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ANIMAL

Effect of non-dairy creamer (NDC) supplementation in a corn-soybean meal based diet on growth performance, nutrient digestibility, and meat quality in broilers

Hao Yang Sun, In Ho Kim*

Department of Animal Resource and Science, Dankook University, Cheonan 31116, Korea

*Corresponding author: inhokim@dankook.ac.kr

Abstract

A total of 576 seven-day-old male Ross 308 broilers with an average initial BW of 180 ± 1 g were used in a 4 week feeding experiment which included a starter phase (7 to 21 d) and a grower phase (22 to 35 d). Birds were randomly allocated into 1 of 3 treatments with 12 replicates per treatment and 16 birds per pen. The treatments consisted of the following: T1, Control; T2, T1 + 0.1% Creamer (Dongsuh Foods Corporation, Incheon, Korea), and T3, T1 + 0.5% Creamer. The broilers were weighed by pen and feed intake (FI) and the number of living broiler chickens were recorded on d 7, 21, and 35. These information were used to calculate the body weight gain (BWG) and feed conversion ratio (FCR). As results of this experiment, there were no significant differences in the BWG, FCR and nutrient digestibility among the treatments. With regards to meat quality, no adverse effects were observed among the treatments. However, a higher score in redness was observed in T3 than in T1. In addition, the relative weight of breast muscle was reduced in T3 compared with T1. Regardless of the non-dairy creamer (NDC) inclusion levels, no negative effects on growth performance and nutrient digestibility were observed. In conclusion, non-dairy creamer could be a kind of fat sources additive in broiler diets, further studies are needed to test the optimum levels of the NDC to be supplemented in broilers diet.

Keywords: broiler, carcass quality, growth performance, non-dairy creamer, nutrient digestibility

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Introduction

Feed fats are routinely included into broiler diets as a source of essential fatty acids and energy. Animal fats are rich in long-chain saturated fatty acids such as tallow and lard, meanwhile, most of vegetable fats have higher content of unsaturated fatty acids (Smink, et al., 2008). Some studies have reported that unsaturated fats had higher metabolizable energy (ME) utilization than saturated fats (Zollitsch et al., 1997; Crespo and Esteve-Garcia, 2001). The use of unsaturated fats decreased the melting point of the fat in broiler carcass (Bavelaar and Beynen, 2003), diminished the firmness of the fat (Gläser et al., 2004). Kavouridou et al. (2008) reported that with the similar amount of fat intake, unsaturated fat treatments had higher fat digestibility. However, Crespo and Esteve-Garcia (2002) also reported that chickens fed 10% tallow diet had significant higher fat intake but no significantly differences on digestibility with 10% olive, sunflower or linseed oil diets.

Newman et al. (2002) reported that there was a significant improvement in body weight and feed conversion ratio when feeding 3% of canola oil than animal fat. However, Fébel et al. (2008) reported that there were similar average weekly body weights and feed conversion among lard, sunflower oil, soybean oil, and linseed oil in broiler diets. Some other studies have shown that abdominal fat deposition of broilers was decreased when tallow was replaced by vegetable fats rich in polyunsaturated fatty acids (Ferrini et al., 2008; Wongsuthavas et al., 2008). On the other hand, Cortinas et al. (2005) reported that higher poly-unsaturation level cause lipid oxidation in thigh meat. Therefore, it would be interesting to consider the effect of replacing animal fats by vegetable fat sources in the diet of broiler chickens.

It was well known, that Non-Dairy Creamer (NDC) is one kind of additive intended to substitute for milk or cream in coffee, tea, hot chocolate or other beverages, which often contain hydrogenated vegetable-based fats, in another word saturated fatty acids (SFA). By hydrogenation, liquid vegetable oils converts into solid or semi-solid fats increased oxidative stability, longer shelf life and cheaper than animal fats. As far as we know, there are limited studies using NDC as a kind of fat sources in broiler diets. Consequently, the objective of the current study was to evaluate the effect of two different levels of NDC added to diets on growth performance, nutrient digestibility and carcass quality in corn-soybean meal based diet broilers.

Materials and Methods

The Animal Care and Use Committee of Dankook University approved all experimental protocols used in the current study.

Experimental design, Animals, and Housing

A total of 576 seven-day-old malebroiler chickens (Ross 308) with an average initial BW of 180 ± 1 g were used in a 4 wk growth assay. The experiment was conducted in 2 phases consisting of a starter phase (7 to 21 d) and a grower phase (22 to 35 d). Broilers were randomly allotted to 3 dietary treatments containing: T1, Control; T2, T1 + 0.1% Creamer (Dongsuh Foods Corporation, Incheon, Korea); T3, T1 + 0.5% Creamer. All diets were formulated to meet or exceed the NRC (1994) requirements for broiler chickens (Table 1). The analyzed composition of the Creamer is presented in Table 2. There were 12 replicated pens per treatment with 16 broiler chickens per pen. Broiler chickens were housed in the animal building of Dankook University and practiced an all-in and all-out production system. The room was cleaned every week during the experiment and it was sterilized

Table 1. Feed composition of control diet (as-fed basis).

Items	Starter (d 7 to 21)	Finisher (d 22 to 35)
Ingredients (g/kg)		
Corn	553.4	629.2
Soybean meal, 480 g/kg of CP	282.5	246.1
Corn gluten meal, 600 g/kg of CP	65.0	35.0
Soybean oil	55.0	48.9
Dicalcium phosphate	24.6	22.9
Linestone	8.9	7.5
Salt	2.0	2.0
DL-Met, 980 g/kg	1.7	1.7
L-Lys-HCL, 780 g/kg	2.1	2.1
Vitamin premix[y]	2.0	2.0
Trace mineral premix[z]	2.0	2.0
Choline chloride	0.8	0.6
Calculated composition		
ME (MJ/kg)	13.14	12.93
Analytical composition (g/kg)		
CP	221.0	198.0
Met + Cys	9.0	7.4
Ca	10.0	9.0
Total P	7.9	7.6

[y]Provided per kg of diet: 15,000 IU of vitamin A (vitamin A acetate), 3750 IU of vitamin D3, 37.5 IU of vitamin E (α-tocopheryl acetate), 2.55 mg of vitamin K3, 3 mg of thiamin, 7.5 mg of riboflavin, 4.5 mg of vitamin B6, 24 μg of vitamin B12, 51 mg of niacin, 1.5 mg of folic acid, 0.2 mg of biotin and 13.5 mg of pantothenic acid.
[z]Provided per kg of diet: 37.5 mg Zn (as $ZnSO_4$), 37.5 mg of Mn (MnO_2), 37.5 mg of Fe (as $FeSO_4 \cdot 7H_2O$), 3.75 mg of Cu (as $CuSO_4 \cdot 5H_2O$), 0.83 mg of I (as KI), and 0.23 mg of Se (as $Na_2SeO_3 \cdot 5H_2O$).

Table 2. Composition of Non-Dairy Creamer (NDC).

Item	%
Moisture	5.21
Crude protein	3.02
Crude fat	5.86
Crude fiber	2.42
Crude ash	3.27
Lysine	0.16
Methionine	0.09
Cystine	0.02
Met + Cys	0.11
Threonine	0.11
Vailne	0.13
Isoleucine	0.11
Leucine	0.23
Arginine	0.07
Histidine	0.07
Alanine	0.07
Aspartic Acid	0.17
Serine	0.15
Glutamic Acid	0.51
Glycine	0.04
Tyrosine	0.09
Phenylalanine	0.12
Proline	0.25

regularly by using a disinfectant (Virkon-S). The temperature of the room was maintained at 33 ± 1℃ for the first 3 d, and then gradually decreased by 3℃ per week to 24℃ until the end of the experiment and the humidity was kept around 60% through the whole experiment. Artificial light was provided 24 h per day by fluorescent lights, and were allowed free access to feed and water during the experiment. Each pen was equipped with two feeders in each side and two nipple drinkers.

Growth Performance and Nutrient Digestibility

The broilers were weighed by pen and feed intake (FI) and the number of living broiler chickens were recorded on d 7, 21, and 35. This information was then used to calculate body weight gain (BWG), feed conversion ratio (FCR), and survival rate. From d 28 to 35, chromic oxide (0.2%) as an indigestible marker was added to diets for determination of nutrient digestibility of dry matter (DM), Calcium (Ca), phosphorus (P), and nitrogen (N). Fresh fecal samples were collected from each pen on d 33, 34, and 35. Fecal samples were stored in a freezer at - 20℃ until analyzed. Before chemical analysis, the fecal samples were thawed and dried at 70℃ for 72 h, and then they were finely ground to a size that could pass through a 1-mm screen. Then, all the feed and fecal samples were analyzed, following the procedures outlined by the AOAC (2000). Chromium was analyzed via ultraviolet absorption spectrophotometry (Shimadzu UV-1201, Shimadzu, Kyoto, Japan) following the method described by Williams et al. (1962). The digestibility was then calculated using the following formula: 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) (Cai et al., 2015).

Carcass Quality and Relative Organ Weights

At the end of the experiment, 1 broiler per pen was randomly selected, weighed individually, and slaughter by cervical dislocation. The liver, spleen, bursa of fabricius, breast muscle, abdominal fat, and gizzard of the same broilers were removed by trained personnel and weighed. All organ weights were expressed as a percentage of body weight. The meat quality was evaluated by measuring the breast muscle color of lightness, redness, and yellowness values using a Minolta CR410 Chroma Meter (Konica Minolta Sensing, Inc., Osaka, Japan) immediately after mortem. Meat samples were measured at three different locations across the breast. The center of the cut was measured in triplicate to determine CIE color values and was expressed as L* (lightness), a* (redness) and b* (yellowness) values. At the same time, duplicate pH values for each sample were measured using a pH meter (Fisher Scientific, Pittsburgh, PA, USA). After which drip loss was measured using approximately 2 g of breast muscle sample according to the plastic bag method described by Honikel (1998). For determining the cooking loss percentage, breast meat samples were weighed before and after cooking, then the cooked weight divided by uncooked weight and multiplied by 100.

Statistical Analysis

For growth performance and nutrient digestibility measurements, each pen of birds was considered as an experimental unit for statistical analysis. For carcass quality, the individual bird was considered as an experimental unit. All data were statistically analyzed using the GLM Procedure of SAS (SAS Inst. Inc., Cary, NC, USA) Differences among treatments were separated by Duncan's multiple range test. Results were expressed as least square means and SEM. Probability values less than 0.05 were considered statistically significant.

Results and Discussion

Growth Performance and Nutrient Digestibility

The growth performance of broilers fed treatment diets were shown in Table 3. There were no significant differences on BWG and FCR among different treatments during both phases of experiment. However, from d 22 to 35 and in the overall period, broiler chickens fed T2 diet had slightly higher BWG than broilers fed T1 and T3 diets. In addition, the nutrient digestibility was not significantly different among treatments (Table 4). Smink et al. (2008) showed similar result that hydrogenated oil mixed with sunflower oil had significant higher than only sunflower oil in feed

Table 3. Effect of dietary supplementation of non-dairy creamer on growth performance in broilers[y].

Items	T1	T2	T3	SEM[z]
d 7-21				
BWG (g)	661	673	658	8.0
FI (g)	941	948	937	6.0
FCR	1.428	1.412	1.426	0.020
d 21-35				
BWG (g)	811ab	825ab	796b	21.0
FI (g)	1480	1478	1471	17.0
FCR	1.837	1.801	1.865	0.057
Overall				
BWG (g)	1472b	1499ab	1455b	20.0
FI (g)	2420	2426	2408	18.0
FCR	1.647	1.621	1.66	0.026

[y]Dietary treatments were: T1, basal diet; T2, T1 + 0.1% Creamer; T3, T1 + 0.5% Creamer.
[z]Standard error of the mean.
a, b: Means in a row with different letters are significantly different ($p < 0.05$).

Table 4. Effect of dietary supplementation of non-dairy creamer on nutrient digestibility in broilers[y].

Items	T1	T2	T3	SEM[z]
Dry Matter	72.40ab	72.75ab	71.62b	0.92
Nitrogen	68.15	68.37	67.10	1.23
Calcium	59.44	58.92	57.22	1.39
Phosphorus	47.56	46.25	46.8	1.61

[y]Dietary treatments were: T1, basal diet; T2, T1 + 0.1% Creamer; T3, T1 + 0.5% Creamer.
[z]Standard error of the mean.
a, b: Means in a row with different letters are significantly different ($p < 0.05$)

intake and feed conversion during finishing period, which means that the addition of saturated fats could affect the growth performance positively in broiler feeding. But in this present study, the supplementation of NDC didn't showed the significant effect on BWG and FCR which possibly because of the level of NDC inclusion was not so high in the diet. However, the aim of this study was testing if NDC could be a kind of fat source additive, in this regard; it seems that NDC could be a kind of additive which can influence broiler growth performance and more studies are needed to optimize the concentration level of supplemental NDC. There was also no significantly difference on nutrient digestibility among treatments. On the dry matter (DM), there was an increase tendency between T2 and T1. There were no nutritional limitations in the diet of the control group provided, as it met or exceeded NRC (1994) recommendations for nutrients and energy, thus improved growth performance from NDC addition was not attributed to increased feed consumption but due to improved efficiencies of nutrient use by the bird.

Meat Quality

The effect of NDC on meat quality attributes are presented in Table 5. The meat quality did not have adverse effect with the dietary supplementation of NDC. Moreover, the redness score of breast muscle color was increased ($p < 0.05$) in broiler chicken fed T3 diet compared with the T1 treatment (Table 5). However, the relative weight of breast muscle was reduced ($p < 0.05$) in T3 compared with T1. Cashman and Hayes (2017) reported red meat has more nutrition factors especially vitamin D. Poultry meat was always defined as "white meat" which seems pale meat (OLD, 2017). Likely,

Table 5. Effect of dietary supplementation of non-dairy creamer on carcass quality in broilers[y].

Items	T1	T2	T3	SEM[z]
pH value	6.15	6.18	6.16	0.11
Breast muscle color				
Lightness (L*)	45.89	45.94	45.21	0.47
Redness (a*)	9.63b	10.13ab	10.68a	0.20
Yellowness (b*)	9.19	9.18	9.13	0.17
Cooking loss (%)	17.73	17.86	17.66	0.58
Drip loss (%)				
day 1	2.47	2.38	2.97	0.31
day 3	6.28	5.81	6.39	0.50
day 5	9.59	9.57	9.75	0.47
day 7	13.51	13.75	13.76	0.69
Relative organ weight (%)				
Breast muscle	15.74ab	15.60b	13.97c	0.48
Liver	3.02	2.91	2.77	0.14
Bursa of Fabricius	0.15	0.16	0.15	0.01
Abdominal fat	1.25	1.20	1.22	0.09
Spleen	0.14	0.15	0.13	0.01
Gizzard	1.21	1.28	1.35	0.07

[y]Dietary treatments were: T1, basal diet; T2, T1 + 0.1% Creamer; T3, T1 + 0.5% Creamer.
[z]Standard error of the mean.
a - c: Means in a row with different letters are significantly different ($p < 0.05$).

Jaturasitha et al. (2016) suggested that fatty acid could improve meat quality in poultry diet. The results in this study proved this point. Poorghasemi et al. (2013) showed a result of breast weight that mixed fat sources by animal fat and plant fat were bigger than any other single fat sources. Conversely, in this study, the breast muscle weight was lower in T3 compared with T1. This possibly because of that there was more unsaturated fatty acid in breast meat in T1 (Smink et al., 2008).

Conclusion

In conclusion, the present study demonstrated that the Non-Dairy Creamer could be a kind of fat sources additive in broiler diets, not only because of the tendency to influence BWG, FCR and DM, but also regardless of NDC inclusion levels, generally results did not have negative effects on bird healthy performance. Further studies should be done to discover the best supplementation concentration for the growth performance.

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