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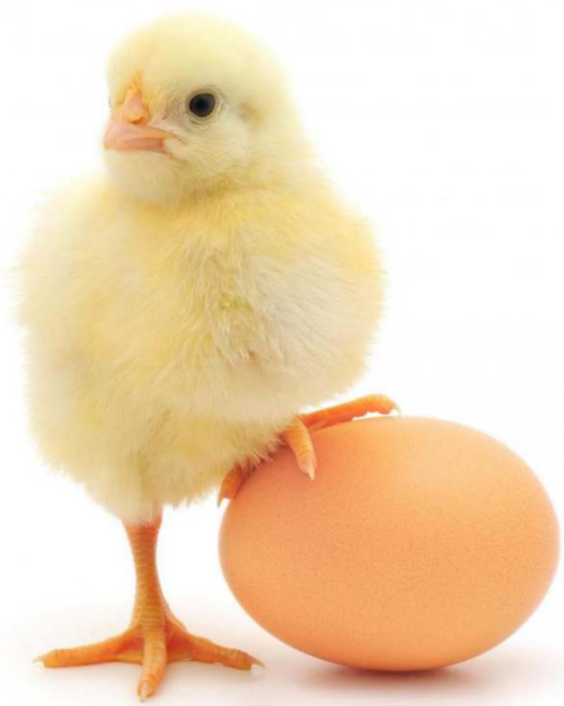

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Effects of Yellow Grease Addition to Broiler Rations Containing DDGS with Different Fat Contents

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Abstract: In the recent past, fat levels in Dried Distillers Grain with Solubles (DDGS) have changed due to the extraction of corn oil during the ethanol production process as the value of the oil has been seen as a profitable addition to the process. Due to the price of DDGS and the huge quantities available, continued and possibly increased use of DDGS is foreseen. However, the lowered fat content of the new products makes their use more difficult given the already reduced energy diets currently being fed due to the high cost of fat addition. The objective of this study was to determine if utilization of a rendered fat (yellow grease) could be used as a replacement for the fat removed from these products. The experiment was conducted on Cobb 500 broilers using three treatments. The three treatments included low fat DDGS, low fat DDGS+fat addition (yellow grease) to match a high fat DDGS and high fat DDGS at 10 and 20% inclusion rate (starter and grow-finish diets). The low fat DDGS treatment without fat addition acted as the negative control and was fed as a direct replacement for the high fat DDGS to demonstrate any loss in performance. In the following study these treatments were replicated 16 times with 30 broilers per pen to 49 days of age. There was no difference in weight gain between the treatments. Feed efficiency was significantly improved in the low fat DDGS+yellow grease treatment when compared to the other treatments. Feed efficiency was better in all cases with the high fat DDGS, but was not statistically different. Fat pad increased slightly in the yellow grease fed broilers as well and chilled carcass was larger as well. Additionally, breast yield was significantly higher for the birds fed the added grease. In conclusion, while it is difficult to pick up statistical differences with such small changes in energy when feeding high fat versus low fat DDGS (60 kcal differences), it would appear that the replacement of the lost oil with yellow grease does restore feed efficiency in broilers.

Key words: Broilers, turkeys, energy, fat addition

INTRODUCTION

Annually, the rendering industry produces significant quantities of feed grade quality rendered fats, providing a relatively inexpensive source of energy. The addition of concentrated fat sources to broiler rations is often times economically beneficial due to increased rates of gain, decreased feed intake and results in improved feed efficiency. Furthermore, numerous studies have been conducted comparing a variety of available fat sources, both animal and vegetable origin, included in broiler rations. Based on these experiments, variations in the ME levels occur between as well as within fat sources, however do not correlate to a difference in growth or carcass yield. Therefore, price should be the major determinate when selecting a fat source (Firman *et al*., 2008). Yellow grease is widely available and, in many cases, the cheapest fat source available for animal feeding.

Dried distillers' grains with solubles (DDGS) are a corn co-product that results from ethanol production. A good deal of research has been conducted concerning the use of DDGS for poultry rations, although concern does exist over ingredient quality and variability. In the dry-grind ethanol production process industry, an effort to utilize more of the energy found in corn is growing in popularity. Ethanol plants are installing corn oil extraction systems that remove crude corn oil from the thin stillage, a product of the centrifuge step following fermentation and distillation, but prior to the drying step. Corn oil removal alters the nutritional profile of the DDGS, reducing the fat and energy content and concentrating the available amino acids (Rochelle *et al*., 2011). This creates the potential to add a fat source when feeding the oil extracted DDGS to increase energy levels fed in broiler rations.

While plant-to plant product variation appears to be greater than within-plant variation, nutrient variability within plant can occur due to the drying process (Applegate and Adeola, 2006; Noll *et al*., 2007). For example, the grain drying process can affect metabolizable energy values and result in damaged proteins that reduce amino acid digestibility (Parsons *et al*., 2006). DDGS also tend to contain higher levels of oil than corn grain (Applegate and Adeola, 2006) and sources may vary in fat content. Samples collected from four ethanol processors in Minnesota in 2002 ranged in

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fat content from 8.9-11.4%, with the NRC (1994) estimating 9.0% (Noll *et al.*, 2003). More recently, the fat content of US corn DDGS exported to Korea from 2006-2009 was reported with a minimum value of 7.80%, a maximum value of 12.17% and a mean value to 10.67% (Salim *et al.*, 2010).

The objective of this study was to determine the effect of fat addition to diets containing low fat DDGS in broilers when compared to high fat DDGS.

MATERIALS AND METHODS

One thousand and five hundred day-old Cobb 700 broiler chicks were sourced from a commercial hatchery. Upon arrival, 1,440 chicks were randomly assigned to forty eight 4' x 8' floor pens in a curtain sided environmentally controlled house that is similar to industry curtain houses. The trial was conducted in accordance to University of Missouri standard operating procedures and following Animal Care and Use Committee guidelines. Block randomizing was done for each set of treatments, resulting in 16 randomly assigned three treatment groups. In each pen, water and feed were provided ad libitum via nipple drinkers and a hanging feeder. Birds were placed on used litter that had the cake removed. Throughout the study, broilers were exposed to continuous fluorescent lighting. At day zero, building temperature was set to 87°F and in each pen an infrared heat lamp was used as well. The temperature was reduced by five degrees per week and heat lamps were removed after the birds feathered.

The treatments included high fat DDGS containing 11% corn oil, low fat DDGS with 4% corn oil and low fat DDGS+yellow grease addition equalizing the fat level to the high fat DDGS. The inclusion rate of DDGS in the starter diets 0-17 days was 10% (Table 1); that level increased to 20% for the grow and finish period diets, 17-35 days (Table 2) and 35-49 days (Table 3), respectively. The positive control treatment diet containing high fat DDGS was first formulated to meet or exceed the National Research Council's required levels regardless of intake. The negative control was then formulated by replacing the high fat DDGS in the diet with low fat DDGS. Because the low fat DDGS was fed as a direct replacement, differences in performance can be assumed to be due to the 7% difference in DDGS fat levels (Table 4). In the low fat DDGS+yellow grease treatment, the dietary fat level was raised to the same level as the high fat DDGS diet via addition of yellow grease. Soy hulls were used as filler in both diets to make room for the yellow grease addition treatment. The 0.7% (starter diet) or 1.4% (grow-finish diets) addition of yellow grease replaced the fat lost from feeding the low fat DDGS. Therefore, any improvement in performance compared to negative control can be assumed to be due to the yellow grease inclusion. Once the diets were formulated, a premix was made for each treatment in each period which was then used to make the complete feed. The DDGS were sourced from two local POET Ag ethanol production facilities; their plant in Laddonia, Missouri provided the high fat DDGS, while the low fat came from their Macon, Missouri facility. The yellow grease was provided by Darling International Incorporated in National Stockyards, IL.

Table 1: Ingredient composition of Broilers fed rations containing high fat distillers grains (HF DDGS), low fat distillers grains (LF DDGS) and low fat distillers grains+yellow grease (LF DDGS+YG) from 0-17 days of age

Treatments	HF DDGS	LF DDGS	LF DDGS+YG
Ingredients			
Corn	53.373	53.373	53.373
Soybean meal	24.157	24.157	24.157
Porkmeal	6.750	6.750	6.750
Soy hulls	2.000	2.000	1.300
Trace mineral premix[2]	0.100	0.100	0.100
DL-Methionine	0.050	0.050	0.050
Yellow grease	0.000	0.000	0.700
Salt	0.200	0.200	0.200
Sodium bicarbonate	0.252	0.252	0.252
Vitamin premix[3]	0.100	0.100	0.100
Limestone	1.949	1.949	1.949
Lysine HCl	0.020	0.020	0.020
Threonine	0.000	0.000	0.000
Avatec 20	0.050	0.050	0.050
DDGS (HF)	10.00	0.000	0.000
DDGS (LF)	0.000	10.00	10.00
Lard	1.000	1.000	1.000
ME	2975	2940	2975
CP	22.00	22.246	22.246
Fat (%)	5.045	4.345	5.045
Lysine	1.180	1.188	1.188
Met+Cys	0.902	.910	.910
Threonine	0.786	0.793	0.793
Ca	1.497	1.497	1.497
P	0.462	0.462	0.462

[1]Trace mineral premix provided per kilogram: Mn 160,000 mg, Zn 150,000 mg, Fe 10,000 mg, Se 240 mg, Mg 2%

[2]Yellow Grease analysis: Total fatty acids, min. 90.0%; Moisture, max. 1.0%; Insoluble impurities, max. 0.5%; Unsaponifiable matter, max. 1.0%; Total M.I.U., max. 2.0%; Free fatty acids, max. 15.0%

[3]Vitamin premix provided per kilogram: Vitamin A 7,138,658 IU, B-12 14,000 mcg, D 3,569,720 ICU, E 71,386 mg, K 4,015 mg; Biotin 156 mg; Folate 2,677 mg; Pantothenic 13,385 mg; Niacin 62,463 mg; Riboflavin 7,139 mg

During the first ten days, feed pans were placed on the floor of each pen to provide easy feed access for chicks. Diets were changed at 17, 35 and 49 days, birds and feed were weighed in order to determine weight gain, feed intake and feed conversion. Feed:gain was adjusted for mortality by adding mortality weight to the pen weight.

On day 49, three average weight birds were selected from each pen, wing banded in the right wing and transported to the abattoir. The following day all one hundred and forty four were slaughtered, eviscerated and then chilled in an ice water bath. Chilled carcass weight as well as fat pad weight were measured and recorded. The major and minor pectoralis muscles, wings, thighs and legs were removed from the carcass and individually weighed. The weight of each part divided

Table 2: Ingredient composition of Broilers fed rations containing high fat distillers grains (HF DDGS), low fat distillers grains (LF DDGS) and low fat distillers grains+yellow grease (LF DDGS+YG) from 18-35 days of age

Treatments	HF DDGS	LF DDGS	LF DDGS+YG
Ingredients			
Corn	54.644	54.644	54.644
Soybean meal	16.842	16.842	16.842
Porkmeal	3.681	3.681	3.681
Soy hulls	2.000	2.000	0.600
Trace mineral premix[2]	0.100	0.100	0.100
DL-Methionine	0.008	0.008	0.008
Yellow grease	0.000	0.000	1.400
Salt	0.200	0.200	0.200
Sodium bicarbonate	0.150	0.150	0.150
Vitamin premix[3]	0.100	0.100	0.100
Limestone	1.052	1.052	1.052
Lysine HCl	0.153	0.153	0.153
Threonine	0.020	0.020	0.020
Avatec 20[4]	0.050	0.050	0.050
DDGS (HF)[5]	20.00	0.000	0.000
DDGS (LF)[6]	0.000	20.00	20.00
Lard	1.000	1.000	1.000
ME	3025	2955	3025
CP	20.00	20.492	20.492
Fat (%)	5.813	4.413	5.813
Lysine	1.050	1.066	1.066
Met+Cys	0.870	0.886	0.886
Threonine	0.695	0.709	0.709
Ca	0.834	0.834	0.834
P	0.420	0.420	0.420

[1]Trace mineral premix provided per kilogram: Mn 160,000 mg, Zn 150,000 mg, Fe 10,000 mg, Se 240 mg, Mg 2%
[2]Yellow Grease analysis: Total fatty acids, min. 90.0%; Moisture, max. 1.0%; Insoluble impurities, max. 0.5%; Unsaponifiable matter, max. 1.0%; Total M.I.U., max. 2.0%; Free fatty acids, max. 15.0%
[3]Vitamin premix provided per kilogram: Vitamin A 7,138,658 IU, B-12 14,000 mcg, D 3,569,720 ICU, E 71,386 mg, K 4,015 mg; Biotin 156 mg; Folate 2,677 mg; Pantothenic 13,385 mg; Niacin 62,463 mg; Riboflavin 7,139 mg

Table 3: Ingredient composition of Broilers fed rations containing high fat distillers grains (HF DDGS), low fat distillers grains (LF DDGS) and low fat distillers grains+yellow grease (LF DDGS+YG) from 36-49 days of age

Treatments	HF DDGS	LF DDGS	LF DDGS+YG
Ingredients			
Corn	59.142	59.142	59.142
Soybean meal	12.650	12.650	12.650
Porkmeal	2.821	2.821	2.821
Soy hulls	2.000	2.000	0.600
Trace mineral premix[1]	0.100	0.100	0.100
DL-Methionine	0.005	0.005	0.005
Yellow grease[2]	0.000	0.000	1.400
Salt	0.200	0.200	0.200
Sodium bicarbonate	0.150	0.150	0.150
Vitamin premix[3]	0.100	0.100	0.100
Limestone	1.110	1.110	1.110
Lysine HCl	0.205	0.205	0.205
Threonine	0.070	0.070	0.070
Avatec 20	0.050	0.050	0.050
DDGS (HF)	20.00	0.000	0.000
DDGS (LF)	0.000	20.00	20.00
Lard	1.396	1.396	1.396
ME	3075	3005	3075
CP	18.00	18.492	18.492
%Fat	6.252	4.852	6.252
Lysine	0.950	0.966	0.966
Met+Cys	0.809	0.825	0.825
Threonine	0.666	0.680	0.680
Ca	0.76	0.76	0.76
P	0.38	0.38	0.38

[1]Trace mineral premix provided per kilogram: Mn 160,000 mg, Zn 150,000 mg, Fe 10,000 mg, Se 240 mg, Mg 2%
[2] Yellow Grease analysis: Total fatty acids, min. 90.0%; Moisture, max. 1.0%; Insoluble impurities, max. 0.5%; Unsaponifiable matter, max. 1.0%; Total M.I.U., max. 2.0%; Free fatty acids, max. 15.0%
[3]Vitamin premix provided per kilogram: Vitamin A 7,138,658 IU, B-12 14,000 mcg, D 3,569,720 ICU, E 71,386 mg, K 4,015 mg; Biotin 156 mg; Folate 2,677 mg; Pantothenic 13,385 mg; Niacin 62,463 mg; Riboflavin 7,139 mg

by the chilled carcass weight provided the percent yield for each part. The total weight of the parts was then divided by the chilled carcass weight to determine the overall carcass yield.

Mortality, bird weight, feed intake and feed efficiency were measured at each period and for the entire trial. Analysis of the collected data was performed using Minitab statistical analysis software. Each pen served as an experimental unit; the data underwent an analysis of Variance (ANOVA) using the general linear model. Means were separated with Least Significant Difference test. Level of statistical significance was defined as $p<0.05$.

RESULTS

Table 5 displays the growth performance data recorded at 17, 35 and 49 days of age. At day 17, there was no statistically significant difference between average feed intake/bird, average bird weight and feed conversion rate among treatment groups. Through 35 days of age, a statistically significant difference between average feed intake/bird and average bird weight was not observed. However, the low fat treatment exhibited a statistically greater feed conversion rate compared to the low fat+yellow grease treatment, while the high fat treatment was statistically similar to both treatments. At completion of the trial, the average bird weight was statistically similar between all three treatments. The average feed intake/bird was statistically similar for high fat and low fat+yellow grease treatments, yet comparatively the low fat treatment group consumed more feed per bird. Consequentially, birds in the low fat treatment group exhibited a higher, less favorable, feed conversion rate. On day 50, three average weight birds were selected from each pen for processing, totaling 48 birds per treatment (Table 6). The weights were collected for the chilled carcass, fat pad, major breast, minor breast, leg, thigh and wing. The data is expressed as a percentage of the chilled carcass. Except chilled carcass weight, this is expressed as a percentage of the live weight of the bird. The three treatment groups showed no statistically significant difference for the percent major breast yield, percent minor breast yield, percent leg yield, percent thigh yield, percent wing yield and finally percent total yield. As for the percent of chilled carcass yield from live weight, there was a statistically greater percent of chilled

Table 4: Chemical amino acid and fat analyses of dried distillers grains with solubles

ME (Kcal/kg)	-- LF DDGS (2432) --		-- HF DDGS (2782) --	
Amino acids (%)	Total	Digestible	Total	Digestible
Aspartic acid	1.95	-	1.79	-
Threonine	1.15	0.82	1.05	0.75
Serine	1.35	0.86	1.22	0.82
Glutamic acid	4.47	-	3.98	-
Glycine	1.33	0.90	1.25	0.87
Alanine	2.20	0.82	1.99	0.78
Cysteine	0.57	0.82	0.53	0.79
Valine	1.56	0.79	1.46	0.72
Methionine	0.64	0.87	0.59	0.82
Isoleucine	1.21	0.82	1.13	0.75
Leucine	3.54	0.90	3.23	0.87
Tyrosine	1.14	0.86	1.04	0.82
Phenylalanine	1.55	0.87	1.43	0.83
Lysine	1.09	0.82	1.06	0.74
Histidine	0.82	0.90	0.76	0.87
Arginine	1.34	0.89	1.23	0.86
Tryptophan	0.23	0.88	0.20	0.82
Fat content (%)	4.3	-	11.3	-

Table 5: Growth performance for broilers fed high fat DDGS, low fat DDGS and low fat DDGS plus yellow grease from 0-49 days of age

Period	HF DDGS	LF DDGS	LF DDGS+YG	POOLED SE
0-17 days				
Feed intake	0.492	0.501	0.489	0.007
Body weight	0.487	0.491	0.499	0.006
Adj. Feed/gain	1.327	1.352	1.306	0.017
0-35 days				
Feed intake	2.400	2.462	2.423	0.620
Body weight	1.916	1.923	1.941	0.036
Adj. Feed/gain	1.335_{AB}	1.369_{A}	1.318_{B}	0.020
0-49 days				
Feed intake	5.039_{B}	5.259_{A}	5.104_{B}	0.117
Body weight	3.151	3.209	3.224	0.072
Adj. Feed/gain	1.693_{A}	1.713_{A}	1.620_{B}	0.023

[a-b]Means within a row with no common subscripts differ significantly ($p<0.05$)

carcass for the low fat+yellow grease treatment compared to the high fat treatment, but the low fat treatment was statistically similar to high fat and low fat+yellow grease. Additionally, the percent of fat pad was statistically greater for the low fat+yellow grease treatment as compared to low fat treatment, but the high fat treatment showed no statistical difference compared to low fat and low fat+yellow grease.

DISCUSSION

The focus of the study was to determine if a reduction in corn oil levels of dried distillers grains with solubles, as large as seven percent difference in fat level of high-fat vs low-fat DDGS, results in a decrease in growth performance from 0 to 49 days of age in a commercial broiler. Additionally, we attempted to study whether any decrease in performance that was observed could be regained through the addition of yellow grease, typically the lowest cost source of energy, which is the recommended selection determinate (Firman *et al*., 2008). Multiple studies (Min *et al*., 2012; Wang *et al*., 2007) have shown that high quality DDGS can be included at 15 to 20% of the diet without affecting meat quality or growth performance in the broiler model. Min *et al*. (2012), showed yellowness of muscle color was the only measurement of meat quality that differed significantly between 15 and 20% DDGS inclusion in the diet. In addition, shear force, water holding capacity, pH, as well as lightness and redness were measured as indicators of meat quality and no significant difference was shown between the two inclusion rates. Therefore, it may be assumed that DDGS can safely be added at 20% of the diet without detriment to muscle quality. Furthermore, Wang *et al*. (2007), displayed no significant variation between the control ration and 20% inclusion of DDGS for body weight, feed conversion and feed intake of the broiler from 0-49 days, when fed a high quality DDGS feedstuff.

For the trial a high quality DDGS was sourced locally, high-fat and low-fat products were obtained and samples were sent to the University of Missouri chemical analysis laboratory for proximate and amino acid analysis. Digestibility was determined using the leghorn rooster as a model, in order to correctly formulate the basal diet. The high-fat DDGS contained an ether extract level of 11.3% while the low-fat DDGS contained 4.3%, creating a 7% difference. It can be argued that a 7% decrease in fat levels of the DDGS may not be large enough to see a visible difference. However, data collected from this broiler trial shows that the 7% difference in corn oil, can exhibit growth performance differences detectible through statistical analysis. Moreover, when an additional source of energy, yellow grease in this study, is added to the low-fat DDGS diet at a level matching the 7% corn oil lost, feed conversion was improved significantly. The two DDGS were included at 10% of the starter and 20% of the grower rations and the total ration ether extract level decreased by 0.7 and 1.4%, respectively.

At 17 days of age no statistical differences were seen in the growth performance data, body weights among treatments were similar, feed intake for the low-fat DDGS was slightly higher when compared to the high-fat DDGS treatment and while low-fat DDGS feed:gain was not statistically significantly greater than the high-fat treatment, a numerical difference was evident. This is likely due to the relatively small amount of feed consumed during the period. These results reflect similar findings of Lumpkins *et al*. (2004) who found significant reduction in feed efficiency and body weight for 0-18 day old chicks fed a low density DDGS versus a 50 Kcals/kg greater high density DDGS when fed at 15% inclusion rate to the diet.

After thirty five days of age the feed conversion for the low-fat DDGS was three points higher than that of high-fat DDGS, while it did not present a statistical difference,it did show a trend toward a reduction growth when feeding a low-fat DDGS. The addition of yellow grease did show a statistically significant improvement of six points when compared to without the grease.

Table 6: Processing yield of broilers fed rations containing high fat distillers grains (HF DDGS), low fat distillers grains (LF DDGS) and low fat distillers grains+yellow grease (LF DDGS+YG) at 50 days of age, after 12 h fasting

	HF DDGS	LF DDGS	LF DDGS+YG	Pooled S.E.
Chilled carcass[1]	75.576_{B}	75.860_{AB}	76.763_{A}	0.2880
Fat pad[2]	2.077_{AB}	1.813_{B}	2.243_{A}	0.0630
Major breast[2]	22.549	23.513	23.439	0.2050
Minor breast[2]	4.610	4.681	4.491	0.0565
Leg[2]	13.552	13.312	13.210	0.1060
Thigh[2]	16.881	16.647	17.035	0.1100
Wing[2]	11.058	10.851	11.055	0.0882

[a-b]Means within a row with no common subscripts differ significantly ($p<0.05$)
[1]Chilled Carcass yield expressed as a percent of live weight
[2]Yields expressed as a percentage of the chilled carcass weight

At completion of the study the broilers fed low-fat DDGS alone ate significantly more feed compared to those fed high-fat DDGS and low-fat DDGS plus yellow grease, which consumed similar amounts. The reduction in energy is enough to cause the broiler to consume a larger amount of feed to meet a similar bodyweight of the higher energy rations. The addition of the yellow grease to the diet appeared to produce better results than having the fat inherent to the DDGS.

Overall, little differences were observed when comparing processing yields. It appeared the added fat produced greater percent carcass yield when compared to the high-fat DDGS treatment, but this was somewhat unexpected and would need to be repeated before any confidence was placed in the results.

Conclusions:

1: Use of the lower fat DDGS does result in increased feed intake when compared to the higher fat product or the low fat+yellow grease in broilers
2: Increased feed intake translated into reduced overall feed efficiency at market weight
3: Addition of yellow grease reversed this and improved feed efficiency when added to the low fat DDGS diets

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