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Nutritional Evaluation of Honey Bee Slum gum Meal as Replacement for Maize in the Feed of Growing Rabbits

Ojebiyi O. O.[*1], Yusuff A.O.[1], Oladunjoye I. O.[2] and Babarinde S. A.[3]
[1]Department of Animal Nutrition and Biotechnology
[2]Department of Animal Production and Health
[3]Department of Crop Production and Soil Science
LadokeAkintola University of Technology, PMB 4000, Ogbomoso, Nigeria
* E-mail of the corresponding author: segunojebiyi@gmail.com

Abstract
As part of the efforts in developing alternative feed ingredients for feeding rabbits a feeding trial was conducted to investigate the nutritional potential of Honey Bee slum gum meal (HBSM) on the performance characteristics of growing rabbit. Thirty (30) growing rabbit of 7 weeks of age were weight-balanced and divided into three (3) dietary treatment groups of 10 rabbit each in a completely randomized designed experiment. Diet 1 had 0% inclusion of HBSM while 25 and 50% maize in diets 2 and 3 were replaced by HBSM respectively. Rabbits received feed and water *ad libitum* during the 12 weeks of the experiment. The final weights decrease linearly ($P<0.05$) as the level of inclusion increases (1663.20g 1630.00g and 1458.40g for rabbits on treatments 1, 2 and 3 respectively). Rabbit on diets 1 and 2 had higher ($P<0.05$) daily weight gains (13.59g and 13.15 respectively) compared with rabbits on diet 3 (11.1g). The digestibility of nutrients were not affected ($P>0.05$) by the dietary treatments. The values obtained for final weight, carcass weight, abdominal fat, kidney, liver and lungs were significantly ($P<0.05$) affected by dietary treatment. HBSM can be used as an alternative for substituting maize in growing rabbits diets up of 25% beyond which depression in performance is observed.
Key words: Honey slum gum meal, Digestibility, Final weight, growing rabbits.

Introduction

Although in most African countries, renewed efforts to meet the animal protein need of an ever increasing population are a common programme and policy of their governments, the tropical world is largely faced with shortage of feed resources (FAO 2012). According to Ojebiyi (2009), one sustainable way of meeting the animal protein requirements of the Nigerian populace is through the production and multiplication of small animals that can immediately meet the need and guarantee a future for continuous sustenance. The animal of choice is rabbit because of the obvious advantages it has over other livestock. The domestic rabbit when compared with other livestock is characterized by early maturity, high prolificacy, relatively short gestation period, short generation interval, high productive potential, rapid growth, good ability to utilize forages and fibrous plant materials and agricultural by-product, more efficient feed conversion, low cost per breeding female and its profitability for small-scale system of production and in backyards (Cheeke 1986; Finzi and Amici, 1991). Feed, accounting for between 65-70% of the total running cost is a major input in animal agriculture. According to FAO (2000), poor nutrition of animals among other factors has been identified as the major constraint to animal production in most of the developing countries of world. Looking into various ways of making possible reduction in feeding cost to make their production relatively cheaper and the products affordable are therefore critical.
According to FAO (2012), 40% of cereal produced are used for livestock feed in the United States, While only 14% are used in Africa. The high cost of energy feed resources in particular has pushed the animal nutritionist and livestock farmers into utilization of cheaper alternatives. In Nigeria, many non-conventional feedstuffs have great potential in sustaining intensive rabbit production and can partly or completely replace the conventional feedstuffs in rabbit diet (Ibitoye *et al.,* 2010).
The utilization of non-conventional feed ingredients by rabbits has been well documented. These include cassava waste meal (Olorunsanya *et al.,* 2007) , maize sievate (Okon *et al.,*2007) , coffee bean testa (Hamzat *et al.,*2007), mango seed kernel (Yusuf *et al.,* 2009) and sweet potato peel meal (Akinmutimi and Osuagwu 2008) . However, the potential of Honey Slumgum meal (HBSM) as a feed resource in rabbits has not been well investigated in Nigeria. Honey Slumgum is obtained after melting of the honeycomb into wax. According to Babarinde *et al.,* (2011), experiences in South Western Nigeria have shown that Slum gum are good breeding materials for apicultural pests most especially the wax moth (*Galleria melonella*) and hive beetle (*Aetheniatumida*). Consequent upon lack of local market for bee wax and lack of technical knowhow for its processing, the local farmer in most places throw away honey comb after honey extraction. The aftermath of such action is that the area is prone to pest infestation which may require a great financial cost in pest control and lost of or reduction in income accruable to farmers. Honey comb often contain pollens, brood lining and eggs that are potential sources of protein and energy. According to Tew (1992), Slum gum is composed of a mixture of dead bees, cocoons,

honey, beeswax and propolis.
The present study was therefore designed to investigate the grain replacement potential of Slum gum meal in rabbit feed.

Materials and Methods
The study was carried out at the Rabbitry Unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State Nigeria. Ogbomoso is in the derived savannah zone of Nigeria.
Collection and Preparation of Test Ingredient **:** Honeybee comb was collected from the Apiary unit of Ladoke Akintola University of Technology Teaching and Research Farm. Preparation of Honey Slumgum (residue derived from wax processing) involves straining of Bee comb done according to the method of Segeren (1997) (Figure 1).
Honey Bee comb + Water (in open vat)
↓ Heat (80 – 90^0C)
Decantation of water and wax
↓Straining (using Cheese cloth)
Honey slumgum (Residue)
↓
Sun drying
Figure 1: Processing of Honey slum gum
The honey bee slumgum obtained was sun dried and used in formulating the experimental diets.
Experimental diets: Three experimental diets were formulated with diet 1 without Honey Slum gum serving as the control. Diets 2 and 3 had 25% and 50% of their maize replaced with honey Slum gum meal respectively (Table 1).
Experimental Animal and Management**:** Thirty growing mixed breed (Newzealand White X Chinchilla) rabbits of 7 weeks of age and between 520 ± 5g initial weights were randomly assigned on the basis of their relative equal mean group weights to three treatments of 10 rabbits each. The rabbits were housed individually in all wire cages measuring 44 x 34 x 44cm. The drinking and feeding through were made of earthen pots re-enforced with cement and flatten at the bottom to prevent tipping off. They were removable type for easy washing and cleaning. A total of 100g of feed divided into two portions of 50g in the morning at 8:00 hour and 50g in the evening at 16:00 hour were supplied to each rabbit per day. To determine feed intake, waste were collected and weighed each morning while water was provided *ad libitum*. The rabbits were weighed at the commencement of the experiment and thereafter weighing was done on weekly basis to monitor weight changes.

Table 1: Composition of Experimental diets

Ingredients	**Control**	**25%**	**50%**
Maize	25.00	18.75	12.50
Honey slum gum meal		6.25	12.50
*Fixed ingredients	75.00	75.00	75.00
Total	**100.00**	**100.00**	**100.00**
Nutrient composition			
Calculated energy (ME) kcal/kg	2478.75	2449.13	2479.50
†Dry matter (%)	90.76	90.85	90.77
†Crudeprotein (%)	18.02	18.51	18.87
†Crude fibre (%)	11.74	11.67	11.84
†Ether extract (%)	3.61	3.57	3.63
†Ash (%)	6.61	6.48	6.66
†Nitrogen free extract (%)	50.78	50.62	49.77

‡**Analyzed**
***Fixed ingredients(%):** Corn bran 15, Palm Kernel Cake 10, Groundnut Cake 15, Brewer's Dry Grains 20, Rice husk10, Fish meal 1.25, Bone meal 3.00, **Premix 0.25 and Salt 0.50
****Premix Composition/kg of feed: Vitamin A:3200000IU, Vitamin D3:1200IU, Vitamin E:3200IU, Vitamin B_2:1000mg, Vitamin B_{12}:2000mg, Niecin:4000mg, Selenite (Se):40mg, Magnesium(Mn):3200mg, Pantothenic Acid:2000mg, Folic Acid:200mg, Choline-Chloride:60000mg, Iron(Fe):8000mg, Cupper(Cu):3200mg, Zinc:20000mg*
Digestibility of nutrients was determined at the 7th week of the experiment by collection of faeces for 5 days.

Records of the wet as well as dry weight of the faeces were kept and after bulking together samples were taken for determination of proximate composition.
Representative samples of the test ingredient, experimental diets and faecal samples were analyzed for dry matter, crude protein, crude fibre, ether extract and ash composition using the standard methods of AOAC (2005). Gross energy was determined by Gallenkamp Ballistic Bomb Calorimeter.
Carcass and Organ Evaluation: At the 12th week of the experiment, the animals were starved overnight and three animals were randomly selected from each treatment group for carcass and organ evaluation. The rabbits were stunned and bled after cutting of the jugular vein with sharp knife and evisceration was carried out immediately. Carcass, Liver, Kidney, spleen, heart weights and the abdominal fat of each animal were recorded.
Statistical analysis: All data collected were subjected to analysis of variance using the general linear model according to SAS (2000) and means were compared using Duncan Multiple Range Test of the same package.

Results and Discussion
The proximate composition of the test ingredient shows that it contain 90.37 dry matter, 3.62kcal/g gross energy.16.10% crude protein, 2.02% crude fibre, 3.92% ether extract, 5.40% Ash and 62.93% Nitrogen free extract.
The nutrient composition of diets 2 and 3 compared well with that of the control 1 (Table 1) and the nutrient content falls within the range recommended for growth of growing rabbits by Lebas *et al* (1997) and NRC (1977).
The performance characteristics of the rabbits of each group are presented in Table 2. Rabbit performance were significantly ($p< 0.05$) affected by the dietary treatments.

Table 2: Growth performance of growing rabbits fed varying inclusion levels of Honey bee slumgum meal

Parameters	T1	T2	T3	SEM
Initial weight (g)	521.50	525.35	524.88	35.10
Final weight (g)	1663.20[a]	1630.00[a]	1458.40[b]	1.96
Daily weight gain (g)	13.59[a]	13.15[a]	11.11[b]	0.55
Daily feed intake (g)	76.23[a]	69.19[b]	66.68[b]	1.62
Feed to gain ratio	5.61 [a]	5.26 [b]	6.00 [a]	0.18

[abc]Means along the same row with similar superscript are not significantly (P>0.05) different
SEM- Standard error of the mean
T1, T2 and T3= 0 %, 25% and 50% replacement level of maize with honey slum gum.
The final weight obtained for rabbits fed diets 1 and 2 are similar but higher ($p< 0.05$) than the weight of rabbits fed with diet 3. Similar trend was observed for daily weight gain. The final weight values obtained in this study are higher than that of Togun *et al* (2009) and Ojebiyi *et al* (2008), Nsa *et al* (2010), Ocheja *et al*(2011) and Malik *et al*. (2011). This may be an indication of good quality as well as better utilization of the test ingredient used in this study.The daily weight gains obtained in this study for rabbits on diets 1and 2 are similar to 12.9g/day reported by Omole and Ajayi (1976) but are lower than the range of 15.6 - 18.7g/day reported by Omole (1979) and 25.5 - 31.0g/day reported for rabbits kept in temperate region and fed standard diets made from conventional feed sources (Lebas *et al* 1996).
The daily feed intake of the rabbits in the control diet is higher ($p< 0.05$) than the feed intakes of rabbits on diets 2 and 3. The similar final weight of rabbits in treatments 1 and 2 is an indication of better feed utilization of rabbits in treatment 2 because the rabbits had lower feed intake and lower ($p<0.05$) feed to gain ratio when compared with the control.
The nutrient digestibility of diets is presented in Table 3.

Table 3: Nutrient digestibility of growing rabbits fed varying inclusion levels of Honey slum gum

Nutrients (%)	T1	T2	T3	SEM
Crudeprotein	76.06[c]	81.29[b]	85.14[a]	0.13
Crude fat	92.64 [b]	93.55 [b]	94.15 [a]	0.26
Crudefibre	26.70 [a]	23.61 [b]	24.91 [b]	0.64
Gross energy	84.21	85.00	84.42	0.23
Ash	81.31	81.74	83.62	0.50
Dry matter	84.83	84.18	84.79	0.73

[abc]Means along the same row with similar superscript are not significantly (P>0.05) different
SEM- Standard error of the mean
T1, T2 and T3 = 0 %, 25% and 50% replacement level of maize with honey slum gum
The nutrient digestibility of diets is presented in Table 3. The results obtained show that apart from the ash and dry matter and gross energy digestibility other parameters measured were significantly ($p< 0.05$) affected by the dietary treatments. The crude protein digestibility increased linearly ($p<0.05$) as the level of inclusion of HBSM increases. Coefficients of digestibility of crude protein are higher than those reported by Ondruska et al (2010).The crude fibre digestibility however was lower ($p<0.05$) in rabbits on diets 2 and 3. None of the values obtained for crude fibre in this study falls below the values reported by Lakabi-loualitene *et al.,* (2003) but are lower than the values obtained by Ondruska *et al* (2010). The gross energy digestibility values for rabbits on diets 1 and 2 are similar but significantly ($p<0.05$) higher than the value for rabbits on diet 3.
The carcass and organ characteristics of rabbits fed varying inclusion levels of honey slumgum is presented in Table 4.

Table 4: Carcass and organ characteristics of growing rabbits fed varying inclusion level of Honey bee slum gum meal

Parameters	T1	T2	T3	SEM
Final weight (g)	1663.20[a]	1630.00[a]	1458.40[b]	.96
Dressed Carcass (g)	878.00[a]	841.90[b]	764.79[c]	25.61
Dressing percentage (g)	52.79	51.65	52.44	0.44
Abdominal fat (%)	1.41[a]	1.29[a]	0.31[b]	0.16
Heart (% of body weight)	0.21	0.18	0.21	0.00
Kidney (% of body weight)	0.55[ab]	0.52[b]	0.60[a]	0.13
Liver (% of body weight)	2.52[b]	2.53[b]	2.89[a]	0.07
Lungs (% of body weight)	0.39[b]	0.44[ab]	0.51[a]	0.21
Spleen (% of body weight)	0.04	0.12	0.05	0.03

[abc]Means along the same row with similar superscript are not significantly (P>0.05) different
SEM- Standard error of the mean
T1- 0 % Inclusion level of honey slum gum meal
T2- 25% Inclusion level of honey slum gum meal
T3- 50% Inclusion level of honey slum gum meal
Dressing percentage, relative heart and spleen weights were not affected (P>0.05) by dietary treatments. The final weight for T1 (1663.20g) and T2 (1630.00g) are similar (P>0.05) but higher (P< 0.05) than T3 (1458.40g). Dressed carcass decreased with increase level of honey bee slum gum meal.
The dressing percentage range of 51.65% to 52.79% obtained for rabbits in this study compared well with the average of 56.50% ready to cook carcass of different European breeds reported by Lebas *et al.,* (1996). The liver and lungs weight, expressed as percentage of live weight increased as the level of honey slum gum in the diet increased. The abdominal fat however, also tend to decrease as the level of honey slum gum in the diet increased. This observation may be due to differences in carbohydrate metabolism in maize and honey slum gum. There was no significant difference in the weight values of organs measured except for the liver and lungs whose weight increased ($P<0.05$) more in honey slum gum containing diets this may be due to the presence of undetected level of anti-nutritional factors in the diets. Caution must therefore be exercised in the optimum level of honey slumgum to be recommended in the rabbit's diet as an alternative energy source.

Conclusion

It can be concluded from this study that Honey Bee Slum gum meal has potential as feed ingredients in the formulation of rabbit diets. It offers a cost saving alternative to Maize in growing rabbit's diet. This is because it is less competed for in terms of usage and is relatively easy and cheap to obtain.

It is recommended that 25% of maize in the diet of growing rabbits be replaced with Honey Slum gum meal to reduce the cost of production and improve the income of the farmers thus encouraging further production and making more meat available for human consumption. A further study is recommended to investigate the histology of internal organs.

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