Snail shell as an efficient mineral feedstuff for layer hens: Effects and optimum rate

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Abstract

An experiment was carried to determine the optimal rate of snail shell in diet of layer hens and its effects on productivity and quality of eggs. A total of 90 ISA Brown laying hens having 60 weeks-old and 87.0 ± 5.5 % as average laying rate were divided into 5 dietary treatments. In diets, the oyster shell was substituted by snail shell at 0% (SS0), 25% (SS0), 50% (SS50), 75% (SS75) and 100% (SS100). Completely Randomized Design was used. Hens were housed in Californian cages and each diet was delivered to nine cages (replications) of two hens each.

The results demonstrated that the laying rate improved significantly in dietary treatments SS25 and SS50 ($P < 0.05$), whereas, eggs weight and eggshell thickness were significantly higher in control group SS0. The daily feed intake was significantly lower in SS100 and the feed conversion ratio was significantly improved in SS25 and SS50 treatments. The Haugh units and albumen height of eggs were similar between diets. The feed costs were significantly lower in SS25 (27.6 FCFA/egg) and SS50 (27.4 FCFA/egg) than in SS0 (29.9 FCFA/egg), SS75 (29.6 FCFA/egg) and SS100 (28.16 FCFA/egg). It can be concluded that up to 50% of oyster shell can be efficiently substituted by snail shell in diet of laying hens.

Keywords: Benin, calcium, diet, egg, poultry

Introduction

The development of poultry production has been very fast these two last decades in developing countries, especially in South of Sahara part of Africa (Téguia et al 2002). This because meat and eggs from poultry industry are well accepted by consumers (Oluyemi and Roberts 2000). Poultry is also one of the main sources of income and protein in the developing countries (Zaman et al 2004). However, the major limitation to the growth of poultry industry is the high cost of feed that represents about 70 % of total production cost (Omole et al 2005).

Mineral sources such as bone meal, oyster shell, limestone, calcium, phosphate and gypsum are necessary for bone formation and adequate utilization of the feed (NRC 1994 and Omole et al 2005). They are also important for birds' egg shell formation (Larbier and Leclercq 1992). Calcium is the key feedstuff for shell strength (Nys 1999). Snail shell is a mineral ingredient that contains about 98% of calcium carbonate (Cobbinah et al 2008). It is therefore a biological source of calcium that can be used in animal feeding. Investigations has been done on the use of many sources of calcium such as gypsum, limestone and oyster shell in layers and broilers diets (Omole et al 2005; Safaa et al 2008 and Saunders-Blades et al 2009); but there is a lack of information on the use of snail shell in animal feeding.

This study aimed to investigate the effect of snail shell used as mineral feedstuff in substitution of oyster shell in layer hens' diet.

Materials and methods

An experiment was carried out at the Laboratory of Poultry Research and Zoo-Economy, University of Abomey-Calavi in Benin. *Achatina* species snail shells were purchased, washed with water, sundried and ground. They were used to substitute the oyster shells in layer hens' diet. The snail shell and oyster shell cost 47 FCFA/kg and 110 FCFA/kg, respectively.

A total of 90 ISA Brown laying hens weighting on average 1683.9 ± 20.95 g was housed in Californian battery cages. Hens were 60 weeks-old and their average laying rate was 87.0 ± 5.5%. The birds were distributed in five equal groups of eighteen hens housed in nine cages of two hens each. During 12 weeks, each of the five dietary treatments was delivered to a group of hens. The control diet (SS0) contained 0% snail shell, while in SS25, SS50, SS75 and SS100 diets, oyster shell was substituted by snail shell at 25%, 50%, 75% and 100%, respectively (Table 1). Daily, each hen received 120 g of feed. Water was given *ad-libitum*.

Table 1. Ingredients and nutritional composition of the experimental diets.

Ingredients/Nutrients	**Diets**				
	SS0	**SS25**	**SS50**	**SS75**	**SS100**
	0% SS[1]	**25% SS**	**50% SS**	**75% SS**	**100% SS**
Ingredients, %					
Maize	55.4	55.4	55.4	554	55.4
Soybean cake	24	24	24	24	24
Cotton cake	9	9	9	9	9
Oyster shell	10	7.5	5	2.5	0
Snail shell	0	2.5	5	7.5	10
Lysine	0.05	005	0.05	0.05	0.05
Methionine	0.15	0.15	0.15	0.15	0. 15
Dicalcium Phosphate	0.8	0.8	0.8	0.8	0.8
Iron Sulfate	0.025	0.025	0.025	0.025	0.025
Salt (NaCl)	0.3	0.3	0.3	0.3	0.3
Premix[2]	0.25	0.25	0.25	0.25	0.25
Total	100.0	100.0	100.0	100.0	100.0
Price/kg (FCFA[3])	207.6	206.1	204.5	202.9	201.3
Nutritional Composition					
Dry Matter, %	88.6	88.6	88.6	88.6	88.6
Crude Protein, %	18.9	18.9	18.9	18.9	18.9
Crude Fibre, %	4.2	4.2	4.2	4.2	4.2
Lysine, %	0.97	0.97	0.97	0.97	0.97
Methionine, %	0.46	0.46	0.46	0.46	0.46
Methionine + Cystine, %	0.78	0.78	0.78	0.78	0.78
Calcium, %	4.05	3.91	3.76	3.62	3.47
Phosphorus, %	0.57	0.57	0.57	0.57	0.57
Sodium, %	0.16	0.15	0.14	0.14	0.13
Ca/P	7.1	6.8	6.6	6.3	6.1
Metabolisable Energy, Kcal/kg	2593	2593	2593	2593	2593

[1] *SS = snail shell*

[2] *Premix contained per kg: Vitamins: A 4000000 UI; D3 800000 UI; E 2000 mg; K 800 mg; B1 600 mg; B2 2000 mg; niacin 3600 mg; B6 1200 mg; B12 4 mg; choline chloride 80000 mg. Minerals: Cu 8000 mg; Mn 64000 mg; Zn 40 000 mg; Fe 32000 mg; Se 160 mg.*

[3] *Euro (€) = 655.9 FCFA*

Feeding and laying performances (feed intake, feed conversion ratio, and laying rate), egg quality (weight, shape index, Haugh units, shell thickness, shell weight, shell index, albumen and yolk weight) and economics of feeding (feed cost and Economic Feed Efficiency) were evaluated. Haugh units and Economic Feed Efficiency were calculated according to Haugh (1937) and Houndonougbo et al (2009), respectively.

Data were analysed in SAS 9.2 by using the General Linear Model (GLM) procedure. In tables, the mean values and the pool standard error of mean (SEM) are shown. The significant effect was stated when $P < 0.05$.

Results

Feeding and laying performance

Dietary treatments had significant effect ($P < 0.05$) on feed intake, feed conversion ratio and laying rate of hens (Table 2). The substitution of 25 and 50% of oyster shell by snail shell in layer hens' diet improved significantly the laying rate and the feed conversion ratio, without a significant effect on feed intake. However, a full substitution of oyster shell by snail shell (SS100 diet) decreased significantly the feed intake of layer hens.

Table 2. Feeding and laying performance of hens fed with oyster and snail shells based diets

Parameters	Diets					SEM	P-value
	SS0	SS25	SS50	SS75	SS100		
Feed intake, g/hen/day	118[a]	117[a]	119[a]	115[b]	111[b]	0.05	< 0.0001
Feed conversion ratio, kg feed/kg egg	2.25[a]	2.13[b]	2.13[b]	2.38[c]	2.30[ac]	0.06	< 0.0001
Laying rate, %	82.1[a]	87.6[b]	89.1[b]	80.4[a]	80.6[a]	2.02	< 0.0001

[abc]*Means in the same row without common letter are different at P<0.05*

Egg quality

The inclusion of snail shell in diet had a depressive effect on egg weight (Table 3). In SS100 group, the egg weight decreased by about 5% compared to the control group. In general the egg weight decreased significantly when the level of snail shell increases in diet (Figure 1).

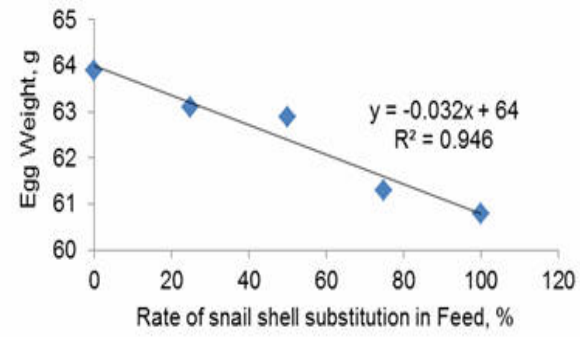

Figure 1. Correlation between egg weight and the level of snail shell in the diet.

No significant difference ($P > 0.05$) was recorded between dietary treatments on egg shape index and Haugh units. But, the substitution of oyster shell by snail shell had a significant effect on weight and proportion of eggshell, its thickness, and on the proportion of both edible parts of the egg (Table 3). The decrease of eggshell thickness reduced the mass of eggshell per unit of egg surface. Thus, the shell index was significantly affected by the diet. However,

eggshell from hens fed with SS50 (50%) had similar thickness with those from the control diet, indicating in certain instance the efficient rate of snail shell substitution.

Table 3. Quality of eggs from layer hens fed with oyster and snail shells based diets

Parameters	Diets					SEM	P-value
	SS0	SS25	SS50	SS75	SS100		
Egg Weight, g	63.9[a]	63.1[b]	62.9[b]	61.3[c]	60.8[c]	0.35	< 0.0001
Shape Index	0.78	0.77	0.77	0.76	0.76	0.01	0.21
Eggshell weight, g	6.58[a]	6.00[b]	6.31[c]	6.03[b]	6.05[b]	0.09	< 0.0001
Eggshell proportion, %	10.0[a]	9.29[b]	9.92[a]	9.68[a]	9.63[ab]	0.19	0.0029
Eggshell thickness, mm	0.376[a]	0.356[b]	0.368[ab]	0.360[b]	0.359[b]	0.01	0.0224
Shell Index, g/100 cm²	8.61[a]	7.97[b]	8.46[ac]	8.20[bc]	8.19[bc]	0.16	0.0005
Haugh Units	88.4	87.7	86.4	86.7	88.7	1.62	0.54
Albumen & Yolk, %	90.0[a]	90.7[b]	90.1[a]	90.3[a]	90.4[ab]	0.19	0.0029

[abc]*Means in the same row without common letter are different at P<0.05*

Economics of feeding

Compared to the control (SS0) and SS75 diets, feed cost and economic feed efficiency improved in dietary treatments SS25 and SS50 in which oyster and snail shells were associated at the respective rate of 25:75 or 50:50 (Table 4). Economically, SS50 diet appeared therefore as the more efficient diet.

Table 4. Feed cost and economic feed efficiency (EFE) of layer hens fed with oyster and snail shells based diets

Parameters	Diets					SEM	P-value
	SS0	SS25	SS50	SS75	SS100		
Feeding cost, FCFA[1]/egg	29.9[a]	27.6[b]	27.4[b]	29.6[a]	28.1[b]	0.638	< 0.0001
EFE, FCFA Egg/ FCFA Feed	2.12[a]	2.31[b]	2.32[b]	2.17[a]	2.28[b]	0.049	< 0.0001

[1] Euro (€) = 655.9 FCFA

[ab]*Means in the same row without common letter are different at P<0.05*

Discussion

Feeding and laying performances

At high rate of substitution (75 % and 100 %), the snail shell reduces the feed intake. In diet of layer hens, INRA (1989) recommends 6.67 as Ca/P ratio. This rate is closed to 6.8 and 6.6 obtained respectively in SS25 and SS50 diets. That explains the efficiency of these diets through the highest laying rate and the lowest feed conversion ratio of hens.

In the feeding of Lohmann Brown layer hens, Safaa et al (2008) did not found a significant effect in feed intake and feed conversion ratio when evaluating the effect of limestone and oyster shell between 58 to 73 weeks of age. In this study, the results demonstrate that the calcium source and especially snail shell has an effect on feed intake and feed conversion ratio. Thus, a combination of snail shell and oyster shell at an optimum rate 50:50 is more efficient in layer hens feeding than a complete substitution (0:100). The laying rates in SS25 and SS50 (87.6 and 89.1%, respectively) are higher than 79.8% reported with limestone based diets (Saunders-Blades et al 2009). They are also higher than 72.7%, when the limestone and oyster shell were combined at 60:40 in Lohmann Brown hens' diet (Safaa et al 2008).

Egg quality

The effect of calcium source on egg weight is in agreement with the results of Lichovnikova (2007); but not with those reported by Pelícia et al (2007). The egg weights (60.8 to 63.9 g) are in the range of 60-65.5 g mostly recorded in the latest laying month of brown eggs layer hens (Nys et al 2008).

Using limestone and oyster shell, Khalil and Anwar (2009) did not found a significant effect on eggshell weight and eggshell proportion. The negative effect of snail shell on eggshell quality confirms the effect of calcium source on egg quality reported by Lichovnikova (2007) who observed significant effect of different dietary mineral feedstuffs on eggshell weight, eggshell proportion and eggshell thickness.

In high ambient temperature (32-35 °C versus 21-24 °C), hens decrease the synthesis of shell between 6 and 30% (Nys 1995); hence the ambient temperature of 27.9 °C in the poultry house during the experimental period might contribute to the decrease of eggshell thickness.

The age of hens is also reported to affect their calcium efficiency (Curtis 2008). In this experiment old hens were used. The quality of eggs could be therefore affected by the age of hens (60 to 72 weeks-old) during this experiment.

The similarity of shape index and Haugh units of eggs is in agreement with the results reported by Safaa et al (2008) and Pelícia et al (2007) when they supplied different dietary calcium sources to layer hens. However, the significant depressing effect of the mineral feedstuff on the shell index and on the albumen and yolk percentage is contrary to the findings of Safaa et al (2008) regarding these variables.

Economics of feeding

At the current price of snail shell, its using in laying hens diet in substitution of oyster shell decreased the feed cost and increased the economic feed efficiency. The values of these two variables improved significantly in SS25, SS50 and SS100 diets compared to the control diet, SS0. Thus, economically, the snail shell can be used even alone in diet of old layer hens.The snail shell appeared therefore as an efficient source of mineral in layer hens feeding at its current price.

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