Effect of feed forms, mash and pellets on productive performance and carcass weights of broiler chicken

Basim Aboud Abbas[1], Luma K. Bander[2] and Abdulrazzak A. Jasim[2]

[1]College of Agriculture - University of Diyala – Republic of Iraq
[2] College of Agricultural Engineering Sciences - University of Baghdad – Republic of Iraq.
Correspondent author Email basimabbas@uodiyala.edu.iq.

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Abstract

This study has aimed to investigate the effect of feed forms, mash and pellet on productive performance and carcass yields of broilers. 225 unsexed birds of the hybrid Ross 308 broiler were used, with a starting weight of 45.4 g one day old. The experiment lasted up to 35 days. The birds were randomly distributed into five treatments; each treatment contained 45 chicks according to three replicates (15 birds/ replicate). The experiment's treatments included: (T1) Control mash 100% (pellet 0%), (T2) mash 75% (pellet 25%), (T3) mash 50% (pellet 50%), (T4) mash 25% (pellet 75%) and (T5) mash 0% (pellet 100%). Results were recorded a significant superior of T4 compared with other treatments ($P \leq 0.05$) in live body weight, weight gain, feed intake, feed conversion ratio, carcass weights and dressing percentage, productive index, and economic indicator. It has been found that the growth performance and carcass yield in broiler chickens was improved by using feed pellet instead of mash for 35 days.

Keywords: Meat chicken, feed pellet, Feed conversion ratio, Feed intake, dressing percentage.

Introduction

Feed is defined as a mixture of several ingredients containing nutrients that are required in terms of quantity and quality for optimal growth (14). Various feed ingredients are combined into compound rations to meet feeding requirements to increase production (16). Feed pellet formation is a related manufacturing process in poultry feed production (1). The physical feed form has a beneficial effect on broiler performance; it reduces feed waste and energy waste during feed intake (5). Pellet feed is widely used in poultry farming, due to its comprehensive nutrition, strong stability and absorbability, and digestibility (8). The physical form of the feed (Mash and Pellet) is one of the most important factors that can affect the productive performance of broiler, and the extent of its improvement (34). The feed intake, growth rate, and production are greatly affected by the physical feeds shape (15). The formation of feed pellet is one of the most important and common techniques in the poultry industry (33). It is well established that broiler chickens fed on pellet feed have better performance (20). Feed intake is one of the main factors that affecting the broiler growth, as that the physical form affecting on feed intake, whether mash or pellet (2). Providing higher proportions of intact pellet leads to improve performance of broiler (17; 29). The shape of the feed, affects the performance of birds, during the stages of growth, the researchers have indicated that the early chicks growth has a significant effect on the final body weight of the broilers by feeding them more palatable feed that results in improving their growth and performance (27). Netto *et al*. (25) indicated that the feed industry directly affects in feed intake of broiler chickens, weight gain, and feed conversion ratio, comparison with mash. Several indicators have been shown to support the benefits of feeding pellet over mash, by increasing the feed intake by facilitating ingestion and achieving the availability of key nutrients in the feed (3). The net ratio is one of the important measurements that give an indication of the amount of meat produced by breeding broilers, and it is calculated as a percentage of the weight of the carcass ready for intake from the live weight (13). Sena et al. (30) explained that using the divided feed ing into mash and pellet for broiler Ross 308 till to the age of 42 days, they noticed a significant effect of the pellet in carcass weight and dressing percentage. The productive index is one of the criteria for evaluating broiler flocks according to their nutritional value (24). Mirghelenj and Golian (23) pointed out, that in an experiment on a local breed of 144 birds using feed mash and complete pellet feed, there was a significant superiority in the completed pellet treatment in the productive index and the economic indicator. Poultry is one of the main sources of income in agricultural production and provides a large part of animal protein, which is characterized by high nutritional value, and is associated with many other industries, including the animal feed industry (19). One of the main constraints in poultry farming projects is the high cost of breeding represented by the costs of feed, control of composition and distribution of feed mixes (4). This study has aimed to find out the effect of feed forms, mash and pellet on productive performance and carcass yields of broilers.

Materials and Methods

Ethical approval: Every effort was made to minimize pain and discomfort for the animal during the experiments procedures used in this study for breeding birds.

Experiment was carried out in the poultry farm of the department of animal production/ College of agricultural engineering sciences/ University of Baghdad from 15/12/2021 to 19/1/2022 (35 days) in a closed poultry house. 225 unsexed broiler (Ross 308 hybrid), one day old, were used in the experiment, with an average starting weight of 45.4 g/chick. Chicks were brought from a local commercial hatchery in Baghdad city.

Bird's management**:** The environmental conditions of the breeding hall were prepared before the arrival of chicks. The temperature, lighting, and humidity schedules are modeled as that of a commercial integrator. The chicks were distributed in floor pens, to 15 pens with wire mesh fence, and the dimensions of each pen were 2 x 1.5 meters. The floor of the breeding hall was concrete and was covered with a mattress of a thickness ranging from 3-5 cm. The hall was equipped with air intakes. Two electric heaters, as well as two gas incubators, were used as sources of heating due to the low temperatures during the first days of the chicks' life. The temperature and humidity in the hall's environment of the hall were monitored using 3 measuring devices (HTC-2 Thermo hygrometer) distributed at the beginning, middle, and end of the hall, at the same level as the birds. Water was provided during the experiment using inverted plastic drinkers with a capacity of 3.5 liters and according to one drinker per pen. The height of inverted plastic drinkers was gradually changed with the age of the bird, with the birds back height to be able drinking water, until the end of the experiment. Circular feeder trays with a 42 cm diameter were used in the first week, one feeder per pen, and then they were replaced with hanging cylindrical plastic feeders of a diameter of 38 cm, which are gradually lifted according to the height of the bird's back to facilitate the feed intake and to save the feed from loss.

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Experimental design: The experiment included five treatments, each one containing 45 chicks. The chicks were randomly distributed into three replicates as 15 chicks/ replicate. The experimental treatments included: (T1) the control treatment, mash 100% (pellet 0%), (T2), mash 75% (pellet 25%), (T3) feed mash 50% (pellet 50%), (T4) feed mash 25% (pellet 75%), (T5) feed mash 0 % (p e l l e t 1 0 0 %) .

Feed materials used in the experiment

The feeds were purchased from the local market, and they included three compositions: a starter feed, a growth feed, and a final feed of age shown in Table 1. The feed has been formulated according to the basic nutritional requirements of broiler chickens of Ross-308 breed according to the National Research

Council (26). pellet are made after grains are ground, then mixed with the ingredients of the feed , and finally dividing it into two parts; using the first part to produce the pellet, that were conditioned with steam at 60°C for about 20-30 seconds. The second part was used to feed the birds with mash feed according to the experimental parameters. Pellet was cooled with airflow from a fan for 10 minutes (15). All manufactured bird-fed pellet had a similar diameter of 3 mm, and lengths of 8 mm.

Table 1. The components of broiler feed used in the experiment

Components	Ingredients (%)		
	Starter (1-10 days)	Grower (11-21 days)	Final (22-35 days)
Corn/maize	37.5	35	40.64
Wheat	20	26	24
Soy bean meal	32	28	24
Protein concentrate	5	5	5
Oil	3	4	4.5
Di Calcium Phosphate	0.7	0.5	0.4
Free lime	1.2	1.14	1.1
Methionine	0.25	0.13	0.13
Lysine	0.25	0.13	0.13
Salt	0.1	0.1	0.1
The total	100	100	100
Calculated chemical composition			
Energy (kilocalories/ kg from feed)	3036	3132	3206
protein	23.1	21.8	20.1
Fat	5.5	6.5	7.1
fiber	2.8	2.8	2.7
methionine + cysteine	1.12	0.95	0.91
Lysine (%)	1.49	1.29	1.18
Calcium (%)	0.98	0.90	0.85
Phosphorous (%)	0.49	0.45	0.42

1- Soybean cake used an Argentine source, Crude protein is 48%, and 2440 kilocalories/kg represents energy.

2- Protein concentrate used is a product from a Dutch company (imported) Brocon that contains 40 % crude protein, 2107 calories/kg protein represented energy, 5 % crude fat, 2.20 % crude fiber, 5 % calcium, 2.65% phosphorous, 3.85% lysine, 3.70% methionine, 4.12% methionine + cysteine, 0.42% tryptophan, 1.70% threonine.

3- The diet chemical composition was formulated according to the NRC (26).

Health prevention program

The birds were vaccinated against major diseases and according to generally accepted commercial practices and immunized against Newcastle diseases.

Productive performance and carcass traits

Live Body Weight (LBW) - (g): Chicks were weighed on the first day. At the end of each week, the LBW of the birds was measured for each replication within the treatment by following equation(13).

LBW (g) = sum of broiler weights per replicate/ number of broiler per replicate …… (1)

The Weight Gain **(**WG**)** - (g): was calculated using the equation by El-Medany *et al.* (12):

BWG (g) = LBW at the end of the week (g) - LBW at the beginning of the week (g)/ number of birds
…… (2)

Calculate total body weight gain for 5 weeks by applying the equation (6):

Total WG (g) = final WG - starting WG …… (3)

Feed Intake (FI) - (g/bird): The feed intake weekly was measured at the end of each week by weighing the remaining of feed at the end of the week and subtracting it from the amount provided at the beginning of the week, according to the equation (12):

FI (g/bird) = feed provided at the week beginning (kg) - remaining feed at the week end (kg).
…… (4)

Total FI calculated from the collection of the weekly feed intake for five weeks according to the following equation (6):

Total FI (g/bird) = the provided feed at the first day (kg) – the remaining feed at the last day (kg) …… (5)

Feed Conversion Ratio (FCR)**:** was measured according to Wasman (32): FCR = the feed intake in a certain period (g) / the weight gain for the same period (g) …..(6)

Carcass Traits Net Ratio without Internal Viscera**:** Six birds were taken randomly at the last day of the experiment, from each treatment as two birds (male and female for each replication). The birds were weighed with an electronic scale individually, afterward, the birds were slaughtered and the feathers removed using a plucking machine with rubber picking fingers, after that the internal viscera were separated and the carcasses were weighed to extract the net ratio according to the following equation (13):

Netting ratio = carcass weight (g) / live weight (g) * 100 …..(7)

Productive Index (PI**):** Was calculated according to the following equation (24):

PI = live body weight (g) * vitality ratio / number of days of rearing * feed conversion ratio * 10

Where: vitality percentage = 100 - mortality rate ….. (8)

Economic Indicator (EI)**:** Was calculated according to the following equation (24):
EI = total weight of feed intake during the rearing period (kg) / number of marketed birds * length of rearing period (day) * feed conversion ratio * 10000 …… (9)

Statistical Analysis

Data analyzed according to general linear model (GLM) using Complete Randomized Design (CRD) to investigate the effect of treatments on the studied traits. Significant differences among the means were detected according to Duncan multiple ranges test (11). The program SPSS software (31) used in the statistical analysis of the data.

Results and Discussion

The results in Table 2 show the effect of feed forms, mash and pellets on live body weight. In the first week, treatment T5 was significantly superior ($p \leq 0.05$) compared to other treatments in the average body weight, where there was no significant difference between the two treatments T4 and T3, which were significantly superior on the treatment T1. In the second week, it was observed that treatments T5 and T4 were significantly superior ($p \leq 0.05$) compared to T2 and T1 treatments, and were no significantly superior on the T3 treatment in the live body weight. This result continued in favor of the additional treatments compared to the T1 control treatment during the third and fourth weeks of the experiment. In the fifth week of the experiment, the treatments T5, T4 and T3 were significantly superior ($p \leq 0.05$) in an increase of live body weight compared to T2 and T1 treatments.

Table 2. Effect of feed forms, mash and pellet on live body weight (g/bird) of broilers (mean ± standard error)

Treatment	Week				
	1	2	3	4	5
T1	146.51±0.52 c	377.54±7.00 C	811.80±14.36 D	1439.73±24.85 c	2217.62±25.39 B
T2	149.27±1.37 bc	388.82±12.80 Bc	850.27±35.50 Cd	1505.91±47.73 c	2308.49±48.40 B
T3	153.71±1.72 b	415.04±6.30 Ab	902.85±15.61 Bc	1607.45±28.29 b	2425.60±3.87 A
T4	157.71±1.07 b	432.33±5.74 A	934.44±5.60 Ab	1688.64±14.50 ab	2428.53±42.56 A
T5	167.22±3.98 a	441.31±9.60 A	966.98±3.15 A	1748.49±15.36 a	2502.29±5.73 A
Sig. level	*	*	*	*	*

* Different letters in each column indicate a significant difference among the mean treatments on a level of $p \leq 0.05$.
* T1, T2, 3T, 4T and T5 the treatments of the pellet instead of the mash at 0, 25, 50, 75 and 100% pellet respectively.

The Table 3 show the effect of feed forms, mash and pellets on the weekly and total weight gain. Treatment T5 were significantly superior (p≤0.05) in the best weekly weight gain in the first week compared to other treatments. In the second week, the treatments T5 and T4 were significantly superior (p≤0.05) in weight gain on the T2, T1 treatments, this result continued for additional treatments compared to the T1 control treatment during the third week of experiment. In the fourth week, the treatments T5 and T4 were significantly superior (p≤0.05) in weight gain compared to other treatments. It was obvious in the fifth week that there were no significant differences among all treatments. As for the total weight gain (1-5 weeks), the treatments T5, T4 and T3 were significantly superior (p≤0.05) to other treatments.

Table 3. Effect of feed forms, mash and pellet on weight gain (g/bird) for broilers (mean ± standard error)

Treatment	Week					
	1	2	3	4	5	1 – 5
T1	101.65±0.12 c	231.02±6.56 B	434.27±21.27 c	627.93±10.49 c	777.89±3.79	2172.76±25.82 B
T2	104.00±0.88 bc	239.56±13.81 B	461.45±22.96 bc	655.64±17.53 c	802.58±6.55	2263.22±48.87 B
T3	109.96±1.85 bc	261.33±7.52 Ab	487.80±11.30 ab	704.60±16.57 b	818.16±24.91	2381.84±3.59 A
T4	113.49±1.35 ab	274.62±4.77 A	502.11±2.33 ab	754.20±9.36 a	739.89±49.73	2384.31±42.74 A
T5	122.62±4.24 a	274.09±5.90 A	525.67±7.93 a	781.51±13.91 a	753.80±19.79	2457.69±5.17 A
Sig. level	*	*	*	*	n.s	*

* Different letters in each column indicate a significant difference among the mean treatments on a level of p≤0.05.
* T1, T2, T3, T4 and T5 the treatments of the pellet instead of the mash at 0, 25, 50, 75 and 100% feed pellet respectively.
* n.s: No significant differences.

The Table 4 shows the effect of feed forms, mash and pellets on feed intake. In the first week, the treatments T5, T4, and T3 were significantly superior (p≤0.05) to the T1 treatment, this result continued in favor of addition treatments compared to the T1 control treatment during the third and fourth weeks of the experiment. In the second week, the treatments T5 and T4 were significantly superior (p≤0.05) to the T2 and T1 treatments. In the fifth week, the treatments T1 were significantly superior (p≤0.05) to the T5 treatment. For the total intake feed, the results showed a significantly superior (p≤0.05), it was, the treatments T5, T4, were significantly superior (p≤0.05) to the T2 and T1 treatments.

Table 4. Effect of feed forms, mash and pellet on feed intake (g/bird) for broilers (mean ± standard error)

Treatment	Week					
	1	2	3	4	5	1 - 5
T1	90.27±0.28 b	254.02±1.69 B	545.02±12.91 c	855.16±14.71 C	1185.67±2.89 a	2930.13±24.84 b
T2	100.67±0.15 ab	248.11±13.31 B	623.78±21.79 b	920.27±29.23 B	1113.67±5.68 ab	3006.49±57.28 b
T3	107.36±1.73 a	286.24±2.09 Ab	645.93±1.78 ab	951.27±15.22 Ab	1158.00±16.41 ab	3148.80±23.88 ab
T4	107.22±0.22 a	301.15±0.79 A	661.22±4.25 ab	966.44±15.01 Ab	1076.82±46.97 b	3112.87±59.89 a
T5	108.13±0.79 a	308.14±6.53 A	667.53±1.55 a	1005.13±11.84 A	1084.40±8.29 b	3173.33±26.16 a
Sig. level	*	*	*	*	*	*

*Different letters in each column indicate a significant difference among the mean treatments on a level of p≤0.05.
*T1, T2, 3T, 4T and T5 the treatments of the pellet instead of the mash at 0, 25, 50, 75 and 100% feed pellet respectively.

Table 5 shows the effect of feed forms, mash and pellets on the feed conversion ratio. In the first week, the treatments T5 and T1 were significantly superior (p≤0.05) on the T3 and T2 treatments. In the second week, it was obvious that there were no significant differences among all treatments, this result continued in favor of additional treatments compared to the T1 control treatment during the third and fourth weeks of the experiment. In the fifth week, there was a significant effect (P ≤ 0.05) between the treatments, respectively, and the treatment T1 had the lowest feed conversion ratio. From the final result, it was found that the total feed conversion ratio (1-5 weeks) had a significant superiority in treatment T5 on T1 treatment, Treatments T4, T3 and T2 were not significantly different.

Table 5. Effect of feed forms, mash and pellet on feed conversion ratio for broilers (mean ± standard error)

Treatment	Week					
	1	2	3	4	5	1 - 5
T1	0.89±0.01 b	1.10±0.03	1.26±0.04	1.36±0.01	1.52±0.01 a	1.35±0.01 a
T2	0.97±0.01 a	1.04±0.05	1.36±0.03	1.40±0.06	1.39±0.01 b	1.33±0.03 ab
T3	0.98±0.03 a	1.10±0.03	1.32±0.03	1.35±0.04	1.42±0.03 b	1.32±0.01 ab

T4	0.94±0.01 ab	1.10±0.02	1.32±0.01	1.28±0.02	1.46±0.06 ab	1.30±0.01 ab
T5	0.89±0.03 b	1.12±0.02	1.27±0.02	1.29±0.04	1.44±0.03 ab	1.29±0.01 b
Sig. level	*	n.s	n.s	n.s	*	*

* Different letters in each column indicate a significant difference among the mean treatments on a level of p≤0.05.
* T1, T2, T3, T4 and T5 the treatments of the pellet instead of the mash at 0, 25, 50, 75 and 100% feed pellet respectively.
* n.s: No significant differences.

Table 6 shows the effect of feed forms, mash and pellets on the carcass weights and dressing percentage of the broiler. In terms of live weight before slaughter, the two treatments T5 and T4 were significantly superior (p≤0.05) to T2 treatments, and no significant difference was observed between the two treatments T2 and T1. This result continued in favor of T5 and T4 treatments significantly superior (p≤0.05) compared to the T2 and T1 treatments for hot carcass weight.

Also, the cold carcass weight did not differ much, as the treatments T5 and T4 were significantly (p≤0.05) superior to the two treatments T2 and T1, and no significant difference was observed between the two treatments T2 and T1. the direct relationship between live weight and the weight of hot and cold carcasses was explained by Fayadh and Naji (13) that the weight of the carcass increases as the weight of the living body increases. On the other hand, the results showed that the treatments T5, T3 and T2 were significantly superior (p≤0.05) in the dressing percentage of the hot and cold net compared to the T1 treatment.

Table 6. Effect of feed forms, mash and pellet on carcass weight and dressing percentage for broiler of main cuts (mean ± standard error)

Treatment	Studied Traits				
	Living weight	Carcass hot weight	Carcass cold weight	Hot net percentage	Cold Net percentage
T1	2356.00±55.43 bc	1710.00±27.47 bc	1700.67±28.03 C	72.61±0.57 b	72.21±0.54 B
T2	2229.67±60.31 c	1671.67±49.37 c	1666.00±48.81 C	74.97±0.29 a	74.71±0.30 A
T3	2360.33±30.66 b	1770.67±33.20 b	1765.00±32.88 b	75.01±0.74 a	74.77±0.73 A
T4	2594.00±47.17 a	1930.33±53.20 a	1924.33±53.05 a	74.40±1.02 ab	74.17±1.03 Ab
T5	2475.67±79.28 ab	1859.33±60.79 ab	1855.00±60.37 ab	75.10±0.08 a	74.92±0.0.13 A

Sig. level	*	*	*	*	*

* Different letters in each column indicate a significant difference among the mean treatments on a level of p≤0.05.
* T1, T2, T3, T4 and T5 the treatments of the pellet instead of the mash at 0, 25, 50, 75 and 100% feed pellet respectively.

Table 7 shows the effect of feed forms, mash and pellets on the productive index and economic indicator at 35 days of age. Whereby it was obvious that treatments T5, T4, and T3 were significantly superior (p≤0.05) in the productive index compared to the T1 treatment which recorded the lowest value of the productive index. Also it was obvious that treatments T5, T4, and T3 were significantly superior (p≤0.05) in the economic indicator compared to the T2 and T1 treatments which recorded the lowest values of the economic indicator. The reason for the significant superiority of the treatments T5, T4, and T3 for the productive index and the economic indicator is the improvement in average body weight.

Table 7. Effect of feed forms, mash and pellet on the productive index, economic indicator for broilers (mean ± standard error)

Treatment	productive index	Economic indicator
T1	463.49±6.91 c	620.79±7.38 b
T2	479.27±17.88 bc	645.59±14.66 b
T3	507.47±3.88 b	680.34±1.21 a
T4	510.43±10.88 ab	681.14±12.17 a
T5	524.05±3.19 a	702.20±1.48 a
Sig. level	*	*

* Different letters in each column indicate a significant difference among the mean treatments on a level of p≤0.05.
* T1, T2, T3, T4 and T5 the treatments of the pellet instead of the mash at 0, 25, 50, 75 and 100% feed pellet respectively.

In this treatments, the reason for the improvement in the live body weight of birds with increase feed pellet ratios is due to high feed intake, because of the ease in intake and the role in improving the palatability process, the diversity of components, and acceptance (9), whereby the physical form and heat treatment of feed , leads to improvements in the use of nutrients, which results in an increase in the availability of the main nutrients in the feed , thus improve live body weight and the productive performance (18). Also, the results of the study are consistence with the findings of Rubio (28); McKinney and Teeter (21) who indicated that the use of feed pellet instead of mash feed , recorded a significant superiority in the average body weight, the weight gain, they stated that it decreased by increasing the percentage of mash feed .

Results of this study proven the studies conducted by Netto et al. (25) who showed

that replacing feed pellet with mash feed, resulted in higher of feed intake, thus improving performance. These results were also consistent with the results of Mingbin et al. (22), the results of their studies indicated that feed pellet improve the feed conversion factor in comparison with the mash feed. also consistent with the results of Sena et al. (30) who showed that using feed pellet instead of mash feed recorded better results in carcass weight and the dressing percentage, In the productive index and economic indicator, these results were consistent with the results recorded by Mirghelenj and Golian (23) there was a significant effect with pellet in the productive index and the economic indicator, where broiler feed intake and growth performance are affected by the physical form of feed (10). Moreover, that feed formation enhances the economics of production by improving growth responses and feeding efficiency in broiler chickens, small improvements in feed efficiency can increase economic returns (7).

Conclusion

This study concludes that the feed forms, mash and pellets which was fed to the broiler chickens, showed an improvement in increasing the live body weight, weight gain, and total feed intake, moreover an improvement was recorded in the total feed conversion ratio, an increase in the weights of carcasses and an increase in the productive and economic index, thus an improvement In production performance through an increase in the proportion of feed pellet provided to the birds instead of mash feed.

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Conflict of interest

The authors have no conflict of interest.

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