Archives of Agriculture Sciences Journal
Print ISSN: 2535-1680
Online ISSN: 2535-1699

ARCHIVES OF AGRICULTURE SCIENCES JOURNAL

Volume 2, Issue 2, 2019, Pages 31–42

Available online at www.agricuta.edu.eg

DOI: https://dx.doi.org/10.21608/aasj.2019.22043.1017

Effect of dietary germinated sorghum on growth performance, carcass characteristics and some blood parameters of growing Japanese quails

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Abstract

This study was carried out to evaluate the effect of germination in improving the nutritive value of grain sorghum and the effect of using germinated sorghum (GS) as partially or completely replacement of yellow corn in growing Japanese quail diets on growth performance, carcass characteristics and some blood parameters. A total number of two hundred and sixty-four 10-day-old Japanese quails were randomly distributed into four dietary treatment groups (each of 66), each treatment subdivided into 3 replicates (each of 22). Quail chicks in the first group fed corn-based diets (2922 kcal/kg feed and 24% crude protein) and served as control, while the chicks in the second, third and fourth groups received diets containing germinated sorghum as replacement of diet corn at levels 25, 50 and 100%, respectively. Results indicated that the inclusion of GS at all levels in growing Japanese quail diets had no significant effect on body weight, body gain, feed consumption, feed conversion ratio and carcass characteristics measured among all dietary treatments. Blood cholesterol decreased significantly in birds fed GS at levels 50 and 100% as replacement of yellow corn compared to the other birds. Nevertheless, triglyceride significant reduced in group of birds that fed dietary GS at level 100% of yellow corn compared to the other groups. In conclusion, germinated sorghum could be safely incorporated in Japanese quail diets as replacement of yellow corn to improve growth rate and reduce the levels of serum cholesterol and triglyceride.

Keywords: germinated sorghum, quails, performance, carcass characteristics, blood parameters.

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1. Introduction

The major cost of poultry production is the feeding cost that can be 60-70% of the total production expenses. Energy sources as corn represents about 60 to 70% of the feed formulation. Thus, corn as an energy source represents about 50% of the total feed cost. The use of corn in livestock and poultry diets and its use as an alternative fuel in ethanol production has increased demand for corn, necessitating the exploration of other energy sources for livestock and poultry diets (Nyannor *et al*., 2015). Sorghum may be the next alternative to maize in poultry feed in terms of the nutritive value, cost and availability. Sorghum grain is the fifth most important cereal after wheat, rice, maize and barley worldwide in terms of both production and area planted (Popescu and Condei, 2014). The leading countries of sorghum production are the United States, Nigeria, Sudan, Mexico, Ethiopia, India, Argentina, China and Niger (FAO, 2017). The planted area of sorghum in Egypt is about 352410 feddan (feddan = 0.420 hectares = 1.037 acres) produce 724 thousand tons with average yield 2.05 ton/feddan (CAPMAS, 2018). More than 70% of the area planted with sorghum is located in Assiut, Sohag and Fayoum (Afify *et al.,* 2012). Sorghum grain contains about 8.9 – 15% crude protein (CP), 2.8-5.3% fat, 1 – 2.5 % ash, 1.5 – 4% crude fiber (CF) and 70 – 83% nitrogen free extract (NFE) on as fed basis (Raihanatu *et al.,* 2011; Robertson and Perez-Maldonado, 2006; Shakouri *et al.,* 2009; Tulasi *et al.,* 2004). Therefore, it is comparable to corn grain in feeding value for poultry (Kumar *et al.*, 2007; Tyagi *et al.*, 2003) and can reduce feed cost and dependency on maize. However, results are not always consistent because of the variable amounts of tannin present in different cultivars or varieties of sorghum (Emami *et al.,* 2012). Bennick (2002) noticed that tannins have a number of effects on animals, including growth rate depression and inhibition of digestive enzymes. Hassan *et al.* (2003) reported that high tannin sorghum caused a highly significant reduction in the weight gain and feed intake of broiler chicks compared to low tannin sorghum and increased the feed conversion ratio. Germination is one of the traditional and simple methods for handling sorghum that could be reduce the levels of anti-nutritional organic factors, which including Phytates, Phenols, Tannins and enzyme inhibitors by releasing exogenous and endogenous enzymes such as Phytase enzyme formed during processing (Afify *et al.*, 2012). Also, germination caused degradation of the stored nutrients like starch and protein to soluble sugars and free amino acids by hydrolytic enzymes to meet the seed requirements and the embryo growth (Yang *et al.,* 2016). This makes it a beneficial processing technique for enhancing nutritive value of sorghum as result of its greatly influencing nutritional composition, bio-availability and utilization of nutrients (Singh *et al.*, 2015). This study was carried out to evaluate the efficiency of germination method in improving the nutritive value of grain sorghum and to determine the effect of using germinated sorghum as replacement of yellow corn in diets of Japanese quails on body weight, body weight gain, feed consumption, feed conversion ratio, carcass characteristics and some blood parameters.

2. Materials and methods

2.1 Preparation of germinated sorghum

Sorghum grain was cleaned from foreign matter and broken seed. The grains were soaked in 1:2 volumes of 0.2% formaldehyde solution for 40 minutes to prevent mold growth during germination. The soaked seeds were washed with tap water several times and re-soaked in water for 20 minutes to remove remaining formaldehyde. The wet grains were spread on trays lined with cloth and kept wet by frequent spraying of water at every morning and evening and allowed to germinate at room temperature for 72 hours. The grains after the removal of roots and shoots were sun dried, a representative sample of dry grains was taken and milled into fine flour and kept until analysis.

2.2 Chemical analysis

Ether extract, ash, total carbohydrate and total nitrogen (micro-Kjeldahl) of sorghum flour were determined according to A.O.A.C (1990). Protein was calculated as N% × 6.25. Moisture content was determined by drying a sample at 105℃ for 3 hours. Crude fiber content was determined according to the acid/alkali digestion method of Southgate (1976). The energy values of samples were calculated according to Pauzenga (1985) as follows:

$$\text{ME} = 35 \times \text{CP}\,\% + 81.8 \times \text{EE}\,\% + 35.5 \times \text{NFE}\,\%.$$

2.3 Location, birds, diet, experimental design and managerial procedure

This study was carried out at Poultry Production Research Unite, Faculty of Agriculture, Al-Azhar University (Assiut branch), Assiut, Egypt, during May, 2018. A total number of two hundred and sixty four of 10-day-old Japanese quails were randomly distributed into four dietary treatments (66 birds for each treatment), each treatment subdivided into three replicates (22 birds for each replicate). All birds were housed in mesh wire cages (100×50×30 cm) with deep floor from straw. The bird in the first group were fed corn based diet (2922 kcal/kg diet and 24% crude protein) and served as control, while birds in the second, third and fourth groups were fed diets contained germinated sorghum as replacement of corn at levels 25, 50 and 100%, respectively, the formulation and chemical composition of all diets are shown in Table (1). A continuous lighting program was used 23h Light: 1h Dark along the experimental period, diet and water were offered ad libtium and temperature was performed according to standard managerial procedure.

2.4 Parameters measured

2.4.1 Live Body weight and body weight gain

Birds of each treatment were individually weighed weekly and body weight gain (BWG) was calculated according to the following equation:

$$BWG = BW_{week\ n} - BW_{week\ n-1}$$

Table (1): Ingredients and chemical analysis of the experimental diets for growing Japanese quail.

Ingredients	Treatments			
	T1	T2	T3	T4
Yellow corn (8.5%)	57.74	43.31	28.87	0.0
Germinated sorghum	0.0	14.43	28.87	57.74
Soy bean meal (48%)	27.77	27.77	27.77	27.77
Wheat fain bran	3.2	3.2	3.2	3.2
Broiler Concentrates (52%)	9.4	9.4	9.4	9.4
Di calcium phosphate	1.0	1.0	1.0	1.0
Limestone	0.12	0.12	0.12	0.12
Vitamin and mineral mix1	0.3	0.3	0.3	0.3
DL-methionine	0.12	0.12	0.12	0.12
Sodium chloride	0.35	0.35	0.35	0.35
Total	100	100	100	100
Chemical analysis				
Crude protein, %	24.01	24.31	24.61	25.20
ME, Kcal/kg diet	2922	2890	2858	2794
Curd fiber, %	2.88	2.75	2.61	2.07
Calcium, %	1.0	1.0	1.0	1.0
Total phosphorus, %	0.55	0.55	0.55	0.55
Methionine & cystine, %	0.94	0.94	0.94	0.94
Lysine, %	1.29	1.29	1.28	1.28

Each 3 kg of vitamin mineral premix: contains: vitamin A, 1200000IU; vitamin D3, 300000IU; vitamin E,700 mg; vitamin K3, 500 mg; vitamin B1 500 mg; vitamin B2 200 mg; vitamin B6, 600 mg, vitamin B12, 3 mg; folic acid, 300 mg; choline chloride, 1000 mg; Niacin, 3000 mg; Methionine 3000 mg; Biotin 6 mg; panathonic acid 670 mg; manganese sulphat, 3000 mg; iron sulphat, 10000 mg, zinc sulphat, 1800 mg, copper sulphat 3000 mg, iodine 1.868 mg, cobalt sulphat, 300 mg; selenium, 0.108 mg. T1=Birds fed control diet. T2 = Birds fed diets containing 25 % germinated sorghum as replacement of corn. T3= Birds fed diets containing 50 % germinated sorghum as replacement of corn. T4= Birds fed diets containing 100 % germinated sorghum as replacement of corn.

2.4.2 Feed consumption and feed conversion ratio

Weekly feed consumption of each replicate was calculated by subtracting the weight of residual feed at the end of each week from the weight of the feed offered at the start of the week for each replicate. Feed conversion ratio (FCR) was calculated weekly by dividing the total feed consumed in each replicate by total BWG of the birds in the same replicate taking body weight gain of the mortalities into account.

$$\text{FCR} = \text{feed, g} \,/\, \text{body weight gain, g}$$

2.5 Blood sampling

Approximately 3.0 mL of blood was collected in heparinized tube during slaughter (3 birds/ treatment); consequently, the serum was separated by centrifugation (10 mins. X 3000 rpm). Serum samples from each individual were divided into two samples in Eppendorf tubes and stored at -20ºC for later analyses. Frozen sera was thawed at room temperature and assayed for total protein, albumin, cholesterol, triglycerides and glucose using kits from Spectrum Diagnostics, Egypt.

2.6 Carcass characteristics

At the end of the experiment 3 males selected from each treatment around average body weight of the treatment. The Selected chicks were fasted for 12 hours prior termination then all males were slaughtered to evaluate the carcass Characteristics and the impact of dietary treatments on the internal organs (heart, liver, spleen, gizzard, proventriculus, testes and Small intestine).

2.7 Statistics analysis

Data was statistically analyzed by Analysis of Variance (ANOVA) using the General Liner Model (GLM) of SAS (2009). Significant differences among treatment means were separated by Duncan's multiple rang test (Duncan, 1955) with a 5% level of probability. All data obtained was analyzed by using the following model:

$Yij= \mu + Ti + eij$

Where; Yij and yijk = the analyzed measurement. μ= is the overall mean, Ti = is the effect of germinated sorghum feeding treatments (i =0.0, 25, 50 and 100%). eij = random error.

3. Results and Discussion

3.1 Nutrient composition of germinated sorghum

The chemical composition of raw and germinated sorghum are shown in (Table 2). The results of the chemical analysis revealed that raw sorghum grains contained 9.32 % crude protein, 4.87 % ether extract, 1.11% crude fiber, 72.22 % nitrogen-free extract and 1.9 % ash. These results are agreement with Yang *et al.* (2016) who reported that grain sorghum contained 9.99% crude protein, 4.74% crude fat and 69.42% starch. Germination of sorghum for 72 hours significantly increased the contents of moisture, crude protein, crude fiber and ash. While significantly reduced the contents of dry matter, organic matter, ether extract and nitrogen free extract compared to raw sorghum grains. These results are completely agreement with Warle *et al.* (2015) who noted that the germination of sorghum grains for 72 hours significantly increased the contents of moisture, crude protein and crude fiber. While, significantly reduced the contents of dry matter, organic matter, fat and nitrogen free extract. Narsih *et al.* (2012) suggested that the increase of protein content during germination process due to the presence of synthesis processes and reduced of dry matter in the process of soaking. While, the reduce of fat content its due to lipolytic enzyme activated during germination and hydrolyze fat into fatty acid and glycerol. Also, Yang *et al.* (2016) reported that Fat content decreased during germination, because germinated seeds need another source of energy rather than sugars which have been already utilized. The decrease in carbohydrate content of germinated sorghum may be due to utilization of some sugars during the growth metabolic activity (Okporo *et al.*, 2015 and Nour *et al.*, 2015). An increase in ash content is considered to be apparently caused by the loss of starch (Singh *et al.*, 2015).

Table (2): Effect of germination process on the chemical composition of sorghum grains ($\bar{x}$±SE).

Items	Row sorghum	Germinated sorghum	Sign
Moisture	9.58±0.09^{b}	13.5±0.13^{a}	**
Dry matter	90.4± 0.09^{a}	86.5±0.13^{b}	**
Crud protein	9.32±0.09^{b}	10.86±0.11^{a}	**
Ether extract	4.87±0.19^{a}	3.72±0.11^{b}	*
Crud fiber	1.04±0.06^{b}	1.26±0.04^{a}	*
Ash	1.69±0.05^{b}	1.82±0.02^{a}	*
Organic matter	88.7±0.14^{a}	84.7±0.13^{b}	**
Nitrogen free extract	73.5±0.25^{a}	68.9±0.11^{b}	**

[a&b] Means with the same letter within rows are not significantly different. *= probability (P<0.05). **= probability (P<0.01).

3.2 Growth performance

The results of weekly body weight and body weight gain are presented in Table (3). The results indicated that the inclusion of germinated sorghum in diets of growing Japanese quails at levels 25, 50 and 100% had no effect (P>0.05) on body weight during the period from 10 to 38 days of age. Also, there was no significant (P>0.05) effect on body weight gain of Japanese quails during the first two weeks of the experiment. During the 3rd week of experiment, birds that received germinated sorghum at level 100% recorded the lowest (P<0.01) body weight gain compared the other treatments. During the 4th week of experiment, the highest (P<0.01) body weight gain was found in group that received germinated sorghum at level 25% while the lowest (P<0.01) was found in those fed germinated sorghum at level 50%. However, body weight gain did not show significant (P>0.05) differences among all dietary treatments. The previous results are agreement with Younis *et al.* (2012) who found no significant difference between body weight and body weight gain of two quail strains (Black and brown) that fed diets containing germinated sorghum at levels 25, 50, 75 and 100% of yellow corn. Also, Maidala *et al.* (2016) found no significant differences in the body weight gain of broiler chicks that fed corn based diet or these fed germinated sorghum based diets. The results of weekly feed consumption and feed conversion ratio are presented in Table (4). No significant (P>0.05) difference was observed in feed consumption among all dietary treatments during the experiment period. Also, no significant differences were found in feed conversion ratio among all dietary treatment during the first two weeks of the experiment. During the period from 24 to 31 days of age, birds fed dietary SG, 50% of yellow corn recorded the best (P<0.05) FCR, however, during the period from 31 to 38 days of age, the best (P<0.0) FCR was recorded for birds fed dietary GS, 25% of yellow corn and control diet compared with other dietary treatments. No significant differences were observed in the overall mean of feed conversion ratio among all dietary treatments.

Table (3): Effect of dietary germinated sorghum on body weight and body weight gain of Japanese quails (x̄±SE).

Age	Treatments				Sign
	T1	T2	T3	T4	
	Live body weight				
10 day	38.0±0.72	37.9±0.70	37.8±0.79	38.0±0.73	Ns
17 day	73.4±1.42	74.6±1.41	74.6±1.52	76.0±1.36	Ns
24 day	124.2±2.10	125.0±2.05	122.8±2.10	126.9±1.97	Ns
31 day	170.7±2.48	173.5±2.43	170.5±2.45	170.9±2.06	Ns
38 day	205.5±2.76	209.9±2.87	202.2±2.70	206.0±2.33	Ns
	Body weight gain				
10-17 day	35.36±0.74	36.63±0.76	36.64±0.79	38.01±0.69	Ns
17-24 day	50.75±0.87	50.70±0.78	48.33±1.03	50.69±0.74	Ns
24-31 day	46.50±0.60[a]	47.66±0.79[a]	47.80±0.69[a]	43.94±0.50[b]	**
31-38 day	34.78±0.76[b]	37.73±0.83[a]	32.20±0.69[c]	34.97±0.66[b]	**
Overall mean	41.88±0.57	43.26±0.54	41.21±0.59	41.96±0.50	Ns

[a, b&c] Means with same letters within rows are not significant different (p >0.05). Ns = non-significant means. **= probability (P<0.01). T1=Birds fed control diet. T2 = Birds fed diets containing 25% germinated sorghum as replacement of corn. T3= Birds fed diets containing 50% germinated sorghum as replacement of corn. T4= Birds fed diets containing 100 % germinated sorghum as replacement of corn.

Table (4): Effect of feeding dietary germinated sorghum on feed consumption and feed conversion ratio of Japanese quails (x̄±SE).

Age	Treatments				Sign
	T1	T2	T3	T4	
	Feed consumption (g/bird/Week)				
10-17 day	73.83±1.50	77.85±1.14	73.96±0.46	74.06±1.06	Ns
17-24 day	133.6±5.34	133.9±1.89	129.1±5.90	132.1±1.96	Ns
24-31 day	156.2±5.29	163.3±4.60	155.1±0.75	155.0±1.89	Ns
31-38 day	184.6±4.00	185.7±4.09	177.2±5.51	189.7±3.56	Ns
10-38 day	547.7±2.80	560.2±1.85	535.1±2.13	550.5±0.95	Ns
	Feed conversion ratio (g feed/ g gain)				
10-17 day	2.16±0.06	2.22±0.08	2.08±0.05	2.0± 0.05	NS
17-24 day	2.68±0.05	2.68±0.04	2.73±0.05	2.64±0.05	Ns
24-31 day	3.39±0.05[ab]	3.46±0.05[ab]	3.33±0.07[b]	3.55±0.04 [a]	*
31-38 day	5.48±0.14[ab]	5.12±0.16[b]	5.64±0.12[a]	5.55±0.12[a]	*
Overall mean	3.31±0.05	3.29±0.05	3.29±0.05	3.31±0.03	Ns

[a & b,]Means with same letters within rows are not significant different (p >0.05). Ns = non-significant means. T1=Birds fed control diet. T2 = Birds fed diets containing 25% germinated sorghum as replacement of corn. T3= Birds fed diets containing 50% germinated sorghum as replacement of corn. T4= Birds fed diets containing 100% germinated sorghum as replacement of corn.

3.3 Carcass characteristics

The weights and percentages of edible parts of Japanese quail (liver, heart and gizzard), organs (spleen, small intestine and testes) and dressing are presented in (Table 5). The results of weight and percentage of edible parts, organs and carcass dressing showed no significant

(P>0.05) differences among all dietary treatments. The present results are agreement with (Al-Mashehadani, 2016) who found no significant differences in the percentage of edible parts and carcass dressing between groups of broiler chicks that fed germinated sorghum or corn based diets.

Table (5): Effect of feeding dietary germinated sorghum grain on weight and percentage of edible parts, organs and dressing of japanese quails ($\bar{x}$±SE).

Items	Treatments				sign
	T1	T2	T3	T4	
Weight (g)					
Live body weight	199.4±1.42	194.9± 2.72	199.4±2.13	198.3±2.33	Ns
Heart	1.63±0.08	1.57±0.03	1.75±0.10	1.59±0.095	Ns
Liver	4.43± 0.34	4.45±0.45	4.77±0.28	4.16±0.09	Ns
Gizzard	3.73±0.29	3.34±0.16	3.27±0.09	3.01±0.055	Ns
Spleen	0.12±0	0.11±0.01	0.13±0.03	0.10±0.01	Ns
Small intestine	7.22± 1.04	8.66±0.78	9.74±1.25	9.06±1.10	Ns
Testes	2.26±0.18	2.61±0.80	2.76 ±0.04	2.24±0.60	Ns
Dressing	142.8±1.85	137.1 ±0.61	138.3±1.25	139.7±2.24	Ns
Percentage (%)					
Heart	0.82±0.04	0.81±0.02	0.88±0.06	0.80±0.06	Ns
Liver	2.22±0.18	2.28±0.20	2.40±0.15	2.10± 0.07	Ns
Gizzard	1.87±0.13	1.71± 0.09	1.64±0.032	1.52±0.03	Ns
Spleen	0.06± 0.00	0.06±0.01	0.07±0.01	0.05±0.00	Ns
Small intestine	3.62±0.52	4.43±0.34	4.87±0.57	4.57±0.54	Ns
Testes	1.14 ±0.10	1.33±0.40	1.39±0.03	1.14±0.31	Ns
Dressing	71.62±0.46	70.35±0.78	69.37±0.63	70.48±0.70	Ns

Ns = non- significant mean. T1=Birds fed control diet. T2 = Birds fed diets containing 25% germinated sorghum as replacement of corn. T3= Birds fed diets containing 50 % germinated sorghum as replacement of corn. T4= Birds fed diets containing 100 % germinated sorghum as replacement of corn.

3.4 Blood parameters

Data regarding some blood parameters expressed as percentage of; total protein, albumin, globulin, A/G ratio, Triglyceride and cholesterol are presented in Table (6). The feeding of Japanese quail on different levels of germinated sorghum had no effect (P>0.05) on the levels of serum total protein, albumen, globulin, A/G ratio and glucose. Inclusion of germinated sorghum in Japanese quail diet at level 100% of yellow corn significantly (P<0.05) reduced the level of Triglycerides compared the other treatments. Also, serum cholesterol decreased (P<0.05) significantly for birds fed germinated sorghum at levels 50 and 100% of yellow corn compared to the other treatments. These results are in agreement with Fafiolu *et al.* (2006) who reported that the higher levels of malted sorghum sprouted inclusion in the diets show a corresponding reduction in triglyceride and cholesterol. Also, Ahmed *et al.* (2017) indicated a significantly

($p<0.05$) decrease on cholesterol content in whole blood serum of birds fed on germinated sorghum compared to those fed un-germinated sorghum.

Table (6): Effect of feeding dietary germinated sorghum grain on some blood parameters of growing Japanese quail ($\bar{x}$±SE).

Blood parameters	Treatments				Sign
	T1	T2	T3	T4	
Total protein	4.36±0.11	4.53±0.14	4.49±0.07	4.77±0.10	Ns
Albumen (A)	2.25± 0.20	2.41± 0.12	2.56±0.16	2.43± 0.09	Ns
Globulin (G)	2.11±0.17	2.12±0.20	1.93±0.17	2.34±0.12	Ns
A/G	1.15±0.23	1.28±0.20	1.48±0.24	1.07±0.09	Ns
Triglyceride	196.8±4.09a	199.7±2.62a	189.2±6.08a	175.5±2.59b	*
Cholesterol	185.7±1.94a	187.7±3.34a	170.2±4.15b	165.6±4.73b	*
Glucose	120.9±2.64	121.8±4.75	123.6±3.37	116.7±3.77	Ns

[a & b] Means with same letters within rows are not significant different (p >0.05). Ns = non- significant mean. *= probability (P<0.05). T1=Birds fed control diet. T2 = Birds fed diets containing 25% germinated sorghum as replacement of corn. T3= Birds fed diets containing 50% germinated sorghum as replacement of corn. T4= Birds fed diets containing 100% germinated sorghum as replacement of corn.

4. Conclusions

Germinated sorghum could be safely incorporated in Japanese quail diets as replacement of yellow corn with no negative effect on growth rate and carcass characteristics. Germinated sorghum significantly reduce the levels of serum cholesterol and triglyceride.

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