EFFECT OF HIGH PROTEIN DDGS USES ON PRODUCTIVE PERFORMANCE, PHYSIOLOGICAL AND IMMUNOLOGICAL TRAITS OF BROILER

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ABSTRACT

An experiment was conducted to evaluate the uses of different levels of golden colored high protein corn distillers dried grains with soluble (Hp-DDGS) in broiler diets throughout 42d. This study included (0, 2.5, 5.0, 7.5) % in the treatments T0, T1, T2 and T3 HP-DDGS successively. A total of 600 chicks of a commercial broiler strain Ross-308 were randomly distribute to three replicate in each treatment. At the end of the study five representative birds per replicates in each treatment were processed to determine physiological and immunological characteristics.

The results showed that use of HP-DDGS in broilers diet is presented significantly increase ($P<0.05$) in performance traits: body weight and body weight gain, the percentage weight of: dressing, carcass cuts (breast, thigh and drumstick) and internal organs (liver, proventriculus, heart and gizzard) at 42 days in the treatments T2 and T3 as compared to the T1 and the control (T0). FCR differed significantly ($P<0.05$) among treatments, better feed conversion was found in T3, T2 and T1, respectively as compared to T0 at 42 days. But, the results showed significantly decrease ($P<0.05$) in mortality, neck and back percentages at the end of the experiment in T3 and T2 as compared to T1 and T0, while, there were non-significant differences among all treatments in feed consumption and wings weight percentage. The results also showed a significant increase ($P<0.05$) in total count of red blood cells (RBCs), hemoglobin (Hb), packed cell volume (PCV), total protein, globulin concentration and high density lipoprotein (HDL) in the treatments T3 and T2 as compared to T1 and control (T0), while, shown significant reduction ($p<0.05$) in H/L ratio and albumin, total cholesterol and low density lipoprotein (LDL) concentration in blood serum in the treatments T1, T2 and T3 as compared to T0. The immunological traits also shown high significant increase ($p<0.05$) in the antibodies titer of Newcastle disease (ND), Gumboro disease (IBD) and Infectious Bronchitis Viral (IBV), the ileum of small intestine histology also shown high significant increase ($P<0.05$) in Villi height (μm), crypt depth (μm) and V/C ratio in the treatments T3 then T2 compared to the control T0 at the age 42. These results indicated that HP

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DDGS could be used at the level of 7.5% in broiler diets by its significant effect on productive performance, physiological and immunological traits.

Keyword: HP-DDGs, broilers, performance, physiology and immunity.

INTRODUCTION

Corn distiller's dried grains with soluble (DDGS) are a byproduct obtained from the milling process of corn for ethanol production (Wisner, 2013). Increased emphasis on ethanol production in the U.S. has and will continue to increase the production of DDGS drastically (Shurson, 2003). This corn co-product is known to be an acceptable feed ingredient for poultry (Lumpkins *et al.* 2004). Results increasing of corn price in the global grain market, along with the prices of other grains with it. This will make the feed situation worse in far eastern countries, such as Japan, Taiwan, and South Korea, where most of the feed grains are imported. The production of DDGS, however, is expected to double in a few years, providing the opportunity to use it replacing corn and soybean meal. More than eight million metric tons of DDGS should be produced in the year 2006. Some industry experts are predicting that distiller's by-product production will reach ten to fourteen million metric tons within the next few years. Most of the DDGS produced in the United States has been consumed locally as a ruminant feed, and only about 10% of DDGS produced was shipped to foreign countries (Shurson, 2003).

Early use of DDGS shown growth performance benefits in various species of poultry and was often associated with "unidentified growth factors" (Noll *et al*. 2001). Early research with DDGS shown that it was a good source of riboflavin and thiamine and that most of the riboflavin is found in the soluble fraction (Sloan, 1941).

It is especially important in feeding broiler chickens which due to a high growth are characterized by high demand for this element, it is also important from the ecological viewpoint, because the DDGS-containing mixtures enable a decrease intake of dietary phosphates, owing to which the release of phosphorus to the environment is minimized (Koreleski & Świątkiewicz 2006). It showed uses of 14% HP-DDG could be added to diets composed primarily of corn, soybean meal and poultry byproduct meal result in better bird performance (Kim et al., 2008). Oryschak *et al.* (2010) found that there was no adverse affect of including corn or wheat DDGS up to 10% of the diet on broiler performance. Schilling *et al*. (2010) shown fed diets containing 0, 6, 12, 18, and 24% DDGS to broilers for 42 days yielded high quality breast and thigh meat quality was similar among birds fed diets containing 0 to 12% DDGS.

The aim of this study was to investigate the effect of adding different level of HP-DDGS in broiler diet on productivity, blood measurement, immune response and ileum histological of broiler.

MATERIALS AND METHODS

The experiment was carried out at the poultry farm of Agriculture College, Salahadden University in Erbil/Iraq. It was conducted with 600 one day old broiler sexed male chicks (Ross-380) reared for a period of 42 days.

Chicks were randomly distributed into four treatments, each treatment contain three replicates (50 chicks for each replicate), the golden colored HP-DDGS added (0, 2.5, 5.0, 7.5) % in the treatments T0, T1, T2 and T3, HP-DDGS composed of ME (2859 kcal/kg), dry matter 90.3%, crude protein 40.5%, crude fat 8.9%, crude fiber 6.8%, lysine 1.09%, methionine 0.76%, phosphorus 0.83%, Ca 0.059%. Feed and water were supplied *ad libitum*, the feed content (3003, 2968, 2985 kcal/kg) metabolized energy, (21, 19.75, 20.35%) crude protein in (starter, grower and finisher) diet respectively.

Throughout this experiment body weight, feed intake, feed conversion ratio, body weight and body gain, mortality, the percentage of dressing, edible & non edible internal organs, abdominal fat, carcass cuts (breast, thigh, drumstick, back, wings and neck) were measured at 42 day.

In this study, blood was collected in K_3-EDTA tubes from the brachial vein of 15 birds from each treatment, and used fresh blood for determination of hematological indexes. The number of total RBC ($10^6/mm^3$) and total WBC ($10^3/mm^3$) were determined using Natt & Herrick staining solution (Natt and Herrick, 1952) in a haemocytometer chamber. Differential leukocyte count (heterophil and lymphocyte) made on slides stained with Wright-Giemsa and observed in an optical microscope (100x) to determined H/L ratio. A hemoglobin level (g/100 ml) was measured by the cyanmethemoglobin method and packed cell volume (PCV) (%) was determined using a micro-hematocrit capillary. Blood also collected in normal tubes then centrifuged for biochemical analyzer, thus serum collected for studying the concentration of cholesterol, HDL, LDL and total protein by using commercial kits from Bio-Lab Co., the same birds serum also used for measuring antibody titer of Newcastle Disease (HI), Infectious Bursa Disease (IBD) or Gumboro and Infectious Bronchitis Viral (IBV). Small intestine took out of five birds from each replicate in all treatments than cut two cm length of ileum (anterior portion to the cecum), this fragment was opened longitudinally on Styrofoam plates and washed with saline, all samples were fixed with Bouin's solution for 24 h for histological

analysis, according to Uni *et al*. (1999), the fragments cuts of five µm thick and stained with hematoxylin and eosin, morphometric data from villus height and crypt depth were obtained from images captured by photomicroscope (Olympus).

All data were analyzed by using CRD (Complete Randomize Design) by SAS (Statistical Analysis System, 2002), as per variance, significant differences among treatment means were determined by Duncan's multiple range tests (Duncan, 1955).

RESULTS AND DISCUSSION

The effect of high protein DDGs added to broilers diet in productive performance is presented in Table 1. Body weight and body weight gain at 42 days were significantly higher (P<0.05) in the treatments T2 and T3 compared with the T1 and the control (T0), at the same table FCR had differ significantly (P<0.05) among treatments, better feed conversion was found in T3, T2 and T1, respectively compared to T0. While, the mortality was significantly decreased (P<0.05) in at the end of the experiment in T3 T2 and T1 compared to T0, but there were no significant differences among all treatments in feed consumption. Day *et al*. (1972) recorded an improvement in the body weight of broilers fed diets containing DDGS rates of 2.5% or 5 %. Manley *et al*. (1978) shown that DDGS is partly due to an improvement in the palatability of feed that led to increases in body weight and body gain also improves in feed conversion ratio. DDGS is a source of energy, amino acids and phosphorus in poultry diets (Spiehs *et. al*., 2002).

Table 1. Effect of HP-DDGs added in diet on broiler performance at 42 days age

Traits	T0	T1	T2	T3
Body weight (g)	2850±108 ^{c}	2942±98 ^{bc}	3007±83 ^{b}	3133±88 ^{a}
Body weight gain (g)	2809±104 ^{c}	2901±96 ^{bc}	2966±82 ^{b}	3092±85 ^{a}
Feed consumed (g)	5168.6±153 ^{a}	5192.8±140 ^{a}	5190.5±110 ^{a}	5194.6±126 ^{a}
Feed conversion ratio (FCR)	1.84±0.13 ^{a}	1.79±0.10 ^{b}	1.75±0.08 ^{b}	1.68±0.07 ^{c}
Mortality %	4.67±0.45 ^{a}	2.95±0.31 ^{b}	1.17±0.25 ^{c}	1.33±0.30 ^{c}

T0= control T1=2.5% HP-DDGS T2= 5.0% HP-DDGS T3=7.5% HP-DDGS

$^{a-c}$ Means within rows with different superscripts differ significantly at (P≤ 0.05).

Variations may exist among levels of HP-DDGS for metabolized energy content and availability of protein 40.5% which content essential amino acids (especially lysine 1.09% and methionine 0.76%), and bioavailability of phosphorus (0.83%) content. The acceptance of high levels of DDGS as seen in the present study may be associated with the apparent high nutrient quality

(Wang *et al*, 2007), thus DDGS due to the contents of vitamins B_2 and B_6, elements and rare minerals, which will be a shortage in poultry diets (Cantor and Johnson, 1983).

Table 2 explains that the percentage of dressing, carcass cuts (breast, thigh and drumstick) was significantly increased (P<0.05) in the treatments T2 and T3 compared to the control T0. While, the percentage of neck and back were significantly decrease (P<0.05) in T2 and T3 compared to T1 and T0, but non-significant differences among the treatments in wings weight percentage. The percentage of internal organs also (heart and gizzard) were significantly higher (P<0.05) in T2 and T3, thus increased (P<0.05) in the percentage of liver and proventriculus in T3 compared to T1, T2 and the control (T0). While, the percentage of abdominal fat was significantly decrease (P<0.05) in T3 compared to other treatments. In fact the increases in body weight in the Table 1 effect positively on the percentage of dressing, internal organs and carcass cuts weights.

Table 2. Effect of HP-DDGs added in diet on broiler dressing, internal organs and carcass cuts percentages at 42 days age

Traits	T0	T1	T2	T3
Dressing %	72.20±2.8 ^{c}	72.87±1.7 ^{bc}	73.04±1.0 ^{b}	74.07±1.3 ^{a}
Carcass cuts %/ Breast %	25.50±2.4 ^{c}	26.33±1.9 ^{bc}	27.25±1.3 ^{b}	28.50±1.7 ^{a}
Thigh & Drumstick %	29.75±1.6 ^{c}	30.66±1.5 ^{bc}	31.33±0.9 ^{b}	32.40±1.2 ^{a}
Wings %	11.30±0.65 ^{a}	11.45±0.34 ^{a}	11.15±0.28 ^{a}	10.97±0.33 ^{a}
Neck and Back %	18.37±0.17 ^{a}	18.23±0.13 ^{a}	17.48±0.11 ^{b}	17.05±0.13 ^{b}
Internal organ %/: Heart %	0.481±0.036 ^{b}	0.490±0.033 ^{b}	0.535±0.027 ^{a}	0.523±0.028 ^{a}
Liver %	2.123±0.103 ^{b}	2.182±0.105 ^{b}	2.391±0.087 ^{ab}	2.584±0.077 ^{a}
Gizzard %	1.413±0.18 ^{b}	1.550±0.14 ^{b}	1.763±0.10 ^{a}	1.800±0.11 ^{a}
Proventriculus %	0.398±0.031 ^{b}	0.387±0.037 ^{b}	0.411±0.027 ^{ab}	0.440±0.032 ^{a}
Abdominal fat %	1.160±0.042 ^{a}	0.941±0.026 ^{ab}	0.913±0.019 ^{ab}	0.719±0.023 ^{b}

T0= control T1=2.5% HP-DDGS T2= 5.0% HP-DDGS T3=7.5% HP-DDGS

$^{a-c}$ Means within rows with different superscripts differ significantly at (P≤ 0.05)

Non-Significant differences within rows same letters.

Results in Table 3 shown significant increase (p<0.05) in total count of red blood cells (RBCs), hemoglobin (Hb) and packed cell volume (PCV)%in T3 and T2 compared with T1 and control (T0). Also total proteins, globulins and high density lipoprotein (HDL) concentrations in blood serum significantly increase (p<0.05) in T1, T2 and T3 compared with control (T0). While, H/L ratio was significantly improved (p<0.05) in T3 and T2 compared to control (T0).

However albumin, total cholesterol and low density lipoprotein (LDL) concentrations were significantly decreased ($p<0.05$) in T1, T2 and T3 compared to T0. The HP-DDGs content of essential amino acids lysine and methionine, vitamins such as riboflavin and thiamine (Sloan, 1941) and minerals as phosphorus led to improve in blood parameters.

Table 3. Effect of HP-DDGs added in diet on some whole blood and blood biochemical parameters at 42 days age

Traits	T0	T1	T2	T3
Total RBC (10^6cells/mm^3)	2.73±0.3 1 ^{b}	2.89±0.27 ^{b}	3.02±0.22 ^{a}	3.14±0.18 ^{a}
Hb (gm/100ml)	10.05±0.29 ^{b}	10.28±0.38 ^{b}	11.63±0.27 ^{a}	11.97±0.21 ^{a}
PCV %	33.3±3.11 ^{b}	34.15±3.00 ^{b}	37.55±2.25 ^{a}	38.45±1.41^{a}
H/L ratio	0.31±0.017 ^{a}	0.30±0.013 ^{ab}	0.27±0.014 ^{b}	0.22±0.011 ^{c}
Total proteins (g/dL)	2.640±0.123 ^{c}	3.225±0.135 ^{b}	3.667±0.098 ^{ab}	3.890±0.076 ^{a}
globulins (g/dL)	1.296±0.089 ^{c}	1.428±0.055 ^{c}	2.113±0.057 ^{b}	2.510±0.047 ^{a}
albumin (g/dL)	1.247±0.076 ^{a}	1.205±0.103 ^{b}	1.189±0.071 ^{cb}	1.160±0.060 ^{c}
Total cholesterol(mg/dL)	132±3.55 ^{a}	121±3.09 ^{b}	118±2.67 ^{bc}	111±2.25 ^{c}
HDL (mg/dL)	50.8±1.22 ^{d}	56.3±1.45 ^{c}	67.0±1.25 ^{b}	77.3±1.0 5 ^{a}
LDL (mg/dL)	77.1±2.15 ^{a}	64.5±1.33 ^{b}	48.0±1.55 ^{c}	38.9±0.55 ^{d}

T0= control T1=2.5% HP-DDGS T2= 5.0% HP-DDGS T3=7.5% HP-DDGS

$^{a-c}$ Means within rows with different superscripts differ significantly at ($P\leq 0.05$).

The results in Table 4 shown significantly increases ($p<0.05$) in the antibodies titer of Newcastle Disease (HI) in T1, T2 and T3, the antibodies titer of Gumboro disease (IBD) and Infectious Bronchitis Viral also were significantly increased ($p<0.05$) in T2 and T3 compared to the treatment T1 and control T0 at the age 42. The evidence of improving the immunity shown from the table 1. The added HP-DDGs treatments reduced the mortality because improving in body health. Moreover DDGs content of xanthophylls (40 mg/kg) converted to vitamin A in broilers body also DDGS content high level of proteins and globulins that refer in table 3 which increased antibodies titer against diseases (Shurson *et. al*., 2003 ; Roberson *et. al*., 2005).

Table 4. Effect of HP-DDGs added in diet on antibodies titer against some diseases at 42 days age

Traits	T0	T1	T2	T3
HI Log 2^n	4.66±0.55 ^{c}	6.33±0.60 ^{b}	7.67±0.35 ^{ab}	8.00±0.50 ^{a}
IBD Log 2^n	3.33±0.25 ^{c}	3.33±0.15 ^{c}	3.79±0.15 ^{b}	4.33±0.20 ^{a}
IBV Log 2^n	2.50±0.17 ^{b}	2.67±0.12 ^{b}	3.80±0.13 ^{a}	3.75±0.09 ^{a}

T0= control T1=2.5% HP-DDGS T2= 5.0% HP-DDGS T3=7.5% HP-DDGS

$^{a-c}$ Means within rows with different superscripts differ significantly at ($P\leq 0.05$).

Table 4 shows the effect of HP-DDGs added on Ileum of small intestine histological parameters at 42 days age. The results of villi height and V/C ratio were significantly higher ($p<0.05$) in T1, T2 and T3, crypt depth also was significant higher ($p<0.05$) in T2 and T3 compared to T1 and T0. The end part of small intestine (Ileum) shown increase in villi height and crypt depth that led to enlarge the surfaces of absorption in this region then increased body and organs weights as in tables 1 & 2.

Table 4. Effect of HP-DDGs added in diet on Ileum of small intestine histological parameters at 42 days age

Traits	T0	T1	T2	T3
Villi height (µm)	414±38 ^{d}	477±33 ^{c}	528±31 ^{b}	596±33 ^{a}
crypt depth (µm)	76±9.3 ^{c}	79±9.5 ^{c}	84±9.1 ^{b}	91±8.6 ^{a}
V/C ratio	5.45±1.6 ^{b}	6.04±1.3 ^{a}	6.29±1.1 ^{a}	6.55±1.1 ^{a}

T0= control T1=2.5% HP-DDGS T2= 5.0% HP-DDGS T3=7.5% HP-DDGS

$^{a-c}$ Means within rows with different superscripts differ significantly at ($P\leq 0.05$).

CONCLUSION

The HP-DDGs added in the broiler diet at the levels (5 & 7.5%) enhanced broiler growth by improving the productive performance and achieving optimum internal organ development, improving blood parameters, increasing antibodies titer against infectious diseases and more villi height and crypt depth. Moreover, added HP-DDGs decreased mortality rate and non-economic carcass cuts (neck and back).

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تأثير استخدام الذرة المقطرة الجافة عالية البروتين مع ذوائبها (HP-DDGs) في الصفات الإنتاجية والفسلجية و المناعية لفروج اللحم

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المستخلص

أجريت هذه التجربة في قاعة الدواجن التابعة لكلية الزراعة/جامعة صلاح الدين-أربيل/العراق، لمعرفة تأثير استخدام مستويات مختلفة من حبوب الذرة المقطرة الجافة عالية البروتين مع ذوائبها (Hp-DDGs) ذات اللون الأصفر الذهبي في علائق فروج اللحم مدة 42 يوما. تضمنت هذه التجربة المستويات (0 ، 2.5، 5.0 و 7.5)% Hp-DDGs في المعاملات T0 (عليقة قياسية بدون اية إضافة)، T1 ، T2 وT3 على التوالي. وزع 600 فرخ فروج اللحم التجارية سلالة Ross-308 بعمر يوم واحد عشوائيا في 3 مكررات لكل معاملة. قدمت علائق البادئ (0 - 10) يوما ، النمو (12 - 25) يوما والناهي (26 - 42) يوما، وفي نهاية التجربة قيس الأداء الأنتاجي والفحوصات الفسلجية والمناعية.

أظهرت النتائج ان اضافة Hp-DDGs في علائق فروج اللحم سببت ارتفاعا معنويا ($p<0.05$) في الصفات الإنتاجية: وزن الجسم، الزيادة الوزنية، النسبة المئوية للتصافي ونسبة وزن قطعيات الذبيحة (الصدر والفخذ والوصلة الفخذية)، وكذلك ارتفاع معنوي ($p<0.05$) في الوزن النسبي للأعضاء الداخلية (الكبد والمعدة الغدية والقلب والقانصة) بعمر 42 يوما في المعاملات T2 وT3 مقارنة بالمعاملة T1 ومعاملة السيطرة T0، أيضا وجد تحسن معنوي ($p<0.05$) في معامل التحويل الغذائي في المعاملاتT1، T2 وT3 مقارنة بمعاملة السيطرة T0 بعمر42 يوما، بينما لوحظ انخفاض معنوي ($p<0.05$) في النسبة المئوية للهلاكات، والوزن النسبي للرقبة والظهر، في حين لم يُلحظ أية فروق معنوية بين معاملات التجربة في كمية العلف المستهلك والوزن النسبي للجناحين. وجد أيضا ارتفاع معنوي ($p<0.05$) في العدَد الكلي لخلايا الدم الحمر (RBC)، والهيموغلوبين (اليحمور) Hb ، وحجم خلايا الدم المرصوصة (PCV) وتراكيز: البروتين الكلي، والكلوبيولين والكولسترول عالي الكثافة HDL في المعاملتين T2 وT3 مقارنة بالمعاملة T1 ومعاملة السيطرة T0، بينما وجد انخفاض معنوي ($p<0.05$) في نسبة H/L وتراكيز: الألبومين، والكولسترول الكلي والكولسترول منخفض الكثافة (LDL) في بلازما الدم في المعاملات T1 وT2 وT3 مقارنة بمعاملة السيطرة T0، وأظهرت أيضا الصفات المناعية أرتفاعا معنويا ($p<0.05$) في المعيار الحجمي لاختبار التلازن الدموي لحمى النيوكاسل (ND)، ومرض التهاب كيس الجراب (الكمبورو) (IBD) ومرض التهاب الشعب المعدي (IBV)، وأظهر أيضا التشريح النسيجي لمنطقة اللفائفي في الأمعاء الدقيقة أظهر تحسنا معنويا ($p<0.05$) في ارتفاع الزغابات وعمق خبايا ليبركن ونسبة ارتفاع الزغابة/عمق الخبايا في المعاملتين T2 و T3 مقارنة بالمعاملة T1 ومعاملة السيطرة T0 بعمر42 يوما. أشارت هذه النتائج إلى إمكانية استخدام HP-DDGS بنسبة 7.5% في علائق فروج اللحم لتأثيراته الإيجابية في الأداء الإنتاجي والصفات الفسلجية والمناعية.

الكلمات المفتاحية: HP-DDGS، فروج اللحم، الأداء الإنتاجي والفسلجي والمناعة.