.

2.3 Animal Management and Experimental Design

Fifty- eight weeks old cross breed male growing rabbits (Newzealand white × Chinchilla) with an initial body weight of 406.1 ± 0.60 grams was used for the experiment. On arrival to Sumitra Research Farm, Gujarat animals were quarantined for fourteen days and fed basal diet which is adequate in all nutrient's as specified by Nutritional Research Council in 1977. They were also treated against parasites with Albendazole Plus® which was administered according to the manufacturers specification. Rabbits were reared in a galvanized battery cage measuring 150 cm by 100 cm by 80 cm (length × width × height) equipped with manual concrete feeders and drinkers in a semi closed pens. Pens were also disinfected two weeks before the commencement of the trial with Morigad® before they were stratified based on their body weight and randomly assigned to five treatments with ten replicates consisting of one rabbit each in a completely randomized design. The experimental diets were offered trice a day at 6:30AM, 12:00 PM and 16:00PM hours throughout the experimental period. Water was made available at all times and the experiment lasted for 56 days.

3 EXPERIMENTAL DIET AND SET-UP

Melon and groundnut shell meal was mixed in ratio 1:1 and combined with other conventional feed stuffs presented in Table 2 to formulate the experimental diet. Rabbits in treatment 1 was fed basal diet without melon-groundnut shell mixture while melon-groundnut shell mixture was used to replace maize at 5 %, 10 %, 15 % and 20 % in treatment 2, 3, 4 and 5 respectively.

3.1 Growth Performance

Prior to assigning rabbits to their different treatments, their initial body weight was measured using a digital sensitive scale. The rabbits' weight was then measured weekly in the morning before they were fed. The final body weight was obtained at the end of the feeding study (56 days). Feed intake was calculated as the difference between the feed supplied and the leftovers on a daily basis. The feed conversion ratio was computed by dividing total feed consumption by weight increase.

3.2 Blood Collection and Analysis

At the end of the trial, blood sample was collected from the marginal ear vein of five randomly selected rabbits per treatment for haematological evaluation. Samples were collected into a sterile labeled bottles containing ethylene diamine tetra acetic acid. Blood collection was done very early in the morning and placed in an ice pack before it was sent to the department of biochemistry, Sumitra Research Institute, Gujarat. Analysis was done immediately using an automated

Sysmex® blood analyzer (Model: DS/008C/20, China). The kit is maintained at an ambient temperature of 19 to 30℃ and humidity between 60 - 80 % to ensure precision in result.

3.3 Chemical Evaluation of Experimental Diet and Test Ingredients

Proximate analysis of experimental diet and test ingredients (melon-groundnut shell meal) was carried out using Automated Near Infra-Red analyzer. 150 grams of each sample was placed in a plastic sample collector and the kit was maintained at a wavelength range, reproducibility and accuracy of 900 – 1800 nm, <0.001 – 0.003 nm and 0.2 – 0.4 nm, photometric noise (< 10 µAu) according to the manufacturers specifications to ensure precision in results obtained. Calcium and phosphorus were determined using Murray® Atomic Absorption Spectrometry (Model DF/66Y, China) and adjusted to a wavelength (500 nm) and heating rate (2500 ℃) before results were displayed via the monitor within 3 minutes.

4 STATISTICAL ANALYSIS

All data collected were subjected to a One- Way ANOVA analysis of variance using SPSS (version 20) statistical package of 2011. Means showing significant differences were separated using Duncan's Multiple Range Test.

5 EXPERIMENTAL OUTCOME

Proximate composition of groundnut shell, melon shell and their combination is presented in Table 2. Dry matter content in melon shell, groundnut shell and their mixture is 89.22 %, 90.84 % and 90.03 % correspondingly. Crude protein (3.94 %, 4.52 %, 8.46 %), crude fibre (11.33 %, 15.18 %, 41.51 %), ether extract (0.33 %, 1.74 %, 2.07 %), ash (3.76 %, 7.12 %, 10.88 %), ash (3.76 %, 7.12 %, 10.88 %) and energy [(1891.2 (kcal/kg), 1340.6 (kcal/kg), 3231.8 (kcal/kg)] accordingly. Groundnut shell had a higher crude protein, crude fibre, ether extract, ash but lower energy compared to melon shell. Crude protein (3.94 %), crude fibre (16.33 %) and ether extract (0.33 %) recorded for melon shell is lower than 4.43 %, 59.0 % and 0.50 % reported by Abdulrazak et al., [24]; Abiodun and Adeleke [25]. Crude protein (4.56 %) and ether extract values (1.74 %) recorded in this study was higher compared to 3.74 % and 0.79 % reported by Yusuf et al. [26]. The variation in values may be attributed to the age of harvesting, climate conditions, agronomic practices, geographical location as well as methods of processing[27, 28]. A mixture of groundnut-melon shell shows that it contains significant quantity of energy, fibre and ash content. According to Ishida et al. [41], fibers in the diet are necessary for digestion and for effective elimination of wastes, and can lower the serum cholesterol and the risk of heart disease. Ash is an index used to ascertain the mineral content in a sample, the high ash content suggests that can be promote the activities of muscles and skeletal development, cellular activity and oxygen transport, chemical reaction in the body and intestinal absorption, fluid balance and nerve transmission[28, 29]. Low protein content was recorded in groundnut-melon shell mixture which indicates that it cannot be used as to replace protein in the diet of animals[30].

Table 1: Proximate composition of groundnut shell, melon shell and their mixtures

Variables	Melon shell	Groundnut shell	Melon-groundnut shell mixture
Dry matter	89.22	90.84	90.03
Crude protein	3.94	4.52	8.46
Crude fibre	11.33	15.18	26.51
Ether extract	0.33	1.74	2.07
Ash	3.76	7.12	10.88
Energy (kcal/kg)	1891.2	1340.6	3231.8

Table 2: Ingredients and composition of experimental diet (percentage dry matter)

Ingredients	T1	T2	T3	T4	T5
Yellow maize	50.00	47.50	45.00	42.50	40.00
Wheat bran	15.00	15.00	15.00	15.00	15.00
Palm kernel meal	10.00	10.00	10.00	10.00	10.00
Soya meal	18.00	18.00	18.00	18.00	18.00
Fish meal (72 percent)	2.00	2.00	2.00	2.00	2.00
*Melon-groundnut shell meal	-	2.50	5.00	7.50	10.00
Oyster shell	3.00	3.00	3.00	3.00	3.00

Bone meal	1.50	1.50	1.50	1.50	1.50
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
**Mineral – Vitamin Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis (%)					
Crude protein	15.70	15.68	15.66	15.64	15.62
Crude fibre	6.05	7.07	8.88	9.17	10.12
Ether extract	4.00	3.82	3.66	3.45	3.25
Calcium	1.46	1.46	1.46	1.46	1.46
Phosphorus	0.55	0.55	0.55	0.55	0.55
Methionine + Cysteine	0.62	0.62	0.62	0.62	0.62
Lysine	1.04	1.04	1.04	1.04	1.04
Energy (kcal/kg)	2810.0	2806.4	2802.9	2797.4	2793.7
Determined analysis (%)					
Crude protein	16.92	16.89	16.60	16.43	16.25
Crude fibre	7.11	9.97	10.29	11.11	12.02
Ether extract	4.09	4.00	3.92	3.83	3.75
Calcium	1.57	1.57	1.57	1.57	1.57
Phosphorus	0.72	0.72	0.72	0.72	0.72
Methionine + Cysteine	0.79	0.79	0.79	0.79	0.79
Lysine	1.08	1.08	1.08	1.08	1.08
Energy (kcal/kg)	2794.5	2752.0	2733.9	2725.8	2716.9

Note: 2.5 kg of grower's premix contains: Thiamine, 2000 mg, riboflavin, 5000 mg, pyridoxine, 3000 mg, cyanocobalamin, 1000 mg, niacin, 25,000 mg, Panthotenic acid, 12,000 mg, folate, 500 mg, biotin, 1000 mg, Retinyl acetate, 10,000 iu., cholecalciferol, 2,000,000 iu., tocopherol, 20,000 iu., ascorbic acid, 52,000 mg, manganese, 8200 mg, iron, 6,200 mg, zinc, 300 mg, copper, 200 mg, cobalt, 150 mg, iodine, 200 mg, selenium, 100 mg, choline chloride, 50,000 mg.

Effect of Melon-groundnut shell mixture on the growth performance of growing rabbits is presented in Table 3. Weight gain, total feed intake and feed conversion ratio of rabbits fed treatment 1 (without melon-groundnut shell mixture), treatment 2 (5 % replacement of melon-groundnut shell meal) and treatment 3 (10 % replacement of melon-groundnut shell meal) were similar (P>0.05) to those fed treatment 4 (15 % replacement of melon-groundnut shell meal) and treatment 5 (20 % replacement of melon-groundnut shell meal). Average daily weight gain, average daily feed intake and feed conversion ratio values took the form of 27.73 – 28.10 grams, 105.0 – 105.1 grams and 3.75 – 3.77 in each case. All the parameters were not influenced (P>0.05) by the treatment. The final body weight and weight gain which varied from 1958 – 1979.6 g and 1552.7 – 1573.5 g was similar to the result of a study by[22] who found out that groundnut forage meals can promote the performance of growing rabbits. Bawa et al. [20] recorded a lower final body weight 1249.1 – 1390.0 g was recorded when growing rabbits were fed groundnut haulms. The present study suggests that melon-groundnut shell mixture contains valuable nutrients who are capable of improving body mass of animals when metabolized. Total feed intake observed in this study were similar to those reported by Etchu et al., 2008 [23]. Alagbe and Daniel (2023)[31] recorded a higher feed intake 6000.2 – 6381.1 grams in weaned rabbits fed doum palm meal as replacement for maize. Feed conversion ratio observed in this experiment was lower than that reported by Iyeghe-Erakpotobor and Adeyegun, 2012 [22] which ranged from 8.51 – 10.1 when growing rabbits were fed diets containing groundnut haulms without palm oil.

Table 3: Effect of Melon-groundnut shell meal on the growth performance of growing rabbits

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Duration of experiment in days	56	56	56	56	56	-
Initial body weight (g)	406.1	406	405.8	406.1	405.5	0.09
Final body weight (g)	1979.6	1969.1	1963.4	1960.1	1958.2	0.45
Weight gain[1] (g)	1573.5	1563.1	1557.6	1554	1552.7	0.39
Average daily weight gain[2] (g)	28.10	27.91	27.81	27.75	27.73	0.01
Total feed intake (g)	5885.61	5887	5881.2	5880.6	5880.1	2.69
Average daily feed intake[3] (g)	105.1	105.1	105.0	105.0	105.0	0.06
Feed conversion ratio	3.75	3.76	3.76	3.77	3.77	0.01

Mortality	0	0	0	0	0	-

Note: [1]final weight minus initial body weight; [2] weight gain/experimental period in days; [3] Total feed intake /experimental period in days; T_1: basal diet without melon-groundnut shell meal; T_2: (5 % replacement with melon-groundnut shell meal); T_3: (10 % replacement with melon-groundnut shell meal); T_3: (15 % replacement with melon-groundnut shell meal); T_5: (20 % replacement with melon-groundnut shell meal); SEM: standard error of mean.

Effect of Melon-groundnut shell mixture on the haematological indices of growing rabbits is presented in Table 4. Haemoglobin, pack cell volume and red blood cell count which took the form of 98.00 – 110.6 g/L, 30.02 – 35.10 % and 5.46 – 7.92 ($\times10^{12}$/L) respectively. Values obtained among rabbits fed treatment 2 (5 % melon-groundnut shell mixture), treatment 3 (10 % melon-groundnut shell mixture) were similar ($P>0.05$) to those fed treatment 4 (15 % melon-groundnut shell mixture) and treatment 5 (20 % melon-groundnut shell mixture) but significantly lower ($P<0.05$) than those fed treatment 1 (without melon-groundnut shell mixture). However, haemoglobin, pack cell volume and red blood cell count were within the normal range 90.00 – 130.0 g/L, 27.00 – 36.00 % and 5.00 – 11.00 ($\times10^{12}$/L) cited by Mitruka and Rawnsley (1977)[32]; Jain (1983)[33]. This result suggests that the animals were not malnourished which removes the doubt of iron deficiency in the blood John, 2024[34]. The red blood count result in this study also indicate sufficient oxygen in the animal's tissue which is capable of driving absorbed nutrients round the body John, 2024[34]; Adewale et al., 2021 [35]. Pack cell volume test can also be used to diagnose dehydration, polycythemia, anaemia, folate deficiency and other health conditions in animals[36, 34]. Platelet values which ranged from 117.1 – 120.8 ($\times10^9$/L) were higher in rabbits fed treatment 4 and 5, intermediate among rabbits in treatment 2, 3 and lowest in treatment 1 ($P<0.05$). However, counts recorded were within the normal range cited by Thrall [37]; Banks [38]. Platelets are parts of the blood that aids in blood clotting[39, 35]. Causes of low platelets includes, bone marrow infection, folate deficiency, cirrhosis, amongst others[3, 40]. White blood cell is a key part of the immune system that help to fight against infections and foreign invaders[42]. Value of white blood cell count varied from 10.42 – 13.51 ($\times10^9$/L) was within the normal range reported by John, 2024[40]. Low white blood cell count is an indication of bone marrow disorder, infections and liver and spleen disease[31].

Table 4: Effect of Melon-groundnut shell meal on the haematological indices of growing rabbits

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Haemoglobin (g/L)	110.6^a	98.24^b	98.12^b	98.02^b	98.00^b	0.72
Pack cell volume (%)	35.10^a	30.96^b	30.60^b	30.55^b	30.02^b	0.41
Red blood cell ($\times10^{12}$/L)	7.92^a	5.62^b	5.53^b	5.50^b	5.46^b	0.02
Total platelet count ($\times10^9$/L)	102.6^c	114.8^b	117.1^b	120.1^a	120.8^a	0.93
White blood cell ($\times10^9$/L)	10.42^b	12.33^a	12.65^a	13.40^a	13.51^a	0.01

Note: T_1: basal diet without melon-groundnut shell meal; T_2: (5 % replacement with melon-groundnut shell meal); T_3: (10 % replacement with melon-groundnut shell meal); T_3: (15 % replacement with melon-groundnut shell meal); T_5: (20 % replacement with melon-groundnut shell meal); SEM: standard error of mean; Means within a row with different letters are significantly different ($P < 0.05$).

6 CONCLUSION

In conclusion, melon-groundnut shell meal contains some available nutrients which can be used in feeding rabbits. The study showed that it contains high energy, minerals and fibre which can be utilized by rabbits. Replacing maize with up to 20 % melon-groundnut shell meal in the diet of growing rabbits will help to promote livestock sustainability, increase animal protein and reduce environmental pollution without compromising their performance and health status.

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AUTHOR CONTRIBUTION

PhD Alagbe Olujimi John designed the experiment, data collection, statistical analysis and writing of the manuscript.
PhD Shittu, M.D – Correction of manuscript
PhD Ojediran, T.A - Correction of manuscript
PhD Anuore, D.N – Correction of manuscript

ETHICAL APPROVAL

Animal guidelines was followed in this study for species observation and identification ((FH/008D/2023).

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CONFLICT OF INTEREST

The authors have no relevant financial or non-financial interests to disclose.

DATA AND MATERIALS AVAILABILITY

All data associated with this research are present in the manuscript.

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