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# THE DIGESTIBILITY OF COCOA HUSK-BASED DIETS FED TO SHEEP

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**Digestibility studies were conducted on four diets in which maize was substituted for dried cocoa husks (DCH) and fed to Nungua Blackhead wethers. The treatments were: A) 60% DCH:0% maize; B) 40% DCH:20% maize; C) 20% DCH:40% maize and D) 0% DCH:60% maize. Average dry matter intake per kg body weight decreased with increases in the level of maize in the diets. Significant decreases in dry matter, crude protein, ether extract and nitrogen free extract digestibilities and total digestible nutrients (TDN) occured in the wethers with increase in the level of cocoa husks substitution. Crude fibre digestibility increased with a reduction in cocoa husk level. The level of cocoa husks in the diets significantly explained from 67-96% of the variability in the digestibility of several proximate components except for crude fibre.**

Key words: digestibility, sheep, cocoa husk

Livestock production in Ghana suffers from numerous constraints. The effects of inadequate nutrition of ruminant livestock, especially in the long dry season when fodder is scarce and of poor nutritive quality, have been demonstrated by Rose-Innes (1961), Lansbury (1960) and Otchere et al (1977). Maize is too expensive for feeding livestock. Besides, annual maize production is inadequate for human consumption. An area which needs to be intensively investigated is the use of agricultural and agro-based industrial by-products.

Ghana, the world's leading cocoa producer, is estimated to produce over 4 million tonnes of fresh cocoa husks annually which are discarded as waste (Adomako 1975). The husks have been demonstrated to have a great potential for feeding ruminants (Bateman and Fresnillo 1967; Adeyanju et al 1975; Doamekpor 1977). Doamekpor (1977) fed wethers on rations containing 45, 60 and 75% cocoa husks and found that the total digestible nutrients (TDN) content of the ration was just about enough for maintenance. The objective of this study was to determine the effect of substitution of maize for cocoa husks on the digestibility of proximate components and the TDN requirement in rations for sheep.

## Materials and Methods

Fresh cocoa husks were sun-dried, coarsely milled and used to formulate the experimental diets. Twelve Nungua Blackhead wethers weighing 16.5 kg on average, were divided into four groups of three animals each. The groups were randomly assigned to the four diets shown in Table 1 in a digestibility trial. Diets A, B, C and D included 60, 40, 10 and 0% cocoa husk respectively (air dry basis). The experiment was made up of a 14-day adjustment and a 7-day collection period.

Prior to the commencement of the experiment all animals were drenched and dipped against endo- and ecto-parasites. The animals were weighed at the end of the collection period. The animals were kept in individual metabolism crates and had free access to feed, water and mineral blocks

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*Table 1:*

*Composition of experimental diets (% air dry basis)*

| Ingredients | Diet | | | |
|---|---|---|---|---|
| | A | B | C | D |
| Cocoa husks | 60 | 40 | 20 | 0 |
| Yellow maize | 0 | 20 | 40 | 60 |
| Wheat bran | 35 | 35 | 35 | 35 |
| Groundnut cake | 3 | 3 | 3 | 3 |
| Bone meal | 1 | 1 | 1 | 1 |
| Common salt | 0.5 | 0.5 | 0.5 | 0.5 |
| Vitamin A & D supplement | 0.5 | 0.5 | 0.5 | 0.5 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

Daily faecal output for each animal was collected, weighed in polythene bags and stored at -18°C. Feed and faecal samples were then dried to constant weight in an oven at 85°C and stored for chemical analysis. Chemical analyses of the feed and faecal samples were according to the methods of the Association of Official Analytical Chemists (1970).

The data were analysed using analysis of variance and regression of the digestibility and coefficients on the percentage of cocoa husks in the diets (Snedecor and Cochran 1967).

## Results and Discussion

Table 2 shows the chemical composition of cocoa husks and the experimental diets. The proximate composition of the dried cocoa husks agreed

*Table 2:*

*Chemical composition of cocoa husks and experimental diets (% air dry basis)*

| Nutrients | Cocoa husks | Diets | | | |
|---|---|---|---|---|---|
| | | A | B | C | D |
| Dry matter | 87.64 | 87.35 | 87.51 | 88.15 | 88.37 |
| Crude fibre | 41.66 | 29.04 | 20.46 | 12.04 | 5.38 |
| Crude protein | 7.99 | 12.61 | 13.19 | 13.66 | 13.86 |
| Ether extract | 2.37 | 3.12 | 3.35 | 3.60 | 4.76 |
| Nitrogen-free extract | 25.77 | 33.54 | 43.05 | 53.44 | 64.13 |
| Ash | 9.85 | 9.04 | 7.46 | 5.91 | 4.24 |
| Gross-energy(Kcal/g) | 4.71 | 4.29 | 4.15 | 4.02 | 3.65 |

with data reported in the literature (Oyenuga 1959; Greenwood-Barton 1965; Pessey 1976 and Doamekpor 1977). Crude fibre and ash decreased while NFE increased with increases in the maize content of the diets. A similar

trend had been observed by Adeyanju et al (1975). No explanation could be ascribed to the high gross energy in cocoa husks which had low crude protein and ether extract but high ash content. Similarly, it is difficult to explain why gross energy level in the diets decreased markedly from diets A (60% husk) to D (0% husk). This trend has also been observed by Doamekpor (1977).

Table 3 shows dry matter intake and performance data. Dry matter intake increased with increase in the level of cocoa husks, and was inversely related to TDN content. This indicates that level of consumption was influenced by energy density of the diets. Statistical analysis showed that there were significant differences ($P < 0.05$) between dry matter intake of the different rations by the wethers. Comparison of the means showed no significant differences ($P > 0.05$) between rations A and B which were both significantly different ($P < 0.05$) from C and D. Similarly consumption of C was significantly higher ($P < 0.05$) than D. The reason for the lower intake of D is not apparent but could be due to the higher TDN content of the ration. Studies by Lofgren and Warner (1972) had indicated that dry matter intake in sheep decreased with increased energy concentration.

*Table 3:*

*Dry matter intake, TDN and weight gain of the sheep fed the experimental diets*

| | Diets | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | SE |
| Total dry matter intake (g/d) | $819^{a}$ | $786^{a}$ | $505^{b}$ | $372^{c}$ | |
| Dry matter intake (% of body weight) | $4.56^{a}$ | $4.52^{a}$ | $3.12^{b}$ | $2.17^{c}$ | 0.39 |
| TDN (%) | $39.73^{a}$ | $51.96^{b}$ | $58.04^{bc}$ | $61.30^{c}$ | 5.22 |
| Weight gain, kg/d | $0.060^{a}$ | $0.143^{b}$ | $0.202^{c}$ | $0.143^{b}$ | 0.007 |

$^{abc}$ Means with common letters in the same row are not significently different ($P > 0.05$)

There were significant differences ($P < 0.05$) in the levels of TDN in the diets. Mean comparison, however, showed no differences between rations B and C or between C and D. However, ration A was significantly lower than B, C and D ($P < .05$), while B was significantly lower ($P < 0.05$) than D.

Analysis of variance showed that there were significant differences ($P < 0.05$) in the average daily weight gains of the wethers. Animals on diet C made the highest gains (202 g/d) followed by B and D, and A the least. The reason for the low weight gain on ration D is not apparent. The average daily weight gains of animals on diets B and D were similar and were significantly higher ($P < 0.05$) than A. Similarly mean weight gain by animals of diet C was significanly ($P < 0.05$) superior to those of A, B and D. The performance of wethers in an experiment in which Doamekpor (1977) gave a diet containing 41% TDN is similar (0.060 versus 0.054 kg/d) to that observed in the animals on diet A which contained about 40% TDN in the present study. The results of this study indicate that the wethers required about 50 - 60% TDN for a weight gain between 0.14 - 0.20 kg/head/d.

Table 4 shows the results of the digestibility trial. Increases in

*Table 4:*
*Mean coefficients of apparent digestibility (%) for the diets*

| Nutrients | Diets | | | | SE |
|---|---|---|---|---|---|
| | A | B | C | D | |
| Dry matter | 52.6[a] | 62.2[b] | 64.6[b] | 71.[c] | 1.53 |
| Crude fibre | 32.8[a] | 40.0[b] | 42.9[b] | 35.4[a] | 1.72 |
| Crude protein | 51.2[a] | 60.7[b] | 65.8[c] | 71.6[d] | 1.84 |
| Ether extract | 67.0[a] | 75.5[b] | 85.4[c] | 89.9[c] | 2.39 |
| N.F.E. | 57.4[a] | 69.1[b] | 69.7[b] | 72.2[b] | 2.38 |
| Gross energy | 54.3[a] | 61.4[b] | 67.3[c] | 74.6[d] | 0.74 |

the level of cocoa husk significantly reduced dry matter digestibility ($P < 0.05$). Comparison of the mean percentage dry matter digestibility showed the difference between diets B and C to be non-significant. However the digestibility of A was significantly lower($P<0.05$) than those of B, C and D being significantly higher ($P<0.05$) than B and C. Adeyanju et al (1975) had reported that when cocoa husks constituted 25% of rations for sheep, dry matter digestibility was significantly depressed.

Apparent crude fibre digestibility showed no significant differences between diets A and D. Similarly B and C were not statistically different. However, values for B and C were significantly higher ($P < 0.05$) than values for A and D. The reason for the low digestibility of diet D was not apparent.

Apparent digestibility coefficients for crude protein showed a general significant ($P < 0.05$) decrease as the level of cocoa husks in the diet increased. The progressive depression in crude protein digestibility as the level of cocoa husks in the diet increased might be related to the corresponding increase in crude fibre content of the rations. A similar trend had been observed by Adenyanju et al (1975). Glover and Duthie (1958) have demonstrated a significant depressing effect of crude fibre on digestibility of crude protein by non-ruminants,

The apparent digestibility of ether extract was also signifcantly ($P < 0.05$) depressed with increases in the level of cocoa husks. This observation is at variance with results obtained by Adeyanju et al (1975). The levels of cocoa husks in the rations fed by Adeyanju et al (1975) were probably not high enough to depress the digestibility of ether extract.

Apparent digestibility of NFE in diets B, C and D were nor significantly affected by the increased levels of cocoa husks. However, in diet A, which contained 60% coca husks, NFE digestibility was significantly depressed ($P < 0.05$).

Table 5 shows correlation and regression coefficients of level of cocoa husks (%) on digestibility. All the correlation and regression coefficients were negative for the various parameters signifying that increases in the level of dried cocoa husks depressed the digestibility of proximate components in the diets and TDN. The level of cocoa husks

*Table 5:*

*Correlation coefficients and regression coefficients of level of cocoa husks (5) on percentage apparent digestibility*

| Nutrient | Correlation coefficient | | Regression coefficients (b) | Intercept (a) |
|---|---|---|---|---|
| | r | $R^2$ | | |
| Dry matter | -0.92** | 0.85 | -0.30 | 71.89 |
| Crude fibre | -0.32 NS | 0.10 | -0.06 | 39.55 |
| Ether extract | -0.96** | 0.92 | -0.33 | 72.23 |
| Ether extract | -0.98** | 0.96 | -0.39 | 91.28 |
| Nitrogen free extract | -0.82** | 0.67 | -0.24 | 74.66 |
| T.D.N. | -0.94** | 0.88 | -0.35 | 63.38 |

** ($P < 0.01$) NS Not significant

in the diets explained from 67 - 96% of the variability in the digestibility of several of the proximate components (Table 5). However, level of cocoa husks explained only 10% of the variability in the digestibility of crude fibre. The reason for this is not apparent.

Cocoa beans and cocoa bean shells have been shown to contain theobromine. The theobromine concentration in the beans and shells is markedly higher than in the husks (Pessey 1976). The high concentration of theobromine in the beans and shells therefore limits the use of these by- products for livestock feeding, particularly non-ruminants. No symptoms of theobromine toxicity were encountered in the present study in which cocoa husks were fed, this being in agreement with observations reported by Pessey(1976) and Doamekpor(1977).

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## References

Adeyanju S A, Ogutuga D B A, Illori J O & Adegbola A A 1975 Cocoa husk in maintenance rations for sheep and goats in the tropics Nutrition Reports International 11:351-357

Adomako D 1975 Commercial utilization of cocoa by-products in Ghana Cocoa Research Journal 10:160-169

A.O.A.C. 1970 Official Methods of Analysis 11th Ed. Association of Official Analytical Chemists Washington DC

Bateman J V & Fresnillo O 1967 Digestibility of *Theobroma cacoa* pods when fed to cattle Journal of Agricultural Science (Cambridge): 86:23-25

Doamekpor S K 1977 Performance of sheep fed cocoa husk rations B Sc Dissertation, Legon: University of Ghana

Glover J & Duthie D W 1958 The apparent digestibility of crude protein by non-ruminants and ruminants Journal of Agricultural Science (Cambridge) 51:289-293

Greenwood-Barton L H 1965 Utilization of cocoa by-products Ed.Manuf. 40:52-56

Lansbury T J 1960 A review of some limiting factors to the nutrition of cattle on the Accra-Plains Tropical Agriculture (Trin.) 37:182-192

Lofgren P A & Warner R G, 1972 Relationship of dietary caloric density and certain blood metabolites to voluntary feed intake in mature wethers Journal of Animal Science 35:1239-1247
Otchere E O, Dadzie C B M, Ayebo D A & Erbynn K G 1977 Response of grazing sheep to rice straw or cassava peels fortified with urea and molasses as supplemental feeds Ghana journal of Agricultural Science (in press)
Oyenuga V A 1959 Nigerian feeding stuffs 2nd edition Ibadan University Press
Pessey D E 1976 Preliminary studies on the nutritive value of cocoa by-products B Sc Agric Dissertation, Legon: University of Ghana
Rose-Innes R 1961 Sugar in the sky or beef for the butcher 1st Grassland Symposium Ministry of Agriculture Accra
Snedecor G W & Cochran W G 1967 Statistical methods Iowa State University Press Ames Iowa USA

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