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Utilisation of giant taro (*Alocasia macrorrhiza*) root meal with or without coconut oil slurry by layers and broilers

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Abstract. Replacements of maize with *Alocasia macrorrhiza* root meal (AMRM) with or without added coconut oil slurry (COS) in poultry diets were investigated in a series of two experiments. In Experiment 1, the replacement of maize with two levels (10% and 20%) each of AMRM and AMRM–COS on egg production and egg quality was investigated. Experiment 2 investigated the same treatments as in Experiment 1 on broiler performance. In both experiments, each diet was fed to four replicates of 10 birds in a completely randomised design. There was no marked effect on feed intake (FI) in both experiments ($P > 0.05$). In Experiment 1, percentage hen-day production and feed conversion ratio were depressed ($P < 0.05$) on 20% AMRM and egg weight on 10% AMRM, but these depressing effects were overcome by COS addition. Egg mass was significantly ($P < 0.05$) increased on 20% AMRM–COS compared with the other AMRM groups, but did not differ ($P > 0.05$) between the control and AMRM–COS. Haugh unit and percentage shell were not affected by the treatment ($P > 0.05$). In Experiment 2, bodyweight gain was significantly ($P < 0.05$) reduced with the inclusion of AMRM in the diet, with the lowest gain on 20% AMRM–COS. Feed conversion ratio was adversely affected when AMRM was included at a concentration greater than 10% of dietary maize ($P < 0.05$). Coconut oil-slurry treatment of the meal did not improve performance. It was concluded that inclusion of AMRM at a concentration greater than 10% dietary maize adversely affects the performance of both layers and broilers. Treatment of AMRM with COS at 9 : 1 overcomes these adverse effects in laying hens, but not in broilers. More research is warranted on the effects of higher concentrations of COS-treated AMRM in the diet on layers, and on processing methods that will improve performance of poultry.

Additional keywords: alternative ingredients, high feed cost, poultry performance, processing.

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Introduction

Feed cost is a major impediment to the growth of the poultry industry in the South Pacific region. Ayalew (2011) reported a 56–100% increase in retail prices of commercial poultry feeds in Papua New Guinea from 2003 to 2011. Traditional energy feed ingredients for poultry feeding, such as maize and wheat, are not grown in the region and, are, thus, expensive. However, there are many locally available raw materials in the region, but the feeding of such materials as energy source in poultry diets has not been documented. Therefore, there is need for further research into the feeding value of such under-utilised materials to poultry.

Giant taro (*Alocasia macrorrhiza*), a root crop native to Malesia (Malaysia, Philippines and Indonesia), Queensland and Solomon Islands is now widely distributed to many tropical and subtropical regions (Wagner *et al*. 1999; USDA-ARS 2012). It grows wild in Pacific Island countries and has become invasive in most countries (Smith 1979; Space *et al*. 2009; Florence *et al*. 2013). At the moment, the crop has little or no food value in most countries. In Samoa, it is locally known as 'tamuu', with two main cultivars, namely, the purple tamuu (tamuu New Guinea) and the white tamuu (tamuu Tonga). Tamuu Tonga grows well in Samoa, but production figures are not available as it is rarely eaten by Samoans, except during periods of famine, thus making it readily available for stock feeding in the country. Chemical analysis of tamuu Tonga at the USP Alafua Central Laboratory showed ~11.3 MJ metabolisable energy (ME)/kg and 130 g crude protein (CP)/kg (S. S. Diarra and D. Perera 2015, unpubl. data). Calcium (Ca) oxalate has been identified in *Alocasia macrorrhiza* root (AMR; Pham *et al*. 2005), but adequate supplementation of diets with inorganic Ca sources has been reported to overcome the adverse effect of Ca oxalate (Ravindran *et al*. 1996). Although there are reports on the feeding of AMR meal to pigs (Pham *et al*. 2005, 2006), at the moment its feeding to poultry is not documented. Fat is a highly concentrated source of energy that is used to boost the energy content of low-energy feeds. Coconut oil slurry (COS) is a fat-rich white-yellowish liquid residue of cold-press coconut oil extraction. On average, 18–25 kg of COS is produced from the extraction of 1 t of fresh coconut. In Samoa, it is commonly referred to as second-grade oil that has no major uses in the country and is mainly disposed in the landfill at the moment. The present study investigated the utilisation of AMR with or without COS as a source of dietary energy by poultry (layers and broilers).

Materials and methods

Experimental site, source and processing of Alocacia macrorrhiza *root meal (AMRM)*

The study was conducted at the Poultry Unit of the School of Agriculture and Food Technology of the University of the South Pacific, Alafua Campus, Samoa. Fresh tamuu roots harvested from farms around the Campus were chopped and sun-dried for 72 h. The sun-dried root was then ground in a hammer mill to pass through a 2-mm sieve and labelled AMRM. Half of the meal obtained was left as AMRM (untreated) and the other half was treated with COS at the ratio of 9 : 1 and labelled AMRM–COS. The COS was collected from a small-scale cold-press coconut oil mill where disposal of the by-product is a major problem at the moment. Maize, AMRM and AMRM–COS (ratio 9 : 1) were analysed for proximate composition and AMRM for oxalic acid concentration (Table 1).

Experiment 1

Utilisation of AMRM with or without COS by Shaver Brown laying hens was investigated.

Experimental diets and birds

A control layer diet based on maize and four other diets containing two concentrations (10% and 20%) each of AMRM and AMRM–COS as a replacement for maize (weight for weight) were formulated (Table 2). All diets were formulated to contain

Table 1. Proximate composition, calculated metabolisable energy (ME) and price (Western Samoan tala, WST$) of maize, *Alocacia macrorrhiza* root meal (AMRM) and *Alocacia macrorrhiza* root meal with coconut oil slurry (AMRM–COS; on a dry-matter basis)

AMRM, *Alocacia macrorrhiza* root meal; AMRM-COS, *Alocacia macrorrhiza* root meal with coconut oil slurry

Constituent (%)	Maize	AMRM	AMRM–COS
Dry matter	94.7	93.88	93.51
Crude protein	8.96	12.7	11.75
Ether extract	3.1	1.37	3.14
Crude fibre	3.74	7.13	7.09
Ash	4.07	6.4	6.64
Nitrogen-free extract	74.83	66.28	64.89
ME[A] (MJ/kg)	13.5	12.3	12.5
Calcium oxalate (mg/kg)	–	48.3	–
Price/kg (WST$)	4.00	0.30	0.32

[A]Calculated according to Fisher and Boorman (1986) as follows: ME = 37 × % crude protein + 81 × % ether extract + 35.5 × % nitrogen-free extract. WST$ = US$0.4 at the time of the experiment.

Table 2. Composition of the layer diets in Experiment 1 (as-fed basis)

AMRM, *Alocacia macrorrhiza* root meal; AMRM–COS, *Alocacia macrorrhiza* root meal with coconut oil slurry

Ingredient	Diet				
	Control	AMRM		AMRM–COS	
		10	20	10	20
Maize (g/kg)	482.9	434.61	386.32	434.61	386.32
Mill mix (g/kg)	241.4	257.3	273.2	241.4	249.3
Taro (g/kg)	0	48.29	96.58	48.29	96.58
Fish meal (g/kg)	31.2	28.6	25.9	30.8	29.9
Meat and bone meal (g/kg)	62.4	57.1	51.8	61.5	59.8
Soya bean meal (g/kg)	93.6	85.7	77.7	92.3	89.7
Lime stone flour (g/kg)	50	50	50	50	50
Snail shell (g/kg)	30	30	30	30	30
Lysine HCl (g/kg)	2	2	2	2	2
DL-methionine (g/kg)	1	1	1	1	1
Vitamin–mineral premix[A] (g/kg)	2.5	2.5	2.5	2.5	2.5
NaCl (g/kg)	3	3	3	3	3
Analysed composition (%)					
Dry matter	90.88	89.93	89.85	88.74	88.58
Crude protein	15.98	16.1	16.3	16	16.2
Crude fibre	5.3	6.15	5.87	6.1	6.4
Calculated composition (%)					
Lysine	0.9	0.89	0.88	0.89	0.88
Methionine	0.51	0.49	0.5	0.48	0.47
Calcium	4.1	3.97	4.13	4.14	4.14
Phosphorus (available)	1.1	1.09	1.11	1.13	1.1
ME (MJ/kg)	11.92	11.83	11.85	11.87	11.9

[A]Bio-mix supplied/kg diet, vitamin A: 10 000 IU; vitamin D_3: 2000 IU; vitamin E: 23 mg; niacin: 27.5 mg; vitamin B_1: 1.8 mg, B_2: 5 mg, B_6: 3 mg, B_{12}: 0.015 mg; vitamin K_3: 2 mg; pantothenic acid: 7.5 mg; biotin: 0.06 mg; folic acid: 0.75 mg; choline chloride: 300 mg; cobalt: 0.2 mg; copper: 3 mg; iodine: 1 mg; iron: 20 mg; manganese: 40 mg; selenium: 0.2 mg; zinc: 30 mg; and anti-oxidant: 1.25 mg.

~11.9 MJ ME/kg, 16.5% CP, 4% Ca, and 1.1% available phosphorus, 0.9% lysine and 0.5% methionine, according to NRC (1994) recommendations. In total, 200 Shaver Brown pullets aged 18 weeks and weighing (mean ± s.d.) 1622 g ± 2.72 were randomly allotted to 20 open-sided floor pens (10 birds per pen). Each diet was fed as mash to birds in pens replicated four times in a completely randomised design for a period of 20 weeks. Birds received 16 h light (12 h daylight and 4 h artificial light). Diets and clean drinking water were supplied *ad libitum* throughout the experimental period.

Data collection

Data were collected on feed intake, egg production and bodyweight change. A weighed quantity of feed was given daily and the left-over weighed the next day, so as to account for the quantity consumed by difference. Egg number and mean weight per pen were recorded daily. Percentage hen-day production was calculated as follows:

$$\%\ \text{hen-day} = \frac{\text{number of eggs collected}}{\text{number of hens in the house}} \times 100.$$

Feed conversion ratio (FCR) was calculated as grams of feed consumed per grams of egg in each pen. The birds were weighed at the beginning and end of the experiment (Weeks 18 and 38) and weight gain per pen was recorded.

Five eggs per pen, randomly selected weekly, were used for egg-quality assessment (weight, Haugh unit and percentage shell). Eggs were weighed using a digital scale sensitive to 0.1 g. The eggs were then broken on a glass table and albumen height taken immediately at three different locations by using a spherometer. Haugh unit was calculated using the following formula: Haugh unit = 100 log($h - 1.7w^{0.37} + 7.6$; Eisen *et al.* 1962) where, h is albumen height (mean of 3 measurements) in millimetres and w the weight of the egg in grams. Eggshells (with membranes) were oven-dried at 60°C overnight and weighed, and percentage shell was calculated according to Chowdhury and Smith (2001).

Experiment 2

Utilisation of AMRM with or without COS by Cobb broiler chickens was investigated.

Experimental diets and birds

A control maize-based broiler finisher diet and four other diets containing two concentrations (10% and 20%) each of AMRM and AMRM–COS as a replacement for maize (weight for weight) were formulated (Table 3). All diets were formulated to contain ~20% CP, 13 MJ ME/kg, 1% lysine and 0.5% methionine. In total, 200 Cobb broiler chicks aged 20 days and weighing (mean ± s.d.) 687 g ± 8.1 were divided into 20 groups of 10 birds, each housed in open-sided floor pens measuring 238 cm × 109 cm. Each diet was fed as mash to birds in four pens, in a completely randomised design for a period of 22 days. A 14 h light/10 h dark program was maintained throughout the duration of the experiment. Diets and clean drinking water were supplied *ad libitum* throughout the experimental period.

Table 3. Composition of the broiler finisher diets in Experiment 2 (as-fed basis)
AMRM, *Alocacia macrorrhiza* root meal; AMRM–COS, *Alocacia macrorrhiza* root meal with coconut oil slurry

Ingredient	Control	AMRM		AMRM–COS	
		10	20	10	20
Maize (g/kg)	436.3	392.7	349.1	392.7	349.1
Mill mix (g/kg)	218.1	233.6	248	229	238.5
AMRM (g/kg)	0	43.6	87.2	43.6	87.2
Fish meal (g/kg)	49.1	46.7	44.3	47.3	45.8
Meat and bone (g/kg)	98.2	93.3	88.5	94.9	91.7
Soya bean (full-fat) (g/kg)	147.3	140	132.8	142.0	13.76
Coral sand (g/kg)	22	22	22	22	22
Snail shell (g/kg)	20	20	20	20	20
Lysine HCl (g/kg)	2	2	2	2	2
DL-methionine (g/kg)	1.5	1.5	1.5	1.5	1.5
Vitamin–mineral premix[A] (g/kg)	2.5	2.5	2.5	2.5	2.5
NaCl (g/kg)	3	3	3	3	3
Analysed composition (%)					
Dry matter	89.92	89.93	89.88	89.94	89.87
Crude protein	20	20.2	19.9	19.9	19.8
Crude fibre	4.9	5.1	5.17	5.28	5.21
Calculated composition (%)					
Lysine	1.01	1	0.98	0.99	0.96
Methionine	0.51	0.49	0.48	0.5	0.49
ME (MJ/kg)	13.02	13.04	12.94	13.18	13.22

[A]Bio-mix supplied/kg diet, vitamin A: 10 000 IU; vitamin D3: 2000 IU; vitamin E: 23 mg; niacin: 27.5 mg; vitamin B1: 1.8 mg, B2: 5 mg, B6: 3 mg, B12: 0.015 mg; vitamin K3: 2 mg; pantothenic acid: 7.5 mg; biotin: 0.06 mg; folic acid: 0.75 mg; choline chloride: 300 mg; cobalt: 0.2 mg; copper: 3 mg; iodine: 1 mg; iron: 20 mg; manganese: 40 mg; selenium: 0.2 mg; zinc: 30 mg; and anti-oxidant: 1.25 mg.

Data collection

Data were collected on growth performance (feed intake, bodyweight gain and FCR), and carcass and gut measurements. Feed consumption data were collected as in Experiment 1. Weight change was monitored by weekly weighing and FCR was calculated as the ratio of feed consumed to weight gained.

At the end of the experiment (Day 42), all the birds were fasted overnight, stunned electrically and slaughtered by decapitation. Slaughtered birds were scalded at 50°C for about 1 min, plucked manually, eviscerated and dressed. The weights of dressed chickens and carcass cuts (breast meat, thighs and drumsticks) were expressed as percentages of the liveweight.

Segments of the gut (gizzard, small intestine and caeca) were weighed full and empty by using an electronic scale sensitive to 0.1 g and digesta contents were calculated by difference. The weights of the segments and their digesta contents were expressed as a percentage of liveweight of the bird.

Chemical analyses

Maize, AMRM, AMRM–COS and the diets were analysed for proximate composition according to AOAC (1990). Dry matter was determined after 24 h in a forced-air oven (103°C). Nitrogen concentration was analysed by Kjeldahl method (AOAC 1990, ID 954.01) and CP was calculated as nitrogen × 6.25. Total fat, ash and fibre contents were analysed according to AOAC (1990, ID 942.05, 920.39 and 962.09 respectively). Oxalic acid concentration was determined using high-performance liquid chromatography (Savage *et al*. 2000).

Statistical analyses

Data collected from Experiments 1 and 2 were subjected to ANOVA (Steel and Torrie 1980) of the GLM in SPSS (SPSS for Windows, version 22.0; IBM Corp., Armonk, NY, USA), using the pen as the experimental unit for feed intake, egg production and egg quality. Bodyweight-change, carcass and gut data were measured on individual birds and related to pen as the experimental unit. Treatment means were compared using the least significant difference (l.s.d.) and differences were considered significant at 5% level of probability.

Results

Experiment 1

Results of hen performance (Table 4) showed that there were no significant ($P > 0.05$) dietary effects on feed intake (FI) and the intake of individual nutrients (lysine, methionine and ME). Bodyweight gain (BWG) during the period of the experiment was lower in birds fed the 20% AMRM–COS than in the control ($P < 0.05$). There was no significant ($P > 0.05$) difference in BWG between the control and the other AMRM groups, as well as among the AMRM-fed birds. Percentage hen-day production and FCR were depressed on 20% AMRM and egg weight on 10% AMRM ($P < 0.05$). These depressing effects were overcome with COS treatment. A heavier egg mass ($P < 0.05$) was recorded in the group fed 20% AMRM–COS diet compared with the other AMRM-based diets. The poorest egg mass was observed in the group fed 20% AMRM diet ($P < 0.05$). Egg mass did not differ between the control and 20% AMRM–COS as well as among the control, 10% AMRM and 10% AMRM–COS groups ($P > 0.05$). Haugh unit and percentage shell were not affected by the diet ($P > 0.05$).

Experiment 2

The results of growth performance of the broilers are presented in Table 5. There were no effects on FI ($P > 0.05$), and the intake of methionine and ME, but daily lysine intake was significantly reduced in birds fed the 20% AMRM–COS diet. Feeding AMRM with or without COS significantly reduced BWG, with the lowest gain recorded on 20% AMRM–COS ($P < 0.0$). A higher BWG was observed on the 10% AMRM than with other AMRM groups ($P < 0.0$). FCR was depressed when AMRM was included at a concentration greater than 10% of dietary maize ($P < 0.05$). FCR of birds fed with 20% AMRM-based diet did not differ significantly ($P > 0.05$) from the

Table 4. Laying performance and some egg quality parameters of the hens in Experiment 1

AMRM, *Alocacia macrorrhiza* root meal; AMRM–COS, *Alocacia macrorrhiza* root meal with coconut oil slurry; FCR, feed conversion ratio; s.e.m., standard error of the mean. Means in the row followed by different letters are significantly different (at $P = 0.05$)

Performance index	Control	AMRM		AMRM–COS		s.e.m.	*P*-value
		10	20	10	20		
Initial weight (g/bird)	1621	1627	1620	1621	1619	19.926	0.475
Final weight (g/bird)	1936	1911	1903	1911	1853	47.997	0.807
Weight change (g/bird)	315a	284ab	283ab	290ab	234b	25.434	0.037
Daily feed intake (g/bird)	108.6	116.8	109.2	115.2	107.7	6.682	0.809
Hen-day production (%)	68.7ab	69.2ab	49.6b	68.7ab	75.6a	6.437	0.029
Mean egg weight (g)	60.4a	56.8b	60.5a	57.6ab	60.6a	1.000	0.049
FCR (g feed/g egg)	2.67ab	2.98ab	3.35a	2.99ab	2.36b	0.238	0.047
Egg mass (kg/bird)	5.81ab	5.5b	4.2c	5.54b	6.4a	0.553	0.037
Haugh unit	90.53	90.37	89.95	89.97	90.60	1.903	0.999
Percentage shell	11.85	12.43	12.08	11.81	11.96	0.428	0.844
			Calculated daily intake				
Lysine (%)	0.98	1.04	0.96	1.03	0.95	0.059	0.760
Methionine (%)	0.54	0.56	0.52	0.58	0.53	0.033	0.771
ME (MJ/kg)	1.3	1.38	1.29	1.37	1.28	0.079	0.852

AMRM–COS-fed birds. AMRM-COS even at 10% inclusion did not improve performance.

Results of carcass and gut measurements (Table 6) showed no significant ($P > 0.05$) dietary effects on dressing out percentage and percentage breast meat and thigh. The yield of drumstick was improved on the 20% AMRM–COS diet compared with diets based on untreated AMRM ($P < 0.05$). Percentage drumstick did not differ among the control, 10%, 20% AMRM and 10% AMRM–COS diets. The weight of empty gizzard, caeca and their digesta contents expressed as a percentage of the liveweight were not affected by dietary treatment ($P > 0.05$). Higher small intestinal weight and lighter weight of digesta in the small intestine were recorded in the control and 10% AMRM-based groups than in the other groups.

Discussion

Experiment 1

The CP content of AMRM in the present study was higher than the value (8.6%) reported in the root meal by Pham *et al*. (2006). The root used in the present study contained 48.3 mg Ca oxalate/kg against 113 mg/kg reported in the root by Pham *et al*. (2005). Studies have shown that several factors, including cultivars, stage of growth and edaphic factors, influence the composition of cassava products (Rogers and Milner 1963; Eggum 1970; Ravindran and Ravindran 1988). These might be responsible for the variations observed in AMR.

A major problem affecting the utilisation of AMRM as feed ingredient has been its irritation (Pham *et al*. 2005), mainly due to the physical structure of oxalic acid needles that reduces palatability. The similarity in FI among dietary treatments in the present study suggested that there were no palatability problems with the meal. Dietary fat addition has been found to slow down digesta passage rate through the gastro-intestinal tract, allowing better nutrient digestion, absorption and utilisation (Mateos *et al*. 1982; Latshaw 2008), probably through increased contact with digestive enzymes. This could be a possible explanation for the improved performance of hens fed the 20% AMRM–COS-based diet despite the similarities in FI and intake of individual nutrients (lysine, methionine) and ME among the diets. Wignjosoesastro *et al*. (1972) observed that addition of 10% coconut oil significantly improved rate of lay and egg weight. Dietary unsaturated fat has also been reported to increase protein accretion in broilers (Sanz *et al*. 2000),

Table 5. Growth performance of Cobb broiler chickens in Experiment 2

AMRM, *Alocacia macrorrhiza* root meal; AMRM–COS, *Alocacia macrorrhiza* root meal with coconut oil slurry; FCR, feed conversion ratio. s.e.m., standard error of the mean. Means in the row followed by different letters are significantly different (at $P = 0.05$)

Parameter	Control	AMRM 10	AMRM 20	AMRM–COS 10	AMRM–COS 20	s.e.m.	*P*-value
Daily feed intake (g/bird)	142.05	137.39	133.88	139.21	131.10	3.608	0.291
Weight gain (g/bird)	1311.3a	1225.8b	1058.6c	1083.2c	928.3d	12.914	0.018
FCR (g feed/g egg)	2.2b	2.2b	2.5a	2.6a	2.6a	0.087	0.035
			Calculated daily intake (%)				
Lysine	1.43a	1.38a	1.31a	1.38a	1.26b	0.014	0.038
Methionine	0.72	0.67	0.64	0.70	0.64	0.011	0.055
ME (MJ/kg)	1.85	1.8	1.73	1.83	1.73	0.023	0.059

Table 6. Carcass measurements and gut content of Cobb broiler chickens in Experiment 2

AMRM, *Alocacia macrorrhiza* root meal; AMRM–COS, *Alocacia macrorrhiza* root meal treated with coconut oil slurry. s.e.m., standard error of the mean. Means in the row followed by different letters are significantly different (at $P = 0.05$)

Measurement	Control	AMRM 10	AMRM 20	AMRM–COS 10	AMRM–COS 20	s.e.m.	*P*-value
Carcass yield	80.8	76.9	80.9	77.6	75.1	2.980	0.588
			Carcass cuts (% liveweight)				
Breast meat	23.4	22.5	20.5	21.1	23.3	2.537	0.890
Thigh	10.8	10.8	12.5	10.6	10.3	1.003	0.560
Drumstick	10.4ab	8.4b	8.5b	9.6ab	11.3a	0.721	0.049
			Gut (% liveweight)				
Empty gizzard	8.5	10.83	8.93	8.17	10.17	0.893	0.245
Gizzard contents	0.64	0.74	0.94	0.48	0.76	0.153	0.363
Empty small intestine	2.83a	2.67a	2.01b	2.03b	1.92b	0.156	0.025
Digesta in small intestine	0.11b	0.12b	0.18a	0.17a	0.17a	0.015	0.002
Empty caeca	5.4	3.37	3.2	3.07	5.57	0.981	0.176
Digesta in the caeca	0.04	0.05	0.07	0.03	0.06	0.013	0.375

probably by sparing protein from being used as energy. The presence of mono- and poly-unsaturated fatty acids in coconut oil (Chowdhury *et al*. 2007) might have spared more protein for egg production in the 20% AMRM–COS-fed hens. Firman *et al*. (2010) observed that fat addition decreased FI and improved feed efficiency in broilers. In the present study, fat addition improved feed efficiency but not FI, probably due to the similarity of the diets in ME content, as birds feed to meet their energy requirement. Possible improvement in the absorption of fat-soluble vitamins on the COS-supplemented diets may also be speculated. The higher nutrient demands for increased egg production on the 20% AMRM–COS group might be the main reason for the lower BWG recorded in these birds during the period of the experiment.

Experiment 2

The similarity in FI suggested that there were no palatability problems with the test ingredient, as was observed in Experiment 1. The performance reduction at concentrations greater than 10% dietary AMRM despite similar FIs could not be explained but was probably due to an anti-nutritional property of AMRM. The use of limestone flour and snail shells, both of which are excellent sources of inorganic Ca, could not improve performance of the group fed 10% AMRM–COS compared with 10% AMRM-fed group. The utilisation of dietary fat by poultry is reported to be age dependent (Katongole and March 1980; Sell *et al*. 1986). Katongole and March (1980) observed a better utilisation of dietary fat in 6-week-old than in 3-week-old broilers and Leghorn layers and attributed this to the poor ability of younger birds to recycle bile salts efficiently. The inability of the broilers to utilise AMRM–COS-based diets in the present study compared with the layers may be due to age differences. The sensitivity of broiler chickens to dietary amino acid balance in terms of weight gain and feed efficiency has been reported (Bartov 1998; Kidd *et al*. 2004). The lower intake of lysine of the 20% AMRM–COS-fed birds could be a possible reason for the reduced growth performance of birds fed this diet. As dietary fibre content is an important factor in gut emptying, the similarity of fibre content in all the diets may be a possible reason for the trend in gut content observed. A heavier small intestine weight in birds on the control and the 10% AMRM diets may indicate increased nutrient absorption, which might be the reason for improved growth performance of birds fed these diets.

Conclusions

Replacement of more than 10% of dietary maize with *Alocasia macrorrhiza* root meal compromises performance of laying hens and young broilers, whereas coconut oil slurry-treated meal can replace up to 20% maize in laying hens, without adverse effects on egg production and egg weight. Addition of COS does not improve broiler performance.

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