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STUDIES ON THE FEEDING VALUE OF AGRO-INDUSTRIAL BY-PRODUCTS AND THE FEEDING VALUE OF COCOA PODS FOR CATTLE

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Two cattle studies were carried out to determine the maximum level at which cocoa-pod, an agricultural by-product could replace maize or sorghum in cattle fattening diets. In the first experiment, 3 groups of 12 cattle each were fed 3 diets containing 0, 20 and 40% cocoa pods for 112 days, while in a second study, 3 other groups were fed diets containing 0, 30 and 60% cocoa-pod for 84 days. A trend of increasing feed intake and decreasing weight gains with increasing cocoa-pod levels was observed. Nevertheless, differences in weight gains and feed utilisation only reached significance ($P < .05$) above the 40% dietary cocoa-pod level. Moreover feed costs were lower for all cocoa-pod diets compared to the control. Apparently, cattle can profitably utilise fattening diets containing up to 40% cocoa-pod in place of maize or sorghum.

Key words: agro-industrial by-products, cocoa-pods, cereal substitution, feed value, cattle

Over the last decade, there has been a rapid and continuous increase in the cost of cereals and protein concentrates which form the basis of compounded animal feeds. Attention has therefore been focussed on identifying cheaper alternative feed sources. A number of crop residues produced on the farm after harvesting or in the industry after primary processing, are being evaluated on a world-wide basis, as to their suitability as animal feeds. Cocoa-pod, produced after the removal of the cocoa bean from the fruit is one such crop residue being evaluated in Nigeria.

According to Boussard (1979), every unit of dry cocoa-beans produced generates two units of wet pods. Atanda and Jacobs (1973) estimated that about four million tonnes of wet pods are produced annually, and left to rot and waste on Nigerian plantations - a significant wastage of nutrients, since according to Branckaert et al (1976) and Gohl (1975), cocoa - pods contain about 6 - 10% crude protein, 49-61% nitrogen free extract, 24 % crude fibre and 10% ash, made up primarily of potassium salts. The material apparently has potential as a feed ingredient particularly for ruminants. The following is a report of studies carried out to establish a rational use of cocoa-pods in cattle fattening diets.

Materials and Methods

First study: A total of 36 local type cattle bearing Ndama and Keteku markings were quarantined on arrival from the cattle market for four weeks. The animals were treated against internal parasites with Thibenzole[1] and sprayed against ecoparasites with malathion during the first week of quarantine. They were gradually introduced to concentrate feeding during this quarantine period, being fed a reception diet made up of maize, dried brewers grains, groundnut cake and a mineral vitamin supplement.[2] On day 1 of the experimental period, the animals were each injected with 10 ml of a vitamin A, D_3, E and C preparation[3]. They were then

[1] Thibenzole (Merck, Sharp and Dohme) [2] Agricare (Pfizer Nigeria Ltd)

weighed, having been fed and water fasted for 18 and 12 h periods respectively. The initial shrunk weight thus obtained, was used to rank them into three comparable groups, which were in turn randomly assigned to three experimental diets whose compositions are shown in Table 1. The an-

Table 1:

Composition of experimental diets - First study

Ingedients (% as fed)	Diets		
	Control	20% cocoa-pod	40% cocoa-pod
Guinea corn (sorghum)	62.3	43.2	24.4
Cocoa-pods	0.0	19.2	38.4
Dried brewers grain	19.5	19.5	19.3
Groundnut cake	4.7	4.7	4.7
Molasses	11.7	11.6	11.5
Oysters shell	0.9	0.6	0.3
Dicalcium phosphate	0.4	0.7	0.9
Salt	0.3	0.3	0.3
Vitamin mineral mix[1]	0.2	0.2	0.2
Nutrients:			
Dry matter	88.1	87.5	86.6
Crude protein (% DM)	14.0	13.5	13.3
Crude fibre (% DM)	8.9	10.2	13.5
Ash (% DM)	6.7	8.3	9.5

[1] Agricare, Pfizer Livestock Feeds Co., Lagos, Nigieria

imals were fed their respective diets ad libitum for 112 days in groups of 4 with 3 groups per diet.

Unshrunk body weights were recorded at 28 day intervals, while feed intakes were calculated and recorded at weekly intervals. Representative samples of the diets were taken twice every week,bulked on a monthly basis, and analysed for proximate contents according to AOAC (1975) procedures . On the 112th day, final body weights were recorded after 18 and 12 h periods of feed and water fast respectively. Three animals were then randomly selected from each treatment, slaughtered, and carcass weight, amd longissmus dorsi area were recorded. The relationship between carcass weight (Y) and final liveweight (X) of the 9 slaughtered cattle was defined by a regression equation $Y = -6.49 + .55X$ ($R^2 = 0.96$). This equation was then used to estimate carcass weights of the unslaughtered cattle whose dressing percentages were subsequently calculated.

Second study: A second set of 29 cattle treated the same way as described for the first set above were fed the slightly modified diets shown in Table 2, for 84 days. The dietary modifications were (a) a change from guineacorn (sorghum) to maize as the main energy source in the control diet; (b) removal from the diets, of molasses, a scarce, seasonal and difficult to transport product; (c) a change in the dietary levels of cocoa-

Table 2:
Composition of experimental diets - Second study

	Diets		
	Control	30% cocoa-pod	60% cocoa-pod
Maize	69.4	38.9	8.9
Cocoa-pod	0.0	30.5	60.2
Wheat bran	10.5	10.5	10.5
Dried brewers grains	14.6	14.5	14.4
Groundnut cake	3.4	3.6	3.5
Bone meal	1.0	1.5	2.0
Oysters shell	0.6	0.0	0.0
Salt	0.3	0.3	0.3
Vitamin-mineral mix[1]	0.2	0.2	0.2
Nutrients			
Dry matter (DM)	88.1	87.0	86.1
Crude protein (% DM)	12.1	12.4	12.3
Crude fibre (% DM)	5.8	13.6	21.3
Ash (% DM)	4.5	9.0	13.9

[1] Agricare, Pfizer Livestock Feeds Co., Lagos, Nigeria

pod from 20 and 40% to 30 and 60% in the test diets. Data recorded and samples collected for analysis were as described under the first study. Data collected from both studies were analysed by the least squares analysis of variance amd significant differences among means determined by Tukey's procedure (Steel and Torrie 1960).

Results

First study: Performance data shown in Table 3 indicate normal feed consumption and growth responses across treatments. Cattle must have found the test diets palatable as shown by a definite trend of increasing feed intake with increasing dietary levels of cocoa-pods. The differences observed among treatments for daily liveweight gains were not significant ($P > .05$), although a clear trend of reduced gains with increasing levels of cocoa-pod is evident. This trend was confirmed by the poorer ($P < .05$) feed utilization values of the test cattle. The control diet was better utilised ($P < .05$) than both test diets, while the 20% cocoa-pod diet had a poorer value ($P < .05$) than the 40% cocoa-pod diet. Differences observed in longissimus muscle area, carcass weight and dressing percentage as shown in Table 4, were not significant ($P > .05$).

Second study: Growth rate, feed intake and efficiency of feed utilisation as affected by dietary levels of cocoa-pod in this study are shown in Table 5. Daily gains based on initial and final shrunk weights were similar ($P > .05$) in control cattle and cattle fed 30% cocoa-pod diet. Both the control and 30% cocoa-pod diets supported higher gains

Table 3:

Cattle response to grain substitution with cocoa-pod. Performance data. First study

	Diets			
	Control	20% Cocoa-pod	40% Cocoa-pod	S.E.[1]
Number of cattle	12	12	12	
Initial weight (kg)	106.9	106.8	104.7	
Final weight (kg)	194.9	177.2	161.2	
Length of study (days)	112	112	112	
Average daily gain (kg)	0.79[a]	0.63[a]	0.51[a]	0.1
Daily dry matter intake (kg)				
- Cocoa pods	-	1.4	3.2	
- Total feed	5.2[a]	5.5[a]	5.6[a]	0.1
Feed efficiency (kg DM/kg gain)	6.6[a]	8.8[b]	10.9[c]	0.4

[1] Standard error of mean

[a,b,c,] Means on the same row bearing different letters are different (P < .05)

Table 4:

Cattle response to grain substitution with cocoa-pods
Carcass data

	Diets			
Item	Control	20% Cocoa-pod	40% Cocoa-pod	S.E.[1]
Final live weights (kg)	194.4	177.2	161.2	21.4
Carcass weight (kg)	101.2	92.5	80.9	11.6
Dressing percentage	51.9	51.6	50.2	0.5
Longissimus muscle area (cm^2)	80.0	66.9	74.9	10.2

[1] Standard error of means, 12 observations per mean

Table 5:

Cattle response to grain substitution with cocoa-pod. Performance data. Second study

	Diets			
	Control	30% Cocoa-pod	60% Cocoa-pod	S.E.[1]
Number of cattle	7	10	10	
Initial weight (kg)	141.0	139.3	133.8	
Final weight (kg)	202.6	191.2	154.7	
Length of study (days)	84	84	84	
Average daily gain (kg)	0.73^a	0.62^a	0.24^b	0.1
Daily dry matter intake				
- cocoa-pod (kg)	-	1.7	3.3	
- total feed (kg)	5.3^a	5.2^a	5.6^a	0.2
Feed efficiency (kg DM/kg (kg DM/kg gain)	7.3^a	8.4^b	23.0^c	0.5

[1] Standard error of mean

a,b,c, Means on the same row bearing different letters are different ($P < .05$)

($P < .05$) than the 60% cocoa-pod diet. In fact, many of the animals fed the 60% cocoa-pod diet lost weight or barely maintained their weight, and this accounts for the extremely poor feed efficiency figures of 23 kg DM/kg gain. This figure was higher ($P < .05$) than those of 9.2 and 7.3 kg DM/kg gain for the 30% cocoa-pod and control diets respectively. The former, in turn was different ($P < .05$) from the latter. Feed intake was similar ($P > .05$) across treatments, indicating that even the 60% cocoa-pod diet was readily accepted by the cattle.

Discussion

The objective of these studies was not to compare maize or sorghum (which were replaced with cocoa-pod in the test diets) with cocoa-pod. The objective was to determine how much of these two expensive cereals can be replaced with cocoa-pod without reducing cattle performance to the point where it becomes uneconomical to feed cocoa-pod. Short of manipulating rumen fermentation to improve feed utilization, a dietary level of 60% cocoa-pod in an all concentrate cattle diet appears excessive and not profitable. Increasing the particle size of the ground cocoa-pod to slow down rate of passage, and supplementation with forage to provide bulk, and supply readily fermentable carbohydrates and micronutrients (such as the B vitamins), might sufficiently stimulate the rumen to render animal performance on 60% or higher cocoa - pod diets as profitable

Results obtained in the present studies , as well as those of Bateman and Larragan (1966), without the benefits of such rumen manipulation, indicate that levels of up to 40% cocoa-pod in all concentrate cattle fattening diet will not compromise animal performance, and will lower costs.

The cost per tonne (t) of dried cocoa-pod was computed from the following in-puts: unskilled labour for collecting, spreading for sun-drying, packaging and storage after drying; transportation cost from point of collection to point of processing and utilisation. Total cost came to $240.2/t, and this is lower than current costs of maize: $463.5/t or sorghum $705.3/t . When the cost of the major energy feeds as well as those of other ingredients listed in Tables 1 and 2 were used to calculate the cost of the 5 cattle diets containing 0 (1), 20 (2), 30 (3), 40 (4) and 60% (5) cocoa-pods, a trend of decreasing cost with increasing levels of cocoa-pod was observed ; $439.2. $392.2, $329.4, $313.7 and $215.0/t for 1, 2, 3, 4 and 5 respectively.

This cost advantage in favour of cocoa-pod diets, was reduced or even lost in the case of 60% cocoa-pod diet when adjustments were made for the efficiency of utilisation of the diets. It should be noted, however, that the highest overhead cost for the production of the cocoa-pod feed was transportation which made up 78% of total cost. Transportation costs can be reduced by processing and utilising the material on or near cocoa farms. In other words, the cocoa farmer keeping some livestock or his livestock farmer neighbour should be the target users at present.

Cocoa-pod is available in sufficient amounts in cocoa-growing areas, it requires simple and cheap processing methods, and it is readily consumed by livestock. Moreover, it economically replaces large amounts of conventional energy feeds in ruminant diets thus alleviating man-animal competition for cereals. Feeding to ruminants appears feasible and, based on results of the present studies, a maximum dietary level of 40% in cattle diet is recommended.

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