Effect of Feed Form on the Physical and Sensory Properties of Broiler Chickens Meat

Aymen M. N. Al-Nassiri **Tareq Kh. H. Aljumaily**

Depart. Of Animal Production, College of Agriculture, Tikrit University, Iraq.

1E-mail: Abodhai1976@gmail.com

2E-mail: tariq.aljomaily@tu.edu.iq

Abstract

The study aimed to evaluate the effect of the physical form of feed on the physical characteristics (water holding capacity, thawing loss, cooking loss, and drip loss) and sensory attributes (flavor, tenderness, juiciness, and overall acceptability) of broiler chickens meat. A total of 90 one-day-old Ross 308 broiler chicks were used in this experiment. The birds were randomly distributed into three treatments, with three replicates per treatment and 10 birds per replicate. Birds in the first treatment were fed a pelleted diet, which served as the control treatment. Birds in the second treatment were fed a crumbled diet, while birds in the third treatment were fed a mash diet. The results revealed that treatments two and three showed a significant improvement ($P < 0.05$) over the control treatment in water holding capacity. Furthermore, treatment two exhibited a significant superiority ($P < 0.05$) over the other treatments in drip loss. Additionally, treatment two showed a significant improvement ($P < 0.05$) in the sensory characteristics of the meat compared with the other treatments. We conclude that the form of feed has a positive effect on the physical and sensory characteristics of broiler chickens meat.

Keywords: Feed form, Physical characteristics, Poultry meat, Sensory attributes.

Introduction

Poultry production occupies a fundamental position in supplying a substantial portion of human food requirements. In recent decades, this industry has witnessed remarkable progress across various production aspects, resulting in significant improvements in productivity and efficiency [1]. With the growing demand for poultry products alongside the rapid increase in the global population, ensuring adequate supplies of animal protein has become a major priority for future food security[2]. However, the considerable expansion in poultry production has also been associated with several negative impacts on poultry health [2]. Poultry products represent one of the most important sources of animal protein, which constitutes an essential component of the nutrients required for human nutrition[3,4].Consequently, consumers have increasingly relied on poultry meat as a primary source of animal protein due to its high palatability, ease of digestion, relatively low production cost, and its lower fat and cholesterol contents compared with other types of meat [3,4]. The primary objective of the poultry industry is to meet the growing global demand for animal protein. Therefore, this sector requires continuous development of strategies aimed at improving growth performance and production efficiency. Among the most important of these strategies is nutrition, particularly the development of feed types and forms within appropriate feeding programs [5] that correspond to the different growth stages of broiler chickens. Selecting suitable feed forms for each stage is essential, as optimal feed utilization is a key determinant for achieving maximum production efficiency [6]. Despite the substantial genetic improvement in broiler strains and advancements in feeding programs, this progress has been accompanied by several challenges, most notably the rising costs of production, especially feed prices [7]. Feed expenses account for approximately 60–70% of the total production cost in broiler production systems, and feed processing operations represent a significant proportion of this cost. The physical form of feed is therefore considered an important factor influencing broiler performance [8]. Feed manufacturers and poultry nutrition specialists continue to explore innovative approaches to enhance feed utilization efficiency in order to increase productivity and improve meat quality[9]. Recently, considerable attention has been directed toward modifications in the physical form of poultry feed [9]. One of the most critical aspects of poultry feed manufacturing is selecting feed characteristics that optimize bird performance and product quality, particularly feed particle uniformity and appropriate texture [10]. Consequently, feed mills produce a variety of feed types and forms specifically designed for broiler production. The selection of these forms often depends on the age of the flock, as each feed form has its own advantages and disadvantages. Nevertheless, poultry producers still face challenges in determining the most appropriate feed form for each stage of broiler production under practical farming conditions [11]. Mash, crumble, and pelleted feeds are among the most commonly used feed forms in poultry nutrition. Each form possesses specific advantages and disadvantages in terms of economic cost, nutritional value, and acceptability by birds [12]. Feed form has been shown to exert a significant influence on growth performance, meat quality, and the chemical, physical, and sensory characteristics of poultry meat [13]. Therefore, the present study aimed to evaluate the effect of different feed forms on the physical and sensory characteristics of broiler meat under local rearing conditions.

Bird Management and Experimental Design

This experiment was conducted at the broiler research unit of the Animal Production Farm, College of Agriculture, Tikrit University, during the period from 12 October to 16 November 2025. A total of 90 one-day-old Ross 308 broiler chicks were used in the experiment, with an average initial body weight of 42.5 g. All necessary managerial and sanitary procedures were carried out prior to the arrival of the chicks. The rearing hall, equipment, and tools were thoroughly cleaned and disinfected, and the cages were prepared one week before chick placement. Cages measuring 80 × 120 cm were used for rearing the birds in a multi-tier system, with a total of nine cages. Upon arrival, the chicks were randomly distributed among the cages, with 10 chicks allocated to each cage. Three different feed forms were used in the experiment, with each feed form assigned to a specific treatment. Birds in the first treatment were fed a pelleted diet, which served as the control treatment. The second treatment was fed a crumbled diet, while the third treatment received a mash diet. The diets used in this study were produced by Noor Feed Company for Feed Production in Kirkuk. Three feeding phases were applied during the rearing period. The starter diet was provided from day 1 to day 8, the grower diet from day 9 to day 22, and the finisher diet from day 23 until the end of the experiment, as presented in Table (1).

Table (1): Composition and Calculated Chemical Analysis of the Experimental Diets (Starter, Grower, and Finisher)

Feed ingredients	Starter (1–8 d)	Grower (9–22 d)	Finisher (23–35 d)
Yellow corn (%)	56.22	60.23	65.82
Soybean meal (48%)	34.00	33.62	28.45
*Protein concentrate (%)	5.00	2.50	2.50
Sunflower oil (%)	2.00	2.15	2.03
Dicalcium phosphate (%)	0.43	0.90	0.60
Limestone (%)	1.66	0.10	0.10
L-lysine (%)	0.19	0.13	0.14
DL-methionine (%)	0.25	0.12	0.11
Sodium chloride (%)	0.25	0.25	0.25
Total	**100**	**100**	**100**
Calculated chemical composition			
Parameter	**Starter**	**Grower**	**Finisher**
Metabolizable energy (kcal/kg feed)	3000	3050	3101*
Crude protein (%)	23.09	21.51	19.50
Crude fiber (%)	3.77	2.30	2.28
Lysine (%)	1.44	1.18	1.08
Methionine (%)	0.746	0.59	0.56
Methionine + Cystine (%)	1.09	0.92	0.86
Calcium (%)	0.962	0.87	0.79
Phosphorus (%)	0.483	0.42	0.36

* Protein concentrate: Brocon-5 Special W protein concentrate produced by WAFI Company (Netherlands) was used. It contains 40% crude protein, 5% crude fat, 3.04% calcium, 5.39% available phosphorus, 3.85% lysine, 3.70% methionine, 4.13% methionine + cystine, 2157 kcal/kg metabolizable energy, 3.20% crude fiber, 2.40% sodium, and 4.16% chloride. In addition, it provides the following vitamins: Vitamin A (200,000 IU/kg), Vitamin D_3 (80,000 IU/kg), Vitamin E (600 mg/kg), Vitamin B_1 (60 mg/kg), Vitamin B_2 (140 mg/kg), Vitamin B_6 (80 mg/kg), Vitamin B_{12} (700 mg/kg), Vitamin H (Biotin, 2 mg/kg), Niacin (800 mg/kg), Folic acid (20 mg/kg), and Vitamin K_3 (50 mg/kg).

** The calculated chemical composition of the diets was estimated according to the chemical composition values of the feed ingredients reported by NRC (1994).

Health and Preventive Programs

All routine health management and preventive vaccination programs commonly applied in broiler production were implemented during the experimental period. Birds were administered the antibiotic Enrosol at a dosage of 1 ml/L of drinking water from day 1 to day 5 of age as a preventive measure against omphalitis (navel inflammation). At three days of age, the chicks were vaccinated against Newcastle disease + Infectious Bronchitis (IB) using the eye drop method. On the same day, the birds were also vaccinated with an oil-emulsion vaccine against

Newcastle disease, Avian Influenza, Infectious Bronchitis, and Viral Hepatitis. Immediately after vaccination, the chicks were provided with paracetamol combined with vitamin C for 24 hours through drinking water to alleviate post-vaccination stress. At 15 days of age, the birds were vaccinated again against Newcastle disease using the spray method. Immediately after vaccination, paracetamol and vitamin C were administered through drinking water for 24 hours. Subsequently, during days 16–18 of age, the birds received a multivitamin supplement for three consecutive days. The health care and preventive program followed during the experimental period is presented in Table (2).

Table (2): Health Management and Vaccination Program Applied to Broiler Chickens During the Experimental Period

No.	Treatment / Vaccination	Age	Duration of Use
1	Treatment for omphalitis (Enrosol)	1–5 days	5 days
2	Newcastle disease + IB vaccine (eye drops)	3 days	—
3	Oil vaccine against Newcastle disease, Avian influenza, IB, and viral hepatitis	3 days	—
4	Paracetamol + Vitamin C	3 days	24 hours
5	Newcastle disease vaccine (spray method)	15 days	—
6	Paracetamol + Vitamin C	15 days	24 hours
7	Multivitamin supplement	16–18 days	3 days

Studied Traits

Physical Characteristics of Meat

Water Holding Capacity (WHC)

The water holding capacity (WHC) of meat was determined according to the method described by [14]. According to this method, meat samples weighing 5 g were collected from different parts of the carcass. Each sample was placed inside a filter paper, and pressure was applied by placing a 2-kg weight on top of the sample. The samples were maintained under pressure for 5 minutes. Afterward, the samples were weighed again to determine the weight after pressing. The difference between the sample weight before and after pressing represented the amount of water lost. The water holding capacity of the meat was then calculated using the following equation:

$$\text{Water Holding Capacity (\%)} = \text{Moisture content of meat (\%)} - \text{Water loss due to pressing (\%)}$$

Thawing Loss

The percentage of thawing loss was determined according to the method described by [15]. In this procedure, frozen carcasses were placed in a refrigerator at 4 °C for 24 hours to allow thawing. After thawing, the carcasses were removed from the refrigerator and gently dried using absorbent paper towels to remove surface moisture. The samples were then weighed, and the thawing loss percentage was calculated using the following equation:

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$$\text{Thawing loss (\%)} = \frac{\text{Weight before thawing} - \text{Weight after thawing}}{\text{Weight before thawing}} \times 100$$

Cooking Loss Percentage

The cooking loss percentage was determined according to the method described by [16]. In this procedure, meat samples weighing 10 g were collected from different parts of the carcass. The samples were then subjected to dry cooking (grilling) using an electric oven at 160 °C for 7–8 minutes. After cooking, the samples were gently dried with absorbent paper towels to remove excess surface fluids. The cooked samples were then weighed, and the cooking loss percentage was calculated using the following equation:

$$\text{Cooking loss (\%)} = \frac{\text{Sample weight before cooking} - \text{Sample weight after cooking}}{\text{Sample weight before cooking}} \times 100$$

Drip Loss Percentage

After slaughtering and cleaning the carcasses, the hot carcass weight was recorded. The carcasses were then placed in polyethylene bags and stored in a refrigerator at 4 °C for 24 hours. After the chilling period, the samples were removed from the refrigerator and gently dried using absorbent paper towels to remove surface moisture. Subsequently, the carcasses were weighed again to obtain the cold carcass weight. The drip loss percentage was calculated according to the method described by [17] using the following equation:

$$\text{Drip loss (\%)} = \frac{\text{Carcass weight before chilling} - \text{Carcass weight after chilling}}{\text{Carcass weight before chilling}} \times 100$$

Sensory Evaluation of Meat

Sensory evaluation was conducted on meat samples to assess flavor, juiciness, tenderness, and overall acceptability. Meat samples were collected from the carcasses, specifically from the thigh cuts, and were cooked using a dry cooking method (grilling) with the addition of table salt only. The grilled meat samples were then presented to a panel consisting of faculty members of the department and postgraduate students who had prior experience in sensory evaluation. The sensory assessment was conducted at 11:00 a.m. in the Department of Animal Production. Between tasting each sample, panelists were instructed to drink water to cleanse their palate and minimize carry-over effects between samples. The evaluators recorded their scores using a previously prepared questionnaire form, following the method described by [18].

Statistical Analysis

After completing all measurements and collecting the data related to the studied traits, the data were statistically analyzed using the SAS software package based on a Completely Randomized Design (CRD). Duncan's multiple range test was applied to determine the significant differences among treatment means at a probability level of ($P < 0.05$), as described by [19] and [20].

The following mathematical model was used to analyze the data obtained for the studied traits:

$$Y_{ij} = \mu + t_i + e_{ij}$$

Where:

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- Y_{ij}: Observation value for treatment i.
- μ: Overall mean of the observations.
- t_i: Effect of treatment i.
- e_{ij}: Experimental error.

Results

Effect of Feed Form on the Physical Characteristics of Meat

The results presented in Table (3) indicate that treatments two and three showed a significant improvement (P < 0.05) compared with treatment one in water holding capacity. Treatment two recorded a water loss of 15.21%, while treatment three recorded 15.92%, whereas treatment one recorded a higher loss of 19.32%. No significant differences were observed among the three treatments in thawing loss and cooking loss. The treatments recorded 0.44%, 1.06%, and 0.27%, respectively, for thawing loss. Similarly, for cooking loss, the treatments recorded 62%, 65%, and 64%, respectively. However, regarding drip loss, treatment two showed a significant superiority (P < 0.05) over treatments one and three. Treatment two recorded a drip loss of 0.57%, whereas treatments one and three recorded 0.34% and 0.11%, respectively.

Table (3): Effect of Feed Form on the Physical Properties of Broiler Meat (Mean ± SE)

Treatments	Water Holding Capacity (%)	Thawing Loss (%)	Cooking Loss (%)	Drip Loss (%)
T1	19.32 ± 0.80[a]	0.44 ± 0.26	61.78 ± 1.18	0.34 ± 0.04[ab]
T2	15.21 ± 0.96[b]	1.06 ± 0.37	65.27 ± 1.61	0.57 ± 0.16[a]
T3	15.92 ± 1.11[b]	0.27 ± 0.27	63.62 ± 1.78	0.11 ± 0.11[b]
Significance level	*	NS	NS	*

- **T1:** Pelleted diet; **T2:** Crumbled diet; **T3:** Mash diet.
- ***** Indicates the presence of **significant differences among treatments**.
- **Different superscript letters within the same column indicate significant differences among treatment means at (P ≤ 0.05).**
- **NS:** Not significant differences among treatments.

Effect of Feed Form on the Sensory Characteristics of Meat

The results presented in Table (4) indicate that treatment two showed a significant superiority (P < 0.05) over treatments one and three in the sensory characteristics of broiler meat, including flavor, juiciness, tenderness, and overall acceptability. Treatment two recorded values of 5.28, 5.34, 5.66, and 5.80, respectively, for the evaluated sensory attributes. In contrast, treatment one recorded values of 4.84, 4.50, 5.05, and 4.96, respectively, while treatment three recorded 4.58, 4.50, 4.25, and 4.82, respectively, for the same sensory traits. This improvement may be attributed to the crumbled feed form, which may enhance

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intramuscular fat deposition, thereby increasing the water retention capacity of muscle tissues and improving the flavor, tenderness, and juiciness of the meat, ultimately leading to higher overall acceptability of broiler meat.

These results are due to the fact that feeding broiler chickens compressed and crushed feed leads to a higher percentage of fat inside muscle cells[21]. This increases the meat's ability to retain water and raises the moisture content, resulting in increased tenderness, flavor, and juiciness of the chicken meat[21].

Table (4): Effect of Feed Form on the Sensory Attributes of Broiler Meat (Mean ± SE)

Treatments	Flavor	Juiciness	Tenderness	Overall Acceptability
T1	4.84 ± 0^{b}	4.50 ± 0^{b}	5.05 ± 0^{b}	4.96 ± 0^{b}
T2	5.28 ± 0^{a}	5.34 ± 0^{a}	5.66 ± 0^{a}	5.80 ± 0^{a}
T3	4.58 ± 0^{c}	4.50 ± 0^{b}	4.25 ± 0^{c}	4.82 ± 0^{c}
Significance level	*	*	*	*

- T1: Pelleted diet; T2: Crumbled diet; T3: Mash diet.
- * Indicates the presence of significant differences among treatments.
- Different superscript letters within the same column indicate significant differences among treatment means at ($P \leq 0.05$).
- NS: Not significant differences among treatments.

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Conclusions

We conclude the following from the results of the study:

- Using pelleted and crushed feed in broiler chicken feeding increases the meat's ability to retain water.
- Using pelleted and crushed feed in broiler chicken feeding improves the sensory qualities of the meat.

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