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Research Article

Comparative Evaluation of Palm Oil and Lard as Partial Replacement for Maize in Broiler Chicken Diets

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Abstract

This study investigated the effect of animal and plant lipids in the diets of broiler finisher birds with respect to their growth performance and abdominal fat deposition. A total of 360 birds of mixed sexes were completely randomised into three dietary treatments A, B and C with 0, 4% animal lipid and 4% plant lipid as replacements for maize respectively. Each treatment was replicated thrice with each replicate having 40 birds. Result showed significant improvement ($P < 0.05$) in feed intake of birds on lard, followed by palm oil and then the control in that order. Final live weight and weight gain were significantly ($P < 0.05$) better for birds on lard followed by palm oil, likewise feed conversion ratio was significantly ($P < 0.05$) better in both lard and palm oil diets than the control diet. The protein efficiency ratio followed a similar trend like the feed convention ratio with better ($P < 0.05$) protein utilisation witnessed by birds on palm oil and lard diets. The cost/kg feed intake did not show any significant differences likewise the cost/kg weight gain. Among the nutrient retention parameters, only ash and ether extract showed significant ($P < 0.05$) differences, with birds on the control diet having significantly ($P < 0.05$) higher ash content than both lard and palm oil diets. Ether extract was better retained by birds on lard, followed by palm oil. The liver and heart of birds on lard and palm oil were heavier than that of the control. Birds on diet containing lard had the highest ($P < 0.05$) abdominal fat followed by birds on palm oil diet. It was concluded that 4% animal fat (lard) (replacing maize) as an energy source enhances growth performance than palm oil in broiler finisher diets but with attendant abdominal fat deposition.

Keywords: *Animal Lipid; Ether Extract; Plant Lipid; Rancidity*

Introduction

Fats and oil are the most concentrated sources of energy in feeds but may have an effect upon other feed constituents as well as digestive processes [1]. Based on volume and nutritional importance, one of the most important ingredients used in poultry and livestock feed formulation, is feed grade fats and oils [2]. These ingredients are cheaper and more efficient supplements of the conventional energy feed ingredient like maize, barley and wheat.

According to Satabdee (2017) animal lipids have the following characteristics; relatively rich in saturated fatty acids, iodine number is relatively less (iodine number denotes the degree of un-saturation in fatty acids, animal fats have relatively higher value of Reichert-

meisl-number (which is how much volatile acid can be extracted from a fat through saponification), oxidative rancidity is observed more frequently and finally are stored in the liver and beneath the skin, furthermore, plant lipids are comparatively rich in unsaturated fatty acids and due to their high unsaturation tend to stay liquid at room temperature, hence commonly known as oils (Satabdee, 2017). Iodine number of plant fats is more than that of plants; oxidative rancidity is relatively less in plants. Obioha [3] reported that the fat present in the meat of monogastrics reflects the type of oil contained in the diet fed to the animals as some oils have undesirable taints.

Feed grade fats in animal feed formulation contribute 6 - 20% of the metabolisable energy. It increases feed efficiency, decreases feed intake, improves feed conversion ratio, increases growth rate, reduces the rate of passage of the digesta in the gastro-intestinal tract [4] and according to Finman., *et al*. (2008) ensures better absorption of all nutrients. Various sources of feed grade fats include: tallow, poultry fat, lard (pork), yellow grease (restaurant) and vegetable fat like sunflower, soybean, canola and palm oils [5].

These various oil and fats however, differ in the type of fatty acids they contain as such differ in their contribution to energy in the feed and abdominal fat deposition [6].

This study was therefore designed to determine the effect of animal lipid (lard) and plant lipid (palm oil) on growth performance and fat deposition of broiler finisher birds.

Materials and Methods

Experimental site

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm, University of Calabar, Calabar, Nigeria. The climatic records during the period of the experiment (Dry season, December-February) showed an average temperature and relative humidity of 32^0C and 72.5% respectively [7].

Three hundred and sixty (360), 28-day old 'Fidan', heavy strain birds were used for a 28-day feeding trial. The finisher birds were individually weighed after passing through a common starter diet (Top feed) after undergoing all routine vaccination and necessary medications. They were then randomly assigned to three treatment groups of sixty birds per treatment, with each treatment consisting of three replicates of twenty birds each. Feeds and water were given to the birds *ad libitum*. The birds were reared on deep litter house with wood shavings as litter material.

Digestibility trial

At the end of the feeding trial, 4 birds per replicate were randomly selected and kept in metabolic cages. The birds were fed the same diets offered during the feeding trial. Records on feed intake and excreta were taken on a daily basis with the use of electronic weighing balance. The daily excreta were dried to a constant weight of 80^0C in the oven. The dried samples were milled in a meadows model 35 hammer mill and sieved through a mesh of 5 mm and stored at room temperature for proximate analysis. The digestibility trial lasted 10 days: 7 days for excreta collection and 3 days for acclimatization. The following formula was used in calculating nutrient digestibility:

$$\% \text{ Nutrient digestibility} = \frac{\text{Amount of nutrient in feed - amount of nutrient in faeces x 100}}{\text{Amount of nutrient in feed}}$$

Carcass analysis

Six birds per replicate after being starved for 18 hours at the end the experimental period were slaughtered, de-feathered after scalding in warm water. They were then cut into retail parts and weighed. Weights of parts were expressed as percentage of the live weight.

Experimental diets

The plant lipid (Palm oil) and animal lipid (Lard) were sourced from within the University of Calabar Community. The lard from the back of pigs was boiled until all the water content was removed, while the oil was collected for this experiment. Maize was replaced by 0, 4% palm oil and 4% lard to form dietary treatments A (Control), B and C respectively.

Ingredients (%)	Diet A (Control) (0% lipid)	Diet B (Palm oil) (4% replacement for maize)	Diet C (Lard) (4% replacement for maize)
Maize	59.00	55.00	55.00
Soybean meal	28.00	28.00	28.00
Wheat offal	6.00	6.00	6.00
Palm oil	-	4.00	-
Lard	-	-	4.00
Fish meal	2.50	2.50	2.50
Bone meal	2.50	2.50	2.50
Oyster shell	1.25	1.25	1.25
Lysine	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
*Vit/min premixes	0.25	0.25	0.25
Total	100.00	100.00	100.00
Calculated analysis			
Crude protein (%)	20.92	20.78	20.78
Crude fibre (%)	4.28	4.26	4.26
Calcium (%)	1.23	1.20	1.20
Available phosphorus (%)	0.78	0.75	0.75
Methionine (%)	0.46	0.43	0.43
Lysine (%)	1.18	1.14	1.13
ME (Kcal/Kg)	3,099.12	3,194.00	3,205.00
Determined analysis			
Crude protein (%)	20.86	20.59	20.61
Ether extract (%)	3.97	5.55	5.84
Ash (%)	4.03	3.48	3.41
Gross Energy (Mj/kg)	14.36	14.74	14.91

Table 1: *Gross composition of experimental finisher diets.*

**Composition per 2 kg of mixture contains; Vitamin A- 15,000,000 iu, Vitamin D- 3,000,000 iu, Vitamin E- 15,000 iu, Vitamin K- 2.5g, Vitamin B_1- 1g, Vitamin B_2- 10g, Vitamin B_{12}- 4g, Folic acid - 2g, Biotin - 0.1g, Niacin - 70g, BHT - 125g, Calcium D-Pantothenic acid - 20g.*

Proximate analysis

Feed, test ingredients and faecal samples were dried for 24 hours and milled into 1 mm screen before analysis (Fanimo., *et al.* 2007). Dry matter (DM), ash, CP (N x 6.25), ether extract and crude fibre (CF) were determined according to AOAC [8] methods.

Determination of meat quality

Samples of meat from the thigh and drumstick regions were analysed using [8] methods to proximate composition. For sensory evaluation, frozen meat samples thawed with the skin and bone intact from three samples per carcass were analysed. The meat samples were cooked at 170°C in a conventional pre-heated gas oven for 20 minutes. Cooked meat samples were removed from the oven, allowed to cool for 10 minutes, de-boned and muscles cubed according to Fanimo., *et al.* (2007) method. A modified hedonic scoring scale was used (Williams and Damron, 1998). The 16 panellists used 5 point scale to score for each sample namely: juiciness, flavour, intensity, tenderness and off flavour.

Cost- benefits evaluation

The prevailing market prices of the ingredients at the time of the study were used to determine the cost of 1 kg feed consumed and the cost of 1 kg feed consumed/weight gain.

Data collection and statistical analysis

Data on weight gain, feed intake, feed conversion ratio, protein efficiency, mortality and abdominal weight were all subjected to one-way analysis of variance for CRD using SPSS Statistical package [9]. Significant means among variables were separated using the Duncan Multiple Range Test [10].

Results and Discussion

Result of the partial replacement of maize with palm oil and lard is presented in table 3, it revealed significant ($P < 0.05$) differences in all the parameters considered apart from the cost/kg feed consumed, cost per kg weigh (₦) and some organs.

Parameters	Diet A Control	Diet B (4% Palm oil replacement for maize)	Diet C (4% Lard replacement for maize)	SEM
Initial weight (g/ bird)	785.50	790.00	770.80	1.98
Final live weight(g/bird)	2800.78^{c}	2950.70^{b}	2988.45^{a}	2.02
Daily weight gain(g/bird)	39.86^{c}	49.73^{b}	53.90^{a}	0.58
Daily feed intake(g/bird)	142.48^{b}	159.64^{ab}	161.71^{a}	3.88
Feed Conversion Ratio	3.58^{a}	3.21^{b}	3.00^{c}	0.06
Protein intake(g/bird)	29.81^{b}	33.17^{a}	34.85^{a}	0.15
Protein efficiency ratio	1.34	1.50	1.55	0.02
Mortality (%)	0.00	0.10	0.00	0.01
Cost/kg feed, (₦)	118.34	120.00	119.34	1.88
Cost/kg WG, (₦)	599.13	619.55	607.88	2.81
Abdominal fat deposition(g/bird)	2.17^{c}	5.10^{b}	8.91^{a}	0.08
Nutrient utilization (%)				
Dry Matter	88.91	85.30	86.09	1.51
Crude protein	68.10	70.00	69.86	1.22
Crude fibre	31.08	35.07	38.00	1.08
Ether extract	55.93c	61.17b	68.03a	1.94
Ash	64.04a	56.00b	54.98b	2.01
Nitrogen free extract	70.89	71.00	70.54	2.80

Table 2: *Performance of finisher birds fed diets containing palm oil and lard as replacement for maize.*

^{a,b}: Means on the same row with different superscripts differ significantly ($P < 0.05$).

The result revealed that more feed was significantly consumed ($P < 0.05$) by birds fed palm oil and lard diets which values were numerically ($P < 0.05$). The result agrees with the findings of Nsa., *et al.* [11]; Akpan and Nsa [12], who all attributed it to improvement in feed palatability as a result of oil inclusion in a diet for broiler birds.

The improved feed consumption by birds on oil palm and lard diets manifested in their final live weight and weight gain, where there was significant ($P < 0.05$) improvement of both parameters in birds fed diets with palm oil and lard over the control diet. More feed intake means more weight gain [13].

Parameters (g)	Diet A	Diet B	Diet C	SEM
Dressing percentage	79.05	79.34	79.59	1.11
*Relative weight of cut up parts (%)				
Head	3.07	3.11	3.13	0.02
Neck	3.80	4.01	4.03	0.05
Breast	24.45^{b}	27.03^{a}	27.89^{a}	0.87
Back	14.84	18.61	18.28	1.09
Drumstick	9.29	10.65	10.59	0.61
Thighs	11.04	12.76	12.99	0.42
Shanks	4.05	4.90	5.11	0.18
Wings	9.03	9.41	9.68	0.15
*Relative weight of organs (%)				
Kidney	0.89	1.19	1.44	0.43
Spleen	0.22	0.25	0.23	0.05
Liver	0.24^{b}	0.88^{a}	0.98^{a}	0.50
Pancreas	0.33	0.35	0.89	0.04
Heart	0.59	1.45^{a}	1.19^{b}	0.09
Lungs	0.71	0.69	0.65	0.06
Abdominal fat	0.02^{c}	0.09^{b}	1.79^{a}	0.02

Table 3: *Effect of palm oil and lard as partial replacement of maize on the carcass characteristics of finisher broiler chickens.*

$^{a, b, c}$: Means within the same row with different superscripts differ significantly ($P < 0.05$).

**: Percentage of live weight.*

There was significant ($P < 0.05$) improvement in feed utilisation by birds on lard than birds on palm oil which in turn was significantly ($P < 0.05$) better than that of the control diet. The observed better utilisation of feed by birds on lard than palm oil could be due to the fact that lard is an animal lipid that is high in saturated fatty acid than plant lipid. Saturated fat is known to be absorbed and stored directly than unsaturated fat. Balao and Lara (2005), Lugas and Riaz [14], Nsa., *et al.* [15], also animal fats have relatively higher value of Reichert-Meissl number, which can equally be responsible for the observed better feed utilisation (Satabdee, 2017). The cost/kg (₦) feed showed no significant ($P > 0.05$) differences despite the high value recorded for diet with palm oil and did not translate to any significant improvement in cost/kg weight gain (₦). This means that the partial replacement of palm oil and lard in maize based diets has no cost sparing effect.

The nutrient retention apart from the digestible ether extract and ash indicated no significant differences. The digestible ether extract showed significant improvement with birds on lard and palm oil than the control diet. This could be due to the fact that oil added more energy density to the diets which led to more utilisation. The ash digestibility showed a significant ($P > 0.05$) depression with birds on palm oil and lard when compared to the control diet. Fat and oil in diets are known to affect utilisation of minerals, as they bind some

minerals making them unavailable; also rancidity that might set in, in any form can destroy most of the minerals. Some scientists have advocated increase input of minerals and vitamins beyond their recommended levels in feeds that are of high oil content [5]. The abdominal fat deposition was significantly ($P < 0.0$) higher in birds on lard, followed by birds on palm oil. The differences in values of birds on the two diets confirmed findings by Sanz., *et al.* [5], Akpan and Nsa [12] that fat metabolism and deposition in poultry can be affected by different dietary fats.

On carcass characteristics, significant differences were observed only in the liver out of all the organs examined. Percentage weight of liver and heart were significantly ($P < 0.05$) enlarged in birds fed lard and palm oil diets. This confirms the fact that liver is where bile is produced, which helps in the emulsification of fat. More fat/oil means more pressure on the liver to produce more bile. This pressure on the liver might cause the liver to enlarge to meets its primary function. The heart showed significant ($P < 0.05$) differences in weight with the highest weight recorded for birds on lard followed by palm oil. The observed higher weight of heart of birds on lard was specifically due to deposition of more fat on the heart tissues. This confirms the reason why people on meat/fat are easily prone to related heart diseases like stroke and heart failure than people on plant fat oil. Fat from animal origin can easily settled or deposited on sensitive organs, adipose tissues and under the skin because of high content of saturated fatty acids (Satabdee, 2017) [16].

Conclusion

The results of this study have shown that 4% lard (animal lipid from pigs) is a better source of energy than palm oil (plant lipid) in broiler finisher diets in terms of growth performance but with the demerit of encouraging more abdominal fat deposition.

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