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Effects of feeding untreated or reconstituted sorghum grain (*Sorghum bicolor* L.) on growth performance of Japanese quails (*Coturnix coturnix japonica*)

Fayyaz Emami, Naser Maheri-Sis*, Abolfazl Ghorbani, Tohid Vahdatpour

Department of Animal Science, Shabestar Branch, Islamic Azad University, Shabestar, Iran

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Abstract

This study was conducted to evaluate the effects of replacing untreated or reconstituted sorghum grain (*Sorghum bicolor* L.) in place of corn grain, on feed intake, body weight gain, feed conversion ratio and final live body weight of Japanese quail (*Coturnix coturnix japonica*). For this purpose, local sorghum grains were reconstituted to reach their moisture near the 30% and then preserved in aerobic condition for 21 days. After reconstitution, grains dried and ground for further use in the experiment. A total of 700 one-day old unsexed quail chicks were fed same diet for 20 day (starter period) in cage system. After 20 days the quails were sexed and 300 male chicks reared for 21 days of experimental (grower) period. The statistical arrange of the study was done as completely randomized design (CRD) with 5 treatment and 4 replicates contain 15 birds in each treatments. Experimental treatments were as: A) diet contains corn grain and without sorghum grain (control group); B) replacing 50% reconstituted sorghum grain in place of corn grain; C) replacing 50% untreated sorghum grain in place of corn grain; D) replacing 100% reconstituted sorghum grain in place of corn grain and E) replacing 100% untreated sorghum grain in place of corn grain. Results showed that feed intake, body weight gain, feed conversion ratio and final live body weight were significantly different between treatments. However, reconstitution could not improve the feeding value of sorghum grain. Replacing 100% untreated or reconstituted sorghum grain in place of corn grain led to decrease growth performance of Japanese quails.

***Corresponding Author:** Naser Maheri-Sis ✉ nama1349@gmail.com

Introduction

Grain sorghum (*Sorghum bicolor* L. Moench; Figure 1) ranks fifth in worldwide production among cereal crops, after wheat, rice, corn and barley (Wong et al. 2009; Selle et al., 2010). Sorghum is used for human consumption and animal production (Selle et al., 2010) as well as industrial products such as alcohol (Shawrang et al. 2011). Over 55% of sorghum grain produced in the world is used for human consumption and about 33% of grain used in animal nutrition (Gangaiah, 2007). However, one limitation of sorghum is the poor nutritional quality of its protein, which is owing to low solubility, deficiencies in essential amino acids (e.g. lysine) and interactions with tannin. A second limiting factor is that sorghum generally has the lowest starch digestibility amongst cereal grains, due to resistant and peripheral endosperm layer encasing starch granules (Selle et al., 2010).

Selle et al. (2010) summarized that sorghum cultivars depending on genotypes and tannin contents, can be divided into three categories. Type I sorghums do not have a pigmented testa and are tannin-free. Type II sorghums have a pigmented testa layer that contains condensed tannins and Type III sorghums contain tannin in both the testa and the pericarp. They are cited that tannin concentrations in Type I, II and III sorghum categories were 0.28, 4.48 and 11.95 g kg $^{-1}$, respectively.

Sorghum grain contains about 10-12% proteins, 3% fat and 70% carbohydrates (Gangaiah, 2007). Therefore, it is comparable to corn grain in feeding value for poultry (Nagra et al., 1990; Tyagi et al., 2003; Kumar et al., 2007) 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. The extent of tannin (as a major anti-nutritional factor in sorghum) mainly depends on variety, stage of harvesting, agro-climatic conditions and color of the seed coat. In general the cultivars of sorghum with lighter seed coat color contain less tannin and have superior nutritional values than that of darker (Kumar et al., 2007).

Removal of undesirable components (such as phenolic acids, flavonoids, phytic acid and tannins) is essential to improve the nutritional quality of sorghum and effectively utilize its potential as human food or animal feed (Shawrang et al. 2011). Physical, chemical and enzymatic methods have been used to overcome anti-nutritional factors in sorghum grain (Douglas et al., 1991; Duodu et al., 2003; Selle et al., 2010; Shawrang et al. 2011). Reconstitution is an energy-efficient process for improving nutritive value of grains. In this method, moisture content of grains rise to 25-30% and then storing in anaerobic conditions for about 21 days and has beneficial effects on the physical characteristics and utilization of grain (Pflugfelder and Rooney 1986; Madacsi et al 1988; Kumar et al. 2007). Madacsi et al (1988) indicated that reconstitution can be lowered or eliminate tannins in high-tannin sorghum grain and improve nutrient availability for broiler chickens. Research of Kumar et al. (2007) using reconstituted sorghum in broiler chickens had three important conclusions as below: (1) the reconstitution of high tannin red sorghum resulted in about 30% reduction in its tannin concentration; (2) the feeding of reconstituted sorghum based diets to broiler chickens did not exert any appreciable influence on nutrient utilization, blood biochemical parameters and enzymes and pathological changes; and (3) the birds fed on raw red sorghum exhibited higher immuno-responsiveness in comparison to their reconstituted counterparts. Manwar and Mandal (2009) suggested that the reconstitution of sorghum was beneficial in improving growth performance and nutrient utilization in broiler chickens.

There is a little information about nutritive value of raw and reconstituted high-tannin sorghum and tannin tolerance in Japanese quails (Ragab et al., 2002; Faquinello et al., 2004). It seems that Japanese quail can tolerate more tannin than broiler chickens in their diet. But it is need to further comparative study.

The aim of the current study was to evaluate the effect of raw and reconstituted *desi* sorghum grain (*Sorghum bicolor* L.) on growth performance of Japanese quails (*Coturnix coturnix japonica*).

Materials and methods

Samples preparation

Sorghum grains were supplied from farms of the Miyaneh region in East Azerbaijan, Iran. Half of grains reconstituted by adding water to whole grain to raise the moisture level to about 30% (DM 70%), followed by anaerobic storage in sealed plastic buckets for 21 days at room temperature (25°C). Subsequently, the grains were sun-dried, until the moisture content reached 10%, and then ground for use in diets of Japanese quails (Kumar et al. 2007).

Experimental treatments

A total of 700 one-day old unsexed quail chicks were obtained from commercial hatchery and fed same diet for 20 day in cage system. After 20 days the quails were sexed based on their breast feather color and 300 male chicks reared for 21 day experimental period. The statistical arrange of the study was done as completely randomized design (CRD) with 5 treatment and 4 replicates contain 15 birds in each treatments. Diets (Table 1) were formulated according to the nutritional requirements of NRC (1994). Experimental treatments were as: A) diet contains corn grain and without sorghum grain (control group); B) replacing 50% reconstituted sorghum grain in place of corn grain; C) replacing 50% untreated sorghum grain in place of corn grain; D) replacing 100% reconstituted sorghum grain in place of corn grain and E) replacing 100% untreated sorghum grain in place of corn grain.

Statistical analysis

Data were subjected to one-way analysis of variance (ANOVA) in a completely randomized design and treatment means were tested for statistical significance by Duncan's multiple range tests using software of SAS (2001).

Results and discussion

Feed Intake

Effect of replacing corn grain with raw or reconstituted sorghum grain on feed intake of the Japanese quails is offered in Table 2. There is a significant differences among experimental treatments ($p<0.0142$). Statistical analysis showed that treatment containing 100% untreated sorghum grain in place of corn grain had a highest and control group (without sorghum grain) had a lowest feed intake. Although, feed intake is increased by increasing substitution rate of sorghum grain, reconstitution could not affect feed intake in experimented Japanese quails. Results of the current study are in line with Nyachoti and Atkinson (1995) and Ragab et al. (2002).

Ragab et al. (2002) found that feeding the yellow corn diet (without sorghum grain) resulted in the lowest feed intake during the period from 7 to 42 days of age in Japanese quails. However, some other workers reported that low tannin sorghum variety (Madacsi et al. 1988; Attia, 1998), reconstitution (Madacsi et al. 1988) and sorghum grain level (Makled and Afifi, 2001) had not significant effects on feed intake of broiler chickens. Faquinello et al. (2004) concluded that high tannin sorghum may replace corn at up to 80% in diets of Japanese quails without any adverse effect on feed intake.

Live weight gain

Effect of replacing corn grain with untreated and reconstituted sorghum grain on live weight gain of the Japanese quails is presented in Table 2. Results indicate that live weight gain of experimental treatments is significantly different ($p<0.0078$). The highest and lowest weight gain obtained for control (no sorghum grain) and treatment with 100% sorghum grain in place of corn grain, respectively. Reconstitution could not significantly affect the sorghum containing diets.

Table 1. Feed ingredients and nutrient contents of experimental diets of Japanese quails at grower period (21- 42 d).

	Treatments				
	A	B	C	D	E
Ingredients	0% sorghum	50% sorghum (reconstituted)	50% sorghum (non-reconstituted)	100% sorghum (reconstituted)	100% sorghum (non-reconstituted)
Corn grain	50	25	25	0	0
Sorghum grain	0	25	25	50	50
Wheat grain	6.80	8.04	8.04	8.01	8.01
Soybean meal	32.61	31.07	31.07	31.15	31.15
Gluten meal	7	7.62	7.62	7.70	7.70
Oyster shell	1.6	1.35	1.35	1.35	1.35
DCP	0.82	0.81	0.81	0.78	0.78
Lys. Sup.	0.25	0.18	0.18	0.19	0.19
Met. Sup.	0.1	0.11	0.11	0	0
Coccidiostat	0.07	0.07	0.07	0.07	0.07
Vit. Premixes	0.25	0.25	0.25	0.25	0.25
Min. Premixes	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Nutrients (calculated)					
ME (Kcal/Kg)	2900	2900	2900	2875.49	2875.49
CP %	23.74	23.50	23.50	23.50	23.50
CF %	3.68	3.64	3.64	3.67	3.67
Ca %	0.90	0.80	0.80	0.80	0.80
Av. P %	0.30	0.30	0.30	0.30	0.30
Met. %	0.50	0.50	0.50	0.40	0.40
Lys. %	1.30	1.20	1.20	1.20	1.20
Cys. %	0.39	0.39	0.39	0.39	0.39
Met.+ Cys. %	0.89	0.89	0.89	0.79	0.79
Threonine %	0.87	0.86	0.86	0.86	0.86
Na %	0.12	0.12	0.12	0.11	0.11
K %	0.86	0.85	0.85	0.86	0.86
Cl %	0.19	0.21	0.21	0.22	0.22

Table 2. Performance traits of Japanese quails fed untreated or reconstituted sorghum grain in place of corn grain.

Treatment	feed intake (g)	weight gain (g)	feed conversion ratio	final body weight(g)
0% sorghum (control)	598.560 ^{b}	129.233 ^{a}	4.63 ^{b}	228.015 ^{a}
50% sorghum (reconstituted)	600.873 ^{ab}	119.233 ^{ab}	5.04 ^{ab}	218.283 ^{ab}
50% sorghum (non-reconstituted)	605.528 ^{ab}	120.740 ^{ab}	5.01 ^{ab}	219.395 ^{ab}
100% sorghum (reconstituted)	607.895 ^{ab}	114.000 ^{b}	5.34 ^{a}	210.663 ^{b}
100% sorghum (non-reconstituted)	609.198 ^{a}	114.970 ^{b}	5.30 ^{a}	213.045 ^{b}
SEM	2.156	2.654	0.114	2.467
P values	0.0142	0.0078	0.0040	0.0017

^{,b}Means within the same column bearing different superscripts differ significantly (P<0.05); SEM: standard error of means.

Fig.1. Sorghum bicolor L. Moench (courtesy of Dr. Gangaiah, B. New Delhi, India)

Feed conversion ratio

As shown in Table 2, feed conversion ratio of birds fed experimental diets was significantly different ($p<0.0040$). It can be observed that, increasing sorghum level in diet (either untreated or treated form) leads to impair feed conversion ratio. Reconstitution could not repair the negative effects of high level of sorghum grain in quail's diet. Findings of the current study is in accordance with Ragab et al. (2002), who reported that levels of sorghum grain significantly affected feed conversion ratio during the period from 7to 42 days of age in Japanese quails. They have stated that quails fed control diet (0.0% sorghum grain) had the best feed conversion ratio during this period, while the worst feed conversion ratio value was obtained by groups fed 50 % sorghum grain substituting yellow corn. These results were in agreement with the findings of Douglas et al. (1991) who indicated that feed efficiency was better for corn diets as compared to sorghum containing diets in broilers. However, Makled and Afifi (2001) showed that 50% of the dietary corn can be replaced by sorghum grain without any detrimental effects on feed conversion ratio. Reza and Edriss (1997) also reported that broiler chicks can tolerate up to 2.6 g/Kg dietary tannin without any adverse effect on performance. Based on our knowledge it seems that Japanese quails can tolerate more tannins than broiler chickens and so they can consume high tannin grains efficiently than broiler chickens. Thus quails may utilize and un-reconstituted sorghum grain similarly. However, Kumar et al. (2007) reported that reconstitution of high tannin red sorghum resulted in reduction in its tannin concentration, but feeding of reconstituted sorghum based diets could not improve nutrient utilization in broiler chickens. Faquinello et al. (2004) stated that high tannin sorghum may replace corn at up to 80% in diets of the quails, but the final decision to replace corn by sorghum grain will be determined based on price and availability of this product. Manwar and Mandal (2009) concluded that feed conversion ratio and energy and protein utilization efficiency were better in birds fed reconstituted sorghum in comparison to those fed untreated sorghum. They are also obtained that feed cost per unit weight gain apparently reduced due to reconstitution.

Final body weight

Data tabulated in Table 2, demonstrated that final body weight of experimental treatments is significantly different ($p<0.0017$). The highest and lowest weight obtained for control and treatment with 100% sorghum grain in place of corn grain, respectively. Reconstitution could not alter the effects sorghum containing diets. These findings supported by Ibrahim et al. (1988), who reported that high tannin sorghum substitution for maize depressed broiler growth by 20-28%. However, some other researchers found that feeding high tannin sorghum had insignificant effects on growth performance of broilers (Attia, 1998) and Japanese quails (Ragab et al. 2002). Manwar and Mandal (2009) suggested that the reconstitution of sorghum was beneficial in improving growth performance in broiler chickens. This is not supported by our results probably due to different bird species (broiler chickens vs. quails), sorghum varieties and tannin contents as well as reconstitution conditions.

Conclusion

Based on the results of the current study it can be obtained three major conclusions: 1) reconstitution could not improve the growth performance of Japanese quails fed sorghum grain partially or totally in place of corn grain, 2) replacing 100% of corn grain by reconstituted or untreated sorghum grain adversely affects feed intake, body weight gain, feed conversion ratio and final live body weight of Japanese quails and 3) sorghum grain could be replaced in place of corn grain up to 50% with no adverse effects on growth performance of Japanese quails.

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