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RESEARCH ARTICLE

Comparative Effects of Poultry Fat and Soybean Oil on Growth Performance in Broiler Chickens

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ABSTRACT

The research was done in order to compare the effects of poultry fat and soybean oil on the growth of broilers. Three dietary treatments including a control diet (CON) with no supplemental fat and a diet (SO) and diet (PF) supplemented with soybean oil or poultry fat were used randomly to allocate 360 one-day-old broiler chicks. The duration of the experiment was 42 days and it was subdivided into three phases; starter (1-14 days), grower (15-28 days) and finisher (29-42 days). Parameters of growth performance such as body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) were measured. These findings indicated that, broilers that were fed diets with soybean oil and poultry fat had a much higher body weight gain and good feed ratio than that of the broilers that were fed the control diet ($P < 0.05$) at each of the growth phases. No significant effect of dietary treatments on the feed intake was found ($P > 0.05$). There were no observed significant differences between the soybean oil and poultry fat groups in most parameters of performance implying that the two sources of lipids are equally effective in supporting the growth of broilers. To conclude, dietary fat enhanced growth performance and feed efficiency in broilers chicken. Poultry fat exhibited similar effects with soybean oil and thus it can be concluded that it is a viable and economically viable alternative source of lipid in broiler diets.

Graphical Abstract

1. Introduction

Broilers are fed on energy-dense feed sources, and thus, the rapid rates of growth and enhanced feed efficiency demand highly digestible and concentrated sources of energy [1]. Lipids are especially significant among dietary factors since they contain over twice the metabolizable energy of carbohydrates or proteins, increase the absorption of the fat soluble vitamins, palatability as well as carcass composition. Conventionally, soybean oil is one of the popular broiler diets because of its energy value, uniform quality, and positive fatty acid composition [2]. Nevertheless, the changing prices, competition with human food and biodiesel production and a necessity to have a cost-effective feed composition have triggered the interest towards alternative sources of lipids [3]. The poultry fat is a rendered by-product of the poultry processing and has become a possible alternative to vegetable oils in broiler diets. Its use is consistent with sustainable production of livestock through recycling industry by-products and lowering the feed cost [4]. Poultry fat normally has more saturated and monounsaturated fatty acids in comparison to the soybean oil which is rich in polyunsaturated fatty acids especially the linoleic acid. These differences in composition have the potential to affect nutrient digestibility, energy utilization and eventually growth performance of broiler chickens.

Body weight gain, feed intake, and feed conversion ratio are the most common measures of growth performance, which is the most important parameter of economic efficiency of broiler production [5]. The quality and type of dietary fat may influence growth by modifying the metabolizable energy, intestinal development and nutrient absorption efficiency. Unsaturated fatty acids, including those that are found in soybean oil, are normally more digestible particularly in young birds whose bile salt and lipase secretion is less than that of the adults [6]. Conversely, those animal fats having higher saturated fatty acid levels could be slightly less digestible, especially at early stages of growth. However, the overall effect on performance is determined by the affecting factors which include the level of fat inclusion, age of the bird, the formulation of the diet, and the condition of processing [4,6].

Besides energy contribution, lipid sources may also have an impact on gut health, oxidative stability, and metabolic responses [5]. The same growth has been reported in some studies when animal fats are partially or fully used in place of vegetable oils so long as the diets are made to be isoenergetic and isonitrogenous [6]. Other reports indicate that there is a variation in the feed efficiency or carcass traits according to the level of substitution and the fatty acid profile of the diet. These discrepancies indicate the necessity to evaluate them in a more rigorous way based on controlled experiments [2,5]. Economically and environmentally, there are the potential benefits linked to the use of poultry fat; increased resource efficiency and reduced feed costs [7]. Care should however be taken of issues of variability in composition, oxidative stability as well as its consequences on the performance of birds [6]. Thus, the systematic comparison of poultry fat with soybean oil is necessary to identify whether the poultry fat can be a realistic alternative without the effect on the growth performance [7,8].

The current research seeks to compare the broiler chicken growth outcomes of poultry fat and soybean oil. This study will offer viable information that can be used in feed formulations planning and development of cost-effective and sustainable broilers, by identifying the most productive parameters of broilers under standardized feeding conditions.

2. Materials and Methods

2.1. Birds and Experimental Design

The experiment was done to compare the effects of poultry fat and soybean oil on the growth performance of broiler chicken. Three hundred and sixty (360) one-day-old male broiler chicks (Ross 308) of similar initial body weight were purchased at a commercial hatchery. Chicks were allocated randomly to three dietary treatments to a completely randomized approach upon arrival and each one was weighed individually. The treatments had 6 replicate pens each of 20 birds each. The experimental treatments were three; Control diet (CON): Control diet is made up of basal corn soybean meal diet: Basal corn soybean meal diet supplemented with no additional supplemental fat (energy adjusted mainly using the basal ingredients). Soybean oil diet (SO): Basal diet diet with soybean oil as the lipid source. Poultry fat diet (PF): Dietary basal diet complemented with poultry fat as the main lipid source. The feeding duration was 42 days and it was separated into three phases of feeding namely; starter (1-14 days), grower (15-28 days) and finisher (29-42 days). Environmentally controlled conditions were used to keep birds in floor pens lined with fresh wood shavings. Temperature and lighting programs were based on breeder management guidelines. During the study, feed and water were availed at will. All animal handlings procedures were carried out in line with the institutional guidelines concerning animal care and use.

2.2 Experimental Diets

Each growth stage was determined using corn-soybean meal based diets that provided nutrient levels that were equal or greater than those suggested by NRC (1994) (Table

1). No added fat was used in the CON diet, and it acted as a control treatment. The soybean oil was added to the SO diet to enhance the diet energy density. The PF diet contained poultry fat amount that was equal to soybean oil in the SO diet. The SO and PF diets were designed as isoenergetic and isonitrogenous with the control diet containing slightly less energy because it did not include additional fat. Every diet was made in the form of a mash. The content of ether extract and fatty acid profile of representative samples of soybean oil and poultry fat was analyzed before the diet formulation.

Table 1. Nutrient Composition of the basal diet

Nutrients	Starter Diet	Finisher Diet
Crude Protein (%)	22.0	20.0
Metabolizable Energy (kcal/kg)	3000	3100
Crude Fiber (%)	3.5	3.0
Calcium (%)	1.0	0.9
Available Phosphorus (%)	0.45	0.40
Lysine (%)	1.2	1.0
Methionine (%)	0.5	0.45

Name of Vitamin and mineral premix provided per kg diet: Vitamin A 12,000 IU, Vitamin D3 3,000 IU, Vitamin E 20 mg, Vitamin K3 2mg, Vitamin B1 2mg, Vitamin B2 6mg, Vitamin B6 4mg, Vitamin B12 0.01mg, Folic Acid 1 mg, Niacin 20mg, Biotin 0.05mg, Choline 500mg, Fe 80mg.

2.3 Performance Measurements, Growth

Performance growth was measured during the 42 days of the experiment on a pen basis whereby the pen was viewed as the experimental unit. Chick weight Individual body weights of chicks were measured at placement (day 1) to get initial body weight. Then, the weight of birds was determined at the pen at the culmination of each feeding period (day 14, 28, and 42) on a calibrated 1 g scale. The amount of feed that was given to each pen and the remaining feed at the end of each unit was recorded to determine the intensity of the feed intake. Feed spillage had been reduced and considered when possible to be accurate. Intake of cumulative feed was summed up in each phase (starter, grower, and finisher) and in the experimental duration (1-42 days). The difference between final and initial body weight of a period was taken as body weight gain (BWG). The calculation of feed conversion ratio (FCR) made the ratio of feed intake divided by body weight gain (FCR = FI/BWG): each pen was calculated on a phase and total basis. Birds were monitored on daily basis to confirm the general health conditions and death was recorded as it happened. Mortality Because of the mortality, the body weight of dead birds was noted, and the feed ratio during mortality was adjusted by changing the feed intake and weight gain.

2.4 Chemical Analysis

Each diet experimental sample was collected at a specific stage and analyzed in relation to dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF) and ash using the AOAC protocols [9]. The calculated metabolizable energy was calculated on the basis of the analyzed nutrient composition.

2.5 Statistical Analysis

Analysis of data was done on the General Linear Model (GLM) procedure of SAS (Version 9.4, SAS Institute Inc., Cary, NC, USA). The experimental unit was regarded as the pen. The effect of dietary treatment (CON, SO, PF) was determined by one-way ANOVA. Tukey multiple comparison test was used to divide the means of treatment in case there was a significant difference between them ($P < 0.05$). It shows the results in the form of means and the standard error of the mean (SEM).

3. Results

3.1 Growth Performance

3.2 Starter Phase (1–14 days)

At the starter phase, the lipid source in the diet had a major impact on weight gain of the body ($P < 0.05$) (Figure 1). The soybean oil (SO) diet group had a greater body weight gain than the control group (CON), whereas the poultry fat (PF) group had intermediate values that did not significantly differ with either SO or CON group, but were significantly higher than the control group. There was no significant difference in the feed intake between the treatments ($P > 0.05$) (Figure 2). Nonetheless, both SO and PF groups would have greatly enhanced their feed conversion ratio (FCR) when compared with the CON group ($P < 0.05$) and this is a sign that the supplemental fat was more effective in enhancing feed efficiency (Figure 2).

3.3 Grower Phase (15–28 days)

During the grower stage, birds fed supplemental fat (SO and PF) had superior body weight and body weight increase

than the CON group ($P < 0.05$) (Figure 1). There were also no significant differences between both SO and PF treatment in the body weight gain ($P > 0.05$). There were no differences in feed intake between treatments ($P > 0.05$) (Figure 1). The two fat sources did not have a significant difference and both SO and PF diets greatly improved FCR as compared to the CON diet ($P < 0.05$) (Figure 2).

3.4 Finisher Phase (29–42 days)

On day 42, body weight at the finisher stage was much greater in SO and PF fed birds than in the CON fed birds ($P < 0.05$) (Figure 1). Gain in body weight was also of the same trend. The dietary treatment did not significantly influence the feed intake ($P > 0.05$) (Figure 1). Feed conversion ratio was still better in SO and PF groups compared to that of CON group ($P < 0.05$), but there was no significant difference in SO and PF treatment groups (Figure 2).

Figure 1. Effects of Dietary Treatments on Growth Performance of Broiler Chickens by Different Production Phase

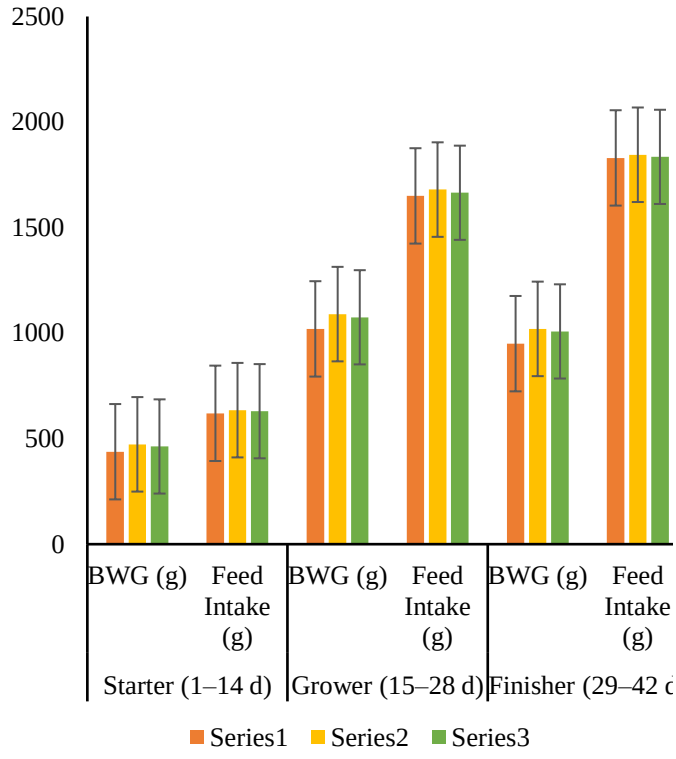
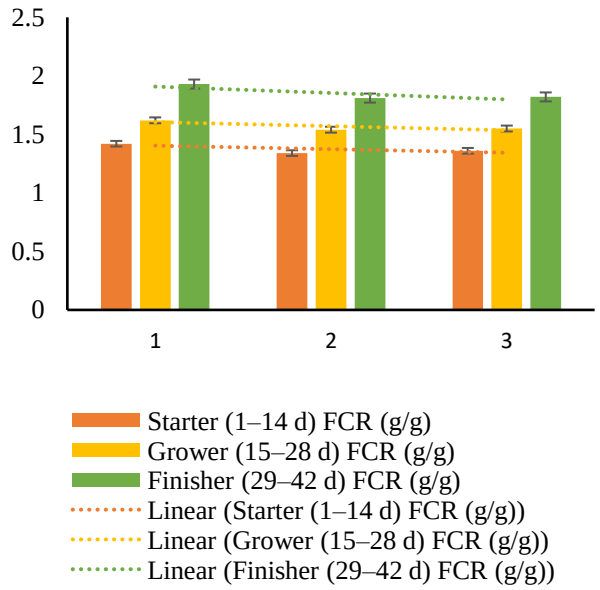


Figure 2. Effects of Dietary Treatments on FCR of Broiler Chickens by Different Production Phase



3.5 Overall Performance (1–42 days)

Dietary fat supplementation also increased growth performance as compared to control diet over the entire period of experiment. Birds fed SO and PF diets had higher final body weight and cumulative body weight gain as compared to its counterparts in the CON control group ($P < 0.05$) (Table 2). The treatment did not have a significant effect on feed intake ($P > 0.05$). Nevertheless, cumulative FCR was much lower (bettered) both in the SO and PF groups than in the CON group ($P < 0.05$). There were no statistically significant differences in the overall body weight gain, feed intake or feed ratio among the SO and PF treatments ($P > 0.05$), indicating that poultry fat could be equal to the soybean oil in supporting broiler growth performance when diets were balanced to that level.

3.6 Mortality

The mortality rate was not significant and it was not different between treatments ($P > 0.05$), so the source of dietary fat was not harmful to the health or survivability of birds over the course of the experiment.

4. Discussion

The research paper compared the relative performances of poultry fat and soybean oil on broiler chicken growth in the starter, grower and finisher stages. The findings proved that growth performance was significantly enhanced by the addition of dietary sources of fat as opposed to control diet that did not have any supplemental fat. Specifically, broilers given soybean oil or poultry fat diets demonstrated better

body weight gain and feed conversion ratio (FCR) during the course of the experiments, which provided evidence of the positive nature of dietary lipids in the nutrition of broilers [10].

Table 2. Effects of Dietary Treatments on Overall (1–42 d) Growth Performance of Broiler Chickens

Parameter	CON	SO	PF	SEM	P-value
Final BW (g)	2450[b]	2625[a]	2588[a]	35	0.018
Total BWG (g)	2408[b]	2583[a]	2546[a]	34	0.018
Total FI (g)	4100	4150	4125	40	0.56
Overall FCR (g/g)	1.70[a]	1.61[b]	1.62[b]	0.02	0.015

Different superscripts (a,b) within a row indicate significant differences ($P < 0.05$). CON = control diet (no added fat); SO = soybean oil diet; PF = poultry fat diet; BWG = body weight gain; FI = feed intake; FCR = feed conversion ratio; SEM = standard error of the mean.

In the starter period (1 14 days), birds fed on diets supplemented with soybean oil and poultry fat gained more body weight and had more effective feed consumption than control diet did. This may have been improved by the fact that dietary fat has a higher energy density in form of supplements. Compared to carbohydrates or proteins, lipids have over twice the metabolizable energy and this increases growth and makes lipids more efficient in nutrient usage in fast growing broiler chicks. Also, dietary fats reduce food transit time through the gastrointestinal tract and more nutrients are digested and absorbed [11]. This can be attributed to the fact that soybean oil group showed a slight higher performance during the early phase which may be due to higher level of unsaturated fatty acid content that is most likely to be more digestible in young birds since it has low melting point and is better emulsified [10].

Dietary fat supplementation had a positive impact on the body weight gain and the feed conversion ratio which was observed in grower phase (15- 28 days). Feeds based on soybean oil and poultry fat diets resulted in birds growing much faster than the control group and feed consumption in treatments did not differ markedly. This implies that the high growth performance was mainly based on the increase in the feed efficiency and not the increase in the feed consumption [12]. The similar outcomes obtained in the soybean oil and poultry fat treatments show that poultry fat has the capability of providing energy to the broilers in the event that diets are constructed correctly to ensure that metabolizable energy needs are met [10].

In a similar manner, supplemental fat-fed broilers recorded good performance even at the finisher stage (29 -42 days) than the control diet-fed broilers. The ultimate body mass and cumulative body mass increase were also greatly observed in both the soybean oil and poultry fat groups. This increase in the feed ratio ratio in fat-supplemented diets could be attributed to the fact that the former has more energy consumption and less heat increment of feeding linked to dietary lipids [10,11]. Besides, the digestive system of older birds is more developed and has a better digestive ability and metabolic ability to digest and metabolise the animal fats which could be the reason of similar performance in the later growth stages between the poultry fat and soybean oil [12].

In general, the findings of the current research show that supplementing the diets of broilers with fat does a great job to improve growth performance and feed efficiency [13]. Significantly, there were no notable differences in the majority of performance parameters in the case of soybean oil and poultry fat which implies that poultry fat could be used as an alternative source of lipids in chicken feed [12]. This observation is especially true in terms of economic and sustainability since the poultry fat is a by-product of the poultry processing industry and can help in saving feed as well as optimizing on the use of resources [10,12].

5. Conclusion

The findings of the study suggest that dietary fat inclusion enhanced growth performance, as well as, feed efficiency of broilers chicken relative to the control diet. The broilers who were fed soybean oil and poultry fat diets recorded an increase in body weight and an increase in the ratio of feed to weight during the experimental period. This means that poultry fat can be used in the diet of broilers instead of soybean oil, since there was no significant difference in the growth performance of broilers fed on soybean oil and poultry fat. Poultry fat can hence be explored as a viable low cost and eco-friendly alternative source of energy in the diet of broilers.

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