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PERFORMANCE AND CARCASS CHARACTERISTICS OF BROILER CHICKENS KEPT ON HEATED SOYBEAN MEAL

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ABSTRACT

Soybean meal (SBM) is an important protein source in poultry feeds. Heat processing was used to overcome anti-nutritional factors. This experiment's objectives were to evaluate Sudan 1 soybean meal (SBM) heat processing on performance, carcass characteristics, and economic evaluation of broiler chickens. A total of 120 one-day-old male Ross 308 broiler chicks were allocated randomly to four dietary treatments using a completely randomized design. Each treatment was of three replicates and 10 birds in each. Treatment one T1 (un-processed SBM), T2 (RSBM15), T3 (RSBM20) and T4 (RSBM25). SBM was roasted at 120°C for 15, 20 and 25min, respectively. RSBM15 significantly ($P \leq 0.05$) reported the best body weight (BW), body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR). RSBM15 had significantly ($P \leq 0.05$) the best results in carcasses and some carcass parts' weights (breasts, thighs, wings, and drumsticks) and dressing percentages, the economic appraisal. The gastrointestinal tract (gizzards, intestines, livers, hearts, and pancreas) and abdominal fat pad weights were significantly ($P \leq 0.05$) different. All treatments had insignificant differences in mortality rates and sensory properties (color, taste, flavor, and tenderness). The economic assessment was the best for RSBM15. It can be revealed that RSBM15 had the best performance parameters. It was concluded that Sudan 1 soybean meal roasted at 120°C for 15min can be a good protein supplement in broiler feeding. Further studies are recommended for the different Sudanese soybean varieties meals.

Keywords: soybean meal; trypsin; antinutritional factor; broiler; performance; carcass.

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1. INTRODUCTION

Poultry production is, at most, an advanced and developed livestock sector (Asyifah et al. 2012) relying on factors involving feed-producing processes. Bans on feeding poultry diets with added animal protein have led to an increasing demand for protein of plant origin (Kocher et al. 2002; Engin and Koyuncu 2023). Soybean meal (SBM) is considered the most important protein source for the poultry and livestock industries in the world (Javed et al. 2020; Agwaan and Waleed 2023). Soybeans contain several anti-nutritional factors (ANF), such as lectins, phytate, trypsin inhibitors, non-starch polysaccharides (NSP), and oligosaccharides (Jezierny et al. 2010; Goswami et al. 2022), that result in reducing nutrients utilization.

Nowadays, the poultry industry has developed due to the high demand for chicken meat, being acceptable to most people, and its reasonable and accessible market price (Petracci et al. 2015). Also, the demand for animal protein will increase with population growth and the high protein needs of meats (USDA 2020).

The nutritional quality of soybean products is not only determined by the quantity and amino acids available, which make up the proteins of such products but is also affected by the processing conditions the manufacturer applies (Liener 1981). Many components in soybeans have negative impacts on the nutritional quality and value of the protein. These factors can be destroyed by heat treatment, such as protease inhibitors and lectins (Liener 1994; Şengü and Çalişlar 2020). There are variations in the world's environmental conditions where soybeans are grown together with other differences in agricultural practices and soybean varieties (Thakur and Hurburgh 2007). The chemical composition of SBM, especially the carbohydrate composition, anti-nutritive factors, and protein/amino acids, are known to be influenced by several factors. These factors include geographical origin, genotype, soybean processing methods, and the environmental and agronomic conditions of growing soybeans (Karr-Lilienthal et al., 2005; Frikha et al., 2012; Rastpoor et al. 2022). Soybean products' anti-nutritional and toxic factors were presented by some authors (Hsiao et al. 2006; Choct et al. 2010; Dourado et al. 2011).

The ANF are compounds that decrease the nutrient utilization and/or food intake of plants or plant products used as human foods or animal feeds (Soetan and Oyewole 2009). They play a vital role in determining the

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use of plants for humans and animals. The heating necessity of soybeans before feeding to poultry has been documented by ASA (1997). Tousi-Mojarrad et al. (2014) used different processing procedures of SBM processing autoclaving at 121°C for 20min, autoclaving at 121°C for 30min, roasting at 120°C for 20min and microwaving at 46°C, 540 watts for 7min). They found there were significant differences between heat processed SBM and unprocessed SBM, where the processed SBM recorded the best results (FI, BW, BWG and FCR). However, there were insignificant differences between the different processing procedures. It was observed that cooking gave averagely better performance traits, nutrient utilization, and economic return than in other treatment groups (Ari et al. 2012). They added that better results were reported by toasting, cooking, roasting, and extrusion, respectively, compared to the control with the worst results. Hamilton and McNiven (2000) concluded that the optimal performance cannot be obtained when roasting full-fat soya bean or soybean meal at low temperatures (120-135ºC) for a short period (5-8min). Patino and Joseph (2022) indicated that overheating of soyabean damaged protein and reduced the nutritional value.

McGovern et al. (2022) highlighted predisposed birds to opportunistic diseases when fed poor diet quality of soyabean that might result in lower BW and economic losses. Full fat soybean (FFSB) either roasted or autoclaved can be a source of protein and fat in poultry, without extra cost for oil extraction; but raw FFSB contains many anti-nutritional factors.

In Sudan, the national soybean breeding program of the Agricultural Research Corporation (ARC), Wad Medani, has conducted for over a decade research on the adaptation of soybeans to the rain-fed and irrigated cropping systems in Sudan (Ibrahim 2012). The domestic demand for soybeans has dramatically changed in the last ten years. These big changes were driven by the growing demand for SBM as an important and major protein source in poultry rations. The rapid growth in SBM demand has promoted the development of improved and adapted varieties suitable for a wide range of agroecological zones, which is a key factor in introducing successful commercial soybean production. During the past 10-year soybean breeding program at Agricultural Research Corporation (ARC), Sudan has successfully produced adapting soybean varieties in rain-fed and irrigated cropping environments in Sudan (Ibrahim 2016). Ibrahim (2017) reported that in 2012, two non-GMO soybean varieties, Sudan 1 and Sudan 2, were produced for commercial production in irrigated and rain-fed farming in Sudan. Sudan 1 and Sudan 2 are the first varieties of soybeans that were released in Sudan. They are very promising varieties that were introduced by the International Institute of Tropical Agriculture (IITA).

No studies concerning the use of the newly released soybean varieties (Sudan 1 and Sudan 11) in poultry feeding were done in Sudan, Gezira State. The objective of this study is to determine and evaluate the best heating treatment of Sudan1 soybean meal on broiler chickens' performance, gastrointestinal tract (GIT), some carcass characteristics, and economic appraisal.

2. MATERIALS AND METHODS

2.1. Experimental Birds and Management

The study was carried out in Gezira State, Wad Medani city, from March to May. The study's main objectives were to determine and evaluate the best heating time of soybean meal SBM on performance and carcass characteristics of broiler chickens. Twelve experimental units (small pens) with 1.5x1.0m2 in dimension allocated inside a semi-closed poultry pen were used. A total of 120 seven days old broiler male chicks (Ross 308) were used. The chicks were allocated randomly to four feeding treatments with three replicates of ten birds in each. Four diets were formulated for each phase of the experiment (starter and finisher) according to the recommendations (NRC 1994) for nutrient requirements for broiler chicks. Treatment one (control, un-processed SBM) and treatment two (RSBM15) SBM was roasted at 120°C for 15min. Treatment three (RSBM20) SBM was roasted at 120°C for 20min and treatment four (RSBM25) SBM was roasted at 120°C for 25min. The formulas of these diets are shown in Tables 1 and 2.

2.2. Parameters Studied

Performance parameters included weekly FI per bird, weekly BW, weekly BWG, weekly FCR, and mortality rate. Weekly FI was calculated by taking the difference between feed offered through the week and feed withdrawal at the end of the week divided by the average number of birds in the replicate. The weekly average BW was calculated by weighing all birds in one replicate and dividing by the number of birds in the small pen (replicate). The average BWG was performed weekly. At the end of the study the overall FI and overall BWG were calculated as well. The weekly FCR was calculated on the basis of (Weekly FI/weekly BWG), and the overall FCR was calculated as well at the end of the experiment.

After six weeks (experimental termination), three birds with average weight were taken randomly from each replicate, weighted, and humanely slaughtered according to Islamic traditions (Ali et al. 2011). The slaughtered birds were then immersed in hot water at 60°C for two minutes to help with feather scalding. Evisceration and

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Table 1: Nutrients' ingredients and chemical composition of broiler diets (starter and finisher)

Ingredients	Starter Diets (8-21 days)				Finisher Diets (22-42 days)			
	UPSBM	RSBM15	RSBM20	RSBM25	UPSBM	RSBM15	RSBM20	RSBM25
Feed ingredients of starter and finisher diets %								
Sorghum	56.0	56.0	56.5	56.5	57.0	57.0	57.0	57.0
Soybean meal	39.0	39.0	39.0	39.0	35.0	35.0	35.0	35.0
Broiler Concentrate	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Vegetable oil	0.5	0.5	0.5	0.5	3.5	3.3	3.5	3.5
L- Lysine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
DL-Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Oyster shell	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Choline chloride	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Antioxidant and antifungal	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Di-Calcium phosphate	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100	100	100	100
Determined Chemical Composition of Starter and Finisher Diets								
ME (Kcal/kg)	3000	3000	3000	3000	3200	3200	3200	3200
CP %	22	22	22	22	20	20	20	20
Ca %	1	1	1	1	0.90	0.90	0.90	0.90
P (available) %	0.45	0.45	0.45	0.45	0.35	0.35	0.35	0.35
Lysine %	1.1	1.1	1.1	1.1	1	1	1	1
Methionine %	0.50	0.50	0.50	0.50	0.38	0.38	0.38	0.38
Methionine + Cysteine %	0.90	0.90	0.90	0.90	0.72	0.72	0.72	0.72
DM %	94.5	94.4	95.0	96.1	95.0	95.0	95.7	96.2
Ash %	6.9	6.4	6.8	7.0	6.8	5.8	6.3	6.3
CP %	22.1	22.1	22.0	21.9	20.0	20.3	20.1	19.8
EE %	3.4	3.5	3.4	3.2	4.4	4.4	4.1	4.1
CF %	3.2	3.2	3.5	3.5	3.0	3.1	3.2	3.3
NFE %	58.9	59.1	59.4	60.6	60.7	61.5	61.9	62.6
ME Kcal/kg	2999	3012	3022	3032	3055	3094	3081	3098

*Super concentrate contains the following: 35% CP, 2% EE, 4% CF, 10% calcium, 4.5% available phosphorus, 5.7% lysine, 4.5% methionine, and 4.9% methionine + cystine. Metabolizable energy 2000 kcal/kg, 2.6% Sodium, with added vitamins and minerals: * * Metabolizable energy (ME Kcal/kg) was calculated according to the formula derived by Lodhi et al. (1976). ME kcal/kg = 32·95 (% crude protein + % ether extract × 2·25 + % available carbohydrate) –29·20: UPSBM, RSBM15, RSBM20 and RSBM25 refer to unprocessed SBM, roasted at 120°C for 15, 20 and 25 minutes, respectively.

removal of internal organs was done, and the different internal parts were kept for further studies. The carcasses were cleaned, thoroughly weighted, and then immersed in ice water for cooling. The carcasses were left to drip and then cooled in a deep freezer for one day. Some carcasses were cut into different parts (breasts, wings, thighs, and drumsticks) and shanks for further investigation. The evaluation of carcass characteristics and sensory evaluation of meat were performed in the Department of Animal Science, Agricultural Sciences Faculty, Gezira University laboratory. The gastrointestinal tract (GIT) organs (gizzard and intestines). The weights of the associated GIT organs (heart, liver, and pancreas) and the abdominal fat pad (AFP) were taken. Some chemical and physical properties of breast meat were taken. Sensory (color, tenderness, flavor, and taste) evaluations of the meat were performed using the sensory description technique with a trained panelist. The cost of production was calculated based on Sudanese pounds, and returns and revenues were also calculated.

2.3. Statistical Analysis

The data collected were analyzed using the SAS (2003) program. The data were subjected to a one-way analysis of variance (ANOVA), as Steel and Torrie (1983) described. Means were compared using Duncan's (1955) multiple-range test with a significance level 0.05.

3. RESULTS

3.1 Broiler Performance

Performance results using soybean meal (SBM) Sudan1 being heated at 120°C for different times are shown in Table 2. There were significant (P≤0.05) differences in weekly feed intake (WFI) and for the whole experimental period. The control group (T1) recorded the lowest feed intake (Table 2). However, the weekly (BW) and body weight gain (BWG) were significantly (P≤0.05) the lowest in T1 (control), whereas RSBM15 had significantly (P≤0.05) the highest BW and BWG followed by RSBM20 and RSBM25, respectively. However, the weekly FCR

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and the overall FCR were significantly (P≤0.05) different, where T1 had the worst FCR whereas RSBM15 recorded the best FCR (Table 2). There was an insignificant difference in mortality rate.

3.2. Gastrointestinal Tracts (GIT)

There were significant (P≤0.05) differences in the weights of gizzards, livers, hearts, pancreases, and abdominal fat pads (Table 3). However, the intestines recorded insignificant (P≥0.05) differences. RSBM15 recorded the highest weights, whereas the control had the lowest weights.

Table 2: The effect of soybean meal heating on broiler chickens' performance

Age (Weeks)	Treatments				C.V %	P value
	UPSBM	RSBM15	RSBM20	RSBM25		
Feed Intake (g)						
Week 1	92.0±2.3[b]	116.0±2.3[a]	116.3±2.0[a]	111.3±2.4[a]	3.7	0.0012
Week 2	210.7±4.8[b]	253.3±7.1[a]	249.3±5.8[a]	249.3±7.1[a]	4.4	0.0001
Week 3	389.3±8.1[b]	534.7±7.4[a]	529.3±10.4[a]	540.0±2.3[a]	2.5	0.0001
Week 4	568.0±12.2[b]	659.3±2.4[a]	670.7±7.4[a]	676.0±2.3[a]	1.7	0.0001
Week 5	737.5±14.0[b]	904.7±8.5[a]	903.2±3.6[a]	869.8±30.9[a]	2.95	0.0023
Week 6	922.2±16.7[b]	1080.5±12.1[a]	1076.7±6.7[a]	1083.0±5.8[a]	1.75	0.0001
Overall	2919.7±65.7[b]	3548.5±16.2[a]	3545.5±15.2[a]	3562.8±21.2[a]	1.48	0.0001
Body Weight (g)						
Week 0	153.0±4.6	159.7±4.3	161.7±4.4	161.7±3.2	4.4	0.6
Week1	222.3±6.2[b]	262.0±1.5[a]	258.3±3.0[a]	252.7±1.3[a]	2.18	0.0015
Week 2	340.7±9.6[c]	431.0±2.1[a]	410.0±5.8[b]	413.3±9.1[b]	3.0	0.0001
Week 3	553.0±15.9[c]	781.0±10.1[a]	758.7±10.8[b]	766.3±13.9[b]	3.2	0.0001
Week 4	869.7±22.8[b]	1145.0±14.4[a]	1137.7±11.4[a]	1155.7±11.9[a]	2.55	0.0001
Week 5	1184.7±30.4[c]	1611.7±21.7[a]	1527.7±3.9[b]	1581.7±8.8[a]	2.1	0.0001
Week 6	1546.3±37.1[c]	2101.7±27.4[a]	2006.7±20.3[b]	2022.7±6.7[b]	2.2	0.0001
Body Weight Gain (g)						
Week 1	59.3±1.7[b]	102.3±5.9[a]	96.7±7.2[a]	91.0±2.1[a]	9.63	0.0010
Week 2	118.3±6.0[c]	168.3±3.1[a]	151.7±8.7[b]	160.7±7.9[ab]	7.75	0.0035
Week 3	212.3±6.5[b]	350.7±8.7[a]	348.7±5.8[a]	353.0±5.1[a]	3.65	0.0001
Week 4	316.7±8.7[b]	390.0±21.9[a]	379.0±3.8[a]	389.3±5.2[a]	2.90	0.0001
Week 5	318.3±7.6[c]	440.0±31.8[a]	406.7±11.6[b]	426.0±3.8[ab]	3.17	0.0001
Week 6	361.7±7.3[c]	490.0±5.8[a]	462.3±17.4[a]	441.0±2.1[b]	6.24	0.0001
Overall	1383.3±33.1[c]	1941.3±23.5[a]	1845.0±16.1[b]	1861.0±3.6[b]	2.17	0.0001
Feed Conversion Ratio						
Week 1	1.55±0.01[a]	1.13±0.04[b]	1.20±0.07[b]	1.22±0.02[b]	5.45	0.0008
Week 2	1.78±0.06[a]	1.51±0.02[b]	1.64±0.06[ab]	1.55±0.03[b]	4.55	0.0131
Week 3	1.83±0.02[a]	1.52±0.04[b]	1.52±0.009[b]	1.53±0.02[b]	2.52	0.0001
Week 4	1.79±0.03	1.69±0.01	1.72±0.01	1.74±0.03	4.50	0.6311
Week 5	2.32±0.03[a]	2.06a±0.01[b]	2.22±0.07[a]	2.04±0.07[ab]	6.65	0.0610
Week 6	2.55±0.02[a]	2.21±0.02[b]	2.33±0.09[b]	2.46±0.01[a]	2.59	0.0057
Overall	2.11±0.01[a]	1.83±0.006[c]	1.92±0.01[b]	1.91±0.01[b]	1.00	0.0001
Mortality Rate						
Overall	0.9±0.9	0±0	0±0	0.9±0.9	86.6	0.450

Values (mean±SE) showing different alphabets in a row differ significantly (P≤0.05). CV=Coefficient of Variation. UPSBM, RSBM15, RSBM20 and RSBM25 refer to unprocessed SBM, roasted at 120°C for 15, 20 and 25 minutes, respectively.

Table 3: Effect of different heating times of soybean on the gastrointestinal (GIT) weights (g)

Parameters	Treatments				C.V %	P value
	Control	RSBM15	RSBM20	RSBM25		
Gizzard	28.0±1.0[c]	49.7±1.5[a]	38.0±2.1[b]	43.0±1.0[b]	6.2	0.0002
Intestines	42.0±3.5	57.3±10.1	54.0±5.6	54.0±3.1	18.18	0.1589
Liver	20.3±0.7[b]	40.7±3.0[a]	34.0±3.1[ab]	34.7±4.3[ab]	13.8	0.0317
Heart	6.0±0.29[b]	10.0±0.2[a]	7.5±0.87[bc]	8.1±0.38[ab]	10.1	0.002
Pancreas	10.0±0.5[a]	6.7±0.4[c]	7.5±0.76[b]	8.03±0.5[b]	12.6	0.015
AFP	6.3±0.3[c]	20.3±2.7[a]	12.7±2.3[b]	18.3±1.7[a]	19.75	0.0009

The footnote remains the same as that of Table 2.

3.3. Some Carcasses Characteristics and Sensory Evaluation

Significant (P≤0.05) differences were found in live body weights, carcass weights, and some carcass parts (breasts + wings, thighs, drumsticks, and shank) and dressing percentages. However, RSBM15 recorded the best body weight and body weight gains (Fig. 1). As presented in Fig. 2, there were insignificant differences in the various sensory properties (color, flavor, taste, and tenderness) among all treatments.

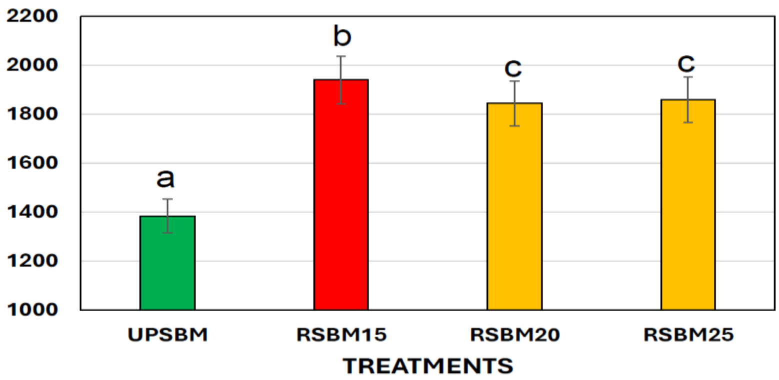

Fig. 1: The Effect of different levels of soyabean meal heating on body weight (g) gains in broiler chickens.

3.4. Economical Appraisal

Fig. 3 presents the economic appraisal of this study based on production costs, returns, and revenues per bird. Significant (P≤0.05) differences were reported among the different treatments; however, RSBM15 had the best economic evaluation.

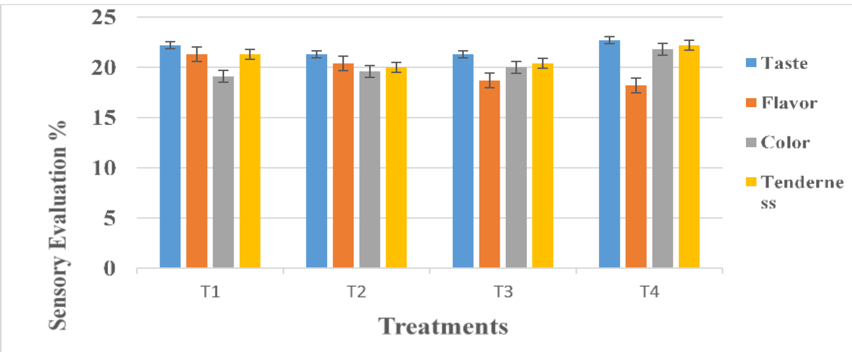

Fig. 2: The Effect of different levels of soybean meal heating on sensory evaluation of broiler chicken meat.

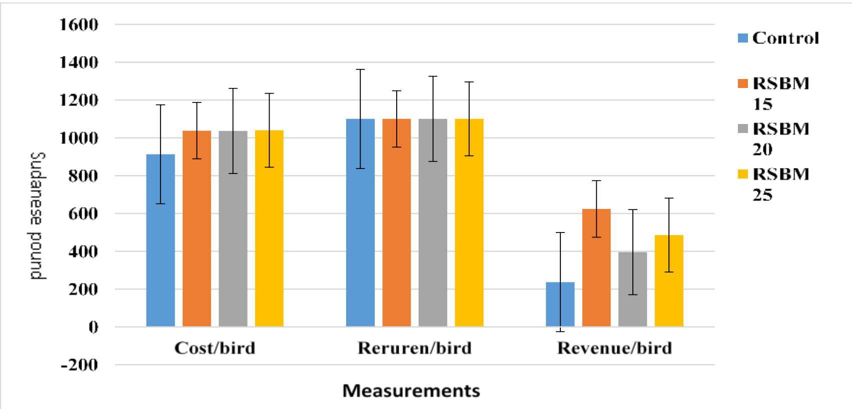

Fig. 3: Effect of different heated soybean on the economical appraisal meat/bird.

4. DISCUSSION

4.1. Broiler Performance

This study's findings showed that birds fed on rations with SBM heated at 120°C for different periods reported significantly better performance regarding FI, LBW, and FCR. However, (RSBM15) had the best results compared to other treatments, whereas the control (unheated SBM) reported the worst results. The processing temperature of 120°C ensured sufficient TIA reductions in both soybean varieties (Hemetsberger et al. 2021). These findings agree with some authors (Hamilton and McNiven, 2000; Ari et al. 2012; Karimi et al. 2022). They reported that heat-treated SBM improved the nutritive value of broiler diets due to decreasing or removing ANFs from these diets, hence improving the growth performance of the chickens. These results agree with other studies that reported that untreated soybeans resulted in the lowest growth performance in the grower and finisher phases (Heger et al. 2016). These results contrast with those reported by Ayanwale and Kolo (2001) and Kalavathy et al. (2003). However, these authors used fermented SBM, which this study did not use. This study's findings agreed with that of Kaankuka et al. (1996), who found that broilers fed unprocessed raw SBM compared to heat-processed SBM resulted in reduced FI and growth performance. These findings are online, with Tousi-Mojarrad et al. (2014) reporting that BW, BWG, and FCR were the best in broiler chickens fed heat-processed SBM diets. They added that might probably be due to the higher availability of nutrients. These findings also agree with Masey O'Neill et al. (2018), who reported that birds fed rations supplemented with processed soybean meal diets performed better than that fed unprocessed SBM.

4.2. Gastrointestinal Tract (GIT)

GIT findings are similar to those of Kaankuka et al. (1996), who reported that consumption of raw unprocessed SBM resulted in increased pancreas weight compared to those fed on heat-processed SBM. In other studies, untreated soybeans caused reduced pancreatic weight accordingly, which is in line with previous results (Heger et al. 2016). However, these findings contradict Subuh et al. (2002), who found an insignificant liver-to-live weight ratio. This might be because they presented their weight as percentages of carcass weights. These findings disagree with those of Anderson-Haferman et al. (1992), who showed no significant difference in the percentage of abdominal fat and pancreas of birds fed treatments containing processed raw soybean and control treatment. This also shows that they presented these weights as percentages of live body weight. These findings were compared to the results of Tousi-Mojarrad et al. (2012) and Hoffmann et al. (2019), where maximum pancreas weight was observed in broiler chickens fed the raw SBM diet than in those fed the heat-processed SBM diets. These findings agree with Gilani et al. (2005), who found that raw unprocessed SBM feeding to broiler chickens resulted in the enlargement of the pancreatic gland and decreased digestibility and the availability of amino acids. These results are online with Javed et al. 2022 in that they observed pancreatic hypertrophy in the pancreas in birds fed FFSB processed at a lower temperature for a shorter duration. They reported that FFSB toasting at various temperatures affected broiler chickens' performance (growth and digestibility).

4.3. Some Carcass Characteristics and Sensory Evaluation

These results contrast with those of Subuh et al. (2002) and Powell et al. (2011), who noted insignificant differences in the carcass weights of slaughtered birds. This might be because their results were affected by other factors, including genetics, environmental conditions, or diets (ingredients and form). Also, it might be affected by the age at which the chickens were slaughtered.

These findings are online in line with those of Hoffmann et al. (2019), who highlighted the necessity of complete elimination of trypsin inhibitor activity (TIA) in broiler rations as far as technically possible. These results coincide with that of Kuenz et al. (2022), who confirmed that TIA severely depressed the digestibility of essential and nonessential amino acids. These findings also agree with Hamilton and Bryden (2021) in that processing soybeans reduced TIA in used soybean varieties. They added that the high TIA concentrations reduced the broiler chickens' growth performances. The findings of this study concord with that of Masey O'Neill et al. (2018), who stated that the BWG and FCR of birds fed on the processed SBM diets were significantly better than those fed unprocessed SBM diets. Also, Korosh et al. (2021) concluded that extruded SBM improved broilers' growth performance parameters and positively affected carcass characteristics, reduced abdominal fat, and increased carcass economical components (thighs and muscles). Ekeocha et al. (2023) concluded that roasted soybeans can be more efficient for Japanese quails and have maximum and better performance.

This study found no significant differences in the sensory evaluation of the breast muscle, except for the overall acceptability. These results contrast with those of Janocha et al. (2022). This might be because they compared SBM with extruded full-fat soybean. Tan et al. (2024) suggested that a combination of soybean and red kidney beans was promising for producing tempeh, giving a desirable sensory profile providing new approaches to producing tempeh by using plant-based protein sources,

5. CONCLUSION

It can be concluded that using roasted soybean at 120°C for 15min improved BW, FI, BWG, and FCR performance. Enhanced meat quality and quantity with a high dressing percentage. Good economic appraisal was achieved by using RSBM15. It can be revealed that roasted soyabean meal at 120°C for 15min is recommended for broiler feeding during both phases of feeding (starter and finisher).

Author's Contribution

Syada Awad Mohamed Ali and Hiba Saeed Ali Nouri tailored the idea and planned the research. Syada Awad Mohamed Ali supervised the research and followed the first author's undertaking. Hiba Saeed Ali Nouri was responsible for managing birds, collecting data, conducting chemical and physical analyses, and drafting the manuscript. Hyder Osman Abdalla and Hatim Badwi Ahmed participated in bird management and data collection.

Hiba Saeed Ali Nouri and Syada Awad Mohamed Ali performed statistical analysis, interpreted the data, and edited the manuscript. All authors approved the final version of the manuscript.

REFERENCES

Agwaan K and Waleed H, 2023. Some physiological effect of different protein sources in ruminants ration: a comparative review. Journal of Applied Veterinary Sciences 8(2): 55-61. https://doi.org/10.21608/JAVS.2023.182063.120

Ali SAM, Abdalla HO and Mahgoub IM, 2011. Effect of slaughtering method on the keeping quality of broiler chickens' meat. Egyptian Poultry Science 31: 727–736.

Anderson-Haferman JC, Yipo Z, Parson CM and Hymowitz T, 1992. Effect of Heating on Nutritional Quality of Conventional and Kunitz Trypsin Inhibitor-Free Soybeans, Poultry Science 71(10): 1700-1709. https://doi.org/10.3382/ps.0711700

Ari MM, Ayanwale BA, Adama TZ and Olatunji EA, 2012. Evaluation of the chemical composition and ant nutritional factors (ANFs) levels of different thermally processed Soybeans. Asian Journal of Agricultural Research 6: 91-98. https://doi.org/10.3923/ajar.2012.91.98

ASA, 1997. A guide to important soybean facts and figures. American Soybean Association, USA, pp. 45.

Asyifah MN, Phang LY and Azlian MN, 2012. Brown rice as a potential feed stuff for poultry. The Journal of Applied Poultry Research 21: 103-110. https://doi.org/10.3382/japr.2011-00379

Ayanwale BA and Kolo ES, 2001. Effects of Cooking and Fermentation Time on the Nutritive Value of soya beans for Broilers: Nigerian Society for Experimental Biology Journal 1: 3.

Choct M, Dersjant-Li Y, Mcleish J and Peisken M, 2010. Soy oligosaccharides and soluble non-starch polysaccharides: A review of digestion, nutritive and antinutritive effects in pigs and poultry. Asian-Australian Journal of Animal Science 23: 1386-1390.

Dourado LRB, Pascoal LAF, Sakomura NK, Costa FGP and Biagiotti D, 2011. Soybeans (Glycine max) and soybean products in poultry and swine nutrition. IntechOpen. https://doi.org/10.5772/18071

Duncan D, 1955. Multiple Range and Multiple F Tests. Biometrics 11: 1-42.

Ekeocha AH, Aganga AA, Emerue PC and Akinsoyinu OV, 2023. Carcass and internal organs characteristics of broiler chickens fed soybean diet. Journal of World Poultry Research 13: 89-95. https://doi.org/10.36380/jwpr.2023.9

Engin K and Koyuncu C, 2023. The recent advances to increase nutrient utilization of dietary plant proteins by enzyme supplementation and fermentation in rainbow trout (Oncorhynchus mykiss): A review. Journal of Agricultural Sciences 29(4): 960-972.

Frikha M, Serrano MP, Valencia DG, Rebollar PG, Fickler J and Mateos GG, 2012. Correlation between ileal digestibility of amino acids and chemical composition of soybean meals in broilers at 21 days of age. Animal Feed Science Technology 178: 103-114.

Gilani GS, Cockell KA and Sepehr E, 2005. Effects of antinutritional factors on protein digestibility and amino acid availability in foods. Journal AOAC International 88: 967-987.

Goswami R, Ray K, Ghosh S, Dutta S, Mandal S, Nayak J, Chakraborty S and Banerjee H, 2022. Multiple pathways of legume-based systems towards environmental, social, and economic sustainability in smallholder systems. In: Advances in Legumes for Sustainable Intensification. Academic Press, pp: 657-678.

Hamilton RMG and McNiven MA, 2000. Replacement of soybean meal with roasted full-fat soybeans from high-protein or conventional cultivars in diets for broiler chickens. Canadian Journal of Animal Science 80: 483-488 https://doi.org/10.4141/a99-064

Heger J, Wiltafsky M and Zelenka J, 2016. Impact of different processing of full-fat soybeans on broiler performance. Czech Journal of Animal Science 61: 57–66.

Hemetsberger F, Hauser T, Domig KJ, Kneifel W and Schedle K, 2021. Interaction of soybean varieties and heat treatments and its effect on growth performance and nutrient digestibility in broiler chickens. Animals (Basel) 11: 2668-2680. https://doi.org/10.3390/ani11092668

Hoffmann D, Thurner S, Ankerst D, Damme K, Windisch W and Brugger D, 2019. Chickens' growth performance and pancreas development exposed to soy cake varying in trypsin inhibitor activity, heat-degraded lysine concentration, and protein solubility in potassium hydroxide. Poultry Science 98: 2489–2499. http://dx.doi.org/10.3382/ps/pey592

Hsiao HY, Anderson DM and Dale NM, 2006. Levels of β-mannan in soybean meal. Poultry Science 85: 1430-1432. https://doi.org/10.1093/ps/85.8.1430

Hamilton RM and Bryden WL, 2021. Relationship between egg shell breakage and laying hen housing systems–an overview. World's Poultry Science Journal 77(2): 249-266. https://doi.org/10.1080/00439339.2021.1878480

Ibrahim SEI, 2012. Agronomic studies on irrigated soybeans in central Sudan: I. Effect of plant spacing on grain yield and yield components, International Journal of Agricultural Science 2: 733–739.

Ibrahim SEI, 2016. Current and the future of soybean breeding in Sudan, Proceedings of 7th International Crop Science Congress, August 14–19, 2016, Beijing, China, pp: 16–17.

Ibrahim SEI, 2017. The current and the future of soybean breeding in Sudan. Agricultural Research Corporation (ARC), Wad Medani, Sudan. 16

Janocha A, Milczarek A, Pietrusiak D, Łaski K and Saleh M, 2022. Efficiency of Soybean Products in Broiler Chicken Nutrition. Animals 12: 294. https://doi.org/10.3390/ani12030294

Javed N, Javed MT, Mirza MA, Saleem G, Aslam B, Manzoor F, Aslam MS, Bhutta MN and Faizan SM, 2020. Pathological effect of replacement of solvent extracted soybean meal with expeller extracted soybean meal in broilers. Pakistan Journal of Agricultural Sciences 57(4):
Javed MM, Mirza MA, Rehman MA and Rahman MS, 2022. Effect of various toasting conditions of full fat soybean on nutritive value and growth performance in broiler chickens. Sarhad Journal of Agriculture 38(5): 252-262. https://dx.doi.org/10.17582/journal.sja/2022/38.5.252.262
Jezierny D, Mosenthin R and Weiss E, 2010. The use of grain legumes as a protein source in pig nutrition: A review. Animal Feed Science and Technology 157: 111-128. https://doi.org/10.1016/j.anifeedsci.2010.03.001
Kaankuka FG, Balogun TF and Tegbe TSB, 1996. Effects of duration of cooking of full-fat soya beans on proximate analysis, levels of antinutritional factors and digestibility by weanling pigs. Animal Feed Science Technology 62: 229-237.
Kalavathy R, Abdullahi N, Jalaludin S and Ho YW, 2003. Effects of lactobacillus cultures on growth performance, abdominal fat deposition, serum lipids and weight of organs of broilers chickens. British Poultry Science 44: 139-144. https://doi.org/10.1080/0007166031000085445
Karimi Z, Torki M and Abdolmohammadi A, 2022. Effect of dietary roasted and autoclaved full-fat soybean on the performance of laying hens and egg quality traits. Veterinary Medicine and Science 8: 1603–1610. https://doi.org/10.1002/vms3.827
Karr-Lilienthal LK, Kadzere CM, Grieshop and Fahey Jr. GC, 2005. Chemical and nutritional properties of soybean carbohydrates as related to non-ruminants: A review. Livestock Production Science 97: 1-12.
Kocher A, Choct M, Porter M and Broz J, 2002. Effects of feed enzymes on nutritive value of soyabean meal fed to broilers. British Poultry Science 43: 54-63. https://doi.org/10.1080/00071660120109890
Korosh T, Kaveh J, Mehrdad I and Hamed K, 2021. The Effect of Substitution of Extruded Soybean Meal (ESM) on Growth Performance, Carcass Characteristics, Immune Responses, Biochemical Variables of Blood and Nutrient Digestibility of Ileal in Broiler Chickens. South Asian Research Journal of Agricultural Fisheries 3: 40-51. https://doi.org/10.36346/sarjaf.2021.v03i03.002
Kuenz S, Thurner S, Hoffmann D, Kraft K, Wiltafsky-Martin M, Damme K, Windisch W and Brugger D, 2022. Effects of gradual differences in trypsin inhibitor activity on the estimation of digestible amino acids in soybean expellers for broiler chickens. Poultry Science 101: 740. https://doi.org/10.1016/j.psj.2022.101740
Liener IE, 1981. Factors affecting the nutritional components in soya products. Journal of American Oil Chemistry Society 58: 406-415.
Liener IE, 1994. Implications of anti-nutritional components in soybean foods. Critical Reviews in Food Science and Nutrition 34: 31-67.
Masey O'Neill H, Hall H, Curry D and Knox A, 2018. Processed soya to improve performance of broiler chickens. The Journal of Applied Poultry Research 27: 3382/japr/pfx074.
McGovern K, Duff A, Trombetta M, Whelan R, Yacoubi N, Teague K, Rochell S and Bielke L, 2022. Effect of poor-quality soybean meal on broiler performance. 2022 International Poultry Scientific Forum, Research Abstract P334
Patino D and Joseph M, 2022. Assessment of the quality of extruded full fat soybean meal subjected to different processing temperatures. 2022 International Poultry Scientific Forum, Research Abstract M74
Petracci M, Mudalal S, Soglia F and Cavani C, 2015. Meat quality in fast-growing broiler chickens. World Poultry Science Journal 71: 363-374.
Powell S, Naranjo VD, Lauzon D, Bidner TD, Southern LL and Parsons CM, 2011. Evaluation of an expeller-extruded soybean meal for broilers. Journal of Applied Poultry Research 20: 353–360.
Rastpoor H, Vakili SA, Naserian AA, Danesh Mesgaran M and Valizadeh R, 2022. Evaluation of chemical composition, gas production and digestibility of Lathyrus sativus grain treated using different heat-processing by in vitro and in situ experiments. Iranian Journal of Animal Science Research 14(1): 27-41.
SAS, 2003. Statistical analysis system. User's Guide SAS/STA-t version, 8th Ed, SAS, Institute, Inc. New York, USA.
Şengü AY and Çalişlar S, 2020. Effect of partial replacement of soybean and corn with raw or processed chickpea. South African Journal of Animal Science 50(3): 461-470.
Soetan KO and Oyewole OE, 2009. The need for adequate processing to reduce the antinutritional factors in plants used as human foods and animal feeds: A review. African Journal of Food Science 3: 223-232.
Steel RGD and Torrie JH, 1983. Principles and Procedures of Statistics: A Biometrical Approach. 2nd McGraw Hill Book Co.
Subuh AMH, Motl MA, Fritts CA and Waldroup PW, 2002. Use of various ratios of extruded full fat soybean meal and dehulled solvent extracted soybean meal in broiler diets. International Journal of Poultry Science 1: 9-12.
Tan ZJ, Abu Bakar MF, Lim SY and Sutimin H, 2024. Nutritional composition and sensory evaluation of tempeh from different combinations of beans. Food Research 8: 138 – 146.
Thakur M and Hurburgh CR, 2007. Quality of US soybean meal compared to the quality of soybean meal from other origins. Journal of American Oil Chemistry Society, 84: 835-843.
Tousi-Mojarrad M, Seidavi A and Dadashbeiki M, 2012. Effects of soybean meal processing on broiler organs. Annual Biology Research, 3: 3732-3739.
Tousi-Mojarrad MT, Seidavi A, Dadashbeiki M and Roca-Fernández AI, 2014. Short communication. Effect of soybean meal heat procedures on growth performance of broiler chickens. Spanish Journal of Agricultural Research, 12: 180-185. https://doi.org/10.5424/sjar/2014121-4714
USDA, 2020. Livestock and poultry: world markets and trade. United States Department of Agriculture; Accessed April 2020. https://apps.fas.usda.gov/psdonline/circulars/