EFFECT OF DIETARY MAIZE SUBSTITUTION WITH SWEET POTATO MEAL ON PERFORMANCE OF LAYERS

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ABSTRACT

Two experiments were conducted with two sets of layers to determine the suitability of SPM in layers diet and monitor its effect on birds' performance at different stages of laying period. One hundred and eighty 22-week or 35-week old Shika Brown layers were used for the two experiments. In each experiment, the birds were weighed in equal groups of 12 and randomly distributed over 15 pens after which they were placed on 5 dietary treatments consisting graded levels of sweet potato meal (SPM). Each treatment consisting of 0, 10, 20, 30 and 40% SPM was replicated 3 times. Diets were iso-nitrogenous for each experiment. The differences in the two experiments lie in the energy and protein contents of the control diets. The experimental setup was a complete randomized design (CRD). Parameters measured and calculated include feed intake, body weight gain, final body weight, feed conversion ratio, mortality, hen-day egg production, cumulative egg production, yolk index, Haugh unit, shell thickness and egg weight. The experiment lasted for 12 and 18 weeks respectively. The result did not show significant effect on final body weight of birds, egg weight, feed conversion, haugh unit, yolk index, shell thickness and mortality. However, cumulative weight, cumulative egg production and hen-day egg production decreased linearly ($P<0.05$) with increase in dietary SPM, while feed intake, feed intake/egg, feed conversion ratio and feed cost/egg increased. In all cases except cumulative weight gain, similar results were produced by the control, 10, 20 and 30% SPM diets while the 40% SPM diet proved significantly inferior ($P<0.05$). Similar weight gains were recorded for birds on control, 10 and 20% SPM, while the weight gains of birds on 30 and 40% SPM diets were significantly lower. The performance indices thus showed that SPM should not be incorporated beyond 30% level for layers.

INTRODUCTION

The gross inadequacy of animal protein in the diets of most Nigerians is clearly recognized by nutritionists (Lowrie, 1985). The bulk of proteins consumed in most developing countries like Nigeria are of plant origin. While these sources lack certain essential amino acids, proteins of animal origin are more balanced and complete in amino acids. The need for animal protein sources therefore cannot be over-emphasized. Future meat production from cattle, sheep and goat is unlikely to meet the expected demand for animal protein in developing countries like Nigeria. These species of animals, according to Kroeski (1984) have strong biological constraints for a rapid growth in population as increasing their population takes a very long time. Besides, the traditional animal husbandry system characterized by low output cannot cope with the increasing demand for animal protein. A scientific approach at meeting this need has been directed to the expansion in the production of animals, such as poultry with the advantages of short generation intervals, faster rate of growth and other attributes of economic importance. However, high cost of feed has been the major hindrance to the growth of poultry industry in Nigeria. Feed constitutes between 60 – 80% of the production costs. The conventional energy feed sources of which maize is the most widely employed constitute between 40 – 65% of formulated poultry diets. Their prices are high and becoming more unpredictable. There is therefore the need to identify local feedstuffs that are affordable, available all year round, stable in price and with limited alternative uses to replace the conventional energy sources presently in use and being competed for by man. Sweet potato has been identified as one of the novel crops with great potential for energy. Sweet potatoes are utilized in many forms for livestock feeding. Results from various studies (Edmond and Ammerman, 1971; Gohl 1975; Job *et al.*, 1979 and Oboh, 1986) point to dehydrated sweet potato as being fairly suitable as partial replacement for maize in livestock diets. Comparative studies of sweet potato with other root and tuber crops (Gerpacio *et al*, 1974; Fetuga and Oluyemi, 1976; Lee *et al.*, 1977 and Cerning-Beroad and Dividich, 1977) showed that sweet potato could compare favourably as replacement for maize. Sweet potato is well adapted to the tropical climate and its production cost has been found to be lower than that of cereals. It is in view of these facts that sweet potato which at present has limited alternative uses, cheap and more stable price is being considered for evaluation in the feeding of layer chickens. The objectives of this study were to determine whether SPM as a source of energy can be a good substitute for maize in the diets of layers and its effect on egg quality.

MATERIALS AND METHODS

In two separate experiments, diets containing graded levels of SPM were fed to layers to determine the suitability of SPM in layers diets and monitor its effect on birds' performance at different stages of laying period. In the first experiment, one hundred and eighty 12-week old Shika Brown birds acquired from a grower study experiment were used for the young layer study. They were fed a common commercial layer diet for a week after which they were divided into equal groups of 12, with the groups adjusted to approximately equal weight (1811.33g/bird) and then distributed randomly into 15 pens before allotted to treatments. The treatments consisted of diets containing 0, 10, 20, 30 and 40% levels of SPM. Each treatment was replicated 3 times. The control diet was formulated to meet the recommended energy (2600kcalME/kg) and protein (16%CP) established for layers in Nigeria. The ingredients' composition as well as the calculated proximate chemical composition of the diets is shown in Table 1. The feeding trial was a complete randomized design (CRD). Feeds and water were given *ad-libitum*. The feeding trial lasted 12 weeks during which birds were weighed weekly and records of feed consumption, body weight, weight gain and mortality were kept for each treatment. Collection of eggs was done twice daily (11.00am and 6.00pm) and recorded. Eggs weights were taken and collections were pooled together to determine the hen-day egg production. Two freshly collected eggs of average weight for each group were broken to determine the shell thickness, yolk index and haugh unit as a measure of egg quality. The yolk index measurement was obtained by determining the yolk height and diameter and using the expression given by Card and Nesheim (1976). A total of one hundred and eighty birds acquired from the first experiment at 35 weeks of age were used for the second experiment. The setup of the experiment was the same as that of the first experiment, except that birds' weights were adjusted to approximately 1998.5g/bird before distribution into pens and energy and protein content of control diet were approximately 2600kcalME/kg and 16.5%CP respectively. The ingredients' composition as well as the calculated proximate chemical composition of the diets is shown in Table 2. Parameters similar to those taken in experiment 1 were also taken in this study. The feeding trial lasted 18 weeks. The data collected in the two experiments were summarized and then subjected to analysis of variance (ANOVA) and where statistical significances were observed, the means were compared using the DMRT according to SAS (1995).

RESULTS

The results of the first and second experiment are summarized in Table 3 and 4 respectively. In both experiments, the result showed that the final body weight, cumulative weight gain, hen-day egg production and cumulative egg production per bird decreased ($P<.05$) as the sweet potato level of diets increased while the daily feed intake/bird and feed cost/egg increased ($P<0.05$). However, there were no differences ($P>0.05$) across the treatments in the haugh unit, yolk index, shell thickness, number of eggs/kg feed, egg weight at 50% production or subsequently and mortality. Age at which 50% egg production was attained increased with increase in dietary SPM. While no difference was noticed in number of eggs/kg feed in the early period of lay, there was a decrease as dietary SPM increased in the older birds.

DISCUSSION

The observation that body weight, weight gain, age at 50% egg production and production from 23 – 35 weeks of the young layers decreased linearly while feed consumption, feed conversion and feed cost/egg increased linearly with increasing levels of dietary SPM is in similarity with the findings earlier reported for broilers, pullet chicks and growers. For the older layers, weight gain and egg production also decreased, while feed consumption, feed conversion and feed cost per egg increased with increasing levels of SPM. In both experiments egg weight, haugh unit, yolk index and shell thickness were not affected by dietary SPM. For the young layers, performance on 0, 10 and 20% dietary SPM were similar while 30% was the limit for the older layers, which suggests that the antinutritional factors militating against complete replacement of maize by SPM had greater effect on younger layers. These results prevailed in spite of the fact that egg production was higher for the older layers (62 – 65%) compared to 53.5 – 58.0 for pullets). No reason could be adduced for the lower than expected performance of the young layers as the experimental period covered the period during which they should have reached the peak of production (Vantsawa *et al.,* 2007). The result of the effect of SPM on egg production obtained here is similar to that of Sobamiwa (1988) who included SPM at levels of up to 20% and reported no adverse effect on production. Agwunobi (1995) recommended a level of up to 40% SPM while Ladokun and Tewe (2003) established a limit of 30% level of dietary SPM for layers.

Conclusion

It can be concluded from this study that up to 30% SPM can be included in laying chickens diets without adverse effect on egg production.

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Table 1. Compositions of Experimental Young Layers Diets (23 – 35 Wks)

	Levels of dietary SPM (%)				
Ingredients (%)	0	10	20	30	40
Maize	41.52	29.52	18.62	7.72	0.00
Sweet potato meal	0.00	10.00	20.00	30.00	40.00
Groundnut cake	15.00	17.00	17.90	18.80	20.00
Maize offals	20.00	20.00	20.00	20.00	16.52
Wheat offals	5.00	5.00	5.00	5.00	5.00
Palm kernel meal	9.00	9.00	9.00	9.00	9.00

Bone meal	4.58	4.58	4.58	4.58	4.58
Common salt	4.00	4.00	4.00	4.00	4.00
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15
Vit-min premix	0.25	0.25	0.25	0.25	0.25
Calculated Analysis	0.25	0.25	0.25	0.25	0.25
ME (Kcal/kg)					
Crude protein (%)	2610.00	2556.00	2511.00	2466.00	2451.00
Calcium (%)	16.01	16.02	16.01	16.00	16.03
Available Phosphorus (%)	3.15	3.18	3.20	3.22	3.25
Lysine (%)	1.00	1.00	1.00	1.00	1.00
Meth. +Cyst (%)	0.75	0.77	0.78	0.79	0.81

Layers' vitamin premix supplies the following per kg diet : Vit. A 10,000 IU, Vit.D3 2,000 IU,Vit.E 51 IU, Vit, K 2.34mg, Riboflavin 5.5mg, Vit.B_{12}10mg, Calcium pantothenate 10mg, Niacin 25mg, Choline chloride 250mg, Folic acid 1mg, Manganese 56mg, Zinc 50mg, Copper 10mg, Iron 20mg, Cobalt 1.25mg, Amprolium 125mg and Tetracycline 100mg.

Table 2. Compositions of Experimental Layers Diets (36 – 54 Wks)

Ingredients	Levels of dietary SPM (%)				
	0	10	20	30	40
Maize (%)	42.00	31.10	20.13	9.20	0.00
SŴP (%)	0.00	10.00	20.00	30.00	40.00
GNC (%)	17.50	18.40	19.37	20.30	21.32
Maize Offals(%)	20.00	20.00	20.00	20.00	18.18
PKC (%)	9.00	9.00	9.00	9.00	9.00
Bone meal (%)	3.50	3.50	3.50	3.50	3.50
Limestone (%)	7.00	7.00	7.00	7.00	7.00
Common salt (%)	0.25	0.25	0.25	0.25	0.25
Methionine (%)	0.20	0.20	0.20	0.20	0.20
Lysine (%)	0.30	0.30	0.30	0.30	0.30
Vit-min premix (%)	0.25	0.25	0.25	0.25	0.25
Calculated Analysis					
ME (Kcal/kg)	2599.00	2554.00	2508.00	2462.00	2433.00
CP (%)	16.50	16.50	16.50	16.50	16.50
Ca (%)	3.81	3.83	3.85	3.87	3.90
P (%)	0.80	0.80	0.80	0.80	0.80
Lysine (%)	0.79	0.80	0.81	0.82	0.84
Meth. +Cyst (%)	0.61	0.61	0.61	0.62	0.61
Feed cost(N/kg)	31.01	30.53	30.06	29.59	29.34

Layers' vitamin premix supplies the following per kg diet : Vit. A 10,000 IU, Vit.D3 2,000 IU,Vit.E 51 IU, Vit, K 2.34mg, Riboflavin 5.5mVit.B_{12}10mg, Calcium pantothenate 10mg, Niacin 25mgCholine chloride 250mg, Folic acid 1mg, Manganese 56mg, Zinc 50mg, Copper 10mg, Iron 20mgCobalt 1.25mg, Amprolium 125mg and Tetracycline 100mg.

Table 3. Response of Young Layers to graded Levels of Sweet Potato Meal in Layer Diets (23 - 35wks)

Parameters	Levels of dietary SPM (%)						
	0	10	20	30	40	SEM	Sig.
Initial BW (g/bird)	1780.50	1780.50	1780.50	1780.50	1780.50	-	-
Final BW (g/bird)	2041.11^{a}	2025.33^{a}	2003.66^{a}	1961.11^{b}	1955.33^{b}	15.25	*
Cum. wt gain(g/bird)	260.61^{a}	244.83^{a}	223.16^{a}	180.61^{b}	174.83^{b}	12.25	*
DFI (g/bird/day)	137.08^{b}	140.33^{ab}	141.04^{ab}	142.48^{a}	144.18^{a}	1.76	*
Feed intake/egg(g)	245.10^{b}	240.38^{b}	257.73^{b}	314.47^{a}	310.56^{a}	28.95	*
FCR (FI/egg wt)	4.63^{b}	4.49^{b}	5.09^{b}	7.25^{a}	7.67^{a}	0.68	*
Cum. egg prodn/bird	47.00^{ab}	49.00^{a}	46.00^{ab}	38.00^{b}	39.00^{b}	2.33	*
Hen-day egg prodn (%)	53.54^{a}	58.04^{a}	54.86^{a}	47.32^{b}	46.63^{b}	2.83	*
No. of eggs/kg feed	4.08	4.16	3.88	3.18	3.22	0.21	NS
Feed cost/egg (N)	7.78^{a}	7.46^{a}	8.54^{a}	11.84^{b}	12.59^{b}	0.96	*
Age at 50% prodn(days)	164^{b}	155^{c}	164^{b}	166^{b}	175^{a}	3.18	*
Egg wt at 50% prodn(g)	54	54	53	53	53	0.25	NS
Average egg weight(g)	56	56	57	56	56	0.18	NS
Haugh unit	80.44	79.75	78.97	78.31	77.03	0.81	NS
Yolk index	0.42	0.42	0.41	0.41	0.41	0.00	NS
Shell thickness (mm)	0.36	0.36	0.36	0.36	0.37	0.00	NS

Mortality (%)	0.00	0.00	2.78	0.00	0.00	1.19	NS

^{abc} Means within the same row with different superscripts are significantly different (P<0.05).
SEM: Standard error of the means, NS: Non-significant, *: Significant.

Table 4. Response of Layers to graded Levels of Sweet Potato Meal in Layer Diets (36- 54wks)

	Levels of dietary SPM (%)						
Parameters	0	10	20	30	40	SEM	Sig.
Initial BW (g/bird)	1998.50	1998.50	1998.50	1998.50	1998.50	-	-
Final BW (g/bird)	2016.67	2014.44	2011.11	2010.22	2008.33	1.34	NS
Cum. wt gain(g/bird)	18.17^{a}	15.94^{a}	12.61^{ab}	11.72^{b}	9.83^{b}	1.34	*
DFI (g/bird/day)	134.61^{b}	140.61^{ab}	138.91^{b}	137.74^{b}	145.22^{a}	1.46	*
FCR (FI/egg wt)	2.10	2.19	2.20	2.21	2.32	0.01	NS
Cum. Egg prodn/bird	82^{a}	83^{a}	80^{a}	77^{a}	67^{b}	3.00	*
Hen-day egg prodn(%)	65^{a}	65^{a}	63^{a}	62^{a}	53^{b}	2.17	*
Egg wt(g)	64.14	64.07	63.23	62.63	62.52	0.52	NS
Feed intake/egg(g)	208.69^{b}	214.68^{b}	219.26^{b}	226.11^{b}	280.54^{a}	13.53	*
No. of eggs/kg feed	4.84^{a}	4.68^{a}	4.57^{a}	4.44^{a}	3.66^{b}	0.21	*
Feed cost/egg(N)	6.47^{a}	6.55^{a}	6.59^{a}	6.69^{a}	8.22^{b}	0.03	*
Haugh unit	90.85	89.48	89.76	87.46	86.93	0.31	NS
Yolk index	0.43	0.43	0.43	0.43	0.43	0.43	NS
Shell thickness(mm)	0.37	0.37	0.37	0.37	0.37	0.37	NS
Mortality(%)	0.00	6.67	0.00	0.00	6.67	0.00	NS

^{ab} Means within the same row with different superscripts are significantly different (P<0.05).
SEM: Standard error of the means, NS: Non-significant.