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Assessing effect of feeding poultry byproducts compost on organoleptic characteristics and compositional profile of meat of broiler chickens

Avaliação do efeito da alimentação com composto de subprodutos avícolas nas características organolépticas e no perfil compositivo da carne de frangos de corte

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Abstract

Large amounts of waste, including dead birds, manure, and poultry litter, are produced by the poultry industry. Poultry waste should be disposed of properly to avoid major pollution and health risks. Composting litter and dead birds could be an option to recycle the waste and use in poultry feed. A study was conducted to investigate the effects of feeding composted poultry waste on the organoleptic qualities and compositional profile of the meat of broiler chickens. A total of 300 day-old broiler chicks (500-Cobb) were randomly allocated to five treatment groups replicated six times with 10 birds each, under a completely randomized design (CRD). Five iso-caloric and iso-nitrogenous diets including composted poultry byproducts at concentrations of 0, 2.5, 5, 7.5, and 10% were fed *ad libitum* to the birds from day 0 to day 35. The sensory grading and meat composition profile of 500 Cobb broiler chickens were tested at 35 days of age. The findings showed that there were no variations in the sensory profiles of the meat from birds given various diets (P>0.05). Although the results were somewhat lower for the chicks fed compost-containing diets than for the control group, this difference was deemed to be insignificant (P>0.05). Similarly, there were no variations in the compositional profile values of the meat between meat from birds fed various diets (P>0.05). These findings imply that broiler chickens may be raised on diets containing up to 10% poultry byproduct compost without any negative impacts on the meat's sensory quality or composition. Additionally, using compost into broiler diets may help to lower the cost of feed.

Keywords: compost, broiler, sensory quality, compositional profile.

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Resumo

Grandes quantidades de resíduos, incluindo aves mortas, esterco e cama de frango, são produzidas pela indústria avícola. Resíduos de aves devem ser descartados adequadamente para evitar grandes riscos de poluição e saúde. A compostagem de lixo e aves mortas pode ser uma opção para reciclar os resíduos e usá-los na alimentação de aves. Um estudo foi conduzido para investigar os efeitos da alimentação com resíduos de aves compostados nas qualidades organolépticas e no perfil de composição da carne de frangos de corte. Um total de 300 pintos de corte de um dia (500-Cobb) foram alocados aleatoriamente em 5 grupos de tratamento, replicados 6 vezes com 10 aves cada, sob um delineamento inteiramente casualizado (CRD). Cinco dietas isocalóricas e isonitrogenadas incluindo subprodutos compostados de aves nas concentrações de 0, 2,5, 5, 7,5 e 10% foram fornecidas *ad libitum* às aves do dia 0 ao dia 35. A classificação sensorial e o perfil de composição da carne de 500 frangos de corte Cobb foram testados aos 35 dias de idade. Os achados mostraram que não houve variações nos perfis sensoriais da carne de aves recebendo várias dietas (P > 0,05). Embora os resultados tenham sido um pouco menores para os pintos alimentados com dietas contendo composto do que para o grupo controle, essa diferença foi considerada insignificante (P > 0,05). Da mesma forma, não houve variações nos valores do perfil composicional da carne entre carnes de aves alimentadas com várias dietas (P > 0,05). Essas descobertas indicam que os frangos de corte podem ser criados com dietas contendo até 10% de composto de subproduto de aves sem qualquer impacto negativo na qualidade sensorial ou na composição da carne. Além disso, o uso de composto nas dietas de frangos de corte pode ajudar a reduzir o custo da ração.

Palavras-chave: composto, frango de corte, qualidade sensorial, perfil composicional.

1. Introduction

Due to the development of environmentally controlled housing technology during the past three decades, the poultry industry has experienced tremendous expansion. However, the chicken industry's quick expansion has led to some environmental issues. Several hundred tonnes of chicken waste are produced every day, including dead birds, litter, and manure (Bolan et al., 2010). This waste must be regularly and promptly disposed of during a normal production cycle. Any delay in taking action to address these poultry wastes will increase costs and could have an adverse impact on the environment (Coufal et al., 2006; CAST, 2008). The most common means of carcass disposal over the past few decades have been burial, incineration, landfills, rendering, on-farm freezers, or other preservation methods (CAST, 2008). The easiest and most affordable method of handling mortality losses is on-farm burial (Wilkinson, 2011). However, concerns of annoyance are raised when carcasses are buried (CAST, 2008; Bonhotal et al., 2014). Incineration of carcasses is one of the safest methods of carcass disposal. However, there are certain logistical and environmental concerns with this choice (Malone, 2006), most notably with regard to emissions (Bonhotal et al., 2014). The majority of the time, poultry carcasses are disposed of in municipal landfills. The health of animals, poultry, and people, however, may be at risk from garbage disposal (Wilkinson, 2011). Recycling chicken carcasses through rendering is environmentally friendly (NABC, 2004). However, this strategy raises concerns about the potential for disease transmission during routine pickup (CAST, 2008; Bonhotal et al., 2014). To preserve poultry carcasses for short-term storage, on-farm freezers have been employed. However, it is important to carefully examine the expenses of transportation and on-farm refrigeration (CAST, 2008). To preserve the sustainability of the environment and the poultry business, alternate, environmentally friendly carcass disposal methods with potential advantages are necessary. Composting of litter and dead birds is the logical solution to this problem (Kelleher et al., 2002; Kumar et al., 2007).

Composting is a secure method of recycling chicken wastes, including hatchery waste, poultry litter, and on-farm mortalities, into a nutrient-rich final product (Ryckeboer et al., 2003; Charnay, 2005; Wilkinson, 2011; Khan et al., 2019b). Composting is now the most often used method of carcass disposal (CAST, 2008). Many of the issues with air and water quality brought on by combustion and burial are addressed by on-farm composting (Ahmed et al., 2012). Additionally, this procedure eliminates the expense of routine carcass pick-up and delivery to rendering facilities (CAST, 2008). In addition, pathogenic bacteria, fungi, viruses, and parasites are killed by the process' produced heat (Seekins, 2011; Wilkinson et al., 2011; Ahmed et al., 2012; Bonhotal et al., 2014; Miller et al., 2016). According to earlier studies (Murphy, 1990; Senne et al., 1994), composting waste gets rid of microorganisms linked to poultry, viruses linked to egg drop syndrome (EDS-76), and highly pathogenic avian influenza (HPAI). Conner et al. (1991) found no enteric bacteria in chicken waste after a two-stage (primary and secondary) composting process was complete. These findings show that two-stage composting can successfully eliminate potential pathogens in poultry litter (Imbeah, 1998; Vinodkumar et al., 2014); producing a biosecure, less toxic, and environmentally friendly product (Ahmed et al., 2012); which can be used safely and effectively as an ingredient in poultry feed (Wilkinson et al., 2011; Khan et al., 2021). While a number of studies have primarily examined the nutritional evaluation, microbiological contamination, and nutrient composition of rendered spent hens and dead hens (Erturk and Celik, 2004; Mutucumarana et al., 2010; Xavier et al., 2011; Mahmud et al., 2015); to our knowledge, very little research has been done on the use of compost in poultry feed. Thus, this study was designed to determine the effects of feeding poultry byproducts compost on the organoleptic qualities and compositional profile of the meat of commercial broilers.

2. Materials and Methods

2.1. Compost production, birds, study design, and husbandry

Compost manufacturing and analysis are clearly documented in a recent work by Khan et al. (2019a).

The feeding experiment was carried out in a properly ventilated experimental broiler house. A total of 300 day-old broiler chicks (500-Cobb) were randomly allocated to five treatment groups replicated six times with 10 birds each, under a completely randomized design (CRD). Five iso-caloric and iso-nitrogenous diets including composted poultry byproducts at concentrations of 0, 2.5, 5, 7.5, and 10% were fed *ad libitum* to the birds from day 0 to day 35. Under the direction of a veterinarian, the chicks were immunized in the hatchery against infectious bronchitis and Newcastle disease. The chicks were housed in thirty replicate floor pens that were set up on a deep litter system with rice husk utilized as bedding. Each replicate floor pen (1 × 1 m^2) contained two round feeders and a nipple drinker to supply feed and water. Temperature and relative humidity (RH) were adjusted at 34 ± 1.1 °C and 62 3%, respectively, for the first week of age while brooding. After that, the temperature dropped by 3°C each week until it reached 24°C on day 21 with a 65% RH. Throughout the investigation, a 23L:1D lighting programme was used. The nutritional needs of broilers during the starter (Table 1 and Table 2) and finisher (Table 3 and Table 4) phases were taken into consideration while developing treatment diets (NRC, 1994).

2.2. Measurements

2.2.1. Sensory quality and compositional profile

The sensory grading and meat composition profile of 500 Cobb broiler chickens were tested at 35 days of age. From each replicate floor pen, three broilers of average weight were chosen for this. After being kept off food for four hours, they were slaughtered in accordance with Halal guidelines. The carcasses were eviscerated and defeatedhered after the slaughter. The sensory evaluation of cooked meat samples from the breast muscle was then performed by a panel of seven experts from the Department of Poultry Production at UVAS, Ravi Campus. The panelists got training in the fundamentals of organoleptic assessment according to ISO 3972:2011 (ISO, 2011) using Viriyajare's (1992) methodologies before engaging in sensory evaluation. Initial preparations included washing each sample thoroughly in clean water, wrapping it in a polythene bag, and labeling it with the dietary category. They were then microwaved in water for 45 minutes at 80 degrees Celsius before being served to a panel of seven judges, who each had to masticate one sample per treatment. A nine-point hedonic scale, with 1 denoting "extremely dislike" and 9 denoting "extremely like," was used to ask panelists to rate samples for appearance, aroma, taste, color, texture, tenderness, juiciness, and acceptability. A sensory laboratory room with individual booths was used for the entire assessment in accordance with ISO requirements (ISO, 1998). Each booth was equipped with a computerized system for data collection and processing. Three carcasses per treatment were separated in order to obtain the data for the compositional profile. The raw breast and thigh meat samples from each carcass were then analyzed for moisture, protein, fat, and ash content in accordance with the approved AOAC (2005) protocols.

2.2.2. Statistical analysis

One-way ANOVA under the CRD with GLM technique of SAS (SAS INSTITUTE INC., 2003) was used to analyze

Table 1. Compositional profile of diets for starter phase.

Ingredient (%)	Treatment[1]				
	T1	T2	T3	T4	T5
Corn	52.00	52.00	52.00	52.00	52.00
Rice tips	4.90	3.35	2.25	1.25	0.00
Canola Meal	4.10	2.10	1.20	0.50	0.00
Corn Gluten 60%	2.00	2.00	2.00	2.00	2.00
Soybean Meal	30.00	310	31.00	31.00	31.00
Canola oil	2.00	2.20	2.20	2.20	2.20
$CaCO_3$	1.20	1.00	.50	0.00	0.00
DCP.$2H_2O$	2.20	2.20	2.20	2.20	2.20
Lysine-SO_4	0.60	0.60	0.60	0.60	0.60
DL-Methionine	0.15	0.15	0.15	0.15	0.15
Threonine	0.10	0.10	0.10	0.10	0.10
Sodium chloride	0.20	0.20	0.20	0.20	0.20
Sodium bicarbonate	0.10	0.10	0.10	0.00	0.00
Vitamin premix	0.20	0.20	0.20	0.20	0.20
Minerals premix	0.30	0.30	0.30	0.30	0.30
Compost	0.00	2.50	5.00	7.50	10.00

[1]T1: 0% compost (control), T2: 2.5% compost, T3: 5% compost, T4: 7.5% compost, T5: 10% compost.

Table 2. Nutrient profile of diets for starter phase.

Nutrient[2]	Treatment[1]				
	T1	T2	T3	T4	T5
DM (%)	88.78	88.82	88.84	88.87	88.87
ME (kcal/kg)	2900	2900	2900	2900	2900
CP (%)	21.0	21.0	21.0	21.0	21.0
EE (%)	4.58	4.60	4.62	4.62	4.63
Ash (%)	6.80	6.81	6.83	6.81	6.81
CF (%)	3.95	4.00	4.05	4.04	4.15
Ca (%)	1.04	1.05	1.04	1.05	1.05
PP (%)	0.82	0.83	0.82	0.83	0.84
Na (%)	0.19	0.19	0.20	0.20	0.20
K (%)	0.91	0.91	0.92	0.94	0.96
Cl (%)	0.17	0.17	0.17	0.17	0.16
Lys (%)	1.38	1.38	1.37	1.36	1.36
Met (%)	0.50	0.50	0.50	0.50	0.50
Thr (%)	0.89	0.89	0.88	0.88	0.88
Cys (%)	0.37	0.37	0.36	0.36	0.35
Met+Cys (%)	0.87	0.87	0.86	0.86	0.85
Arg (%)	1.39	1.39	1.38	1.37	1.37
Val (%)	1.00	1.00	1.00	1.00	1.00
Ile (%)	0.89	0.89	0.89	0.89	0.88
Leu (%)	1.90	1.90	1.90	1.90	1.90
His (%)	0.57	0.57	0.57	0.56	0.56
Phe (%)	1.06	1.06	1.06	1.05	1.05
Linoleic Acid (%)	1.55	1.56	1.56	1.55	1.55

[1]T1: 0% compost (control), T2: 2.5% compost, T3: 5% compost, T4: 7.5% compost, T5: 10% compost; [2]DM: dry matter, ME: metabolizable energy, CP: crude protein, EE: ether extract, CF: crude fiber, Ca: calcium, PP: phytic phosphorus, Na: sodium, K: potassium, Cl; chloride, Lys: lysine, Met: methionine, Thr: threonine, Cys: cystine, Arg: arginine, Val: valine, Ile: isoleucine, Leu: leucine, His: histidine, Phe: phenylalanine.

Table 3. Compositional profile of diets for finisher phase.

Ingredient (%)	Treatment[1]				
	T1	T2	T3	T4	T5
Corn	57.00	57.00	57.00	57.00	57.00
Rice tips	5.34	4.20	3.50	2.20	0.00
Canola meal	5.00	2.00	0.80	0.00	0.00
Corn gluten 60%	2.00	2.00	2.00	3.00	3.00
Soybean meal	22.00	24.00	24.00	22.90	22.30
Canola oil	4.20	4.15	4.15	4.15	4.45
$CaCO_3$	0.90	0.70	0.20	0.00	0.00
DCP.2H_2O	2.10	2.10	2.10	2.10	2.10
Lysine-SO_4	0.40	0.40	0.40	0.40	0.40
DL-Methionine	0.12	0.12	0.12	0.12	0.12
Threonine	0.04	0.04	0.04	0.04	0.04
Sodium chloride	0.30	0.20	0.20	0.13	0.10
Sodium bicarbonate	0.10	0.10	0.00	0.00	0.00
Vitamin premix	0.20	0.20	0.20	0.20	0.20
Minerals premix	0.30	0.30	0.30	0.30	0.30
Compost	0.00	2.50	5.00	7.50	10.00

[1]T1: 0% compost (control), T2: 2.5% compost, T3: 5% compost, T4: 7.5% compost, T5: 10% compost.

Table 4. Nutrient profile of diets for finisher phase.

Nutrient[2]	Treatment[1]				
	T1	T2	T3	T4	T5
DM (%)	88.80	88.83	88.85	88.87	88.92
ME (kcal/kg)	3100	3100	3100	3100	3100
CP (%)	18.0	18.0	18.0	18.0	18.0
EE (%)	6.90	6.88	6.88	6.89	6.89
Ash (%)	6.00	6.00	6.05	6.00	6.00
CF (%)	3.61	3.61	3.62	3.64	3.66
Ca (%)	0.90	0.90	0.90	0.91	0.91
TP (%)	0.77	0.78	0.78	0.80	0.83
Na (%)	0.20	0.20	0.20	0.20	0.21
K (%)	0.78	0.78	0.81	0.81	0.83
Cl (%)	0.23	0.21	0.21	0.20	0.19
Lys (%)	1.09	1.09	1.09	1.09	1.09
Met (%)	0.44	0.44	0.44	0.44	0.44
Thr (%)	0.73	0.72	0.71	0.71	0.71
Cys (%)	0.33	0.32	0.32	0.31	0.31
Met+Cys (%)	0.77	0.76	0.76	0.75	0.75
Arg (%)	1.15	1.15	1.14	1.14	1.12
Val (%)	0.87	0.87	0.87	0.86	0.86
Ile (%)	0.75	0.75	0.75	0.75	0.74
Leu (%)	1.70	1.70	1.68	1.72	1.69
His (%)	0.50	0.49	0.49	0.48	0.48
Phe (%)	0.91	0.92	0.91	0.91	0.90
Linoleic acid (%)	2.02	2.01	2.00	2.00	2.03

[1]T1: 0% compost (control), T2: 2.5% compost, T3: 5% compost, T4: 7.5% compost, T5: 10% compost. [2]DM: dry matter, ME: metabolizable energy, CP: crude protein, EE: ether extract, CF: crude fiber, Ca: calcium, TP: total phosphorus, Na: sodium, K: potassium, Cl: chloride, Lys: lysine, Met: methionine, Thr: threonine, Cys: cystine, Arg: arginine, Val: valine, Ile: isoleucine, Leu: leucine, His: histidine, Phe: phenylalanine.

the data. Using each pen as an experimental unit, the Duncan's Multiple Range test was used to differentiate means at a 5% probability level.

3. Results and Discussion

3.1. Sensory evaluation and compositional profile

Table 5 shows the effects of various compost incorporation levels on sensory grading. The sensory values of the birds given compost-added diets were slightly lower than those of the control group, but this difference was not found to be statistically significant (P>0.05). Similar to this, data on compositional profiles (Table 6) showed no variations (P>0.05) in compositional profile values between meat from birds fed various diets.

Consumers place a high value on organoleptic qualities because they are thought to affect the acceptability of the products (Sanudo et al., 2000; Lyon et al., 2004; Wood et al., 2004). Tenderness and juiciness are reported to contribute to the eating quality of meat (Seabra et al., 2001). The choice of a product by a consumer is also said to be significantly influenced by its look (Baracho et al., 2006). Lyon and Lyon (2001) claimed that organoleptic characteristics are used as a guide for choosing foods. Our sensory panel did not find any variations in the sensory profiles of the meat from the birds fed the various diets (P>0.05), albeit the values did tend to decline as the amount of compost in the diet increased. However, these variations were judged to be insignificant (P>0.05). According to this, broiler chickens may be raised on diets including up to 10% poultry byproduct compost without the meat losing its organoleptic quality. Additionally, the overall acceptability scores for boiled chicken meat across all treatments ranged from 7.15 in the control group to 6.34 in the 10% compost-fed group, although statistical analysis revealed that these variations were not statistically significant (P>0.05). The compositional profile data for breast and thigh muscles did not show any difference between treatment groups (P>0.05), implying that compost may be successfully added to broiler diets up to 10% without changing the compositional profile of

Table 5. Effect of feeding poultry byproducts compost on organoleptic characteristics of meat of broiler chickens.

Treatment[1]	Sensory attributes							
	Appearance	Color	Aroma	Taste	Texture	Juiciness	Tenderness	Acceptability
T1	6.56	6.63	6.63	6.10	6.38	6.34	6.45	7.15
T2	6.19	6.20	6.36	5.80	6.15	6.16	6.26	6.90
T3	6.08	6.11	6.13	5.51	5.93	5.58	5.85	6.55
T4	5.90	5.89	5.94	5.42	5.70	5.53	5.78	6.36
T5	5.85	5.87	5.91	5.34	5.61	5.47	5.98	6.34
SEM	0.11	0.11	0.10	0.12	0.11	0.14	0.11	0.12
P-value	0.305	0.213	0.163	0.210	0.182	0.114	0.278	0.138

Means with a common superscript in the same column do not differ (P>0.05) difference. [1]T1: 0% compost (control), T2: 2.5% compost, T3: 5% compost, T4: 7.5% compost, T5: 10% compost, SEM: standard error of the mean.

Table 6. Effect of feeding poultry byproducts compost on compositional profile for meat of broiler chickens.

Parameter	Treatment[1]						
	T1	T2	T3	T4	T5	SEM	P-value
				Breast			
Moisture, %	74.66	74.93	74.78	75.26	74.60	0.25	0.942
Protein, %	21.06	21.46	21.38	21.09	21.33	0.18	0.947
Fat, %	1.82	1.70	1.81	1.76	1.76	0.08	0.994
Ash, %	1.05	1.02	1.07	1.05	1.08	0.02	0.875
				Thigh			
Moisture, %	73.81	74.66	73.66	74.92	74.37	0.24	0.444
Protein, %	19.52	19.52	19.62	19.77	19.43	0.15	0.969
Fat, %	3.76	3.78	3.58	3.64	3.58	0.12	0.974
Ash, %	1.01	1.01	1.03	1.00	1.01	0.02	0.987

Means with a common superscript in the same row do not differ (P>0.05). [1]T1: 0% compost (control), T2: 2.5% compost, T3: 5% compost, T4: 7.5% compost, T5: 10% compost, SEM: standard error of the mean.

the breast and thigh meats. Williams and Damron (1998a) observed that the inclusion of rendered whole-hen meal at the 12% level in broiler diets had no influence (P>0.05) on the sensory attributes and compositional profiles of the meat from the breast and thigh. Similarly, Williams and Damron (1998b) used up to 12% of rendered wasted hen meal in broiler meals and discovered no differences in the sensory qualities and compositional profiles of the meat from the breast and thigh (P>0.05). Since the current study is the first of its type to assess the potential impact of compost on broiler chicken diets on the organoleptic properties and compositional profile of the meat produced, it is unable to directly compare it to earlier investigations.

4. Conclusion

According to the current research, compost may be fed to broiler chickens in diets up to 10% without negatively affecting the meat's sensory qualities or composition. Additionally, using compost into broiler diets may help to lower the cost of feed.

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