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PERFORMANCE OF GROWING AND LAYING JAPANESE QUAIL FED SORGHUM GRAINS

BY

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ABSTRACT: This experiment was conducted to study effects of substituting yellow corn (YC) in quail diets by four varieties of sorghum grain (SG) during growing and laying periods. The SG varieties used were: Baladi, Giza 15, Mena and Strain 113. YC of the control diet was partially substituted by SG varieties at replacement ratio of 0, 50 or 100 %. The experimental diets were formulated to be isonitrogenous and isocaloric.

A total of 360 one-day old unsexed Japanese quail birds were fed the control diet during the first week. The birds were given the experimental diets from the end of the first week until 42 days of age (growing period) and from 43 to 112 days of age (laying period).

Results of the growing period indicated generally, insignificant effects of substituting YC by SG varieties in quail diets on live body weight (LBW), live body weight gain (LBWG), feed conversion (FC), performance index (PI), slaughter parameters, plasma constituents, chemical composition of meat and mortality rate of Japanese quail. Therefore, the four SG varieties used in this experiment can completely substitute YC during the growing period.

The results during laying period indicated, significant effects of substituting YC by SG varieties on egg production, feed intake (FI) and FC. The results indicated that SG in laying quails diets adversely affected the economic parameters.

key words: substituting yellow corn , sorghum, slaughter parameters, plasma constituents, chemical composition of meat, performance, Japanese quail

INTRODUCTION

In Egypt, yellow corn (YC) is completely imported to cover the energy needs for poultry and livestock. Such difficulty could be partially solved by offering relatively cheap and local energy substitutes. Sorghum grains (SG) might be considered as a promising cereal grain for poultry and animals.

Results of many studies suggest that tannin–containing sorghum is poorly utilized by poultry compared with non-tannin–containing sorghum or maize (Nyachoti *et al.*, 1997). The growth of poultry has frequently been shown to be reduced by the presence of dietary tannin, probably because tannins reduce utilization of energy, protein and specific amino acids (Trevino *et al*., 1992 and Elkin *et al*., 1996). This consequently results in poor growth rates. However, several investigators studied the utilization of sorghum in broiler diets and found that weight gains of chicks fed diets containing corn or sorghum did not differ significantly (Bornstein and Bartov, 1967, Bornstein and Lipstein, 1971, Douglas *et al.*, 1991, Reddy, 1993, and Makled and Afifi, 2001). Also, some workers reported no significant effects on weight gain of chicks when high-tannin sorghum was fed (Musharaf and Latshaw, 1991).

No clear relationship was found between the amount of tannin contained in the diet and the magnitude of reduction in feed intake (FI) (Nyachoti *et al.*, 1997). Chang and Fuller (1964) reported a non-significant but higher FI for chicks fed tannin-containing sorghum relative to birds fed a maize control diet, while others found significantly higher FI for birds eating high-tannin sorghum (Damron *et al*., 1968 and Nyachoti and Atkinson 1995).

However, significant reduction in FI by chicks fed diets containing tannins was reported by Ibrahim *et al*. (1988), and this effect was attributed to the astringent taste of tannins (Trevino *et al*., 1992). On the other hand, Lucbert and Castaing (1986), Fayek *et al.* (1989) and Attia (1998) found that low-tannin sorghum variety had insignificant effect on FI.

Deaton and Quisenberry (1964) observed that feed conversion (FC) was better for corn diets. Armstrong *et al.* (1973) fed high-tannin sorghum at 71% of the diet and found 37.6% poorer feed efficiency. Similarly, Banda-Nyirenda and Vohra (1990) and Douglas *et al.* (1991) both fed high-tannin sorghum at 53% of the diet to broiler chicks and, reported a 16% to 12% reduction in FC efficiency.

However, Thakur *et al.* (1985), Elkin *et al.* (1990 and 1991) and Reza and Edriss (1997), indicated no adverse effects of low-tannin sorghum on broiler performance. Lucbert and Castaing (1986) concluded that low-tannin sorghum (less than 10g/kg) could be used in broiler diets without any adverse effects on FC and that its nutritional value was similar to that of maize. Also, Attia and Abd El-Rahman (1996), and Attia (1998) found that broiler chicks fed 100% sorghum to replace YC had similar FC ratio to the corn control diet. On the other hand, Lewis *et al.* (1982) reported that SG yielded better (1.4%) feed-to-gain ratio than those fed YC.

There are contradicting reports on the effects of sorghum and tannins on egg production. Armanious *et al*. (1973) observed that there was a trend towards lower egg production with high tannin cultivars. Also, layers fed diets with high-tannin sorghum exhibited the highest loss in body weight (Nyachoti *et al.*, 1997).

High-tannin sorghum can be used in layer diets as long as the level of tannin is below 0.6% and adequate choline and methionine are supplied. The magnitude of the effects of sorghum tannins on egg production and egg quality depends on the composition of the diet and in particular, the protein content (Nyachoti *et al.*, 1997). Sell *et al*. (1983) found significantly lower egg production for layers fed high-tannin sorghum diets that were low in crude protein. Methionine and choline supplementations effectively alleviated the negative effects of both tannic acid and tannin on egg production. In this case, methionine and choline may be donating a methyl group that combines with tannins thus rendering them ineffective (Potter and Fuller, 1968).

MATERIALS AND METHODS

A total of 360 one-day old unsexed Japanese quail birds were used in the experiment. Birds were randomly distributed into 9 groups of 40 birds each, in two replicates containing 20 birds each. All birds were fed a control diet for the first week. The SG varieties were Baladi, Giza 15, Mena and Strain 113, which were grown under identical agronomic conditions in Fayoum. The diet of the first group contained YC as the main source of energy, and served as the control. YC of the first group was substituted by SG at replacement ratios of 0.0 (control), 50 or 100% for the four varieties (Tables 1 and 2). The experimental diets were supplemented with minerals and vitamins mixture and DL-methionine to cover the recommended requirements (NRC, 1994), and were formulated to be iso-nitrogenous and iso-caloric, containing about 24, 19% CP and 2900, 2800 Kcal ME / Kg during growing and laying periods, respectively.

Chicks were raised in electrically heated batteries with wire mesh floors and had free access to feed and water. Batteries were placed into a room provided with continuous lighting and fans for ventilation. The birds were reared under similar environmental conditions, and were given the experimental diets from the end of the first week until 42 days of age (growing period) and from 43 to 112 days of age (laying period).

At the end of the growing period (42 days), a slaughter test was performed using four chicks (2 males and 2 females) around the average LBW of

Table 1: Composition and analyses of the experimental diets (growing period).

Item, %	Control	SG varieties % substitution of YC							
		Baladi		Giza 15		Mena		Strain 113	
		50%	100%	50%	100%	50%	100%	50%	100%
Yellow corn, ground	58.00	29.00	0.00	29.00	0.00	29.00	0.00	29.00	0.00
Sorghum, ground	0.00	29.00	58.00	29.00	58.00	29.00	58.00	29.00	58.00
Soybean meal (44 %CP)	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Fish meal(72.3%CP)	9.00	9.00	9.00	7.00	4.50	9.00	9.00	9.00	9.00
Wheat bran	0.00	0.00	0.00	1.70	4.00	0.00	0.00	0.00	0.00
Ground limestone	1.68	1.68	1.67	1.88	2.08	1.68	1.67	1.68	1.67
Sodium chloride	0 .30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Bone meal	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vit. and Min. premix *	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
DL – methionine	0.02	0.02	0.03	0.12	0.12	0.02	0.03	0.02	0.03
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis :									
CP	24.10	24.04	24.00	24.36	24.33	24.23	24.36	24.36	24.63
EE	3.34	3.42	3.83	3.49	3.59	3.43	3.51	3.61	3.88
CF	3.44	3.42	3.39	3.58	3.79	3.41	3.38	3.37	3.30
Ca	1.09	1.10	1.10	1.13	1.16	1.10	1.10	1.10	1.10
Available P	0.35	0.36	0.36	0.32	0.29	0.36	0.36	0.36	0.36
Methionine	0.50	0.56	0.63	0.57	0.53	0.51	0.52	0.53	0.56
Lysine	1.45	1.44	1.43	1.33	1.18	1.42	1.39	1.58	1.71
ME, K cal./Kg	2905	2905	2905	2910	2904	2908	2911	2904	2902
Determined analysis :									
Moisture	9.79	10.37	9.99	9.35	10.20	9.97	10.31	10.42	10.29
CP	24.46	24.73	24.64	23.81	24.29	24.19	24.76	24.51	24.60
EE	3.51	3.32	3.69	3.48	3.62	3.41	3.61	3.72	3.70
CF	3.35	3.34	3.38	3.35	3.15	3.30	3.33	3.49	3.34
Ash	7.54	7.57	6.22	6.97	7.04	8.18	6.33	6.37	7.23
NFE	51. 35	50.66	52.08	53.04	51.70	50.95	51.67	51.49	50.85
Tannins	0.00	0.031	0.062	0.029	0.058	0.048	0.096	0.034	0.068
Cost (L.E./ton) **	892.68	878.88	865.78	827.07	729.72	878.88	865.78	878.88	865.78
Relative cost ***	100	98.45	96.99	92.65	81.75	98.45	96.99	98.45	96.99

* Each 3.0 Kg of the Vit. and Min. premix contains : Vit. A, 12000000 IU ; Vit. D_3 2500000 IU ; Vit. E, 10 g ; Vit. K, 2.5 g ; Vit. B1, 1.5 g ; Vit. B2, 5 g ; Vit. B6, 1.5 g; Vit. B12, 10 mg ; Biotin, 50 mg ; Folic acid, 1 g ; Nicotinic acid , 30 g ; Ca pantothenate, 10 g ; Zn, 55 g ; Cu,10 g ; Fe, 35 g ; Co, 250 mg ; Se, 150 mg ; I, 1 g ; Mn, 60 g, Choline chloride, 1.05 g and anti-oxidant, 10 g.

** According to market prices of 1998.

***Assuming control equals 100.

Table 2: Composition and analyses of the experimental diets (laying period).

Item, %	Control	SG varieties % substitution of YC							
		Baladi		Giza 15		Mena		Strain 113	
		50%	100%	50%	100%	50%	100%	50%	100%
Yellow corn, ground	63.50	31.75	0.00	31.75	0.00	31.75	0.00	31.75	0.00
Sorghum, ground	0.00	31.75	63.50	31.75	63.50	31.75	63.50	31.75	63.50
Soybean meal (44 %CP)	26.00	26.00	26.00	26.00	25.00	26.00	26.00	26.00	25.90
Fish meal(72.3%CP)	3.50	3.50	3.50	3.00	3.00	3.50	3.50	3.50	3.50
Wheat bran	0.00	0.00	0.00	1.00	2.30	0.00	0.00	0.00	0.00
Ground limestone	3.40	3.35	3.50	3.30	3.40	3.30	3.30	3.30	3.40
Sodium chloride	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Bone meal	2.87	3.00	3.00	2.50	2.00	3.00	3.00	3.00	3.00
Vit. And Min. premix *	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
DL – methionine	0.13	0.05	0.00	0.10	0.20	0.10	0.10	0.10	0.00
Total	100	100	100	100	100	100	100	100	100
Calculated analysis :									
CP	19.21	19.15	19.09	19.56	19.09	19.36	19.50	19.50	19.78
EE	2.97	3.24	3.50	3.34	3.76	3.06	3.15	3.26	3.56
CF	3.27	3.22	3.20	3.32	3.36	3.18	3.12	3.17	3.09
Ca	2.32	2.34	2.37	2.16	2.06	2.32	2.33	2.32	2.37
Available P	0.54	0.56	0.57	0.49	0.44	0.56	0.57	0.56	0.57
Methionine	0.48	0.47	0.48	0.46	0.56	0.46	0.46	0.48	0.40
Lysine	1.06	1.04	1.03	1.01	0.96	1.02	0.99	1.03	1.00
ME, K cal./Kg	2854	2833	2812	2827	2801	2835	2815	2835	2812
Determined analysis :									
Moisture	10.52	9.986	10.38	10.19	9.98	9.92	10.37	9.98	10.28
CP	19.10	19.02	18.91	19.18	19.60	19.36	19.20	19.60	19.23
EE	3.01	3.02	3.2	3.56	3.16	3.26	3.30	3.16	3.62
CF	3.36	3.33	3.24	3.51	3.28	3.16	3.49	3.24	3.40
Ash	8.02	6.59	7.01	7.40	7.03	8.18	7.99	7.03	7.02
NFE	55.99	58.05	57.26	56.16	56.95	56.12	55.65	56.99	56.45
Tannins	0.00	0.034	0.068	0.032	0.063	0.037	0.074	0.037	0.074
Cost (L.E./ton) **	699.25	672.87	652.07	657.29	679.85	679.85	663.98	679.85	646.35
Relative cost ***	100	96.23	93.25	94.00	97.23	97.23	94.96	97.23	92.44

* Each 3.0 Kg of the Vit. and Min. premix contains : Vit. A, 12000000 IU ; Vit. D_3 2500000 IU ; Vit. E, 10 g ; Vit. K, 2.5 g ; Vit. B1, 1.5 g ; Vit. B2, 5 g ; Vit. B6, 1.5 g; Vit. B12, 10 mg ; Biotin, 50 mg ; Folic acid, 1 g ; Nicotinic acid , 30 g ; Ca pantothenate, 10 g ; Zn, 55 g ; Cu,10 g ; Fe, 35 g ; Co, 250 mg ; Se, 150 mg ; I, 1 g ; Mn, 60 g, Choline chloride, 1.05 g and anti-oxidant, 10 g.

** According to market prices of 1998.

*** Assuming control equals 100.

each treatment. Then, birds were individually weighed to the nearest gram, and slaughtered by severing the jugular vein (islamic method). Following a four minutes bleeding time, each bird was dipped into a hot water bath for two minutes, and feathers were removed by hand. After the removal of head, carcasses were eviscerated manually, then their weights were obtained to determine carcass %.

Carcass % = (carcass weight / LBW) x 100. While**,** Dressing % was determined as :

Dressing % = ((carcass weight + giblets) / LBW) x 100.

The bones of front and rear were separated and weighed to calculate meat percentage. The meat and skin from each part was weighed and blended using a kitchen blender and chemical analyses were determined (A.O.A.C., 1990). Measurements of length of different parts of the gut were recorded to the nearest mm. The abdominal fat was removed from the parts around the viscera and gizzard, and was weighed to the nearest gram.

Birds were individually weighed to the nearest gram in the early morning before receiving any food and water at weekly intervals during the experimental period. Live body weight (LBW), live body weight gain (LBWG), FI, FC, performance index (PI) and mortality rate were recorded or calculated weekly.

As for FI during the laying period, a pilot experiment was performed at the same time to determine to what extent the females consume more feed than the males. It was found that females generally consume 13 % more feed than the males. This figure was used to correct the FI of the females to calculate the FC.

At the end of the growing period (42 days), individual blood samples were taken at slaughter from 4 birds (2 males and 2 females). The blood samples were collected into dry clean centrifuge tubes containing heparin and centrifuged at 3000 rpm for 20 min. The clear plasma samples were carefully drawn and transferred to dry, clean, small glass bottles, and stored at–20Ċ in the deep freezer until the time of chemical determinations. The biochemical characteristics of blood were determined colorimetrically, using commercial kits as previously described (Ragab, 2001).

Chemical analyses of representative samples of the experimental diets were carried out (A.O.A.C, 1990). The ME value of the SG was calculated on the basis of the chemical composition according to Janssen (1989)**.** Analysis of variance was conducted on the data in accordance with procedures described by Steel and Torrie (1980). Significant differences among treatment means were determined using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

1. Growing period: -

1.1. Live Body Weight (LBW): -

Data presented in Table 3 show that SG varieties, level and variety x level interaction insignificantly affected LBW at 42 days of age, while females had significantly heavier LBW (P≤0.01) than males. The results indicated insignificant effect of substituting YC by SG varieties on LBW of Japanese quail at the end of the growing (42 days of age). Therefore, the four SG varieties (containig 0.100 to 0.117 % tannins) used in this research can completely substitute YC up to 42 days of age without any detrimental effect on LBW. These results agree with those obtained using broilers by Hulan and Proudfoot (1982); Thakur *et al.* (1985) and Fayek *et al.* (1989). Similarly, Attia (1998) reported that Giza-15 SG containing 0.397 % tannins had insignificant effect on broiler growth during the period from 4 to 45 days of age. However, Ibrahim *et al.* (1988) reported that the Egyptian (0.15 % tannins) and Sudanese (0.20 % tannins) SG substitution for YC depressed broiler growth by 20.8% and 28.4%, respectively.

1.2. Live body weight gain (LBWG): -

Data presented in Table 3 showed that SG varieties, level and variety x level interaction insignificantly affected LBWG during the periods from 7 to 42 days of age. This indicates that quail birds were able to use SG varieties to similar extent as the YC. This is in accordance with the previous data on LBW.

These results are in harmony with the findings of Sharma *et al.* (1979), Douglas *et al*. (1991) and Reddy (1993). Similarly, there were no significant nor consistent differences between sorghum and YC on LBWG of broiler chicks

Table 3: Effects of substituting YC by four varieties of SG at three rates on LBW (g) , LBWG and FC of Japanese quail at 42 days of age.

Item	LBW	LBWG	FC
Variety :			
Baladi	199.89±2.80^{1a}	168.67±2.69^{a}	6.93±0.31^{A}
Giza 15	205.68±2.75^{a}	171.66±2.64^{a}	5.26±0.31^{C}
Mena	206.53±2.70^{a}	173.30±2.59^{a}	6.36±0.30^{AB}
Strain 113	204.92±2.80^{a}	171.49±2.69^{a}	6.37±0.31^{AB}
YC	209.06±1.98^{a}	173.39±1.90^{a}	5.67±0.22^{BC}
Level of SG % :			
0	209.06±1.60^{a}	173.39±1.54^{a}	5.67±0.18^{b}
50	205.52±1.59^{a}	171.92±1.53^{a}	6.33±0.18^{a}
100	203.87±1.58^{a}	177.39±1.52^{a}	6.04±0.18^{b}
Sex :			
F	217.82±1.3^{A}	183.41±1.25^{A}	4.86±0.15^{B}
M	194.48±1.3^{B}	161.03±1.25^{B}	7.18±0.15^{A}
Overall mean	206.15±0.9	172.22±0.88	6.00±0.20
Variety x Level :			
Control	209.06±3.21^{a}	173.39±3.09^{a}	5.67±0.37^{a}
Baladi x 50	198.64±3.23^{a}	167.39±3.11^{a}	7.10±0.37^{a}
Baladi x 100	202.61±3.21^{a}	171.19±3.09^{a}	6.62±0.37^{a}
Giza15 x 50	207.99±3.15^{a}	173.63±3.03^{a}	5.40±0.36^{a}
Giza15 x 100	203.04±3.14^{a}	169.34±3.03^{a}	5.13±0.36^{a}
Mena x 50	209.58±3.09^{a}	175.88±2.97^{a}	5.92±0.35^{a}
Mena x 100	204.57±3.09^{a}	171.75±2.97^{a}	6.69±0.35^{a}
Strain113 x 50	205.87±3.23^{a}	170.78±3.11^{a}	6.91±0.37^{a}
Strain113 x 100	205.26±3.21^{a}	173.17±3.09^{a}	5.72±0.37^{a}

[1] Mean ± standard error of the mean.

a, and b, values in the same column within the same item followed by different superscripts are significantly different at $P \leq 0.05$.

A,B and C, values in the same column within the same item followed by different superscripts are significantly different at $P \leq 0.01$.

(Makled and Afifi, 2001).

1.3. Feed conversion (FC): -

Results presented in Table 3 indicated that SG varieties significantly affected FC (P≤0.01) during the period from 7 to 42 days of age. It was observed that quails fed Giza15 had the best FC values during this period (5.26), while quails fed Baladi had the worst FC value (6.93) during the same period.

Levels of SG significantly affected FC (P≤0.05) during the period from 7 to 42 days of age. Quails fed control diet (0.0% SG) had the best FC during this period, while the worst FC value was obtained by groups fed 50 % SG substituting YC (6.33). These results agree with the findings of Deaton and Quisenberry (1964), Armstrong *et al.* (1973), Armstrong *et al.* (1974), Banda-Nyirenda and Vohra (1990) and Douglas *et al.* (1991) who observed that feed efficiency was better for corn diets as compared to sorghum supplementation diets in broilers. However, Thakur *et al.*(1985), Elkin *et al.* (1990 and 1991), claimed no adverse effects of low-tannin sorghum on broiler performance. Also, Makled and Afifi (2001) indicated that FC ratio of broiler chicks at 6 weeks of age showed that 50% of the dietary YC can be replaced by SG. Similarly, Reza and Edriss (1997) indicated that broiler chicks can tolerate up to 2.6 g/Kg dietary tannin without any adverse effect on performance.

Concerning sex effect, females had significantly better FC (P≤0.01) than males during the period from 7 to 42 days of age. Variety x level interaction, showed insignificant differences during the same period.

1.4. Feed intake : -

The data of Table 4 indicated that SG significantly (P≤0.01) affected FI during the period from 7 to 42 days of age, where quails fed Giza15 variety had the lowest FI (675.49 g), while the highest FI values were obtained by substituting YC by Mena (726.76 g).

Levels of SG varieties also significantly affected FI during growing period of quail. Feeding the YC diet (0.00 % SG) resulted in the lowest FI during the period from 7 to 42 days of age. Similar results were obtained by Chang and Fuller (1964), Damron *et al.* (1968) and Nyachoti and Atkinson (1995).

Table 4: Effects of substituting YC by four varieties of SG at three rates on FI, PI and mortality rate of Japanese quail at 42 days of age.

Item	Feed intake, g	PI[2]	Mortality rate, %
Variety :			
Baladi	701.62±3.75^{1C}	2.61±0.07^{b}	9.19
Giza 15	675.94±3.82 ^{D}	2.69±0.06^{b}	8.23
Mena	726.76±3.33 ^{A}	2.60±0.06^{b}	8.82
Strain 113	716.95±3.69 ^{B}	2.59±0.07^{b}	8.99
YC	684.92±2.52 ^{D}	2.81±0.05^{a}	8.84
Level of SG % :			
0	684.92±2.653^{B}	2.81±0.04^{A}	8.84
50	704.60±2.676^{A}	2.72±0.04^{B}	8.81
100	707.22±2.747^{A}	2.55±0.04^{C}	8.82

[1] Mean ± standard error of the mean.

[2] PI = LBWG (Kg) /FC X 100

a, and b, values in the same column within the same item followed by different superscripts are significantly different at $P \leq 0.05$.

A,B,C and D, values in the same column within the same item followed by different superscripts are significantly different at $P \leq 0.01$.

However, Fayek *et al.*(1989) and Attia (1998) found that low tannin sorghum variety had insignificant effect on FI. Also, Makled and Afifi (2001) indicated that there were no significant effects of SG level on FI of broiler chicks at 6 weeks of age.

1.5. Performance index : -

SG varieties significantly affected PI during the period from 7 to 42 days of age (Table 4). The group fed the control diet had the highest PI compared with those fed the other 4 SG varieties. Levels of SG significantly affected PI during the same period; quails fed diet containing 0.00 % SG had the best PI value.

1.6. Mortality rate: -

There were neither significant nor consistent effects of substituting YC by SG varieties on mortality rate of Japanese quail from 7 to 42 days of age (Table 4). Also, level of SG, insignificantly affected mortality rate from 7 to 42 days of age. This result is in line with those of Deaton and Quisenberry (1964); Bornstein and Bartov (1967), Bornstein and Lipstein (1971) and Abdel-Wahed (1998) who reported that mortality rate was not significantly affected by dietary sorghum. However, Vohra *et al*. (1966) demonstrated that the mortality of chicks fed tannin-containing diets increased with increasing tannic acid content to 5% of the diet. It is difficult to demonstrate this relationship using sorghum varieties as the source of tannin because practical levels of sorghum in the diet do not provide high enough levels of tannin to cause death. In addition, the tannin in sorghum grain is integrally bound with the plant material and would be expected to be less harmful than tannic acid (Nyachoti *et al.*, 1997).

Therefore, the four SG varieties used in this research can completely substitute YC during the period from 7 to 42 days of age without any detrimental effect on the mortality rate.

1.7. Slaughter parameters: -

The percentages of slaughter characteristics are presented in Table 5. The results indicated that SG variety significantly affected percentages of carcass, dressing, front meat, and whole meat. Whereas insignificant differences were observed in percentage of rear meat and giblets.

Table 5: Effects of substituting YC by four varieties of SG at three rates on slaughter parameters of Japanese quail at 42 days of age.

Item	Carcass %	Dressing %	Front Meat %	Rear meat %	Whole meat %	Giblets, %
Variety :						
Baladi	66.57±0.65^{A}	72.19±0.62^{A}	82.23±0.85^{C}	83.46±0.58^{a}	82.84±0.49^{B}	5.61±0.19^{a}
Giza15	66.41±0.65^{A}	72.04±0.62^{A}	84.44±0.85^{B}	83.91±0.58^{a}	84.17±0.49^{A}	5.63±0.19^{a}
Mena	64.06±0.65^{B}	69.96±0.62^{B}	83.60±0.85^{C}	82.38±0.58^{a}	82.99±0.49^{B}	5.91±0.19^{a}
Strain 113	65.50±0.65^{B}	71.05±0.62^{B}	81.95±0.85^{C}	82.13±0.58^{a}	82.04±0.49^{B}	5.55±0.19^{a}
YC	63.88±0.46^{B}	69.60±0.44^{B}	86.22±0.60^{A}	82.32±0.41^{a}	84.27±0.35^{A}	5.71±0.13^{a}
Level of SG%:						
0	63.88±0.35^{B}	69.59±0.39^{B}	86.22±0.65^{A}	82.32±0.41^{a}	84.27±0.31^{A}	5.71±0.11^{a}
50	65.39±0.35^{A}	70.99±0.39^{A}	83.24±0.65^{B}	83.01±0.41^{a}	83.13±0.31^{B}	5.59±0.11^{a}
100	65.88±0.35^{A}	71.63±0.39^{A}	82.86±0.65^{B}	82.75±0.41^{a}	82.81±0.31^{B}	5.75±0.11^{a}
Sex :						
F	64.34±0.28^{B}	70.28±0.32^{a}	83.17±0.52^{a}	82.64±0.34^{a}	83.11±0.25^{a}	5.94±0.09^{A}
M	65.76±0.28^{A}	71.19±0.32^{a}	83.69±0.52^{a}	82.75±0.34^{a}	83.69±0.25^{a}	5.44±0.09^{B}
Overall mean	65.05±0.20	70.74±0.25	84.11±0.38	82.75±0.25	83.40±0.18	5.69±0.06
Variety x Level % :						
Control	63.88±0.69^{a}	69.60±0.78^{a}	86.22±1.30^{a}	82.32±0.82^{a}	84.27±0.61^{a}	5.71±0.22^{a}
Baladi x 50	65.28±0.69^{a}	70.96±0.78^{a}	82.56±1.30^{a}	83.10±0.82^{a}	82.83±0.61^{a}	5.69±0.22^{a}
Baladi x 100	67.87±0.69^{a}	73.42±0.78^{a}	81.84±1.30^{a}	83.09±0.82^{a}	82.49±0.61^{a}	5.55±0.22^{a}
Giza15 x 50	66.37±0.69^{a}	71.93±0.78^{a}	85.27±1.30^{a}	84.09±0.82^{a}	84.68±0.61^{a}	5.56±0.22^{a}
Giza15 x 100	66.44±0.69^{a}	72.13±0.78^{a}	83.60±1.30^{a}	83.73±0.82^{a}	83.66±0.61^{a}	5.69±0.22^{a}
Mena x 50	64.03±0.69^{a}	69.71±0.78^{a}	83.68±1.30^{a}	83.09±0.82^{a}	83.38±0.61^{a}	5.68±0.22^{a}
Mena x 100	64.09±0.69^{a}	70.22±0.78^{a}	83.53±1.30^{a}	81.67±0.82^{a}	83.60±0.61^{a}	6.12±0.22^{a}
Strain113 x 50	65.90±0.69^{a}	71.35±0.78^{a}	81.46±1.30^{a}	81.74±0.82^{a}	81.60±0.61^{a}	5.45±0.22^{a}
Strain113 x 100	65.10±0.69^{a}	70.75±0.78^{a}	82.43±1.30^{a}	82.51±0.82^{a}	82.47±0.61^{a}	5.65±0.22^{a}

[1] Mean ± standard error of the mean.

A, B and C values in the same column within the same item followed by different superscripts are significantly different at $P \leq 0.01$.

Level of SG significantly (P≤0.01) affected percentages of carcass, dressing, front meat and whole meat. However, insignificant differences were observed in percentage of rear meat. Also, sex significantly affected percentage of carcass. Males had significantly (P≤0.01) higher percentage of carcass than females.

These results are in harmony with the findings of Marks and Washburn, 1991, Yannakopoulos *et al.*, 1995 and Sharaf, 1996 who reported significant sex effect on carcass characteristics. On the contrary El Full (2000) and El Full *et al.* (2001) reported that sex insignificantly affected percentage of boneless meat.

Statistically, variety x level insignificantly affected slaughter parameters as shown in Table 5. The results indicated that substituting YC by SG varieties was generally favorable on percentage of carcass and dressing percentage of Japanese quail at 42 days of age. Therefore, the four SG varieties used in this research can completely substitute YC during the period from 7 to 42 days of age without any detrimental effect on slaughter parameters. These results agree with the findings of Fayek *et al.* (1989), Ghazalah *et al.* (1994), Attia and Abd El-Rahman (1996) and Attia (1998) who found that Egyptian sorghum grain in broiler diets had insignificant effects on carcass characteristics and body organs.

1.8. Plasma constituents: -

Data of plasma constituents analyses are summarized in Tables 6 and 7. The results of plasma constituents indicate that SG variety significantly affected calcium and GOT. It can be seen that quails fed the control diet had the highest plasma calcium % than those fed the SG varieties, whereas quails fed Baladi diet had the highest GOT as compared with the control diet or other SG varieties. However, insignificant effects were observed in total lipids, urea, total protein, albumin, globulin, phosphorus, triglycerides, and GPT.

Level of SG insignificantly affected total lipids, urea, total protein, albumin, globulin, phosphorus, triglycerides, GOT and GPT. Whereas, there was significant (P≤0.01) differences in calcium. It can be seen that 0% level of SG (i.e. 100 % YC) had the highest plasma calcium level, whereas the lower Ca was

Table 6: Effects of substituting YC by four varieties of SG at three rates on some plasma constituents of Japanese quail at 42 days of age.

Item	Total lipid mg/dl	Urea m mol/L	Total protein g/dl	Albumin g/dl	Globulin g/dl
Variety :					
Baladi	638.86±51.7 [1a]	6.00±0.54 [a]	4.30±0.26 [a]	2.41±0.10[a]	1.89±0.22[a]
Giza 15	510.13±59.7 [a]	4.00±0.62 [a]	4.49±0.30 [a]	2.53±0.12 [a]	1.96±0.25 [a]
Mena	639.25±51.69 [a]	6.07±0.54 [a]	4.46±0.26 [a]	2.67±0.10 [a]	1.79±0.22 [a]
Strain 113	543.41±51.69 [a]	5.33±0.54 [a]	4.39±0.26 [a]	2.55±0.10 [a]	1.85±0.22 [a]
YC	625.71±51.69[a]	5.18±0.54[a]	4.50±0.26 [a]	2.57±0.10 [a]	1.93±0.22 [a]
Level of SG % :					
0	625.71±44.9 [a]	5.18±0.66 [a]	4.50±0.32 [a]	2.57±0.13 [a]	1.93±0.25 [a]
50	605.75±35.5 [a]	5.07±0.52 [a]	4.50±0.25 [a]	2.57±0.11 [a]	1.93±0.19 [a]
100	554.71±31.7 [a]	5.50±0.47 [a]	4.28±0.22 [a]	2.51±0.09 [a]	1.78±0.18 [a]
Sex :					
F	676.59±30.8 [A]	5.36±0.45 [a]	4.55±0.22 [a]	2.57±0.09 [a]	1.98±0.17 [a]
M	514.19±30.8 [B]	5.14±0.45 [a]	4.30±0.22 [a]	2.53±0.09 [a]	1.78±0.17 [a]
Overall Mean	595.39±21.8	5.25±0.32	4.43±0.16	2.55±0.06	1.88±0.12
Variety x Level :					
Control	625.71±89.7 [a]	5.18±1.32 [a]	4.50±0.65 [a]	2.57±0.27 [a]	1.93±0.49 [a]
Baladi x 50	697.21±63.4 [a]	6.07±0.93 [a]	4.51±0.46 [a]	2.53±0.19 [a]	1.99±0.35 [a]
Baladi x 100	580.52±63.4 [a]	5.94±0.93 [a]	4.09±0.46 [a]	2.29±0.19 [a]	1.79±0.35 [a]
Giza 15 x 50	467.14±89.7 [a]	2.95±1.32 [a]	4.17±0.46 [a]	2.51±0.27 [a]	1.66±0.49 [a]
Giza 15 x 100	531.62±63.4 [a]	4.51±0.93 [a]	4.65±0.46 [a]	2.54±0.19 [a]	2.11±0.35 [a]
Mena x 50	674.22±63.4 [a]	6.61±0.93 [a]	4.64±0.46 [a]	2.77±0.19 [a]	1.87±0.35 [a]
Mena x 100	604.29±63.4 [a]	5.54±0.93 [a]	4.29±0.46 [a]	2.56±0.19 [a]	1.73±0.35 [a]
Strain113 x 50	584.42±63.4 [a]	4.64±0.93 [a]	4.67±0.46 [a]	2.47±0.19 [a]	2.20±0.35 [a]
Strain113 x 100	502.40±63.4 [a]	6.03±0.93 [a]	4.11±0.46 [a]	2.63±0.19 [a]	1.49±0.35 [a]

[1] Mean ± standard error of the mean.

A, and B, values in the same column within the same item followed by different superscripts are significantly different at P ≤0.01.

Table 7: Effects of substituting YC by four varieties of SG at three rates on other plasma constituents of Japanese quail at 42 days of age.

Item	Calcium mg/dl	Phosphorus mg/dl	Triglycerides Mg/dl	GOT m mol/L	GPT m mol/L
Variety :					
Baladi	10.18±0.61 [1B]	5.45±0.56 [a]	74.58 ±24.47 [a]	23.63±2.79 [a]	7.50±0.99 [a]
Giza 15	10.72±0.71 [B]	6.00±0.65 [a]	118.03±28.25 [a]	11.50±3.22 [b]	6.17±1.14 [a]
Mena	10.06±0.61 [B]	6.32±0.56 [a]	121.23±24.47 [a]	17.13±2.79 [b]	8.62±0.99 [a]
Strain 113	10.18±0.61 [B]	6.02±0.56 [a]	79.31 ±24.47 [a]	12.63±2.79 [b]	7.00±0.99 [a]
YC	13.56±0.61 [A]	5.71±0.56 [a]	107.50±24.47 [a]	10.18±2.79 [b]	6.00±0.99 [a]
Level of SG % :					
0	13.56±0.65 [A]	5.71±0.66 [a]	107.50±25.3 [a]	10.18±3.36 [a]	6.00±1.00 [a]
50	10.38±0.51 [B]	6.02±0.52 [a]	105.68±20.0 [a]	17.19±2.65 [a]	8.44±0.79 [a]
100	10.20±0.46 [B]	5.75±0.46 [a]	88.37±17.9 [a]	15.25±2.37 [a]	6.50±0.71 [a]
Sex :					
F	11.52±0.45 [a]	6.25±0.45 [a]	129.73±17.4 [a]	14.42±2.31 [a]	6.21±0.69 [a]
M	11.23±0.45 [a]	5.41±0.45 [a]	71.31±17.4 [b]	13.87±2.31 [a]	7.75±0.69 [a]
Overall Mean	11.38±1.29	5.83±0.32	100.52±12.3	14.15±1.63	6.98±0.49
Variety x Level :					
Control	13.56±1.29 [a]	5.71±1.31 [a]	107.50±50.6 [a]	10.18±6.71 [a]	6.00 ±2.20 [a]
Baladi x 50	11.45±0.92 [a]	5.64±0.93 [a]	95.24±35.8 [a]	26.75±4.74 [a]	8.00 ±1.42 [a]
Baladi x 100	8.914±0.92 [a]	5.26±0.93 [a]	53.92±35.8 [a]	20.50±4.74 [a]	7.00 ±1.42 [a]
Giza 15 x 50	10.79±1.29 [a]	5.00±1.31 [a]	97.65±50.6 [a]	11.50±6.71 [a]	8.50 ±2.00 [a]
Giza 15 x 100	10.69±0.92 [a]	6.51±0.93 [a]	128.22±35.8 [a]	11.50±4.74 [a]	5.00 ±1.42 [a]
Mena x 50	9.60±0.92 [a]	5.98±0.93 [a]	148.49±35.8 [a]	17.50±4.74 [a]	10.25±1.42 [a]
Mena x 100	10.51±0.92 [a]	5.67±0.93 [a]	94.07±35.8 [a]	16.75±4.74 [a]	7.00 ±1.42 [a]
Strain113 x 50	9.67±0.92 [a]	6.48±0.93 [a]	81.36±35.8 [a]	13.00±4.74 [a]	7.00 ±1.42 [a]
Strain113 x 100	10.69±0.92 [a]	5.56±0.93 [a]	77.27±35.8 [a]	12.25±4.74 [a]	7.00 ±1.42 [a]

[1] Mean ± standard error of the mean.

a, and b, values in the same column within the same item followed by different superscripts are significantly different at $P \leq 0.05$.

A and B, values in the same column within the same item followed by different superscripts are significantly different at $P \leq 0.01$.

obtained by 50 or 100% SG levels. On the contrary, Makled and Afifi (2001) reported that feeding SG to broiler chicks did not significantly affect blood constituents.

Concerning sex effect, females had significantly higher total lipids (P≤0.01) and triglycerides (P≤0.05) than males, whereas, insignificant differences were observed between the two sexes for others plasma constituents. However, variety x level interaction insignificantly affected plasma constituents. Therefore, the four SG varieties used in this research can satisfactorily substitute YC during the period from 7 to 42 days of age without any detrimental effect on plasma constituents.

1.9. Chemical composition of Japanese quail meat: -

Data presented in Table 8 show that the four SG varieties significantly (P≤0.01) affected moisture, protein, fat, and ash percentages of quail meat. The highest CP (the lowest fat and ash %) value was observed for quails fed YC, while those fed Mena had the highest fat % (and consequently the lowest moisture and protein %). This is in accordance with results reported by Chamber (1990).

Level of SG significantly affected protein, fat and ash % (P≤0.01), showing that feeding quails diet containing 100% YC had the highest values of meat protein (21.52%). Fat and ash % were higher in meats of quails fed 50 or 100 % SG instead of YC. The lower molecular weight of polyphenols associated with tannin in the sorghum grain which can be absorbed and distributed in various tissues may be partially responsible for the observed altering in tissues protein and lipids contents (Jimenez-Ramsey *et al.*, 1994). Evidences indicate that tannin can alter taste of meat, but not meat composition (Petersen, 1969) as well as bind, coagulate and precipitate proteins (Butler *et al.*, 1984). In domestic fowl, the anti-nutritional effects of sorghum tannin have been primarily attributed to inhibition of dietary protein digestion (Gualtieri and Rapaccini, 1990 and Jansman, 1993). However there were insignificant effects of level of SG on moisture % of meat.

Table 8: Effects of substituting YC by four varieties of SG at three rates on chemical composition of Japanese quail meat at 42 days of age.

Item	Moisture %	Protein %	Fat %	Ash %
Variety :				
Baladi	67.23±0.19 ^{1A}	20.58±0.27 ^{B}	8.17±0.17^{B}	1.43±0.06 ^{A}
Giza 15	67.38±0.18 ^{A}	20.86±0.27 ^{B}	8.26±0.17 ^{B}	1.32±0.06 ^{A}
Mena	66.29±0.19 ^{B}	20.30±0.26 ^{B}	8.98±0.18 ^{A}	1.35±0.06 ^{A}
Strain, 113	67.38±0.20 ^{A}	20.80±0.27 ^{B}	8.38±0.19 ^{B}	1.40±0.07 ^{A}
YC	67.52±0.13 ^{A}	21.52±0.19 ^{A}	7.90±0.13^{B}	1.16±0.04 ^{B}
Level of SG % :				
0	67.52±0.12 ^{a}	21.52±0.20^{A}	7.90±0.13^{B}	1.16±0.05^{B}
50	67.09±0.13 ^{a}	20.492±0.20^{B}	8.50±0.13^{A}	1.34±0.05^{A}
100	67.29±0.13 ^{a}	20.753±0.20^{B}	8.40±0.13^{A}	1.41±0.05^{A}
Sex :				
F	67.03±0.11^{B}	21.04±0.16 ^{a}	8.22±0.11 ^{a}	1.27±0.04 ^{a}
M	67.57±0.10^{A}	20.80±0.16 ^{a}	8.31±0.11 ^{a}	1.34±0.04 ^{a}
Carcass part :				
Front part	67.22±0.11 ^{a}	21.25±0.16^{A}	8.17±0.11 ^{a}	1.40±0.04^{A}
Rear part	67.38±0.10 ^{a}	20.59±0.16^{B}	8.37±0.10 ^{a}	1.21±0.04^{B}
Overall mean	67.30±0.08	20.92±0.11	8.27±0.08	1.30±0.03
Variety x Level :				
Control	67.52±0.25 ^{a}	21.52±0.39 ^{a}	7.90±0.25 ^{a}	1.164±0.09 ^{a}
Baladi x 50	67.39±0.25 ^{a}	20.765±0.39 ^{a}	8.237±0.26 ^{a}	1.482±0.09 ^{a}
Baladi x 100	67.08±0.08 ^{a}	20.403±0.39 ^{a}	8.321±0.24 ^{a}	1.370±0.09 ^{a}
Giza 15 x 50	67.67±0.26 ^{a}	20.282±0.39 ^{a}	8.244±0.24 ^{a}	1.306±0.11 ^{a}
Giza 15 x 100	67.44±0.25 ^{a}	21.431±0.39 ^{a}	8.326±0.24 ^{a}	1.304±0.09 ^{a}
Mena x 50	66.16±0.29 ^{a}	20.082±0.39 ^{a}	9.014±0.29 ^{a}	1.274±0.11 ^{a}
Mena x 100	66.85±0.25 ^{a}	20.417±0.39 ^{a}	8.938±0.24 ^{a}	1.441±0.09 ^{a}
Strain113 x 50	67.14±0.25 ^{a}	20.839±0.39 ^{a}	8.515±0.27 ^{a}	1.293±0.09 ^{a}
Strain113 x 100	67.81±0.31 ^{a}	20.762±0.39 ^{a}	8.032±0.31 ^{a}	1.539±0.11 ^{a}

[1] Mean ± standard error of the mean.

A, and B, values in the same column within the same item followed by different superscripts are significantly different at P ≤0.01.

Concerning sex effect, females had significantly lower moisture (P≤0.01) than males. Also, carcass part significantly influenced (P≤0.01) protein and ash % where front part had higher protein and ash % than rear part.

1.10. Economic efficiency

Economic parameters of the present experimental diets are presented in Table 9. It can be seen that Giza15 substituting 100% of YC had better economic and relative efficiency than the control diet. Whereas birds fed Strain113 variety substituting 50 % of YC had the worst economic and relative efficiency than the control diet.

Since sorghum at present is relatively cheaper than YC, the results of this study suggest that SG can be used in place of YC in Japanese quail feeds at level up to 100% (the substitution of YC by 50 or 100% Giza15 is the best choice) with no obvious deterioration of economic efficiency. Feeding Giza15 variety at 50 or 100% of YC resulted in 23-24 % increase in economic efficiency of producing the Japanese quails up to 42 days. The use of the other 3 varieties of SG indicated nearer records to the control groups except for quails fed Strain113 to substitute 50% of YC which gave less economic efficiency by 13.7 than that of the control group.

2. Laying period: -

2.1.Egg production (egg number, egg weight and egg mass): -

The values of average egg production at 43 to 112 days are presented in Table 10, showing that variety of SG significantly affected egg number, weight and mass (g). Quails fed YC diet had the highest egg number and egg mass, while quails fed Giza15 diet had the lowest egg number and egg mass.

Variety of SG significantly affected egg weight during the period from 43 to 112 days of age. Quails fed Mena diet had the highest egg weight (g) during the period from 43 to 112 days of age (12.11g). While quails fed control diet had the lowest egg weight (g) during laying period (11.08). In general and during the

Table 9: Effects of substituting YC by four varieties of SG at three rates during growing period on economic efficiency of Japanese quail.

Item	Control	Baladi		Giza15		Mena		Strain113	
		50%	100%	50%	100%	50%	100%	50%	100%
Average feed intake(Kg/bird) a	0.68	0.69	0.71	0.64	0.72	0.71	0.74	0.77	0.66
Price/Kg feed (PT)* b	89.27	87.89	86.58	82.71	72.97	87.89	86.58	87.89	86.58
Total feed cost (PT)=a x b = c	61.14	61.02	61.52	52.67	52.39	62.73	63.84	67.59	56.91
Price / one quail (PT)** d (total revenue)	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
Net revenue (PT) = d - c = e	138.86	138.98	138.48	147.33	147.61	137.27	136.16	132.41	143.09
Economic efficiency e /c***	2.27	2.277	2.25	2.80	2.82	2.19	2.13	1.96	2.51
Relative efficiency ****	100.00	100.26	99.12	123.16	124.04	96.34	93.92	86.26	110.70

* Based on average price of diets during the experimental time.

** According to the local market price at the experimental time.

*** Net revenue per unit feed cost.

****Assuming economic efficiency of control group equals 100.

Table 10: Effects of substituting YC by four varieties of SG at three rates on average egg number, egg weight (g), egg mass (g), feed intake (g) and feed conversion, during laying period of Japanese quail.

Item	Egg number/ hen/day	Egg weight	Egg mass(g)	Feed intake / hen/day	Feed conversion
Variety :					
Baladi	0.66±0.04[1A]	11.96±0.22[A]	7.84±0.48[A]	32.85±1.68 [a]	4.26±0.35 [B]
Giza15	0.44±0.04[B]	11.55±0.22[B]	5.13±0.48[B]	25.30±1.68 [b]	5.13±0.35 [A]
Mena	0.66±0.04[A]	12.11±0.22[A]	8.04±0.48[A]	29.70±1.68 [b]	3.68±0.35 [B]
Strain113	0.48±0.04[B]	11.46±0.22[B]	5.53±0.48[B]	26.36±1.68 [b]	4.91±0.35 [A]
YC	0.76±0.03[A]	11.08±0.16[B]	8.43±0.34[A]	28.76±1.19 [b]	3.42±0.25 [B]
Level of SG% :					
0	0.76±0.03[A]	11.08±0.19[b]	8.43±0.32[A]	28.76±0.95 [a]	3.42±0.24 [B]
50	0.59±0.03[B]	11.86±0.19[a]	7.04±0.32[B]	28.26±0.95 [a]	4.27±0.24 [A]
100	0.53±0.03[B]	11.68±0.19[a]	6.23±0.32[B]	28.84±0.95 [a]	4.72±0.24 [A]
Overall mean	0.63±0.02	11.54±0.11	7.13±0.19	26.62±0.55	4.14±0.14
Variety x Level % :					
Control	0.76±0.05[a]	11.08±0.37[a]	8.43±0.65[a]	28.76±1.89 [bcd]	3.42±0.47 [a]
Baladi x 50	0.71±0.05[a]	12.23±0.37[a]	8.67±0.65[a]	30.46±1.89 [abc]	3.53±0.47 [a]
Baladi x 100	0.60±0.05[a]	11.69±0.37[a]	7.01±0.65[a]	35.23±1.89 [a]	5.00±0.47 [a]
Giza15 x 50	0.45±0.05[a]	11.74±0.37[a]	5.25±0.65[a]	27.57±1.89 [bcd]	5.64±0.47 [a]
Giza15 x 100	0.44±0.05[a]	11.36±0.37[a]	5.00±0.65[a]	23.02±1.89 [d]	4.62±0.47 [a]
Mena x 50	0.64±0.05[a]	12.09±0.37[a]	7.71±0.65[a]	25.94±1.89 [cd]	3.37±0.47 [a]
Mena x 100	0.69±0.05[a]	12.14±0.37[a]	8.38±0.65[a]	33.46±1.89 [ab]	3.99±0.47 [a]
Strain113 x 50	0.57±0.05[a]	11.40±0.37[a]	6.54±0.65[a]	29.07±1.89[abcd]	4.55±0.47 [a]
Strain113 x 100	0.39±0.05[a]	11.52±0.37[a]	4.52±0.65[a]	23.65±1.89 [d]	5.27±0.47 [a]

[1] Mean ± standard error of the mean.

a, b, c, and d values in the same column within the same item followed by different superscripts are significantly different at $P \leq 0.05$.

A, and B values in the same column within the same item followed by different superscripts are significantly different at $P \leq 0.01$.

10 weeks of this experiment it is of interest to note that comparable egg mass was evident for groups fed the Baladi and Mena varieties as compared to the group fed the control (YC) diet. Lower egg production was observed in the groups fed the other 2 varieties i.e. Giza15 and Strain113.

Level of SG significantly ($P \leq 0.01$) affected egg number and egg mass during the period from 43 to 112 days. It can be seen that quails fed 0% SG (i.e. control diet) had the highest egg number (0.76) and egg mass (8.43 g) during the total production period. Lower egg number and egg mass values were obtained by substituting YC by 50 and 100 % SG during the same period.

Regarding level of SG, birds fed 50 to 100% SG substituting YC had higher egg weight, whereas, lower egg weight was obtained by feeding YC (control diet) during the same period. This reflects the inverse relationship between egg number and egg weight (Fairful and Gowe, 1990 and Marks, 1993).

These results are in harmony with the findings of Deaton and Quisenberry (1964) and Bonino *et al.* (1980). The formers compared SG to corn in diet containing 14 to 16% CP and observed that rate of lay was better for corn diets. They added that, egg weight was significantly higher for the SG diets compared with corn at 16% protein level. On the other hand, Bornstein and Bartov (1967); Bornstein and Lipstein (1971) and Abdel-Wahed (1998) reported that there were neither significant nor consistent differences between birds fed graded level of sorghum grain as substitution for YC than those fed the control diet.

2.2. Feed intake and Feed conversion : -

Data presented in Table 10 indicated that variety of SG significantly affected FI during the period from 43 to 112 days. Birds fed Giza15 had the lowest FI during this period, the highest FI was obtained by quails fed Baladi diet. On the other hand, level of SG insignificantly affected FI during the period studied. Statistically, interaction due to variety x level significantly ($P \leq 0.05$) affected FI during the period from 43 to 112 days of age. This indicates that quails fed Giza15 substituting 100% of YC had the lowest FI (23.02) during the period studied.

Data presented in Table 10 indicated that variety of SG significantly affected FC during the period from 43 to 112 days of age. Birds fed the control diet had the best FC, whereas quails fed Giza15 had the worst FC value.

Regarding level of SG substitution, quails fed YC diets had significantly the best FC compared with those fed 50 and 100 % SG substitution (3.42). Similarly, Sharma *et al.* (1979), Ibrahim *et al*. (1988) and Abdel–Wahed (1998) found that YC resulted in significantly better FC compared with sorghum.

2.3. Economic efficiency: -

Economic parameters of the present experimental diets are presented in Table 11. It can be observed that the diet containing 100% Strain113 instead of YC was the cheapest one in total feed cost being, 1.528 PT. However, the highest values for total revenue and economic efficiency were obtained by quails fed the control (YC) diet. Conclusively, and from a practical point of view, the results indicated that SG in laying quails diets adversely affected the economic parameters, where quails fed SG varieties lowered the economic efficiency by 5.55% (Mena, 50%) to 42.25 (Giza15, 50%). While results of economic efficiency of the growing period favored feeding quail diets containing SG (except Strain 113 at 50 % substitution), it was found from the present data, except for Baladi and Mena grains (at 50 % substitution), that it is not advisable to feed laying quails SG to substitute YC.

Table 11: Effects of substituting YC by four varieties of SG at three rates during laying period on economic efficiency of Japanese quail .

Item	Control	Baladi		Giza15		Mena		Strain113	
		50%	100%	50%	100%	50%	100%	50%	100%
Average feed intake(g/bird/day) a	28.760	30.460	35.230	27.570	23.020	25.940	33.460	29.070	23.650
Price/g feed (PT)* b	0.069	0.067	0.065	0.066	0.068	0.068	0.066	0.068	0.065
Total feed cost (PT)=a x b =c	2.010	2.049	2.297	1.811	1.565	1.763	2.221	1.976	1.528
Price / one egg (PT) d**	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
Egg number (bird / day) e	0.761	0.711	0.602	0.447	0.440	0.637	0.690	0.574	0.391
Total revenue (PT) =d x e = f	11.410	10.660	9.030	6.705	6.600	9.555	10.35	8.610	5.865
Net revenue (PT) = f – c = g	9.405	8.615	6.733	4.894	5.035	7.792	8.129	6.633	4.336
Economic efficiency g /c***	4.678	4.203	2.901	2.702	3.217	4.418	3.659	3.356	2.837
Relative efficiency ******	100.000	89.850	62.640	57.750	68.760	94.450	78.220	71.740	60.640

*** Based on average price of diets during the experimental time.**

**** According to the local market price at the experimental time.**

***** Net revenue per unit feed cost.**

******Assuming economic efficiency of control group equals 100.**

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