

EFFECT OF DIETARY PARTIAL REPLACEMENT OF FERMENTED POTATO PEELS POWDER ON PHYSIOLOGICAL AND MICROBIAL PARAMETERS OF BROILERS

W. H. AL-Shemmari
Researcher

H. A. AL-Mashhadani
Prof.

Dept. Anim. Prod., Coll. Agric. Sci. Engin. University of Baghdad, Iraq.

Walaa.hussein1101a@coagri.uobaghdad.edu.iq

hisham.ahmed@coagri.uobaghdad.edu.iq

ABSTRACT

The experiment was carried out to investigate the effect of dietary replacement of fermented potato peels powder (FPPP) with Kiwi juice or probiotics with yellow corn on pre- and post- storage of meat oxidation for 30 days, physiological and microbial of broiler. A total of 231, day old broiler chicks (Rose 308) were used. The chicks were randomly distributed to seven treatments, with 3 replicate per each (11 chicks/ replicate): 6 males and 5 females. Chicks in the first treatment were fed on an ordinary diet and it was considered as a control treatment (T1). The T2, T3 and T4 treatments were considered as replacement treatments in which the (FPPP) by Kiwi juice was replaced by yellow corn at level of 6, 12 and 18% respectively. The T5, T6 and T7 treatments were used (FPPP) by Iraqi probiotics replaced by yellow corn at level of 6, 12 and 18% respectively. Significant differences ($P \leq 0.01$) were showed among treatments in the oxidation indices so that all the replacement treatments were superior in the oxidation value as compared with control at pre- and post - meat storage period. No significant differences was found in glucose concentration, total protein, uric acid and liver enzymes. The histological in Ileum showed superiority ($P \leq 0.01$) in crypt depth of T3, T6 and T7 while T6 significantly ($p < 0.01$) villus length and the mucosal layer thickness as compared with T1. Excluding data of T1 and T2 groups, all treatments have a crucial role in increasing beneficial bacterial count.

Keywords: potato peels, kiwi, probiotics, meat oxidation.

الشمري والمشهداني

مجلة العلوم الزراعية العراقية- 2025 :56 (5):1802-1811

تأثير الإحلال الجزئي لمسحوق قشور البطاطا المخمرة في علائق فروج اللحم في الصفات الفسلجية والميكروبية

هشام احمد المشهداني
أستاذ

ولاء حسين الشمري
باحث

المستخلص

نفذت التجربة لمعرفة تأثير الإحلال الجزئي لمسحوق قشور البطاطا المخمرة (FPPP) بعصير الكيوي والبروبيوتيك بالذرة الصفراء على أكسدة اللحوم قبل وبعد تخزينها لمدة 30 يوماً، الصفات الفسيولوجية والميكروبية لدجاج اللحم. استعمل في التجربة 231 فرخ فروج لحم (روز 308) بعمر يوم واحد. وزعت الافراخ عشوائياً على سبع معاملات، كل معاملة قسمت الى 3 مكررات بواقع (11 فرخ / مكرر): 6 ذكور و 5 إناث. تم تغذية الافراخ في المعاملة الأولى على عليقة قياسية واعتبرت معاملة السيطرة (T1). تعتبر (T2)، (T3) و (T4) معاملات إحلال (FPPP) بعصير الكيوي بالذرة الصفراء بنسب 6، 12 و 18% على التوالي. تم استخدام (T5)، (T6) و (T7) معاملات إحلال (FPPP) بالبروبيوتيك العراقي بدلاً من الذرة الصفراء بنسب 6، 12 و 18% على التوالي. كان هنالك فروق معنوية ($P \leq 0.01$) بين المعاملات في مؤشرات الأكسدة، إذ تفوقت جميع معاملات الإحلال في مؤشرات الأكسدة مقارنة بـ (T1) قبل وبعد التخزين. لم يلاحظ وجود فروق معنوية في تركيز كل من الكلوكوز والبروتين الكلي وحامض اليوريك وأنزيمات الكبد. اظهر المقطع النسيجي لمنطقة اللفانفي تفوق معاملات الإحلال T3، T6 و T7 معنوياً ($P \leq 0.01$) في عمق الخبايا، كما تفوقت (T6) معنوياً في طول الزغابة وسمك الطبقة المخاطية مقارنة بـ (T1). باستثناء بيانات معاملة T1 و T2 فإن جميع المعاملات الأخرى لها دور مهم في زيادة عدد البكتيريا المفيدة.

الكلمات المفتاحية: قشور البطاطا، الكيوي، المعزز الحيوي، أكسدة اللحم.



This work is licensed under a Creative Commons Attribution 4.0 International License. Copyright© 2025 [College of Agricultural Engineering Sciences](#) - [University of Baghdad](#)

Received:22/3/2023, Accepted:25/6/2023, Published :October 2025

INTRODUCTION

In the poultry industry, approximately 65% of the total feed cost is attributed to energy-providing ingredients (32, 39). To mitigate the rising expenses associated with conventional feed components, animal nutritionists are increasingly turning to agro-industrial by-products as alternative resources (41). There is a wide variety of potatoes that differ in shapes and colors and are marketed for either local or mass consumption (such as in restaurants), and their peels are different too. In the next few years, it is expected that the demand for this tuber and novel food products derived from it will increase both locally and abroad. Consequently, large amounts of PP will be generated, the PPs. PP is a by-product with substantial potential because it is a good source of fiber and contains different bioactive compounds that have been shown to have health benefits. (25). Potato peels account for nearly 10% of total waste and represent between 15% and 40% of the tuber, depending on the peeling method used (34). As global food demand intensifies due to the continuous growth of the world population, the poultry industry faces increasing pressure to meet production demands (2). Feed is considered the most expensive component of poultry production, and feed processing further contributes to the overall cost by adding expenses related to processing and ingredient sourcing. Additionally, feed additives have become essential in poultry nutrition due to their important role in supporting the overall health and performance of birds, making them a necessary component in commercial feed production (1). The poultry industry has been seeking low-cost substitutes. In this way, plant extracts have progressively gained ground on the agenda of scientific researchers due to the secondary metabolites produced by several plants that have antimicrobial, antioxidant and antiviral properties (14). There are many varieties of potatoes including (Sever, Sylvana, Rudolph, Riviera, Everest, Buren, Arizona and Almondo). The widely used potatoes for human consumption provides large quantities of peels, which is a major problem of pollution if it is not treated and used and problems sanitation (12, 42). Some studies have showed the possibility of using potato peels in the diets

of broiler chickens, in small proportions, because of its positive characteristics that encourage its inclusion in the diets for its important nutrients content, as it contains representative energy and crude protein, and it is rich in some essential amino acids and cellulose (15, 24). Potato peels also contain some effective compounds that act as antioxidants, such as phenols, carotenoids, active, vitamins C and E, and choline (18). Some of the common NSPs present in PP are cellulose, hemicellulose, xylose and lignin. (27). Despite these advantages, there are some inhibitors that are found in potatoes, such as non-starchy polysaccharides, manan compounds, tannic acid, phytic acid, solandine compound and others, which have negative effects on broilers when used in high proportions in diets (26), but there are Approved technologies can reduce and limit these inhibitors, including the fermentation process, where the fermentation process leads to an increase in the readiness of the nutrients present in the feed materials because of the action of the microorganisms used in fermentation and its role in activating enzymes such as the phytase enzyme, which increases the liberation of associated phosphorus and increasing the effectiveness of internal enzymes with fodder materials (38). Fermentation has been used to improve the nutritional value of unconventional feed ingredients by lowering the crude fiber content processing methods e.g. fermentation can be employed to eliminate or reduce the anti-nutritional factors present; this will improve the quality and safety feed materials (28). Fermentation of potato peels also led to a decrease some inhibitors such as alkaloid, glycoside, saponins and tannin where it was found that the nutritional value of died materials can be improved by fermentation (6). Bacterial strains used to start fermentation could promote the degradation of complex carbohydrates, consisting of cellulose and hemicelluloses, into short chain organic acids, thus leading to a lower pH and creating an anaerobic microecology environment in the gut (21,31). A research report by (33) has measured the protein content of 12.5% while reporting the effect of *Saccharomyces cerevisiae* on protein enrichment of potato

peels using solid-state fermentation process. He also showed (3) that there is an improvement in the nutritional value of the Nile flower leaves powder when fermented with beneficial bacteria compared to the raw powder. (8) indicated that using probiotics, combination in broiler diets might be one of the promising strategies that might be applied. Since there are no studies on replacing fermented potato peel powder with kiwi juice and Iraqi probiotics, instead of yellow corn in broiler diets, the current study: was done to investigate the use of the fermentation process could improve the nutritional value of potato peelings and to show the effect of substituting it in broiler diets in different proportions for yellow corn in some physiological and histological characteristics and some indicators of meat oxidation and knowing its effect on the growth of microorganisms in the intestinal tract, from other hands to determining the best rates of substitution of potato peelings for yellow corn.

MATERIALS AND METHODS

The study was conducted on 231, day-old broilers chicks Ross 308. Yellow corn was substituted with potato peel powder which was fermented by Kiwi Juice or by Iraqi probiotic in different percentage. The study included seven treatments. (T1) control group with basal diet containing 48% yellow corn, and the second, third and fourth treatments were substitution of fermented potato peel powder with kiwi juice in 6, 12 and 18%, respectively and the fifth, sixth and seventh treatments include the substitution of fermented potato peel powder with the Iraqi probiotic at rate of 12, 6 and 18%, respectively.

Processing potato peelings: Free potato peels were got from one of the large local restaurants, it was filtered from impurities and washed well. To prepare the fermentation with Iraqi probiotic or kiwi Juice according to (4) the potato peels were moistened before fermentation by adding water by 50%, Iraqi probiotic was added, at a rate of 0.5%, and kiwi juice at a rate of 1%, (which got from the local markets), considering good mixing, and then packing them in polyethylene bags, to vacuuming them from air, to provide an anaerobic environment to encourage the growth of beneficial microorganisms. The

mixture was placed in a room with a temperature of 37 °C, it was emptied from the bags and scattered on a clean floor to dry (drying in the shade, with continuous stirring). Analysis: they formed diets of equal energy and protein according to the age stages and replacement percentages (6, 12 and 18%) in place of maize, as mentioned (7): The count of microorganisms in Iraqi probiotic used is shown in Table 1.

Chemical analysis: A chemical analysis was made of fermented potato peels, Table 3 at ministry of higher education and scientific research - scientific research authority - center for environmental and water research (9), then it was introduced with the rest of the diet components after crushing it only. Also, a mycotoxin test was performed using HPLC technology, which showed that it was free of any toxins.

Studied traits: All tests were conducted at the end of the experiment (35 days), included:

Oxidation indicators: Three birds were taken randomly from each replicate, slaughtered and the thighs were cut off to calculate the oxidation indicators in its meat at 0 days and 30 storage days. The oxidation indicators included: estimation of peroxide value and free fatty acid according to (17), determination of reduced glutathione level using reverse phase high-pressure liquid chromatography (RP-HPLC) method.

Blood parameters: Blood was collected from branchial vein, from 3 birds in each replicate then centrifuged at a 4000 rpm/minutes for 10 minutes to separate serum to estimate: glucose concentration (mg/100 ml) according to (10), total protein concentration (g / 100 ml) according to (40), and cholesterol (mg / 100 ml) according to (5). Histological characteristics: 3 birds were taken from each replicate, slaughtered and ileum viscera were cut out and samples were taken from it was done to make histological sections to calculate villi length, crypts depth, villi thickness, and mucous layer thickness. The histological preparations at the University of Baghdad - College of Veterinary Medicine according to (11). height and thickness of the villi and the depth of the crypts was done according to (36).

Microbial tests: The numbers of *E. coli* bacteria *Lactobacilli* in ileum were calculated according to (37).

Statistical analysis: The experiment data were analyzed using Complete Randomized Design (CRD) to determine the effect of treatments

the effect of different levels of artichoke leaves extract powder in the studied traits, then the significant differences were compared between averages with the multiple range test (16) and used statistical analysis system (35).

Table 1. Count of microorganisms in Iraqi probiotic used in the experiment

Microorganisms	Number
<i>Acidophilus Lactobacillus</i>	10 ^{×8}
<i>Bacillus subtilis</i>	10 ^{×9}
<i>Bifidobacterium</i>	10 ^{×8}
<i>Saccharomyces cerevisiae</i>	10 ^{×9}

Table 2. Active compounds in potato peels

No	Name	Con
1	Total phenolic content (mg / 100 gm)	520.18
2	Total flavonoid content (mg / 100 gm)	358.99
3	Total alkaloid content %	4.8
4	Total glycoside content %	3.9
5	Total saponins content %	1.5
6	Total tannin content %	6.5

Table 3. Chemical analysis for raw and fermented potato peels with probiotic and kiwi juice

T	food item	Raw	probiotic	kiwi
1	Crude protein %	10.5	11.02	12.15
2	Ether extract %	2.3	2.69	2.81
3	Humidity %	12.5	13.05	14.12
4	Ash %	6.4	7.00	6.89
5	Crude fiber %	20.9	24.11	22.15
6	starch %	10.3	10.36	10.48
7	carbohydrate %	35.4	31.77	31.37
8	Metabolizable energy (kcal)/Kg	2043	2032	1982
9	Carotene %	3.24	3.58	3.88
10	Phosphorus %	0.08	0.14	0.19
11	Calcium%	0.036	0.058	0.079
12	Vitamin A (IU)	3.2	3.36	3.49
13	Methionine%	0.30	0.34	0.34
14	Lysine%	0.44	0.45	0.46
15	Cysteine%	0.59	0.60	0.63

RESULTS AND DISCUSSION

Indicators of meat oxidation: It is noted from the results of Table (4) about some indicators of oxidation in the thigh meat of broiler chickens before and after the storage process, as there were higher significant differences ($P < 0.01$) between the different experimental treatments in some indicators of oxidation represented by the value of peroxide (P. V), the value of glutathione (GSH) and free fatty acid before and after (30 days) of storage, where T6 recorded the best indicators compared with the control treatment (T1) and all other replacement treatments, and all treatments of fermented husks replacing yellow corn recorded higher significant improvement

($p \leq 0.01$) compared with the control treatment T1. As for estimating the concentration of free fatty acids (FFA), there were higher significant decrease in all treated groups fermented compared with control (T1) before and after the storage period. The reason for the significant decrease ($p < 0.01$) in the indicators of oxidation of broiler meat before and after the storage process may be because of the active compounds present in fermented potato peel powder, especially phenolic compounds and flavonoids (Table 2) and ascorbic acid (19). These compounds exhibit antioxidant activity, which protects biomolecules, nucleic acids, polyunsaturated fats, proteins, and sugars from oxidative damage (20,25).

Table 4. Effect of partial replacement (EPPP) instead of yellow corn on pre- and post- storage of meat oxidation (average $\pm$ standard error)

Treatment	Oxidative indicators					
	(0 days) before storage			After 30 days of storage		
	P.V (meg/100gm)	GSH (mg / kg)	FFA %	P.V (meg/100gm)	GSH (mg / kg)	FFA %
T1	a 3.11 $\pm$ 0.00	g 2.17 $\pm$ 0.01	a 0.51 $\pm$ 0.00	a 4.17 $\pm$ 0.02	g 1.96 $\pm$ 0.00	a 0.62 $\pm$ 0.01
T2	b 2.83 $\pm$ 0.02	f 2.72 $\pm$ 0.02	b 0.47 $\pm$ 0.00	ab 3.97 $\pm$ 0.01	f 2.47 $\pm$ 0.01	b0.53 $\pm$ 0.00
T3	e 2.61 $\pm$ 0.01	c 3.56 $\pm$ 0.03	e 0.34 $\pm$ 0.00	c 3.31 $\pm$ 0.00	c 2.90 $\pm$ 0.01	e 0.41 $\pm$ 0.00
T4	c 2.75 $\pm$ 0.01	e 3.00 $\pm$ 0.02	c 0.43 $\pm$ 0.00	b 3.83 $\pm$ 0.01	e 2.58 $\pm$ 0.00	c 0.49 $\pm$ 0.00
T5	d 2.67 $\pm$ 0.00	d 3.30 $\pm$ 0.03	d 0.39 $\pm$ 0.00	b 3.71 $\pm$ 0.06	d 2.67 $\pm$ 0.01	d 0.44 $\pm$ 0.00
T6	g 2.42 $\pm$ 0.01	a 4.02 $\pm$ 0.03	g 0.24 $\pm$ 0.00	d 2.74 $\pm$ 0.22	a 3.23 $\pm$ 0.01	g 0.32 $\pm$ 0.00
T7	f 2.51 $\pm$ 0.00	b 3.82 $\pm$ 0.03	f 0.31 $\pm$ 0.00	c 3.12 $\pm$ 0.01	b 2.99 $\pm$ 0.02	f 0.35 $\pm$ 0.00
Sign.levels	**	**	**	**	**	**

****:** Highly significant difference ($P \leq 0.01$). T1: a comparison treatment, T2, T3, and T4 are substitution treatments of fermented potato peelings with kiwi juice by 6, 12, and 18%, and T5, T6, and T7 are substitution treatments of fermented potato peelings with probiotics by 6, 12, and 18% of yellow corn, respectively.

Physiological parameters: Results in Table of broiler chickens indicate that there were no significant differences between all treatments (5) concerning serum physiological parameters (glucose, protein, liver enzymes and uric acid) at 35 days of age.

Table 5. Effect of partial replacement (EPPP) instead of yellow corn on some physiological characteristics of broiler blood (average $\pm$ standard error)

Treatment	Physiological traits				
	Glucose (mg /100 ml)	AST (IU/L)	ALT(IU/L)	Uric acid (mg/100ml)	Total Protein (g /100 ml)
T1	265.33 $\pm$ 1.45	222.66 $\pm$ 6.83	50.33 $\pm$ 4.80	4.33 $\pm$ 0.25	2.79 $\pm$ 0.25
T2	250.66 $\pm$ 3.84	208.66 $\pm$ 20.16	56.00 $\pm$ 5.29	3.83 $\pm$ 0.94	2.63 $\pm$ 0.08
T3	275.00 $\pm$ 8.08	212.66 $\pm$ 9.38	55.00 $\pm$ 4.00	4.35 $\pm$ 0.51	3.07 $\pm$ 0.29
T4	277.33 $\pm$ 15.89	174.66 $\pm$ 36.03	50.33 $\pm$ 5.04	5.89 $\pm$ 1.54	2.83 $\pm$ 0.10
T5	270.00 $\pm$ 6.42	176.33 $\pm$ 13.86	61.33 $\pm$ 3.66	4.22 $\pm$ 0.18	2.73 $\pm$ 0.05
T6	265.66 $\pm$ 6.83	182.66 $\pm$ 33.45	59.33 $\pm$ 6.38	3.56 $\pm$ 0.58	2.54 $\pm$ 0.01
T7	256.33 $\pm$ 32.19	198.33 $\pm$ 15.66	58.66 $\pm$ 4.33	4.80 $\pm$ 0.75	2.71 $\pm$ 0.15
Sign.levels	N.S	N. S	N. S	N. S	N. S

N.S. there was no significant. T1: control, T2, T3, and T4 are substitution treatments of fermented potato peelings with kiwi juice by 6, 12, and 18%, and T5, T6, and T7 are substitution treatments of fermented potato peelings with probiotics by 6, 12, and 18%.

Histological study: Results in Table (6) with fig.1 for histological characteristics (crypts depth, villi thickness, villi height, mucous layer thickness) for the ileum region of broiler chickens, showed highly significant differences ($p < 0.01$) in replacement treatments T3, T6 and T7 compared with control (T1), while other replacement treatments (T2, T4 and T5) significant differences with didn't showed control group (T1) in the depth of crypts. There was a highly significant superiority ($P < 0.01$) in villi height in favor of the replacement treatment T6 compared with control group (T1) and the rest of the replacement treatments except T4. Regarding the thickness of the mucous layer, there is a highly significant superiority ($P < 0.01$) in substitution treatments T6 and T7 compared to control group (T1) and the two substitution treatments T2 and T3. As for the thickness of the villi, it was observed that there was a significant superiority ($P \leq 0.05$) in favor of the replacement treatment T5 over the

replacement treatments T2 and T7, while there were no significant differences between all the replacement treatments and the comparison T1. The reason for the increase ($p < 0.05$) in the thickness of the villi may be because of the presence of active compounds in fermented potato peel powder such as phenols and flavonoids (Table 2), which make the gastrointestinal tract more digestible and absorbable by activating bath of epithelial cell division lining the intestine and antibiotic action to suppress germs, and this helps to improve The digestion process (29). The reason for the increase in villi height in favor of the T6 substitution treatment may be because of the fermentation process, especially fermentation with the Iraqi probiotic that contains beneficial bacteria, because the reason for their presence in the intestine works to produce short-chain fatty acids that stimulate the differentiation of the epithelial cells lining the alimentary canal by supplying them with energy to sustain them continuously,

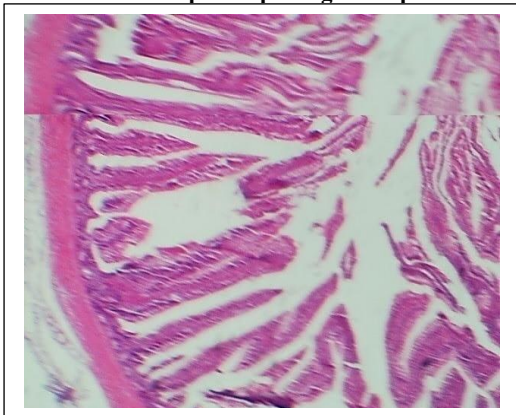
and this helps them to speed up their growth and then increase the length of the villi, which helps them to digest digested food (13). Fermented feed supplementation significantly

improved villus height (VH) of the jejunum and the ratio of villus height to crypt depth (VH/CD) of the ileum ($P < 0.05$) (31).

Table 6. Effect of partial replacement (EPPP) instead of yellow corn on histological characteristics of the ileum region of broiler chickens (average $\pm$ standard error).

Treatment	Duodenum (micrometer)			
	Crypt depth	Villi thickness	Villi height	Mucous layer thickness
T1	cd 112.11 $\pm$ 2.01	ab 73.50 $\pm$ 3.37	b 517.45 $\pm$ 17.25	d 588.80 $\pm$ 12.72
T2	d 108.73 $\pm$ 4.61	b 65.46 $\pm$ 3.44	bc 497.28 $\pm$ 26.35	cd 603.69 $\pm$ 27.66
T3	a 143.22 $\pm$ 5.66	ab 70.37 $\pm$ 2.97	c 450.01 $\pm$ 16.08	cd 607.87 $\pm$ 19.17
T4	bc 126.14 $\pm$ 5.70	ab 67.58 $\pm$ 3.78	ab 534.69 $\pm$ 16.72	bc 656.00 $\pm$ 13.58
T5	bcd 123.35 $\pm$ 2.49	a 77.12 $\pm$ 4.57	b 510.25 $\pm$ 9.16	bcd 640.73 $\pm$ 8.51
T6	ab 138.14 $\pm$ 6.86	ab 67.18 $\pm$ 2.17	a 579.47 $\pm$ 16.01	a 711.61 $\pm$ 21.27
T7	a 146.95 $\pm$ 6.81	b 65.21 $\pm$ 3.96	bc 496.13 $\pm$ 12.04	ab 670.74 $\pm$ 11.41
Sign.levels	**	*	**	**

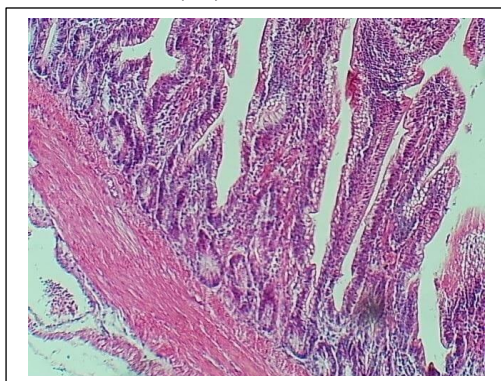
*: significant difference ($P \leq 0.05$). **: highly significant difference ($P \leq 0.01$). T1 control treatment, T2, T3, and T4 are substitution treatments of fermented potato peelings with kiwi juice by 6, 12, and 18%, and T5, T6, and T7 are substitution treatments of fermented potato peelings with probiotics by 6, 12, and 18% of yellow corn, respectively.



(T1): Control



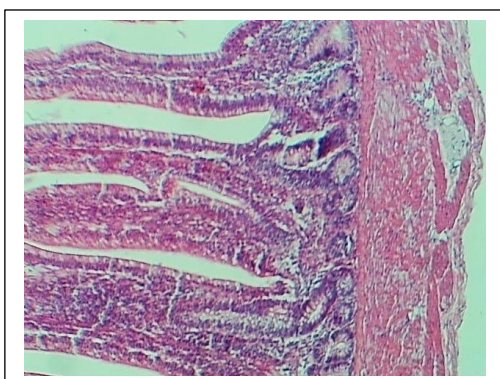
(T2): Replacement 6% of (FPPP) with Kiwi juice



(T3): Replacement 12% of (FPPP) with Kiwi juice



(T4): Replacement 18% of (FPPP) with Kiwi juice



(T5): Replacement 6% of (FPPP) with probiotic



(T6): Replacement 12% of (FPPP) with probiotics



(T7): Replacement 18% of (FPPP) with probiotic

Fig 1. Histological sections of ileum

Microbial count: From the data in Table (7) on the microbial count of beneficial and harmful bacteria in the intestines of broiler chickens, there is a higher significant decrease ($P < 0.01$) in the numbers of harmful bacteria (*E. coli*) in all replacement treatments compared to the comparison treatment T1 at 35 day of age. The microbial count of beneficial bacteria (*Lactobacilli*), results showed a higher significant superiority ($P \leq 0.01$) in favor of the treatments of replacing fermented potato peels with probiotics, compared with the control treatment T1 and T2 treatment. The presence of active compounds such as phenolic compounds and flavonoids in fermented potato peel powder works to establish a balanced ecosystem within the gastrointestinal tract by

producing antibiotics for harmful microorganisms and maintaining beneficial intestinal bacteria and the functions of the digestive system, as these compounds effectively affect the cell membranes of harmful bacteria, especially *Salmonella* and *E. coli* bacteria (23). These compounds also play an important role in the balance of the pH of the intestine, which makes it be acidic, and this encourages the growth and multiplication of beneficial bacteria (lactic acid bacteria) in the intestine, and this is reflected positively on performing birds performance (22). In addition, studies have shown that fermented diets had the potential to improve intestinal digestive function and morphology, as well as modulated the gut microbial ecosystem in poultry (30).

Table 7. Effect of partial replacement (EPPP) instead of yellow corn on ileum microbial count of broiler chickens (mean $\pm$ standard error)

Treatments	Microbial counting of good and harmful bacteria (CUF\ML)			
		<i>Lactobacilli</i>		<i>E. Coli</i>
T1	d	6.37 $\pm$ 0.04	a	6.65 $\pm$ 0.12
T2	dc	6.67 $\pm$ 0.37	b	6.26 $\pm$ 0.03
T3	bc	7.06 $\pm$ 0.21	b	6.12 $\pm$ 0.06
T4	ab	7.34 $\pm$ 0.02	b	6.16 $\pm$ 0.06
T5	a	7.70 $\pm$ 0.15	b	6.34 $\pm$ 0.02
T6	a	7.80 $\pm$ 0.04	b	6.28 $\pm$ 0.08
T7	ab	7.40 $\pm$ 0.03	b	6.22 $\pm$ 0.01
Sign.levels		**		**

****:** Highly significant difference ($P \leq 0.01$) T1: control group, T2, T3, and T4 are substitution treatments of fermented potato peelings with kiwi juice by 6, 12, and 18% of yellow corn respectively, and T5, T6, and T7 are substitution treatments of fermented potato peelings with probiotics by 6, 12, and 18% of yellow corn, respectively

CONCLUSIONS

It was concluded from the study that the replacement of fermented potato peel powder with kiwi juice or with the Iraqi probiotic did not affect the physiological characteristics, while there was an improvement in the oxidation indicators of the thigh meat stored

by freezing for 30 days, as well as the microbial count of beneficial bacteria and the histological characteristics of broiler chickens with replacement rates of 6, 12 and 18%.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

REFERENCES

1. Abbas, B. A., 2023. Traditional and Non-Traditional Feeds in Poultry Feeding: A review. *radinka journal of science and systematic literature review*. 1(2), 111–127. <https://dio.org/10.56778/rjslr.v1i2.139>.
2. Rehman, A. U., J. A. Buzdar, M. A. Arain, S. A. Fazlani, M. Arslan, and C. Zhou., 2025. An in-depth overview of the nutritional advantages of medicinal plant supplementation in poultry feed. *World's Poult. Sci. J.* 81 (2), 569-604. <https://doi.org/10.1080/00439339.2025.2468696>
3. Al- Aboudi. A. M. and S. J. Hamodi., 2023. Improving the nutritional value of water hyacinth leaves (WHL) and adding it to broiler diets during different periods age and its effects on the productive performance. *Iraqi J. Agri. Sci.* 54 (6): 1487-1496. <https://doi.org/10.36103/ijas.v54i6>
4. Aljebory, H. H. and S. A. H Naji., 2021. Effect of pelleted fermented feed - in egg quality of laying hens. *Diyala J. Agri. Sci.* 13 (1), 41 -57. <https://doi.org/10.52951/dasj.21130105>
5. Allain, C. 1974. Enzymatic determination of total serum cholesterol. *Clinical Chemistry*, 20(4), 470-475.
6. Alshelmani. M. I, U. Kaka, E. A. Abdalla, A. M. Humam and H. U. Zamani., 2021. Effect of feeding fermented and non-fermented palm kernel cake on the performance of broiler chickens: a review. *World's J. Poult. Sci.*, 77 (2), 377–388. <https://doi.org/10.1080/00439339.2021.1910472>
7. Al-Shemmari, W. H. A. and H. A. Al-Mashhadani., 2023. The Effect of partial substitution of fermented potato peeling powder instead of yellow corn on the productive performance of broiler chickens. *IOP Conf. Ser.: Earth Environ. Sci.*, 1214, 1180. <https://doi.10.1088/1755-1315/1214/1/012035>
8. Al-Younes, W. M., A. M. Abdelqader, M. K. Abuajamieh, and K. O. Nassar., 2024. Efficacy of probiotics and essential oils as alternatives to antibiotic growth promoters in broiler chickens. *Iraqi J. Agric. Sci.*, 55(2), 633-643. <https://doi.org/10.36103/8mfnd990>
9. AOAC (Association of Official Analytical Chemists). 1995. *Official Methods of Analysis*, 16th Edition. AOAC International, Gaithersburg, MD. PP: 711 – 738.
10. Asatoor, A. M and E. J. King., 1954. Simplified colorimetric blood sugar method. *The Biochemical J.* 01 Jan 1954, 56 (325th Meeting): xlv PMID: 13159933.
11. Bancroft, J. D, and G. Marilyn., 2008. *Theory and practice of histological techniques*. Elsevier Health Sciences. PP: 168-173.
12. Calliope, S. R.; M. O. Lobo, and N. C. Sammán., 2018. Biodiversity of andean potatoes: morphological, nutritional and functional characterization. *Food Chemistry*, 238,42-50. <https://doi.org/10.1016/j.foodchem.2016.12.074>
13. Chaing, W. Q, J. K. Piao, L. Gong and P. A. Thacher., 2010. Effect of feeding solid state fermented rapeseed meal on performance, Nutritional digestibility, intestinal ecology and intestinal Morphology of broiler. *Asain-Austrlas. J. Anim. Sci.* 23 (2), 263-271. <https://doi.org/10.5713/ajas.2010.90145>
14. Diogo F. F., F. L. Valente, R. A.Barros, D. G. G.Schwarz, F. S. Marks and M. A. S. Moreira., 2025. Effects of phenolic compounds on broiler's diet: a systematic review. *World's Poult. Sci. J.* 81 (2): 557-567. <https://doi.org/10.1080/00439339.2025.2459712>
15. Duhan J. S., S. Kumar and S. K. Tanwar., 2013. Bioethanol production from starchy part of tuberous plant (potato) using *Saccharomyces cerevisiae* MTCC-170. *Afr. J. Microbiol. Res.* 7(46): 5253-5260. <https://doi.org/10.5897/AJMR2013.6122>.
16. Duncan D. B., 1955. Multiple range and multiple F tests. *Biometrics*, 11, 1–42. <https://doi.org/10.2307/3001478>
17. Egan. H., R. S. Kirk, and R. Sawyer. 1981. *Pearson's Chemical Analysis of Foods*, Eighth edition, Churchill Living Stone, New York.pp:591.
18. Ezekiel, R., N. Singh,, S. Sharma and A. Kaur. 2013. Beneficial phytochemicals in potato – a review. *Food Res. Int.*, 50 (2), 487-496. <https://doi.org/10.1016/j.foodres.2011.04.025>

19. Hafeez, A., S. A. A., R. U., Shah, Q., Khan, Ullah, and S. Naz, 2020. Effect of diet supplemented with phytogenics and protease enzyme on performance, serum biochemistry and muscle histomorphology in broilers. *J. Appl. Anim. Res.*, 48(1), 326-330. <https://doi.org/10.1080/09712119.2020.1789648>.
20. Heleno, S. A. M. J. R., Martins, Queiroz, and I. C. Ferreira., 2015. Bioa of phenolic acids: Metabolites versus parent compounds: A review. *Food Chemistry*, 173,501-513. <https://doi.org/10.1016/j.foodchem.2014.10.057>.
21. Hui, Z. Y. Men, C. Hu, J. Kang X. Sun, N. Bi and. J. He., 2021. Effect of postoperative radiotherapy for patients with pIIIA-N2 non–small cell lung cancer after complete resection and adjuvant chemotherapy: the phase 3 PORT-C randomized clinical trial. *JAMA Oncology*, 7(8), 1178-1185. <https://doi.org/10.1001/jamaoncol.2021.1910>
22. Iqbal, Y. J. Cottrell, J. H. A. Suleria and F. R. Dunshea., 2020. Gut polyphenol interactions in chicken: A review. *Animals*, 10 (8), 1391. <https://doi.org/10.3390/ani10081391>.
23. Jamroz, D. T. Wrotecki, M. Houszka and C. Kamel., 2006. Influence of the inclusion of plant origin active substances on morphological and histochemical characteristics of the stomach and jejunum walls in chicken. *J. Anim. Physiol.. Anim. Nut.*, 90 (5-6), 255-268. <https://doi.org/10.1111/j.1439-0396.2005.00603.x>
24. Jiang, H., F. Wang, R. Ma. T. Yang, C. Liu, W. Shen and Y. Tian., 2024. Advances in valorization of sweet potato peels: A comprehensive review on the nutritional compositions, phytochemical profiles, nutraceutical properties, and potential industrial applications. *Compr. Rev. Food Sci. Food Saf.*, 23(4),e13400. <https://doi.org/10.1111/1541-4337.13400>
25. Jimenez C. D., L. Frank, R. Orejon, A. M. Reyes, A. M. Muñoz, and F. R. Escudero., 2023. Bioactive compounds in potato peels, extraction methods, and their applications in the food industry: a review. *Cyta-Journal of Food*, 21(1), 418- 432. <https://doi.org/10.1080/19476337.2023.2213746>.
26. Johri, T. S., 2005. Endogenous and exogenous feed toxins. *Poultry nutrition research in India and its perspective*. Central Avian Research Institute Izatnagar - 243 122, Distt. Bareilly (U.P.) <http://www.fao.org/docrep/article/agrippa/659-en-10.htm>.
27. Jozefiak, D. A. Rutkowski, B. B. Jensen and R. M. Enberg., 2006. The effect of betaglucanase supplementation of barley and oat-based diets on growth performance and fermentation in broiler chicken gastrointestinal tract. *Br. Poult. Sci.*, 47, 57 – 64. <https://doi.org/10.1080/00071660500475145>
23. Khempaka, S., W. Molee and M. Guillaume., 2014. Effect of palm kernel meal and β -mannanase on growth performance, nutrient digestibility, and carcass quality in broilers. *Asian-Australas. J. Anim. Sci.*, 27 (3), 364 – 374. <https://doi.org/10.5713/ajas.2013.13403>.
29. Kumar, P. and K. D. Kashyap., 2019. Current perspectives and future strategies for fructose oligosaccharides production through membrane bioreactor. *Appl. Microbiol. Bioengin.*, 185- 202. <https://doi.org/10.1016/B978-0-12-815407-6.00010-1>
30. Li, Q. X. Guan, P. Wu, X. Wang, L. Zhou Y. Tong and Z. Feng., 2020. Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. *New England J. Med.*, 382(13), 1199-1207. <https://doi.org/10.1056/NEJMoa2001316>
31. Lv, J. L. Guo, B. Chen, K. Hao, H. Ma, Y. Liu and Y. Min., 2022. Effects of different probiotic fermented feeds on production performance and intestinal health of laying hens. *Poult. Sci.*, 101(2), 101570. <https://doi.org/10.1016/j.psj.2021.101570>
32. Lysenko Y., K. Andrei, L. Albina, O. Ruslan, and S. Sergei., 2021. Organic meat production of broiler chickens hubbard redbro cross. *Int. J. Vet. Sci*; 10: 25-30. <https://doi.org/10.47278/journal.ijvs/2020.021>.
33. Maxwell, O. I., U. B. Chinwuba and M. G. Onyebuchukwu., 2018. Protein enrichment of potato peels using *Saccharomyces cerevisiae* via solid-state fermentation

process. *Adva. Chem. Eng. Sci.* 9 (1), 99 – 108.

<https://doi.org/10.4236/aces.2019.91008>

34. Rodríguez-Martínez, B., B. Gullón and R. Yáñez, 2021. Identification and recovery of valuable bioactive compounds from potato peels: A comprehensive review. *Antioxidants*, 10 (10), 1–18.

<https://doi.org/10.3390/antiox10101630>

35. SAS., 2012. Statistical Analysis System, Users Guide. Statistical. Version 9. 1th ed. AS. Inst. Inc. Cary. N. C. USA.

36. Schindelin, J. C. T. Rueden and M. C. Hiner., 2015. The Image J ecosystem: an open platform for biomedical image analysis, *Mol. Reprod. Dev.*, 82 (7-8), 518-529.

<https://doi.org/10.1002/mrd.22489>.

37. Scoters, S. Aldridge, M. and K. Capps., 2000. Validation of a method for the detection of *E. coli* O157: H7. in foods. *Food Control* 11: 85 - 95.

[https://doi.org/10.1016/S0956-7135\(99\)00065-1](https://doi.org/10.1016/S0956-7135(99)00065-1)

38. Uchewa, E. N. and P. Onu., 2012. The effect of feed wetting and fermented feed on the performance of broiler chick. *Biochem. Anim. Husband.*, 28, 433-439.

<https://doi.org/10.2298/BAH1203433U>

39. Walters, H. G., B. Brown, N. Augspurger, R. Brister, S. Rao and T. Lee., 2018. Evaluation of NSPase inclusion in diets manufactured with high- and low-quality corn on male broilers. *J. Appl. Poult. Res.*, 27: 228–239.

<https://doi.org/10.3382/japr/pfx063>

40. Wotton, I. D. P and H. Freeman., 1982. *Micro Analysis in Medical Biochemistry* 6th ed. Churchill Livingstone, London, p. 141.

41. Xia, C., Y. Liang, S. Bai, H. Yang, A. U. R. Muhammad, S. Huawei and C. Binghai., 2018. Effects of harvest time and added molasses on nutritional content, ensiling characteristics and in vitro degradation of whole crop wheat. *Asian-Australas. J. Anim. Sci.*, 31: 354–362.

<https://doi.org/10.5713/ajas.17.0542>

42. Xu, Q., S. Wang, H. Milliron and Q. Han, 2022. The efficacy of phenolic compound extraction from potato peel waste. *Processes*, 10 (11), 2326.

<https://doi.org/10.3390/pr10112326>.