



## Inclusion of Dietary Palm Oil and Soy Oil on Growth Performance and Nutrition Digestibility in Broiler Chickens

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**ABSTRACT** The effects of palm oil and soy oil supplementation in broiler chickens on growth performance and nutrient digestibility of dry matter, nitrogen, and energy was evaluated. In this experiment, 702 one-day-old Ross 308 cross bred chicks with an initial body weight of 42.23±0.05 g (mean±SD) were utilized in a completely randomized treatment design (13 replicates/treatment, 18 chickens/cage) and fed for 35 days with CON (basal diet), T1 (Basal diet + 1.3 % palm oil), and T2 (Basal diet + 1.3% soy oil). From days 1 to 7, the body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR) were not significantly affected by the supplementation with palm oil or soy oil. However, from days 7 to 21, BWG showed a tendency to increase compared to that with the control treatment. Moreover, BWG was significantly improved ( $P<0.05$ ) with palm and soy oil supplementation during the overall experiment in comparison to that with the control diet. In addition, the palm oil-supplemented group had higher BWG than the soy oil treatment group ( $P<0.05$ ). During the overall experiment, FI tended to increase in the T1 group compared to that in the other groups. There was no significant effect on FCR and nutrient digestibility of dry matter, nitrogen, and energy during the overall trial with the supplementation of palm or soy oil. In summary, the inclusion of dietary palm and soy oil has a beneficial effect on the growth performance of broiler chickens.

(Key words: growth performance, nutrient digestibility, palm oil, soy oil, broiler)

## INTRODUCTION

Chicken meat is commonly consumed around the world because they are rich in protein and lower in fat. Energy is the foremost dietary component for the high performance of animals. With a high energy density, fats and oils have become more important energy sources in poultry feed composition. Thus, chicken requires a diet with high nutritional and energy density to enhance their growth performance. During the 21st century, the cost of poultry feed meets approximately 60~70% of the total production cost (Wilson and Bayer, 2000), however, energy alone contributes almost 70% of the feed cost (Saleh et al., 2004). In order to minimize feed cost, poultry producers are showing their interest to use the cheapest form of energy source that promotes the growth rate.

In the past decades, grains and cereals were replaced with highly concentrated energy sources like fats and oils in poultry diet. Oils or fats are the main source of monounsaturated fatty acid (MUFA) and polyunsaturated (PUFA) fatty acid in the

diet (De Sousa Lima et al., 2016). Such oils or fats are very essential not only for humans but also for animals. Fats supplementation in diet recognized as a valuable method for meeting high energy requirements of rapid growth in broilers. Vegetable oils are highly digestible and considered as the best source of energy for livestock. Palm oil is one of the most abundant and generally used as vegetable oil worldwide (Murugesan et al., 2013; Ayisi et al., 2017). It contains adequate amounts of  $\beta$ -carotene, tocopherols and tocotrienols, 50% saturated fatty acids, 40% MUFA and 10% PUFA and these natural antioxidants provides high energy density in the diet (Babalola et al., 2011). Previously, Smink et al. (2008) reported that use of palm oil in broiler had a positive influence on meat firmness. Moreover, Soy oil is a high-quality of edible oil for humans and high-quality of vegetable protein in animal feed worldwide. It contains 61% (PUFA) and 24% (MUFA) and rich in sterols, vitamin A, E and K. Ayed et al. (2015) stated that using soy oil and palm oil in poultry feed would subsequently affect human health in a positive manner.

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Moreover, Kamran et al., (2020) reported that supplementation of soy oil had higher performance than other sources in growing broiler. In addition, Blanch et al. (1996) and Zhao and Kim (2017) reported that soy oil and palm oil had enhance the growth performance in broiler chickens. However, Soybean meal, wheat bran, and tallow are significantly contributed as dietary fat sources, although the limited use of these sources does not suggest that they are less important to the poultry industry. To our knowledge, there is limited information presented on the use of palm oil and 1.3% soy oil in poultry diet. Therefore, the objective of this study was carried out to find the effect of palm oil and soy oil on growth performance and nutrient digestibility of dry matter, nitrogen and energy in broiler chickens.

## MATERIALS AND METHODS

The experiment was performed under protocols approved by the Animal Care and Use Committee of Dankook University, Cheonan, Republic of Korea, for animal experimentation (Approval no DK-1-1930).

### 1. Experimental Diet and Birds Housing

A total of seven hundred and two 1-d old Ross 308 broiler chicks (mixed-gender) with an initial weight of  $42.23 \pm 0.05$  g (mean $\pm$ SD) were used in 35 days growth assay. Chickens were randomly distributed (13 replicates/treatment, 18 chickens/cage) into three treatment groups and fed with the following diet: CON (basal diet), TRT 1 (Basal diet + 1.3% palm oil), TRT 2 (Basal Diet + 1.3% soy oil). Initially, birds were raised in  $33 \pm 1^\circ\text{C}$  temperature later it was reduced up to  $24^\circ\text{C}$  and the humidity was maintained around 60% for the remaining trials. During the trial chickens were housed using the stainless-steel cages of the same size ( $1.75 \times 1.55$  m) and had free access to feed and water. The basal diets were formulated to meet or exceed the dietary requirements of broilers during starter (d 1~21) and finisher (d 22~35) phase, according to NRC (1994) recommendations. Experimental diet ingredients and chemical compositions were shown in Table 1 and 2.

### 2. Sampling and Measurement

**Table 1.** Chemical composition of experimental diets (as fed-basis)

| Item                        | Starter <sup>1</sup> |               |               |
|-----------------------------|----------------------|---------------|---------------|
|                             | Control              | Palm oil      | Soy oil       |
| <b>Ingredients (%)</b>      |                      |               |               |
| Corn                        | 50.61                | 48.90         | 48.61         |
| Soybean meal                | 37.04                | 36.50         | 36.38         |
| Corn gluten meal            | 4.50                 | 6.76          | 7.16          |
| Wheat bran                  | 3.00                 | 3.00          | 3.00          |
| Soybean oil                 | -                    | -             | 1.30          |
| Tallow                      | 1.30                 | -             | -             |
| Palm kenel oil              | -                    | 1.30          | -             |
| Tricalcium phosphate        | 1.95                 | 1.94          | 1.94          |
| Limestone                   | 0.84                 | 0.84          | 0.84          |
| Salt                        | 0.36                 | 0.36          | 0.36          |
| DL-Methionine (98%)         | 0.19                 | 0.19          | 0.19          |
| L-Lysine (98%)              | 0.01                 | 0.01          | 0.02          |
| Mineral mix <sup>2</sup>    | 0.10                 | 0.10          | 0.10          |
| Vitamin mix <sup>3</sup>    | 0.10                 | 0.10          | 0.10          |
| <b>Total</b>                | <b>100.00</b>        | <b>100.00</b> | <b>100.00</b> |
| <b>Chemical composition</b> |                      |               |               |
| ME (kcal/kg)                | 3200                 | 3200          | 3200          |
| Crude protein (%)           | 23.00                | 23.00         | 23.00         |
| Ether extract (%)           | 3.89                 | 3.94          | 3.94          |
| Crude fibre (%)             | 3.18                 | 3.28          | 3.30          |
| Ash (%)                     | 6.57                 | 6.63          | 6.63          |
| Ca (%)                      | 1.10                 | 1.10          | 1.10          |
| Available P (%)             | 0.57                 | 0.57          | 0.57          |
| Lysine (%)                  | 1.26                 | 1.26          | 1.26          |
| Methionine (%)              | 0.54                 | 0.54          | 0.54          |

<sup>1</sup> Starter diet provided during d 1 to 21.

<sup>2</sup> Provided per kg of complete diet: 37.5 mg Zn (as ZnSO<sub>4</sub>); 37.5 mg Mn (as MnO<sub>2</sub>); 37.5 mg Fe (as FeSO<sub>4</sub> · 7H<sub>2</sub>O); 3.75 mg Cu (as CuSO<sub>4</sub> · 5H<sub>2</sub>O); 0.83 mg I (as KI); and 0.23 mg Se (as Na<sub>2</sub>SeO<sub>3</sub> · 5H<sub>2</sub>O).

<sup>3</sup> Provided per kg of complete diet: 15,000 IU of vitamin A, 3,750 IU of vitamin D<sub>3</sub>, 37.5 IU of vitamin E, 2.55 mg of vitamin K<sub>3</sub>, 3 mg of thiamin, 7.5 mg of riboflavin, 4.5 mg of vitamin B<sub>6</sub>, 24 µg of vitamin B<sub>12</sub>, 51 mg of niacin, 1.5 mg of folic acid, 0.2 mg of biotin and 13.5 mg of Ca-pantothenate.

**Table 2.** Chemical composition of experimental diets (as fed-basis)

| Item                        | Finisher <sup>1</sup> |               |               |
|-----------------------------|-----------------------|---------------|---------------|
|                             | Control               | Palm oil      | Soy oil       |
| <b>Ingredients (%)</b>      |                       |               |               |
| Corn                        | 54.45                 | 53.41         | 53.33         |
| Soybean meal                | 33.39                 | 33.19         | 33.17         |
| Corn gluten meal            | 2.25                  | 2.25          | 2.25          |
| Wheat bran                  | 5.46                  | 6.70          | 6.80          |
| Soybean oil                 | -                     | -             | 1.30          |
| Tallow                      | 1.30                  | -             | -             |
| Palm kenel oil              | -                     | 1.30          | -             |
| Tricalcium phosphate        | 1.35                  | 1.35          | 1.35          |
| Limestone                   | 1.14                  | 1.14          | 1.14          |
| Salt                        | 0.36                  | 0.36          | 0.36          |
| DL-Methionine (98%)         | 0.10                  | 0.10          | 0.10          |
| Mineral mix <sup>2</sup>    | 0.10                  | 0.10          | 0.10          |
| Vitamin mix <sup>3</sup>    | 0.10                  | 0.10          | 0.10          |
| <b>Total</b>                | <b>100.00</b>         | <b>100.00</b> | <b>100.00</b> |
| <b>Chemical composition</b> |                       |               |               |
| ME (kcal/kg)                | 3,200                 | 3,200         | 3,200         |
| Crude protein (%)           | 21.50                 | 21.50         | 21.50         |
| Ether extract (%)           | 3.96                  | 3.98          | 3.98          |
| Crude fibre (%)             | 3.19                  | 3.27          | 3.27          |
| Ash (%)                     | 6.06                  | 6.10          | 6.10          |
| Ca (%)                      | 1.00                  | 1.00          | 1.00          |
| Available P (%)             | 0.45                  | 0.45          | 0.45          |
| Lysine (%)                  | 1.15                  | 1.15          | 1.15          |
| Methionine (%)              | 0.43                  | 0.43          | 0.43          |

<sup>1</sup> Starter diet provided during d 1 to 21; Finisher diet provided during d 22 to 35.

<sup>2</sup> Provided per kg of complete diet: 37.5 mg Zn (as ZnSO<sub>4</sub>); 37.5 mg Mn (as MnO<sub>2</sub>); 37.5 mg Fe (as FeSO<sub>4</sub> · 7H<sub>2</sub>O); 3.75 mg Cu (as CuSO<sub>4</sub> · 5H<sub>2</sub>O); 0.83 mg I (as KI); and 0.23 mg Se (as Na<sub>2</sub>SeO<sub>3</sub> · 5H<sub>2</sub>O).

<sup>3</sup> Provided per kg of complete diet: 15,000 IU of vitamin A, 3,750 IU of vitamin D<sub>3</sub>, 37.5 IU of vitamin E, 2.55 mg of vitamin K<sub>3</sub>, 3 mg of thiamin, 7.5 mg of riboflavin, 4.5 mg of vitamin B<sub>6</sub>, 24 µg of vitamin B<sub>12</sub>, 51 mg of niacin, 1.5 mg of folic acid, 0.2 mg of biotin and 13.5 mg of Ca-pantothenate.

On day 0, 7, 21 and 35 broilers were weighed, and feed intake was calculated to determine average BWG, FI, and FCR.

To find out the nutrient digestibility of dry matter and nitrogen on days 28% to 35%, 0.2% of chromic oxide as an indigestible marker was added to the diets. Fresh excreta samples were collected from each pen on days 33, 34, and 35 and stored at -20°C until analyzed. Before starting chemical analysis, the excreta samples were thawed and dried at 70°C for 72 h. Soon after, dried samples were grinded well and passed through a 1mm screen. All feed and fecal samples were freeze-dried and finely ground to pass through a 1 mm screen. DM and N digestibility were determined using methods established by the Association of Official Analytical Chemists (AOAC, 2000). UV absorption spectrophotometry (UV- 1201, Shimadzu, Kyoto, Japan) was used to determine chromium in the diets and feces and Parr 6100 oxygen bomb calorimeter (Parr Instrument Co., Moline, IL, USA) was used to analyze energy by measuring the heat of combustion in the samples. The apparent total tract digestibility of nutrients was calculated by the following techniques: digestibility (%) =  $\{1 - [(Nf \times Cd) / (Nd \times Cf)]\} \times 100$ , where Nf: nutrient concentration in feces (% DM), Cd: chromium concentration in diet (% DM), Nd: nutrient concentration in diet (% DM), and Cf: chromium concentration in feces (% DM).

All data were analyzed using the GLM procedure of SAS/STAT<sup>®</sup> (Statistical Analysis System, version 9.2, Cary, NC, USA). Replication (n=13) was used as the experimental unit. Orthogonal contrasts were used for the effects of treatments. Mean values and standard errors of the mean were reported. A threshold value of  $P < 0.05$  was established to denote statistical significance and  $P < 0.1$  was considered a trend.

## RESULTS AND DISCUSSION

Earlier studies indicated that supplementation of vegetable oils such as palm oil and soybean oil in broiler diet had positive impact on the growth performance (Blanch et al., 1996; Zhao and Kim, 2017), which agrees with our study. The supplementation of palm oil and soy oil in broilers fed has trended to increase ( $P=0.089$ ) body weight gain at day 7 to 21. While, body weight gain was significantly improved ( $P < 0.05$ ) during

overall experiment period compared than the control diet. In addition, the palm oil treatment group has significantly improved the body weight gain compared to the soy oil treatment group ( $P<0.05$ ). In contrast, Ao and Kim (2020) stated that soy oil supplementation had enhance the body weight gain in pekin ducks comparability to palm oil treatment group. The contradictory was happening in this result due to the variation of animals and differences in palm oil and soy oil dietary compositions. However, in the overall experiment feed intake (FI) was trend to increase in palm oil treatment group compared to other groups. There was no significant effect on FCR during overall trial (Table 3) our findings concede with the of Azman et al. (2004) and Abdulla et al. (2016) who stated that the supplementation of dietary soy oil did not affect the FI in broilers. The inclusion of soybean oil

had improved body weight gain and reduced FCR compared with tallow in chicken indicated by Zhang et al. (2011). In addition, Febel et al. (2008) and De Witt et al. (2009) reported that dietary inclusion with soy oil had no beneficial effect on the FI and FCR of chicken.

In previous study, Zhang et al. (2011) denote that the inclusion of soy oil and palm oil in broiler fed had no significant effect on nutrient digestibility of DM, N, and energy. Similarly, our findings also have no significant ( $P>0.05$ ) effect on nutrient digestibility of dry matter (DM), nitrogen (N), and energy due to the dietary soy oil and palm oil supplementation showed in Table 4. Moreover, Kavouridou et al. (2008), reported that nutrient digestibility of nitrogen had not significantly affect the broilers fed diet containing palm oil, soybean oil and linseed oil. In contrast, Chung et al. (1993)

**Table 3.** The effect of palm oil and soy oil supplementation on growth performance in broilers<sup>1</sup>

| Items      | CON                | T1                 | T2                  | SEM <sup>2</sup> | P-value        |           |
|------------|--------------------|--------------------|---------------------|------------------|----------------|-----------|
|            |                    |                    |                     |                  | Con vs. others | T1 vs. T2 |
| d 1 to 7   |                    |                    |                     |                  |                |           |
| BWG (g)    | 104                | 109                | 105                 | 2.62             | 0.428          | 0.351     |
| FI (g)     | 126                | 130                | 125                 | 3.85             | 0.719          | 0.388     |
| FCR        | 1.204              | 1.197              | 1.195               | 0.030            | 0.961          | 0.677     |
| d 7 to 21  |                    |                    |                     |                  |                |           |
| BWG (g)    | 614                | 635                | 623                 | 7.18             | 0.089          | 0.266     |
| FI (g)     | 1,053              | 1,073              | 1,062               | 7.09             | 0.147          | 0.349     |
| FCR        | 1.718              | 1.692              | 1.707               | 0.025            | 0.335          | 0.674     |
| d 21 to 35 |                    |                    |                     |                  |                |           |
| BWG (g)    | 950                | 991                | 962                 | 13.54            | 0.112          | 0.143     |
| FI (g)     | 1,767              | 1,804              | 1,763               | 20.15            | 0.495          | 0.156     |
| FCR        | 1.863              | 1.822              | 1.835               | 0.027            | 0.372          | 1.00      |
| Overall    |                    |                    |                     |                  |                |           |
| BWG (g)    | 1,667 <sup>b</sup> | 1,735 <sup>a</sup> | 1,691 <sup>ab</sup> | 14.52            | 0.017          | 0.042     |
| FI (g)     | 2,945              | 3,007              | 2,950               | 22.37            | 0.236          | 0.083     |
| FCR        | 1.767              | 1.733              | 1.745               | 0.017            | 0.380          | 0.759     |

<sup>1</sup> Abbreviation: CON, basal diet; T1, basal diet + 1.3% palm oil; T2, basal diet + 1.3% soy oil.

<sup>2</sup> Standard error of means. Values are represented by 13 replicates/treatment, 18 chickens/cage into three treatment groups.

<sup>a,b</sup> Mean values within a row without a common superscript differ significantly ( $P<0.05$ ).

BWG, body weight gain; FI, feed intake; FCR, feed conversion ratio.

**Table 4.** The effect of palm oil and soy oil supplementation on nutrient digestibility in broilers<sup>1</sup>

| Items (%)  | CON   | T1    | T2    | SEM <sup>2</sup> | P-value        |           |
|------------|-------|-------|-------|------------------|----------------|-----------|
|            |       |       |       |                  | Con vs. others | T1 vs. T2 |
| Dry matter | 70.62 | 71.39 | 70.89 | 0.810            | 0.607          | 0.666     |
| Nitrogen   | 68.6  | 69.66 | 69.21 | 0.817            | 0.417          | 0.702     |
| Energy     | 69.05 | 69.72 | 69.23 | 0.976            | 0.728          | 0.731     |

<sup>1</sup> Abbreviation: CON, basal diet; T1, basal diet + 1.3% palm oil; T2, basal diet + 1.3% soy oil.

<sup>2</sup> Standard error of means. Values are represented by 13 replicates/treatment, 18 chickens/cage into three treatment groups.

and Zollitsch et al. (1997) believed that vegetable oil is rich in unsaturated fatty acids that helps animals for easy digestion than animal fat which is rich in saturated fatty acids. However, the lack of nutrient digestibility performance among species and the usage of palm oil and soy oil composition in the diet was limited. we could not conclude our studies related to this diet supplementation. Thus, further investigation is needed to determine the nutrient digestibility of broilers fed with palm oil and soy oil.

## SUMMARY

The present study will be the base of forthcoming research. The dietary supplementation of palm oil and soy oil has a positive effect on broilers growth performance. However, in this study palm or soy oil additive has not affect the nutrient digestibility. Therefore, more investigation and wide knowledge is needed to understand overall functional performance in broilers with different percentage of palm oil and soy oil supplementation.

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