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EFFECT OF USING DIFFERENT PERCENTAGES OF WASTE FROM RESTAURANTS AND FOOD FACTORIES ON THE PRODUCTIVE, PHYSIOLOGICAL, AND MICROBIAL CHARACTERISTICS OF BROILERS

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Abstract

To compare traditional broiler feed with unconventional feed, this study used restaurant and food factory wastes as broiler feed and how it affects their performance physiological and microbial features. 500 Lohman breed broilers were used in a 6 week experiment with a starting weight of 39 gm/bird and assigned to 5 treatments. Each treatment included four replicates with 25 birds in each. The treatments were T1 as a control, T2 with 25% food waste, T3 with 50% food waste, T4 with 75% food waste, and T5 with 100% food waste. The microbial count was performed at 15, 28, and 42 days of the experimental period. Average body weight, cumulative weight gain, and feed consumption at the end of the 6 weeks were the highest ($p<0.05$) for the T_3 treatment (50% waste, 50% remaining) group. cumulative feed conversion factors were the best ($p<0.05$) for T_1 and T_3 reaching 1.56±0.04 and 1.61±0.02 grams of feed/gram of weight gain. Carcass weight was increased ($p<0.05$) with the T_4 group. Birds' abdominal fat was increased ($p<0.05$) in $T_{5,}$ while T_1 had the lowest percentage of abdominal fat weight. In conclusion, certain grains in traditional broilers diets can be substituted with animal feed manufactured from food waste, which may positively affect resource conservation and pollution reduction.

Keywords: Broilers, Food waste, Performance, Carcass Characteristics, Blood metabolites, microbial count.

INTRODUCTION

The global population reached 8 billion in 2022. Meeting the needs of the world's new population requires achieving sustainable development for various sectors of the economy to raise economic growth, enhance food security for members of society, and solve the problem of food shortages. With expectations that the world's population will increase annually by 93-95 million people, it is necessary to pay attention to poultry production sectors with low-cost and rapid production industry as one of the solutions to provide food for the new mouths in the world (UN, 2023). The poultry sector is one of the most important sectors in the livestock industry. This sector has many production levels, including breeding farms, hatcheries, feed

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factories, and broiler and layer farms (Gowda, 2023) .Among the significant types of meat produced worldwide, poultry has recorded the highest absolute and relative growth rate over the past 50 years (Windhorst, 2017), and poultry meat is expected to remain the main growth area for total meat production, considering the expanding global demand. Among the poultry sector, the importance of the broiler chicken sector lies in that it works to secure animal protein and solve food shortages in the world efficiently due to low production costs and fast production (AL-Masad et al., 2014). The broiler chicken sector is of great importance as a cheap source of meat (Iman and Behmanesh, 2012). Broiler chicken production also has the advantage of a rapid growth rate and high feed conversion efficiency and is not prohibited by any culture or religion (Onyebimana, 2000). Small-scale broiler chicken production has been the primary source of poultry meat in Jordan for more than fifty years, and this industry has developed over the past two decades due to its high contribution to the value of the livestock sector. High capital turnover, quick return on investment, and ease of management are the main reasons that gave the broiler sector in Jordan its economic importance. Global demand for food, especially protein, is expected to increase sharply in the next few decades, driven by global population growth, social and economic changes such as increasing urbanization and rising incomes in developing countries, as well as a greater appreciation for the importance of high-quality protein for a healthy life(FAO, 2009; Mottet and Tempio, 2017).

Despite the importance of the poultry sector in ensuring food security for the world's growing population, it represents a significant challenge that must be addressed because of increasing public concerns about pressure and competition for limited natural resources, the loss of animal and plant biodiversity, the spread of antimicrobial resistance, as well as the environmental burden of production(Zampiga, 2021) .One of the biggest challenges facing the world is the need for food security for members of societies, especially in developing countries. Jordan, like the rest of the world, has been affected by this problem due to the lack of available water resources, climate change conditions, and the steady increase in population. These conditions in Jordan have led, according to the National Strategy for Food Security 2021-2030, to a degree of food insecurity among Jordanian households as stated in the Jordanian Strategy for Food Security for the years 2021-2030, that Approximately 3% of Jordanian households suffer in one way or another from food insecurity. About 53% of households are exposed to cases of food insecurity in its various forms, including the lack of diversity in the food (Ministry of Agriculture, 2021). There is an increase in demand for poultry products in Jordan. On the other hand, according to data from the Ministry of Agriculture, within the framework of the priorities of the National Food Security Strategy (2021-2030), there is an increase in food waste, as food waste in Jordan is estimated at 93 kilograms per capita per year. That is about 955 thousand tons of food, sufficient to cover the food needs of about 1.5 million people for an entire year . One of the problems facing poultry production in Jordan is the provision of feed materials. Jordan imports 80 to 90% of its feed materials (NCR, 1994). Restaurant and kitchen waste varies in chemical composition, percentage of dry matter, and microbial content, which is considered a raw material for poultry feed (Abu Ghazaleh, 2006). The first commercial use of restaurant waste in poultry feed was in the 1940s. In addition to the other ingredients of the diet, it was found that adding waste at up to 30% in the broiler chicken diet, especially soybean

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meal, gave satisfactory results related to growth rates, the amount of feed consumed, and the feed conversion ratio. In another experiment, using kitchen waste at up to 20% in broiler chicken diets led to positive growth and feed conversion rates when the protein source was from meat meal (Soliman et al., 1978) .Through scientific dealings with food waste by using low-cost organic food sources and introducing them to poultry diets, environmental and health problems can be reduced. This will benefit society, the economy, and the environment, stimulate markets, reduce poverty in rural areas, and produce animal products at reasonable prices (Al-Yassin and Abdel Abbas, 2010). Within the general goal of achieving food security, providing feed materials, and seeking to reduce the import of some of them, this study aims to use low-cost organic food sources as an essential source of carbohydrates, proteins, minerals, fats, and vitamins, and include them in broiler diets after treating them so that these wastes replace yellow corn and soybean in different proportions: 0%, 25%, 50%, 75%, 100%, in rations as granulated feed. This organic food, which is food waste, is obtained from restaurants, food factories, grocery stores, and materials resulting from the manufacturing of unsold food that does not comply with the marketing conditions in the factories and is not suitable for human consumption.

MATERIAL AND METHODES

The Scientific Research and Innovation Fund (SRIF) supported this study and was affiliated with the Jordanian Ministry of Higher Education and Scientific Research. The experiments were conducted on the Jerash University farm from October 13, 2021, until December 19, 2023. A completely randomized design (CRD) was used. The Duncan multi-range test was used to find significant differences (DUNKAN.1955), and the SAS 2012 software was used in the statistical analysis. Five hundred one-day-old broiler birds (unsexed) of the Lohman breed were raised on deep bedding with a thickness of sawdust 5 cm, using a continuous lighting system, with 23 hours of light and 1 hour of darkness to accustom the birds to the dark for fear of power outages. The birds with an average starting weight of (39) gm/bird were distributed into five treatments. Each treatment included four replicates (25 birds each) with a control group of birds with no treatment. The birds were freely fed on three diets: starter (1-14 days), grower (15-28 days), and finisher (29-42 days). Food waste was analyzed before and after processing. The analysis includes E.coli, Salmonella, Ash moisture, D.M., Protein, Fiber, and Fat Aflatoxin. Eight birds/treatment were taken 42 days after fasting them for 12 hours, and their live weights were recorded with a sensitive scale. They were slaughtered, the internal entrails were removed, and the purification percentage was calculated according to Al-Fayad and Naji's (1989) procedure. Likewise, the edible viscera (liver, heart, gizzard) and inedible viscera (abdominal fat, small intestine, cecum, and crop) were weighed. The primary and secondary carcass segments (chest, thigh, back, neck, and wings) were considered individually to calculate their relative weight. As for the physiological characteristics, which include blood analysis, blood samples from 8 birds were collected randomly for each group and placed in two types of tubes, the first containing an anticoagulant and the second without an anticoagulant to conduct the required tests, which are CHOL, T.B., LDL, HDL, TRI, GLU, AST. ALB URIC, CA, GLOB, CORT, Heterophils, Hemophiles, monocytes, basophils, eosinophils, and Het\Lym. The

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microbial count was done at 15, 28, and 42 days. The birds were slaughtered, their digestive tracts were taken, and 1-gram samples were taken from the cecum sterilely from two birds for each replicate and eight for each treatment. They were kept at a temperature -80 until the analysis was carried out. The required tests were for Bifidobacteria, E. coli, Total coliform, and Enterococcus spp Lactobacillus. The birds were vaccinated with the ND+IB vaccine at one day old by spraying, and the vaccine was repeated at seven days of age. At 14 days of age, the Gumboro vaccine was given via drinking water. Vitamins were given after each vaccination. The following characteristics were studied: live weight (gm/bird), weight gain, feed consumed, feed conversion factor, mortality rate, production index, carcass characteristics, dressing percentage, relative weight of internal organs, and relative weight of carcass parts. Blood tests and microbial counts were conducted. The proportions of feed materials that make up the diet and their chemical composition are shown in Tables 1- 6. Table 7 shows the analysis of waste samples before and after processing, and Table 8 offers the chemical analysis of food waste before and after processing.

Table (1): Proportions of feed materials.

Treatment	Waste Percentage (%)	Other Ingredients (%)
T1 (Control)	0	100%
T2	25%	75%
T3	50%	50%
T4	75%	25%
T5	100%	0

Table (2): Percentages and calculated chemical composition of feed components (0% food waste added)

Feed material	Starter	Grower	Finisher
Yellow corn	61.9	68.6	73.4
Soybean meal (44% protein)	35.5	28.8	24
Dicalcium phosphate	2.0	2.0	2.0
Food wastes	0	0	0
Methionine	0.1	0.1	0.1
Premix	0.1	0.1	0.1
salt	0.3	0.3	0.3
Choline chloride	0.1	0.1	0.1
Total	100	100	100
Calculated chemical composition			
Representative energy (kcal/kg)	2940	3001	3045
Crude protein (%)	22.6	20.0	18.3
Methionine + Cysteine (%)	130	150	166.4
Calcium (%)	0.94	0.95	1.07
Available phosphorus	0.73	0.74	0.76
Lysine (%)	1.02	1.09	1.26
Methionine (%)	0.46	0.48	0.49

1 kg of premix contains: 12000000 IU vitamin A, 2500000 IU vitamin D3, 10000 mg vitamin E, 2000 mg vitamin K3, 1000 mg Vitamin B1, 5000 mg vitamin B2, 10 mg vitamin B12, 30000 mg Nicotinic acid, 3000 mg Ca-pantothenate, 1000 mg folic acid, 50 mg biotin, 40000 mg Fe, 5000 mg CU, 60000 mg Mn, 100 mg I, 60000 mg Zn, 150 mg Co, 10000 mg B.H.T

**: The chemical composition of nutrients for each feed ingredient was calculated using NRC tables (1994)

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Table 3: Analysis of waste samples before and after processing.

Source	Results											
	Total count\ CFU\ g	**Salmonella\ g**	**E.coli \gm**	**Fecal coliform\ gm**	**Total coliform\ gm**	**Cu ppm**	**Zn ppm**	**Co ppm**	**Cr ppm**	**Ni ppm**	**Pb ppm**	**Cd ppm**
Restaurant waste before processing	$8*10^6$	Negative	<3	$240*10^2$	$>1.100*10^3$	0.25	1653	<0.011	<0.005	<0.004	0.33	<0.0012
Restaurants and food factories waste before processing	$27*10^4$	Negative	<3	$9*10^2$	$>1.100*10^3$	<0.003	85	<0.011	<0.005	<0.004	0.74	<0.0012
Food factory waste before processing	$4*10^4$	Negative	<3	<3	$43*10^1$	2.64	380	<0.011	<0.005	<0.004	0.73	<0.0012
Restaurant waste after processing	$1*10^4$	Negative	<3	<3	<3							
Restaurants and food factories waste after processing	$55*10^3$	Negative	<3	<3	<3							
Food factory waste after processing	$5*10^4$	Negative	<3	<3	<3							

Table 4: The chemical analysis of food waste after processing.

Source	Aflatoxin	ADF %	NDF%	Ash %	Fiber %	E.E %	Energy	C.P %	D.M %	Moisture%
Restaurant waste after processing	1.11	17.28	40.63	15.33	7.08	15.62	2980	69.52	94.1	5.90
Restaurants and food factories waste after processing.	1.97	9.82	38.40	9.18	8.28	9.80	2930	15.89	94.52	5.75
Food factory waste after processing	2.90	16.28	36.48	11.49	12.86	8.70	2910	9.05	96.12	3.88

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Table 5: Effect of adding food waste to broilers' diet on the birds' body weight.

Treatments	Average live weight at the end of weeks 2, 4 and 6		
	2	4	6
T_1	374.25ab ± 17.52	1218.28 b ± 31.17	2181.74c ± 18.37
T_2	368.55ab± 13.83	1277.33ab± 20.59	2266.31ab± 31.52
T_3	377.23ab ±10.51	1298.43ab± 23.36	2291.85ab± 41.11
T_4	372.21a ± 9.26	1339.71 a± 14.83	2226.25a± 29.76
T_5	359.1b ± 15.42	1269.91ab ± 35.35	2192.15bc± 42.45
Sig.	*	*	*

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level (P<0.05). (*) indicate a significant probability level of 5%.$T_1 – T_5$, as indicated in Table 1.

Table 6: Effect of adding food waste to the diet of broilers on the weekly weight gain (g).

Treatments	Weekly weight gain (g)at the end of weeks 2, 4 and 6			Cumulative weight gain (g)
	2	4	6	
T_1	335.25 ± 27.25	883.03 b ±12.62	963.46 ±28.05	2181.74 c ± 18.37
T_2	329.55 ±17.01	947.78 a ±12.69	993.42 ±16.98	2266.31ab± 31.52
T_3	338.23 ±9.52	960.20 a ±17.23	993.42 ±25.69	2291.85ab± 41.11
T_4	333.21 ±7.93	1006.05 a ±18.59	886. 54 ±21.72	2226.25a± 29.76
T_5	320.10 ±17.34	940.81 a ±25.17	922.24 ±9.83	2192.15bc± 42.45
Sig.	N. S	*	N.S.	*

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level (P<0.05). (*) indicate a significant probability level of 5%. $T_1 – T_5$, as indicated in Table 1. N.S.: Not significant.

Table 7: Effect of adding food waste to the diet of broilers on the average quantity of consumed feed (g) by the birds.

Treatments	Average feed consumption by birds (gm/bird)at the end of weeks 2, 4 and 6			Cumulative quantity of consumed feed (g)
	2	4	6	
T_1	349.8 ± 10.48	1457.591± 28.44	1612.79 b ±28.70	3420.18 b ±27.10
T_2	363.4 ±24.15	1468.78 ±33.39	1839.71 a ±19.77	3671.89 ab ±32.11
T_3	379.65 ±22.01	1525.12 ±21.69	1779.05 a ±17.17	3701.82 a ±36.96
T_4	375.2 ±18.67	1529.80 ±19.09	1784.73 ab ±31.12	3689.73 a ±43.78
T_5	359.14 ±23.04	1530.83 ±21.13	1735.22 ab ±32.76	3625.19 ab ±49.54
Sig.	N. S	N. S	*	*

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level (P<0.05). (*) indicate a significant probability level of 5%. $T_1 – T_5$, as indicated in Table 1. N.S.: Not significant.

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Table 8: Effect of adding food waste to the diet of broilers on the Feed conversion factor of the birds

Treatments	Average feed conversion factor (g feed/g weight gain) at the end of weeks 2, 4, and 6			Cumulative feed conversion factor
	2	4	6	
T_1	1.04±0.03	1.65±0.07	1.67±0.04	1.56±0.04ab
T_2	1.10±0.03	1.54±0.05	1.85±0.09	1.62±0.03b
T_3	1.12±0.04	1.58±0.07	1.79±0.04	1.61±0.02ab
T_4	1.12±0.04	1.52±0.03	2.01±0.06	1.65± 0.03b
T_5	1.12±0.03	1.62±0.06	1.88±0.07	1.65±0.04b
Sig.	N.S.	N.S.	N.S.	N.S.

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level ($P<0.05$). T_1 – T_5 as shown in table 1. N.S.: Not significant

RESULTS AND DISCUSSION

1. Average live weight of birds (g)

Table 5 below shows the effect of adding different levels of food waste to the diet of broilers on the average live body weight (g) of the birds during the weeks of the experiment (mean ± standard deviation).

As shown in Table 5, the results of the statistical analysis revealed that there is a significant superiority ($p<0.05$) for the T_3 treatment (50% waste, 50% remaining). The average live body weight at the end of the second week is the highest (377.23 ± 10.51) for this treatment. In contrast, at the end of the fourth week, the results revealed that there was a significant superiority ($p<0.05$) for the T_4 treatment (75% waste, 25% remaining) with an average live body weight of (1339.71 ± 14.83). At the end of the sixth week, T_3 was higher in the average live body weight than the rest of the treatments, with significant differences.

2. Weekly weight gain (g)

Table 6 below shows the effect of adding different levels of food waste to the diet of broilers on the average weekly weight gain (g) of the birds during the weeks of the experiment (mean ± standard deviation).

The results in Table 6 show no significant differences between all treatments at the end of the second week of the experiment. At the end of the fourth week, compared to the control group, there was a significant difference) $P<0.05$) for the T_4, as the highest weight gain was recorded, amounting to 1006.05 a ±18.59gm/bird, while T_1 recorded the lowest weight gain, amounting to 883.03 ±12.62gm/bird. At the end of the sixth week of the experiment, there were no significant differences for all treatments. T3 recorded the highest cumulative weight gain, amounting to 2291.85± 41.11gm/bird. In contrast, the control treatment recorded the lowest weight gain, amounting to 2181.74 ± 18.37gm/bird.

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3. Quantity of consumed feed (g)

Table 7 below shows the effect of adding different levels of food waste to the diet of broilers on the average quantity of consumed feed (g) by the birds during the weeks of the experiment (mean ± standard deviation).

As shown in Table 7, the statistical analysis results revealed no significant differences between all treatments at the end of the second and fourth weeks. At the end of the sixth week, T_2 recorded the highest rate of feed consumption ($P<0.05$), reaching 1839.71 ±19.77 g/bird. The lowest feed consumption rate was for T_1, which amounted to 1612.79 ±28.70g/bird. Regarding the cumulative quantity of consumed feed, T_3 had the highest feed consumption rate, amounting to 3701.82 ±36.96g/bird, while T_1 was the lowest, amounting to 3420.18 ±27.10g/bird.

4. Feed conversion factor

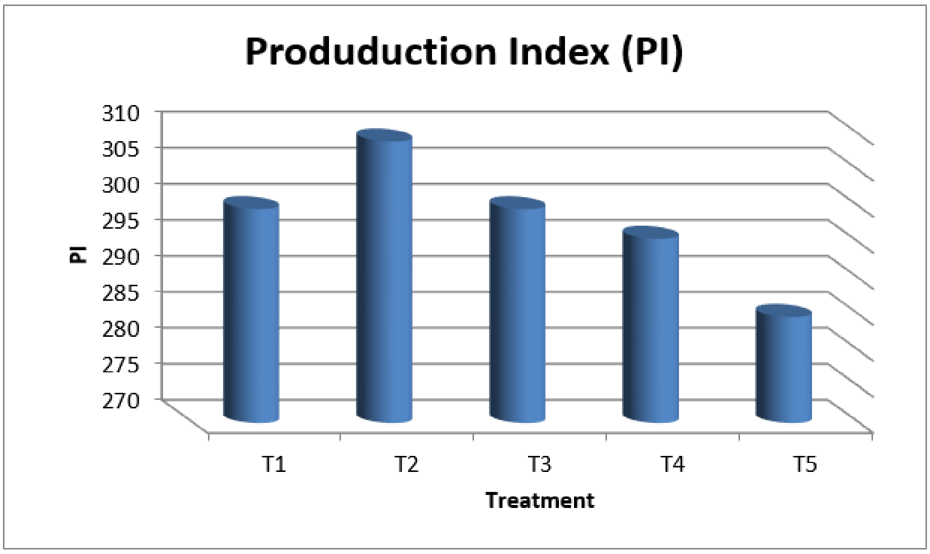
Table 8 below shows the effect of adding different levels of food waste to the diet of broilers on the Feed conversion factor of the birds during the weeks of the experiment (mean ± standard deviation).

As shown in Table 8, the statistical analysis results revealed no significant differences in all the experimental treatments. At the same time, the cumulative feed conversion of T_1 and T_3 were the best cumulative feed conversion factors, reaching 1.56±0.04and 1.61±0.02grams of feed for every 1 gram of weight gain.

5. Production guide

Graphic 1 below shows the effect of adding different levels of food waste to broilers' diets on the birds' production during the weeks of the experiment (mean ± standard deviation).

Graphic 1: shows the effect of adding different levels of food waste



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6. Behavioral observations

Adopting the survey method presented by Freezer and Bro (1990), Table 9 below shows the effect of adding different levels of food waste to the diet of broilers on the bird's behavior during the weeks of the experiment (mean ± standard deviation). The birds' eating, drinking, and movement behavior, including sitting, standing, running, and plucking, were observed for an hour 3 times daily.

Table 9: Effect of adding food waste to the diet of broilers on the birds' behavior.

Treatments	Behavior					
	Eating	Drinking	Sitting	Standing	Running	Plucking
T_1	3.7±1.2a	3.2±1.2a	2.6±1.2 a	14.3±1.1a	2.1±0.8a	2.5±1.4a
T_2	3.6±1.7a	3.2±1.3a	2.8±1.0a	13.2±1.2a	2.2±1.1 a	2.1±1.4a
T_3	3.8±1.5a	3.4±1.4a	3.7±1.3 a	13.5±1.4a	1.8±1.3a	1.4±1.1a
T_4	3.5±1.4a	3.3±1.2a	3.3±1.4a	13.6±1.2a	2.4±1.2a	2.1±1.4a
T_5	3.7±1.4a	3.3±1.1a	3.9±1.2a	13.1±1.2a	2.3±1.1a	2.2±1.3a
Sig.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level ($P<0.05$). T_1 – T_5, as shown in Table 1. N.S.: Not significant. As shown in Table 9, the statistical analysis results revealed no significant difference between the different experimental treatments in drinking, sitting, standing, running, and plucking feathers.

7. Qualitative characteristics of broiler carcasses

7.1 Dressing percentage and the percentages of weights of the main and secondary pieces

Table 10 below shows the effect of adding different levels of food waste to the diet of broilers on the qualitative characteristics of broiler carcasses during the weeks of the experiment (mean ± standard deviation).

Table 10: Effect of adding food waste to the diet of broilers on the qualitative characteristics of the carcass

Treatments	Characteristic							
	Live weight (g)	Carcass weight (g)	Grooming percentage (%)	Chest (%)	Thigh (%)	Neck (%)	Wing (%)	Back (%)
T_1	2130.0±21.0^{ab}	1557.39±12.5^{ab}	73.1±0.75	34.8±0.1	32.3±0.1	5.5±0.1	10.7±0.1	13.4±0.1
T_2	2210.0±18.3^{a}	1633.19±15.4^{ab}	73.9±1.1	35.5±0.1	32.0±0.1	5.7±0.1	10.9±0.1	13.6±0.1
T_3	2160.0±30.0^{b}	1600.93±26.1^{a}	74.1±0.06	36.8±0.1	31.5±0.1	5.9±0.1	11.1±0.1	13.3±0.1
T_4	2260.0±22.5^{a}	1677.06±19.0^{ab}	74.2±0.27	36.9±0.1	30.0±0.1	6.1±0.1	11.6±0.1	13.5±0.1
T_5	2160.0±21.2^{a}	1594.08±14.0^{a}	73.8±0.68	36.9±0.1	30.8±0.1	6.1±0.1	11.3±0.1	13.2±0.1
Sig.	*	*	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

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The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level (P<0.05). $T_1 - T_5$ as shown in table 1. N.S.: Not significant.

As shown in Table 10, the results of the statistical analysis revealed that there were significant differences (P<0.05) between all treatments in live weight (g) and carcass weight (g). T_4 had the highest live weight (2260.0±22.5), while T_1 had the lowest (2130.0±21.0). Regarding carcass weight, the results also showed significant differences (P<0.05) between all treatments. T_4 was with the highest carcass weight (1677.06±19.0). For the dressing percentage, chest, thigh, neck, flank, and back characteristics, the results showed that there were no significant differences between treatments.

7.2 Edible internal organs

Table 11 below shows the effect of adding different levels of food waste to the diet of broilers on the edible internal organs (heart, liver, and gizzard).

Table 11: Effect of adding food waste to the diet of broilers on the edible internal organs.

Treatments	Characteristic		
	Heart (%)	**Liver (%)**	**Gizzard (%)**
T_1	0.51±0.03 ^{a}	3.3±0.04 ^{a}	2.2±0.18^a
T_2	0.51±0.0 ^{a} 1	3.4±0.02 ^{a}	2.4±0.11 ^{a}
T_3	0.49±0.3 ^{a}	2.3±0.03 ^{a}	2.1±0.09 ^{a}
T_4	0.46±0.01 ^{a}	2.9±0.03 ^{a}	1.4±0.13 ^{a}
T_5	0.43±0.02 ^{a}	3.1±0.19 ^{a}	1.9±0.06 ^{a}
Sig.	N.S.	N.S.	N.S.

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level (P<0.05). $T_1 - T_5$, as shown in Table 1. N.S.: Not significant.

As shown in Table 11, the statistical analysis results revealed no significant differences between all treated birds in the relative weight of the edible internal organs (heart - liver, and gizzard).

7.3 Inedible internal organs

Table 12 below shows the effect of adding different levels of food waste to the diet of broilers on the inedible internal organs (abdominal fat, digestive tract, and carpel).

As shown in Table 13, the statistical analysis results revealed significant differences between all treated birds in the abdominal fat (P<0.05). T_5 recorded the highest percentage of abdominal fat weight (10.2 ± 0.7). T_1 recorded the lowest (8.2 ± 0.1). The results revealed no significant differences between all treated birds regarding the digestive tract and carpel.

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Table 13: Effect of adding food waste to the diet of broilers on the inedible internal organs.

Treatments	Characteristic		
	Abdominal fat (%)	Digestive tract (%)	Carpel (%)
T_1	8.2±0.1	^{a}11.6±0.13	0.6±0.1
T_2	8.7±0.3	11.5±0.09^{a}	0.7±0.13
T_3	9.2±0.5	11.3±0.08^{a}	0.5±0.09
T_4	9.7±0.4	10.7±0.11^{a}	0.5±0.08
T_5	10.2±0.7^{ab}	10.7±0.98^{a}	0.6±0.91
Sig.	*	N.S.	N.S.

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level (P<0.05). T_1 – T_5, as shown in Table 1. N.S.: Not significant.

7.4 Cellular blood characteristics of broiler carcasses

Table 14 below shows the effect of adding different levels of food waste to the diet of broilers on some cellular blood characteristics of broiler carcasses (serum lipids).

Table 14: Effect of adding food waste to the diet of broilers on serum lipids.

	Serum lipids			
Treatments	LDL mg/dl	HDL mg/dl	TRI mg/dl	CHOL mg/dl
T_1	34.250ab 3.370±	124.250ab 2.815±	123.625ab ±24.183	151.250ab± 7.219
T_2	b53.000 4.375±	146.750b 4.026±	108.250ab± 4.549	169.75ab± 9.377
T_3	54.750a 3.370±	157.125ab 2.695±	144.375a± 3.662	189.250ab± 6.065
T_4	a56.125 3.440±	161.125a 5.330±	152.000a± 5.070	192.250a± 4.978
T_5	82.000a 14.764±	157.750a 12.032±	154.750a ±18.858	201.125a± 7.160
Sig.	*	*	*	*

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level (P<0.05). T_1 – T_5, as shown in Table 1.

As shown in Table 14, the statistical analysis results revealed significant differences for all treatments (P<0.05). T_5 recorded the highest fat weight percentage, 201.125 ± 7.160, and treatment T1 recorded the lowest fat weight rate, 151.250±7.219.

7.5 Biochemical characteristics of blood serum

Table 15 below shows the effect of adding different levels of food waste to broilers' diets on the blood serum's biochemical characteristics.

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Table 15: Effect of adding food waste to the diet of broilers on the biochemical characteristics

Treatment	Biochemical characteristics of blood serum						
Treatment	URIC mg/dl	CA mg/dl	GLOB g/dl	GLU mg/dl	AST u/l	ALB g/dl	TP g/d
T_1	3.975b±0.261	13.712ab±0.285	1.551b±0.034	196.112ab±3.134	19.112a±1.391	1.550b±0.245	3.350ab±0.244
T_2	3.950ab±0.244	14.850ab±0.307	1.477a±0.118	196.750ab±2.815	19.750a±0.761	2.050ab±0.244	3.300b±0.261
T_3	1.613ab±0.228	15.637ab±0.430	1.613a±0.028	205.500a±4.309	22.600a±0.434	2.050b±0.358	3.960b±0.168
T_4	4.875a±0.212	16.262a±0.277	1.602a±0.147	209.250a±5.365	23.912a±0.435	2.375b±0.301	4.087a±0.216
T_5	5.287a±0.422	16.475a±0.459	1.700a±0.037	212.625b±4.867	24.800a±2.244	2.225a±0.291	4.287a±0.212
Sig.	*	*	*	*	N.S.	*	*

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level (P<0.05). $T_1 - T_5$, as shown in Table 1. N.S.: Not significant. As shown in Table 15, the statistical analysis results revealed significant differences due to treatments in immune cells and blood serum hormones, except for AST. The highest value was for T.P. with T_5. The highest value was for ALB with T_4. T5 was the highest average for all biochemical traits in the blood, and all were significant except for AST.

7.6 Immune cells and hormones of blood serum

Table 16 below shows the effect of adding different levels of food waste to the diet of broilers on immune cells and blood serum hormones.

Table 16: Effect of adding food waste to the diet of broilers on the biochemical characteristics

Treatment	Immune cells and hormones of blood serum						
	Het/Iym	Eosinophils %	Basophils %	Monocytes %	Lymphocytes %	Heterophils %	CORT mg/ml
T_1	0.317a±0.018	3.775a±0.281	1.800a±0.226	5.025b±0.608	59.125a±2.031	20.637ab±0.936	1.491±0.297
T_2	0.363ab±0.051	2.712a±0.418	2.700ab±0.200	4.425a±0.345	63.250b±2.815	22.001b±1.309	1.937a±0.168
T_3	0.438b±0.057	4.450ab±0.370	3.500ab±0.320	6.600ab±0.555	62.375b±2.669	22.687b±0.160	1.700ab±0.185
T_4	0.425ab±0.052	3.887ab±0.344	4.162b±0.266	6.162ab±0.584	63.350ab±2.492	23.312a±2.282	1.790ab±0.392
T_5	3.650a±0.486	3.650a±0.486	3.550b±0.297	6.187a±0.412	61.500ab±2.449	24.212a±0.432	1.921a±0.202
Sig.	*	*	*	*	*	*	*

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level (P<0.05). $T_1 - T_5$, as shown in Table 1. As shown in Table 16, the statistical analysis results revealed statistically significant differences (P<0.05) in the effect of adding different levels of waste from restaurants and feed factories to the diet of broilers on immune cells and blood serum hormones. The results also showed that T_5 had the

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highest average for Heterophils and Het/Iym. T_4 has the highest average for Lymphocytes, Monocytes, and Basophils. T_3 has the highest average for Eosinophils.

7.7 Logarithmic numbers of bacteria in the cecal contents of 14-day-old broiler carcasses

Table 17 below shows the effect of adding different levels of food waste to the diet of broilers on the logarithmic numbers of bacteria in the cecal contents of 14-day-old broiler carcasses.

Table 17: Effect of adding food waste to the diet of broilers on the logarithmic numbers of bacteria in the cecal contents of 14-day-old broiler carcasses.

Treatment	)gr/cfu(Logarithmic numbers of bacteria				
	Lactobacillus	Enterococcus spp	Total coliform	E. coli	Bifidobacteria
T_1	2.838±0.028	6.291±0.209	5.763±0.329	5.375±0.260	4.046a±0.030
T_2	3.162±0.311	6.275±0.755	6.226±0.122	4.850±0.358	3.706ab±0.394
T_3	3.452±0.303	6.412±0.241	6.477±0.299	5.512±0.299	3.602a±0.338
T_4	3.312±0.299	6.270±0.756	7.187±0.155	5.521±0.299	3.568a±0.257
T_5	3.387±0.331	6.877±0.589	7.226±0.123	5.515±0.230	3.601ab±0.381
Sig.	N.S.	N.S.	N.S.	N.S.	*

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level ($P<0.05$). $T_1 - T_5$, as shown in Table 1. As shown in Table 17, the statistical analysis results revealed no significant differences between all treated birds in the logarithmic numbers of bacteria in the cecal contents of 14-day-old broiler carcasses except for the Bifidobacteria.

7.8 Logarithmic numbers of bacteria in the cecal contents of 28-day-old broiler carcasses

Table 18 below shows the effect of adding different levels of food waste to the diet of broilers on the logarithmic numbers of bacteria in the cecal contents of 28-day-old broiler carcasses.

Table 18: Effect of adding food waste to the diet of broilers on the logarithmic numbers of bacteria in the cecal contents of 28-day-old broiler carcasses.

Treatment	)gr/cfu(Logarithmic numbers of bacteria				
	Lactobacillus	Enterococcus spp	Total coliform	E. coli	Bifidobacteria
T_1	3.412±0.309	5.476b±0.209	5.046a±0.337	6.438ab±0.302	4.802a±0.160
T_2	3.562a±0.250	5.472b±0.302	5.325a±0.284	6.375ab±0.296	4.716ab±0.243
T_3	3.396a±0.336	6.412ab±0.241	8.645a±0.615	6.500ab±0.302	4.260ab±0.112
T_4	4.312a±0.344	6.323ab±0.176	6.633a±0.313	7.300ab±0.307	3.568b±0.257
T_5	4.450a±0.292	6.546ab±0.309	7.425a±0.341	7.450a±0.305	3.847ab±0.163
Sig.	N.S.	0.018	N.S.	0.000	0.000

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level ($P<0.05$). $T_1 - T_5$, as shown in Table 1. As shown in Table 18, the statistical analysis results revealed no significant differences between the Lactobacillus and the Total coliform for all treatments. Still, there were significant differences for Enterococcus spp (T_5), E.coli (T_5), and Bifidobacteria (T_1).

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7.9 Logarithmic numbers of bacteria in the cecal contents of 42-day-old broiler carcasses

Table 19 below shows the effect of adding different levels of food waste to the diet of broilers on the logarithmic numbers of bacteria in the cecal contents of 42-day-old broiler carcasses.

Table 19: Effect of adding food waste to the diet of broilers on the logarithmic numbers of bacteria in the cecal contents of 42-day-old broiler carcasses.

Treatment	)gr/cfu(**Logarithmic numbers of bacteria**				
	LactobacillusS	**Enterococcus spp**	**Total coliform**	**E. coli**	**Bifidobacteria**
T_1	3.475ab±026	4.668b±0.308	5.457a±0.337	6.501a±0.288	5.270a±0.337
T_2	4.525ab±0.281	5.382ab±0.220	5.505a±0.275	5.575a±0.249	5.167a±0.063
T_3	4.562a±0.320	5.681ab±0.217	6.475a±0.319	5.487a±0.317	4.827ab±0.110ab
T_4	4.512a±0.290	6.325a±0.205	6.725a±0.328	5.401a±0.286	4.708a±0.329
T_5	4.812a±0.112	6.600a±0.244	6.621a±0.266	4.600a±0.307	4.018ab±0.015
Sig.	N.S.	0.000	N.S.	N.S.	0.000

The values followed by the same letter (a, b, and c) for each treatment are not significantly different. Different letters (a, b, and c) indicate the presence of significant differences between the treatments at the probability level ($P<0.05$). $T_1 - T_5$, as shown in Table 1. As shown in Table 19, the results of the statistical analysis revealed that there were statistically significant differences at the level of $P<0.05$ in the logarithmic numbers of bacteria in the cecal contents at the age of 42 days for Bifidobacteria and Enterococcus spp, while the rest of the cecal contents (Lactobacillus, E.coli and Total coliform) showed differences in the averages.

CONCLUSION

Every year, enormous quantities of food are lost and wasted worldwide, producing major environmental and social damage and considerable economic expenses. This has a negative influence on food security, both locally and nationally. To prevent this phenomenon, it is necessary to have a thorough grasp of what is being lost and why. Humans and cattle consume plant materials for nourishment, which is food for humans and animal feed. Scientific and field research has provided convincing evidence that food waste at the consumption stage is rich in critical elements for animal nutrition and that new processing techniques may transform food waste and feed products that are simple to use and safe for animals. Animal feed from food waste can replace some grains in traditional diets, resulting in a cascade impact on the food system with potential benefits for resource conservation and pollution reduction.

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Conflict Of Interest

As for the requirements of the publishing policy, there is no potential conflict of interest for the authors.

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