Ragab, M. S.; Aly, M. M. M.; Hattaba, N. A. H. and Omar, E. M. (2002). A study of substituting soy bean by raw full fat sunflower seeds on the performance of Japanese quail. ***Second Conference of sustainable agricultural development 8- 10 May, Fayoum, Egypt,*** **239- 256.**

A STUDY OF SUBSTITUTING SOY BEAN MEAL BY RAW FULL FAT SUNFLOWER SEEDS ON THE PERFORMANCE OF JAPANESE QUAIL.

BY

Mona S. Ragab*, M. M.M. Aly* , N. A.H. Hattaba** and E. M. Omar *

* Poultry Prod. Dept., Fac. of Agric., Fayoum,Cairo University.
**Animal Production Research Institute, Egypt.

ABSTRACT: This experiment was conducted to study effects of substituting soy bean meal (SBM) in quail diets by tree varieties of raw full-fat sunflower seeds (FSFS) during growing and laying periods. The FSFS varieties used were : Isoflower, Vebes and Vedock. SBM of the control diet was partially substituted by FSFS varieties at replacement ratio of 0, 10 or 20 %. The experimental diets were formulated to be isonitrogenous and isocaloric.

A total of 280 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 SBM by FSFS 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, mortality rate and economic parameters of Japanese quail. Therefore, it may be concluded that the three FSFS varieties used in this research can substitute SBM up to 20% during the period from 7 to 42 days. Also, the three FSFS varieties can substitute SBM up to 20% during the laying period without any detrimental effects on egg production FI, FC and economic parameters of Japanese quail.

key words: substituting soy bean meal , raw full fat sunflower seeds, slaughter parameters, plasma constituents, chemical composition of meat, performance, Japanese quail.

INTRODUCTION

The gradual increase in the world's poultry production concomitantly increased the need for ingredients to supply protein for diets. As cereals constitute about 60-70% of the diets in order to supply the energy requirements of poultry; also, oilseeds which primarily contribute to the dietary protein requirements of birds occupy the next category of importance.

In recent years, there has been increased interest in the cultivating of sunflower for oil production in Egypt in general and in Fayoum in particular.

According to the latest statistical information of the Ministry of Agriculture (2000), 46453 feddan sunflower were cultivated in 1999, out of which 10617 feddan were cultivated in Fayoum. The corresponding yield per feddan amounted to 1.00 and 0.88 ton. Fayoum Governorate is one of the main regions intended for expansion of sunflower cultivation for oil production, hence more sunflower seeds having unsuitable grade and not appropriate for use in oil extraction will be available for poultry feeding.

Generally, most of the previous work on the use of sunflower in poultry diets has been done with the meal remaining after decortication and extraction of oil (Raya *et al.,* 1989). The first limiting amino acid in sunflower seed meal is lysine, whereas the second one is threonine. The adverse effects of over processing during the course of oil extraction on the protein quality of sunflower seed meal must be put into consideration (Zhang and Parsons, 1994). Therefore, the use of raw full-fat sunflower seed (FSFS) in diets for poultry may be beneficial as a source for both energy and protein, to reduce the costs of processing and to avoid the deleterious effects of overheating.

The chemical composition of FSFS depends primarily on variety, climate, soil fertilizers and cultivation practices. Chemical composition data related to FSFS, especially in the high-oil type varieties, show that the oil content constitutes almost 50% of the achene (whole seed). The oil content of FSFS is negatively correlated with fiber and protein contents. The protein content of the achene, regardless of the type of sunflower, ranged from 15.8 to 23.8% and the

CF (crude fiber) content from 15.2 % to 28% (Earle *et al.*, 1968). The hull comprises 21-30% of the total weight of the achene.

Sunflower seed oil is characterized by its high content of linoleic acid, which constitutes at least 70% of the total fatty acids, especially in seeds produced in cool climates. In addition, sunflower seed is particularly rich in α-tocopherols (608 mg / kg seed) which act as potent antioxidants. Sunflower is, therefore, considered a rich source of vitamin E (Dorrell and Vick, 1997).

Some researches have been conducted to determine the nutritional value of FSFS in diets of broiler chicks (Waldroup *et al.*, 1970, Daghir *et al.*, 1980, Kashani and Carlson, 1988, Elzubeir and Ibrahim, 1991, Roth-Maier and Kirchgessner, 1995 and Raya *et al.*, 1997). Their results showed some discrepancy which could be attributed to variations in the chemical composition of FSFS and content of the CF of the pericarp of the seed, and to whether the energy contents of diets containing different levels of FSFS were adjusted or not.

Broiler diets containing up to 30% FSFS were satisfactory if pelleted, while in mash diets it was necessary to limit the FSFS to not more than 15 to 20% of the diet (Waldroup *et al.*, 1970). Daghir *et al.* (1980) reported that sunflower seeds do not contain any substance toxic to chick, since level up to 20% of the diet did not significantly depress body weight. Similarly, Lee and Yang (1980) reported no significant difference in weight gain of broilers fed 0 or 5% FSFS. Also, Cheva-Isarakul and Tangtaweewipat (1991) reported that weight gain of broiler at 7 week of age was not significantly influenced by FSFS level.

They also found that FI (feed intake) of broiler chicks decreased significantly when FSFS was incorporated in the diet, which resulted in better FC ratio. They added that the group fed 50% FSFS throughout the experiment had the best FC (feed conversion) ratio. Also**,** Daghir *et al.* (1980) found no adverse effects on FC ratio at 25 days of age in broilers raised in battery cages and fed up to 20% FSFS. But birds raised in battery cages and fed semipurified diets containing 30% for 25 days or those raised in floor pens and fed normal diets containing 15 to 30% FSFS for 5 weeks had poorer FC. Similarly, Lee and Yang (1980) reported no significant difference in FC of broiler fed 0 or 5% FSFS.

Raya *et al.* (1997) reported no significant differences in relative weights of blood, feathers, viscera, feet and shanks, spleen, pancreas, and giblets when broiler chicks were fed diets containing FSFS at levels from 10 to 25% of diets. However, they reported significant differences in relative weight of abdominal fat, which increased gradually with increments of the inclusion rate of FSFS (10 to 25%) in the diets. Also, Cheva-Isarakul and Tangtaweewipat (1991) reported that the liver percentage and pancreas weights decreased, but abdominal fat percentage plus visceral fat weight increased significantly, when FSFS was fed at level of 30, 40 and 50% of diets for broiler chicks.

Raya *et al.* (1997) reported no significant differences in percentage of eviscerated weight or total edible parts among the different group of chicks fed diets containing 10 to 25 % FSFS. These results were similar to those reported earlier by Raya (1989) and Raya and El-Shinnawy (1989) for broiler chicks fed isocaloric and iso-nitrogenous diets.

No significant differences were detected among treatments in the chemical composition of either breast or thigh meat of the birds (Raya, *et al.,* 1997). This might be expected as a result of feeding such experimental diets, which had a fairly constant calorie to protein ratio. Composition changes are chiefly in the ratio of moisture to fat with protein level remaining relatively constant (Rand *et al.,* 1957). In addition, changes in fat deposition in the chickens are primarily in skin and adipose tissues, with less marked changes occurring in muscle tissues (Essary and Dawson, 1965).

Lee and Yang (1980) reported no significant difference in mortality rate of broiler chicks fed 0 and 5 % FSFS. Also, Daghir *et al.* (1980) incorporated 0, 10, and 20% FSFS in semi-purified diets and found no adverse effects on mortality rate at 25 days of age in broilers raised in battery cages. Dietary treatments did not affect the level of plasma total lipids and total protein in chicks (Raya, 1989, Raya and El-Shinnawy, 1989 and Raya *et al.,* 1991).

Uwayjan *et al.* (1983) fed White Leghorn layers diets containing FSFS at 0, 10, 20 and 30 %, which were equal to the substitution level of SBM at 0, 15, 30 and 45%, respectively. They reported that egg production tended to decrease with increasing FSFS levels, although no significant differences were obtained. Lee and Moss (1989) fed 0 to 30% FSFS diets to White Leghorn layers aged 32 and 54 weeks. They found that egg production was not significantly different among groups of layers aged 32 weeks, but for those aged 54 weeks, the groups fed the 20 or 30% FSFS diet produced significantly fewer eggs than the control group. They reported no significant difference in FC among groups of layers.

Kashani and Carlson (1988) fed 19 or 38% FSFS diet to pullets during 10 to 19 weeks of age. They reported that the group fed 38% FSFS gained significantly less weight and reached 50% egg production 2 days later than the control group. However, differences in egg production during the total production period were not significant.

Tangtaweewipat and Cheva-Isarakul (1990) fed layers at the peak of production for 3 months with diets containing 0, 4.7, 9.4, 14.1, and 18.8 % FSFS, which were equal to the substitution level of SBM at 0, 20, 40, 60, and 80 %, respectively. All diets were equal in ME. They found no significant difference on egg production. However, feeding diets containing 0 to 25% FSFS to Japanese quail without adjusting ME concentration of the diet resulted in decreased egg production at FSFS levels higher than 10%, but FC ratio was not affected.

MATERIALS AND METHODS

The experimental work of the present study was carried out at the Poultry Research Station, Poultry Production Department, Faculty of Agriculture, Fayoum, Cairo University. Chemical analyses were performed in the laboratories of the same institute according to the procedures outlined by A.O.A.C. (1990).

A total of 280 one-day old unsexed Japanese quail birds were used in the experiment. Birds were randomly distributed into 7 groups of 40 birds each in two replicates containing 20 birds each. All birds were fed a control diet for the first week. Chicks were raised in electrically heated batteries with raised 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).

Seven dietary treatments were designed to study the effects of feeding Japanese quail diets containing three FSFS varieties. These varieties were chosen according to their protein content, yield per feddan and cultivated area. The varieties were, Isoflower, Vebes and Vedock ; these varieties were grown under identical agronomic conditions in Fayoum Governorate.

The diet of the first group contained SBM as the main source of plant protein, and served as the control diet. SBM of the first group was substituted by FSFS at replacement ratios of 0.0 (control), 10 or 20 % for the 3 FSFS varieties (Tables, 1 and 2). In order to get a satisfactory mixture for FSFS, it was proportionally mixed with YC grains and ground together prior to diet formulation. The experimental diets were supplemented with mineral 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 3000, 2900 Kcal ME / Kg during growing and laying periods, respectively (Tables, 1 and 2).

The varieties of FSFS studied were obtained from the Extension Service Section of Directory of Agriculture, Fayoum Gavernorate, Ministry of Agriculture, Egypt.

At the end of the growing experiment (42 days), a slaughter test was performed using four chicks (2 males and 2 females) around the average LBW of 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 in a 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 / live body weight (LBW)) x 100.

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

The bones of front and rear were separated and weighed to calculate meat percentage. The meat from each part was weighed and blended using a kitchen blender and chemical analyses of blended meat was determined (A.O.A.C., 1990). Measurements of length of different parts of the gut were recorded to the nearest cm. 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. LBW, LBWG (live body weight gain), 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 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 and carcass meat (including the skin) were carried out to determine DM, CP (N x 6.25), EE, CF and ash contents according to the methods of A.O.A.C (1990). The ME value of the FSFS 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) and Live body weight gain (LBWG) :-

Data presented in Table 3 show that variety of FSFS significantly affected LBW and LBWG during the period from 7 to 42 age days. Quails fed Isoflower diet had the heaviest LBW and the best LBWG at this age, whereas, the lowest LBW and the worst LBWG were obtained by Vedock variety. Level of FSFS insignificantly affected LBW and LBWG values.

Therefore, the three FSFS varieties used in this research can substitute SBM up to 20% during the growing period of quails without any detrimental effect on LBW and LBWG of Japanese quail. These results agree with Daghir *et al.* (1980) who reported that sunflower seeds do not contain any substance toxic to chick, also and that incorporating 0, 10, and 20% FSFS in semipurified diets had no adverse effects on LBW and LBWG at 25 days of age in broilers raised in battery cages. In general, these results are in partial agreement with reports of Elzubeir and Ibrahim (1991) and Roth-Maier and Kirchgessner (1995) dealing with broiler chicks fed diets containing up to 22.5 or 30% FSFS, respectively. Similarly, Lee and Yang (1980) reported no significant difference in LBWG of broilers fed 0 or 5 % FSFS. Also, Cheva-Isarakul and Tangtaweewipat (1991) reported that LBWG of broiler at 7 weeks of age was not significantly influenced by FSFS level.

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

Item	LBW	LBWG	FC
Variety :			
Isoflower	208.77±2.68^{A}	169.24±2.57^{A}	3.95±0.07^{B}
Vebes	197.27±2.68^{B}	160.15±2.58^{B}	4.14±0.07^{A}
Vedock	191.41±2.73^{B}	155.94±2.63^{B}	4.29±0.07^{A}
SBM	193.77±2.23^{B}	156.53±2.19^{B}	4.30±0.06^{A}
Level of FSFS, %:			
0	193.77±2.56^{a}	156.53±2.23^{a}	4.30±0.06^{a}
10	200.56±2.10^{a}	162.47±2.07^{a}	4.07±0.05^{b}
20	199.29±2.11^{a}	162.47±2.08^{a}	4.15±0.05^{ab}
Sex :			
F	202.87±1.91^{A}	166.19±1.82^{A}	4.03±0.04^{B}
M	192.88±1.60^{B}	155.15±1.52^{B}	4.32±0.04^{A}
Overall mean	197.87±1.24	160.64±1.18	4.20±0.03
Variety x Level :			
Control	193.77±3.9^{BC}	156.53±3.86^{c}	4.30±0.10^{a} `
Isoflower x 10	216.42±3.7^{A}	173.96±3.63^{a}	3.83±0.10^{a}
Isoflower x 20	204.71±3.6^{B}	167.40±3.54^{ab}	4.01±0.09^{a}
Vebes x 10	194.33±3.6^{BC}	158.06±3.5^{bc}	4.16±0.09^{a}
Vebes x 20	201.69±3.7^{BC}	164.11±3.6^{abc}	4.08±0.09^{a}
Vedock x 10	190.92±3.6^{C}	155.37±3.6^{c}	4.22±0.09^{a}
Vedock x 20	191.48±3.7^{C}	155.89±3.6^{c}	4.34±0.10^{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 $P \leq 0.05$.

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

Females had significantly heavier LBW (P≤0.01) and significantly better LBWG than males during the period from 7 to 42 days.

Variety x level interaction significantly affected LBW and LBWG during the period from 7 to 42 days of age, the heaviest LBW value was obtained for quails fed Isoflower substituting 10% of SBM. Whereas, quails fed Vedock substituting 10% of SBM had the lowest LBW at the same age (Table 3).

1.2. Feed conversion (FC) :-

Variety of FSFS significantly affected FC during the growing period (Table 3), where, quails fed Isoflower had the best FC, while the quails fed SBM had the worst FC during the same period. Results of FC are in accordance with data obtained for LBW, LBWG and FI indicating that Isoflower variety can be used in growing quail diet to substitute 10 to 20% of dietary SBM.

Level of FSFS significantly affected FC during the period from 7 to 42 (P≤0.05) days of age, feeding FSFS to substitute 10% of SBM gave the best FC during this period, while feeding SBM had the worst FC at the same period. However, earlier reports of Daghir *et al.* (1980) indicated that birds raised in battery cage and fed semi-purified diets containing 30% FSFS for 25 days and those raised in floor pens fed normal diets containing 15 to 30% FSFS for 5 weeks had significantly poorer feed efficiency. In this regard, Lee and Yang (1980) reported no significant difference in FC of broilers fed 0 and 5% FSFS.

Females had significantly better FC (P≤0.01) than males during the whole growing period (Table3).

1.3. Feed intake (FI): -

Variety of FSFS significantly (P≤0.01) affected FI during the growing period (Table 4), quails fed Vebes variety had the lowest FI. The highest FI was obtained for quails fed SBM diet during the same period.

Level of FSFS also significantly affected FI during the growing period of quails. It can be seen that FSFS substituting 10 % of SBM had the lowest FI during the same period. This result is in line with those of Cheva-Isarakul and Tangtaweewipat (1991) who reported that FI decreased significantly when FSFS was incorporated in the diet. However, Lee and Yang (1980) reported no significant difference in FI of broiler fed 0 and 5% FSFS.

1.4. Performance index (PI):-

Data show that feeding Isoflower variety to growing quails to substitute part of SBM gave the best PI (P≤0.01) while feeding the other 2 varieties of FSFS gave PI of similar value compared with that of quails fed the control (SBM) diet (Table 4). This is in accordance with LBW, LBWG and FC data previously discussed.

1.5. Mortality rate :-

Data presented in Table 4, showed that variety and level of FSFS insignificantly affected mortality rate of Japanese quail during the growth period. This result is in accordance with that of Daghir *et al.* (1980) who incorporated 0, 10, and 20% SFS in semi-purified diets and found no adverse effects on mortality rate at 25 days of age in broilers raised in battery cages. Also, Lee and

Table 4: Effects of substituting SBM by three varieties of FSFS at three rates during growing period on FI (g / bird), PI and mortality rate of Japanese quail.

Item	Feed intake	P I	Mortality rate, %
Variety :			
Isoflower	**657.73±1.22^{C}**	**5.42±0.14^{A}**	**7.79 ± 0.00 ^{a} [1]**
Vebes	**656.19±1.22^{C}**	**4.82±0.14^{B}**	**7.79± 0.00 ^{a}**
Vedock	**661.92±1.24^{B}**	**4.53±0.14^{B}**	**8.00 ± 0.00 ^{a}**
SBM	**666.51±1.01^{A}**	**4.61±0.12^{B}**	**7.86 ± 0.00^{a}**
Level of FSFS, %:			
0	**666.51±0.799^{A}**	**4.61±0.12^{b}**	**7.86 ± 0.00 ^{a}**
10	**651.86±0.788^{B}**	**5.04±0.11^{a}**	**7.86 ± 0.00 ^{a}**
20	**665.27±0.788^{A}**	**4.90±0.11^{ab}**	**7.86 ± 0.00 ^{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 $P \leq 0.01$.

Yang (1980) reported no significant difference in mortality rate of broiler fed 0 and 5% FSFS. Therefore, the three FSFS varieties used in this research can substitute SBM up to 20% during the growing period without any detrimental effects on mortality rate of Japanese quail.

1.6. Slaughter parameters: -

Data presented in Tables 5 and 6 revealed that FSFS varieties significantly affected: abdominal fat, intestinal length percentages of front meat, rear meat and whole meat. Quails fed Isoflower diet had higher intestinal length, front, rear and whole meat %. However, lower values were obtained for quails fed SBM diet.

Level of FSFS significantly affected abdominal fat %, intestinal length (cm) carcass, dressing, front meat, rear meat and whole meat percentage. The data indicated that birds fed FSFS substituting 10-20% of SBM had higher values for carcass, dressing, front, rear meat, and whole meat percentages. Abdominal fat % was significantly ($P \leq 0.05$) lower in carcasses of quails fed 10-20% of FSFS replacing SBM. Substitution of 10-20% of SBM by FSFS was related to longer intestine being 65.24 to 67.71 (cm) vs 51.50 for the control. However, insignificant differences were observed in giblets percentages, and cecum length.

Therefore, the three FSFS varieties used in this research can substitute up to 20% of SBM during the period from 7 to 42 days of age without any detrimental effects on slaughter parameters of Japanese quail at 42 days of age. This result is in line with those of Daghir *et al.* (1980), Elzubeir and Ibrahim (1991) and Raya *et al.* (1987) who observed no significant differences in relative

Table 5 : Effects of substituting SBM by three varieties of FSFS at three rates on some slaughter parameters of Japanese quail at 42 days of age.

Item	Giblets %	Abdominal fat %	Intestinal length, Cm	Cecum length, Cm
Variety :				
Isoflower	5.34±0.22 ^{a}	1.263±0.36 ^{b}	67.75±2.02 ^{A}	9.81±0.44 ^{a}
Vebes	5.97±0.22 ^{a}	0.575±0.36 ^{b}	66.88±2.02 ^{A}	9.91±0.44 ^{a}
Vedock	5.86±0.22 ^{a}	0.750±0.36 ^{b}	64.81±2.02 ^{A}	9.61±0.44 ^{a}
SBM	5.72±0.20 ^{a}	2.133±0.34 ^{a}	49.67±1.90 ^{B}	9.33±0.42 ^{a}
Level of FSFS, %:				
0	5.66±0.22 ^{a}	1.10±0.21^{a}	51.50±1.90^{B}	9.12±0.51 ^{a}
10	6.01±0.19 ^{a}	0.31±0.18^{b}	67.71±1.70^{A}	9.55±0.44 ^{a}
20	5.57±0.19 ^{a}	0.47±0.18^{ab}	65.24±1.70^{A}	9.59±0.44 ^{a}
Sex :				
F	5.92±0.18 ^{a}	0.73±0.17 ^{a}	64.00±1.60^{a}	8.86±0.42 ^{a}
M	5.59±0.14 ^{a}	0.53±0.13 ^{a}	58.96±1.20^{b}	9.98±0.33 ^{a}
Overall mean	5.75±0.11	0.63±0.11	61.48±1.01	9.42±0.27
Variety x Level :				
Control	5.66±0.38 ^{a}	1.10±0.36 ^{a}	51.50±3.35 ^{a}	9.125±0.89 ^{a}
Isoflower x 10	5.33±0.31 ^{a}	0.53±0.29 ^{a}	67.75±2.73 ^{a}	10.05±0.72 ^{a}
Isoflower x 20	5.34±0.31 ^{a}	0.63±0.29 ^{a}	67.75±2.73 ^{a}	9.575±0.72 ^{a}
Vebes x 10	6.36±0.31 ^{a}	0.17±0.29 ^{a}	70.87±2.73 ^{a}	9.850±0.72 ^{a}
Vebes x 20	5.62±0.36 ^{a}	0.26±0.34 ^{a}	62.58±3.15 ^{a}	9.350±0.83 ^{a}
Vedock x 10	6.34±0.36 ^{a}	0.23±0.34 ^{a}	64.50±3.15 ^{a}	8.750±0.83 ^{a}
Vedock x 20	5.76±0.31 ^{a}	0.53±0.29 ^{a}	65.37±2.73 ^{a}	9.850±0.72 ^{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 $P \leq 0.01$.

Table 6: Effects of substituting SBM by three varieties of FSFS at three rates on other slaughter parameters of Japanese quail at 42 days of age.

Item	Carcass %	Dressing %	Front meat %	Rear meat %	Whole meat %
Variety :					
Isoflower	62.56±1.30 ^{a}	67.90±1.31^{a}*	84.77±0.78 ^{A}	83.63±0.82 ^{a}	84.20±0.71 ^{A}
Vebes	64.17±1.30 ^{a}	70.14±1.31 ^{a}	84.22±0.78 ^{A}	83.18±0.82 ^{a}	83.70±0.71 ^{A}
Vedock	62.93±1.30 ^{a}	68.79±1.31 ^{a}	83.65±0.78 ^{A}	82.68±0.82 ^{a}	83.16±0.71 ^{A}
SBM	59.67±1.23 ^{a}	65.39±1.23 ^{a}	80.80±0.73 ^{B}	80.28±0.77 ^{b}	80.54±0.67 ^{B}
Level of FSFS, %:					
0	58.50±1.40^{b}	64.17±1.44^{b}	79.90±0.59^{B}	79.01±0.34^{B}	79.46±0.39^{B}
10	61.91±1.20^{ab}	67.92±1.24^{ab}	84.05±0.59^{A}	83.35±0.29^{A}	83.70±0.34^{A}
20	63.96±1.20^{a}	69.54±1.24^{a}	84.46±0.59^{A}	82.98±0.29^{A}	83.72±0.34^{A}
Sex :					
F	59.63±1.16^{b}	65.55±1.20^{b}	81.66±0.57^{B}	80.43±0.28^{B}	81.04±0.33^{B}
M	63.28±0.90^{a}	68.87±0.92^{a}	83.95±0.44^{A}	83.13±0.22^{A}	83.54±0.25^{A}
Overall mean	61.46±0.73	67.21±0.76	82.80±0.36	81.78±0.18	82.29±0.21
Variety x Level :					
Control	58.50±2.42 ^{a}	64.17±2.50 ^{a}	79.90±1.19 ^{a}	79.01±0.58 ^{a}	79.46±0.68 ^{a}
Isoflower x 10	61.88±1.98 ^{a}	67.21±2.04 ^{a}	83.90±0.97 ^{a}	83.15±0.48 ^{a}	83.52±0.56 ^{a}
Isoflower x 20	63.24±1.98 ^{a}	68.59±2.04 ^{a}	85.64±0.97 ^{a}	84.11±0.48 ^{a}	84.87±0.56 ^{a}
Vebes x 10	62.51±1.98 ^{a}	68.88±2.04 ^{a}	84.41±0.97 ^{a}	83.26±0.48 ^{a}	83.84±0.56 ^{a}
Vebes x 20	65.53±2.28 ^{a}	71.15±2.35 ^{a}	84.38±1.12 ^{a}	82.40±0.55 ^{a}	83.39±0.64 ^{a}
Vedock x 10	61.33±2.28 ^{a}	67.67±2.35 ^{a}	83.85±1.12 ^{a}	83.64±0.55 ^{a}	83.74±0.64 ^{a}
Vedock x 20	63.11±1.98 ^{a}	68.87±2.04 ^{a}	83.36±0.97 ^{a}	82.42±0.48 ^{a}	82.89±0.56 ^{a}

[1] Mean ± standard error of the mean.

*Dressing % included: Carcass weight, liver, gizzard, and heart.

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

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

weights of giblets of broiler chicks fed semi-purified diets containing up to 22.5% FSFS. On the contrary, Raya *et al.* (1997) reported significant differences in relative weight of abdominal fat, which increased gradually with increments of the inclusion rate of FSFS (10 to 25%) in the diets. Also, Cheva-Isarakul and Tangtaweewipat (1991) reported that the abdominal fat percentage plus visceral fat weight increased significantly, when FSFS was fed at level of 30,40 and 50% of diets for broiler.

Males had significantly higher carcass, dressing, front meat, rear meat and whole meat % than females. These results are in harmony with the findings of Tserveni- Gousi and Yannakopoulos (1986), who reported that sex significantly influenced carcass weight expressed as a proportion of live body weight. The increased yield in males, with a body weight less than females, may be attributable to the lighter liver and alimentary tract weights. Also, Cheva-Isarakul and Tangtaweewipat (1991) reported that weights of the liver is noticeably higher in female than in male chicks. This reflected the effect of fat accumulation due to the influence of sex hormone (Guyton, 1971). Similarly, Yannakopoulos *et al*., 1995 and Sharaf, 1996, reported significant sex effect on carcass characteristics. However, El Full *et al.* (2001) reported that sex insignificantly affected percentages of boneless meat. While, sex difference was more apparent in dressing % after sexual maturity due to the relatively large ovaries, liver and intestines of the females (Wilson *et al*., 1961). Data presented in Tables 5 and 6 revealed that variety x level interactions insignificantly affected slaughter parameters.

1. 7. Plasma constituents: -

Data of plasma constituents analyses are summarized in Tables 7 and 8. The results indicated that FSFS varieties significantly affected plasma phosphorus and triglycerides. Quails fed Vebes diet had the highest value of phosphorus and quails fed Isoflower diet had the highest value of triglycerides, whereas, the lowest values for phosphorus and triglycerides was obtained for quails fed SBM diet. The plasma triglycerides of quails fed the control (SBM) diet was almost 1/3 of that in plasma of quails fed the FSFS diets. This may be a result of the high EE of the 3 FSFS varieties, although the EE of the diets fed ranged between 4.11 and 4.54% compared with 3.59% for the control (SBM) diet. Further research is needed to clarify this point. However, insignificant differences were observed for other plasma constituents.

Concerning effects of level of FSFS on plasma constituents data in Tables 7 and 8 show significant effects on P, triglycerides and GOT. Results indicate that FSFS substituting 20% of SBM had the highest values, whereas lower values were obtained from quails fed the lower substitution or the control diet. Again the effect of feeding FSFS varieties as 10 or 20% from the SBM express itself in gradual but consistent increase in plasma P, triglycerides and GOT. Further research is warranted to investigate the relationships between these constituents and the FSFS. Total lipid, total protein, albumin, globulin, triglycerides, GOT

Table 7: Effects of substituting SBM by three varieties of FSFS at three rates on some plasma constituents of Japanese quail at 42 days of age.

Item	Total lipids mg/dl	Urea M mol/L	Total protein g/dl	Albumin g/dl	Globulin g/dl
Variety :					
Isoflower	611.36±34.3[1a]	7.01±0.49[a]	4.62±0.23[a]	2.87±0.19[a]	1.75±0.16[a]
Vebes	593.14±34.3[a]	7.39±0.49[a]	4.84±0.23[a]	3.00±0.19[a]	1.83±0.16[a]
Vedock	589.87±33.5[a]	6.44±0.46[a]	4.78±0.22[a]	2.97±0.18[a]	1.80±0.15[a]
SBM	539.22±30.8[a]	7.11±0.40[a]	4.70±0.19[a]	2.83±0.15[a]	1.64±0.13[a]
Level of FSFS, %:					
0	539.22±37.6[a]	7.11±0.47[a]	4.50±0.17[a]	2.83±0.15[a]	1.64±0.16[a]
10	581.75±32.6[a]	6.74±0.41[a]	4.71±0.15[a]	3.06±0.14[a]	1.65±0.14[a]
20	653.42±31.7[a]	7.11±0.39[a]	4.77±0.15[a]	2.85±0.13[a]	1.92±0.14[a]
Sex :					
F	596.98±30.7[a]	7.48±0.39[a]	4.79±0.14[a]	3.01±0.13[a]	1.77±0.13[a]
M	585.84±24.6[a]	6.49±0.31[a]	4.53±0.11[a]	2.81±0.10[a]	1.72±0.11[a]
Overall Mean	591.46±19.6	6.99±0.25	4.66±0.09	2.91±0.08	1.75±0.09
Variety x Level :					
Control	539.22±65.1[a]	7.11±0.82[a]	4.47±0.30[a]	2.83±0.28[a]	1.64±0.28[a]
Isoflower x 10	592.79±56.4[a]	7.23±0.71[a]	4.60±0.26[a]	3.00±0.24[a]	1.60±0.25[a]
Isoflower x 20	702.08±56.4[a]	6.78±0.71[a]	4.65±0.26[a]	2.74±0.24[a]	1.91±0.25[a]
Vebes x 10	607.59±56.4[a]	7.32±0.71[a]	5.00±0.26[a]	3.25±0.24[a]	1.75±0.25[a]
Vebes x 20	632.59±56.4[a]	7.46±0.71[a]	4.67±0.26[a]	2.75±0.24[a]	1.92±0.25[a]
Vedock x 10	544.87±56.4[a]	5.67±0.71[a]	4.54±0.26[a]	2.93±0.24[a]	1.60±0.25[a]
Vedock x 20	625.58±51.5[a]	7.09±0.65[a]	4.98±0.24[a]	3.06±0.22[a]	1.92±0.23[a]

[1] Mean ± standard error of the mean.

Table 8: Effects of substituting SBM by three varieties of FSFS 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 :					
Isoflower	9.91±0.79 ^{1a}	5.00±0.51 ^{ab}	145.16±21.5^{A}	16.87±2.25 ^{a}	8.00±1.13^{a}
Vebes	10.23±0.79 ^{a}	5.81±0.51 ^{a}	112.15±21.5^{A}	17.00±2.25 ^{a}	7.12±1.13^{a}
Vedock	9.54±0.74 ^{a}	5.64±0.48 ^{a}	118.38±20.3^{A}	13.67±2.12 ^{a}	6.67±1.06^{a}
SBM	9.61±0.64 ^{a}	4.29±0.42 ^{b}	35.75 ±17.5^{B}	11.00±1.84 ^{a}	6.00±0.92^{a}
Level of FSFS, %:					
0	9.61±0.68 ^{a}	4.29±0.47^{b}	35.75±15.5^{C}	11.00±1.85^{b}	6.00±1.88 ^{a}
10	9.82±0.59 ^{a}	4.96±0.41^{ab}	99.74±13.4^{B}	13.17±1.60^{b}	7.42±0.88 ^{a}
20	9.89±0.58 ^{a}	6.08±0.40^{a}	140.82±13.0^{A}	18.58±1.56^{a}	7.00±0.85 ^{a}
Sex :					
F	10.76±0.56^{a}	5.76±0.39 ^{a}	106.11±12.6 ^{a}	13.51±1.51 ^{a}	6.06±0.83 ^{a}
M	8.78 ±0.45^{b}	4.46±0.31 ^{b}	78.02 ±10.1 ^{a}	15.28±1.21 ^{a}	7.56±0.66 ^{a}
Overall Mean	9.77 ±0.36	5.11±0.25	92.06 ±8.09	14.25±0.97	6.81±0.53
Variety x Level :					
Control	9.61±1.19 ^{a}	4.29±0.82 ^{a}	35.75±26.8 ^{a}	11.00±3.20 ^{a}	6.00±1.70 ^{a}
Isoflower x 10	10.59±1.03 ^{a}	4.34±0.71 ^{a}	108.29±23.2 ^{a}	16.50±2.77 ^{a}	8.00±1.52 ^{a}
Isoflower x 20	9.23±1.03 ^{a}	5.67±0.71 ^{a}	159.64±23.2 ^{a}	17.25±2.77 ^{a}	8.00±1.52 ^{a}
Vebes x 10	10.48±1.03 ^{a}	5.20±0.71 ^{a}	114.83±23.2 ^{a}	10.00±2.77 ^{a}	9.25±1.52 ^{a}
Vebes x 20	9.97±1.03 ^{a}	6.43±0.71 ^{a}	109.46±23.2 ^{a}	24.00±2.77 ^{a}	5.00±1.52 ^{a}
Vedock x 10	8.38±1.03 ^{a}	5.34±0.71 ^{a}	76.09 ±23.2 ^{a}	13.00±2.77 ^{a}	5.00±1.52 ^{a}
Vedock x 20	10.47±0.94 ^{a}	6.15±0.65 ^{a}	153.35±21.1 ^{a}	14.50±2.53 ^{a}	8.00±1.39 ^{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 $P \leq 0.01$.

and GPT in this study are within the normal range of quail chick as reported by Khashaba, *et al.* (2000 and 2001). On the other hand, insignificant differences were found in total lipid, urea, total protein, albumin, globulin, calcium and GPT.

Females had significantly (P≤0.05) higher calcium than males (10.76 vs 8.78), whereas insignificant differences were observed for other plasma constituents. Although triglycerides in females were 35% higher than in males but this difference was insignificant.

In this regard, Raya (1989), Raya and El-Shinnawy (1989), Raya *al.* (1991) and Raya *et al.*(1997) reported no significant differences among treatments in plasma total lipids of broiler chicks fed isocaloric and iso-nitrogenous diets .

Therefore, the three FSFS varieties used in this research can substitute SBM up to 20% during the period from 7 to 42 days of age without any detrimental effects on plasma constituents of Japanese quail at 42 days of age.

1.8. Chemical composition of Japanese quail meat :-

Data presented in Table 9 showed that there were neither significant nor consistent effect of substituting SBM by FSFS varieties on chemical composition of Japanese quail meat at 7 weeks of age except ash %. This might be expected as a result of feeding such experimental diets, which had similar CP and ME contents. In addition, there were no specific changes in their composition. It is well know that, only specific changes in either dietary protein, fat or energy level produce changes in total body composition. These composition changes are

Table 9: Effects of substituting SBM by three varieties of FSFS at three rates on chemical composition of Japanese quail meat at 42 days of age.

Item	Moisture %	Protein %	Fat %	Ash %
Variety :				
Isoflower	65.81±0.25[1a]	20.66±0.13 [a]	8.75±0.20 [a]	1.42±0.05 [a]
Vebes	65.93±0.25 [a]	20.53±0.13 [a]	8.91±0.20 [a]	1.28±0.06 [b]
Vedock	66.12±0.25 [a]	20.60±0.13 [a]	8.79±0.20 [a]	1.37±0.06 [b]
SBM	66.03±0.24 [a]	20.62±0.12[a]	8.33±0.19[a]	1.18±0.05 [b]
Level of FSFS, %:				
0	66.03±0.25 [a]	20.62±0.15 [a]	8.33±0.18[b]	1.18±0.04[B]
10	66.28±0.28 [a]	20.53±0.13 [a]	8.77±0.16[ab]	1.39±0.04[A]
20	65.62±0.20 [a]	20.65±0.13 [a]	8.99±0.15[a]	1.33±0.04[A]
Sex :				
F	65.91±0.19 [a]	20.53±0.12 [a]	8.47±0.13[b]	1.34±0.04 [a]
M	66.05±0.16 [a]	20.66±0.10 [a]	8.93±0.13[a]	1.26±0.03 [a]
Carcass part :				
Front part	66.03±0.18 [a]	20.61±0.11 [a]	8.42±0.13[B]	1.40±0.03[A]
Rear part	65.92±0.18 [a]	20.59±0.11 [a]	8.97±0.14[A]	1.21±0. 03[B]
Overall Mean	65.98±0.12	20.60±0.08	8.70±0.09	1.30±0.02
Variety x Level :				
Control	66.03±0.42[AB]	20.62±0.26 [a]	8.33±0.31[B]	1.18±0.08 [a]
Isoflower x 10	65.86±0.3[ABC]	20.45±0.21 [a]	8.98±0.26[AB]	1.49±0.06 [a]
Isoflower x 20	65.75±0.35[BC]	20.85±0.21 [a]	8.52±0.26[B]	1.34±0.06 [a]
Vebes x 10	67.02±0.35[A]	20.59±0.21 [a]	8.26±0.26[B]	1.28±0.06 [a]
Vebes x 20	64.84±0.35[C]	20.51±0.24 [a]	9.65±0.27[A]	1.31±0.07 [a]
Vedock x 10	65.96±0.35[AB]	20.55±0.24 [a]	9.07±0.30[AB]	1.39±0.06 [a]
Vedock x 20	66.28±0.35[AB]	20.57±0.21 [a]	8.80±0.26[AB]	1.34±0.06 [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 $P \leq 0.01$.

chiefly in the ratio of moisture to fat with protein level remaining relatively constant (Rand *et al.*(1957). In addition, changes in fat deposition in the chickens are primarily in skin and adipose tissues, with less marked changes occurring in muscle tissues (Essary and Dawson, 1965). Since such dietary changes were not made in the present work, it is not surprising therefore that any variation in the chemical composition for meat of the experimental quails did not appear.

On the other hand, level of FSFS significantly, affected fat (P≤0.05) and ash % (P≤0.01). It was observed that quails fed 20% and 10 % substitutions of SBM by FSFS had the highest fat and ash %, respectively as compared with the lowest values obtained for quails fed the SBM diet. However, insignificant differences were observed in moisture and protein % (Table 9).

Females had significantly (P≤0.05) lower fat % than males. On the contrary, sex did not affect chemical components of Japanese quail meat for front, rear, and whole carcass (Yanakopoulos *et al.*, 1995), whereas, insignificant differences were observed for moisture, protein and ash %.

Regarding effect of carcass part, it significantly influenced (P≤0.01) fat and ash %. It can be seen that rear meat had the higher fat % than front meat but front meat had the higher ash % than rear meat. On the other hand, it insignificantly influenced moisture and protein %. These results are in line with those of Raya *et al.* (1997) who observed no significant differences among treatments in the chemical composition (moisture and protein %) of either breast or thigh meat of the broilers. Statistically, variety x level interactions insignificantly affected chemical composition of Japanese quail meat except moisture and fat %.

1.9. Economic efficiency :-

Data in Table 10 illustrate the economic parameters of the present experimental diets. It can be seen that Isoflower substituting for 10% SBM gave best economic and relative efficiency. Whereas, birds fed Vedock to replace 20% SBM had the worst values. The relative efficiency varied between – 6% to + 4% which is of minor importance considering other factors of production. It can be concluded that feeding different varieties and levels of FSFS had no detrimental effects on economic parameters at the marketing time of growing quail.

2. Laying period: -

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

The values of egg production during the period from 43 to 112 days of age are presented in Table 11. Results showed that variety, level and variety x level of FSFS insignificantly affected egg number and egg mass during the period from 43 to 112 days of age. From these results where comparable values for egg number, egg weight and consequently egg mass, were obtained during the experimental period (43- 112 days), it may be concluded that the 3 varieties of FSFS can be satisfactorily used in laying quail diets up to 112 days of age.

Insignificant effects were observed in egg weight and egg mass during the entire experimental period due to the use of FSFS at level substituting 10-20% of

Table 10: Effects of substituting SBM by three varieties of FSFS at three rates during growing period on economic efficiency of Japanese quail.

Item	Control	Isoflower		Vebes		Vedock	
		10%	20%	10%	20%	10%	20%
Average feed intake(Kg/bird) a	0.67	0.66	0.65	0.65	0.66	0.64	0.68
Price/Kg feed (PT)* b	90.80	89.09	92.03	92.03	93.70	92.290	92.67
Total feed cost (PT)= axb =c	60.52	58.79	60.32	59.94	61.94	59.435	62.99
Price / one quail (PT)** d (total revenue)	200.00	200.00	200.00	200.00	200.00	200.00	200.00
Net revenue (PT) = d - c = e	139.48	141.21	139.68	140.06	138.06	140.56	137.01
Economic efficiency e /c***	2.30	2.40	2.32	2.34	2.23	2.36	2.17
Relative efficiency****	100.00	104.22	100.47	101.39	96.71	102.62	94.37

* 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 groups equals 100.

Table 11: Effects of substituting SBM by three varieties of FSFS at three rates on egg number, egg weight (g), egg mass (g) Feed intake (FI) and Feed conversion (FC) of Japanese quail during laying period.

Item	Egg number	Egg weight(g)	Egg mass(g)	Feed intake (g)	Feed conversion
Variety :					
Isoflower	0.54±0.08 [a]	11.97±0.19[a]	6.52±0.93 [a]	27.89±2.72[a]	4.77±0.67[a]
Vebes	0.61±0.08 [a]	11.65±0.19[a]	7.13±0.93 [a]	30.73±2.72 [a]	4.72±0.67 [a]
Vedock	0.63±0.08 [a]	12.35±0.19[a]	7.78±0.93 [a]	29.87±2.72 [a]	4.26±0.67 [a]
SBM	0.54±0.06 [a]	11.88±0.15[a]	6.44±0.76[a]	34.08±2.22 [a]	5.74±0.55 [a]
Level of FSFS, %:					
0	0.54±0.08 [a]	11.88±0.13[a]	6.44±0.92 [a]	34.08±2.418 [a]	5.74±0.62 [a]
10	0.57±0.08 [a]	11.80±0.13[a]	6.72±0.92 [a]	30.74±2.418 [a]	5.11±0.62 [a]
20	0.62±0.08 [a]	12.18±0.13[a]	7.57±0.92 [a]	28.25±2.418 [a]	4.06±0.62 [a]
Overall mean	0.58±0.04	11.95±0.07	6.91±0.53	31.02±1.396	4.97±0.36
Variety x Level % :					
Control	0.54±0.14 [a]	11.88±0.22[a]	6.44±1.60[a]	34.08±4.19 [a]	5.74±1.07 [a]
Isoflower 10	0.50±0.14 [a]	11.98±0.22[a]	6.07±1.60[a]	25.51±4.19 [a]	4.85±1.07 [a]
Isoflower 20	0.58±0.14 [a]	11.95±0.22[a]	6.98±1.60[a]	30.26±4.19 [a]	4.69±1.07 [a]
Vebes 10	0.57±0.14 [a]	11.58±0.22[a]	6.60±1.60[a]	33.70±4.19 [a]	5.53±1.07 [a]
Vebes 20	0.65±0.14 [a]	11.73±0.22[a]	7.66±1.60[a]	27.77±4.19 [a]	3.96±1.07 [a]
Vedock 10	0.63±0.14 [a]	11.85±0.22[a]	7.49±1.60[a]	33.02±4.19 [a]	4.95±1.07 [a]
Vedock 20	0.63±0.14 [a]	12.85±0.22[a]	8.06±1.60[a]	26.72±4.19 [a]	3.58±1.07 [a]

[1] Mean ± standard error of the mean.

SBM. Thus, FSFS can be used satisfactorily to substitute up to 20% SBM in laying quails diets. These results are in harmony with the findings of Uwayjan *et al.*(1983), Lee and Moss (1989) , Kashani and Carlson (1988) and Tangtaweewipat and Cheva-Isarakul (1990).

2.2. Feed intake (FI) and Feed conversion (FC) :-

Data presented in Table 11 indicated that variety, level and variety x level of FSFS insignificantly affected FI and FC during the laying period of quails.

2.3. Economic efficiency

Economic parameters of the present experimental diets are presented in Table 12. It can be observed that quails fed diet containing Vedock substituting 20% SBM had the best economic and relative efficiency. It may be noted that the Vedock diet (20 %) was 6 % lower than the control in economic efficiency during the growing period. The respective values for Vebes diets (20%) were 3.52 and 159.24. Relative efficiency values for other diets ranged between 109.18 (Vebes, 10%) and 135.51 (Isoflower, 10%). Whereas, birds fed the control diet had the worst values, being 2.21 and 100.00, respectively. It can be concluded that feeding different varieties and levels of FSFS had no detrimental effects on economic parameters during laying period of quails since all diets used were better than the control diet with respect to economic efficiency.

Table 12: Effects of substituting SBM by three varieties of FSFS at three rates during laying period on economic efficiency of Japanese quail.

Item	Control	Isoflower		Vebes		Vedock	
		10%	20%	10%	20%	10%	20%
Average feed intake(g/bird/day) a	34.08	25.51	30.26	33.70	27.77	33.02	26.72
Price/g feed (PT)* b	0.074	0.074	0.077	0.074	0.078	0.075	0.077
Total feed cost (PT)= a x b = c	2.53	1.88	2.34	2.50	2.17	2.46	2.06
Price / one egg (PT)** d	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Egg number (bird / day) e	0.54	0.50	0.58	0.57	0.65	0.63	0.63
Total revenue (PT) = d x e = f	8.13	7.50	8.77	8.55	9.82	9.53	9.45
Net revenue (PT) = f – c = g	5.60	5.62	6.43	6.04	7.65	7.10	7.39
Economic efficiency g / c ***	2.21	3.00	2.74	2.41	3.52	2.86	3.58
Relative efficiency****	100.00	135.51	124.06	109.18	159.24	129.43	162.09

* 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 groups equals 100.

REFERENCES

A.O.A.C., 1990. Official Methods of Analysis Association of Official Analytical Chemists, 15th Edition, Washington, D.C, USA.

Cheva-Isarakul, B. and S. Tangtaweewipat, 1991. Effect of different levels of sunflower seed in broiler rations. Poultry Sci., **70**: 2284-2294.

Daghir, N.J., M.A. Raz and M. Uwayjan, 1980. Studies on the utilization of full fat sunflower seed in broiler rations. Poultry Sci., **59**: 2273-2278.

Dorrell. D.G. and B.A. Vick, 1997. Properties and processing of oilseed sunflower. in: Sunflower Technology and Production (Schneiter, A.A., Ed.) , Amer. Soc. Agron., Madison, Wisconsin, USA.

Duncan, D.B., 1955. Multiple range and multiple F tests. Biometrics, 11: 1-42.

Earle, F.R., C.H. Vanetten, T.F. Clark and I.A. Wolff, 1968. Compositional data on sunflower seed. J. Amer. oil Chem., Soc. **45**: 876-879.

El Full, E.A., A. A. Ali , M. H. Abd El Fattah and M. A. Khalifa 2001. Genetic parameters of some carcass characteristics and chemical composition in the Japanese quail. Egypt. Poultry Sci. J., **21**: 741-763 .

Elzubeir, E.A. **and M.A. Ibrahim, 1991.** Effect of dietary full-fat raw sunflower seed on performance and carcass skin colour of broilers. J. Sci., Food Agric., **55:** 479-481.

Essary, E.O. and L.E. Dawson, 1965. Quality of fryer carcass as related to protein and fat levels in the diet. 1- Fat deposition and moisture pickup during chilling. Poultry Sci., **44:** 7-15.

Guyton, **A.C., 1971**. Textbook of Medical Physiology, 4th ed. W. B. Saunders Company, Philadelphia, USA.

Janssen, W. M. M. A., 1989. European Table of Energy Values For Poultry Feedstuffs, 3rd ed, Spelderholt Center for Poultry Research and Information Services, Beekbergen, Netherlands.

Kashani, A. and C.W. Carlson, 1988. Use of sunflower seed in grower diets for pullets and subsequent performance as affected by aureomycin and pelleting. Poultry Sci., **67**: 445-451.

Khashaba, B.M., K. M. Y. El-Nagmy and M. R. Ibrahim, 2000. Effect of bacitracin source and type of diet on growth, carcass characteristics and blood constituents of Japanese quails. Zagazig J. Agric. Res., **28 (5):** 215-229.

Khashaba, B.M., E. M. A. Qota and N.M. El-Naggar, 2001. Effect of garlic powder or its ethanolic extract on the performance and biochemical traits in Japanese quails, pp. 595-606. The Second Inter Conf. on Anim. Prod. & Health in Semi Arid Areas, Sept. 2001, El Arish, Egypt.

Lee, K. and C.W. Moss, 1989. Performance of laying chickens fed diets containing confectionary-type sunflower seeds. Poultry Sci., **68:** 84.

Lee, P.K. **and Y.F. Yang, 1980.** Raw unhulled sunflower seed feedstuff for broiler chicks. J. Taiwan Livest. Res., **13(2):** 49-57.

Ministry of Agriculture and Land Reclamation, 2000. Economic Affairs Sector, Agricultural Statistics, Vol 2.

National Research Council, 1994. Nutrient Requirements of Poultry. National Academy Press. Washington, D.C., U.S.A.

Ragab, M. S., 2001. A study of substituting yellow corn and soybean meal by sorghum grain and raw sunflower on the performance of Japanese quail. Ph.D. Thesis, Fac. Agric., Cario University, Fayoum.

Rand, N.T., F.A. Kummerow and H.M. Scott, 1957. The relationship of dietary protein, fat and energy on the amount composition and origin of chick carcass fat. Poultry Sci **36**: 1151.

Raya, A.H., 1989. Some nutritional studies on the efficiency of sorghum grain to replace yellow corn in ration for broiler chicks. 2- Effects on carcass yield, composition of meat and blood constituents. J. Agric. Sci., Mansoura Univ., **14(2):** 1326-1335.

Raya, A.H. and M.M. El-Shinnawy, 1989. Comparative study on the nutritive value of broken rice and yellow corn in ration for broiler chicks. 2- Effects on carcass yield, composition of meat and blood constituents. J. Agric. Sci., Mansoura Univ., **14(2):** 1374-1385.

Raya, A.H., A.K. Abou-Raya, M.M. El-Shinnawy and A.A. El-Serwy, 1987. Some nutritional studies on unextracted soybean for broiler chicks. 3.Effects of heat treatment on nutrients digestibility and energy metabolizability of unextracted soybean. J. Agric. Sci., Mansoura Univ., **12(2):** 1475-1489.

Raya, A.H., T. Gippert, L. Halmgyi and S. Hejja, 1989. The possibility of using sunflower meal to replace soybean meal in broiler ration and effect on the performance of chicks and nutrients digestibility. J. Agric. Sci., Mansoura Univ., **14(2):** 1336-1348.

Raya, A.H., A.M. Abbas and M.A.A. Hussein, 1991. Comparative study on the efficiency of plant protein sources to replace soybean meal in rations for broiler chicks. 2- Nutrient digestibility and blood constituents. J. Agric. Sci., Mansoura Univ., **16(2):** 2514-2527.

Raya, A.H., M. Tork, M.M, El-Shinnawy and H.I.A. Sitteen, 1997. Nutritional and physiological studies on the utilization of raw full-fat sunflower seed in diets for broiler chicks. 1- Performance, carcass yield and economic efficiency. J. Agric. Sci., Mansoura Univ., **22(5):** 1369-1382.

Roth-Maier, D.A. and M. Kirchgessner, 1995. Feeding of full-fat flax seed and sunflower seed to fattening chickens. Arch. Gefugelk., **59(6):** 319-322.

Sharaf, M. M., 1996. Cage versus floor rearing of Japanese quails as affected by sex, age and bird density. Egypt. Poultry Sci., **16**: 725-738.

Steel, R.G.D. and J.H. Torrie, 1980. Principles and procedures of statistics: A Biometrical Approach 2nd ed. McGraw-Hill Book Co., Inc., New York, USA.

Tangtaweewipat, S. and B. Cheva-Isarakul, 1990. Utilization of sunflower seeds as protein and energy source in poultry diet. Pages 47-59 in: Proceedings of the 28th Annual Agric. Conf., Anim. Div. 29-31 January 1990, Kasetsart Univ., Amarin Printing Group Co., Ltd., Bangkok, Thailand.

Tserveni-Gousi, A.S. and A. L. Yannakopoulos, 1986. Carcass characteristics of Japanese quail at 45 days of age. Br. Poultry Sci., **27**: 123-127.

Uwayjan, M.G., E.J. Azar and N.J. Daghir, 1983. Sunflower seed in laying hen rations. Poultry Sci., **62**: 1247-1253.

Waldroup, P. W., C. M. Hillard and R. J. Mitchell, 1970. Sunflower meal as a protein supplement for broiler diets. Feedstuffs, 42(43): 41.

Wilson, W. O., U.K. Abbott and A. Abplanalp, 1961. Evaluation of coturnix (Japanese quail) as pilot animal for poultry. Poultry Sci., **40**: 651-657.

Yannakopoulos, A.L., F. Christaki and P. Florou-Paneri, 1995. Effect of age and carcass composition on the onset of sexual maturity in quail under normal feeding regimens. Br.Poultry Sci., **36**: 771-777.

Zhang, Y. And C.M. Parsons, 1994. Effects of overprocessing on the nutritional quality of sunflower meal. Poultry Sci., **73**: 436-442.