Effect of Naturally Fermented Sweet Orange (*Citrus sinensis*) Fruit Peel Meal on Performance and Economics of Production of Growing Pullets

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Abstract

The study evaluated the nutritional potential of graded levels of 48-hour fermented sweet orange (Citrus sinensis) fruit peel meal in the diets of growing pullets. One hundred and twenty 8-week-old Nera black pullets were assigned in a completely randomized design to experimental diets in which SOFPM substituted maize at 0, 10, 20 and 30%. The study lasted 12 weeks. The diets were F_0, F_{10}, F_{20} and F_{30}. Daily feed intake were 65.15, 65.43, 65.61 and 65.09g/bird and was not significantly different ($p>0.05$). The corresponding daily weight gains were not significantly different ($p>0.05$) but were depressed with increase in SOFPM in the diet. FCR was significantly different ($p<0.05$). Substitution of maize with SOFPM significantly ($p<0.05$) reduced feed cost per 25kg, feed/cost bird and cost of production while it decreased efficiency of feed utilization for growth. Nevertheless, SOFPM is a potential feedstuff that could substitute maize at up to 20% in growing pullets' diet when fermented for 48 hours.

Keywords: Fermented, growing pullets, sweet orange fruit peel meal

Introduction

The problem of protein malnutrition is not new to our country as one of the developing nations of the world. Consequently, many see poultry as the solution to this problem. However, unlike their ruminant counterparts poultry depend on cereal and legume crops as sources of energy and protein, which form the largest proportion of their feed and feed cost. Therefore, current research efforts are targeted towards the use of cheaper and readily available feed resources which are mostly agro-industrial by-products such as sweet orange (*Citrus sinensis*) fruit peels that can possibly replace or substitute conventional feed resources such as maize. Sweet orange fruit peels (SOFP) are generated in large quantity in Nigeria and can be obtained at relatively no cost, as orange retailers and processors mostly discard them. It is comparable in energy and protein to maize (Oluremi *et al.,* 2006) and not prone to pest attack like maize when dry.

Objectives of the study

The general objective of this study was to evaluate the nutritional potential of sun-dried 48-hour fermented sweet orange (*Citrus sinensis*) fruit peel meal (SOFPM) in the diets of growing pullets. The specific objectives were to determine the effect of substitution of maize with sun-dried fermented SOFPM on the performance of growing pullets (8 to 20 weeks) and the economics of its utilization.

Materials and Methods

The feeding trial was conducted in the Poultry Unit of the Teaching and Research Farm of Kogi State University, Anyigba, Kogi State, Nigeria. Anyigba is located on longitude 07° 30' N and latitude 07° 09' E (Kogi State Agricultural Development Project 2010). Fresh sweet orange (*Citrus sinensis*) fruit peels of mixed varieties were collected from orange sellers and fermented for 48 hours as described by Oluremi *et al.* (2010). The fermented peels were afterwards spread on concrete floor and allowed to sun-dry until they became crispy. The sun dried fermented SOFP was later milled to obtain sweet orange fruit peel meal (SOFPM), which was then used to substitute dietary maize at 0, 10, 20 and 30%. Four diets each were formulated as shown in Table 1. Fermented SOFPM substituted maize at 0%, 10%, 20% and 30% in the experimental diets coded as F_0 (control), F_{10}, F_{20}, F_{30}.

Table 1: Gross composition of experimental diets for growing pullets fed fermented sweet orange fruit peel meal (kg/100kg)

Ingredients	48-hour fermentation			
	F_0	F_{10}	F_{20}	F_{30}
Maize	50.00	45.00	40.00	35.00
SOFPM[1]	0	5.00	10.00	15.00
FFSBM[2]	24.00	24.00	24.00	24.00
BDG[3]	20.00	20.00	20.00	20.00
Bone ash	2.00	2.00	2.00	2.00
Limestone	2.20	2.20	2.20	2.20
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Common salt	0.30	0.30	0.30	0.30
Vitamin/mineral premix	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Analyzed nutrients				
Dry matter (%)	90.16	90.03	90.11	90.09
Crude protein (%)	19.84	19.63	20.18	20.43
Crude fibre (%)	4.12	4.16	4.19	4.23
Ether extract (%)	3.77	3.86	3.87	3.84
Ash (%)	6.41	6.80	6.47	6.47
Nitrogen free extract (%)	56.02	55.58	55.20	55.13
Energy (kcal/kgME)[4]	3003.17	2986.39	2995.23	2999.50

[1]SOFPM=Sweet orange fruit peel meal, [2]FFSBM=Full fat soyabean meal

[3]BDG=Brewer's dried grain, kcal/kgME[4] = 37 x %CP + 81 x %EE + 35.5 x %NFE (Pauzenga, 1985)

The study was conducted in an open sided deep litter poultry house. The building was partitioned into individual units of about 1.8m x 1.2m dimension. One hundred and twenty Nera black eight-week old growers were used for the feeding trial that lasted for twelve (12) weeks. The birds were randomly allocated to the experimental diets in a Completely Randomized Design. Each diet group had 30 growers, of 3 replicates with each replicate having 10 birds. Standard management practices were observed. Feed and drinking water were given *ad libitum*.

Chemical analysis

The experimental diets were analyzed for their proximate composition according to AOAC (1995) procedures. Nitrogen free extract (NFE) was determined by difference. The gross energy (GE) values of the samples were determined using the adiabatic oxygen Bomb calorimetric technique and converted to metabolizable energy (ME) as outlined by Pauzenga (1985).

Feed cost/bird (₦) = Cost of feed consumed (₦) / Number of birds

Cost of feed/kg gain (₦) = Feed cost per bird x 1000(g)

Performance criteria (indices)

Feed intake was obtained by subtracting left-over feed from the quantity offered each week to obtain weekly feed intake per replicate. The average daily feed intake was obtained by dividing the weekly feed consumed by 7 days and by the number of birds/replicate. Birds were weighed at the beginning, fortnightly and at the end of the study. Weight gain was computed by subtracting initial weight from final weight. Average daily weight gain (ADG) was determined by dividing weight gain by the number of birds and the number of days of the feeding trial. Feed/gain ratio was computed by dividing the average daily feed consumed per bird with the average daily weight gain per bird.

Economic indices

Economic indices determined include; cost of producing 25kg of feed, cost saving due to SOFPM, feed cost per bird, cost of feed per kg weight gain and cost of production.

Total gain per bird (g)

Cost of production (₦) = Cost of chicks+operational cost +cost of consumed feed

Statistical analysis

All data collected were statistically analyzed using the Analysis of Variance (ANOVA) outlined in the MINITAB statistical software for completely randomized design (MINITAB 1991). Where significant effects of the experimental diets were obtained, means were separated using Fisher's least significant difference (LSD) as outlined by Steel and Torrie (1980).

Results and Discussion

Effect of fermented SOFPM on performance of growing pullets is shown in Table 2. Feed intake which varied from 65.09g to 65.61g/day^{-} was not significantly ($p>0.05$) affected by treatment. This indicates that substitution of maize by SOFPM in the diets did not depress the appetite, as all the diets were equally palatable and acceptable to the birds. Whereas, substitution of maize did not depress daily weight gain significantly ($p>0.05$), it was evident that weight gain tended to decline as percent replacement of maize increased. Observed weight gain is lower than the ranges of 8.65g to 12.90g for 12 to 21week-old growers reported by Tuleun *et al.* (2001) and 12.48

observed by Nworgu and Fasogbon

Nera black growing pullets aged 10 to 18 weeks. Feed conversion ratio significantly ($p<0.05$) became poorer from 8.54 to 12.03 as substitution level of maize by SOFPM increased. Observed values are within the range 7.18 to 12.68 obtained by Tuleun *et al.* (2001). This might be a reflection of the utilization of the diets by the birds. Final body weight of birds was depressed ($p<0.05$) with percent increase in substitution of maize. This is in agreement with report by Agu *et al.* (2010) that sweet orange peels reduced the final weight of broiler. The final weight seems to be a reflection of the suitability of the test diets for growing pullets. Only the weight of the birds on the control falls within 1289g to 1571g reported by Tuleun *et al.* (2001) but higher than 1237.74g reported by Ojedapo *et al.* (2008) for 20 week old Nera black pullets. No mortality was recorded. It may suggest that 48-hour fermented SOFPM was not toxic to growing pullets.

Table 2: Effect of fermented sweet orange (*citrus sinensis*) fruit peel meal on performance of growing pullets

Performance indices	Experimental diets				SEM
	F_0	F_{10}	F_{20}	F_{30}	
Initial weight (g)	705.00^{a}	655.00^{b}	645.00^{b}	626.67^{b}	9.63
Final weight (g)	1343.30^{a}	1275.00^{a}	1170.00^{ab}	1088.30^{b}	27.9
Feed intake (g)	65.15	65.43	65.61	65.09	0.43^{ns}
Daily weight gain (g)	7.60	7.36	6.25	5.49	0.87^{ns}
FCR	8.54^{a}	8.89^{ab}	10.56^{ab}	12.03^{b}	0.62
Mortality (%)	0	0	0	0	-

Means on the same row with different superscripts are significantly different ($p< 0.05$)

^{ns} = Not significant ($p > 0.05$)

SEM = Standard error of means

The economics of production of growing pullets fed 48-hour fermented SOFPM is presented in Table 3. Substitution of maize with SOFPM resulted in significant ($p<0.05$) reductions in feed cost per 25kg and feed cost/bird. This could be because the SOFP used was obtained at no cost relative to maize. Feed cost/kg gain of birds on SOFPM based diets is comparable to the control. However, the highest cost was recorded with birds on diet F_{30}. This is an indication of declined efficiency in the utilization of the dietary nutrients in the SOFPM-based diets for body growth. Cost of production of birds declined significantly ($p<0.05$) as percent substitution level of maize increased. Thus, indicating that maize substitution by SOFPM in growing pullet diets is capable of reducing cost of production but at the expense of body growth. This is because dietary SOFPM was cheaper compared with maize. Consequently, the cost of the SOFPM-based diets was lower than the control.

Table 3: **Economics of feeding fermented sweet orange (*citrus sinensis*) fruit peel meal to growing pullets**

Economic indices	Experimental diets				SEM
	F_0	F_{10}	F_{20}	F_{30}	
Feed cost (₦/25kg)	1992.75[a]	1871.50[b]	1800.25[c]	1729.00[d]	0.00
Cost saving (₦/25kg)	-	121.25	192.50	263.75	-
[1]Operating cost(₦/b) (8-20 weeks)	45.14	45.14	45.14	45.14	-
Feed cost /kg gain (₦/kg)	684.45	672.25	760.58	832.22	44.45[ns]
Feed cost/bird (₦) (8-20 weeks)	436.17[a]	411.40[b]	396.82[c]	378.10[d]	2.71
Cost of production (8-20weeks) (₦/bird)	681.31[a]	656.54[b]	641.96[c]	623.24[d]	12.25
Cost saving (8-20weeks) (₦/bird)	-	29.95	47.93	67.97	-
[2]Operating cost (₦/b) (0-20 weeks)	139.80	139.80	139.80	139.80	-
Cost of production (0-20weeks) (₦/bird)	944.03[a]	914.08[ab]	896.10[bc]	876.06[c]	5.91
Cost saving (0-20weeks) (₦/bird)	-	24.77	39.35	58.07	-

Means on the same row with different superscripts are significantly different ($p < 0.05$)
[ns] = Not significant ($p > 0.05$)
SEM = Standard error of means
[1]Operating cost computed from cost of energy, vaccination, medication and detergents.
[2]Operating cost computed from operating cost during chick phase + cost of detergents, medication, vaccination and antiseptics during the grower phase

Conclusion

Substitution of maize with 48-hour fermented SOFPM above 20% significantly reduced the live weight of growing pullets, while at the same time resulted in decreases in feed cost and cost of production.

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