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Effect of Using Extruded Full-Fat Soybean on Performance and Carcass Characteristics in Female Turkeys

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ABSTRACT

The use of full fat soybeans (FFSB) in poultry nutrition is limited because of the presence of anti-nutritional factors, which can be inactivated by means of heat treatment. Over-processing of FFSB may result in deficient amino acid availability. An experiment, effects of replacing soybean meal (SBM) with different levels of the EFFSB on performance and carcass characteristics of diets turkeys were evaluated. A total of 300 one day female turkey B.U.T (big 6) were selected and divided into four experimental groups with three replicates containing 25 poults each, in a completely randomized design and were fed experimental diets for 18 weeks. The basic diet of the control groups and included 0, 10, 15 and 20% of the extruded full-fat soybean. There was negligible changes in mortality and properties of the carcass. The results showed that the level of feed intake was decreased, while feed efficiency and body weight gain was improved in female turkey fed with different levels of the EFFSB. As a result, the best growth performance was determined for female turkeys fed diets containing 15 and 20% of EFFSB, which was exceeded significantly ($p \leq 0.05$). The experiment confirmed that addition of extruded full-fat soybean in female turkey diets had influenced on biochemical parameters of blood, so that cholesterol and triglyceride were reduced significantly ($p \leq 0.05$) on serum lipid of female turkey.

Key words: Extruded, female turkeys, performance, soybean meal

INTRODUCTION

Soybean and soybean products are the most important sources of protein and energy in livestock feeds for many animals. Soybeans have a good amino acids profile, with high content of lysine, tryptophan, isoleucine, valine and threonine (Larbier and Leclercq, 1994). In addition, soybean contain form 18-22% of oil with good quality mainly with high content of linoleic acids. In general, full-fat soybean may be not only good sources of protein but also of energy and it can replace soybean meal in swine and poultry diets with similar anticipated performance. However, raw soybean contain a number of anti-nutritional factors.

The necessity of heat treatment before feeding full fat soybean diet to poultry has been documented (ASA., 1997). This is due to the presence of several Anti-Nutritional Factors (ANFs) in variable amount in the raw soybean seeds. The ANFs in soybean consist mainly of heat labile (trypsin inhibitors, lectins, goitrogens, phytates) and heat stable (oligosaccharides) factors (Feng *et al*., 2007; Soetan and Oyewole, 2009; Ebrahimi-Mahmoudabad and Taghinejad-Roudbaneh, 2011). These ANFs compounds interfere with metabolic processes and nutrient availability thereby, leading to the low acceptance and utilization of soybean products (Caprita *et al*., 2010; Coulibaly *et al*., 2011).

Extrusion is the process in which the material (feedstuff or mixture) is subjected to mixing, shearing and heating under high pressure before the extruded is forced through a die (Sorensen *et al*., 2002) and is exposed to high temperatures (up to 200°C) for 1-2 min or more precisely the material temperature increases progressively within the last 15-20 sec up to the optimum one to achieve the desired effects (Riaz, 2007).

Extrusion cooking may influence the nature of feed components by changing physical (particle size), chemical (starch gelatinization, inactivation of antinutrients) and nutritional (nutrient digestibility) properties (Alonso *et al*., 1998; Abd El-Hady and Habiba, 2003; Diaz *et al*., 2006). Camire (2000) reported that five general physicochemical changes can occur during extrusion cooking: Binding, cleavage, loss of native conformation, recombination of fragments and thermal degradation. In addition, the composition of feed materials could be altered by physical losses such as leakage of fat, evaporation of water and volatile compounds at the die.

The degree of change in feed constituents depends on a number of factors such as the type of ingredient or diet, particle size, type of extruder and the extruder conditions (e.g. moisture content, screw speed, barrel temperature, die diameter, feed rate, screw compression ratio, residence time, torque, pressure, energy input and pH) and type of reactants present, such as water, lipids, carbohydrate and proteins (Grela *et al*., 2001; Anguita *et al*., 2006).

Turkeys, as with chickens are sensitive to the presence of trypsin inhibitors, with pancreatic hyper secretion and hypertrophy. Mian and Garlich (1995) have discovered that the maximum level of trypsin inhibitors tolerated by this species was 2.5 mg g^{-1} of diet at three weeks and 3 mg g^{-1} of diet for animals above that age. Given that a feed for turkeys may contain up to 50% beans and soybean meal, the use of products that have been deficiently processed is not suitable for newly-born animals. This research aims to study the possibility of replacing soybean meal with different ratio of extruded full-fat soybean in female turkey diet and determine the optimum ratios for replacement.

MATERIALS AND METHODS

Processing of soybean: Whole soybean were gotten locally, the beans were brought to Oils factory in Damascus, for processing. Technological soybean extruding has included: Soybean→Cleaning →Grinding→Softening→Flaking→Then extruded without steam in a commercial extruder (EXTRUDER E-250).

After drying, the product was placed in bags and returned to the University of Damascus for use in the feeding trials. A sample of the product was analyzed by animal laboratory and found to contain 38.90% crude protein, 18.5% crude fat, 0.07% urease rise and 76.95% protein solubility in 0.2% KOH, urease level and protein solubility indicate that the FFSB was processed sufficiently to denature the trypsin inhibitor without overcooking (Waldroup *et al*., 1985; Dale and Arabra, 1987). A laboratory specializing in protein nutrition conducted protein analysis of the product and the metabolizable energy content was estimated from equations published by NRC (1994).

Diets were isoprotein and isoenergy with a different content of extruded full-fat soybean (EFFSB). Diets were formulated for (0-4 weeks) starter, (5-12 weeks) grower and (13-18 weeks) finisher. The basal diet had no extruded full fat soybean (control) (Table 1-2), while those for three treatments contained within 10, 15 and 20% of extruded full fat soybean, respectively. Soybean was processed under temperature 140°C during 15 sec. Diets met or exceeded the amino acid requirements suggested by the NRC (1994) adjusted to the dietary energy content. Complete vitamin and trace mineral mixes obtained from a commercial poultry integrator were used. All diets were pelleted with steam; diets fed from 0-4 weeks were fed as mash.

Table 1: Composition (g kg^{-1} air dry basis) of the basal diet

Ingredients	1-4 (weeks)	5-12 (weeks)	13-18 (weeks)
Corn	511.7	598.6	726.2
Soybean meal (44%)	383.8	318.2	245.2
Fish meal (61%)	79.4	61.9	-
Dicalcium phosphate	2.0	-	2.0
Limestone	15.0	12.0	15.5
Lysine	-	1.8	1.7
DL-Methionine	0.6	-	0.4
vitamin premix[1]	2.5	2.5	2.5
Trace mineral[2]	2.5	2.5	2.5
Salt	2.5	2.5	4.0
Calculated analysis			
Crude protein (%)	25.98	22.77	16.88
Metabolizable energy (kcal kg^{-1})	2806.0	2915.0	3038.0
C/P ratio (kcal, kg/% protein)	108.0	128.0	180.0

[1]Provided the following/kg feed irrespective of the chemical form, Vitamin A: Palmitate 4400 IU, Cholecarciferol: 900 ICU, DL-"-tocopherol acetate, 22 IU, Menadione: 1.1 mg, Thiamine mononitrate: 2.75 mg, Riboflavin: 5.5 mg, Calcium pantothenate: 154 mg, Niacin: 70 mg, Pyridoxine HCl: 4.5 mg, Biotin: 0.33 mg, Choline chloride: 2200 mg, Folacin: 1 mg, Vitamin B: 19.8 μg, 12 [2]Supplied in mg kg^{-1} feed: Cu: (as copper sulfate) 8, I (as potassium iodide): 0.4, Fe: (as Ferric citrate) 110, Mn: (manganous sulfate) 77, Se: (as sodium selenite) 0.2 and Zn (as zinc carbonate): 60

Table 2: Vaccines used in immunization of birds

Age/day	Vaccine name	Method of vaccination
1	Swollen Head Disease (SHD)	Water
7	Newcastle	Water
15	Turkey Rhinotracheitis (TRT)	Injection chest
22	Oil emulsion vaccine	Injection chest
60	Smallpox vaccine	Scratching of wing

Newcastle vaccine will be returned on every 25 day until the end of fattening

Birds and housing: Three hundred day-old female turkeys of a commercial turkey strain (B.U.T. big 6) were purchased from a commercial hatchery. The birds were randomly assigned to 4 dietary treatments; twenty five birds per pen and three replicate pens per treatment (0.36 m^2 per bird) with used wood shavings over concrete floors. Each pen was contained two trough feeder and one water trough. Birds were brooded using whole house brooding, Indoor temperature was 32°C at the beginning of the experiment and step by step reduced 2°C every week to reach a constant temperature of 22±2°C. The lighting was a continuous 24 h in the first three days and then were reduced to 22 h lighting and so until the second week of life and after the second week until the week (12) was used intermittent lighting as follows program: (16 L:2 D:3 L:3 D). The test diets and water were available *ad libitum*.

Growth performance: Birds and feed were weighed in the 4th, 12th and 18th weeks and individually to determine Weight Gain (WG), Feed Intake (FI) and Feed Conversion Ratio (FCR).

Carcass characteristics: At the end of the experiment, three birds were selected from each replicate for processing to determine carcass yield and its parts. Turkeys were processed at the slaughter-house of Agricultural Faculty. Feed was withdrawn for 12 h before slaughter and turkeys were weighed individually to get live weight at the plant. After chilling process, the carcasses were placed on ice for 5 h and separated for the parts. Carcass yield, breast, thighs, drumsticks, live were recorded. Abdominal fat was removed and weighed and their relative weights to live body weight (%) were calculated.

Blood lipids: At the end of the period three turkey broilers were selected from each replicate and blood samples were collected from wing veins, approximately 5 mL of blood were taken from

each bird for the analysis. Cholesterol, Triglyceride, High Density Lipoproteins (HDL) and Low Density Lipoproteins (LDL) were measured in blood.

Statistical analysis: Data from study was subjected to a statistical analysis by one-way analysis of variance test (ANOVA) using the General Linear Model procedure of SAS (1997). Differences were considered to be significant at $p \leq 0.05$ and significant differences between means were separated by the Fisher's Least Significant Difference test.

RESULTS AND DISCUSSION

Results of the study relating to effects of experimental diets on performance in turkey poults were in Table 3-6.

Table 3: Effect of different levels of extruded soybean on mortality rate of female turkey

	Mortality rate (%)				
Treatments	1-4 (weeks)	5-12 (weeks)	13-18 (weeks)	1-12 (weeks)	1-18 (weeks)
Control	1.33^{NS}	2.67^{NS}	4.17^{NS}	4^{NS}	8^{NS}
10% EFFSB	2.67	1.33	2.78	4	6.67
15% EFFSB	1.33	2.72	5.56	4	6.67
20% EFFSB	2.67	1.33	4.23	4.01	9.33

NS: Not significant, EFFSB: Extruded full-fat soybean

Table 4: Effect of different levels of extruded full fat soybean on weight gain of female turkey

	Weight gain (kg bird^{-1})				
Treatments	1-4 (weeks)	5-12 (weeks)	13-18 (weeks)	1-12 (weeks)	1-18 (weeks)
Control	0.920^{b}	5.151^{b}	4.743^{b}	6.071^{b}	10.813^{b}
10% EFFSB	0.955^{a}	5.199^{ab}	4.809^{ab}	6.154^{ab}	10.963^{ab}
15% EFFSB	0.949^{ab}	5.244^{a}	4.842^{a}	6.193^{a}	11.035^{a}
20% EFFSB	0.936^{ab}	5.228^{ab}	4.877^{a}	6.164^{ab}	11.040^{a}
LSD^{1}	0.035	0.080	0.07	0.114	0.183

a,b: Values in the same column not sharing a common superscript differ significantly ($p<0.05$), ^{1}Least significant differences of means (5% level). NS: Not significant, EFFSB: Extruded full-fat soybean

Table 5: Effect of different levels of extruded soybean on feed intake of female turkey

	Feed consumption (kg bird^{-1})				
Treatments	1-4 (weeks)	5-12 (weeks)	13-18 (weeks)	1-12 (weeks)	1-18 (weeks)
Control	1.203^{NS}	9.663^{NS}	14.129^{NS}	10.896^{NS}	25.025^{NS}
10% EFFSB	1.204	9.676	14.114	10.880	24.994
15% EFFSB	1.1988	9.660	14.092	10.859	24.951
20% EFFSB	1.193	9.651	14.086	10.844	24.929
LSD^{1}	-	-	-	-	-

a,b: Values in the same column not sharing a common superscript differ significantly ($p<0.05$), ^{1}Least significant differences of means (5% level). NS: Not significant inhibitor, EFFSB: Extruded full-fat soybean

Table 6: Effect of different levels of extruded full fat soybean on feed conversion ratio in female turkey

	FCR (feed:gain)				
Treatments	1-4 (weeks)	5-12 (weeks)	13-18 (weeks)	1-12 (weeks)	1-18 (weeks)
Control	1.308^{a}	1.882^{NS}	2.979^{a}	1.795^{a}	2.314^{a}
10% EFFSB	1.261^{b}	1.861	2.935^{ab}	1.768^{ab}	2.280^{ab}
15% EFFSB	1.263^{b}	1.842	2.910^{b}	1.753^{b}	2.261^{b}
20% EFFSB	1.275^{b}	1.846	2.888^{b}	1.760^{ab}	2.258^{b}
LSD^{1}	0.019	-	0.058	0.042	0.04

a,b: Values in the same column not sharing a common superscript differ significantly ($p<0.05$), ^{1}Least significant differences of means (5% level). NS: Not significant, FCR: Feed conversion ratio, EFFSB: Extruded full-fat soybean

Mortality: The results in Table 3 showed that mortality rates of birds during the experimental period did not influence by dietary supplementation of EFFSB. Similar results were obtained by Subuh *et al*. (2002). This implies that EFFSB supplementation had no toxicity with the birds.

Weight gain: The weight gain in poults during starter and grower period in the experimental groups fed different levels of extruded full fat soybean were increased than control group ($p>0.05$) in Table 4. But what must be considered is the fact that weight gain of turkeys due to fed with the extruded full-fat soybean from 15-20% at whole experiment and the finisher period was increased than control diet ($p\leq0.05$). This significantly increase probably due to absence of fish meal in this period.

The positive impact clearly has been observed to add extruded soybean with the progress of the birds at the age during the last phase of life with the increasing need for energy and the lack of fish meal in the ration, which confirms that the extruded soybean is not only a good source of protein but also a good source energy.

The results of the present study were in conformity with the results of previous studies (Jones *et al*., 1995; Leeson and Atteh, 1996) from viewpoints body weight gain and increased level of EFFSB. Whereas, these findings were not in conformity with results of some other studies (Marsman *et al*., 1997) from based on the fact that of lack of effectiveness of extrusion on broiler body weight gain.

Feed consumption: Amount of feed consumption on turkeys in starter, finisher periods (Table 5) and the whole period in experimental groups with different levels of the extruded full-fat soybean (EFFSB) were decrease than control group but this difference was insignificant ($p>0.05$). The findings of the present study are in conformity with the findings of the previous research works (Marsman *et al*., 1997; Nalle *et al*., 2011) but at the same time they were not in conformity with the findings of the researchers who witnessed increased intake of EFFSB (Smulikowska *et al*., 2006). This might be due to an underestimation of the energy content of the beans used and was probably due to the fact that the energy value available to the bird as a result of rolling and extrusion, coupled with pelleting of the diets, was underestimated. Wiseman (1984) also showed that the ME value of diets containing extruded whole soybean was greatly enhanced by pelleting the diets.

Feed Conversion Ratio (FCR): The results relating to effects of experimental diets on Feed Conversion Ratio (FCR) of turkeys in starter, grower, finisher and the whole period were summarized in Table 6. The FCR for turkeys feeding on higher level of EFFSB (15-20%) during grower period and also during the whole period ($p\leq0.05$) were lower than the control group. This finding was in line with the results of the research works done on broilers fed on EFFSB which found out that the FCR decreased significantly (Leeson and Atteh, 1996). Furthermore, FCR in experimental groups which received regular level of the full fat soybean seed were significantly compared to the control group. Nevertheless, it was not significant among the groups fed with different levels of the EFFSB. The reason for such discrepancy could be due to the apparent increase in indigestibility of protein, starch and non-starch polysaccharides in ileum. These results were in line with the results obtained in previous research works, which reflect positive effect of extruded feed on increased FCR and as a result, performance of poultry (Marsman *et al*., 1997; Smulikowska *et al*., 2006).

Results showed, it can also be claimed that the 15 and 20% EFFSB is suitable due to higher weight gain and decreased FCR. So, it is suggested that future research studies with over 20%

Table 7: Effect of different levels of extruded full fat soybean on carcass characteristics at 18 weeks

	Carcass traits (%)					
Treatments	Dressing percentage	Breast	Thigh	Drumstick	Liver	Abdominal fat
Control	81.67^{NS}	26.47^{NS}	8.80^{NS}	8.73^{NS}	0.69^{NS}	0.85^{NS}
10% EFFSB	81.70	26.47	8.79	8.71	0.69	0.85
15% EFFSB	81.74	26.50	8.83	8.75	0.70	0.82
20% EFFSB	81.75	26.49	8.87	8.75	0.69	0.82
LSD[1]	-	-	-	-	-	-

a,b: Values in the same column not sharing a common superscript differ significantly ($p< 0.05$), [1]Least significant differences of means (5% level). NS: Not significant, EFFSB: Extruded full-fat soybean

EFFSB diet are undertaken to see if better result can be achieved. Moreover, Subuh *et al*. (2002) indicated that whole extruded will enhance nutrient release and denature the trypsin inhibitor, was a highly effective feed ingredient for broiler diets.

Carcass traits: The results presented in Table 7 showed no significant differences between the control and any of the experimental treatments ($p>0.05$). It is postulated that if the ratio of nutrients to energy in a diet remained constant, no adverse effect on carcass yield could be anticipated. In our study, all diets were isocaloric and isonitrogenous, therefore no significant differences were observed in percentage of carcass yield, breast (with bone), thigh (with bone) and liver weight to live weight of birds.

Feeding turkeys 15%, 20% EFFSB were resulted in better percentage of carcass compared to those fed 0 or 10% EFFSB. Similar results of no significant differences between treatment groups in carcass characteristics were found by Subuh *et al*. (2002). Moreover, Subuh *et al*. (2002) indicated that whole extruded will enhance nutrient release and denature the trypsin inhibitor, are a highly effective feed ingredient for broiler diets. In addition, FFSB as such, provide more energy than SBM due to its fat content, which is inside the seed protected from oxidation and ultimately rancidity for the presence of natural antioxidants such as vitamin E and selenium dependent enzyme, glutathione peroxidase in the seed (North and Bell, 1990).

It showed that there was no significant difference in the percentage of abdominal fat and pancreas of birds fed treatments containing processed raw soybean and control treatment. Soybean processing cause to loss of inhibitory factors. These inhibitors factors such as trypsin inhibitors, lectin and chymotrypsin reduced the digestibility of nutrients in the soybean and increases metabolic excretion of bile acids that can reduce the digestibility of fats (Anderson-Haferman *et al*., 1992).

Moreover, when beans that have been correctly valued were used to replace their equivalent of soybean meal and oil there were no differences expected in the quality of the carcass or in the consistency of the fat (Zollitsch *et al*., 1997).

Serum lipids: Cholesterol is the precursor of all steroid hormones and bile salts. Cholesterol levels may vary depending on the climatic conditions of the environment, nutrition, fitness broilers and sexual activity (Itoh *et al*., 1998). Data in Table 8 showed that utilization of the extruded full-fat soybean had significant effect in serum lipids of the turkeys. The serum cholesterol was a function of sinusoidal curve of the extruded soybean in a way that with increased level of soybean, the cholesterol serum significantly decreased with birds fed the extruded full-fat soybean from 15-20% ($p\leq0.05$). Plant-derived protein especially extruded full-fat soybean has been shown to decrease cholesterol.

Table 8: Effect of different levels of extruded full fat soybean on serum lipid of female turkey

	Parameters (mg dL^{-1})			
Treatments	Cholesterol	Triglyceride	LDL	HDL
Control	136.3[a]	54.6[a]	92.75 [NS]	33.43[NS]
10% EFFSB	135.3[ab]	52.8[ab]	92.77	34.77
15% EFFSB	134.6[b]	51.47[b]	92.47	33.33
20% EFFSB	134.3[b]	51.0[b]	91.7	33.67
LSD[1]	1.4	2.48	-	-

a,b: Values in the same column not sharing a common superscript differ significantly ($p<0.05$), [1]Least significant differences of means (5% level). NS: Not significant, LDL: Low density lipoproteins, HDL: High density lipoproteins, EFFSB: Extruded full-fat soybean

The effect of extruded soybean on triglyceride was significant as the level of extruded soybean increased resulting in lower concentration triglyceride significantly with birds fed the extruded full-fat soybean from 15-20% ($p \leq 0.05$). But LDL levels decreased insignificantly with birds fed the extruded full-fat soybean ($p>0.05$). Hermier and Dillon (1992) reported that serum lipoprotein concentrations could be changed by dietary fat in broilers. Anderson *et al.* (1995) reported that EFFBS was effective in lowering the levels of serum triglycerides and cholesterol in humans and animals. However, the mechanism of FFSB on blood cholesterol is unknown, although several theories have been proposed. One hypothesis suggests that the amino acid composition of FFSB protein causes some changes in cholesterol metabolism. In other studies, some authors proposed that non-protein components (such as fiber and isoflavones) associated with FFSB protein affect cholesterol metabolism either directly or indirectly (Potter, 1995).

Soya bean contains isoflavonoids (genistein and daidzein) that have estrogenic effects (Messina, 1999). Yousef *et al.* (2003) showed a positive effect of isoflavonoids on biochemical parameters of blood in male rabbits. Isoflavonoids led to the lowering of cholesterol and triglycerides. Oligosaccharides may have significant impact on reducing levels of cholesterol and triglycerides in rats fed with high fat content (Chen *et al.*, 2010). Thus lipoproteins low density may be reduced due to the presence of soybean oil in the diet, which contains a high proportion of unsaturated fatty acid and the liver converts unsaturated fatty acid preferentially to bodies of ketone instead of lipoproteins LDL or triglycerides and are transferred acids to the tissues of the oxidation without the impact of lipoproteins stays low density (Nitsan *et al.*, 1997). The most popular theory suggests that FFSB protein reduces cholesterol metabolism in the liver by increasing the removal of LDL 'bad' cholesterol (Sirtori *et al.*, 1995).

The HDL level were not influenced by inclusion rate of EFFSB ($p \leq 0.05$). Serum HDL carries about 75% of total cholesterol in broiler (Peebles *et al.*, 1997), it is more likely that this lipoprotein may be more influence by the type of dietary fat.

CONCLUSION

In conclusion, the results of this experiment indicate that use of extruded full-fat soybean in turkey diets did not influence on performance of female turkeys during the whole period. Inclusion dietary different levels of from 10-20% on diet is decreased feed consumption and weight gain increased of turkey. Therefore, utilization of the EFFSB at the 20% level led to increase in performance of turkeys. The experiment confirmed that add extruded full-fat soybean in female turkey diets has influenced on biochemical parameters of blood, so that it reduced cholesterol, triglyceride and LDL on serum lipid of female turkey. It's suggested to used up to 20% extruded soybeans in turkeys diet.

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