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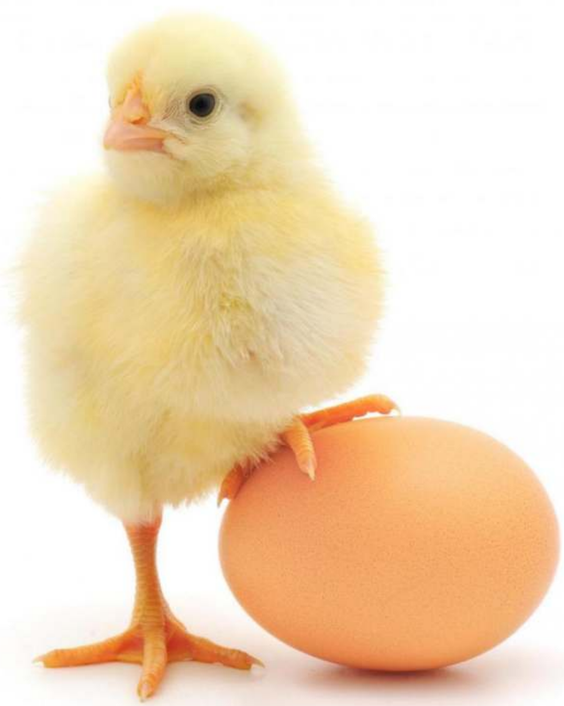

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The Egg Quality Characteristics of Layers Fed Varying Dietary Inclusions of Siam Weed (*Chromolaena odorata*) Leaf Meal (SWLM)

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Abstract: Twenty-four layers in their eighth month in lay were used to study the effects of dietary inclusion of Siam weed (*chromolaena odorata*) leaf meal (SWLM) on egg quality characteristics. SWLM was incorporated into the diets at 0%, 2.5% 5.0% and 7.5% in diets 1, 2, 3 and 4 respectively. Total egg production and total feed intake increased up to 5% level (diet 3) of inclusion after which there was a decline. The highest hen-day production (%) was obtained for diet 3 with the 5% inclusion. The control diet 1 had the best feed efficiency value. The average egg weight was not negatively affected by the treatment levels of SWLM. The average shell thickness slightly but insignificantly increased (P=0.05) with the increasing introduction of SWLM in the diets. The yolk colour score gave highly significant statistical differences ($P < 0.05$) among treatment means in proportion to the dietary inclusion of SWLM. The albumen height showed a proportionate increase up to 5% level of SWLM inclusion before a decrease. The Haugh's unit was also best at the 5% dietary inclusion level of SWLM. It can therefore be concluded at the level of this study that SWLM would probably not result in mortality as previously envisaged and can be included up to 5% level in the diets of laying hens with desirable aesthetic effect on egg yolk colouration.

Key words: Siam weed, leaf meal, yolk colour, albumen height, Haugh's unit, egg shell thickness

Introduction

The performance and egg quality characteristics in response to different dietary inclusions of leaf meals (LMs) and leaf protein concentrates (LPCs) have been studied (Byers, 1961; Oke, 1973; Hamilton, 1978; Edwin and Maron, 1986; Fasuyi and Aletor, 2005a). The green vegetable has long been recognized (Byers, 1961; Oke, 1973) as the cheapest and most abundant potential source of proteins because of its ability to synthesize amino acids from a wide range of virtually unlimited and readily available primary materials such as water, CO_2, atmospheric N_2 (as in legumes). Cassava (*Manihot esculenta, Crantz*) leaf protein concentrates (CLPCs) as protein replacement in broiler starter diets had been studied (Fasuyi and Aletor, 2005b) and it was found that there was no deleterious effect up to 60% CLPC replacement of fish meal in birds on such diets. The major constraints to the utilization of these leaf meals have been their high levels of fibre and antinutritional factors like saponins, phenols and other antinutrients (Cheeke and Myer, 1975; Liener, 1989; Huisman and Tolman, 1992; Aletor, 1993a; Jansman and Poel, 1993; Fasuyi, 2005). These antinutritional factors have been implicated in the reduction in feed intake, growth inhibition and production of very watery droppings by birds (Onwudike and Oke, 1978). Consequently, it has been suggested (Oke, 1973; Fasuyi, 2005) that with mechanical separation of the fibre, fibre-free proteins from leaves can be obtained for incorporation into monogastric diets and thus improves the utilization of this non-conventional protein resource. Nwokolo (1987), which assaying for the true digestibility of minerals and amino acids in the leaf meals of cassava and *Chromolaena odorata* concluded that as far as monogastric nutrition in concerned in the tropics, the future lies in the use of leaf meals. This present study investigated further more, the nutritional potentials of SWLM in laying hens in respect to egg quality characteristics.

Materials and Methods

Collection and preparation of SWLM: The leaf meal used for this study was prepared by cutting the stems of nearly matured and just maturing *Chromolaena odorata* plants with the leaves intact and sundrying these for 3-4 days. The dried leaves were hand picked directly into jute sacks. The entire collection period lasted 15 days. The sun-dried leaves were later milled and the leaf meal obtained there-from was used in combination with other feed ingredients to compound the treatment diets used in this study.

Proximate and amino acids composition: Proximate composition of the SWLM was determined by AOAC (1980) method, while the amino acids were determined using amino acid analyzer. The gross and digestible energy values were computed by method of Ng and Wee (1989).

Experimental diets: The SWLM processed as earlier

Table 1: Proximate composition (g/100g) and amino acid content (g/16gN) of Siam weed (*Chromolaena odorata*) leaf meal (SWLM)

Nutrients	SWLM
Dry matter (%)	87.40
Crude protein	18.67
Ether extracts	1.01
Crude fibre	11.67
Ash	3.63
Nitrogen free extract	65.03
Amino acids:	
Alanine	4.03
Aspartic acid	6.12
Arginine	4.96
Glycine	4.61
Glutamic acid	9.38
Histidine	2.63
Isoleucine	5.52
Lysine	2.01
Methionine	1.58
Cystine	1.30
Meth. + Cys.	2.88
Leucine	7.01
Serine	3.81
Threonine	4.90
Phenylalanine	4.30
Valine	6.20
Tyrosine	4.71
Tryptophan	2.36

Means are for duplicate determinations

discussed was one of the major ingredients used in the diet formulation. Other feed ingredients were purchased from reputable sources in Akure, Ondo State, Nigeria. The results of the proximate compositions earlier determined were used in the eventual formulation of the different diets. Four isonitrogenous (15% crude protein) and nearly isocaloric layers diets were formulated with the feed ingredients shown in Table 1. Diet 1 was the control diet without the test SWLM in the diet. Diets 2, 3, and 4 were formulated such that SWLM was introduced into the diets at graduated levels of 2.5, 5.0 and 7.5% respectively. Other fixed protein sources in all the diets were groundnut cake, fish meal and brewers' dried grain. All diets were also supplemented with feed-grade methionine and lysine.

Management of experimental layer birds and experimental design: Twenty four layer birds were randomly selected from a stock of laying birds in their eighth month of lay. They were randomly allotted into individual cages, replicated thrice under four dietary treatments. Two layer birds were used per replicate making six birds per treatment. The birds were given feed and water *ad libitum* throughout the entire experimental period of 8 weeks.

Data Collection: Feed intake was determined on a daily basis by subtracting the weight (g) of the left over feed from the weight (g) of the feed initially offered. Feed efficiency was computed by calculating the amount of feed consumed per dozen of eggs laid. The percentage hen-day production was computed as the percentage of the total number of eggs over the total number of days by number of hens i.e.

% hen day production =

$$\frac{\text{total number of eggs}}{\text{total number of days x number of hens}} \times \frac{100}{1}$$

Weekly egg production was determined by collecting eggs laid per replicate every day and pooling together for counting the total collection for seven days. Eggs weights were taken by collecting the fresh eggs per replicate per day and then weighing. The various weights were recorded against each replicate. The average egg weight for each replicate was later determined at the end of the experimental period. Determination of internal egg quality was carried out after the determination of egg weight. The fresh eggs (48 eggs i.e. 4 eggs per replicate) were broken out on a flat non- absorbent surface (smooth-surface transparent glass slab) and the weight of the thick albumen was measured with a tripod micrometer as described by Haugh (1937). The yolk colour was scored with the aid of Roche Yolk colour fan. The two egg membranes were pulled off the shells immediately after being broken and the shells so peeled (48 shells) were air-dried for a day after which the egg shell thickness was determined with a micrometer screw gauge. The values so obtained were used to compute the average shell thickness per replicate. The Haugh's unit was calculated per replicate from the values obtained from albumen height and egg weight by employing the formula:

Haugh's unit = 100 log (H+ 7.57-1.7 W 0.37) where H= observed albumen height in millimeters and W= observed egg weight in grams.

Mortality was calculated on percentage basis I. e

$$\text{\% mortality} = \frac{\text{Number of dead birds}}{\text{Number of birds housed}} \times \frac{100}{1}$$

Statistical analysis: Data obtained on each parameter were subjected to either coefficient of variation analysis and analysis of variance (ANOVA) (Steel and Torrie 1980) and differences between treatment means were compared using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

Results

Performance characteristics: Table 3 shows the performance characteristics of the layers for the entire period of the study. There was no significant difference (P=0.05) for all the performance characteristics investigated. However, numerically, the highest body weight change was recorded with birds on 5% inclusion

Table 2: Composition of Experimental Diet (g/100g)

Ingredient	Diets			
	1	2	3	4
Maize (11.0% CP)	56.29	56.25	56.23	56.20
Groundnut cake (45.0% CP)	10.51	10.55	10.57	10.60
Fish meal (68.0% CP)	2.50	2.50	2.50	2.50
SWLM (18.67% CP)	0.00	2.50	5.00	7.50
Bone meal	6.00	6.00	6.00	6.00
Oyster shell	4.00	4.00	4.00	4.00
Premix*	0.50	0.50	0.50	0.50
Nacl	0.50	0.50	0.50	0.50
Total	100.0	100.0	100.0	100.0
Calculated crude protein %	15.00	15.00	15.00	15.00
GE**(kcal/100g) DM	263.2	263.2	263.2	263.2

* Contained Vitamins A 800 I.U.; D_3 (1,4731.C.U); Riboflavin 4.20mg; Pantothenic acid 5.0mg; Nicotinic acid 20.0mg; Folic acid 0.5mg; Choline 300mg; Vitamin K, 2.0mg; Vitamin B_{12}, 0.01mg; Vitamin E, 2.5I.U; Manganese, 56.0mg; Iodine, 1.0mg; Iron 20.0mg; Copper 10.0mg; Zinc 50.0mg and Cobalt 1.25mg. GE** (kcal/100g) DM calculated based on 5.7kcal/g protein; 9.5kcal/g lipid; 4.0kcal/g carbohydrate (Ng and Wee, 1989).

level of SWLM. The total feed intake per bird and total feed consumed per treatment were higher in treatments with varying inclusion levels of SWLM than in the control diet. Feed efficiency although not significantly different (P=0.05) in all the 4 diets was however better in the control diet than in those with dietary inclusions of SWLM. The total egg production and hen-day production (%) values for the laying hens were also not significantly different (P=0.05) in all diets but the numerical values of these 2 parameters were better in diets with SWLM inclusion than in the control diet with no inclusion of SWLM. All the performance indices except for feed efficiency were tilted towards the 5% inclusion level as the best treatment level even though there was no significant statistical differences (P=0.05) between treatment means. It is also noteworthy that no mortality was recorded through out the duration of this study.

Egg quality characteristics: Table 4 shows the egg quality characteristics of layers fed varying levels of SWLM. In Table 4 above, the values for average egg weight were 59.11g, 63.85g, 58.44g and 59.9g for diets 1, 2, 3, and 4 respectively. Birds on treatment 2 with 2.5% level of SWLM gave the highest egg weight while birds on treatment 4 with the highest inclusion level (7.5%) of SWLM gave a higher value than the control diet. These various values obtained are however not statistically different (P=0.05) from each other. The average shell thickness gave the same value of 0.34mm for treatments 2 - 4 and a value of 0.33mm for treatment 1. However, there was no significant statistical difference (P=0.05) in these shell thickness values. The yolk colour score was significantly different (P<0.05) among the eggs scored for the 4 treatment means. There was a progressive and consistent increase in the yolk colour score from treatments 1 to 4 at 1.00, 4.75, 6.50 and 8.58 in diets 1, 2, 3 and 4 respectively. The Haugh's unit values for treatments 1-4 were 73.43, 72.60, 78.74 and 76.55 respectively. The highest value was recorded for birds fed dietary inclusion of a 5% level of SWLM while it was poorest on 2.5% level of inclusion of SWLM. These values are not statistically different (P =0.05) from each other. The values for albumen height were directly proportional to the Haugh's unit. The only exemption to the rule is treatment 2. The highest albumen gave best Haugh's unit and vice versa. There was a progressive increase in albumen height up to treatment 3 after which there was a decline. The numerical values of the albumen heights for SWLM diets (2-4) were still higher than for the control diet 1 without SWLM albeit with no significant statistical difference (P=0.05).

Discussion

This study revealed a higher feed intake per bird in diets with inclusions of SWLM than in the control diet. This implies that feed intake may not be negatively affected at these inclusion levels. The total feed consumed per dietary treatment also followed the same trend. These two parameters showed an initial increase from treatments 1 to 3 after which they showed a decline. This result showed that the inclusion of SWLM in the diets was most beneficial in terms of feed intake up to treatment 3. The highest body weight change recorded in treatment 3 corroborated this claim. The inclusion of SWLM beyond 5% would probably result in reduced feed intake. This result is in concert with studies earlier conducted on other leaf meals like alfalfa leaf meal (Onwudike and Oke, 1978), alfalfa leaf meal and black locust tree leaf meal (Horton and Christensen, 1981) and alfalfa leaf meal and leaf protein concentrate

Table 3: Proximate composition (g/100g) and Amino Acid content (g/16gN) of Experimental Diets

Composition	Diets			
	1	2	3	4
Dry matter	90.10±0.1	90.05± 0.1	89.46± 0.3	89.3± 0.4
Crude protein	15.14± 0.2	15.23± 0.8	15.18± 0.1	15.16± 0.4
Ether extracts	4.23± 0.4	4.38± 0.1	3.91± 0.1	4.19± 0.3
Crude fibre	5.38± 0.4	5.72± 0.7	5.60± 0.8	5.23± 0.4
Ash	5.32± 0.1	5.78± 0.1	6.12± 0.1	5.82± 0.4
Nitrogen free extract	69.93± 0.5	68.89± 0.2	69.19± 0.2	69.60± 0.2
Amino acidsArginine	5.96	6.18	6.38	6.01
Histidine	2.63	2.85	2.90	2.78
Isoleucine	5.52	5.50	5.74	5.66
Leucine	9.56	9.60	9.20	9.51
Lysine	6.69	5.18	5.12	4.92
Methionine	2.48	2.51	2.01	2.01
Cystine	1.33	1.30	1.21	1.19
Methionine + Cystine	3.81	3.81	3.22	3.20
Phenylalanine	6.30	6.52	6.22	6.01
Threonine	4.90	4.81	4.52	4.42
Thyrosine	4.71	4.91	5.00	4.73
Valine	6.20	6.35	5.98	6.49
Glycine	5.61	5.81	6.10	5.85
Tryptophan	2.36	2.30	2.37	2.42
Alanine	6.12	6.34	6.51	6.40
Aspartic acid	9.98	7.10	7.31	7.12
Glutamic acid	11.38	11.52	10.85	11.62
Serine	4.87	5.00	5.30	5.14

Means are for duplicate determinations

(Cheeke and Myer, 1975). The reason for this reduced feed intake as a result of increased dietary level of these leaf meals has been ascribed to the antinutritional factors inherent in all these plants (Cooney *et al.,* 1948; Hewyoung and Bird, 1953; Nwokolo, 1987). The feed consumed per dozen of eggs is the yardstick used for the measurement of feed efficiency in this study (Oluyemi and Roberts, 1979). Inherent in its determination are total egg production and total feed intake. The best feed efficiency was recorded in the control diet while the poorest feed efficiency was recorded for treatment 2. This parameter did not follow a clear-cut trend but results obtained were in consonance with available literature (Hamilton, 1978). Laying hens on 5% level of SWLM gave the best egg production value. This is probably due to the highest feed intake recorded in this treatment. Laying hens on this treatment also ranked second in terms of feed efficiency and gave comparable feed efficiency value with that of the control diet. This trend is also reflected in the work of Onwudike and Oke (1978) during which there was an initial increase in egg production due to the inclusion of alfalfa leaf meal after which egg production dropped significantly at a level beyond 75% inclusion. Birds on treatment 3 had the best percentage hen-day production. The values obtained compared with those found in literature (Wright *et al.,* 1968; Onwudike and Oke, 1978). The reason for the difference in the numerical values for this parameter could also be traced to the feed consumption pattern in the different treatments. The highest hen day production (%) value was recorded for the treatment that showed the best feed consumption while the lowest value was recorded for the treatment that showed the lowest feed intake. No mortality was recorded throughout the duration of the experiment and this seems to have given the SWLM a clean bill of health as regards its utilization in livestock nutrition. It also helped to allay fear about the widespread speculation of its high toxicity and unpalatability as reported in literature (Madrid, 1974). The reason for the observed acceptability of SWLM by the birds might not be unconnected with the drastic reduction/elimination of these antinutrients by the effective processing methods (shredding, sun-drying etc.) of the leaf meal (Fasuyi, 2005). The average weight of the eggs showed that the inclusion of SWLM up to 7.5% of the diet did not affect the weight of the eggs. This level even surpassed the inclusion level of between 2-5% and 3-5% recommended for *leucaena* leaf meal and citrus pulp respectively by Hutagalung (1981). The numerical differences observed among treatment means are probably suggestive of the individual genetic

Table 4: Performance characteristics of layers fed varying dietary levels of SWLM

	Diet			
	1	2	3	4
Initial body weight (g)	1480± 4.0	1450±4.1	1470± 2.0	1470±4.2
Final body weight (g)	1670± 6.1	1620± 5.0	1820± 6.1	1800± 4.2
Total feed intake (g)	6590± 3.2	6860 ±4.1	7340 ±5.4	7010 ±4.2
Daily feed intake (g)	117.67±4.1	122.50±5.0	131.17±1.4	125.17±2.0
Feed consumed/ dozen egg (g)	2380± 2.0	2760± 1.8	2460±2.2	2510±2.1
Total egg production	66.3± 2.1	61.0±1.0	72.0±2.4	67.3±2.2
Mortality	0.0	0.0	0.0	0.0
Weight Change	190.0±0.1	170.0±0.4	350.0±1.2	310.0±2.4
Hen day production (%)	59.2±2.1	54.5±4.2	64.3±5.2	60.1±4.0

Each value represents mean of 6 birds per treatment ±SEM. All mean values are not significantly different (P = 0.05)

Table 5: Egg quality characteristics of layers fed varying dietary levels of SWLM

Diet	Average egg weight (g)	Av. shell thickness (mm)	Yolk colour score	Hough's unit	Albumen Height (mm)
1	$59.1±0.1^a$	$0.33±0.1^a$	$1.00±0.3^a$	$73.43±2.1^a$	$5.47±0.1^a$
2	$63.9±0.2^a$	$0.34±0.1^a$	$4.75±0.2^b$	$72.60±3.4^a$	$5.68±0.4^a$
3	$58.4±0.4^a$	$0.34±0.2^a$	$6.50±0.4^c$	$78.74±3.1^a$	$6.23±0.6^a$
4	$60.0±0.6^a$	$0.34±0.1^a$	$8.58±0.4^c$	$76.55±4.1^a$	$6.02±0.1^a$

Means with differing superscripts in the same column are significantly different (P < 0.05).

differences among the birds in terms of egg weight traits (Hamilton, 1978). The values obtained were however in tandem with values quoted by various researchers (Alkali and Filkry, 1972; Ernst *et al*., 1975; Peebles and Drake, 1986). The nearly uniform values for the average egg shell thickness in all the treatments showed clearly that the dietary inclusion of SWLM up to 7.5% would not have any deleterious effect on egg shell thickness. The result also gave a pointer to the fact that layers may be able to accommodate a higher inclusion of the leaf meal in their diets without any side effect on their egg shell quality. The results obtained for this parameter are in agreement with those reported by Ernst *et al.* (1975) and Oluyemi and Roberts (1979). The egg shell thickness is also an indicator of the specific gravity (relative density of eggs, since both are positively correlated) (Oluyemi and Roberts, 1979). It is therefore suggestive that the utilization of SWLM at the levels of inclusion in this study has no depressing effects on the specific gravity of eggs. The reason for the highly significant statistical differences (P<0.05) in yolk colour score and for the gradual increase in yolk colouration in consonance with the corresponding increase in the level of SWLM might be due to the carotenoid contents of the leaf meal which are metabolized in the gut of the birds and hence converted to vitamin A. This phenomenon was also reported by Kuzmicky *et al.* (1968) and Onwudike and Oke (1978). The initial increase followed by a decrease in Haugh's unit beyond 5% level might be as a result of the reduction in feed intake recorded at a higher level of inclusion of the leaf meal. This is another pointer to the 5% level as the optimum and a corroboration of the work of Hutagalung (1981). Values obtained for Haugh's unit were slightly lower but in the vicinity of those found in literature (Alkali and Filkry, 1972; Ernst *et al*., 1975; Edwin and Maron, 1986). The albumen height has a correlative relationship with the Haugh's units pointing to the desirability of SWLM in laying hens diets. However, the SWLM dietary inclusion might not be beneficial to albumen height as an egg quality index at levels higher than 5%. The height of the albumen determines the Haugh's unit of the egg. The higher the height of the albumen, the greater the numerical value of Haugh's unit and the better the quality of the egg (Oluyemi and Roberts, 1979). The inclusion of SWLM might not however be implicated in the trends observed above as even the control diet gave the poorest albumen height and one of the lowest Haugh's unit values.

Conclusion: The utilization of SWLM in layers ration would probably not result in mortality as previously envisaged. SWLM is probably beneficial in terms of hen-day production, egg weight, egg shell thickness and yolk colour score. SWLM could be counted as a feed additive that improves egg yolk colouration to the consumers delight. It is recommended that an inclusion level of 5% of SWLM can be tolerated and would be nutritionally useful to laying hens. SWLM layer's diets have a probable beneficial effect on the albumen height and Haugh's unit and may therefore be useful in reducing the rate of deterioration in eggs' quality thereby increasing the egg's shelf life.

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