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Effect of Adding the Local Strain of Shiitake Mushroom in Broiler Diets on Production Performance

Aya A. K. Al-Kanain *[1] Luma K. Bandr [2], Rukaibaa A. Chechan [3]
* [1]Department of Animal Production, College of Agricultural Engineering Sciences, University of Baghdad
*[2]Department of Food Sciences, College of Agricultural Engineering Sciences, University of Baghdad
*[3]Department of Food Sciences, College of Agricultural Engineering Sciences, University of Baghdad

ABSTRACT

This study was conducted in two distinct phases at the University of Baghdad's College of Agricultural Engineering Sciences at the first phase was conducted in the laboratories of the Department of Food Science and lasted six months. The second phase will be conducted from December 26, 2023, to January 30, 2024, in the poultry field, Department of Animal Production - Abu Ghraib to determine the effects of adding powdered shiitake mushrooms of the local variety to broiler feed on production efficiency. The study used 200 ROSS 308 broiler chicks sexed with an average initial weight of 45 grams at 1 day of age. There were a total of four treatments, to each of which fifty chicks were randomly assigned. Each treatment was conducted in five replicates with 10 birds each. T1, T2, T3 and T4 were the three treatments with different amounts of shiitake mushrooms in the feed: 0, 2, 4 and 6 g/kg, respectively. These were a starter, grower and finisher diet tailored to the specific needs of the birds at different points in their life cycle. The results of this study showed a significant improvement ($p < 0.05$) in feed conversion ratio when using 2 or 4 g/kg shiitake mushrooms in the diet for broilers. However, there were no significant differences in the dressing percentages and major cuts of the carcass.

Key words: Carcass traits,Food fungi, Meat chicken ,Production performance.

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INTRODUCTION

Recent research has shown that natural feed additives can improve the health of poultry, including broilers, which in turn increases their productivity and the quality of their carcasses. This is because these additives create a better environment for the birds' digestion and boost their immunity through their antibacterial effects. Some of them are mushrooms that are used as food additives (Al-Azzawi, & Bandr, 2023). Although 140,000 different edible mushroom species have been documented in recent years, the nutritional value of only 10% of these species is known (Savoie& Largeteau, 2011). The shiitake mushroom (Lentinula edodes) is the best known of these mushroom species. It has important chemical and nutritional properties. For example, it is a useful source of rare minerals that play a role in metabolism, as well as other vitamins and minerals, including thiamine, riboflavin, ascorbic acid, and vitamin B2. It also contains protein, fiber, carbohydrates and tiny amounts of lipids, phospholipids, triglycerides, sterols, and monounsaturated fatty acids (Heleno *et al*., 2010). In addition, shiitake mushrooms have a variety of bioactive components, including phenols, triterpenes, steroids, alkaloids, and β-glucan polysaccharides. These chemicals confer a range of beneficial effects, including antioxidants, antibacterial, antiviral, anticoagulant, anti-inflammatory and anti-cancer capabilities (Vaz *et al*., 2010), shiitake mushrooms of all varieties are a source of natural medicines and substances that are considered functional or therapeutic (Chang ShuTing & Miles, 2004). In terms of

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production, nutritional content and biological importance, shiitake mushrooms rank second among edible mushrooms (Chang, 1999). Due to its high nutritional value, it has been developed locally to serve as a source of functional materials. Poultry, such as broilers, are fed with it to benefit from its chemical and nutritional properties that allow them to grow faster. This is particularly important for commercial chicken breeds that need to regulate their metabolism and treat oxidative disorders caused by their rapid growth (Kwon *et al*., 2024). Nevertheless, there is a lack of research on feeding shiitake mushrooms to broiler chickens, both nationally and internationally. Research on the mushroom has instead focused on its production, chemical analysis, and nutritional value. Therefore, the aim of this study was to grow the mushroom locally and investigate its nutritional value.

MATERIALS AND METHODS

Studied traits: This study included two laboratory and field phases:

The first stage (laboratory): Shiitake mushroom development and diagnosis: The city of Baghdad is the place where you should get a species of the genus Lentinula mushroom. The diagnosis was made after a morphological examination of fungal fruiting bodies. Fragments of fruiting body tissue were cultured in Petri dishes in PDA media. The dishes were then covered with parafilm and stored at a temperature of 25 °C. Cultivation on solid potato dextrose at 4 °C yielded pure isolate. The S rRNA 18 gene amplification technique was then used to confirm the diagnosis of the isolate by analyzing its sequences. Samples with a diameter of 5 mm were then taken with a cork borer from the uncontaminated margins of a modern farm. The samples were then relocated onto new plates to obtain pure isolates, which were subsequently stored at 4 °C. The inoculum for the mushrooms was prepared from high quality wheat grains. The ratio was one grain of wheat to two cups of boiling water, and they were boiled for 20 minutes. After filtering, they were continuously mixed until half of the moisture was absorbed. The amount of calcium carbonate and calcium sulfate added was 3.3 and 12.5 g per 1000 g mixture, respectively. They are then packed in thermos bags. First, the bags are sealed with cotton plugs. Then the spouts are covered with strips of aluminum foil. The bags are then sterilized for one hour in an autoclave at 121 °C and 1.5 pounds per square inch. The bags were then cooled so that the grains could be inoculated with pieces of mushrooms harvested from the parent farm. More mycelia grew on the wheat grains until the bags were placed in an incubator set at 25 °C. The culture medium consisted of corn cobs that were soaked in boiling water for one hour, filtered and then spread out with constant stirring to remove excess water. This procedure was repeated until the moisture content reached 50%. The final product was then filled into thermos bags, which could be sterilized immediately after adding a certain amount of wheat bran. The bags were sealed with cotton plugs and the nozzles were completely covered with strips of aluminum foil. In an autoclave at 121 °C, they were compressed to 1.5 pounds per square inch for one hour and sterilized. After the bags had cooled, they were inoculated under sterile conditions with a fungal inoculum at a concentration of 5% of their average weight (measured by wet weight). This was to ensure that the experiment remained valid. The bags were placed in the incubation chamber heated to 25 °C after the nozzles had been tightly sealed and left there until the fungal isolates had reached maturity. The bags were then transferred to an additional incubation chamber, which was kept at a temperature of 16 °C until fruiting was complete. The fungus was chemically analyzed in food safety laboratories, Ministry of Science and Technology, Department of Environment and Water, reported by Jensen (Jensen 1995), .As shown in Table (1) .

Table 1. Chemical composition of shiitake mushrooms

Components	Concentration (%)
CHO	53.68
Crude protein	18.9
Fats	0.14
Ash	9.80
moisture	3.58
Crude fiber	13.9

Results in Table (2) show the types of mineral elements and vitamins found in shiitake

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mushrooms were determined by Jensen (Jensen 1995) analysis.

Table 2. Minerals and vitamins in the shiitake mushrooms used in the study

Element	kg)/Concentration (mg
K	498.7
Na	105.9
Fe	50.9
Ca	33.5
Zn	19.8
Cu	12.9
Se	0.78
D	33.6
C	30.5
B_2	20.6
B_9	19.8
B_6	10.8
A	20.4
B_1	2.14

Following the protocol described by Rice et al. (Rice *et al.* 2012), the mushrooms were analyzed to determine the types and amounts of fatty acids and amino acids as shown in Table (3). An analysis was carried out to determine the active compounds in shiitake mushrooms, such as: Total phenolic content (mg gallic acid / 100 g), total flavonoid The second stage (field) This study was conducted at the University of Baghdad - College of Agricultural Engineering Sciences, in the Department of Animal Production, in the poultry field. For this study, 200 Ross 308 broiler chicks were used. On the first day of life, these 140 males and 60 females weighed an average of 45 g. Ten birds (seven males and three females) per replicate formed each of the four treatments. Fifty birds per treatment formed the four groups into which the chicks were divided. Twenty chambers separated by wire mesh were provided to house the birds throughout the rearing process in a narrow, fifteen by six-meter hall. Each chamber was two meters by one meter. The floor of the hall was covered with 5 cm sawdust, extractor hoods provided better ventilation, and light bulbs illuminated the room. The even distribution of these lamps in the hall guaranteed an elevated level of lighting. Photosystem 23 light: 1 dark is used, and the light is uniform, according to the guidelines of Ross Guide 308 (Ross. ,2018).

Table 3. Fatty acids and amino acids in the shiitake mushrooms used in the study

Fatty acids	Concentration(%)
Linoleic	18.7
Oleic	13.6
Palmitic	5.4
Stearic	1.9
Amino acids	**Concentration(%)**
Methionine	15.6
Tyrosine	14.1
Lysine	12.6
Arginine	12.6
Cysteine	12.5
Asparagine	11.3
Phenylalanine	11.2
Aspartic	10.2
Valine	9.5
Threonine	8.9
Histidine	7.9
Alanine	6.3
Proline	5.6
Isoleucine	5.4
Leucine	5.4
Serein	5.1

Table 4. Active compounds in the shiitake mushrooms used in the study

Active compound	Concentration
Total phenolic content (mg / 100 gm)	325.6
Total flavonoid content (mg / 100 gm)	241.6
Total alkaloid content %	4.9
Total glycoside content %	2.6
Total tannin content %	1.8
Total saponine content %	0.58

The birds were fed ad libitum with three different diets: Firstly, the starter diet with 3030 kcal/kg feed and 23.06% crude protein at the age of 1-10 days. Secondly, between the 10th and 24th day of age, a rearing feed with 3105 kcal/kg feed (grower), which corresponds to 21.8% crude protein. Thirdly, between the 24th and 35th day of age, a finishing feed with 3133 kcal/kg feed, corresponding to energy and 19.6% crude protein (finisher), must be given (Table 5). All diets were supplemented with 0, 2, 4 or 6 g/kg shiitake mushroom powder. Each of these percentages represents a different treatment: T1, T2, T3 and T4. The characteristics studied

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were measured at the end of each study period and according to the duration of the diets. Live body weight and feed intake were recorded, and weight gain and feed conversion were calculated as described in (.Lacy,2002). Four birds were selected from each replication, two males and two females, and their weights were kept equal. The birds were slaughtered and cleaned after recording their weight before and after slaughter.

Table 5. Percentage and chemical composition of the feed ingredients used in the study

Components	Diets		
	Starter	Grower	Finisher
	1-10 days	10-24 days	24-35 days
yellow corn	33	33.67	40
Wheat	25	28	28
Soybean meal (48% protein)	31.52	28	22.3
Protein concentrate [(1)]	5	5	5
Sunflower oil	3	3.5	3
Limestone	1.1	1	1
Dicalcium phosphate	0.8	0.5	0.4
Salt	0.1	0.1	0.1
Methionine	0.24	0.13	0.1
Lysine	0.24	0.1	0.1
Total	100	100	100
Calculated chemical composition [(1)]			
Metabolic energy (kcal/kg feed)	3030	3105	3133
Crude protein %	23.06	21.8	19.6
Ether extract %	5.4	6	5.7
Crude fiber %	2.8	2.8	2.7
Methionine + cysteine	1.1	0.96	0.87
Lysine	1.48	1.27	1.12
Calcium	0.96	0.85	0.81
Available phosphorus	0.51	0.45	0.42

[1] The animal protein concentrate used is produced by a Dutch company (imported) and contains 40% crude protein, 2390 kilocalories/kg protein as representative energy, 2.40% crude fat, 4.40% crude fiber, 3.60% calcium, 5.50% phosphorus, 4.50% lysine. 4.60% methionine, 2% threonine, 3% sodium, 5.10% methionine + cysteine.

[2] The chemical analysis of the feed was estimated according to NRC (Nogueira, B. R. F.*et a*l,2021).

The percentage of dressing was then calculated by dividing the weight of the carcass by the live weight and multiplying the result by 100. The carcasses were cut into their basic components, i.e., breast, thigh, and drumstick. The weight of each cut was divided by the weight of the carcass and the result was then multiplied by 100 . In addition, the organ weights were divided by the live weight and then multiplied by 100 to obtain the relative weights of the heart, liver, gizzard, spleen, fabricia gland and abdominal fat (Biesek *et al,*2020). This allowed us to compare the weight of these different organs. The study showed no evidence that the birds died as a result of the experiment. According to (Levine ,2013) the study data was analyzed using the SPSS statistical program in a one-sided completely randomized design (CRD). In the case of statistically significant differences among the mean values, Duncan's multinomial test (Duncan ,1955) was performed.

RESULTS AND DISCUSSION

Table (6) shows that there were no statistically significant differences (P<0.05) in the average body weight of the birds at 1 day and 10 days of age when comparing the different treatments used in the study. When comparing the T1 and T4 birds at 24 days of age, it was found that the T4 birds had a significantly lower average body weight (P<0.05) compared to T1. In contrast, no significant differences were found when comparing T1 birds with T2 and T3 birds. When comparing the treatments at the first (1-10 days) and third (24-35 days) age of the birds, Table 7 shows that there are no significant differences. The addition of treatment T4 resulted in statistically significant differences compared to treatments T1, T2 and T3. The shiitake mushrooms showed the slowest weight gain of 6 g/kg over the entire period from 1 to 35 days and especially from 10 to 24 days. This was true for the entire period.

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Table 6. Effect of adding shiitake mushroom powder in broiler diets on live body weight (g/bird; mean ± standard error).

Treatment	Body weight (BW; g bird)			
	1day	10 days	24 days	35 days
T1	45.50±0.52	224.10±3.31	979.50±16.32a	2020.74±46.17a
T2	45.17±0.50	227.40±4.27	981.06±12.09a	2003.60±19.20a
T3	45.25±0.54	229.20±2.58	985.62±17.03a	2001.22±42.63a
T4	45.42±0.54	224.00±4.31	889.44±32.39b	1875.30±25.95b
Significance level	N.S	N.S	0.05	0.05

T1: control treatment (without addition); T2, T3 and T4 with shiitake mushroom powder at 2, 4 and 6 g/kg, respectively. Different letters within a column indicate significant differences at 0.05 between the means; NS: differences didn't significant.

Table 7. The effects of using shiitake mushroom powder in broiler diets on weight gain (g/bird; mean ± standard error).

Treatment	Gain body weight (GW; g bird)			
	1– 10 days	10 – 24 days	24 – 35 days	1– 35 days
T1	178.60±3.16	755.40±14.19a	1041.24±32.79	1975.24±46.24 a
T2	182.23±3.79	753.66±7.89a	1022.54±13.37	1958.43±18.76 a
T3	183.95±2.87	756.42±18.21a	1015.60±41.94	1955.97±43.06a
T4	178.58±4.52	665.44±33.10b	985.86±28.80	1829.88±25.95 b
Significance level	N.S	0.05	N.S	0.05

T1: control treatment (without addition); T2, T3 and T4 with shiitake mushroom powder at 2, 4 and 6 g/kg, respectively. Different letters within a column indicate significant differences at 0.05 between the means; NS: differences didn't significant.

Table (8) shows that there was a statistically significant reduction (P<0.05) in feed intake (g feed/bird) for the three shiitake mushroom treatments compared to T1 over the study periods of 1 to 10 days, 10 to 24 days and 24 to 35 days for all time periods from 1 to 35 days. The initial and full treatment durations with treatment T4 were significantly shorter than those of treatments T2 and T3.

Table 8. Effect of the using shiitake mushroom powder in broiler diets on feed intake (g feed/bird; mean ± standard error).

Treatment	Feed intake (FI; g feed / bird)			
	1– 10 days	10 – 24 days	24 – 35 days	1– 35 days
T1	290.00±4.18a	1280.44±5.20a	1861.48±23.04a	3431.92±23.29a
T2	256.90±12.27b	1165.52±11.97b	1750.54±15.05b	3172.96±33.65b
T3	233.00±3.00c	1169.20±3.01b	1789.32±17.87b	3191.52±18.52b
T4	210.00±2.74c	1122.10±44.66b	1743.60±13.44b	3075.70±46.05c
Significance level	0.05	0.05	0.05	0.05

T1: control treatment (without addition); T2, T3 and T4 with shiitake mushroom powder at 2, 4 and 6 g/kg, respectively. Different letters within a column indicate significant differences at 0.05 between the means; NS: differences didn't significant.

Table (9) shows that all shiitake mushroom treatments, regardless of concentration, there was a highly significant (P<0.05) decrease in feed conversion ratio when shiitake mushroom powder was added to broiler diets compared to control treatment T1. This was observed within the periods of 1-10 days and 24-35 days. During the whole period (from 1 to 35 days) and the second phase (from 10 to 24 days), T2 and T3 showed a significant reduction (P<0.05) compared to T1. However, no significant differences were found between T4 and T1 in the second period. Compared to the control group, the shiitake mushroom treatments had no statistically significant effect on dressing percentage or relative weight of breast, thigh, drumstick, or abdominal fat (Table 10). Results in Table (11) show that the percentage of internal organs in broiler chickens fed a diet containing shiitake mushrooms. There were no significant differences in the relative weights of liver, gizzard and fabricia gland between all experimental treatments, but there were

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significant differences in the percentage weights for heart and spleen. While treatments T3, T2 and T4 all resulted in increased relative weights of the heart, treatment T2 significantly increased the weight of the spleen compared to control treatment T1, which was not statistically different from treatments T3, T4 and T1.

Table 9. Effect of the using shiitake mushroom powder in broiler diets on the feed conversion ratio (g feed/g weight gain; mean ± standard error).

Treatment	Food conversion factor (FCR; g gain / g feed)			
	1– 10 day	10 – 24 days	24 – 35 days	1– 35 days
T1	1.63±0.04a	1.70±0.03a	1.80±0.06a	1.74±0.04a
T2	1.42±0.09b	1.55±0.03b	1.71±0.03b	1.62±0.02b
T3	1.27±0.02bc	1.55±0.04b	1.77±0.06b	1.63±0.03b
T4	1.18±0.03c	1.69±0.03a	1.78±0.05b	1.68±0.02ab
Significance level	0.05	0.05	0.05	0.05

T1: control treatment (without addition); T2, T3 and T4 with shiitake mushroom powder at 2, 4 and 6 g/kg, respectively. Different letters within a column indicate significant differences at 0.05 between the means; NS: differences didn't significant.

Table 10. Effect of the using shiitake mushroom powder in broiler diets on the dressing percentage and main cuts of carcass (mean ± standard error).

Treatment	Carcass weight	Dressing percentage	Relative weight (%)			
			breast	thigh	Drumstick	Abdominal fat
T1	1428.50±24.61	71.30±0.87	36.92±0.95	17.04±1.16	13.85±0.59	2.785±0.806
T2	1437.00±28.01	70.15±0.51	40.17±2.32	14.69±1.05	13.44±0.50	1.610±0.074
T3	1451.75±24.77	70.23±0.61	38.06±1.22	15.24±0.16	12.78±.39	2.047±0.263
T4	1412.75±21.86	70.37±0.95	37.95±0.96	15.27±1.02	13.70±0.52	1.918±0.164
Significance level	N.S	N.S	N.S	N.S	N.S	N.S

T1: control treatment (without addition); T2, T3 and T4 with shiitake mushroom powder at 2, 4 and 6 g/kg, respectively. Different letters within a column indicate significant differences at 0.05 between the means; NS: differences didn't significant.

Table 11. The effects of using shiitake mushroom powder in broiler diets on the percentage of some internal organs (mean ± standard error) of broilers at 35 days

Treatment	Relative weight (%)				
	Heart	Liver	Gizzard	Spleen	Fabricia gland
T1	1.408±0.091b	4.93±0.31	5.27±0.33	0.175±0.010b	0.353±0.048
T2	1.297±0.105b	5.08±0.25	5.46±0.32	0.248±0.030a	0.358±0.023
T3	3.037±0.595a	4.86±0.16	5.40±0.33	0.228±0.019ab	0.370±0.040
T4	1.360±0.143b	5.00±0.26	5.68±0.29	0.225±0.009ab	0.403±0.026
Significance level	0.05	N.S	N.S	0.05	N.S

T1: control treatment (without addition); T2, T3 and T4 with shiitake mushroom powder at 2, 4 and 6 g/kg, respectively. Different letters within a column indicate significant differences at 0.05 between the means; NS: differences didn't significant.

The results show that aspects of the rearing and management of the birds, as well as the amount and type of nutrients contained in the feed have an influence on the production performance of broilers. Some studies have shown that treatments with different concentrations of shiitake mushrooms significantly improve the productivity of broilers. Since the mushrooms contribute 2 g/kg of crude protein in addition to lipids and other important components, this is particularly evident at mushroom concentrations of 2 and 4 g/kg. As Citores *et al.* (Citores *et al., 2023*) have shown, shiitake mushrooms are also rich in essential amino acids such as valine, isoleucine, methionine, arginine, lysine, and tryptophan (Table 3). They have also shown that the role of these amino acids in the growth of broiler chicks is clearly defined. Maynard *et al.* (Maynard *et al*, 2022) states that proteins are not the most important requirement for the development of

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broiler chicks, but certain amino acids are. There are also the relationships between proteins and fats and the relationships between amino acids such as valine, isoleucine, and leucine (Kidd *et al*, 2021) and the balance of these amino acids in the diet (Kidd *et al*, 2021), which is especially important for the control of development. Therefore, shiitake mushrooms can be considered to get daily dose of methionine, the first and most important critical growth factor, which is also an important regulator of growth. As Nogueira *et al.* 2021. stated, in addition to an increased dose of methionine, the diet for broilers should also contain a sufficient amount of arginine and lysine. For the simple reason that these amino acids together promote nitrogen fixation in the muscles, which in turn favors the growth of muscle mass, which in turn improves the quality of performance. Broiler feed is excellent for promoting development and product quality as it provides a natural supply of minerals and vitamins (Table 2). Vitamins and minerals not only regulate development, but also intestinal and liver activities (Kleyn & Ciacciariello. 2021). There is a possibility that the increase in production performance is due to the activity of active chemicals that are powerful antioxidants that limit the action of free radicals. The production of antioxidant enzymes such as glutathione, peroxidase, and catalase enzyme (CAT) by these compounds helps to prevent the formation of free radicals and oxidative stress (Zhang & Xie. 2024). This in turn leads to an improvement in the health status of the birds, which in turn leads to an improvement in their production performance. According to Kumar and Goel (Kumar & Goel. 2019), shiitake mushrooms contain a group of phenols (Table 4), that have antioxidant properties (Lazeeza, 2021). These phenols help to protect the body's cells from the harmful effects of free radicals and minimize themetabolites that are formed as metabolic products during oxidation processes. Studies by Rubió *et al.* 2013 have shown that phenolic compounds play a role in increasing the production of antioxidant enzymes in the mitochondria. In addition, phenolic compounds have the ability to improve absorption functions in the intestine, as shown in the growth of broilers (Adaszyńska-Skwirzyńska and Szczerbińska., 2017, Sheoran *et al* ,2017). According to Lipiński *et al.* (Lipiński *et al*, 2017), phenols have the ability to both promote the formation of immunological globulin and suppress the secretion of cytokines, thus preventing inflammation in the intestine.

CONCLUSION

The results of this study showed a significant improvement ($p < 0.05$) in feed conversion ratio when using 2 or 4 g/kg shiitake mushrooms in the diet for broilers. However, there were no significant differences in the dressing percentages and major cuts of the carcass.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

AUTHOR/S DECLARATION

Conflicts of Interest: None. - We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re publication attached with the manuscript. - Ethical Clearance: The project was approved by the local ethical committee in University of Baghdad, Iraq.

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تأثير إضافة السلالة المحلية من فطر شيتاكي إلى علائق فروج اللحم في الأداء الإنتاجي

آية علاء خزعل الكناني [1]، لمى خالد بندر [2]، رقيباء علي جيجان [3]
[1,2] قسم الانتاج الحيواني – كلية علوم الهندسة الزراعية – جامعة بغداد. بغداد، العراق
[3] قسم علوم الأغذية – كلية علوم الهندسة الزراعية – جامعة بغداد. بغداد، العراق

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المستخلص

أجريت هذه الدراسة على مرحلتين في كلية علوم الهندسة الزراعية بجامعة بغداد، المرحلة الأولى أجريت في مختبرات قسم علوم الأغذية واستمرت ستة أشهر، والمرحلة الثانية أجريت للمدة من 26 ديسمبر 2023 إلى 30 يناير 2024 في حقل الدواجن بقسم الإنتاج الحيواني – أبو غريب لمعرفة تأثير إضافة مسحوق الفطر الشيتاكي *Lentinula edodes* المحلي إلى علائق فروج اللحم في الاداء الانتاجي. استخدمت الدراسة 200 فرخ فروج لحم من سلالة ROSS 308، مجنسة، بمتوسط وزن ابتدائي 45 غم بعمر يوم واحد. تضمنت الدراسة أربعة معاملات، خصص 50 فرخًا لكل معاملة عشوائياً. تضمنت كل معاملة خمسة مكررات بواقع 10 طيور لكل منها. كانت المعاملات: T1 وT2 وT3 وT4، اضيف إلى العلائق مسحوق الفطر الشيتاكي بالمستويا ت 0و2 و4 و6 غم /كغم على التوالي. غذيت الطيور على ثلاثة علائق وحسب مرحلة العمر، البادئ والنمو والنهائي. أظهرت نتائج هذه الدراسة تحسنًا معنوياً ($p < 0.05$) في معامل التحويل الغذائي لدى استعمال 2 أو 4 غم /كغم من الفطر الشيتاكي في علائق فروج اللحم. فيما لم تظهر فروق معنوية في نسب التصافي وقطعيات الذبيحة الرئيسية.

الكلمات المفتاحية: الاضافات الغذائية؛ الفطريات الغذائية؛ الصفات الانتاجية؛ دجاج اللحم؛ صفات الذبيحة.