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# Effect of Processing Method of Soybean on Nutrient Utilization, Performance and Carcass Characteristics of Sheep

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**Abstract:** Full fat soybeans (FFSB), extruded soybean (ESB) or soybean meal (SBM) were incorporated at level of 15% in rations fed to twenty four male Rahmani lambs in three groups for 14 weeks growth experiment. Digestion trails were carried out at the end of the growth experiment. Ruminal pH, ammonia nitrogen ($NH_3$-N) and total volatile fatty acids concentration (VFA's) were estimated and five lambs from each group were slaughtered to study carcass traits. Digestibility values of CP, CF and NFE were ($P<0.05$) higher in SBM and ESB than in FFSB rations. The highest ($P<0.05$) value of total digestible nutrients (TDN) was recorded for the ESB ration. However, the highest ($P<0.05$) value of digestible crude protein (DCP) was recorded for the SBM ration. There was a slight decrease in ruminal ammonia concentrations by feeding ESB compared with FFSB or SBM group. Average daily weight gain and feed conversion ratios were comparable among the three groups. This might mean that lambs utilized the raw and extruded SB efficiently as SBM. Yet, knife separable fats were less ($P<0.05$) in carcass of SBM group. It could be concluded that processing of whole full fat soybean into soybean meal or extruded soybean enhanced the digestibility values of most nutrients but it has no significant effect on body weight gain and feed efficiency of Rahmani sheep.

**Key words:** Rahmani sheep soybean processing · Nutrient utilization · Performance · Carcass characteristics

## INTRODUCTION

When ruminants were fed whole full fat soybeans, ruminal digestion was less negatively impacted than by free soybean oil, possibly because of a slower release of oil encased in the seed [1]. On the other hand, the high degradability of protein in whole soybeans and soybean meal by rumen microbes reduce values as protein supplements for ruminants.

Orias *et al.* [2] reported that almost half of the CP in whole soybeans will be converted to ammonia almost instantaneously by the ruminal microbes. While the synergistic effect of heating and high pressure imposed during extrusion might offer an alternative to fully enhance the digestion characteristics of whole soybeans by ruminants.

Jirik [3] reported that the extruded full fat soybeans may be able to provide growing animals with the necessary protein to support fast growth along with the good fats (polyunsaturated fatty acids) necessary to improve fatty acid composition for a healthier product for the consumers. Cattle fed whole soybeans had more polyunsaturated fatty acids and less saturated fatty acids in the meat.

The objective of this work is to compare the effects of feeding whole full fat or extruded soybean and soybean meal on nutrient utilization, performance and carcass characteristics of growing sheep.

## MATERIALS AND METHODS

This work was carried out at Agricultural Experimental Station, Faculty of Agriculture, Cairo University and Laboratories of Animal Production Department, National Research Center (NRC), Egypt. In 14 week growth-fattening trail, twenty four male Rahmani lambs of seven months old and average about 36 kg live body weight were randomly divided into three groups of eight lambs each. Three rations differ in protein supplement were prepared using 15% from full fat soybeen (FFSB), soybean meal (SBM) or extruded soybeen (ESB) along with 22.5% yellow corn, 22.5% barley, 12.0 % wheat bran and 25% artificially dried berseem hay (roughage: concentrate ratio being 1:3).

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Table 1 shows ingredients and chemical composition of the experimental rations. Rations were left to *ad. libitum* intake. Animal were group fed twice a day at 8 am and 2 pm while feed residues, if any, were removed once a day before morning feeding to calculate the actual daily feed intake. Fresh water was freely available all time. Lambs were individually weighed at the beginning of the experiment and at biweekly intervals thereafter.

At the end of the growth trail, three sheep from each group were selected to be used in a digestion trial. Animals were housed in metabolisme cages for three days to get acquainted on cages, followed by a seven days collection period. Feces and urine were quantitatively collected. Samples of feed and feces were analyzed according to the AOAC [4].

On the last day of the digestion trial, rumen fluid samples were taken 3 hrs after the morning feeding. Ruminal fluid pH and ammonia nitrogen concentrations ($NH_3N$) were measured immediately upon sampling via stomach tube according to AOAC [4]. The concentrations of total VFA's were later determined according to Warner [6]. Also, five animals from each group were slaughtered after fasting for 12 hrs. External and internal offals were removed and the hot carcass was weighed. Digestive tract and Knife separable fat were also removed and weighed. Dressing percentage was calculated as a percentage of hot carcasses from slaughter body weight.

Data collected were statistically analyzed as One-way analysis of variance using SAS [7]. Differences among means were tested using Duncan's multiple rang test [8].

Table 1: Ingredients and chemical composition of the experimental rations fed to sheep

| | Treatment* | | |
|---|---|---|---|
| Item | FFSB | SBM | ESB |
| *Ingredient, %* | | | |
| Berseem hay | 25.0 | 25.0 | 25.0 |
| Yellow corn | 22.5 | 22.5 | 22.5 |
| Barley | 22.5 | 22.5 | 22.5 |
| Wheat bran | 12.0 | 12.0 | 12.0 |
| Soybean meal | 0 | 15.0 | 0 |
| Full fat soybean | 15.0 | 0 | 0 |
| Extruded soybean | 0 | 0 | 15 |
| Common salt | 1.3 | 1.3 | 1.3 |
| Vitamin and mineral Mix# | 0.7 | 0.7 | 0.7 |
| Lime stone | 1.0 | 1.0 | 1.0 |
| *Chemical composition, %* | | | |
| Dry matter (DM) | 90.10 | 89.51 | 90.22 |
| DM composition | | | |
| Organic matter (OM) | 94.18 | 94.20 | 94.14 |
| Crude protein (CP) | 15.93 | 17.06 | 15.98 |
| Crude fiber (CF) | 12.76 | 13.02 | 12.91 |
| Ether extract (EE) | 6.02 | 2.72 | 6.16 |
| Nitrogen free extract (NFE) | 59.47 | 61.40 | 59.09 |
| Ash | 5.82 | 5.80 | 5.86 |

Treatment, FFSB: Whole full fat soybean ; SBM: Soybean meal; ESB:Extruded whole soybean

#Vitamin and mineral Mix contains adequate levels enough to cover growing sheep requirements as recommended by NRC [5].

Table 2: Effect of processing method of soy bean on nutrients digestibilty and nutritive values of the experimental rations fed to sheep

| | Treatment | | | |
|---|---|---|---|---|
| Item | FFSB | SBM | ESB | SE |
| Nutrient Digestibility % | | | | |
| Dry matter | 77.47$^{b}$ | 82.67$^{a}$ | 82.07$^{a}$ | 1.03 |
| Organic matter | 82.67$^{b}$ | 87.97$^{a}$ | 86.20$^{a}$ | 0.84 |
| Crude protein | 76.57$^{b}$ | 82.53$^{a}$ | 80.27$^{a}$ | 1.06 |
| Ether extract | 85.43$^{a}$ | 78.17$^{b}$ | 88.60$^{a}$ | 1.75 |
| Crude fiber | 54.00$^{b}$ | 60.17$^{a}$ | 63.97$^{a}$ | 2.36 |
| Nitrogen free extract | 88.17$^{c}$ | 93.20$^{a}$ | 90.27$^{b}$ | 0.76 |
| Nutritive value (% DM) | | | | |
| TDN | 84.29$^{b}$ | 85.53$^{b}$ | 87.97$^{a}$ | 0.63 |
| DCP | 12.20$^{b}$ | 14.08$^{a}$ | 12.83$^{b}$ | 0.18 |

$^{a,b}$Means within a row without common superscript differ (P< 0.05).

## RESULTS AND DISCUSSION

Data in Table 1 showed that rations containing SBM had about 1% higher crude protein but 3% lower fat than rations containing FFSB or ESB. The DM, OM, CF, NFE and ash showed comparable values among the three experimental rations. The difference in protein and fat is a result of higher CP but lower EE values of SBM than FFSB or ESB rations.

The results in Table 2 showed that digestibility values of CP, CF and NFE were higher ($P<0.05$) in SBM and ESB than the FFSB rations. Saleh and Saleh [18] found ($P<0.05$) higher digestion coefficients of CP, CF and EE with inclusion of heated soybean seeds compared to soybean meal.

Apparent DM, NDF and ADF digestibilities were similar between full fat soybean and soybean treatments, yet FFSB treatment tending to be lower in DM digestibility [9]. The lower digestibility of CF of full fat ration could be due to the effect of its high fat content 6.02% than 2.72 for SBM ration [9, 10].

Table 3: Effect of processing method of soybean on ruminal pH, ammonia-N and total VFA's at 3 hrs after feeding of sheep

| | Treatment | | | |
|---|---|---|---|---|
| Item | FFSB | SBM | ESB | SE |
| Ammonia nitrogen(mg/100ml) | 19.26[a] | 15.46[b] | 17.10[ab] | 1.50 |
| Total volatile fatty acids m.eq./100ml | 15.36 | 17.53 | 15.66 | 0.76 |
| pH | 6.50[a] | 5.70[b] | 5.73[b] | 0.18 |

[a,b] Means within a row without common superscript differ (P< 0.05)

Table 4: Performance and carcass characteristics of lambs fed the experimental rations

| | Treatment | | | |
|---|---|---|---|---|
| Item | FFSB | SBM | ESB | SE |
| Initial body weight, kg | 35.9 | 35.9 | 35.9 | 1.43 |
| Final body weight, kg | 55.9 | 56.2 | 55.7 | 2.03 |
| Average daily gain, g | 204 | 207 | 202 | 9.75 |
| Average daily intake, g | | | | |
| DM | 1497 | 1490 | 1495 | |
| TDN | 1262 | 1274 | 1315 | |
| DCP | 183 | 210 | 192 | |
| Feed conversion ratio: | | | | |
| DM / gain | 7.34 | 7.20 | 7.40 | 0.46 |
| TDN / gain | 6.19 | 6.15 | 6.51 | 0.42 |
| DCP/gain | 0.99 | 1.01 | 0.95 | 0.08 |
| Carcass characteristics: | | | | |
| Slaughter weight (kg) | 56.33 | 58.17 | 56.17 | 0.30 |
| External organs (kg) | 12.07 | 12.48 | 12.39 | 1.18 |
| Knife separable fat (kg) | 5.00[b] | 4.44[c] | 5.95[a] | 0.05 |
| Internal organs (kg) | 2.05 | 1.94 | 2.00 | 0.98 |
| Carcass weight (kg) | 28.13 | 28.35 | 26.67 | 2.43 |
| Dressing, % | 49.9 | 48.71 | 47.31 | 1.08 |

External organs: feet, head and skin

Internal organs: livers, heart, lungs, kidneys, spleen and testes

Knife seprable fat: omentum, intestine, kidney and tail fats.

Dressing percent

The EE digestibility of SBM ration was (P<0.05) lower than full fat or ESB rations. Tice *et al.* [11] reported a 10 percentage unit increase in apparent total tract digestibility of C18 fatty acid and total fatty acids when soybeans were roasted compared with raw soybeans. Moreover, Aldrich *et al.* [12] that found total tract digestibility of total fatty acids was 5.3 percentage units greater for roasted (86.3%) than for raw soybeans (81.0%). These differences led to lower (P< 0.05) DM and OM digestibilities of SBM ration than full fat or ESB rations. The highest (P<0.05) TDN value among the three experimental rations was recorded for the ESB ration, however, the (P<0.05) highest value for DCP was recorded for the SBM ration.

There was a slight decrease in ruminal $NH_3N$ concentration by feeding ESB compared with FFSB (19.26 vs 17.10 mg/100 ml) but this effect was not significant (Table 3). This was in agreement with those found for steers by Orias *et al.* [2]. A decrease in ruminal $NH_3N$ concentrations was found when dairy cows were fed extruded whole soybeans [13]. In contrary to our results that SBM treatment showed the lowest ruminal $NH_3N$ concentrations (15.46 mg/100 ml), Albro *et al.* [14] has shown that treatment of SBM+barley had a higher (P <0.05) ammonia release at 3 hrs by weaned beef steers than FFSB and ESB.

The ruminal total volatile fatty acids (VFA's) concentrations showed an inverse trend to ruminal ammonia. The SBM group showed higher VFA's concentrations (17.53 m.eq./100ml) than FFSB (15.36 m.eq./100ml) or ESB groups (15.66 m.eq./100ml) but these differences were not significant. Orias *et al.* [2] found no differences in VFA's concentrations for the contrasts between raw and extruded soybeans.

The ruminal pH values were 6.50, 5.70 and 5.73 for FFSB, SBM and ESB groups, respectively. Sheep fed FFSB ration showed the (P<0.05) highest pH value at 3 hrspost feeding but there is no significant difference between SBM and ESB groups. It is important to note that FFSB group showed the highest ruminal ammonia but the lowest VFA's concentrations. Orias *et al.* [2] found that ruminal pH at 3 h averaged 6.3 across treatments (FFSB and ESB) and was not affected by treatment (P > 0.05).

Data in Table 4 showed insignificant differences in body weight gain among the experimental groups. The average daily gain was 204, 207 and 202 g/ h /day for FFSB, SBM and ESB groups, respectively.

The average dry matter and TDN intakes (g/ h / day) were not differ among the three groups. However, DCP intake from SBM ration was higher (210 g/day) than the other two groups (183 g/day for FFSB and 192 g/day for ESB groups). The intake values were not statistically analyzed because of animals were fed in groups. The higher average DCP intake (g/day) of SBM group might be due to the higher protein content of SBM ration (17.04%; Table 1) as well as its digestibility value (82.53; Table 2).

Feed conversion ratio expressed as units of DM, TDN and DCP required to produce one unit body weight recorded narrow ranges among the treatments (Table 4). The recorded values for DM were 7.34, 7.20 and 7.40 for

lambs fed FFSB, SBM and ESB, respectively. The corresponding values for TDN were 6.19, 6.15 and 6.51 and being 0.99, 1.01 and 0.95 for DCP. Albro *et al.* [14] concluded that average daily gains were not influenced by source of soybean protein but steers fed ESB tended to exhibit better feed efficiency than steers fed FFSB. The more efficient gains by steers fed ESB may reflect a lower amount of degradable CP [15].

Similar to our results, Felton and Kerley [16] found no significant difference in average daily gain (1.68 vs. 1.69 kg) and gain: feed ratio (0.126 vs. 0.134) between steers fed rations containing 11.6 % soybean meal or 16% whole raw soybeans. Moreover, Rumsey *et al.* [17] found no differences in performance (daily gain, DM intake and feed conversion) under feedlot conditions when roasted soybeans replaced soybean meal in the ration of beef cattle. On contarary, Saleh and Saleh [18] found that the partial replacement of soybean meal with heated soybean seeds in rations of growing lambs improved weight gain and feed conversion.

Carcass characteristics and dressing percentages were not significatly affected by treatments, yet animals fed FFSB and ESB rations showed higher knife seprable fats (kg) than the SBM group. The values were 8.88, 7.63and 10.59% of slaughter weight. This effect might be due to the higher ether extract content and digestibility of FFSB and ESB than SBM ration. The EE contents were 6.02, 2.72 and 6.16 7 % (Table 1) and their corressponding digestibilities values were 85.43, 78.17 and 88.60% (Table 2). Felton and Kerley [19] examind Performance and carcass quality of steers fed whole raw soybeans at increasing inclusion as a replacement of soybean meal. They found no significant differences in kidney, pelvic and heart fat or dressing percentage.

It could be concluded that processing of whole soybean into soybean meal or extruded soybean enhanced the digestibilities of most nutrients but it has no significant effect on body weight gain, feed efficiency or carcass characteristics of Rahmani sheep.

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