Volume 6, Issue 2, 2022 ISSN: 2617-3530
DOI: https://doi.org/10.31058/j.as.2022.62002

Effect of Maize Offal (*Zea Mays*) with Groundnut Haulms as Replacement For Wheat Offal in Diet of Weaner Rabbits (*Oryctolagus Cuniculus*) on Growth Performance, Nutrient Digestibility and Economics of Production

Ajimohun Felicia[1*], Doma Umar Dass[2], Mancha Yusufu Pam[2], Kalla Demo Joab[2], Oshibanjo Debola Olusegun[3]

[1] Rabbitary Division, National Veterinary Research Institute, Vom, Nigeria
[2] Department of Animal production, Faculty of Agriculture and Agricultural Technology, Abubakar Tafawa Balewa University, Bauchi, Nigeria
[3] Department of Animal production, Faculty of Agriculture, University of Jos, Jos, Nigeria

Email Address

ajumohunfelicia@gmail.com (Ajimohun Felicia)
*Correspondence: ajumohunfelicia@gmail.com)

Received: 2 January 2022**; Accepted:** 15 March 2022**; Published:** 28 May 2022

Abstract:

This study evaluates the effect of maize offal (zea mays) with groundnut haulms as replacement for wheat offal in diet of weaner rabbits (oryctolagus cuniculus) on growth performance, nutrient digestibility and economics of production. A total of 60 rabbits mixed sexes aged 5-6 weeks were used in the experiment. Five experimental diets were formulated using graded levels (0, 25, 50, 75 and 100%) and designated as diets 1, 2, 3, 4, and 5 with groundnut haulms constituting 20% and soya beans as protein source with 12 rabbits per treatment each treatment was replicated three times with 4 rabbits per replicate in a Completely Randomised Design. There was no significant difference in growth performance. Organ weights were not influenced across dietary treatment groups except weight of heart, gall bladder, abdominal fat, Ceacum and Large intestine were influenced ($P<0.05$) by dietary treatments of maize offal. There was significant differences observed between dietary treatment groups in results of neutrophil, and lymphocyte. It was also observed that there was no significant differences in nutrients digestibility of rabbits fed maize offal diets except values of crude protein and ether extract were influenced ($p<0.05$). It was also observed that there were no significant differences on varied values of feed intake 4.14 -4.52kg obtained on diet 4 and diet 5, values were similar between dietary levels. However, there was significant ($p<0.05$) differences on values for feed cost, total feed cost, feed cost per kilogram gain, cost saving and % saving cost. The economics of production revealed that feed cost (N /kg) decreases with increase in maize offal at 50% with corresponding improvement in cost saving values as observed on the cost analysis. It was concluded that maize offal can serve as fibrous source which replace

wheat offal at 50% in the diets of weaner rabbits without compromising performance and carcass yield of rabbits.

Keywords:
Weaner Rabbit, Maize Offal, Groundnut Haulms, Wheat Offal, Growth Performance

1. Introduction

Rabbit is increasingly becoming an important meat source worldwide and is now recommended for production in countries that are experiencing animal protein shortage [1]. The recent understanding of the usefulness of rabbit meat for diabetics, hypertensive and middle aged people has further raised awareness on the production of rabbit. There by increasing demand for rabbit meat [2]. Rabbits are efficient converters of feed to meat and can utilise up to 30% crude fibre as against 10% by most poultry species which makes rabbit production attractive [3,4,5]. It also gives rabbits their potential as an emerging meat and fur producing animal [6].

The problem of feed supply and availability on a sustainable basis has been the major concern of the livestock industry in Nigeria. Faced with the competition between humans and livestock for grains and the need to bridge the gap of animal protein consumption, Nigeria was look in wards for her feed resources. The livestock sector is required to shift emphasis from the usual conventional to non-conventional feed materials that are locally available and cheap. [7] reported that wheat has long been used as source of fibre, energy and protein supplement in monogastric diets. Presently, very little may be used in feeding animals as much are processed into breakfast. Wheat consumption has been steadily increasing during the past 20 years as a result of growing population, changing food preferences and a strong urbanization trend which has led to a growing food gap where all regions are largely met by import. Thus, it is essential and timely to look at other existing cheap and local agro industrial by-products and crop residues that are not directly utilised by humans but can be in cooperated into feedstuff formulation and the possibility of converting them into cheap and wholesome animal products for human consumption could be exploited [7]. Of such is groundnut haulms and maize offal.

Groundnuts haulms (GNH) are the residues left after harvesting groundnuts and are produced at very high quantity. The forage, is made up of leaves, stems and roots, is called haulms [8]. Groundnut haulms are good source of protein and calcium [9]. Groundnut haulms have nutritive values [10]. They have also shown great promise as a source of protein for feeding monogastric animals [11,12,13].

According to [14] maize offal is by product of maize milling process, which gives rise to there by-products, the germ, bran and gluten which are collectively refered to as maize offal. Maize gluten feed contains about 21-23% crude protein with fibre of 9-10%. [15] reported 11.9% crude protein, 10.5% crude fibre, 1.7% either extracts as proximate composition of maize bran. Maize offal is second to wheat offal as the most preferred and utilised conventionally in livestock feeds in Nigeria. The relatively low crude fibre content compared to other agro industrial by-products could be an advantage in fibre nutrition whereas the low protein content appears to be a limitation. This study evaluates the effect of maize offal (*zea mays*) with groundnut haulms as replacement for wheat offal in diet of weaner rabbits (*oryctolagus).*

2. Materials and Methods

2.1. Experimental Site

The research was conducted in the Rabbitry section Dagwom Farm, National Veterinary Research Institute, Vom, Plateau State in the Sudan savanna zone of North Central Nigeria.

2.2. Experimental Animals and Management

The rabbits were managed according to the provisions of International Guideline principles of Biomedical Research involving animals [16]. A total of 60 cross bred weaner rabbits aged 5- 6 comprising of New Zealand white, Californian white, Dutch Belted, American checkered, Chinchilla and English Spotted of both sexes were purchased from reputable rabbit farmers in Vom Jos South. In this experiment, sixty (60) aged 5- 6 weeks with an average mean weight value of 529 - 574g where used in 8 weeks feeding trial. The hutches were provided with suitable facilities for drinking, feeding and faecal collection. Management practices, health and sanitation programme were strictly followed. At the end of the acclimatisation week the weaners were randomly allocated to five dietary treatments in a Completely Randomised Design (CRD). Feed was given at 7.00am- 9.00am in the morning and the left over from previous day were collected and weighed in order to determine feed intake. Each experiment lasted for eight weeks (56 days). Faecal samples were collected for 7 days within the 7th and 8th week of conducting the experiment.

2.3. Experimental Diets

In this experiment, five iso-nitrogenous diets were formulated to meet 16% crude protein nutritional requirements of the weaner rabbits and similar levels of crude fibre by replacing 1 wheat offal with graded levels of maize offal respectively in which groundnut haulms constituted 20% of each diet. The diets were designated 1, 2, 3, 4 and 5. Diet 1 contained wheat offal which served as the control (0%) while treatments (2-5) contained maize offal at graded levels of 25, 50, 75, and 100% respectively. The test ingredients and five diets were analysed for their proximate composition. The composition and proximate composition of the diet is shown in Table 1.

Table 1. *Ingredients and Percentage Composition of Diets Containing Graded levels of Maize Offal in Diets of Weaner Rabbits.*

	Diets				
Ingredients	**1**	**2**	**3**	**4**	**5**
	0%	**25%**	**50%**	**75%**	**100%**
Maize	31.87	30.54	29.22	27.90	26.58
Soya beans	14.88	16.21	17.53	18.85	20.17
Wheat Offal	30	22.5	15	7.5	0
Maize Offal	0	7.5	15	22.5	30
Groundnut haulms	20	20	20	20	20
Bone meal	1.5	1.5	1.5	1.5	1.5
Limestone	1.0	1.0	1.0	1.0	1.0
Salt	0.25	0.25	0.25	0.25	0.25
Premix Lysine Methionine Total (%)	0.25 0.13 0.12 100	0.25 0.13 0.12 100	0.25 0.13 0.12 100	0.25 0.13 0.12 100	0.25 0.13 0.12 100

Calculated analysis (%)					
Crude Protein (CP)	16.00	16.00	16.00	16.00	16.00
MetabolisableEnergy(ME Kcal/Kg)	2619.71	2657.19	26904.75	2723.32	2769.87
Crude fibre (CF)	9.00	9.13	9.45	9.77	10.09
Either Extract (EE)	4.63	4.57	4.51	4.45	4.40
Calcium	1.12	1.12	1.13	1.12	1.13
Phosphorus	0.50	0.48	0.40	0.46	0.45
Lysine	1.39	1.37	1.35	1.32	1.30
Methionine	0.54	0.53	0.54	0.54	0.54
Ash	4.76	4.42	4.09	3.75	4.16

Bio-premix supplied per kg of diet: Vitamin A, 12500I.U; Vit. D_3, 2500 I.U;Vit E, 50mg; Vit K3, 2.5mg; Vit B_3.0mg; Vit B_6 6.0mg; Niacin, 40.0mg; Calcium pantothenate 10.0mg; Biotin 0.8mg; VitB 12 0.25mg; Folic acid 1.0mg; Choline chloride 300mg; Manganese 100mg; Iron 100mg; Zinc,50mg;Iodine 1.55I.U; Selenium 0.1mg

2.4. Experimental Design

After the 7 days acclimation period, the rabbits were randomly distributed into 5 groups of 12 rabbits, divided into three replicates of 4 rabbits per replicate in a Complete Randomise Design (CRD).

2.5. Data Collection

2.5.1. Nutrient Digestibility

At the end of collection period, all samples from each animal were bulked, milled thoroughly mixed to obtain a homogenous mixture and 10% sub-samples were taken for determination of proximate composition using [17] methods.

2.5.2. Economics of Production Analysis

The following parameters were used to estimate the cost and returns of the by - products and other feed ingredients used in production includes:

a. Cost of feed per kilogram (N/kg) – This was computed using the prevailing market prices of ingredients

b. Cost of feed per unit weight gain- This was be computed as the feed conversion ratio multiplied by the unit price of feed.

c. Cost of production: The cost of production was estimated as sum of cost of animals, feed, medications, labour and housing.

2.5.3. Statistical Analysis

Data obtained were subjected to One Way Analysis of Variance (ANOVA) using the SPSS statistical package version 25, where applicable, significant differences between the means will be separated using Duncan's New Multiple Range Test.

3. Results and Discussion

3.1. Results

3.2. Growth Performance

Table 2 shows the growth performance of weaner rabbits fed graded levels of maize offal diets as replacement for wheat offal. There was no significant ($p>0.05$) difference in all the parameters evaluated on the different graded levels.

Table 2. *Growth Performance of Weaner Rabbits Fed Graded levels of Maize Offal Diets with Groundnut Haulms as Replacement for Wheat Offal.*

	Diets					
Parameters	**1**	**2**	**3**	**4**	**5**	**SEM**
	0%	**25%**	**50%**	**75%**	**100%**	
Initial weight (g)	554.17	550.00	541.33	529.00	574.67	7.60^{NS}
Final weight (g)	1230.00	1281.33	1424.67	1280.67	1263.33	31.93^{NS}
Weight gain (g)	675.83	731.33	883.33	751.67	688.67	35.30^{NS}
Total feed intake (g)	4449.20	4285.68	4286.80	4142.32	4523.68	45.32^{NS}
Daily Feed intake (g)	79.45	76.53	76.55	73.97	80.78	2.07^{NS}
Daily weight gain (g)	12.07	13.06	15.77	13.42	12.30	0.63^{NS}
FCR	6.58	5.85	4.85	5.76	6.71	0.36^{NS}
Mortality	0.00	0.00	0.00	0.00	0.00	0.00^{NS}

SEM = Standard Error of Mean, NS = Not significant, FCR = Feed conversion ratio

The results of organ weights of rabbits fed graded levels of maize offal diets are presented in Table 3. Weights of kidney ranged from (0.71% - 1.08%), liver (2.67 – 4.81%), lungs (0.70 – 1.09%), spleen (0.07 -0.13%), stomach (3.40 – 6.03%) and length of small intestine (20.09 – 31.78%) and were significantly ($p<0.05$) influenced by dietary treatments of maize offal. Length of small intestine was longest (31.78cm) on diet 1 (control) and shortest (3.61cm) in weaner rabbits fed diet 4, values obtained were significant ($p<0.01$) across dietary treatments means. It was observed that organ weights of weaner rabbits fed control diet 1 had the highest weights of kidney 1.08g, liver 4.81g, lungs 1.09g, stomach 6.03g and length of small intestine 8.81cm.

Table 3. *Organ Weights of Weaner Rabbits Fed Graded Levels of Maize Offal Diets with Groundnut Haulms as Replacement for Wheat Offal.*

			Diets			
Parameters (%)	**1**	**2**	**3**	**4**	**5**	**SEM**
	(0%)	**(25%)**	**(50%)**	**(75%)**	**(100%)**	
Kidney	1.08^{a}	0.71^{b}	0.89^{ab}	0.75^{b}	0.72^{b}	0.05*
Liver	4.81^{a}	2.96^{b}	3.52^{b}	2.81^{b}	2.67^{b}	0.26**
Heart	0.36	0.28	0.32	0.32	0.27	0.02^{NS}
Lungs	1.09^{a}	0.82^{ab}	0.91^{ab}	0.71^{b}	0.70^{b}	0.05*
Spleen	0.11^{ab}	0.07^{b}	0.09^{ab}	0.13^{a}	0.07^{b}	0.01*
Gall bladder	0.05	0.03	0.06	0.07	0.05	0.01^{NS}
Abdominal fat	3.22	2.77	1.06	1.39	1.28	0.44^{NS}
Caecum	4.41	3.46	4.36	3.89	4.01	0.28^{NS}
Stomach	6.03^{a}	4.25^{b}	3.61^{b}	3.40^{b}	4.40^{b}	0.30**
Small intestine length (cm)	31.78^{a}	22.60^{ab}	24.42^{ab}	20.09^{b}	22.03^{ab}	1.58**
Large intestine length (cm)	8.81	7.71	9.59	8.56	7.88	0.52^{NS}

a,b,c means with different superscripts on the same row differ significantly (= $p<0.05$, ** = $p<0.01$), SEM = Standard Error of Mean, NS = Not significant*

Table 4 shows the results of White blood cell differential count of weaner rabbits fed graded levels of maize offal diets. There was no significant differences on the values of monocyte (1.33 – 4.67%), eosinphil (0.00 – 0.00%) and basophil (0.00 – 0.00%) across dietary treatments groups all values were similar. However, significant differences were observed on values of white blood cell (5.90 – 9.80 x1012/µL), neutrophil (31.33 – 54.67%) and lymphocyte (40.33 – 69.50%). Rabbits fed diet 3 had the highest white blood cell (9.80 x1012/µL) and the lowest value (5.90 x1012/µL) on control diet 1 were significantly ($p<0.05$) affected by dietary treatments of maize offal. Neutrophil values ranged from (31.33 – 54.67%). The highest value (54.67%) of neutrophil was on diet 3 and lowest value (31.33%) on diet 2 was similar to control diet 1 (35.83%) and diet 5 (37.05%) but lower than value of (42.17%) on diet 4. The values of lymphocytes ranged between (55.50 – 69.50%). There was significant ($p<0.05$) increase in value of lymphocytes on diet 5 (69.50%) and lowest value (40.33%) on diet 2.

Table 4. *White Blood Cell Differential Count of Weaner Rabbits Fed Graded Levels of Maize Offal Diets with Groundnut Haulms as Replacement for Wheat Offal.*

			Diets			
Parameters (%)	**1**	**2**	**3**	**4**	**5**	**SEM**
	(0%)	**(25%)**	**(50%)**	**(75%)**	**(100%)**	
White blood cell ($x10^{12}$/µL)	5.90^{b}	9.35^{ab}	9.80^{a}	6.71^{b}	9.10^{ab}	0.81*
Neutrophil	35.83^{bc}	31.33^{bc}	54.67^{a}	42.17^{ab}	37.50^{bc}	3.02**
Lymphocyte	59.83^{a}	67.83^{a}	40.33^{b}	55.50^{a}	69.50^{a}	3.27*
Monocyte	4.00	1.33	4.33	4.67	4.00	0.81^{NS}
Eosinphil	0.00	0.00	0.00	0.00	0.00	0.00^{NS}
Basophil	0.00	0.00	0.00	0.00	0.00	0.00^{NS}

a,b,c means with different superscripts on the same row differ significantly (= P<0.05,** = p<0.01), SEM = Standard Error of Mean, NS =Not significant,*

The results of nutrients digestibility of weaner rabbits fed graded levels of maize offal diets are presented in Table 5. There was no significant ($p>0.05$) difference across dietary treatments groups on parameters measured.

Table 5. *Nutrient Digestibility of Weaner Rabbits Fed Graded Levels of Maize Offal Diets with Groundnut Haulms as Replacement for Wheat Offal.*

			Diets			
Parameters (%)	**1**	**2**	**3**	**4**	**5**	**SEM**
	(0%)	**(25%)**	**(50%)**	**(75%)**	**(100%)**	
Dry matter	74.57	56.25	67.88	54.94	74.89	3.60^{NS}
Crude protein	77.15	70.48	77.12	73.55	79.78	3.36^{NS}
Crude fibre	71.58	54.11	70.4	62.81	76.29	2.97^{NS}
Ether extract	86.91	81.34	85.42	81.82	87.51	1.38^{NS}
Ash	84.53	73.41	80.55	79.79	80.83	1.72^{NS}

a,b,c, means with different superscripts on the same row differ significantly, SEM = Standard Error of Mean, NS = Not significant

Table 6 shows the economics of production and cost benefits. There were no significant ($p>0.05$) differences on varied values of total feed intake (4.14 – 4.52kg) obtained on diet 4 and diet 5; values were similar between dietary levels. Total weight gain of weaner rabbits values ranged between (0.68 - 0.88kg) the highest value (0.88kg) observed on diet 3 and lowest value (0.68kg) on control diet 1 were similar. However, there was significant ($p<0.05$) differences on values for feed cost, total feed cost, feed cost per kilogram gain, cost saving and % saving cost. The highest value

(95.43N/kg) on feed cost obtained on control diet 1 and lowest value (71.07N/kg) on diet 4 were highly significant ($p<0.05$) across dietary treatments means. Total feed cost varied from (294.23 – 424.93N) the highest value (424.93N) obtained on diet 1 (control) and lowest value (294.23N) on diet 4 were highly significant ($p<0.05$) across dietary treatments means.

Table 6. *Economics of Production of Weaner Rabbits Fed Graded Levels of Maize Offal Diets with Groundnut Haulms as Replacement for Wheat offal.*

			Diets			
Parameters (%)	**1**	**2**	**3**	**4**	**5**	**SEM**
	(0%)	**(25%)**	**(50%)**	**(75%)**	**(100%)**	
Total Feed Intake (kg)	4.45	4.29	4.29	4.14	4.52	0.22^{NS}
Feed Cost ₦ /kg	95.49^{a}	93.65^{b}	74.90^{d}	71.07^{e}	85.75^{c}	2.62*
Total Feed Cost (₦)	424.93^{a}	401.18^{b}	321.32^{d}	294.23^{e}	387.59^{c}	13.3*
Total Weight Gain (Kg)	0.68	0.73	0.88	0.75	0.69	0.22^{NS}
Feed Cost 1kg Gain (₦)	624.90^{a}	549.56^{c}	365.14^{e}	392.31^{d}	561.72^{b}	27.2*
Cost Saving ₦	0.00^{e}	75.34^{c}	259.76^{a}	232.59^{b}	63.18^{d}	27.2*
% Saving Cost	0.00^{e}	12.06^{c}	41.57^{a}	37.22^{b}	10.11^{d}	4.35*

a,b,c means with different superscripts on the same row differ significantly, SEM = Standard Error of Mean, NS = Not significant

3.3. Discussion

The growth performance of weaner rabbits fed graded levels of maize offal-based diets were not significantly affected by the dietary treatments. Reports on the final weight values (1230.00 – 1424.67) obtained in this study showed that rabbits fed diet 3 (50%) attained the highest final weight numerically although were lower than 1580 – 1700g earlier reported by [7] higher than 993.3 – 1224g reported by [18] similar to 1290.33 – 1530.33 and 1200 – 1425g reported by [18] respectively. Highest final body weight may be as a result of the high fibre content, which may have influenced intake and growth. Fibrous diets stimulate feed intake causing ceacal colonic motility. This present finding was in line with the previous finding of [19]. The poor growth performance on the control diet (wheat offal) may have been due to inadequate fibre in the diets. The reduced growth rates as observed in diets 1 (control) may be due to decrease in dietary fibre [20]. The low feed intake (73.97 – 80.78g) as per the value of 131g/day reported by [21] for rabbits reared in temperate countries may be due to the variation in ambient temperature. [22] reported that high ambient temperature has adverse effect on feed intake. [23] reported utilisation impairment when high fibrous feeds are fed to rabbit. The daily weight gain 12.07 – 15.77g recorded in this study compared favourably 9.88 – 15.55g reported by [25,26]. The increased mean weight gain of rabbits fed diets 3, 4 and 5 over those fed diets 1 and 2 could be attributed to the favourable effect of fibre, termed “ballast” effect. Feed conversion ratio 4.85 – 6.71 obtained in this study was in line with the values 4.97 – 5.34 reported by [25] who fed replacement levels of sun dried soyabean milk residue to weaner rabbits and other workers [26,27] who fed diets containing about 30% maize offal to growing rabbits. Feed conversion ratio of rabbits observed in this study shows that the feed efficiency value of maize offal is comparable to the control diets this agrees with the work of [28] that weaner rabbits perform better with adequate required fibre requirements.

The internal organs measured showed no significant effect except on kidney liver, lungs, spleen, stomach and small intestine. The weights of liver, lungs and spleen,

stomach and small intestine were depressed in rabbits fed diets 2 (25%), 3 (50%), 4 (75%) and 5 (100%) with increasing levels of maize offal and highest in rabbits fed control diets. This observation conforms to the report of [29] in rabbits fed pelleted sweet potatoe roots meal. Hypertrophy and hypotrophy of these organs have also been linked to the presence of toxins [30]. The weights of stomach and small intestine decreased with increase in levels of maize offal [30]. Big stomach and intestine could be due to individual differences inherent among the rabbits also it could be an indication of ingesta lasted longer in the stomach and small intestine. The significant differences among the rabbits fed maize offal diets could be attributed to the presence of anti – nutritional factors that increases the activities of the organs.

The results revealed that experimental diets had significant effect on white blood cell (WBC). The values varied from 5.90 – 9.80X12/µLfor white blood cell (WBC) obtained in this study were within the normal range and compares with (5.0 – 12.0X10/µL) reported by [31]. Normal WBC values of 2.5 – 12.5 x 103mm3 for rabbits. The higher values of WBC observed in rabbits fed diets 3(50%) and 5(100%) is an indication that the rabbits' immune system may have been challenged probably by the anti-nutritional factors associated with high dietary content of the test ingredients which lead to production of more WBC. This agrees with findings of [31] that the increased value of WBC due to increased inclusion of maize offal suggests an increased immunity in the animals. White blood cells are meant to fight infections; the higher the WBC, the better the ability of the animal to fight diseases [32] reported that a reduction in WBC count may be partly attributed to reduction in protein intake [33]. There was significant effect on levels of neutrophil and lymphocytes values which ranged from 31.33 – 54.67% and 40.33 – 69.50% respectively this values were similar to ranged values of 11.25 – 41.35% and 40.20 – 75.00% for neutrophils and lymphocytes reported by [33] fell within 34 – 70% and 43 – 80% reported for rabbits [34]. According to [35] the proportion of neutrophil and lymphocytes should be ratio 1:1, variation is an indication of infection. The non significant effect of dietary treatments of maize offal on monocyte, eosinphil and basophil values ranging from (1.33 – 4.67%) and (0.00%) of recorded in this study are lower than values of 9.77 – 17.53% reported by [34] but within the range of 2 – 10% reported by Gillet (1994). This also indicates a normal blood physiology across the treatments [36]. It may also be attributed to physiological reactions to anti-nutrients.

The non - significant difference in the estimate of dry matter, crude protein, crude fibre, ether extract and nitrogen free extract observed in this study shows the utilisation of nutrients in diets to the weaner rabbits. This also indicates that there was no influence on nutrient digestibility of maize offal diets. The crude fibre digestibility obtained in this study had average values this agrees with the work of [37] who obtained average digestibility of crude fibre ranging from 42.20 – 58.12% with significant levels and concluded that fibre content determine the digestibility pattern in diets.

The feed cost in N per kg body weight gain also decreased with increasing level of maize offal in the diets lowest on diet 4 (75%). This agrees with findings of [38] who fed mucunna seed meal to New Zealand White rabbit bucks. All the diets containing maize offal were cheaper than the wheat offal control diet. The percentage cost saving in naira was best (41.57N) on diet 3 (50%). This is in agreement with findings of [2] who reported a lower feed gain/kg and higher savings in rabbits fed varying levels of groundnut haulms. [39] confirmed that the profit obtained from meat animals depends

on the carcass quality and feed conversion ratio. Maize offal indicates the potentials of reducing cost of producing rabbits on fibrous ingredients.

4. Conclusions

It was concluded that maize offal can serve as fibre sources which replace wheat offal at 50%, 25% and 100% respectively without any visible adverse effect on the performance and carcass yield of rabbits.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

References

[1] Ewuola, E.O.; Jimoh, O.A.; Aluma, O.U.; Sodipe, O.D. Haematological and serum biochemical response of growing rabbits fed graded levels of Moringa Oleifera Leaf Meal. Proceedings of the 10th World Rabbit Congress, September 3-6, 2012. Sharm- El-Sheikh, Egypt, 2012; pp. 679-683.

[2] Iyeghe-Erakpotobor, G.T.; Adeyegun, E. Evaluation of growing rabbits fed diets containing varying levels of groundnut forage meal *(Arachis hypogea)*. *Journal of Applied Agricultural Research,* 2012, 4(2), 41-51.

[3] Egbo, M.L., Dom, U.D.; Laldolks, A.B. Management in Bauchi Metropolis. Proceeding of the 26th Ann. Conf. Nig. Soc. for Anim. Prod. (NSAP) March 18-21 2001, ABU Zaria 2001; pp. 160-162.

[4] Bassey, I.O.; Oluwatosin, O.O.; Olawoyin, O. Performance characteristics of rabbits fed millet bran as a replacement for wheat bran. *African Journal Animal Biomedical Science,* 2006, 3(2), 1-4.

[5] Makinde, O.J.; Ibe, E.A.; Ajibade, A.J. Response of growing rabbits to concentrate diet supplemented with leucaena (Leucaena leucocephala) or siratro (Macroptiliumatropurpureum) leaves. *Journal of Biology, Agriculture and Healthcare,* 2015, 5(12), 17-12.

[6] Etchu K.A.; Ngu G.T.; Yongabi K.A.; Woogeng, I.N. Effect of varying levels of groundnut (Arachis hypogaea) on the growth performance of weaner rabbits (orytolagus cuniculus). *International Journal of Livestock production,* 2014, 5(5), 81-87.

[7] Ramchum R. and Raggoo J. The Development of Multi-nutrient blocks for the domestic rabbit in Mauritus. Livestock Research for Rural Development. 2000, 12(1). Available online: http://www/cipav.org.10/lrrd/lrrd12/1/ram12/a.html (accessed on 31 March 2022).

[8] Iyeghe-Erakpotobor, G.T.; Mbaduga, L.; 1Sabo, M.N.; Okunola, B.O. Performance of growing rabbits fed groundnut forage meal diets with or without palm oil. *Journal Aminal Production Research,* 2013, 25, 37- 44.

[9] Reston, T.R. Tropical Animal Feeding.A manual for Research Workers. Animal production and Health paper No. 126. FAO, Rome, 1995.

[10] Melesse, A.; Getye, Y.; Berihum. K.; Banerjee, S. Effect of feeding graded levels of Moringa stenopetala leaf meal on growth performance, carcass traits and some serum biochemical parameters of koekoek chickens. *Livestock Science*. 2013, 157(2-3), 498- 505.

[11] Iyeghe-Erakpotobor, G.T.; Abdulmalik, M.E.; Uguru, J.O.; Abeke, F.O. Determination of optimum concentrate and forage combination for small holder feeding of rabbits. *Trop. J. Anim. Sci*. 2002, 5(1), 181-187.

[12] Iyegh-Erakpotobor, G.T.; Osuhor, C.U.; Olugben, T.S. Performance and digestibility of weaner rabbits fed graded levels of soyabean cheese waste/maize offal diet and brachiaria grass hay. *African Journal of Biotechnology.* 2006, 5(17), 1579-1583.

[13] Iyeghe-Erakpotobor, G.T. Performance of grower rabbits fed concentrate and Stylosanthes (verano) combinations under tropical conditions. *Animal Science Journal,* 2007, **77**(1), 71-78.

[14] Olomu, J.M. Monogastric Animal Nutrition. Principles and practice. 2nd edition university of Benin, Jackson publication Nigeria, 2011.

[15] Aduku, A.O. Practical Livestock Feeds production in the Tropics. Asekome and Co- Publishers, Samaru, Zaria, Nigeria 1992; pp. 44-49.

[16] CIOMS. International guideline principles for biomedical research involving animals. Council for International Organization of Medical Sciences. Available online: http://www.cioms.ch/frame_1985_tests of guidelines.html (accessed on 31 March 2022).

[17] A.O.A.C. The official method of Analysis. Association of official Analytical Chemist 18th Edition Washington D.C. 2000.

[18] Bolarin, O.; A.O.; Olanite, J.A.; Onwuka, C.F.I. Peformance, blood indices and carcass yield of grower rabbits fed diets containing Moringa Oleifera, *Asphilia Africana* and *Azadiradita indica* leaf meal. *Nigerian Journal of Animal Production*. 2017, 44(4), 139-149.

[19] Onifade, A.A.; Babatunde, G.M.Comparison of the utilization of palm kernel meal, brewers dried grains and maize offal by broiler chicks. *British Poultry Science,* 1998, 39, 245-250.

[20] Bamgbose, A.M.; Abimbola, M.; Olayemi, W.A.; Osofowora, A.O.; Oso, A.O.; Ojo, O.T. (2002). Performance of weaner rabbits fed supplemented Tridax procumbens diets. In: Bamgbose, A.M., Ogunbenro, S.D., Obasohan, E.E., Aruna, M.B., Oteku, I.T., Igene, U.F., Otoikhian, C. S.O. and Imaseun, J.A.(2004). Replacement value of maize offal/cashew nut for maize. Proceedings of 29th Annual Conference of Nigerian Society for Animal Production (NSAP), March 21st-25th Usman Danfodio University, Sokoto, Nigeria. pp. 219-221.

[21] Cheeke, P.R. Rabbit nutrition and feeding: Recent advances and future perspectives. *Journal Applied Rabbit Research,* 1984, 7(1), 31-37.

[22] Fielding, D. Rabbits. The tropical agriculturist. CTA. Macmillan Educatiob Ltd. Macmillan Publishers London, UK, 1991; pp. 16-17.

[23] Sobayo, R.A.; Okubanjo, O.A.; Adeyemi, O.A.; Usman, J.M. Nutritional evaluation of graded levels of fermented maize milling waste. (Maize gluten) in rabbit diet. 2007.

[24] Saleh, I.I.; Bawa, G.S.; Hudu, M.I.; Ibrahim, U.M .; Abubakar, S. Soyabean curd residue as an alternative. Non-conventional protein source for improving rabbit performance. *Nigerian Journal of Agricultural Extension,* 2018, 19(3), 42-49.

[25] Abdullahi, U.; Yusuf, H.B.; Wafar, R.J.; Mijinyawa, A.; Abubakar, A.; Shuaibu, U.S.; Mohammad, A. Growth performance, carcass characteristics and internal organ weights of weaner rabbits fed replacement levels of sun0dried soyabean milk residue. *Nigerian Journal of Animal Production,* 2021, 48(3), 93-99.

[26] Onifade A.A., Tewe O.O. Alternative tropical feed resources in rabbit diets; growth performance, diet digestibility and blood composition. *Journal of World Rabbit Science,* 1993, 1(1), 17-24.

[27] Agunbiade, J.A.; Bello, R.A.; Adeyemi, O.A. Performance characteristics of weaner rabbits on cassava peel-based balanced diets. *Nigerian Journal Animal Production,* 2002, 29, 171-175.

[28] Adejinmi, O.O.; Adejinmi, J.O.; Adeleye, I.O. Livestock Production in Nigeria at commissions and omissions inaugural lecture series, 17 University of Ife-Press. Ile-Ife, Nigeria, 2010.

[29] Tewe, O.O. Sustainability and development paradigms from Nigeria's livestock industry. An inaugural lecture delivered on October 9, 1997 at the university of Ibadan. Polygraphics Venture Limited, Ibadan, Nigeria. 1997; pp. 42.
Available online: http://80.240.30.238/bitstream/123456789/3209/1/ui_ina_sustainability_tewe_1997.pdf (accessed on 31 March 2022).

[30] Ewuola, E.O.; Folayan, O.A.; Gbore, F.A.; Adebunmi, A.I.; Akanji, R.A.; Ogunlade, J.T.; Adeneye, J.A. Physiological response of growing West African Dwarf goats fed groundnut shell-based diets as the concentrate supplements. *Journal of Agriculture,* 2003, 1(1), 61-69.

[31] Azi, J.A.; Alu, S.E.; Ogah, D.M.; Baba, M.K. Heamatology and serum biochemistry of rabbits fed acha offal (Digitaria exills) meal-based diets supplemented with Maxigrains enzyme. *Nigerian Journal Animal Production,* 2021, 48(1), 102-113.

[32] Ogbuewu, I.P.; Kadurumba, O.E.; Okli, I.C.; Iloeje, M.U. Effect of ginger rhizome powder supplement and sex on haematological indices of prepubertal rabbits. *Journal of Agricultural Technology,* 2013, 9, 11-19.

[33] Murray, R.K.; Granner, D.K.; Mayes, P.A.; Rodwell, V.W. Harper biochemistry. 24th edition, Appleton and Lange. 2013.

[34] Medirabbit. Complete blood count and biochemistry reference values in rabbits. Available online: www.medirabbit.com/EN/Haematology/blood_chemsistry.html (accessed on 31 March 2022).

[35] Gillet, C.S. Selected drug dosages and clinical reference data. In: Manning P.J., Ringler D.H. Newcomer C.E. (eds.). The Biology of the Laboratory Rabbits (2nd Editon). Academic. Press, New York, USA, 1994; pp. 467-472. DOI: 10.1016/B978-0-12-4692350.50028-2.

[36] Shaahu, F.T.; Ayoade, J.A.; Ate, M.E. Carcass characteristics haematological parameters and reproductive tract morphometry of rabbits fed cassava leaf meal. *Journal of Agriculture and Veterinary Science,* 2014, 7(5), 2319-2372.

[37] Lang J. The nutrition of commercial rabbit, Part 1: physiology, digestibility and nutrients requirements. Part 2: Feeding and general aspects of nutrition. *Nutrition Abstarct Review Series. B. Livestock Feeds.* 1981, 51, 225, 287-302.

[38] Ekpo, J.S.; Udia, V.S.; Ogundu, E.C.; Sam, I.M.; Eyoh, G.D. Carcass traits of crossbred rabbit Bucks Fed Diets Supplemented With Pumpkin Stem waste. *European Journal of Advanced Research in Biological Sciences,* 2021, 4(3), 1-7.

[39] Olorunsaya, B.; Ayoola, M.A.; Fayeye, T.R.; Olagunju, T.A.; Olorunsaya, E.O. Effect of replacing maize with sun-dried cassava waste meal on growth-type rabbits. Animal production Department, University of Ilorin, Nigeria, 2001.