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CASSAVA OR MAIZE MEAL FOR BROILERS AND THE EFFECT OF SUPPLEMENTATION WITH METHIONINE AND SULPHATE IN CASSAVA BASED DIETS

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Three experiments were carried out with growing chicks to investigate the effect of substituting cassava for maize and to establish optimal levels of methionine and sulphate in practical cassava based diets.

ln the first experiment 150 day-old chicks were fed for 8 weeks on diets in which the level of replacement for maize by cassava meal was 0, 33, 67 and 100%. }n a sixth treatment 10% of the cassava in the diet containing no maize was replaced by cane molasses. Liveweight gain and conversion efficiency decreased linearly as the proportion of cassava in tbe diet increased. The inclusion of 10% molasses in a cassava based dier gave little improvement in performance. Thyroid weight increased when cassava completely replaced maize.

In the second experiment 270 day-old chicks were fed for three weeks on a practical cassava based diet supplemented with 0, 0.15. 0.30% methionine, 0, 0.15 or 0.30%. sodium sulphate, in a 3 x 3 factorial arrangement of treatments. Ihere was a linear increase in liveweight gain with additions of methionine with either 0 or 0.15% additional sodium sulphate but additional methionine had no effect with 0.30% additional sodium sulphate. There was no significant effect on liveweight gain when sulphate alone was added to the diet. Food consumption and food conversion were not affected by any of the treatments.

In the third experiment 240 day-old chicka were fed for three weeks on practical cassava based diets containing either 0, 0.20,.0.40 or 0.60% added methionine or 0.15. 0.30, 0.45 or 0.60% added sodium sulphate. There was a linear decrease ir liveweight gain as the level of methionine increased. There were no significant effects of sulphate on weight gain, or of either sulphate or methionine on food consumption or food conversion efficiency.

Key words: Broiler, cassava, methionine, Sulphate

Intensive poultry production in the tropics is based on the extensive use of cereals as the main energy source. However, other, more socially appropriate energy sources exist in the tropics. Among these cassava is increasingly utilised in animal feeding because of its high yield and the low management requirements for producing the final cassava meal (eg Nestel & Graham 1977). Nutritionally one of the problems with cassava is the presence of toxic cyanoglucosides. It has been shown that for the detoxification of these, sufficient sulphur amino acids or sulphur donors are required (Oke 1973). It has also been demonstrated that part of the sulphur amino acid requirements of poultry diets car. be met by inorganic sulphate (eg Baker 1976; Plavnik & Bornstein 1977). It is thus important to establish whether the interrelationships of sulphur amino acids and sulphur in cassava based diets are the same as in cereal based diets.

The following experiments explore firstly the effect of substituting cassava meal for maize in broiler diets and secondly the effect of additions of methionine or sulphate to practical cassava based diets at levels above those generally regarded as necessary for optimal performance in cereal diets.

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Materials and Methods

Experiment 1: 150 day old Anak chicks were allotted according to weight outcome groups to 15 pens so that each pen contained 5 males and 5 females. The pens were concrete floored and had an area of 0.90 square metres. Rice hulls was used as litter. Supplementary heat was supplied electrically for the first 4 weeks. Five diets were fed, the composition of which is shown in Table 1.

Table 1:
Composition of the experimental diets used in Experiment 1

Ingredient	Treatment				
	1	2	3	4	5
Cassava root meal	-	17.00	34.00	51.00	41.00
Maize meal	62.25	43.50	21.75	-	-
Molasses	-	-	-	-	10.00
Sunflower	4.00	7.17	10.33	13.50	13.50
Meat meal	2.00	3.58	5.17	6.75	6.75
Fish Meal (Fresh water)	16.45	16.45	16.45	16.45	16.45
Sesame	5.00	5.00	5.00	5.00	5.00
Cottonseed meal	4.00	4.00	4.00	4.00	4.00
Salt	0.50	0.50	0.50	0.50	0.50
Bone meal	12.40	2.40	2.40	2,1,0	2.40
Vitamin/mineral premix	0.30	0.30	0.30	0 30	0 30
Methionine	0.10	0.10	0.10	0.10	0.10
Analysis					
Dry matter. %	89.7	90.1	90.6	91.1	89.7
Crude protein, % (N x 6.25)	18.6	19.3	20.5	21.5	21.3
HCN, mg/kg	-	9.6	19.1	28.7	23.1
Ash, %	8.0	8.3	9.0	10.7	11.5

[1] Supplied the following per kilogram of diet. Vitamin A 15,000 I U; Vitamin D 3,000 IU; Vitamin E 10 IU; Nicotinic acid 35mg; Riboflavin 12mg; Folic acid lmg; Pantothenate 20mg; Choline chloride 500mg; Vitamin B12 10µ g; Thiamine 50 µg; pyridoxine 60 µg; Biotin 50 µg; Vitamin K 3mg; Payzone 4 mg; Zinc oxide 60mg; Manganous oxide 100mg Potassium iodide 3mg; Copper sul?phate 20mg.

In these, cassava root meal was substituted for maize meal to given levels of cassava of 0, 17, 34 and 51% and the fifth diet contained 41% cassava and 10% final cane molasses. The maize protein was replaced by a mixture of sunflower meal and meat meal in the ratio of 2:1 respectively. The crude protein content of the cassava (2.04%) was ignored in balancing the diet and this, in addition to faulty analysis of the sunflower meal meant that the cassava based diets contained progressively more crude protein. The diets and water were offered ad libitum for 8 weeks, after which the birds were slaughtered. The carcass, liver, pancreas, gizzard and heart weights were recorded on all treatments and thyroid weights from Treatments 1 and 4 only. The varietal origin of the cassava was unknown but it came from the Mtwara region of South West Tanzania. It was ground through a 2 mm screen, and the same sample was used in all three experiments. The cassava sample was the same as that used by Wyllie & Lekule (1980) and the chemical components are stated in that paper.

Experiment 2: 270 day old Anak chicks were allocated to 27 pens in the same manner as for Experiment 1. Nine cassava diets were formulated by the addition of 0.15 or 0.30% methionine or sodium sulphate to the basal diet shown in Table 2. This gave the following treatments:

Treatment	Methionine, %	Sodium Sulphate, %
1	0	0
2	0.15	0
3	0.30	0
4	0	0.15
5	0	0.30
6	0.15	0.15
7	0.15	0.30
8	0.30	0.15
9	0.30	0.30

Table 2:
Basal diets used in Experiments 2 and 3

Ingredient	Experiment 2	Experiment 3
Cassava	50.00	50.00
Soyabean	14.75	-
Sunflower	10.00	-
Sesame	-	10.00
Fresh water fishmeal	16.50	16.50
Meat meal	-	12.00
Cotton seed	6.00	6.00
Sale	0.50	0.50
Bone meal	2.00	2.00
Premix	0.25	0.25
Calculated analysis		
Crude protein, %	22.0	21.0
Metabolizable energy, Kcal/kg	2957	2867
Methionine, %	0.64	0.61
Cystine, %	0.38	0.31
HCN, mg/kg	28.1	28.1

1 As for Experiment 1

The diets were each offered ad libitum to three replicate pens for three weeks. Management of the birds was similar to that in Experiment 1.

Experiment 3: A total of 240 dayold Anak chicks were allotted to 24 pens. Eight cassava-based diets were formulated using the basal diet shown in Table 2 and the following additions of methionine of sodium sulphate made to the basal diet.

Treatment	Added Methionine, %	Added Sodium Sulphate, %
0	0	0
2	0.20	0
3	0.40	0
4	0.60	0
5	0	0.15
6	0	0.30
7	0	0.45
8	0	0.60

The diets were each offered ad libitum to three replicate pens for four weeks and management was as for Experiment 1.

Results

Experiment 1: The results of Experiment 1 are shown in Table 3. Liveweight gain and conversion efficiency deteriorated linearly as the proportion of cassava in the diet increased and the substitution of 10% molasses to the diet containing 57% cassava did little to alleviate this reduced performance. However, the significant quadratic response for conversion efficiency suggests that the substitution of 17% cassava in an all maize diet may have improved efficiency. Carcass weight decreased progressively as the percentage of cassava in the diet increased. The proportions of heart and liver weight were not sufficiently altered by the level of cassava in the diet, although the inclusion of 10% molasses increased the heart weight. Pancreas weight increased with the proportion of cassava up to a level of 34% cassava in the diet. Gizzard weight increased linearly as the level of cassava in the diet increased, but inclusion of 10% molasses in the 51% cassava diet reduced the gizzard weight to that of the controls. Thyroid weight was increased by the complete substitution of maize for cassava.

Experiment 2: The results for experiment 2 are shown in Tables 4 and 5. There was a linear increase in liveweight gain with additions of methionine with either none or 0.15% additional sodium sulphate, but additional methionine had no effect at the highest level of sulphate inclusion. There was no significant effect on liveweight gain when sulphate was added to the diet. Food consumption and food conversion were not affected by any of the treatments.

Experiment 3: In experiment 3 (Table 6) there was a linear decrease in liveweight gain as the level of methionine in the diet increased, but the reductions in liveweight gain with progressive additions of sulphate were not statistically significant. There were no significant effects on food consumption or food conversion as a result of any of the treatments.

Table 3:
Performance of chicks fed varying levels of cassava and maize in Experiment 1

	Treatment					SEx	Significance	
	1	2	3	4	5		Diets 1-4	Diet 5++
Cassava, %	0	17	34	51	41			
Maize, %	65	44	22	0	0			
Molasses, %	0	0	0	0	10			
Liveweight gain (g/chick)								
0 - 2 weeks	141	148	149	130	145	4.89	NS	NS
0- 4 weeks	534	510	501	470	489	12.54	Linear**	1
0 - 6 weeks	1089	1020	978	963	952	24.97	Linear**	1
0 - 8 weeks	1596	1455	1346	1298	1319	36.16	Linear**	1,2
Conversion efficiency (Food/gain)								
0 - 2 weeks	1.59	1.53	1.39	1.51	1.63	0.05	NS	NS
0 - 4 weeks	2.05	1.92	1.99	2.25	2.21	0.07	Linear* Quadratic**	1,2
0 - 6 weeks	2.28	2.26	2.47	2.68	2.63	0.08	Linear**	1,2
0 - 8 weeks	2.86	2.78	3.21	3.52	3.41	0.09	Linear** Quadratic*	1,2
Mortality, %	3.3	0	10.0	20.0	0	-	-	-
Slaughter data+ + +								
Dressing, %	62.5	62.3	60.0	59.6	59.7	-	-	-
Carcass weight, g	1030	919	845	830	808	28.4	Linear** Quadratic**	1,2
Liver	4.04	3.97	4.24	4.15	4.23	0.111	NS	NS
Heart	0.68	0.65	0.67	0.69	0.72	0.022	NS	2
Pancreas	0.39	0.40	0.42	0.39	0.40	0.039	Quadratic**	NS
Gizzard	3.76	3.88	4.07	4.05	3.79	0.082	Linear**	3,4
Thyroid	0.015	-	-	0.021	-	.0006	(Diet 1 vs 4**)	

+ NS Non Significant: * P < 0.05; ** P <0.01
++ Shows diet numbers which differ significantly from Diet 5 (P <0.05)
+++ 0rgan weights expressed as a percentage of carcass weight

Table 4:
Performance of chicks fed supplemental methionine and sulphate in Experiment 2 (0 - 3 weeks)?

	Diet									SEx	Significance
	1	2	3	4	5	6	7	8	9		
Methionine	0	0.15	0.30	0	0	0.15	0.15	0.30	0.30	-	-
Ka_2SO_4	0	0	0	0.15	0.30	0.15	0.30	0.15	0.30	-	-
Liveweight gain, g/chick	277	303	349	295	322	319	304	316	317	7.3	See Table 5
Food consumption, g/chick	33.0	29.4	34.2	31.7	31.4	30.4	31.1	33.5	32.5	2.9	NS
Food conversion (Gain/food)	0.42	0.51	0.49	0.44	0.51	0.50	0.49	0.45	0.47	0.04	NS
Total consumption of added sulphur,mg/chick	0	199	463	228	452	425	658	695	908	-	-

Tab!e 5:
Simple and main effects of supplemental methionine and sulphate an weight gain in Experiment 2

		Liveweight gain, g			Significance
		Methionine			
		0	0.15	0.30	
	0	277	303	349	Linear**
Sulphate	0.15	295	319	316	Linear*
	0.30	322	304	317	NS
	Significance	NS	NS	NS	
		Methionine			
		0	0.15	0.30	
Pooled sulphate treatments		299	309	327	Linear**
		Sulphate			
		0	0.15	0.30	
Pooled methionine treatments		311	310	314	NS

Table 6:
Performance of chicks fed graded levels of and methionine in Experiment 3 (0-6 weeks)

	Diet								SEx	Significance	
	1	2	3	4	5	6	7	8		Diets 1-4	Diets 1, 5-8
Methionine	0	0.2	0.4	0.6	0	0	0	0	-	-	-
Ka_2SO_4	0	0	0	0	0.15	0.30	0.45	0.60	-	-	-
Liveweight gain, g/chick	433	435	430	403	425	421	419	407	9.42	Linear**	NS
Food consumption, g/chick	24.4	22.8	25.4	21.6	23.5	23.8	22.6	24.1	1.94	NS	NS
Food conversion (Gain/food)	0.61	0.69	0.61	0.67	0.66	0.64	0.68	0.62	0.04	NS	NS
Total consumption of added sulphur,mg/chick	0	275	612	780	225	456	650	924	-	-	-

Discussion

In Experiment 1 the reduction in liveweight gain with diets containing progressively larger amounts of cassava is similar to that found in the majority of other studies such as those of Rendon et al (1969), Gadelha et al (1969) and Vogt & Penner (1963). The food conversion efficiency was optimal at a level of 17% cassava in the diet deteriorating with greater amounts of cassava. The majority of reports in the literature suggests that feed efficiency decreases as the proportion of cassava in the diet increases (Montilla et al 1969) but many reports suggest that up to a level of 20% inclusion, efficiency is little affected, or may even be improved (Soares et al 1968). The reasons for the reduced performance in the present experiment are not clear and there may be several: the presence of cyanoglucosidases in cassava; differences in energy content between cassava and maize; palatability differences and the presence of aflatoxins in the cassava meal.

Montilla et al (1975) have shown, by comparing cassava meals of differing HCN content, that the presence of cyanoglucosides reduces broiler performance. It is therefore likely that in this study the level of 56.2 mg/kg HCN in the cassava meal was important in reducing performance. This is borne out by the highly significant differences in thyroid weight between birds fed a wholly maize and on wholly cassava based diets. Although thyroid weight is a somewhat crude measure of change in thyroid activity, it does indicate that the cyanoglucosides present in the cassava were having some effect on the thyroid. Changes in thyroid weight or activity as a result of increased levels of circulating thiocyanate have been shown for the pig (Sihombing et al 1974) and rat (Ermans et al 1973) but there is less evidence for poultry (Papas et al 1979). The suggestion by Hutagalung (1977) that the presence of molasses might reduce HCN by formation of gluconohydrin is an interesting one, although there was little improvement in performance with the addition of 10% molasses to the cassava based diet.

This lack of improvement in performance with the addition of 10% molasses to a cassava diet, a result similar to that of Enriquez & Ross (1967), suggests that the physical consistency of the diet was not the limiting factor although the apparent progressive increase in gizzard weight with increasing amounts of cassava suggests that physical consistency may have some importance. The addition of 10% molasses to the cassava based diet reduced gizzard size to that of the maize based diet. The reasons for these changes in gizzard weight, and therefore, presumably muscular activity, with increased level of cassava, are not clear. A large part of the effect is due to differences in final liveweight. The significant quadratic effect on pancreas weight with increasing levels of cassava is a curious one and cannot readily be explained.

Although the level of response to additional methionine differed in Experiments 2 and 3, the data suggest that there is little detrimental effect and, as in Experiment 2, there can be a highly positive response, to additions of methionine up to 0.3%. These differences in response to methionine could be attributed to differences in composition of each basal diet: owing to unavailability of ingredients, in Experiment 3 meat meal and sesame meal were substituted for soybean meal and sunflower meal, Although the calculated levels of methionine and cystine were similar for both diets, not too much confidence should be placed in these calculations, since the amino acid composition and availability of Tanzanian oil seed and meat meals varies greatly according to the method of processing. The difference in response between the two experiments was therefore probably due to a better supply of amino acids, including sulphur amino acids, from the meat meal/sesame meal protein mixture as compared to the soybean/sunflower mixture used in Experiment 2. In addition the supply of sulphur from the meat meal compared to the vegetable proteins would also be higher possibly leading to a reduced response to methionine.

Addition of sulphate showed no significant effects on performance although in Experiment 2 there were indications that with no, or very low, levels of additional methionine, low levels of sulphate may prove advantageous. Most studies with additional sulphate in cereal diets have been carried out using levels of sulphate lower than 0.15% with diets deficient in sulphur amino acids. It is possible that at levels of 0.2 or O.3% additional methionine, levels of sodium sulphate of less than 0.155 might prove advantageous. It has been shown (Baker 1976) that sulphate spares cystine rather than methionine and that sulphate per se is not an essential dietary ingredient. It is also clear that to obtain a response to inorganic sulphate the supply of sulphur amino acids needs to be limiting and that of cystine more limiting than that of methionine (Sasse & Baker 1974). In the work reported here the diets were of a practical nature and had, theoretically, sufficient levels of both methionine and cystine.

In these trials neither the total sulphate content of the basal diets nor the sulphur content of the water could be analysed. In cereal diets it has been shown by Sasse & Baker (1974) that the maximal effect of sulphate is reached already at a level of 150-165 ppm. This level may well have been reached already in the basal diet, especially considering the high level of fish meal although the mineral mix contributed only 12 ppm of sulphate to the complete diet through the presence of copper sulphate.

Conclusion

The results of these experiments suggest that where cassava meal is substituted for maize, performance may be reduced, However, although the weight gains were 18% less when the maize in the diet was completely replaced by cassava, the performance would still be highly economic in situations in which cereals are in short supply for animal feeding. The results here also suggest that additions of methionine to practical cassava based diets may be beneficial up to a level of about 0.3% but that there appears to be little advantage gained by additions of sulphate,

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