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RESEARCH ARTICLE

Productive and Haematological Performance of Growing Pullets Fed Fermented Sweet Orange (*Citrus sinensis*) Fruit Peel Meal Based Diets

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ABSTRACT

The 12-week feeding trial was conducted to evaluate the productive and haematological performance of growing pullets fed diets in which fermented sweet orange fruit peel meal (SOFPM) substituted maize at 0%, 10%, 20% and 30% in the experimental diets coded $24F_0$ (control), $24F_{10}$, $24F_{20}$, and $24F_{30}$ respectively. One hundred and twenty growing pullets were assigned to the diets in a completely randomized design, with each treatment comprising of 3 replicates of 10 birds per replicate. Treatment effect on feed intake was not significant and varied from 64.85g to 65.53g/bird at between 8 to 20 weeks of age. Weight gain was depressed linearly with increase in SOFPM, it varied from 7.60g to 5.65g at between 8 to 20 weeks of age. FCR significantly worsened from 8.54 to 10.86 as the substitution level of maize with SOFPM increased. Final body weight of birds was depressed with percent increase of SOFPM. PCV, Hb and RBC values, though within reference ranges for healthy birds, were depressed as maize substitution increased. Observed WBC, MCV, MCH and MCHC values of the treatment groups were statistically similar to the control. The economic implication of feeding fermented SOFPM indicated that feed cost/ 25kg and feed cost/bird significantly reduced linearly from ₦1992.75 to ₦1721.50 and ₦436.17 to ₦407.19, respectively. Feed cost/kg gain was not significantly affected by diet; however, it increased from ₦684.45 to ₦804.54 with inclusion of SOFPM. Poultry farmers may substitute dietary maize with SOFPM fermented for 24 hours in growing pullet diets at not more than 10% for optimum performance.

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INTRODUCTION

Animal protein malnutrition is a major challenge especially in many developing nations. One of the culprits is poverty of the teeming populace which has made many households unable to afford livestock products such as egg. The high cost of livestock products is in effect, the direct result of the high cost incurred in livestock production, especially of monogastric animals, such as poultry. Nutrition tackles the problem of supplying optimum nutrients required by animal at an economic level (Aduku, 2004). Hence nutrition is the most crucial aspect of livestock production especially poultry. Consequently, the pre-occupation of animal nutritionists over the years is to reduce production cost through reducing feed cost thereby provide cheaper livestock products to the populace. Consequently, many research efforts are directed towards the use of cheaper and readily available feed resources that can possibly substitute conventional feed resources such as maize, which is mostly used as the major energy source in poultry feeds. Sweet orange fruit peel is one of the by-products of sweet orange fruit processing. It is found in abundance in Nigeria which is the highest producer of citrus in Africa. However, if this is not harnessed for productive uses such as poultry feeding, it may constitute environmental menace. Agu *et al.* (2010) observed that maize could be replaced by sun-dried orange rind (peel) in broiler starter diet at 20% for optimal performance and nutrient utilization. However, Gohl (1981) had reported the presence of substances toxic to swine and poultry in dried citrus pulp that included seeds and that the high fibre content restricted its use in swine and poultry rations. Due to the presence of anti-nutrients in a number of alternative feedstuffs, various methods of processing have been employed to improve the utilization of their nutrients (Adejinmi *et al*., 2007; Ojokoh, 2007; Obikaonu and Udedibie, 2007; Salami and Odunsi, 2003).

Objectives of the study

The general objective of this study was to evaluate the nutritional potential of sun-dried 24 hour fermented sweet orange (*Citrus sinensis*) fruit peel meal (SOFPM) in the diets of growing pullets. While the specific objectives were to determine the productive and haematological performance of growing pullets fed SOFPM fermented for 24 hours and the economic implication.

MATERIALS AND METHODS

The feeding trial was conducted in the Poultry Section of the Teaching and Research Farm of Kogi State University, Anyigba, Nigeria. The experimental site is located on longitude 07^0 06'N and latitude $06^0$43'E (Amhakhain, 2010). Fresh sweet orange (*Citrus sinensis*) fruit peels of mixed varieties were collected from orange sellers from different locations and fermented for 24 hours under shade by tying in synthetic grains bag. The fermented peels were afterwards spread separately on concrete floor and allowed to sun-dry until they became brittle and then milled before incorporation in the diets. The fermented SOFPM was then used to substitute dietary maize at 0, 10, 20 and 30% (Oyewole *et al.*, 2012).

Samples of the experimental diets were analyzed for their proximate composition according to AOAC (1995).The gross energy (GE) values of the diets were determined using the adiabatic oxygen Bomb calorimetric technique and converted to metabolizable energy (ME) as outlined by Pauzenga (1985). Four diets were formulated for the feeding trial as shown in Table 1. The fermented SOFPM substituted maize at 0%, 10%, 20% and 30% in the experimental diets formulated coded as $24F_0$ (control), $24F_{10}$, $24F_{20}$, and $24F_{30}$ respectively.

Animals and management

One hundred and twenty Nera black 8-week old growing pullets were used for the 12-week feeding trial. Fowl typhoid vaccine was administered at nine weeks. Newcastle disease vaccine Lasota was administered at eleven weeks and Fowl pox vaccine at thirteen weeks of age. Other standard routine management practices were observed. This includes monthly administration of coccidiostat and antibiotics, and the use of vitalyte a day before through to a day after debeaking, vaccination, deworming and blood collection. Feed and drinking water were given *ad libitum*. The birds were assigned to the experimental diets for growers in a completely randomized design; each diet group had 30 growers of 3 replicates. The birds were weighed at the start of the study, fortnightly and at the end of the study. Performance indices observed were average daily weight gain (ADG), average daily feed intake (ADFI), feed/gain ratio and mortality. Blood samples were collected from the wing vein at the end of the feeding trial from two birds per replicate and six birds per treatment. Haematology specimens were collected into EDTA contained tubes. The haematology indices determined were packed cell volume (PCV) using Wintrobe's microhaematocrit method (Dacie and Lewis, 1991), red blood cell (RBC) and white blood cell (WBC) using the improved Neubaer haemocytometer (Jain, 1986). Haemoglobin (Hb) was by cyanomethaemoglobin method (Kelly, 1979), while mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were computed as outlined by Jain (1986).

Economic indices determined include; cost of producing 25kg of feed, feed cost saving due to SOFPM, feed cost per bird and cost of feed/kg weight gain. Cost of feed was determined using prevailing market prices of ingredients, while costs of transportation and handling were allocated to SOFPM. Cost of producing 100kg of each feed was estimated and then used to compute cost of feed/bird, cost of kg feed and cost of feed/kg weight gain.

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 existed, means were separated using Fisher's least significant difference (LSD) using Minitab statistical software (Minitab, 1991).

RESULTS AND DISCUSSION

The performance of growing pullets is presented in Table 2. Treatment effect on feed intake was not significant ($p>0.05$). Feed intake varied from 64.85g to 65.53g/bird, an indication that all the diets were equally palatable and acceptable to the birds. Therefore, substitution of maize by SOFPM in the diets did not depress the appetite of the birds on the various diets. Weight gain was depressed ($p>0.05$) linearly with increase in SOFPM, it varied from 7.60g to 5.65g. 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 12.48g to 13.21g observed by Nworgu and Fasogbon (2007) with Nera black growing pullets aged 10 to 18 weeks. FCR significantly ($p<0.05$) worsened from 8.54 to 10.86 as the substitution level of maize with SOFPM increased. Observed values are within the range 7.18 to 12.68 obtained by Tuleun *et al.* (2001). Result indicates that the birds on the control utilized feed taken comparatively better. Final body weight of birds was depressed ($p<0.05$) with percent increase in substitution of maize. This is in consonance with the reports by Oluremi *et al.* (2006) and Agu *et al*. (2010) that sweet orange peels reduced the final weight of broiler. Oyewole *et al.* (2012) had also reported that SOFPM fermented for 48 hours resulted in the reduction of live weight of growing pullets (8 to 20 weeks of age). Only the weight of the birds on the control fell 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. The absence of mortality might be

Table 1: Gross Composition of Experimental Diets for Growing Pullet (kg/100kg)

Ingredients	24 hours fermentation			
	CD(F_0)	$24F_{10}$	$24F_{20}$	$24F_{30}$
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[4]	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Analyzed nutrients				
Dry matter (%)	90.16	90.08	90.05	90.13
Crude protein (%)	19.84	19.33	19.71	20.42
Crude fibre (%)	4.12	4.10	4.07	4.14
Ether extract (%)	3.77	3.94	3.94	3.95
Ash (%)	6.41	6.88	6.76	6.58
Nitrogen free extract (%)	56.02	55.84	55.38	55.06
Energy (MJ/kgME)	12.57	12.52	12.54	12.57

[1]SOFPM=Sweet orange fruit peel meal, [2]FFSBM=Full fat soyabean meal; [3]BDG=Brewer's dried grain; Biomix[(R)] (8-20 weeks) supply /kg of feed; Vitamin A 800 IU, Vitamin D3 150IU, Vitamin E 0.7mg, Vitamin K3 0.15mg, Vitamin B1 0.2mg, Vitamin B2 0.25mg, Niacin 1.5mg, Pantothenic acid 0.55mg, Vitamin B6 0.2mg, Vitamin B12 0.001mg, Folic acid 0.005mg, Biotin $H_2$0.025mg, Choline chloride 17.5mg, Cobalt 0.02mg, Manganese 4.0mg, Selenium 0.02mg, Zinc 3.1mg, Antioxidant 0.125mg.

Table 2: Effect of 24-Hour Fermented Sweet Orange (*Citrus sinensis*) Fruit Peel Meal on Performance of Growing Pullets

Performance indices	Experimental diets				SEM
	CD(F_0)	$24F_{10}$	$24F_{20}$	$24F_{30}$	
Initial weight (g)	705.00^a	668.33^b	636.67^c	623.33^c	4.84
Final weight (g)	1343.3^a	1258.3^a	1123.3^b	1098.3^b	22.00
Feed intake (g)	65.15	64.85	65.53	65.52	0.64 ^{NS}
Daily weight gain (g)	7.60	7.02	6.05	5.65	0.82 ^{NS}
FCR	8.54^a	9.23^a	10.23^b	10.86^b	11.23
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

Table 3: Effect of 24-Hour Fermented Sweet Orange (*Citrus sinensis*) Fruit Peel Meal on Haematological Characteristics of Growing Pullets

Haematology indices	Experimental diets				SEM
	CD(F_0)	$24F_{10}$	$24F_{20}$	$24F_{30}$	
PCV (%)	36.99^a	35.11^{ab}	34.62^{ab}	33.27^b	0.62
Hb (g/dl)	12.21^a	11.70^{ab}	11.53^{ab}	11.09^b	0.21
RBC (x10^6/ µl)	5.12^a	4.84^a	4.80^a	4.03^b	0.08
WBC (x10^3/ µl)	7.72	7.40	7.61	7.43	0.14 ^{NS}
MCV (fl)	72.08	73.09	74.22	84.19	3.77 ^{NS}
MCH (pg)	23.88	24.34	24.74	26.92	1.11 ^{NS}
MCHC (%)	32.76	33.88	33.30	33.35	0.30 ^{NS}

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

an indication that the growing pullets were able to tolerate SOFPM fermented for 24 hours.

The effect of the experimental diets on the haematological characteristics of growing pullets is shown in Table 3. PCV values tended to decline (P<0.05) as maize substitution by fermented SOFPM increased in the diets. Observed values are within the reference ranges of 24.90% to 45.20% for healthy birds reported by Mitruka and Rawnsley (1977). Substitution of maize by SOFPM depressed (P<0.05) Hb values of experimental birds below that of the control. However, observed Hb values are within the range of 7.40g/dl to 13.10g/dl for healthy birds (Mitruka and Rawnsley, 1977). Observed RBC values were significantly depressed (P<0.05) linearly with increase in SOFPM. However, they were comparable to the range of 4.35x10^6µl to 5.12x10^6µl reported by Oyewole *et al.* (2012). The observed WBC, MCV, MCH and MCHC values of the treatment groups were statistically similar. Observed values of haematology indices in this study might therefore indicate that substitution of maize by fermented SOFPM did somewhat suppress haemopoietic tissue activity. However, the nutritional adequacy of the experimental diets was maintained despite the substitution of maize with SOFPM in the test diets. This is because the observed haematoloical indices fell within reference ranges reported for healthy birds. Consequently, the animals were not anemic. This may suggest that utilization of SOFPM in growing pullets diets did not affect nutrient availability in the diets such as to compromise protein and iron intake thereby causing anemia.

Table 4: Economics of Feeding 24-Hour Fermented Sweet orange (*Citrus sinensis*) Fruit Peel Meal to Growing Pullets

Economic indices	Experimental diets				SEM
	CD(F_0)	$24F_{10}$	$24F_{20}$	$24F_{30}$	
Feed cost (₦/25kg)	1992.75^a	1869.00^b	1795.25^c	1721.50^d	67.81
Cost saving (₦/25kg)	-	123.75	197.50	271.25	-
[1]Operating cost (₦/bird)	45.14	45.14	45.14	45.14	-
Feed cost /kg gain (₦/kg)	684.45	690.31	779.74	804.54	27.38^{NS}
Feed cost/bird (₦)	436.17^a	407.19^b	395.27^b	378.94^c	2.88
Cost of production (₦/bird)	681.3^a	652.33^b	640.40^c	624.08^d	12.07

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.

The economic implication of feeding fermented SOFPM is shown in Tables 4. Feed cost/25kg significantly declined (P<0.05) linearly from ₦1992.75 to ₦1721.50 with increase in the substitution of maize. Feed cost/bird declined (P<0.05) from ₦436.17 to ₦407.19. Feed cost/kg gain was not significantly affected (p>0.05) by diet however, it increased from ₦684.45 to ₦804.54 with increase in substitution of maize. Cost of production/bird was significantly reduced (P<0.05) across the treatment groups as SOFPM substitution for maize increased. It declined from ₦681.31 to ₦624.08. Obviously, substitution of maize with SOFPM resulted in reduction in feed cost/25kg and feed cost/bird. This could be because the sweet orange fruit peels were not bought, although transportation cost for collection and other handling cost were computed. Feed cost/kg gain of birds on SOFPM based diets indicated that efficiency in the utilization of the dietary nutrients in the SOFPM-based diets for body growth was superior with maize despite the achievement of reduced cost of production with SOFPM.

Conclusion and Recommendation

Inclusion of SOFPM fermented for 24 hours at above 10% resulted in reduction in the growth performance of growing pullets. However, haematological characteristics of growing pullets indicated SOFPM did not cause any harm to the physiology process controlling these blood characteristics. In addition, the inclusion of SOFPM in the diets of growers resulted in gradual reduction in feed cost/25kg, feed cost/bird and cost of production of growers at the expense of body growth. Based on the findings in this study, it is recommended that poultry farmers may substitute dietary maize with SOFPM fermented for 24 hours in growing pullet diets at not more than 10% for optimum performance.

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