Effect of Partial and Total Replacement of Raw and Germinated Red Sorghum Instead of Yellow Corn in The Diets on Growth Performance of Broilers

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Abstract

This experiment was conducted at the poultry farm of Animal Production Department - College of Agricultural Engineering Sciences - University of Baghdad, for the period from 11/22/2020 to 2/1/2021, to demonstrate the effect of partial and complete replacement of raw and germinated red sorghum instead of yellow corn in the diets on productive performance of broilers. A total of 225 one day old broiler chicks (Ross 308) were naturalized in the farm and randomly distributed to five treatments, each treatment divided to 3 replicates and each replicate content 15 chicks (10 males and 5 females). The initial weight of the chicks was from (42 to 44 g). Chicks were fed on the starter diet from 1 _ 10 day of age and grower diet from 11 _ 24 days of age and finisher diet from 25 _ 42 days of age. The raw and germinated red sorghum was partial and total replaced with yellow corn by (24 and 48%) respectively. The data of growth performance were taken at the end of each period. The birds were fed on the one of the following diets: T1: control treatment (content 48% yellow corn); T2: (48% raw red sorghum + 0.0% yellow corn); T3: (48% germinated red sorghum + 0.0% yellow corn); T4: (24% raw red sorghum + 24% yellow corn); and T5: (24% germinated red sorghum + 24% yellow corn). The growth performance data represented by body weight, weight gain rate, feed intake and feed conversion ratio were taken. The results were showed no significant differences between all transactions in growth performance during the first age period (0-10 days). In the second period (11-24 days), a significant superiority of the T1 and T2 treatments as compared with T3 and T4 treatments for the body weight and weight gain. For the last period (25 - 42 days), no significant differences were observed between all treatments.

Keywords: Red sorghum, Germination, Growth performance, Broiler

1. Introduction

The cost of poultry constitutes the largest part of the costs involved in the total production process, which may reach 75% of the total cost of breeding [1]. The poultry industry is closely related to plant production as it is the main source for most of the fodder materials used in bird feeding, and as the third world countries, including Iraq, suffer from a severe shortage of feed materials, especially energy and protein sources due to competition between humans and poultry for the consumption of grains. Including yellow corn, wheat, rice, and other grains, which are among the main sources of diets for poultry [2]. The shortage of grains and fodder materials and the entry of competition between humans and animals leads to a significant increase in the prices of grains, which negatively affects the poultry industry through the increase in the cost of feeds, as feeding constitutes 70-75% of the total production cost [3]. Therefore, it has become imperative for nutritionists to search for available alternatives that can replace the main sources of grains such as yellow corn and wheat provided that they fulfill the same desired goal [4]. Nutritionists have worked to find advanced techniques to understand the biology of primary feedstuffs and understand their structures and properties, and these raw materials that makeup diets are either in the form of grains or as a source of carbohydrates and protein [5]. Red Sorghum is one of the feed alternatives that can be used in diets of poultry as it is characterized by its high nutritional value, as it is characterized by high protein content of about 10.9% and levels close to wheat and yellow corn and energy represented up to 3290 kilocalories, as well as the red pigment that is distinguished [6]. The presence of carotenoids, which can be pigment compounds that manufactured by plants and microorganisms. Also, it considered fat-soluble pigments which responsible for the natural yellow, red and orange colors, as there is a positive chain of chemical reactions that use oxygen or scavenge free radicals and remove toxicity to the organism [7]. or any chemical...
compound can accept electrons resulting from oxidation reactions or oxidizing agents. Also, they are the substances donated by hydrogen to saturate free radicals [8]. and convert carotenoids into vitamin (A), thus showing their role in preventing the development of disease [9]. By chemically analyzing of red corn, it was noted that it content several beneficial biological activities, which may have antioxidant activity, anti-cancer activity and antimicrobial activity, which reducing the risk of some diseases, especially cholesterol and cardiovascular diseases [10-12].

By containing red corn on many phenolic acids, which are hydroxybenzoic and hydroxycinnamic, as well as containing many flavonoids, including, anthocyanins, flavan-4-ol, flavones, flavanones flavonols could be attributed the benefit of red corn [13,14]. A side from the benefits of red corn on the growth performance, in turn, leads to a decrease in the costs of broiler feeds which lead to the lower production cost [15], [16]. mentioned that sorghum leaf was planted in Iraq in the seventh century B.C., and that is why we can say, it is possible to re-cultivate and produce it in Iraq on a large scale as before due to the scarcity of rainwater, irrigation and the expansion of saline lands and the adoption of farmers on saline well water for crop watering. However, thin-leaf red sorghum seeds contain, as is the case with most fodder materials, some ant nutrients such as phytic acid and tannin [17]. and the ratios of these antibodies differ according to the variety of corn and the area where it is grown. Therefore, the use of sorghum, including red corn, at high levels requires conducting treatments because the high content of tannin reduces the nutritional value by binding feed protein and other nutrients and make it unavailable for absorption, and within these different ratios of the ant nutrient of tannin in sorghum, techniques have been found to treat and reduce the tannin content and thus it became possible to increase using this crop in poultry feed. These techniques are generally classified as physical methods that include cooking, de-peeling, sterilization, and roasting [18], biochemical methods such as steeping and germination [19], and chemical methods such as adding enzymes, wood ash, or fats. (Grease) [20,21]. The presence of these different methods of treating anti-nutrients, the use of a certain method depends on the cost and effectiveness of the method in reducing or minimizing the negative effects of tannin in poultry feed [22]. Indicated a decrease in the tannin content in sorghum from 1.44% to 0.31% and from 0.32% to 0.20% when the seeds germinated for 48 hours, while [23] noted that the tannin content decreased to 8.45%, and 73.69% when using the seed germination process [24]. Due to the lack of studies on the use of red sorghum in the diets of poultry, this research aims to study the effect of using the germination process in improving the nutritional value of red corn and the effect of introducing raw or sprouted red sorghum in the diets on growth performance and carcass characteristics of broilers.

2. Materials and Methods

The experiment was conducted in the poultry field affiliated to the Animal Production Department at the College of Agricultural Engineering Sciences - University of Baghdad (Abu-Ghraib) for the period from 11/22/2020 to 1/2/2021. For a period of (35 days) to find out the effect of partial and total substitution of raw and germinated thin-leaf red corn in the diets on the production performance of broilers, where the broiler chicks were obtained from the strain (Ross 308), and (225 chicks) were used in the study. They were naturalized in the field at the age of one day and the chicks were distributed randomly into five treatments by 45 chicks/treatment, with three replicates/treatment, 15 chicks/replicate. The chicks were raised in a room divided by wooden cages the area of each cage (2 x 1 m), and the replicates were distributed Homogeneous distribution on the cages since the first day of the chicks’ life, and the chicks were raised in a room with a ground breeding system furnished with sawdust and divided into (15 cages) and the feed and water was provided during the experiment period as at libitum. The continuous lighting system (23 hours per day) with an hour of darkness had given daily to accustom the chicks to darkness and prevent their disturbance when suddenly the electrical power cut off and the birds were fed with one of the diets as shown in table 1. The data was analyzed statistically according to Complete Randomize Design (CRD) by SAS procedure [25]. The differences between the means were compared using the Duncan’s [26] multiple range at probability level 0.05. The red sorghum used in the study was prepared from the local markets after making sure that it was clean, free from impurities, foreign substances, rotting, insects, and germinating. Then the seeds intended for germination were washed and soaked in a plastic container of (50 kg) capacity for 24 hours in the shade. After, the grains were left to fully absorb the water until the germination process occurs for 48-72 hours until the rootstock and feather appear, then the grains were dried directly by spread on a concrete floor in a shadow place with constant stirring until the drying is completed and after that, the red corn with thin germinated leaves was collected, a chemical analysis of the corn was performed (table 1) in the Department of Environment and Water / Ministry of Science and Technology according to the method [27]. Similar nutrients for energy and protein were provided as per the Breeding Guide for Broilers Ross 308 (2019).
3. Results and Discussion

It is noted from Table (2) the effect of partial and total replacement of raw and germinated red corn on the average live body weight (g) of broilers for three periods through feeding on three diets and according to the breeding guide ROSS 308 (0-10 days starting the diet) (11-24 days Growth bush) (25 - 42 days final diet). As no significant differences were observed for the average live body weight between all treatments and the comparison treatment (T1) at the first and third feeding period, while the first treatment (T1 control treatment containing yellow corn) and the second treatment (T2 total substitution treatment for raw red sorghum in place of yellow corn) significantly (P <0.01) on the third treatment (T3, the total substitution treatment for germinated red sorghum for yellow corn) and the fourth treatment (T4 for partial substitution treatment (50%) raw red sorghum + (50%) yellow corn) in the average live body weight at a period The second feeding, which extends from the age of 11 to 24 days.

As for the rate of weight gain, as it is noticed from Table (3) that there are no significant differences for the rate of weight gain between all transactions and the comparison treatment at the first and third age periods and the cumulative rate of the characteristic, while the first treatment (T1) was superior to a control treatment containing yellow atom (T2) total substitution treatment for raw red sorghum for yellow corn (significant (P <0.01) for third treatment (T3 for total substitution treatment for germinated red sorghum for yellow corn) and fourth treatment for T4 for partial substitution (50%) for raw red sorghum + 50 % (Yellow corn) in the average weight gain at the second age period, which extends from the age of 11 to 24 days. The significant superiority of the second treatment T2 during the second age period, which extends from (11-24 days) may be due to the similarity of the nutritional value of this feed material and its content of nutrients similar to that of yellow
corn in protein and amino acids in addition to that it may be a digestive and facilitating factor. These nutrients are high, which is reflected in the transformation or representation of these elements and utilizing them greatly, as noted in Table (1).

**Table 2.** The effect of partial and total substitution of raw and germinated red sorghum on the mean live body weight (gm) of broilers (mean ± standard error).

| Treatment    | (0 - 10 days) | (11-24 days) | (25 - 42 days) |
|--------------|---------------|--------------|---------------|
| T1           | 210.50 ± 9.75 | A 1090.13 ± 15.41 | A 2548.23 ± 246.04 |
| T2           | 194.46 ± 4.39 | A 1109.23 ± 31.98 | A 2819.53 ± 88.35 |
| T3           | 194.43 ± 7.31 | A 989.23 ± 31.37  | B 2744.13 ± 54.12 |
| T4           | 191.10 ± 7.16 | A 964.13 ± 45.35  | B 2744.33 ± 62.23 |
| T5           | 204.63 ± 10.73| A 1054.03 ± 2.63  | AB 2836.13 ± 62.71 |

Level of morale: **N.S.**

- **:** significant difference (P <0.01).
- **N.S:** There are no significant differences between the mean treatment.

- treatment: T1 control treatment containing yellow corn, T2 total substitution treatment for raw red sorghum for yellow corn, T3 for total substitution of germinated red sorghum for yellow corn, T4 for partial substitution (50%) for raw red sorghum + (50%) for corn Yellow, T5, partial replacement treatment (50%) germinated red sorghum + (50%) yellow corn.

**Table 3.** The effect of partial and total substitution of raw and germinated red sorghum on the weight gain rate (gm) of broilers (mean ± standard error).

| Treatment    | (0 - 10 days) | (11-24 days) | (25 - 42 days) | (0 - 42 cumulative) |
|--------------|---------------|--------------|---------------|---------------------|
| T1           | 168.20 ± 9.73 | A 879.63 ± 11.83 AB | 1458.10 ± 246.04 | A 2505.93 ± 245.27 |
| T2           | 154.06 ± 4.94 | A 914.76 ± 31.40 A  | 1710.30 ± 57.08 | A 2779.13 ± 88.81 |
| T3           | 153.40 ± 6.95 | A 794.80 ± 33.90 BC | 1754.90 ± 39.20 | A 2703.10 ± 54.36 |
| T4           | 150.43 ± 6.82 | A 773.03 ± 44.62 C | 1780.20 ± 29.92 | A 2703.67 ± 61.96 |
| T5           | 164.53 ± 10.53| A 849.40 ± 12.98 ABC| 1782.10 ± 64.47 | A 2796.03 ± 62.81 |

Level of morale: **N.S.**

- **:** significant difference (P <0.01).
- **N.S:** There are no significant differences between the mean treatment.

- treatment: T1 control treatment containing yellow corn, T2 total substitution treatment for raw red sorghum for yellow corn, T3 for total substitution of germinated red sorghum for yellow corn, T4 for partial substitution (50%) for raw red sorghum + (50%) for corn Yellow, T5, partial replacement treatment (50%) germinated red sorghum + (50%) yellow corn.

Table (4) shows the effect of partial and total substitution of raw and germinated red sorghum on the rate of feed consumption (g / poultry) for broilers for three periods through feeding on three feeds according to ROSS 308 (0-10 days starting feed) (11-24 (1 day, a growth rennet) (25 - 42 days a final diet) As no significant differences were observed in the feed consumption rate between all treatments, the comparison treatment at the first, second and third age periods, and the cumulative rate of the characteristic. However, it is noticed from the results of the above table that there are an arithmetic superiority and an increase in the consumption of feed for the second treatment (T2 treatment of total substitution of raw red sorghum in place of yellow corn) during the second and third age periods, as well as the cumulative rate of the characteristic and this is a good indication of the quality of the presented material and its absence of nutritional inhibitors in agreement with what The researcher [32] reached it, which may be due to the increase in the amount of feed consumed for birds that feed on diets containing raw, thin red corn, to a decrease in the total metabolized energy, and thus birds try to consume more feed to meet their energy needs. As for Table (5), the effect of partial and total substitution of raw and germinated red sorghum on the feed conversion factor (gm feed / g weight gain) for broilers, as no significant differences were noticed for the food conversion factor between all treatments and the comparison treatment at the first, second, and third age period, and the average Cumulative of the trait. Although there were no significant differences between the transactions at the period (0 - 42 days), there appeared an arithmetic superiority in favor of the fifth treatment T5, as it recorded an arithmetic improvement and this result is consistent with what was reached by [33] which indicated that the inclusion of corn The thin sprouts in broiler diets led to the improvement of the feed conversion factor.

Table (6) shows the effect of partial and total replacement of raw and germinated red sorghum on live weight (g), carcass weight (g), dressing (%) and belly fat (gm) for broilers, and for three life periods (0-10 days starting the diet) (11 24 days a growth rennet (25 - 42 days a final diet). No significant differences were observed between all transactions and the
comparison treatment, and this result is consistent with what was found by [34]. And that the mathematical superiority may agree with the findings of [35]. who did not notice a high percentage of purification for birds fed on diets containing raw sorghum, and the reason for this can be attributed to different breeding conditions.

**Table 4.** The effect of partial and total substitution of raw and germinated red sorghum on the feed consumption rate (g / bird) for broilers (mean ± standard error).

| Treatment | Feed consumption rate (g / bird) | (0 - 10 days) | (11-24 days) | (25 - 42 days) | (0 - 42 cumulative) |
|-----------|---------------------------------|---------------|---------------|----------------|---------------------|
| T1        | 238.33 ± 7.96 A                 | 1199.67 ± 13.92 A | 3117.67 ± 49.90 A | 4555.67 ± 54.12 A |
| T2        | 252.33 ± 12.33 A               | 1458.33 ± 115.31 A | 3542.00 ± 166.68 A | 5232.67 ± 156.95 A |
| T3        | 211.00 ± 4.16 A                | 1346.67 ± 117.80 A | 3162.33 ± 70.24 A | 4730.00 ± 152.97 A |
| T4        | 225.33 ± 17.28 A               | 1263.00 ± 97.98 A | 3292.67 ± 295.33 A | 4781.00 ± 375.73 A |
| T5        | 245.00 ± 5.50 A                | 1287.33 ± 51.52 A | 3211.33 ± 75.82 A | 4743.67 ± 73.66 A |

Level of morale: N.S

- N.S: There are no significant differences between the mean treatment.
- **: significant difference (P <0.01).

**treatment:** T1 control treatment containing yellow corn, T2 total substitution treatment for raw red sorghum for yellow corn, T3 for total substitution of germinated red sorghum for yellow corn, T4 for partial substitution (50%) for raw red sorghum + (50%) for corn Yellow, T5, partial replacement treatment (50%) germinated red sorghum + (50%) yellow corn.

**Table 5.** The effect of partial and total substitution of raw and germinated red sorghum on the feed conversion factor (g feed / g weight gain) of broilers (mean ± standard error).

| Treatment | Feed conversion rate (g / bird) | (0 - 10 days) | (11-24 days) | (25 - 42 days) | (0 - 42 cumulative) |
|-----------|---------------------------------|---------------|---------------|----------------|---------------------|
| T1        | 1.42 ±0.07 A                    | 1.36 ± 0.01 A | 2.26 ± 0.38 A | 1.85 ± 0.17 A | A                   |
| T2        | 1.50 ± 0.05 A                   | 1.59 ±0.10 A | 2.07± 0.05 A | 1.88 ± 0.00 A | A                   |
| T3        | 1.44 ± 0.06 A                   | 1.69 ± 0.14 A | 1.80 ± 0.04 A | 1.74 ± 0.02 A | A                   |
| T4        | 1.49 ± 0.06 A                   | 1.64 ± 0.17 A | 1.85 ± 0.19 A | 1.77 ± 0.16 A | A                   |
| T5        | 1.50 ± 0.10 A                   | 1.51 ± 0.07 A | 1.80 ± 0.03 A | 1.69 ± 0.01 A | A                   |

Level of morale: N.S

- N.S: There are no significant differences between the mean treatment.
- **: significant difference (P <0.01).

**treatment:** T1 control treatment containing yellow corn, T2 total substitution treatment for raw red sorghum for yellow corn, T3 for total substitution of germinated red sorghum for yellow corn, T4 for partial substitution (50%) for raw red sorghum + (50%) for corn Yellow, T5, partial replacement treatment (50%) germinated red sorghum + (50%) yellow corn.

**Table 6.** The effect of partial and total substitution of raw and germinated red sorghum on live weight (g), carcass weight (g), dressing (%), and belly fat (g) for broilers (mean ± standard error).

| Treatment | live weight (g) | carcass weight (g) | dressing (%) | belly fat (g) |
|-----------|----------------|--------------------|---------------|---------------|
| T1        | 2635.33 ± 135.81 A | 1936.67 ± 92.81 A | 73.53 ± 1.19 A | 11.33± 2.40 A |
| T2        | 2632.67 ± 145.79 A | 1967.33 ± 104.66 A | 74.75 ± 0.85 A | 15.33 ± 1.76 A |
| T3        | 2567.33 ± 174.01 A | 1897.33 ± 120.80 A | 73.95 ± 0.59 A | 11.33 ± 1.76 A |
| T4        | 2636.00 ± 139.34 A | 1954.67 ± 111.29 A | 74.13 ± 1.04 A | 12.66 ± 1.33 A |
| T5        | 2620.00 ± 150.11 A | 1928.00 ± 104.40 A | 73.61 ± 0.55 A | 16.00 ± 3.05 A |

Level of morale: N.S

- N.S: There are no significant differences between the mean treatment.
- **: significant difference (P <0.01).

**treatment:** T1 control treatment containing yellow corn, T2 total substitution treatment for raw red sorghum for yellow corn, T3 for total substitution of germinated red sorghum for yellow corn, T4 for partial substitution (50%) for raw red sorghum + (50%) for corn Yellow, T5, partial replacement treatment (50%) germinated red sorghum + (50%) yellow corn.
The lack of significant superiority in the productive performance of broilers fed on diets in which the red sorghum has been partially or completely substituted for yellow corn may be due to the similarity of the nutritional value of this feed material and its content of nutrients similar to that of the yellow corn containing protein and amino acids in addition to It may be that the coefficient of digestion and facilitation of these nutrients is high, which is reflected in the conversion or representation of these elements and utilizing them greatly, as well as distinguishing the red sorghum with its high nutritional value, which contains a high protein content of about 10.9% and levels close to wheat and yellow corn and energy Represented by up to 3,290 kilocalories, as well as the red pigment (carotenoids) that is distinguished by it and its role as antioxidants, which represent the main mechanism that conferred beneficial effects by preventing oxidation and chemical reactions that use oxygen or work to scavenge free radicals and remove toxicity from the organism and convert it into vitamin (A) thus have a role in preventing the development of diseases, as well as a marked improvement in the proportion of nutritional inhibitors (tannin and Phylic) in the red corn with thin leaves due to the germination process had a positive role in accepting this fodder material and raising its nutritional value.

**Conclusion**

The red sorghum can be considered one of the good alternatives to the yellow corn that can be included in the diets of broilers because of its content of nutrients similar to the contents of yellow corn in protein and amino acids, and the raw and germinated red corn did not harm the growth performance of broilers, and the seed germination process led to reducing the tannin content from 45.3 to 33.2.

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