Original Article

Impact of Using Local Shiitake Mushroom (Lentinus Edodes) Waste Powder in Laying Hens' Diets on Some Chemical Traits and The Oxidation Status of Their Eggs

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Abstract

This study was conducted at the poultry research station of the Agricultural Research Department, Ministry of Agriculture from June 27 to October 17, 2024. It investigated the effect of using different proportions of a local shiitake mushroom waste powder in laying hens diets, with or without adding probiotics, on some chemical traits and the oxidation status of their eggs. A total of 135 ISA Brown laying hens were distributed into nine treatments, each containing three replicates, with 5 birds per replicate. The treatments were as follows: control (T1) comprising a basic diet without the shiitake mushroom waste powder, T2, T3, T4, and T5 with the powder at 2, 4, 6 and 8%, respectively, and T6, T7, T8, and T9 with the same powder rates, respectively, together with probiotics. The results indicated no differences in cholesterol concentration between the treatments using the waste powder and the control treatment T1, except for a highly significant ($P \leq 0.01$) decrease in the egg yolk cholesterol for treatment T4. A similar increase was also observed in the concentration of linoleic, palmitic, and oleic fatty acids for most treatments using the mushroom growth waste powder. However, a highly significant ($P \leq 0.01$) decrease was observed in the values for malondialdehyde (MDA), peroxide (PV), and free fatty acids (FFA) of egg yolk stored for 0, 2, and 3 weeks for most treatments with the local shiitake mushroom growth waste powder, compared to the T1 control treatment.

Keywords: agricultural waste, Cholesterol, fatty acids, Peroxides value

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Introduction

The poultry industry is one of the pillars of global food security, providing eggs and white meat to meet growing food needs. Both chicken eggs and meat are highly sought-after by consumers due to their high nutritional value, including protein and energy (23). Eggs are among the most widely consumed foods, due to their high crude protein content, balanced amino acids, and high levels of vitamins, minerals, and other healthy compounds (30). Recently, traditional assumptions that cholesterol in eggs is unhealthy have been proven inaccurate, with studies showing no association between egg consumption and cardiovascular disease (17). In addition, dietary cholesterol intake affects egg yolk levels (8). Modifying fatty acid levels in laying hens' diets is an effective tool for producing improved eggs for consumers (12). Egg characteristics are easily altered during storage, as their quality declines and the oxidation state of the fat-rich yolk changes. This is a highly perishable product that is not consumed immediately after laying.

To reduce the negative effects of egg storage and extend their shelf life, antioxidants are added to laying hens' diets, which can affect egg quality. This also reduces lipid peroxidation in the yolk, which benefits consumer health by reducing free radical levels (19, 28). In recent years, researchers in the field of animal nutrition, including poultry, have sought alternative feed sources that pose no health risks to birds (13, 7). Among them, interest in cultivating edible fungi has increased significantly due to their high ability to decompose cellulosic materials, which facilitates their cultivation on inexpensive agricultural waste. Also, their high protein content from the presence of mycelial biomass, low fiber content, and high levels of biologically active substances are an essential part of the chemical composition of edible fungi and are concentrated in the waste from mushroom cultivation and growth **(9)**.

The nutritional value of edible mushroom wastes is affected by several factors, including the mushroom species, environmental conditions, and the type of growth media **(4)**. Agricultural wastes are a good source of nutrients for mushroom production because they support the growth of food fungi and their development into fruiting bodies of mushrooms. The most commercially used agricultural wastes for edible mushroom production include wheat bran, sawdust, corn cobs, and wheat **(25, 26 and 32)**. When mushrooms are harvested, this waste is considered the spent growing substrate and is referred to as spent mushroom substrate (SMS). Approximately 5 kg of SMS is produced from the cultivation and production of 1 kg of mushrooms **(16)**. One such mushroom is the shiitake, which is an edible fungus favored by Asians. It is widely cultivated worldwide and is considered a delicacy due to its high nutritional value and unique flavor. Mushrooms are considered a complete, healthy food, rich in proteins, dietary fiber, vitamins, and minerals **(10, 15,31)**.

The aim of this study is to conduct a comprehensive evaluation of local shiitake mushroom agricultural wastes before and after cultivation on a mixture of wheat bran and corn cobs, in an attempt to improve the nutritional value of these wastes. It seeks to conduct a chemical analysis to determine the type and concentration of active ingredients and the use of the powdered mixture of these wastes in different proportions, with and without probiotics, in laying hens' diets. It also studies their effect on cholesterol concentrations, the types and proportions of fatty acids in egg yolks, and the oxidative status of eggs stored for 0, 2, and 3 weeks in a refrigerated storage room at 20-22 °C after the end of the field experiment.

Materials and Methods

This field experiment was conducted at the Abu Ghraib Poultry Research Station, affiliated with the Agricultural Research Department of the Ministry of Agriculture. It lasted 16 weeks, comprising 4 periods of 4 weeks each, and used 135 20-week-old ISA Brown laying hens. The birds were raised using the cage-raising system, with one chicken per cage, distributed into 9 treatments, each containing 3 replicates of 5 chickens each.

The treatments were as follows: the control treatment T1 used basic feed without the shiitake mushroom growth waste mixture powder, treatments T2, T3, T4, and T5 used the powder at a rate of 2, 4, 6, and 8%, respectively, and treatments T6, T7, T8, and T9 used the same powder at the same rates with the addition of 0.05% probiotics to the diet. The production diet was prepared by crushing and mixing the diet components according to the required diet as shown in Table 5. Laboratory tests of the eggs produced were conducted to determine the effect of using the local shiitake mushroom growth waste mixture powder grown on corn cobs and wheat bran, with and without the addition of probiotics, in the feed of the laying hens, as well as its effect on some chemical characteristics of the eggs **(7)**.

One egg from each treatment was taken at the end of the experiment to analyze the cholesterol concentration in the egg yolk according to the method by (k.madzaln) as well as to determine the levels and types of fatty acids of the yolk. The sample was prepared according to the method approved by **(3)** based on fat esterification. The analysis of cholesterol concentration and levels and types of fatty acids of the egg yolk was conducted using a gas chromatography device (GC - 2010) in the laboratories of the Scientific Research Authority, Environment and Water Research Center. It also examined its effect on some indicators of oxidation of eggs for storage, as the eggs were stored for 0, 2, and 3 weeks in a refrigerated storage room at 20-22 °C at the end of the experiment. Three eggs were taken from each treatment for each storage period to determine the malondialdehyde (MDA) concentration, according to **(29)**.

The peroxide (PV) concentrations and free fatty acid (FFA) values of the egg yolks were calculated according to **(21)** in the laboratories of the Center for Market Research and Consumer Protection at the University of Baghdad-Al-Jadriya. Statistical analysis was performed using a completely randomized design (CRD), significant differences between means were tested using Duncan's multiple range test by **(27)** to determine the effect of different treatments on the studied traits.

Collection of Local Shiitake Mushroom Growth Waste

The remaining growth media waste was collected after culturing local shiitake mushrooms on wheat bran and corn cobs, and harvesting the fruiting bodies. The media were dried, ground, and stored in bags in suitable locations pending study-related experiments.

Laboratory Tests of Growth Media Waste

A preliminary chemical analysis of the corn cob and wheat bran powder waste before and after growing shiitake mushrooms was conducted to determine the nutritional value of the waste mixture powder in the laboratories of the Scientific Research Authority/Environment and Water Research Center (Table 1). Mycotoxin tests were also conducted in the laboratories of the Quality Control Department, Animal Resources Department, Ministry of Agriculture, as shown in Table (2). An analysis was conducted to determine the type of mycotoxins and their concentration within the permissible limits, if any.

Table 1. Chemical analysis of local shiitake mushroom growth waste mixture powder

Ingredients	(%)	
	Before Development	After Development
Protein	**14.08**	**18.18**
Fat	**3.78**	**4.87**
Ash	**7.45**	**9.25**
Moisture	**8.99**	**5.11**
Fiber	**32.00**	**12.25**
Carbohydrates	**33.70**	**50.34**
Kcal/Kg Energy	**3541**	**3665**

Table 2. Type and concentration of mycotoxins in the powder of local shiitake mushroom growth waste mixture

Mycotoxins	Concentration (PPb)	Permissible Limits (PPb)
Aflatoxin	1.0	20
Trichothecenes T-2| HT-2	**0.0**	**100**
Ochratoxin	**0.0**	**5**
Fumonisin	**0.6**	**10**
Deoxynivalenol	**1.5**	**8**

Tests were also conducted on the powdered mixture of local shiitake mushroom growth waste for the types and proportions of active compounds in this waste, as shown in Table (3).

Table 3. Active compounds of the powdered mixture of local shiitake mushroom growth waste

Name	Con
Total phenolic content (mg /100 gm)	412.5
Total flavonoid content (mg /100 gm)	256.9
Total alkaloid content (%)	5.49
Total glycoside content (%)	3.65
Total tannin content (%)	2.99

Analyses were also conducted on the types and proportions of amino acids in the powder mixture of local shiitake mushroom waste (Table 4).

Table 4. Types of amino acids and their proportions in the powder of local shiitake mushroom waste

Compound Name	Amount (µg/gm)
Lucien	60.25
Histidine	56.98
Methionine	55.79
Isoleucine	50.14
Proline	47.77
Lysine	45.15
Cysteine	40.98
Arginine	35.29
Threonine	33.65
Tyrosine	32.56
Asparagine	30.98
Phenylalanine	28.99
Serine	28.98
Valine	24.78
Aspartic acid	22.89
Alanine	16.48

Table 5. Percentages of diet components used in the study and their calculated chemical composition

Ingredients %	Treatment[1]				
	T1	T2+T6	T3+T7	T4+T8	T5+T9
Yellow Corn	**31**	**30**	**21**	**24**	**22.5**
Wheat	**31**	**31**	**39**	**34.5**	**34**
Soybean Meal[2]	**24.25**	**23.55**	**22.5**	**22.25**	**22**
Premix[3]	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**
Mushroom Waste Powder[4]	**-**	**2**	**4**	**6**	**8**
Vegetable Oil	**1.25**	**0.95**	**1**	**0.75**	**1**
Dicalcium Phosphate	**1**	**1**	**1**	**1**	**1**
Limestone	**8.5**	**8.5**	**8.5**	**8.5**	**8.5**
Salt	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
Methionine	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
Lysine	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
Total	**100**	**100**	**100**	**100**	**100**
Calculated Chemical Composition[5]					
ME (kcal/kg feed)	**2734.90**	**2730.62**	**2730.90**	**2735.70**	**2759.55**
Crude Protein (%)	**18.35**	**18.29**	**18.39**	**18.32**	**18.38**
Crude Fiber (%)	**2.6**	**2.8**	**3**	**3.1**	**3.4**
Crude Fat (%)	**3.5**	**3.2**	**3.2**	**3.2**	**3.4**
Lysine (%)	**1.11**	**1.08**	**1.06**	**1.04**	**1.03**
Methionine + Cysteine (%)	**0.81**	**0.80**	**0.78**	**0.77**	**0.76**
Calcium (%)	**4.07**	**4.07**	**4.06**	**4.06**	**4.06**

Ingredients %	Treatment[1]				
	T1	T2+T6	T3+T7	T4+T8	T5+T9
Available Phosphorus (%)	**0.54**	**0.53**	**0.53**	**0.53**	**0.53**

1T6, T7, T8, and T9 used local shiitake mushroom waste powder at rates of 2, 4, 6 and 8 %, respectively, with 0.05% probiotics addition in the base diet. Each kg of the probiotics contains 2.75*10cfu lactobacillus acidophilus, 8.25*10cfu streptococcus faecium, 1.1*10cfu bacillus subtilis, 2750csu protease, 5550 slu amylase, 275fpui cellulose. 2The soybean meal used is from an Argentinian source, with a crude protein content of 48% and 2,440 kcal/kg of metabolizable energy. 3Shiitake mushroom waste powder, crude protein content 18.18%, energy 3665 kcal. 4The vitamin and mineral premix used is animal-based, produced by the Jordanian company Intraco. It contains 8% crude protein, 2% crude fat, 0.50% crude fiber, 20.40% calcium, 9.50% phosphorus, 5.50% sodium, 6.50% chlorine, 0.95% lysine, 2.30% digestible lysine, 5.60% methionine, 5.75% digestible methionine, 5.80% digestible methionine + cysteine, 5.60% methionine + cysteine, 1.60% digestible troponin, and 0.20% digestible tryptophan. 5These rations were calculated based on **(18)**.

Results and Discussion

Table 6 shows the effect of using different proportions of local shiitake mushroom growth waste powder in laying hens' diet, with and without probiotics, on cholesterol concentration, and the proportions and types of fatty acids in egg yolk. The results indicated highly significant differences ($P \leq 0.01$) between the different treatments in egg yolk cholesterol concentration. Treatments T1, T2, T3, and T6 significantly outperformed T4 ($P \leq 0.01$), recording the lowest cholesterol concentration in egg yolk. However, T4 did not significantly differ from treatments T7, T8, and T9, which used 4, 6, and 8% waste powder with 0.05% probiotics in the diet, and treatment T5, which used 8% of the waste powder without the addition of probiotics. The table also shows the presence of the unsaturated fatty acids alpha-linolenic, linoleic, and oleic, as well as the saturated fatty acids palmitic and stearic, in the egg yolk.

Highly significant differences occurred in the proportions of these acids in the yolk among all treatments ($P \leq 0.01$) for alpha-linolenic fatty acid in egg yolk. Treatment T2, which used 2% shiitake mushroom waste mixture powder, was significantly superior ($P \leq 0.01$) compared to the others which differed significantly among themselves, while treatment T3 recorded the lowest proportion of this acid. As for linoleic fatty acid, treatment T9, with 8% of the mixture powder and 0.05% probiotics, was significantly superior ($P \leq 0.01$) to the others, while the control T1 treatment recorded the lowest proportion of this acid. For palmitic fatty acid, the results also showed highly significant differences ($P \leq 0.01$) between the different treatments, with T9 significantly superior ($P \leq 0.01$) to the others.

As for oleic fatty acid, treatment T6, using 2% of shiitake waste powder and the probiotic, recorded significant superiority ($P \leq 0.01$) over treatments T3, T2, and T1, but not with T9, T8, T7, T5, and T4. These treatments did not differ significantly among themselves and from the others, while the control treatment T1 recorded the lowest percentage of oleic fatty acid in the yolk. As for stearic fatty acid, treatment T6 significantly outperformed ($P \leq 0.01$) in egg yolk over the others which showed significant differences among them.

Table 7 shows the effect of using different proportions of local shiitake mushroom growth waste powder, with and without the addition of probiotics, in the diet of laying hens on the oxidation indicators of malondialdehyde (MDA), peroxide values (PV), and free fatty acids (FFA) during the egg storage period (0 weeks) at the end of the experiment period. While there were no significant differences between the various treatments in MDA values the PV results showed highly significant differences ($P \leq 0.01$). Treatments T3 and T2 recorded the lowest significant value compared to T9 but did not differ significantly from T8, T7, T6, T5, and T4. These treatments, in turn, did not differ significantly from T9 during the same egg storage period. Meanwhile, no significant differences in FFA values were noted between the treatments for this period.

Table 6. Effect of using different level of local shiitake mushroom waste mixture powder with and without probiotics in the chickens' diet on cholesterol concentrations and levels and types of fatty acids in egg yolk (mean ± SE)

T.	Cholesterol (mg/100g Egg yolk)	Alpha-Linolenic)%(	Linoleic)%(	Palmitic)%(	Oleic)%(	Stearic (%)
T1	372.200±0.294^{A}	5.110±0.004^{B}	15.550±0.004^{H}	22.060±0.004^{I}	22.060±0.004^{I}	3.250±0.004^{D}
T2	**367.300±0.248^{A}**	**5.330±0.004^{A}**	**15.890±0.004^{G}**	**22.400±0.041^{H}**	**40.550±0.004^{B}**	**3.400±0.041^{C}**
T3	**342.200±0.294^{A}**	**3.880±0.004^{H}**	**16.100±0.041^{F}**	**22.550±0.004^{G}**	**40.740±0.004^{B}**	**3.600±0.041^{B}**
T4	**231.567±0.227^{B}**	**4.120±0.004^{F}**	**16.400±0.041^{E}**	**22.980±0.004^{E}**	**41.250±0.004^{AB}**	**2.900±0.0041^{F}**
T5	**319.300±0.248^{AB}**	**4.550±0.004^{D}**	**16.880±0.004^{C}**	**23.450±0.004^{C}**	**41.680±0.004^{AB}**	**3.250±0.004^{D}**
T6	**336.300±0.248^{A}**	**3.980±0.004^{G}**	**16.150±0.004^{F}**	**22.750±0.004^{F}**	**43.990±0.125^{A}**	**3.780±0.004^{A}**
T7	**321.533±0.205^{AB}**	**4.300±0.041^{E}**	**16.600±0.041^{D}**	**23.170±0.004^{D}**	**41.400±0.041^{AB}**	**3.050±0.004^{E}**
T8	**309.000±0.208^{AB}**	**4.860±0.004^{C}**	**17.000±0.041^{B}**	**23.770±0.004^{B}**	**41.900±0.041^{AB}**	**3.450±0.004^{C}**
T9	**300.567±0.165^{AB}**	**4.877±0.006^{C}**	**17.230±0.004^{A}**	**23.990±0.004^{A}**	**42.090±0.004^{AB}**	**3.660±0.004^{B}**
Sig.	**	**	**	**	**	**

T1: control treatment (basic diet). T2, T3, T4, and T5: with local shiitake mushroom growth waste powder at 2, 4, 6 and 8%, respectively, in the basic diet. T6, T7, T8, T9: with local shiitake mushroom growth waste powder at similar proportions and 0.05% probiotics in the basic diet. Sig.: Significant. **Significant differences at P≤0.01. T: Treatments.

Table 7. Effect of using different levels of local shiitake mushroom waste mixture powder with and without probiotics in the diet of the chickens on the oxidation indicators of the yolk for the first storage period of 0 weeks (mean ± SE)

Egg Storage Period (0 weeks)		Malondialdehyde)MDA(	Peroxide Value (PV(	Free Fatty Acids (FFA)
Treatments	T1	0.040±.0010	4.73± 0.13^{A}	0.35±0.0010
T2	**0.02±0.01**	**2.33± 0.18^{C}**	**0.037±0.001**	
T3	**0.04±.002**	**2.31± 0.16^{C}**	**0.036±0.001**	
T4	**0.05±0.01**	**2.63± 0.12^{BC}**	**0.034±0.002**	
T5	**0.03±0.01**	**2.49±0.08^{BC}**	**0.035±0.001**	
T6	**0.02±0.00**	**2.79±0.43^{BC}**	**0.040±0.004**	
T7	**0.03±0.01**	**3.00±0.23^{BC}**	**0.034±0.001**	
T8	**0.04±0.01**	**3.33±0.47^{BC}**	**0.034±0.001**	
T9	**0.05±0.01**	**3.53±0.07^{B}**	**0.033±0.001**	
Significance Level		**NS**	**	**NS**

T1: control treatment (basic diet). T2, T3, T4, and T5: with local shiitake mushroom growth waste powder at 2, 4, 6 and 8%, respectively, in the basic diet. T6, T7, T8, T9: with local shiitake mushroom growth waste powder at similar proportions and 0.05% probiotics in the basic diet. **Significant differences at P≤0.01. NS.: Not significant.

Table 8 shows the effect of the above treatments on MDA, PV, and FFA values after 2-week storage of the eggs at the end of the experiment. MDA values showed highly significant differences (P≤0.01) for the various treatments with T4, using 6% shiitake growth waste powder, recording the lowest value compared to T1, T2, T6, and T8. However, it did not differ significantly (P≤0.01) from treatments T3, T5, T7, and T9, but differed highly significantly from treatments T1, T2, T6, and T8. The results indicated a significant decrease (P≤0.01) in yolk PV values after the 2-week storage period for T9, which used the shiitake waste powder together with probiotics, compared to treatments T1 to T5. However, T9 did not differ significantly from treatments T6, T7, and T8, while treatments T2, T3, T4, T5, T6, and T8 did not differ significantly from each other.

As seen from the table, the highest percentage of PV value was in the control treatment, which did not use the shiitake waste powder. As for FFAs, a significant increase (P≤0.01) was observed for both the T1 control treatment and treatment T2, which used the lowest percentage of the waste powder (2%) and without probiotics, compared to all treatments using the waste mixture powder, which had the lowest percentages of FFA despite the presence of highly significant differences (P≤0.01) between them, with T7 and T9 recording usage rates of 4 and 8 %, respectively. The 0.05% addition of probiotics was lower and did not differ significantly from T4, T5, T6, and T8. These treatments did not differ significantly from T3.

Table 8. Effect of using different levels of local shiitake mushroom waste mixture powder with and without probiotics in the diet of the laying hens on the oxidation indicators of the yolk for the second storage period of 2 weeks (mean ± SE)

Egg Storage Period (2 weeks)	Malondialdehyde (MDA(	Peroxide Value) PV(	Free Fatty Acids)FFA)	
Treatments	T1	0.68±0.06^{A}	9.80±0.61^{A}	0.052±0.001^{A}
T2	**0.61±0.07^{A}**	**7.20± 0.23^{B}**	**0.055±0.001^{A}**	
T3	**0.17±0.06^{BC}**	**6.33± 0.18^{BC}**	**0.042±0.001^{B}**	
T4	**0.14±0.02^{C}**	**6.93± 0.07^{B}**	**0.039±0.002^{BC}**	
T5	**0.24±0.05^{BC}**	**7.00±0.50^{B}**	**0.038±0.001^{BC}**	
T6	**0.35±0.02^{B}**	**6.27±0.48^{BCD}**	**0.037±0.001^{BC}**	
T7	**0.33±0.01^{BC}**	**4.93±.33^{CD}**	**0.035±0.001^{C}**	
T8	**0.35±0.04^{B}**	**5.67±0.55^{BCD}**	**0.037±0.002^{BC}**	
T9	**0.27±0.01^{BC}**	**4.53±0.33^{D}**	**0.034±0.001^{C}**	
Significance Level	**	**	**	

T1: control treatment (basic diet). T2, T3, T4, and T5: with local shiitake mushroom growth waste powder at 2, 4, 6 and 8%, respectively, in the basic diet. T6, T7, T8, T9: with local shiitake mushroom growth waste powder at similar proportions and 0.05% probiotics in the basic diet. **Significant differences at P≤0.01

Table 9 shows the effect of using different proportions of local shiitake mushroom growth waste powder with and without adding probiotics in the diet of laying hens on the oxidation indicators malondialdehyde (MDA), peroxide values (PV), and free fatty acids (FFA) after storing the eggs for 3 weeks after the end of the experiment. Highly significant differences (P≤0.01) were recorded between the different treatments in MDA. A significant decrease (P≤0.01) was observed for treatments T3, T4, T6, and T8 in which the mushroom growth waste powder was used with and without probiotics compared to the control treatment T1 in MDA values. This was not significantly different from treatments T2, T5, T7, and T9 which did not differ significantly among themselves and from the other treatments for this period.

As for PV values, the results indicated highly significant differences (P≤0.01) between the treatments with T4, T5, and T6 registering a significant decrease (P≤0.01) in stored egg compared to the control T1. T1 recorded the highest value of 9.47 mEq/kg fat and did not differ significantly from treatments T2, T3, T7, T8, and T9, which did not differ significantly among themselves and from the other treatments for the 3-week egg storage period. For FFA percentages in the stored egg, the results showed highly significant differences (P≤0.01) between the treatments with T6 recording a significant decrease (P≤0.01) compared to T1, T5, and T7. These treatments recorded the highest percentages of FFAs but did not differ significantly from treatments T2, T3, T4, T8, and T9 which did not differ significantly among themselves and from the control treatment T1.

Table 9. Effect of using different levels of local shiitake mushroom waste mixture powder with and without probiotics in the diet of laying hens on the oxidation indicators of the yolk in the third storage period of 3 weeks (mean ± SE)

Egg Storage Period (3 weeks)		Malondialdehyde (MDA(	Peroxide Value) PV(	Free Fatty Acids)FFA)
Treatments	T1	0.94±0.02^{A}	9.47±1.09^{A}	0.079±0.002^{A}
T2	**0.65±0.05^{AB}**	**6.40 ± 0.12^{AB}**	**0.074±0.001^{AB}**	
T3	**0.52±0.03^{B}**	**3.40±1.75^{AB}**	**0.076±0.001^{AB}**	
T4	**0.57±0.05^{B}**	**2.47± 0.13^{B}**	**0.077±0.001^{AB}**	
T5	**0.63±0.04^{AB}**	**2.47±0.68^{B}**	**0.078±0.002^{A}**	
T6	**0.57±0.00^{B}**	**2.67±0.29^{B}**	**0.072±0.001^{B}**	
T7	**0.63±0.0^{AB}**	**3.27±0.82^{AB}**	**0.079±0.001^{A}**	
T8	**0.44±0.20^{B}**	**3.00±0.50^{AB}**	**0.074±0.001^{AB}**	
T9	**0.66±0.04^{AB}**	**4.80±3.62^{AB}**	**0.076±0.001^{AB}**	
Significance Level	**		**	**

T1: control treatment (basic diet). T2, T3, T4, and T5: with local shiitake mushroom growth waste powder at 2, 4, 6 and 8%, respectively, in the basic diet. T6, T7, T8, T9: with local shiitake mushroom growth waste powder at similar proportions and 0.05% probiotics in the basic diet. **Significant differences at P≤0.01.

The low cholesterol concentration in egg yolk in most treatments using the shiitake waste powder mixture may be due to the mushroom being a food fungus rich in biologically active compounds that enhance immunity and reduce cholesterol concentration, such as phenols and flavonoids. These compounds are deposited in the mushroom waste powder mixture and the fermentation of this mixture of corn cobs and wheat bran converts these wastes of low nutritional value due to their high fiber content into products of high nutritional value. This is evident from the results in Table 3.

It also contains ergosterol, which is the main product of sterol synthesis in fungi **(24)** which helps reduce cholesterol absorption in the intestine. It also has a competitive role with glycerides and cholesterol in its association with bile salts and the formation of cholemerone and its absorption first at the expense of other types of fats **(14)**. The composition of fatty acids in egg yolk, which is one of the most important characteristics necessary for producing eggs with high nutritional value is clearly affected by changing the sequence and types of fatty acids in the feed provided to the birds **(1)**. The feed used in the diet containing linked fatty acids, as well as the type and level of unsaturated fatty acids, affect the chemical and qualitative properties of the yolk. This is important in controlling and raising the nutritional value of eggs and making the food functional and organic **(11,31)**.

The qualitative improvement in the fatty acids of the egg yolk of treatments using the shiitake mushroom powdered mixture may be attributed to the waste containing omega-3 fatty acids such as linoleic and oleic acid **(5,32)**, which improve the nutritional value by depositing them in the yolk of the eggs. The waste also contains alpha-linolenic acid, which is one of the types of linked fatty acids that have high biochemical properties, as it works to control fat metabolism through its action on the genetic receptors responsible for fat metabolism in liver cells. The process of redistributing fatty acids and sending them to the ovary takes place for the purpose of depositing them in the egg yolk **(6)**.

The low values of oxidation indicators (FFA, PV, MDA) for the eggs stored for the 3, 2, and 0 weeks after the end of the treatments using the shiitake powder mixture may be due to these wastes containing a large group of active substances and biologically active compounds, including flavonoids and phenols. This is evident from the results shown in Table 3, as these substances work as effective antioxidants that have the ability to inhibit the action of free radicals by donating a hydrogen atom. These compounds increase the formation and effectiveness of antioxidant enzymes such as catalase and superoxidase, thus preventing the synthesis of free radicals and preserving cells **(20)**. It also contains carotenoids **(2)** which are food pigments that are metabolized and deposited in egg yolk. They act as natural antioxidants that prevent the formation of free radicals by binding to the terminal ionic oxygen groups and by donating an electron to the ionic terminals. They then transfer it from the carotenoid pigments to the free radicals, which makes them inactive and thus protect the eggs from oxidation during storage **(22)**.

Conclusion

This study showed that growing local shiitake mushrooms on a mixture of low-nutritional value corn cobs and wheat bran and fermenting them improved their nutritional value and significantly reduced environmental pollution resulting from these agricultural wastes. It also provides the potential for their use as a partial substitute for corn in laying hens' diets, with and without the addition of probiotics, and has a positive impact on improving some chemical traits and the oxidation status of eggs.

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مقالة أصيلة

تأثير استعمال مسحوق مخلفات الفطر الشيتاكي المحلي Lentinus edodes في عليقة الدجاج البياض على بعض الصفات الكيميائية وحالة الاكسدة للبيض

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الخلاصة

أجريت هذه الدراسة في محطة أبحاث الدواجن التابعة لدائرة البحوث الزراعية /وزارة الزراعة للمدة من 27/6/2024 إلى 17/10/2024 لمعرفة تأثير استعمال نسب مختلفة من مسحوق مخلفات زراعة الفطر الشيتاكي المحلي في عليقة الدجاج البياض مع او بدون إضافة المعزز الحيوي وتأثيرها على بعض الصفات الكيميائية وحالة الاكسدة للبيض المخزون. واستعمل في التجربة 135 دجاجة بياضة نوع ايسا بني. موزعة على 9 معاملات كل معاملة تحتوي على 3 مكررات وكل مكرر يحتوي على 5 دجاجة. وكانت المعاملات كالاتي: معاملة السيطرة T1: العليقة الأساس بدون استعمال مسحوق خليط مخلفات تنمية الفطر الشيتاكي اما المعاملات T5,T4,T3,T2 فقد تم استعمال المسحوق فيها وبنسبة 8,6,4,2 % على التوالي اما المعاملات T9,T8,T7,T6 فقد تم استعمال نفس المسحوق وبنفس النسب على التوالي مع إضافة المعزز الحيوي بنسبة 0.05%. واشارت النتائج الى عدم وجود فروق في تركيز الكولسترول ما بين معاملات استعمال مسحوق خليط المخلفات ومعاملة السيطرة T1 ما عدا انخفاض عالي المعنوية P≤0.01في قيمة كولسترول صفار البيض للمعاملة T4 كذلك لوحظ حصول ارتفاع عالي المعنوية P≤0.01 في تركيز كل من الاحماض الدهنية اللينوليك والبالمتيك والاوليك لمعظم المعاملات التي استعمل فيها مسحوق خليط مخلفات تنمية الفطر. ولوحظ حصول انخفاض عالي المعنوية P≤0.01 في قيمة المالونديهايد (MDA) وقيمة البيروكسيد (PV) وقيمة الاحماض الدهنية الحرة (FFA) لصفار البيض المخزون لمدة 3,2 أسبوع لمعظم المعاملات التي استعمل فيها مسحوق مخلفات زراعة الفطر الشيتاكي المحلي مقارنة بمعاملة السيطرة T1

الكلمات المفتاحية: المخلفات الزراعية، الكولسترول، الاحماض الدهنية، قيمة البيروكسيد