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RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

Effect of feeding sun-dried sweet orange (C*itrus sinensis)* fruit peel on pullet chick performance

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Abstract

Four hundred (400) Bovan black pullet chicks were used to evaluate the effect of partial replacement of maize with sun-dried sweet orange (*Citrus sinensis)* fruit peel meal (SOPM). The birds were randomly allotted to five treatment groups of 80 birds and four replicates of 20 birds each. SOPM was used to replace maize at 0, 10, 20, 30 and 40% for diets T_0, T_1, T_2, T_3 and T_4 respectively. The birds were fed *ad libitum* for a period of 6 weeks while performance characteristics, nutrient utilization and economics of production were measured. SOPM in the diet depressed significantly ($P<0.01$) the mean feed intake, body weight gain, feed conversion ratio, protein efficiency ratio and final body weight of chicks. The digestibility of nutrients was adversely affected ($P<0.01$) by the inclusion of SOPM in the diet. The cost per kg of compounded feed reduced significantly ($P<0.01$) with increasing level of SOPM in the diet. Mortality was not affected. While the proximate composition of SOPM would suggest a potential for use as poultry feed ingredient, the results of this study shows that it is not a suitable alternative to maize in the form it was used. Other methods of processing SOPM should be investigated to enhance its nutritional value in the diet of pullet chicks.

Keywords: Sweet orange fruit peel; pullet chicks; performance and nutrient utilization

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Introduction

The state of nutrition of the Nigerian populace is, marked by, protein intake that is inadequate, both in quality and quantity (Oluyemi and Roberts, 2000; Taiwo et al., 2005). The level of animal protein consumption in Nigeria was estimated at 8g per caput, about 29 percent of the 28 g minimum, recommended by the NRC (Obioha, 1992). Dafwang (1990) suggested that the expansion of the Nigerian poultry industry holds the greatest promise of bridging this animal protein gap in the country within the shortest possible time. Chickens are highly prolific and efficient converters of feed (Nworgu et al., 1999). Emenalom (2004) observed that the high cost and poor quality of finished feed have caused serious economic losses in the poultry industry. Efforts to improve on this situation should include harnessing the potentials of relatively inexpensive, unconventional materials which are not competed for by man as replacement for the more expensive ingredients. Some agro industrial by products such as maize offal (Uko et al., 1990), cocoa husk meal (Sobamiwa and Akinwale, 1992), cassava root meal/brewery yeast slurry (Tuleun et al., 2005) and citrus peel (Oluremi et al., 2006) have been used to replace cereal grains in poultry diets.

Sweet orange (*Citrus sinensis*) by products such as peels and pulps are abundant in Nigeria especially in the dry season which is the main harvest period. Oluremi et al. (2007) reported that heaps of the peels of sweet orange are usually noticed on streets and along major roads in Nigeria because Government and orange retailers have no strategic program for its disposal thus becoming an environmental problem. Sweet orange

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rind is comparable in energy and protein with maize (Oluremi et al., 2006). Studies are still in progress to elucidate the usefulness and profitability of the citrus peel as an animal feed ingredient; available reports include studies by Yang and Chang (1984, 1985), Jong-Kyu et al. (1996), Oluremi et al. (2005), Hon et al. (2009), Agu et al. (2010), Ojabo et al. (2012) and Ojabo et al. (2013).

The objective of this study was to determine the performance and nutrient utilization of pullet chicks fed diets containing sun dried sweet orange (C*itrus sinensis)* fruit peel meal.

Materials and Methods

The study was conducted at the Livestock unit of the Teaching and Research Farm, University of Agriculture, Makurdi (07^0 $41^/$, 08^0 $37^/$) Nigeria. The test ingredient, fresh sweet orange (*Citrus sinensis*) fruit peel were collected daily from orange retail sellers in Wadata market, within Makurdi metropolis. To prevent fermentation and other forms of deterioration, the peels were immediately sun-dried on concrete platforms, until crisp. It was then milled to obtain the sweet orange peel meal, which was mixed with other feed ingredients to produce the experimental diets. A sample of the peels was analysed for its proximate constituents (Table 1) using standard method recommended by AOAC (2002). Five experimental diets, designated as T_0, T_{10}, T_{20}, T_{30} and T_{40} were compounded containing similar crude protein, energy and other nutrients, but 0, 10, 20, 30 and 40 % sweet orange peel meal (SOPM) respectively (Table 2).

Four hundred Bovan black chicks were used in a feeding trial, which lasted six weeks. The experimental design was a completely randomized design (CRD). The chicks were divided into 20 groups. Each group of 20 chicks constituted a replicate and four replicates were randomly allotted to each of 5 treatments. They were raised on deep litter of wood shavings. Feed and drinking water were provided *ad libitum* and standard routine management practices were followed. Feed intake, body weight, weight gain, feed conversion ratio (FCR), protein intake, protein efficiency ratio (PER) and mortality rate were the response criteria used in assessing chick performance.

Determination of nutrient digestibility was done at the 6^{th} week of the experiment. 5 chicks per replicate were randomly selected from each dietary group and transferred into metabolism cages. The first 2 days were allowed for adaptation of birds and the respective diets were offered liberally. Daily feed intake and daily faecal were recorded for 5 days. The droppings were collected per replicate once daily at 0800 h, and dried in an oven at 105°C to constant weight. Samples of experimental diets and faeces were analysed for their proximate composition using standard methods (AOAC, 2002). The digestibility coefficient was calculated using the formula

Apparent Digestibility = (% Nutrient in Feed x F1) - (% Nutrient in faeces x FO) x 100 / % Nutrient in feed x F1

Where

FI = Feed intake

FO = Fecal output

The cost of the ingredients at the time of purchase was used to calculate the unit cost of feed. Total cost of production was calculated as the summation of the feed cost, estimated cost of birds and operational cost.

Data collected were subjected to analysis of variance (ANOVA) using the Minitab Statistical Software Release 14.2 (2005). Where significant effects of the experimental diets were obtained, means were separated by the least significance different (LSD) procedure outlined by Steel and Torrie (1980).

Results and Discussion

The proximate composition of dried SOPM (*Citrus sinensis*) (Table 1) showed it has crude protein (CP) and metabolizable energy (ME) contents of 7.40% and 3674.44 kcalME/kg respectively. The CP in the peels were lower than 9.25% CP in maize (Tuleun et al., 2005), while crude fibre (CF) of 13.5% in the peels was higher than 2.20% CF reported for maize (Tuleun et al., 2005). The CF value obtained in this study agreed with CF content of 13.66-14.99% obtained by Oluremi et al. (2007). The high CF in the peel may reduce its feeding value compared to conventional dietary maize in poultry nutrition; however the energy contents of both SOPM and maize were comparable. The CP, CF and ME of 7.50%, 12.50% and 3674.44 kcal ME/kg respectively of peels used in this study were similar to 7.0% CP, 12.50% CF and ME of 3420 kcal/kg obtained for orange peels by Ashbell and Weinbegger (1999) in Israel.

The effect of experimental diets on growth performance and profitability is shown in Table 3. The mean final body weights and feed intake of the birds in the dietary groups decreased with increased levels of

Table 1: Nutrient composition of sweet orange (*Citrus Sinensis*) fruit peel meal

Nutrients %	Feedstuffs	
	SOPM[1]	Maize[2]
Dry matter	86.20	86.50
Crude protein	7.40	9.00
Ash	8.19	1.30
Ether extract	7.19	4.00
Crude fibre	13.50	2.70
NFE	62.65	83.00
[3]ME (Kcal/kg)	3674.44	3432.00

[1]Laboratory analysis; [2]Aduku (1992); [3]Metabolizable energy as determined using Carpenter and Clegg (1956)

Table 2: Percent composition of pullet chicks' diets

Ingredients	T_0	T_1	T_2	T_3	T4
Maize	50.00	45.00	40.00	35.00	30.00
Sweet orange peel	0	5.00	10.00	15.00	20.00
Full fat soya bean	31.00	31.00	31.00	31.00	31.00
Brewers dried grain	15.00	15.00	15.00	15.00	15.00
Limestone	1.00	1.00	1.00	1.00	1.00
Bone meal	2.25	2.25	2.25	2.25	2.25
Premix**	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00
Determined Analysis					
Dry matter	88.63	88.68	88.50	88.54	88.45
Crude protein	21.98	22.25	21.28	21.48	21.93
Crude fibre	4.94	4.82	5.01	5.06	4.87
Crude fat	3.94	3.92	4.05	3.98	3.99
Ash	8.53	8.58	8.31	8.39	8.66
Nitrogen-free extract	60.63	60.45	61.38	61.10	60.55
Gross energy (Kcal/kg)	4380.00	4366.00	4425.00	4434.00	4393.00
ME (Kcal/kg)	2753.46	2744.71	2781.73	2787.36	2761.67

Metabolizable energy = 0.860 + 0.629 (GE – 0.78CF Cambell (1986)

0, 10, 20, 30 and 40% sweet orange for diets T_0, T_1, T_2, T_3 and T_4 respectively; *1 kg of premix supplied the following Vitamin A (Stabilized) 6,670,000 I.U, Vitamin D_3 (Stabilized) 150,000 I.U; vitamin E (Stabilized) 33,401 I.U., Menarandone sodium bisulfate 1,349mg, Vitamin B_{12} 3,000mg, Vitamin B_6 20,000mg, Nicotinic acid 1,467mg, Calcium d-pantothenate 4,000mg, Vitamin B_{12} 8mg, Choline chloride 1,3340mg, D.O.T. (3,5, dinitro-orthotoluamide) 66,700mg, Manganese 533mg, Iron 33,3340mg, Zinc 26,670mg, Copper, 1,600mg, Iodine 93mg, Cobalt 134mg, Selenium 34mg.

Table 3: Performance and economic benefits of chicks fed sweet orange (*citrus sinensis)* fruit peel meal based diets

Parameters	Experimental Diets					
	T_0	T_1	T_2	T_3	T_4	SEM
Initial body weight (g/bird)	97.75	98.34	97.75	98.63	97.75	0.81^{ns}
Final body weight (g/bird)	438.88^{a}	366.88^{b}	392.63^{b}	312.00^{c}	322.50^{c}	4.86^{**}
Daily body weight gain (g/bird)	8.27^{a}	6.45^{b}	5.83^{bc}	5.26^{b}	5.20^{c}	0.14^{**}
Daily feed intake (g/bird)	24.76^{a}	22.09^{bc}	22.53^{b}	21.07^{c}	21.66^{bc}	0.17^{**}
Daily protein intake (g/bird)	5.44^{a}	4.93^{b}	4.79^{bc}	4.52^{c}	4.75^{bc}	0.04^{**}
Feed conversion ratio	3.02^{a}	3.79^{b}	4.14^{bc}	4.30^{c}	4.63^{bc}	0.10^{**}
Protein efficiency ratio	1.53^{a}	1.31^{b}	1.22^{b}	1.16^{b}	1.18^{b}	0.22^{**}
Mortality (%)	0	0.50	0	0.50	0.25	0.10^{ns}
Average cost of day old chick***	170.00	170.00	170.00	170.00	170.00	-
Feed cost/kg***	53.28	51.63	49.03	46.43	43.83	-
Feed cost/bird***	54.88^{a}	47.90^{b}	47.00^{b}	41.09^{c}	39.88^{c}	0.38^{**}
Operational cost***	56.00	56.00	56.00	56.00	56.00	-
Total cost/bird***	280.87^{a}	273.90^{b}	273.00^{b}	267.09^{c}	265.88^{c}	0.38^{**}

0, 10, 20, 30 and 40% sweet orange for diets T_0, T_1, T_2, T_3 and T_4 respectively; ** (P<0.01), ns Not significant (P>0.05); abc Means in the same row with different superscripts are significantly different. SEM = standard error of mean ***: Unit of cost is (N) = Naira (Nigerian Currency), 1 USD = N 164

Table 4: Nutrient digestibility of chicks fed sweet orange (C*itrus sinensis)* fruit peel meal based diets

Nutrients	Experimental Diets					
	T_0	T_1	T_2	T_3	T_4	SEM
Dry matter	59.75^{a}	58.45^{ab}	55.09^{bc}	51.56^{c}	50.02^{c}	0.66^{**}
Crude protein	57.23^{a}	58.11^{a}	53.11^{b}	48.65^{c}	48.85^{c}	0.68^{**}
Ether extract	68.52^{a}	67.56^{ab}	65.18^{b}	63.93^{b}	62.75^{b}	0.39^{**}
Nitrogen-free extract	68.24^{a}	66.53^{ab}	64.53^{bc}	62.72^{bc}	61.00^{c}	0.61^{**}
Metabolizable energy	71.62^{a}	70.59^{ab}	68.66^{b}	67.23^{bc}	66.17^{c}	0.39^{**}

0, 10, 20, 30 and 40% sweet orange for diets T_0, T_1, T_2, T_3 and T_4 respectively; *(P<0.05), ** (P<0.01); a,b,cMeans in the same row with different superscripts are significantly different; SEM = Standard error of mean.

SOPM in the diets. Sweet orange fruit peel contains oil which is acidic and confers on it a sharp taste which may have been responsible for the depression in the quantity of feed consumed by chicks on SOPM test groups (Oluremi et al., 2007). The depressed feed intake by chicks feeding on SOPM based diet could

also be attributed to a decrease in ration palatability due to residual anti-nutritional substances (such as oxalate, saponins, tannins, and phytates) in the peels (Abbas et al., 2013). Yang and Chung (1985) reported that feed intake tended to fall as the level of citrus increased in the diet of broiler. Their report recommended an optimal inclusion level of 5 percent citrus peel meal in broiler diets. Effect of dietary treatment on BWG which is a measure of the growth rate of chicks was highly significant ($P<0.01$). The birds in T_4 had the lowest daily BWG compared to control ($P<0.01$) as shown in Table 3. This could be attributed to the higher feed intake by the birds in the control group and this made nutrients, especially protein more available for faster growth for birds served the control diet. Serres (1999) and Gohl (1981) reported that citrus meal at a level of 10 percent and above in chicken diets reduced growth rate possibly because of anti-nutritional factors in sweet orange peel. The observation that weight gain in this study which fell as the level of SOPM increased in the diets agrees with their report.

The FCR in the treated groups was significantly lower compared to the control. It can be seen that FCR declined as the percent maize substitution with SOPM increased from 0 to 40%. This means that increasing the percentage levels of SOPM in the diets possibly impaired nutrient utilization in the chicks. This result agreed with that of Serres (1999) who reported that citrus level between 10 and 15% inclusion depressed feed conversion in chickens.

The protein efficiency ratio (PER) was significantly higher ($P<0.05$) in treated groups compared to control. Birds on the control diet were able to convert diet protein into flesh (growth) than birds provided with SOPM based diets. This shows that maize has a higher protein quality than SOPM. This is much so because the PER for birds fed SOPM based diets were similar irrespective of the inclusion rate. The rate of mortality among experimental birds in this study was less than the 5 percent regarded as normal for pullet chicks (Oluyemi and Roberts, 2000). Since mortality did not show any significant ($P<0.05$) difference among the dietary treatments, SOPM may be a safe ingredient to use in compounding pullet chick diet.

The cost per kg of feed compounded reduced significantly ($P<0.01$) with increasing level of SOPM (Table 3) due to lower cost of sweet orange peels when compared with maize thus making it better utilized for chick growth.

The nutrient digestibility of pullet chicks fed SOPM based diet is shown in Table 4. Nutrient digestibility values showed that birds in the control group T_1, had comparatively higher values, except for CP where the value obtained in the group fed T_2 was comparatively higher than that obtained for the control group. The similarity in the nutrient digestibility values for all nutrients in the control group and T_2 showed that the birds served these two diets were able to digest the nutrients. Diets containing SOPM at substitution levels of 20 to 40% ($T_3 – T_4$) proved to be less digested as the nutrient digestibility continued to progressively decrease as the level of SOPM in the diets increased from 20 to 40%.

Conclusion

It was established from this study that sweet orange fruit peel meal in its present form cannot replace maize in pullet chick diet. Utilization of 10% sun-dried SOPM (*Citrus sinensis*) by pullet chicks had significant adverse effect on performance and digestibility of nutrients. Further studies are required to determine appropriate processing methods that will enhance the potential of SOPM as a feed resource in chicken production.

References

Abbas, E., Ali, A.A.Q., Alireza, S., Vito, L. and Vincenzo, T. 2013. Effect of different levels of dried sweet orange (*Citrus sinensis*) peel on broiler chickens growth performance. *Archiv Tierzucht,* 56: 11-17.

Aduku, A. O. 1993. Feedstuff Analysis Tables. University Press, ABU, Zaria, Nigeria.

Agu, P.N., Oluremi, O.I.A. and Tuleun, C.D. 2010. Nutritional evaluation of sweet of orange (*Citrus sinensis)* fruit peel as feed resource in broiler production. *International Journal of Poultry Science,* 9: 684-688.

Ashbell Gilad and Weinbeger Z. G. 1999. Silage production and utilization. http://www.fao.org/ag/AGP/AGPC/doc/silage/silage-Israel/silage-Israel.htm#8

AOAC. 2002. Official methods of analysis. Association of Official and Analytical Chemists. 17th Edition, Washington.

Cambell, G.L. 1986. Prediction of metabolizable energy of broiler diets. Chemical analysis. *Poultry Science*, 65: 2126-2134.

Carpenter, K.J. and Clegg, K.M. 1956. The Metabolizable Energy of Poultry Feeding stuff in relation to their Chemical composition. *Journal of Science, Food and Agriculture*, 7: 45-48.

Dafwang, I.I. 1990. Poultry Production in Nigeria. A Paper presented at Workshop organized by the College of Agriculture, Lafia, Nigeria.

Emenalom, O.O. 2004. Comparative performance of broiler chicks fed diets containing differently processed *Mucuna pupuriens* seed meal. *Nigerian Journal Animal Production*, 31: 12-16.

Gohl, B. 1981. In: Tropical Feeds Information Summaries and nutritive values. F.A.O. Animal

production and Health Series No.12 F.A.O. Rome. pp: 10-16.

Hon, F.M., Oluremi, O.I.A. and Anugwa, F.O.I. 2009. The Effect of dried sweet orange (*Citrus sinensis)* Fruit pulp meal on the growth performance of Rabbits. *Pakistan Journal of Nutrition,* 8: 1150-1155.

Jang-Kyu, H., Kim, S.W. and Kim, W.Y. 1996. Use of Agro-Industrial by-products as animal feeds in Korea. http://www.ffc.agnet.org.

Minitab. 2005. Minitab Statistical Software Reference Manual. P.C. Version release. 14. Media cybernetics, New York.

Nworgu, P.C., Egbunike, G.N., Abu, D.A., Fapohunda, J.B. and Omole, A.J. 1999. Effect of concentrate and leaf meals on performance of rabbits. Sustainability of the Nigerian livestock industry in 2000 A.D. Proceedings of 4th Annual Conference of Association of Animal Science of Nigeria. 14th-16th Sept., IITA, Ibadan. pp: 150-153.

Obioha, F.C. 1992. A Guide to Poultry Production in the Tropics. Acena Publication, Enugu. pp: 139-140.

Ojabo, L.D., Adenkola, A.Y. and Odaudu, G.I. 2012. The effect of dried sweet orange *(Citrus Sinensis)* fruit peel meal on the growth performance and haematology of rabbits. *Veterinary Research*, 5: 26-30.

Ojabo, L.D., Oluremi, O.I.A. and Uza, D.V. 2013. Haematology and serum biochemistry of pullet grower chickens fed sweet orange (*Citrus sinensis*) fruit peel meal based diets. *Research Opinions in Animal & Veterinary Science,* 3: 252-256.

Oluremi, O.I.A., Igyu, A.D. and Abu, F.T. 2005. Response of growing rabbits to dietary replacement of maize with sweet orange *(Citrus sinensis)* rind. *Journal of Production, Agriculture and Technology*. (PAT), 1: 130.

Oluremi, O.I.A., Ngi, J. and Andrew, I.A. 2007. Phytonutrients in citrus fruit peel meal and nutritional implication for livestock production. *Livestock Research for Rural Development.* 9 Article 89 http://www.cpav.org.collrrd/19/7

Oluremi, O.I.A., Ojighen, V.O. and Ejembi, E.H. 2006. The nutritive potential of sweet orange *(Citrus Sinensis)* rind in broiler production. *International Journal of Poultry Science,* 5: 613-617.

Oluyemi, J.A. and Roberts, F.A. 2000. Poultry production in warm wet climate 2nd edition reprint Macmillan Press Ltd. London. p: ix.

Steel, R.G. and Torrie, J.H. 1980. Principles and Procedures of Statistics. A Biometrical Approach. 2nd Edition., McGraw Hill, Singapore.

Serres, H. 1999. Manual of Pig production in the Tropics. CABI Publishing in Association with CTA Biddles Ltd. Guilds for Kings Lynn London 101.

Sobamiwa, O. and Akinwale, T.O. 1999. Replacement value of cocoa husk meal for maize diets in growing pullets. *Tropical Journal Animal Science,* 1: 111-116.

Taiwo, A.A., Adejiyugbe, A.D., Adebowale, F.A., Oshofan, J.S. and David, O.O. 2005. Performance and nutrient digestibility of weaned rabbits fed forages supplemented with concentrates. *Nigerian Journal of Animal Production*, 32: 74-78.

Tuleun, C.D., Njike, M.C., Ikurior, S.A. and Ehiobu, N.G. 2005. Laying performance and egg quality of hens fed cassava root meal/brewers yeast slurry based diets. *Production Animal Techniques,* 1: 148-152.

Uko, O.J., Awoyeseku, P. and Babatunde, G.M. 1990. Substitution of maize offals for maize grains in diets of laying hens. *Nigerian Journal of Animal Production*, 17: 56-59.

Yang, S.J. and Chang, C.C. 1984. Studies on the Utilization of citrus by-products as livestock feeds II. A Study on feeding value of the citrus by-products for broiler chicks. *Korean Journal of Animal Science,* 26: 244-250.

Yang, S.J. and Chang, C.C. 1985. Studies on the Utilization of citrus by-products as livestock feeds IV. Feeding value of citrus by-products fed to layer. *Korean Journal of Animal Science,* 27: 239-245.