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Nutritional Evaluation of Bee Wax Residue Meal in the Diet of Lactating Goat

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Abstract: Nine West African dwarf goats were used to investigate the effect of bee wax residue meal on the lactation performance, feed intake and weight gain. Goats were fed a diet with or without bee wax residue meal in a completely randomized design model for a 156 day period. The three diets were A (control), B (1%) bee wax residue meal inclusion) C (3% bee wax residue meal inclusion). Water and feeding were given *ad libitum*. Supplementing the diet with bee wax residue meal increased the crude protein intake from 47 g^{-d} (diet A) to 133g^{-d} (Diet C). The dry matter intake was greater for diet C followed by diet B and C which are similar ($p>0.05$). Animal on diet C consumed the highest percentage of minerals. Milk yield was significantly increased ($p<0.05$) by bee wax supplementation [407g^{-d}] (A), [412g^{-d}] (B) and [446g^{-d}] (C). Supplementation also increased butter fat, protein, calcium and phosphorus contents. The potassium sodium and iron contents were significantly ($p<0.05$) highest in diet C followed closely by diets B and A (control) which are similar ($p>0.05$). It could be concluded that bee wax residue meal could be used to supplement lactating West African goats diet in the tropical environment.

Key words: West African dwarf goats, milk production, bee wax residue meal

INTRODUCTION

Bee wax residue is usually obtained after the honey has been extracted from the comb and wax has been removed as well as the shaft that is thrown away (Monmouth, 1986). The residue from wax rendering contains sufficient nutrient and could be used as poultry feed or tuned into good compost (Faruga *et al*., 1975) Bee wax was considered safe for human consumption and was approved as an ingredient in human food in the USA (USA, 1978). The wax has also been used as a separate agent in the confectionary industries (Ribot, 1960).

Several methods of rendering wax are possible and it may be adapted to numerous circumstances. Wax may be separated in solar wax melters (2) by boiling in water and later filter (3) by using steam or boiling water and special presses. If rain water or soft water is not available, hard water of high calcium content could be used with the addition of 0.1% vinegar (Crane, 1980). Wax should not be heated above 85°C else discolouration occurs. Excessive heating during rendering or further processing changes the wax structurally and alters the beneficial characteristics of many of its minor compounds as well as its aromatics and volatile compounds (Crane, 1980). Direct exposure of wax to hot steam results in partial saponification (Graham, 1992)

Bee wax is needed for the production of artificial combs as well as for musical instruments, coloured crayons and paints. It is vital ingredient in polishing and furniture wax, shoe polish, car wax and lubricants and metal polish. The thrust of this study was to evaluate the efficacy of bee wax residue meal on the performance characteristics of lactating West African dwarf goats.

MATERIALS AND METHODS

Study area: The experiment was conducted between September and October 2007 at the Animal Pavilion of the Department of Animal Production, University of Ilorin, Nigeria.

Preparation of bee wax residue meal: The processing was done at the Teaching and Research Farm, University of Ilorin, Nigeria using the hot water extraction method thus: The wax was obtained by breaking the comb into pieces and soaked in water for 24 h. The comb was then tied in a bligated sack and boiled in a container fill of water while the wax floats on the surface. It was left overnight to cool and a round cake solid of bee wax was formed afterwards.

The waste was collected and dried in the oven at about 60°C later milled and mixed with other ingredients (Table 2).

Experimental diets and management of the animals: Three experimental diets (A, B and C) were prepared with diet A being the Control while bee wax residue meal was included at one and three percentages in diets B and C respectively.

Eighteen West African dwarf goats used for the experiment were kept in a well cleaned, disinfected and well ventilated pens for 180 days (i.e. 150 days

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pregnancy and 30 days milk collection period). The animals were fed and water *ad-libitum* throughout the experimental period.

Milk collection: Milk collection started 5 days after the kids were allowed to take the colostrums. The animal was hand milked for about 5-7 min daily by expressing the milk from the udder of the animal into a clean bowl. The milk was immediately taken to the laboratory for weighing to record the daily milk yield.

Analysis: The chemical composition of the milk was determined by the method of AOAC (1990) while the fat was determined by using Gerber's method.
All data collected were subjected to analysis of variance of a completely randomized design model (Steel and Torrie, 1960) while means were separated using the method of Duncan (1955) multiple range test.

RESULTS AND DISCUSSION

Table 1 showed the proximate composition of the bee wax residue used in this study. The crude protein content (23.07%) of the bee wax residue was higher than the crude protein of most grasses and leguminous crop. Additionally, the bee wax residue meal was higher in dry matter and ether extract. The higher ether extract could be an added advantage in the fat content of the milk.
The proximate composition of the experimental diets (Table 2) revealed increasing percentage of most of the parameters studied in diets B and C compared to the control (diet A). The crude protein content increased by 1.4 or 2.6 times in diets B and C than the control (diet A). Compared with the control (diet A), the animals showed a marked consumption of dry matter, crude protein, ether extract, calcium, phosphorus, potassium and iron in diet A (Control). A moderate consumption of the aforementioned parameters was recorded for animal on diet B (1% bee wax residue inclusion) and the least for the control (diet A).
Contrarily, poor crude fibre intake was recorded for diet A. The increase crude protein content of the diet agreed with the work of Adegbola (1974) that intake of crude protein increased with the level of dietary protein due to the attempt of the animal to satisfy their protein requirement.
The highest milk yield recorded for diet C could be due probably to the highest crude protein and fat intake of the diet. This confirmed the assertion of Broster *et al.* (1969) that good nutrition improves milk production. A progressive increase ($p<0.05$) in the fat content as well as an increase in the protein content of the diet were exhibited as the levels of the protein and fat of the milk were enhanced. The increase of the protein and fat in the milk produced by goats on diets B and C must be regarded as a direct effect of feeding and the positive

Table 1: Composition of the experimental diets

	Experimental diets		
Ingredients (%)	Diet A	Diet B	Diet C
Cassava waste	54.00	53.00	52.00
Soybean meal	2.00	2.00	2.00
SBDG	23.00	23.00	23.00
Rice husk	20.00	20.00	20.00
Bee wax residue			
Meal	0.00	1.00	2.00
Salt	1.00	1.00	1.00

Table 2: Proximate composition of bee wax residue meal and the experimental diets

		Experimental diets		
Parameters (%)	Bee wax residue meal	Control Diet A	Diet B	Diet C
Dry matter	83.44	96.29	94.6	98.5
Crude Protein	23.07	9.39	13.49	24.16
Crude fibre	2.4	23.86	19.21	11.04
Ether extract	42.19	8.43	8.77	8.66
Mineral content (g/kg)				
Calcium	0.14	0.22	0.22	0.25
Phosphorous	1.14	0.14	0.43	0.14
Potassium	0.83	0.73	0.74	0.71
Sodium	0.55	0.49	0.49	0.48
Iron	1.06	0.47	0.4	0.52

Table 3: Nutrient intake of the experimental diets

Parameters (%)	Control Diet A	Diet B	Diet C	±SEM
Dry matter	504.27^a	504.53^a	551.28^b	8.62*
Crude protein	47.35^a	68.06^b	132.82^c	1.42*
Ether extract	41.89^a	44.25^a	47.75^b	0.81*
Crude fibre	120.47^c	96.93^b	60.89^a	1.60*
Mineral content (g/kg)				
Calcium	1.09^a	1.22^b	1.38^c	0.04*
Sodium	2.47^a	2.47^a	2.65^b	0.06*
Potassium	3.68^a	3.71^a	3.92^b	0.06*
Phosphorus	0.70^a	2.17^c	0.77^b	0.02
Iron	2.37^b	2.02^a	2.87^c	0.04*

Means along the rows with similar super scripts are not significant at $p<0.05$

Table 4: Milk quality and quantity of the experimental diets

	Experimental diets			
Parameters	Control Diet A	Diet B	Diet C	±SEM
Milk yield (g/d)	407.33^a	412.24^b	446.84^c	0.08*
Total solids (%)	16.10^b	14.33^a	16.91^c	o.81*
Solids not Fat	13.09^c	11.04^b	11.12^a	0.58*
Fat (%)	3.13^a	3.60^b	6.20^c	0.25*
Protein (%)	2.54^a	3.36^a	4.86^b	0.73*
Lactose (%)	4.44^a	3.72^b	3.10^c	0.03*
Mineral content (g/kg)				
Calcium	0.25^a	0.28^b	0.31^c	0.02*
Phosphorus	0.02^a	0.06^b	0.14^c	0.01*
Potassium	0.47^a	0.48^a	0.51^b	0.03*
Sodium	0.49^a	0.50^a	0.66^b	0.05*
Iron	0.19^a	0.17^a	1.31^b	0.02

Means along the rows with similar superscripts are not significant at $p>0.05$

effect of bee wax residues meal based diets in enhancing these two vital components for dairy industry since milk is purchased based on its fat and protein contents (Cerbulis and Farrel, 1975). The high fat content of milk reported herein will make the milk to command high premium level in the market (Maxine, 1988).

In addition, a positive effect of bee wax residue meal on the mineral content was noted (Calcium, phosphorus, potassium, sodium and iron). This could be due probably to increasing amount being utilized by the animals.

The moderate lactose content reported for animal on diets B and C might be ascribed to the small amount of dietary starch received by the animals on these diets. The assertion agreed with the reports of Succi and Sandrucci (1995) and Rotuno *et al.* (1998). Such moderate lactose content makes possible the milk to be consumed by many people that are lactose intolerance (Alm, 1982).

Conclusion and Implications:

- Bee wax residue meal based diets brought about significant variations in the fat and crude protein contents of the milk of West African dwarf goats
- A progressive increase in dry matter intake, crude protein intake, ether extract intake and considerable increase in the mineral intake were exhibited as the levels of bee wax residues was increased.
- The increased milk yield with high levels of milk protein and fat may be regarded as an index of the nutritional characteristics of the diets. In addition, there was no detrimental effect of the diet on the experimental animals.
- Therefore, these results indicate that the addition of bee wax residues meal in goat diet is effective in altering the composition of goat milk.

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