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The effect of incorporating varying levels of alfalfa powder on the production performance of broiler chickens

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ABSTRACT

This study investigated the incorporation of varying concentrations of dry powdered alfalfa into broiler chicken diets and assessed its impact on performance, production metrics, and specific carcass characteristics. To this goal, 180 one-week-old broiler chicks were allocated into four treatments, each comprising three replicates with 15 birds per replication. The initial treatment served as the control, whereas the subsequent treatments incorporated 2%, 4%, and 6% dry alfalfa powder into the diet, respectively. The examination was performed to analyze several facets of production performance, the comparative weights of carcass components, and internal organs. The results demonstrated that the inclusion of 2% and 4% alfalfa powder did not yield significant differences compared to the control group in terms of body weight, weight gain, feed intake, feed conversion efficiency, all carcass parameters, and internal organs. Nonetheless, the incorporation of 6% alfalfa powder markedly diminished performance metrics and reduced the dressing percentage in comparison to the control group. In conclusion, the findings of this study indicate that the incorporation of 2% and 4% alfalfa powder into the diets did not adversely affect production performance. Conversely, it favorably impacted dressing percentage and relative liver weight, hence improving digestive system functions and activity.

تأثير إضافة مستويات مختلفة من مسحوق الجت على الاداء الانتاجي لفروج اللحم

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الخلاصة

في هذه الدراسة، تم إضافة مستويات مختلفة من مسحوق الجت المجفف إلى علف فروج اللحم وقيّمنا تأثيره على الأداء ومعايير الإنتاج وبعض صفات الذبيحة. لتحقيق ذلك، تم تقسيم 180 فرخ بعمر أسبوع واحد إلى أربعة معاملات (كل معاملة تحتوي على ثلاث مكررات) بواقع 15 طائرًا لكل مكرر. كانت المعاملة الأولى معاملة السيطرة، أما المعاملات الثانية والثالثة والرابعة فتم تزويدها بمسحوق الجت المجفف بنسبة 2% و4% و6% على التوالي في العلف. تم إجراء الاختبار لدراسة جوانب مختلفة من الأداء الإنتاجي، والأوزان النسبية لمكونات الذبيحة والأعضاء الداخلية. أظهرت النتائج أن إضافة 2% و4% من مسحوق الجت لم تختلف معنويا عن مجموعة السيطرة من حيث وزن الجسم، وزيادة الوزن، واستهلاك العلف، وكفاءة تحويل العلف، وجميع معايير الذبيحة، والأعضاء الداخلية. ومع ذلك، أدى إضافة 6% من مسحوق الجت إلى انخفاض كبير في معايير الأداء وانخفاض نسبة التصافي مقارنة مع المجموعة الضابطة. في الختام، بناءً على نتائج الدراسة الحالية، فإن إضافة 2% و4% من مسحوق الجت المجفف إلى العلف لم يكن له تأثير سلبي على الأداء الإنتاجي، بل أثر بشكل إيجابي على نسبة التصافي ووزن الكبد النسبي، مما عزز وظائف الجهاز الهضمي ونشاطه.

الكلمات الافتتاحية: فروج اللحم ، مسحوق الجت ، قطعيات الذبيحة

INTRODUCTION

Given the increasing demand for poultry meat, broiler chicken farming has become one of the principal means of the economies in many countries worldwide (Zampiga & Sirri,2023). To cope with this boom in the consumption of red meat, breeders have been compelled to adopt different methods with the aim of getting the highest productivity from broiler chickens, where the selection and genetic improvement processes are very relevant. Among these, Tavárez *et al*. (2016) stressed that: Although the above measures have increased production, they have also negatively impacted the health and immune status of broiler chickens and the quality of carcasses. The poultry industry is moving toward antibiotic-free production and growth promoters that adversely affect consumer health through certain herbs and medicinal plants, which are used as an alternative to antibiotics (Haque *et al*., 2020).

Forage crops are regarded as natural growth enhancers, comprising seeds or plant stems that contain biologically active chemicals (Tava *et al*., 2022). They execute several biological tasks in contrast to antibiotics and are devoid of hazardous chemicals, rendering them safe for use (Ivanova *et al*., 2024). They are considered optimal growth enhancers in chicken production and have attracted considerable interest as an antibiotic alternative to increase growth by improving feed efficiency or raising the immunity and health of poultry (Saleh *et al*., 2018). Alfalfa, formally designated as Medicago sativa, is among the oldest leguminous pasture crops known to humanity and is highly regarded for its nutritional content (Pleger *et al*., 2020). Alfalfa is regarded as one of the most economical protein sources, distinguished by its high yield and low production expenses (Pleger *et al*., 2021). It comprises protein with a balanced ratio of amino acids and is abundant in minerals and vitamins (El-Kelawy *et al*., 2018).

Alfalfa has 17.5% protein, 24.1% crude fiber, and has a low metabolizable energy of 1,200 kcal/kg. It's high in minerals and vitamins (NRC, 1994). Other research has been able to demonstrate that alfalfa might be able to shed its fiber content or increase its valuable components and the protein content due to the methods of cultivation, harvesting,

and processing (Sommer and Sundrum, 2014). Alfalfa contains high levels of enzyme phytase. Thus, no enzyme or phosphorus needs to be added to the feed, economically reducing costs (Ma *et al*., 2012). According to Liu *et al*. (1948), it contains high levels of arginine, lysine, and tryptophan, as well as a moderate amount of methionine. Alfalfa includes vital vitamins such as A, D, E, K, C, thiamine, riboflavin, pyridoxine (B6), cobalamin (B12), niacin, pantothenic acid, biotin, and folic acid. It is especially abundant in vitamin K (Apostol *et al*., 2017). Carotenoids, a source of vitamins A and E, help maintain epithelial membranes in numerous organs and systems (Wu *et al*., 2001). Alfalfa's high fiber content delays digestion and increases absorption rates (He *et al*., 2021).

Alfalfa includes minerals such as phosphorus, calcium, potassium, sodium, chlorine, sulfur, magnesium, copper, manganese, iron, cobalt, boron, and molybdenum, as well as functional components such sugars, flavonoids, xanthophyll, beta-carotene, and tocopherol (Köninger *et al*., 2024). Alfalfa's high saponin content (2-3% of dry matter) contributes to many biological functions, including decreasing cholesterol, serving as an anti-cancer and anti-inflammatory agent, and giving antioxidant characteristics (Englmaierova *et al*. 2019). Alfalfa powder contains the amino acid L-canavanine, which is similar to the amino acid arginine and has antibacterial, anti-inflammatory effects and inhibits the growth of viruses causing skin diseases (Rosenthal *et al*., 2000). Studies on plant-derived antioxidants indicate that they exert antioxidant effects by scavenging free radicals, reducing LDL levels, and enhancing the activity and expression of antioxidant enzymes (Raeeszadeh *et al*., 2022). Alfalfa flavonoids are often added to animal feed to improve antioxidant activity in serum, liver, and meat (Chen *et al*., 2020). Alfalfa is rich in antioxidants, which protect lipids from radical oxidation (Raeeszadeh *et al*., 2022). Alfalfa's principal flavonoids include tricin and apigenin glycosides, which have stronger antioxidant activity than traditional antioxidants such butylated hydroxytoluene (Goławska *et al*., 2010). Flavonoid substances, such as coumestrol and apigenin, have been shown to enhance the antioxidant capabilities of low-density lipoprotein oxidation systems, collaborating with ascorbic acid and other antioxidants (Stochmal *et al*., 2001).

According to Ouyang *et al*. (2016), alfalfa flavonoids improve antioxidant activity in broiler serum by increasing superoxide dismutase (SOD) levels and decreasing malondialdehyde (MDA). It is a natural source of xanthophyll, which gives poultry carcasses the ideal yellow color (Ouyang *et al*., 20-16). A recent study by He *et al*. (2021) found that adding varying doses of alfalfa to broiler diet enhanced feed intake and body weight. This study examines how adding varying levels of dried alfalfa plant meal to broiler chicken diets affects growth indicators, biometric measurements, and productivity.

MATERIALS AND METHODS

Bird Management and Feeding

The four-week trial took place at the chicken field at Tikrit University's Animal Production Department, College of Agriculture. The study used 180 unsexed Ross 308 broiler chicks, each aged 7 days. Chicks were randomly assigned to four treatments, each with three replicates and 15 birds per replicate. The animals were kept in floor cages with 8 cm thick wood shavings bedding, a hung cylindrical plastic feeder, and a 5-liter plastic drinker. The birds were fed a beginning diet from 1-10 days, a grower diet from 11-21 days, and a finisher diet from 22-35 days. The experiment included free access to food and drink, as well as 24-hour continuous lighting. The ethical committee of animal research of

the department of animal production permitted all experimental protocols (Tikrit University)

The chemical composition of the diets used in the experiment

Components	Starter diet (1-10) days	Grower diet (11-24) days	Finisher diet (25-35) days
Metabolizable energy (kacal/kg)	3000	3100	3200
Crude protein (%)	23.09	21.59	19.52
Calcium (%)	0.962	0.874	0.807
Available phosphorous (%)	0.483	0.436	0.397

Experimental Design:

To determine the effect of adding dried alfalfa powder to broiler diets, this experiment was designed using a completely randomized design with four treatments as follows:

- A1: Control treatment
- A2: Addition of 2% alfalfa leaf powder per kg of feed
- A3: Addition of 4% alfalfa leaf powder per kg of feed
- A4: Addition of 6% alfalfa leaf powder per kg of feed

The treatments began at the age of seven days and continued until the age of 35 days.

Preparing alfalfa powder:

Alfalfa plants were obtained from the fields of the College of Agriculture / Tikrit University. The soft stems and leaves were taken from the upper part of the plant due to the low moisture and fiber content. The drying process took place in a closed room equipped with extractors away from sunlight to preserve the active ingredients in the plant. The drying continued until the moisture content reached about 10%.

Sampling and measurements:

Every week, we wrote down the feed intake (FI), body weight (BW), and feed conversion ratio (FCR). Weighing all the birds in each replication gave us their body weight. The FCR was figured up by adding up the ratio of feed intake to final body weight. Every day, the number of mortalities (if any) was reported.

Organ weights and composition of the carcass:

At the end of the 35th day, 3 birds from each treatment were selected randomly weighed individually, carried to the slaughterhouse, and slaughtered as per the law on animal welfare (Rovinsky & Cohen, 2018). All the chickens were starved for a period of 6 hours before being carried to the slaughterhouse. The chickens that were weighed before slaughter were slaughtered humanely by cervical dislocation, and then plucked and eviscerated to get their organs like liver, spleen, proventriculus, heart, bursa of Fabricio's, and pancreas for the organ weights. The carcass weight of chickens was measured after they were bled, plucked, eviscerated, and the head, neck, shanks, and abdominal fat were

removed. Additionally, warm carcass, breast, leg (thigh + drumstick), and abdomen fat weights were recorded. Carcass yields were calculated for breast meat, including pectoralis major and minor muscles, and leg meat, including thigh and drumstick meat. Values were represented as a % of carcass weight.

Statistical analysis:

The ANOVA was conducted using a completely randomized design, with four experimental treatments and three replicates each. The raw data was initially tested for outliers. Data was analyzed using ANOVA and Duncan's multiple range test to compare mean values across treatments. A value was considered significant if the probability value (P) was < 0.05. Statistical analysis was conducted using IBM SPSS Statistics version 20.

RESULT AND DISCUSSION

Based on the statistical analysis results in Table 1, we observe no significant differences in the average live body weight (BW), and body weight gain (BWG) during the first, second, third, and fourth weeks of the birds' age. However, at the age of five weeks, there is a significant decrease in the average (BW) and (BWG)of birds treated with alfalfa powder at a concentration of 6% compared to birds in treatments A2 and A3. Additionally, no significant differences were recorded in the treatments that included the addition of alfalfa powder at concentrations of 2%, 4%, and 6% compared to the control treatment in terms of the (BW) and (BWG)traits.

The third treatment registered a significant lower feed consumption rate than others in the second week but at par with the rest. During the third week, there was a significant increase in the quantity of feed consumed by the fourth treatment with respect to the control treatment (A1). No marked differences were determined between treatments by the end of the third week of age of the birds. However, birds treated with 4% alfalfa powder posted a significant reduction in feed intake in the fifth week as compared to A4 and A2. Mean overall for the experiment, all feed addition treatments were not significantly different from the control treatment; in contrast, the third treatment had a significant reduction in the quantity of food fed than the fourth treatment. At the end of the second, third, and fifth weeks, no significant difference was observed among all treatments for the feed conversion ratio, but the third treatment showed a significant improvement in the feed conversion ratio compared to the fourth treatment; there was no difference with the rest after the fifth week and for the overall study average.

The obtained results of the present study revealed that supplementation with alfalfa conferred a significant improvement in the productive performance of broiler chickens. It can be highly effective in terms of weekly body weight and cumulative body weight gain due to the leaves of alfalfa, as they contain many vitamins, minerals, and other important compounds. Besides that, alfalfa also contains estrogen which increases body weight and deposition of proteins along with fats in tissues. And also, alfalfa leaves are proteinaceous and rank second to soybeans as the main source of protein (Hadidi *et al*., 2023). Moreover, the added phytase enzyme of alfalfa leaves has an important role in the digestion process, which could be another reason for increased digestion. (Predescu *et al*., 2024). Treatments A2 and A3, with 2% and 3% of alfalfa powder per kg of feed, have shown significant increase than that of the control treatment. This is in confirmation of the results shown by (Pleger *et al*., 2020).

Table (1): The effect of adding different levels of dried alfalfa powder to the broiler chicken feed on the productive performance

Treatments	**A1**	**2% A2**	**4% A3**	**6% A4**	***P. value***
Body weight (BW)/g					
B.W1	169.25±4.33	170.29±1.04	170.91±1.27	170.09±2.08	N. S
B.W2	474.86±11.75	464.27±4.45	487.19±20.74	478.75±3.75	N. S
B.W3	1046.67±28.85	1015.79±30.38	987.19±20.74	1021.83±31.31	N. S
B.W 4	1709.74±37.13	1696.51±14.31	1696.46±35.35	1630.54±12.80	N. S
B.W 5	2181.80±49.81 [ab]	2226.57±75.68[a]	2226.96±27.82[a]	2053.01±16.84[b]	*
Body weight gain (BWG)/g					
BWG1-2	305.61±7.41	293.97±3.43	308.11±5.19	308.65±5.83	N. S
BWG2-3	571.81±38.01	551.52±33.1	508.17±24.03	543.08±27.85	N. S
BWG3-4	663.07±30.01	680.72 ±16.45	709.26±21.13	608.71±43.08	N. S
BWG4-5	472.06±86.07	530.05±71.42	530.49±47.04	422.46±7.74	N. S
BWG Total	2012.55±45.84ab	2056.28±76.71a	2056.04±27.53a	18829.91±14.88b	*
Feed consumption (FC)/g					
FC2	455.78±7.10 a	435.73±3.36 a	453.47±2.48 b	465.24±5.04 a	*
FC 3	650.78±18.90 b	662.03±8.32ab	679.25±8.00ab	727.17±33.16a	*
FC 4	946.09±28.69	919.09±11.79	877.90±35.04	914.9±20.72	N. S
FC 5	1168.00±26.90ab	1214.98±13.68a	1097.16±40.8b	1215.93±20.44a	*
T FC	3220.65±29.52ab	3232.50±20.26ab	3107.79±64.26b	3323.31±43.34a	*
Feed conservation ratio (FCR)					
FCR1	±0.221.49	±0.051.48	±0.041.47	±0.041.50	N. S
FCR2	±0.071.14	±0.051.20	±0.041.34	±0.111.35	N. S
FCR3	±0.11 ab1.43	±0.02 ab1.35	±0.04b1.23	0.09 a ±1.51	*
FC4	±0.472.64	±0.312.37	±0.122.08	±0.092.88	N. S
FCR5	±0.03 b 1.06	±0.05b1.57	±0.01b1.51	±0.01 a1.76	*

A1: Addition of alfalfa powder at 0%, A2: Addition of alfalfa powder at 2% g/kg of feed, A3: Addition of alfalfa powder at 4% g/kg of feed, A4: Addition of alfalfa powder at 6% g/kg of feed. *Different letters within the same row indicate a significant difference between the treatments. N.S.: No significant differences.

The high nutritive value of alfalfa meal in terms of its proteins, vitamins, and all the required essential minerals for broiler growth, including calcium, phosphorus, vitamins A and E, could have been among the several reasons for the increased productive performance. These help to improve growth in birds and elevate weight gain (He *et al*., 2021). On the other hand, the enhanced digestion processes due to the dietary fibers in alfalfa meal would contribute to the improvement in feed conversion efficiency and weight gain, with an increased utilization efficiency of the other nutrients in the feed(Zheng *et al*., 2019). In view of the fact that these cells lining the intestines are active sites that have to absorb nutrients, they will be directly exposed to the risks that increased free radicals bring about in terms of detrimental effects of the reactive oxygen species negatively impacting the activity of these cells. The natural antioxidants in the alfalfa meal may reduce the oxidative stress of the cells of digestive and body organs, with consequential effects on the general health of the broilers and improved productive performance. Alfalfa has been

determined to contain multiple vitamins and phenolic compounds that act as antioxidants. (Köninger *et al.*, 2024).

The growth of birds administered with alfalfa powder and the subsequent increase in weight may be due to the existence of certain growth-promoting factors in alfalfa which are probably plant hormones such as gibberellins that might enhance broiler muscle tissue development. The improvement in nutrient uptake may be due to the effect of alfalfa on the growth and differentiation of microorganisms in the poultry digestive tract, such as the *Lactobacillus* and *Bacteroides*, and inhibiting potential pathogens, including the *Clostridium* (Zheng *et al*., 2019) . Also, He *et al*., (2021) showed that broiler chickens had good weight gain when fed with diets rich in digestible fibers.

The dressing percentage found in the statistical data can be assumed according to Table 2 that it increased the value of the third treatment group compared to the fourth treatment group. No treatment with dried alfalfa powder gave significant differences compared to the control. There were no marked differences with respect to the carcass cuts, breast, thigh, neck, back, and wings among the treatments compared to the control group. The results were compared with the control group, and significant differences among treatments were not noticed for the addition of alfalfa powder and the control. But the fourth treatment represented a significant increase in the relative weight of the liver compared with the second treatment. For other studied traits—gizzard, heart, spleen, and Bursa of Fabricio's—no significant differences were recorded for the treatments inside the experiment.

Table (2) Effect of Adding Different Levels of Dried Alfalfa Powder to Broiler Chicken Diet on Carcass Cuts

Treatments	**A1**	**2% A2**	**4% A3**	**6% A4**	**P. value**
Dressing (%)	± 0.07 ab 74.16	±0.39 ab 74.13	74.62 ± 0.16 a	73.43 ± 0.47b	*
Breast %	±1.54 38.53	39.48 ± 1.77	39.82± 0.41	38.44 ± 1.52	N.S
Thigh%	± 1.45 30.95	31.06 ± 0.8	30.30 ± 0.31	27.76 ± 1.74	N.S
Neck%	± 0.39 3.39	3.07 ± 0.28	3.61± 0.33	3.77 ± 0.314	N.S
Back%	± 2.25 16.42	15.88 ± 0.43	15.54± 0.79	17.89 ± 1.32	N.S
Wings%	±0.15 9.68	9.45 ± 0.34	9.50± 0.32	10.15 ± 0.67	N.S

A1: Addition of alfalfa powder at 0%, A2: Addition of alfalfa powder at 2% g/kg of feed, A3: Addition of alfalfa powder at 4% g/kg of feed, A4: Addition of alfalfa powder at 6% g/kg of feed. *Different letters within the same row indicate a significant difference between the treatments. N.S.: No significant differences.

Table (3): The effect of adding different levels of dried alfalfa powder to the broiler chicken diet on the relative weight of some vital and immune organs

Treatments	**A1**	**2% A2**	**4% A3**	**6% A4**	**P. value**
Liver %	2.50 ±0.14 ab	2.08 ± 0.07 b	2.29 ± 0.10 ab	3.10 ± 0.54 a	*
Gizzard %	1.78 ± 0.16	1.73 ± 0.13	1.60 ± 0.04	1.93 ± 0.35	N.S
Heart %	0.62± 0.02	0.67± 0.12	0.65 ± 0.06	0.73 ± 0.08	N.S
Spleen %	0.09 ± 0.001	0.09 ± 0.01	0.09 ± 0.002	0.09 ±0.03	N.S
Bursa %	0.07 ± 0.01	0.06 ± 0.001	0.06 ± 0.01	0.08 ±0.02	N.S

A1: Addition of alfalfa powder at 0%, A2: Addition of alfalfa powder at 2% g/kg of feed, A3: Addition of alfalfa powder at 4% g/kg of feed, A4: Addition of alfalfa powder at 6% g/kg of feed. *Different letters within the same row indicate a significant difference between the treatments. N.S.: No significant differences.

The study also established that addition of 6% dried alfalfa powder per kg feed in broiler diets led to an increase in feed intake. This was due to the presence of the enzyme phytase in alfalfa, which enhanced utilization of feeds at large, hence increasing general feed intake and acquiring quantities of proteins, minerals, and vitamins with appetite-stimulating effects (Jacob & Pescatore. 2012). Koçer *et al*.(2018) observed depressed feed intake in broiler diets with a level of 10% or more alfalfa powder. These negative effects have been ascribed to several properties of saponins such as reduced feed intake caused by the astringent and irritating taste of saponins (see Oleszek *et al*. 1994), reduction in intestinal motility (Klita *et al*. 1996), reduction in proteindigestibility (Shimoyamada *et al*. 1998).The researcher has the right to explain and connect if there is no research available.

Economic implication is very important here because feed conversion ratio gives an idea about the bird's ability to convert feed to live body weight. In the current study, addition of alfalfa powder in levels of 2% and 4% g/kg of feed resulted in lowered feed conversion ratio as compared to control treatment. This is supported by the findings of Zheng *et al*. (2019) in their study, which found that alfalfa addition at different levels into the Pekin ducks diet reduced the feed conversion ratio as compared to the control treatment.

CONCLUSION

When studying the effect of adding alfalfa powder to broiler feed in increasing proportions, there was a significant improvement observed at concentrations of 2% and 4% compared to the control group. Most aspects of productive performance improved, including live body weight, weight gain, and feed conversion efficiency, resulting in a high carcass yield percentage. However, adding dried alfalfa powder at a concentration of 6% led to a decline in productive performance, accompanied by changes in the relative weight of the liver.

CONFLICT OF INTEREST

Regarding this manuscript, the authors disclose no conflicts of interest**.**

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