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Utilisation of Giant African snail (*Achatina fulica*) meal as protein source for laying hens

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Abstract

A 12-week experiment was carried out to investigate the effects of substituting Giant African snail meal for fish meal in laying hens diet. Four diets were formulated to contain snail meal as replacement for fish meal at 0 (control), 33, 67 and 100 %. A total of 120 Shaver Brown pullets aged 18 weeks were allocated to the dietary treatments in a randomised design. Each treatment consisted of three replicates and ten birds per replicate. Feed intake increased only for the 33 % treatment as compared to the 67 % replacement diet but did not differ from the other treatments. There were no significant treatment effects on egg performance parameters observed (egg production, egg weight, total egg mass, feed conversion ratio and percent shell). The overall feed cost of egg production reduced on the snail meal-based diets. The organoleptic evaluation of boiled eggs revealed no difference between the treatments. Based on these results it was concluded that total replacement of fish meal with cooked snail meat meal does not compromise laying performance or egg quality. The substitution is beneficial in terms of production cost reduction and the reduction of snails will have a beneficial impact especially where these snails are a serious agricultural pest. The manual collection and processing of snails can also become a source of rural income.

Keywords: protein sources, feed cost, snail meal, egg production

1 Introduction

The shortage in supply and high cost of traditional protein feed sources such as fish and soybean meals have increased research interest in alternative sources for poultry feeding. In the free range system, chickens normally obtain an important part of their protein requirement from worms, insects and molluscs. The better amino acid composition of animal proteins compared to plant proteins (Ravindran & Blair, 1993) has increased research into the feeding value of such species normally eaten by scavenging poultry. Several genera and species of insects and worms (Johnson & Boyce, 1990; Despins *et al.*, 1994; Khurso *et al.*, 2012) and molluscs (Ravindran & Blair, 1993; Dragićevic & Baltić, 2005) are reported to have nutritional qualities that make them excellent protein sources for poultry.

Snails, members of the phylum Mollusca, are found in fresh and sea water, and on land (Thompson & Cheney., 1996). The different species of snail do have wide differences in nutrient contents. Protein contents in the dry matter of 53.9 % in *Pila globosa* (Ali & Leeson, 1995), 62 % in *Pomacea insularis* (Serra, 1997) and 54 % in *Achatina fulica* (Diomandé *et al.*, 2008) snail species have been reported. Snail meal is reported to have a good (4.35–4.60 %) lysine content (Creswell & Kompiang, 1981; Ali & Leeson, 1995). These nutritional properties have made snail an increasingly important dietary protein source for human beings in several

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regions of the world (Jess & Marks, 1995). Where snails have no food value however, they could be potential protein supplements in poultry diets. The use of snail meal in broilers (Ali & Leeson, 1995; Diomandé *et al.*, 2008) and laying hens diets (Serra, 1997) has been reported. All these authors also observed improved feed intake on diets based on cooked snail meal compared to raw snail meal.

Giant African snail (*Achatina fulica*) which is native to the east coast of Africa (Mead, 1949) abounds in Samoa, especially during the months of heavy rains (November to April), causing serious damages to crops such as papaya and pineapple (Kant & Diarra, 2014). Actually, chemical treatments are the main measure to control snails. Besides the economic aspect, an excessive use of agro-chemicals can have serious environmental and health consequences. Although there are reports on the inclusion of Giant African snail species in broiler diets (Creswell & Kompiang, 1981; Ali & Leeson, 1995; Diomandé *et al.*, 2008), documented information on its feeding to laying hens is scanty. It may therefore be of interest to investigate the feeding value of this snail species to laying hens, the only form of commercial poultry in Samoa at the moment. In the present study it was hypothesised that replacing fish meal with *Achatina fulica* meal will have no adverse effects on egg production and quality.

2 Materials and methods

2.1 *Experimental site, source and processing of snail meal*

The study was conducted at the Poultry Unit of the IRETA institute of the University of the South Pacific (USP) in Alafua, Samoa (latitude 13.5°S and longitude 172°W). Fresh snails collected from the school campus and surrounding villages were scraped with an iron blade to remove the meat from the shell. The meat was boiled at 100 °C for 20 min and then washed under running tap water to remove the slime. The boiled snail meat was sun-dried for 72 hours, ground in a hammer mill and labelled snail meat meal (SMM). For this study a total of 227 kg of fresh snails were collected that gave about 45 kg of snail meal, representing a yield of 18 %. Snail meal and fish meal were analysed for proximate composition (Table 1) and used for diet formulation.

2.2 *Experimental diets*

Four layer diets containing 16.5 % crude protein each were formulated for the experiment (Table 2). Diet 1 (control diet) was based on copra meal and fish meal as protein sources. Snail meal replaced the fish meal portion at 33, 67, and 100 % in diets 2, 3, and 4, respectively. All the diets were supplemented with lysine and methionine to compensate for the deficiencies of these amino acids in copra meal and fortified with vitamins and mineral premixes to meet the requirements of laying hens (NRC, 1994).

2.3 *Experimental protocol, birds and management*

The research was approved by the University of the South Pacific's research committee and birds were managed in compliance with the University's research ethics guidelines for animal welfare. A total of 120 Shaver Brown pullets aged 18 weeks were weighed individually and allotted to 12 floor pens (2 × 3m) with the floor covered with wood shaving as litter material. A trough feeder and a bell shaped drinker were provided in each pen. Each of the 4 diets was fed as mash to birds in 3 selected pens in a completely randomised design for a period of 12 weeks. The diets and drinking water were supplied ad-libitum throughout the experimental period. The lighting programme was limited to 13 hours day light.

Table 1: *Analysed composition and calculated ME content of fish and snail meals.*

	Constituents (g/100g)					
	Dry matter	*Crude protein*	*Crude fat*	*Crude fibre*	*Total ash*	*ME** (kcal/kg)
Fish meal	92.1	57.9	4.0	1.3	10.9	3,170
Snail meal	94.4	53.5	0.8	5.9	22.4	2,465

*Metabolisable energy calculated according to Fisher & Boorman (1986)

Table 2: *Ingredient composition and calculated analysis of the experimental diets.*

Ingredients (g/kg)	*Replacement level of SMM for fish meal (%)*			
	0	*33*	*67*	*100*
Maize	668.5	668.5	668.5	668.5
Copra meal	173.8	173.8	173.8	73.8
Fish meal	86.2	57.75	28.45	0
SMM	0.00	28.45	57.75	86.2
Limestone flour	62.0	62.0	62.0	62.0
Lysine	2.0	2.0	2.0	2.0
Methionine	1.5	1.5	1.5	1.5
Vitamin-mineral premix *	2.5	2.5	2.5	2.5
Salt	3.0	3.0	3.0	3.0
Calculated analysis (g/100g)				
Crude protein	16.51	16.48	16.47	16.47
Calcium	39.50	39.50	40.00	41.00
Total phosphorous	9.40	9.43	9.46	9.50
Lysine	0.66	0.64	0.65	0.67
Methionine	0.37	0.37	0.35	0.35
Metabolisable energy (kcal/kg)	2,865	2,851	2,850	2,849

SMM: snail meat meal; * Layer premix supplied/kg: Vitamin A 1.000.000 IU., Vitamin D3 200.000 IU, Vitamin E 1.500 mg, Vitamin K3 200 mg, Vitamin B1 150 mg, Vitamin B2 400 mg, Vitamin B6 200 mg, Vitamin B12 1.200 mcg, Niacin 2.000 mg, Calcium pantothenate 500 mg, Biotin 10.000 mcg, Folic acid 40.000 mcg, Choline chloride 40.000 mg, Vitamin C 2.000 mg, Methionine 30.000 mg, Iron 4.000 mg, Copper 800 mg, Manganese 8.000 mg, Zinc 6.000 mg, Iodine 60.000 mcg, Selenium 15.000 mcg, Cobalt 20.000 mcg, Carophyll 2.000 mg, Antioxidant BHT 10.000 mg

2.4 *Data collection*

Data were collected on feed consumption, egg production and external egg qualities (egg weight and percent shell). A weighed quantity of feed was provided daily and refusals weighed the next day to account for quantity consumed. Eggs produced were recorded daily per pen and mean egg weight taken using a digital scale. Feed conversion ratio was calculated as unit feed consumed per unit egg produced. Hen-day production (HDP) was calculated as:

$$\text{HDP} = \frac{\text{eggs produced}}{\text{hens in the house}} \times 100$$

Five randomly selected eggs per pen were weighed fortnightly and broken for shell quality measurement. Shell weight was determined according to the procedures described by Kul & Seker (2004) and percent shell calculated as:

$$\text{percent shell} = \frac{\text{dry shell weight}}{\text{egg weight}} \times 100$$

On the last day of the experiment five eggs were randomly selected per pen (15 per treatment), boiled for 15 min, peeled, cut transversely into two halves and used for sensory test at three different locations within the campus. Four scales (very tasty, tasty, moderate taste, and poor taste) were used for the test.

Birds in all the pens were weighed individually at the end of the experiment and weight change recorded for each pen. Mortality was recorded as it occurred.

2.5 *Chemical and statistical analyses*

Snail meat meal, fish meal and the diets were analysed for proximate composition in the Central Laboratory, USP Alafua Campus, according to AOAC (1995).

Performance data (feed consumption, egg production, egg quality, and weight change) were subjected to analysis of variance (Steel & Torrie, 1980) using the Statistical Package for Social Sciences (SPSS Inc., 2013). Significant differences were reported at 5 % level of probability.

3 Results

3.1 Chemical analysis

Results of proximate composition of fish meal, snail meal and the experimental diets (Tables 1 and 3) showed lower protein and fat but higher fibre and total ash in snail meal compared to fish meal. The proximate composition of the diets (Table 3) showed a linear increase in dietary fibre and a decrease in metabolisable energy (ME) content with increasing level of replacement of fish meal with snail meal.

3.2 Laying performance

The performance data of the hens are presented in Table 4. Daily feed intake (g/bird) significantly increased (P<0.05) on the 33 % diet compared to the 67 % replacement diet. There was no significant dietary effect on feed intake among the control, 33 % and 100 % replacement of fish meal with snail meal diets as well as among the control, 67 % and 100 % replacement diets. No dietary effects were observed on egg performance parameters (hen-day production, egg weight, egg mass, feed : egg, and percent shell). However, feed cost of egg production (WST$/kg egg) reduced on the snail meal-based diets as compared to the control fish meal based diet. A total of three birds died within the 33 % replacement diet groups during the investigation.

The results of the sensory evaluation of eggs (Table 5) showed no significant dietary effects on consumer preference for the scales very tasty and moderate taste. Except for the scale poor taste which recorded the highest (P<0.05) value on the 33 % replacement diet, the control fish meal-based diet was not superior to the snail meal-based diets for any other taste preference scale.

Table 3: *Analysed composition and calculated ME content of the experimental diets.*

Constituents (g/100g)	*Replacement level of SMM for fish meal (%)*			
	0	*33*	*67*	*100*
Dry matter	88.30	89.70	89.10	90.14
Crude protein	16.26	16.24	16.19	16.14
Crude fat	7.59	7.54	7.09	7.04
Crude fibre	5.40	5.76	5.83	6.39
Total ash	14.87	15.61	15.10	16.21
Metabolisable energy * (kcal/kg)	2,785	2,772	2,769	2,742

SMM: snail meat meal
* Calculated according to Fisher & Boorman (1986)

Table 4: *Performance of laying hens fed graded levels of snail meat meal as replacement for fish meal.*

Variables	*Replacement level of SMM for fish meal (%)*					
	0	*33*	*67*	*100*	*SEM*	*P value*
Initial weight (g/hen)	1,418.7	1,419.0	1,417.7	1,415.0	7.64	0.981
Final weight (g/hen)	1,851.0	1,786.0	1,839.0	1,806.0	17.98	0.112
Daily feed intake (g/hen)	79.56^{ab}	81.14^{a}	77.37^{b}	79.33^{ab}	1.05	0.016
Hen-day production (%)	38.06	44.36	41.31	43.00	2.82	0.478
Mean egg weight (g)	53.03	53.45	51.15	52.40	1.10	0.514
Egg mass (kg)	16.97	19.91	17.73	18.93	1.28	0.430
Feed : egg	3.97	3.56	3.77	3.54	0.30	0.740
Feed cost of production (WST$/kg eggs)	4.29^{a}	3.06^{b}	3.13^{b}	2.83^{b}	0.26	0.019
Percent shell	10.51	10.69	10.67	10.88	0.24	0.752
Mortality (%)	0	10	0	0	NA	

^{a,b}: means within the row bearing different superscripts are significantly different (P<0.05);
SMM: snail meat meal; SEM: standard error of the mean; WST$: Western Samoan Dollar (WST$ 1 = US$ 0.424 @ period of experiment).

Table 5: *Sensory evaluation of eggs from hens fed graded levels of snail meal as replacement for fish meal.*

Taste preference scale (%)	*Replacement level of SMM for fish meal (%)*					
	0	*33*	*67*	*100*	*SEM*	*P value*
Very tasty	25.60	22.89	26.67	24.84	1.56	0.482
Tasty	24.00 [ab]	22.11 [b]	25.89 [ab]	28.00 [a]	1.34	0.013
Moderate taste	25.00	26.00	25.00	24.00	1.16	0.693
Poor taste	25.40 [b]	29.00 [a]	22.44 [c]	23.16 [bc]	0.88	0.001

[a,b,c]: means within the row bearing different superscripts are significantly different (P<0.05);
SMM: snail meat meal; SEM: standard error of the mean

4 Discussion

4.1 Chemical analysis

The ash content of the snail meat used in the present study compares favourably with the 22.7 % reported in *Achatina fulica* meal by Diomandé *et al.* (2008). The protein and fat contents (62.4 % and 4.30 % respectively) observed by these authors are however higher than our values. As snails are mainly foragers, the species of foraging materials available will greatly influence their body composition. The effect of the environment in which the snail lives on its body composition has earlier been reported by Gomot (1998). As older animals forage more efficiently than younger ones, the age of the snail may also be a factor of variation in body composition. Dietary protein levels met the requirements of brown egg laying hens (NRC, 1994; ISA, 2005). The decrease in dietary ME observed with increasing level of snail meal was a result of differences in ME content between fish and snail meals. Despite this linear decrease with increasing level of SMM, the ME content of all the diets was comparable to the 2,800 kcal/kg recommended for the breed (NRC, 1994; ISA, 2005).

4.2 Laying performance

Birds normally consume feed to meet their energy requirement. The reason for the decreased intake on the 67 % compared to the 33 % diet despite the steady decrease in ME content was not understood. The pattern of feed intake in the present study did not support the finding of Venugopalan *et al.* (1976) that feed intake of broiler chicks increased on diets based on snail meal compared to fish meal. The body of foraging snails is known to contain different anti-nutrients associated with the foraging substrates (Ravindran & Blair, 1993; Chukwuka *et al.*, 2013). Differences in feed processing methods and temperatures during processing might influence feed intake pattern of poultry fed snail meal.

In the present study, 100 % replacement or 8.62 % dietary snail meal did not affect performance compared to the control fish meal-based diet. This is in agreement with an earlier report by Serra (1997) that 10 % cooked dietary snail (*Pomacea insularis*) meal did not affect performance of laying hens. However, feeding up to 12 % dietary cooked snail (*Pila leopoldvillensis*) did reduce feed consumption but without adversely affecting weight gain in broilers grown to 28 days (Barceló & Barceló, 1991). All mortalities recorded in the group fed 33 % replacement were the result of bleeding and pecking of cloacae following the laying of very large eggs.

Fish meal used for the experiment was imported form Fiji at the cost of WST$ 6.00 per kg dry matter. The cost of snail meal was estimated from collection and processing to be WST$ 1.42 per kg dry matter. This price difference of WST$ 4.58 between the two ingredients resulted in reduced feed costs of egg production on the snail meal-based diets compared to the control.

Based on the results it is concluded that a complete replacement of dietary fish meal with Giant African snail meal has no adverse effects on egg production, egg quality and egg taste. This substitution is not only beneficial in terms of reducing cost of egg production but the manual collection and processing of snail can also become a source of local income. In this way snails can be controlled to some extent and crop damage reduced. Further research into snail meal processing methods with the goal to improve its utilisation by poultry should be considered.

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