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Evaluation of the effects of dietary red palm oil supplementation on the body weights, packed cell volume and serum lipid profile of broilers chicks

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Abstract

This study evaluated the effects of dietary red palm oil (RPO) supplementation on the body weights, packed cell volume and serum lipid profile of broilers chicks. Ninety-day old chicks were used for the study. They were acclimatized for one week and randomly assigned to three groups (A, B and C) of thirty birds each, with three replicates of ten birds in each group. The diets of Group A and B chicks were supplemented with 4% and 2% RPO, respectively, while that of Group C was not supplemented (Unsupplemented Control). The chicks were fed their group specific diets for five weeks. The birds were weighed at the beginning of the study and weekly for the five weeks. At the fourth week, blood samples were collected and packed cell volume (PCV) was determined. At week five, blood samples were also collected for both PCV and serum lipid profile determination. Results showed that there were no significant differences ($p > 0.05$) between the groups in their body weights, PCV and low density lipoproteins, but the serum triglyceride, total cholesterol, high density lipoprotein (HDL) and very low density lipoproteins (VLDL) of the Groups A chicks fed diet supplemented with 4% RPO was significantly ($p < 0.05$) higher than that of the unsupplemented control, while only the serum triglyceride and total cholesterol levels of the Group B chicks (fed diet supplemented with 2% RPO) was significantly ($p < 0.05$) higher than that of the unsupplemented control. It was concluded that supplementation of the diet of broiler chicks with RPO, as used in the study, led to no significant effects on their body weights, PCV and serum LDL levels, but led to significantly higher serum levels of triglycerides, total cholesterol, HDL and VLDL, especially at 4% level of dietary supplementation.

Keywords: Red palm oil; Dietary supplementation; Broiler chicks; Body weights; Packed cell volume; Serum Lipid Profile.

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Introduction

Agriculture is one of the pillars of the Nigerian economy; it impacts on economic development, poverty alleviation, employment and income generation (Philip *et al*., 2009). Livestock production constitutes a major part of the agricultural economy of Nigeria. Poultry, which is a sub-sector of the livestock industry, includes the rearing of chickens, turkeys, ducks, quails, peafowls and guinea fowls. Chicken alone constitutes as much as 95% of all poultry kept on the planet (Kalla *et al*., 2007).

Poultry has been reported to have the highest feed conversion rate/efficiency and offers a very high turnover rate and quickest returns on investment over other livestock enterprises (Sanni and Ogundipe, 2005). It produces the least expensive and best source of animal protein relative to other animal source foods. In broiler production, feed represents a major proportion of production costs (Brockotter, 2022), with grains like maize, wheat, barley, millet and guinea corn forming the major sources of energy (Van der Klis *et al*., 2010). However, there is a current shift towards inclusions of dietary fats as high energy component of diet. Dietary fats are economical, readily available and are either of animal or vegetable sources (as by-products from oil seed processing). Inclusion of dietary fats like red palm oil and other seed oils in poultry diets potentially offers many benefits such as its high energy content, source of essential fatty acids (n-3 and n-6), source of fat soluble vitamins and lecithin among others (Baiao and Lara, 2005; Fagarasan *et al*., 2010).

Chicken meat has a high protein and low fat content and is known as the principal source of polyunsaturated fatty acids (PUFA) with high concentration of omega-3 PUFA (Howe *et al*., 2006). Chicken has been considered an appropriate model in lipid nutrition studies, since it is highly sensitive to dietary fat modifications, and many of the studies done with chickens deal with the degree of saturation or source type of the dietary replaced fat and how it influences the performance and carcass quality improvement of the animal (Rymer and Givens, 2005).

Red palm oil, obtained from the fruit of the oil palm tree, is the most widely produced edible vegetable oil in the world; it's nutritional and health attributes have been well documented (Chandrasekharan *et al*., 2000). It is a low cost and readily available source of vitamin A and beta-carotene, and reports have shown that 70 – 88% of its beta-carotene content is retained during cooking (Manorama and Rukmini, 1991). Red palm oil is rich in the saturated fatty acid, palmitic acid, the content of which is about 45% of the total fatty acids. The use of red palm oil in broiler diets is potentially attractive because it is a saturated source that may be associated with a positive influence on meat firmness (Renner and Hill, 1991). It is relatively of low cost compared to other imported fats and it possesses many good qualities including more vitamin E (antioxidant) content, which makes it more stable (Pesti *et al*., 2002). Red palm oil has been used in food preparation for over 5,000 years.

In 2012, the World Health Organization (WHO), listed ischaemic cardiovascular disease as one of the leading cause of death worldwide (WHO, 2012). Excessive saturated fatty acid consumption has been posited as being responsible for hypercholesterolemia, a condition that predisposes to a higher cardiovascular disease risk (Tierney, *et al*., 2010). Red palm oil, however, contains oleic and linoleic acids which are unsaturated fatty acids and also Vitamin E tocotrienols that are powerful anti-oxidants. A study on the effects of palm oil consumption on serum lipid profile and the heart of humans showed that red palm oil consumed as dietary fat as part of a healthy balanced diet, does not pose any risk of cardiovascular disease (Odia *et al*., 2015). Also, it has been reported that no other vegetable oil has as much Vitamin E as red palm oil (Chow, 1992).

Information on the potential implication of palm oil consumption on the growth performance and serum lipid profile of animals is scarce. The present study investigated the effects of dietary red palm oil supplementation on the body weights, packed cell volume and serum lipid profile of broilers chicks.

Materials and Methods

Study Area, Animals and Sampling: This study was carried out in the Poultry Unit of the Department of Animal Health and Production, Faculty of Veterinary Medicine, University of Nigeria Nsukka. A total of 90 broiler chicks (Ross breed) with average initial body weight ranging from 43 to 44 g were procured for the study from Agrited® Farm, Ibadan, Nigeria. They were housed in brooding pens, supplied with fresh water and feed *ad libitum*. The chicks were allowed to acclimatize for one week prior to the start of the experiment. They were then randomly allocated into 3 groups (A, B and C) of 30 birds per group. The groups were further subdivided into three replicates of 10 birds each. All standard management procedures for broiler production were followed including vaccination against endemic poultry diseases.

Experimental Diets: Seventy-five kilogramme of broiler super starter mash (Top Feeds Ltd., Sapele, Nigeria) with 24% crude protein, 6.0% crude fat, 5.0% crude fibre, 1.0% calcium, 0.45% phosphorus, 1.20% lysine, 0.3% salt, 0.35% methionine, 2900 metabolizable energy, was used for the study. This quantity was divided into three parts labeled A, B and C of 25 kg each and supplemented with 4%, 2%, and 0% red palm oil, respectively. Group A, B and C were fed diets A, B and C with 4%, 2% and 0% red palm oil inclusion, respectively. The birds were fed *ad libitum* and the experiment lasted for five weeks.

Vaccination and health management: The birds were given the routine vaccination against Newcastle and Gumboro disease and an Anti-stress preparation containing multivitamins (Adaminolyte WSP by Kepro B. V, Holland) administered for five days post vaccination. The birds were prophylactically treated with a coccidiostat, which contained sulphadimidine, diaveridine, vitamin A and vitamin K. Strict biosecurity measures were also implemented in the course of raising the birds.

Ethics: The study protocol was guided and approved by the Institutional Animal Care and Use Committee of the Faculty of Veterinary Medicine, University of Nigeria Nsukka (Approval Reference Number: FVM-UNN-IACUC-2019-08/59), and the animals were well cared for and humanely handled all through the study.

Experimental Design: After acclimatization, the chicks were weighed and feeding of the group-specific experimental diets commenced. The chicks were afterwards weighed at weekly intervals till the end of the five week experimental period. At week 2 and 4 of the experiment, blood samples were collected for the determination of packed cell volume, and at the end of the experiment (week 5), blood samples were also collected, from which serum was harvested for the evaluation of the serum lipid profile.

Body Weight Measurement: Body weights were measured at the beginning of the experiment and afterwards at weekly intervals for the five weeks duration of the study, using a digital weighing balance (Metlar digital balance, Metlar Resources Company, London). Nine chicks from each group (three from each replicate) were weighed each time.

Determination of Packed Cell Volume (PCV): The packed cell volume was determined by the microhaematocrit method (Schalm *et al*., 1975). Three birds were selected per replicate and 1 ml of blood was collected from the jugular vein. Two third of capillary tubes were filled with the anti-coagulated blood samples and one end sealed with plasticine. The filled tubes were centrifuged at 10,000 revolutions per minute for five minutes using a microhaematocrit centrifuge (Hawksley, England). Then the PCV was read using a microhaematocrit reader. The group means and standard error were calculated.

Assay of the Serum Lipid Profile: Serum total cholesterol levels were determined using the colorimetric method (Allain *et al*., 1974), using Biosystems Reagent test kits (Elabscience, USA), while serum triglyceride levels was determined using the method described by Bucolo and David (1973). Serum low density lipoprotein (LDL) cholesterol concentration was determined by the method described by Assmann *et al*. (1984). The high density lipoprotein (HDL) concentration was calculated by subtracting the values of low density lipoprotein cholesterol (LDL) from that of the total cholesterol. The very low density lipoprotein (VLDL) cholesterol was calculated by dividing the value of triglyceride by 5.

Statistical Analysis: Data obtained was statistically analyzed using one way analysis of variance (ANOVA). Variant means were compared using Duncan's new multiple range test (Steel and Torrie, 1960). Significance was accepted at probability values < 0.05, and the summary of the results were presented as means with standard error.

Results

There were no significant ($p > 0.05$) differences between the mean body weights of the broiler chicks in the three groups all through the five-week experimental period, though the mean body weight of the unsupplemented control group was relatively higher than those of the two supplemented groups from week 3 of the experiment to the end (Table 1). There were also no significant ($p > 0.05$) differences in the mean packed cell volume of the different groups on both week 4 and week 5 (Table 2).

The serum triglyceride levels of the Group A (supplemented with 4% red palm oil) was significantly ($p < 0.05$) higher than those of the Groups B and C, while the serum total cholesterol levels of both supplemented groups (Groups A and B) were significantly ($p < 0.05$) higher than that of the unsupplemented control group C (Table 3). The serum HDL levels of the Group A chicks were significantly ($p < 0.05$) higher than those of the Groups B and C, but there were no significant ($p > 0.05$) differences between the groups in their serum LDL levels (Table 3).The serum VLDL levels of the Group A chicks was significantly ($p < 0.05$) higher than that of the unsupplemented control (Table 3).

Table 1. Body weights of broiler chicks fed diets supplemented with varied percentages of red palm oil.

Experimental period (weeks)	Mean body weight (g) ± standard error		
	Group A (Supplemented with 4% Red Palm Oil)	**Group B** (Supplemented with 2% Red Palm Oil)	**Group C** (Unsupplemented Control)
Week 1	92.10 ± 2.51 [a]	85.76 ± 2.38 [a]	88.42 ± 6.04 [a]
Week 2	211.84 ± 18.50 [a]	198.06 ± 11.37 [a.]	202.58 ± 19.05 [a]
Week 3	429.00 ± 42.19 [a]	474.40 ± 35.68 [a]	500.00 ± 20.94 [a]
Week 4	558.80 ± 62.88 [a]	637.20 ± 44.17 [a]	703.92 ± 28.26 [a]
Week 5	711.12 ± 72.69 [a]	742.22 ± 30.04 [a]	781.26 ± 36.24 [a]

No significant variations between the groups, p > 0.05

Table 2. Packed cell volumes of broiler chicks fed diets supplemented with varied percentages of red palm oil.

Experimental period (weeks)	Means of packed cell volume (%) ± standard error		
	Group A (Supplemented with 4% Red Palm Oil)	Group B (Supplemented with 2% Red Palm Oil)	Group C (Unsupplemented Control)
Week 4	29.40 ± 0.87 [a]	32.00 ± 0.84 [a]	31.20 ± 1.02 [a]
Week 5	27.20 ± 0.86 [a]	31.80 ± 2.11 [a]	31.00 ± 1.22 [a]

No significant variation between the groups $p > 0.05$

Table 3. Serum lipid profile of broiler chicks fed diets supplemented with varied percentages of red palm oil.

Serum Lipid Profile parameters	Means of serum lipid profile parameters (mg/dl) ± standard error		
	Group A (Supplemented with 4% Red Palm Oil)	Group B (Supplemented with 2% Red Palm Oil)	Group C (Unsupplemented Control)
Triglyceride	60.25 ± 2.24 [a]	49.20 ± 2.05 [b]	46.03 ± 1.83 [b]
Total Cholesterol	152.32 ± 8.73 [a]	150.00 ± 17.42 [a]	97.67 ± 8.05 [b]
High Density Lipoprotein	51.29 ± 5.88 [a]	36.37.40 ± 5.89 [b]	34.95 ± 4.74 [b]
Low Density Lipoprotein	88.6 ± 2.3 [a]	96.90 ± 6.00 [a]	90.50 ± 0.20 [a]
Very Low Density Lipoprotein	7.23 ± 0.25 [a]	5.91 ± 0.25 [ab]	5.52 ± 0.22 [b]

Different superscripts in a row indicate significant difference between the means at $p < 0.05$

Discussion

The result of this study showed that red palm oil supplementation in the diets of the broiler chicks did not significantly affect their body weights; rather the unsupplemented control had a relatively higher body weight later in the experiment. This might be as a result of a decrease in the feed intake which may have been associated with the red palm oil supplementation, as earlier reports have shown that red palm oil supplementation leads to increased heat generation in the diet and consequently reduced feed intake, poor feed conversion efficiency and poor growth (Alverdy and Luo, 2017). The reports of Saminathan *et al* (2022) are in contrast with the findings in this present study, as they reported a higher productive performance in the palm oil supplemented broiler chicks.

The findings in the present study that the packed cell volume (PCV) of both the supplemented and control groups were comparable ($p > 0.05$) implies that palm oil supplementation as used in this study did not significantly affect red blood cell production or destruction, and is in agreement with the reports by Onibi *et al*. (2011) that haematological variables were not significantly affected by palm oil sludge supplementation.

The significantly higher serum levels of triglyceride in the group fed 4% red palm oil supplement (Group A) in believed to be a result of the dietary supplementation, as it has been reported that high blood levels of triglyceride can be of dietary origin (Yuan *et al*, 2007; Packard *et al*, 2020).The finding in this present study of high serum levels of triglyceride in the group given feed with 4% red palm oil supplement contrasts with the earlier reports by Egba *et al*. (2011) in rats given palm oil supplements in which comparable values for both control and supplemented groups was recorded. However, the findings in the current study are in agreement with the reports of Gheisari *et al*. (2017) on broilers fed diets supplemented with lecithinized palm oil.

The significantly higher serum level of cholesterol in the two palm oil supplemented groups in this present study when compared to the unsupplemented control is believed to be of dietary origin, as earlier studies have shown that dietary fats and oils can lead to high blood cholesterol (Grundy and Vega, 1990). This finding concurs with the reports of Onibi *et al*. (2011) on broilers fed diets supplemented with palm oil sludge and that of Khatun *et al*. (2017) on broilers fed diets supplemented with 6% palm oil. Furthermore, the significantly higher level of high density lipoprotein (HDL) concentrations recorded in the group A broilers fed diets supplemented with 4% red palm oil concurs with earlier reports by Egba *et al*. (2011) in albino rats fed diets supplemented with palm oil oleins and that of Baldizan *et al*. (2011) on broilers fed peach palm oil supplement.

The significantly higher levels of HDL cholesterol in the broilers supplemented with 4% red palm oil is considered a positive development, because HDL is regarded as the good cholesterol (Regar *et al*., 2019). HDL cholesterol maintains the balance of other cholesterol components including the LDL, so that they do not accumulate in the cells and tissues. The function of HDL is to carry the remaining cholesterol which is not being used to the liver where the cholesterol will be used as a precursor in the formation of bile salts and steroid hormones while the left over is now excreted (Hassanudin *et al*., 2013).

The finding in this present study that supplementation with red palm oil did not lead to any significant effects on the serum levels of LDL is considered a good development too, as high serum LDL levels are usually associated with atherosclerotic disease (Penson *et al*., 2020). This finding of no significant differences in serum LDL levels of both supplemented and unsupplemented groups is in agreement with earlier reports by Baldizan *et al*. (2011) on broilers fed peach palm oil supplements, but contrasts with the reports of Khatun *et al*. (2017) who reported high serum LDL levels in broilers fed diets supplemented with 6% palm oil.

The significantly higher serum levels of very low density lipoprotein (VLDL) in the group supplemented with 4% red palm oil when compared to the unsupplemented control is in agreement with the reports by Gheisari *et al*. (2017) on broilers fed dietary lecithinized palm oil, but contrasts with the reports by Baldizan *et al*. (2011) on broilers fed peach palm oil supplements.

Conclusion: Based on the results of the study, it was concluded that supplementation of diets of broiler chicks with palm oil at the levels used in this study (4% and 2%) led to no significant effects on the body weights, packed cell volume and serum levels of low density lipoproteins, but supplementation especially at the 4% levels led to significantly higher serum levels of triglyceride, total cholesterol, high density lipoproteins and very low density lipoproteins.

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Conflict of Interest Statement

The authors declare no conflict of interest relative to the research, authorship and/or publication of this article.

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