Evaluation of Jojoba Meal as a Protein Source for Sheep

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Abstract: The present study was conducted to investigate the effect of replacing cotton seed meal (CSM) by jojoba meal (JJM) on the digestibility, ruminal activity and growth performance of lambs. Twenty Rahmany growing ram lambs, weighing 37±1.37 kg, were used for 100 days. Animals were divided into four similar groups and each received one of the four rations. Four concentrate mixtures were formulated to replace JJM at 0 % (ration 1), 33 % (ration 2), 50 % (ration 3) and 100 % (ration 4) of CSM. The offered ration was the tested concentrate mixture (70 %) and wheat straw (30 %). Digestibility trials and ruminal fermentation were conducted. The chemical analysis of the experimental rations did not affected by replacement of CSM by JJM. The digestibility coefficient of dry matter (DM) was ranged from 61.60 to 74.60 %, and there were significant differences ($P<0.05$) between the rations. The same trend was observed with the digestibility of organic matter (OM), crude protein (CP), ether extract (EE) and nitrogen free extract (NFE). The replacement of CSM by JJM till 50 % of it enhanced the digestibility coefficients of DM, OM, CP, EE and NFE. As for CF digestibility, it decreased by increasing the level of replacement. Total digestible nutrients (TDN) and digestible crude protein (DCP) were increased with replacing CSM by JJM till 50% of it. There was ($P<0.05$) significantly reduction in dry matter intake (DMI) when JJM was replaced in the rations. There were no significant ($P>0.05$) differences in rumen pH among all rations for all sampling times. The highest value of ammonia nitrogen (NH_3-N) was 15.57 mg/100 ml rumen liquor (RL) for ration 1, and the lowest value was 12.12 mg/100 ml RL for ration 3. The mean values of total volatile fatty acids (VFA) were 10.89, 8.69, 7.49 and 7.75 meq/100 ml R.L. for rations 1, 2, 3 and 4, respectively. The average daily gains (ADG) of lambs were 0.136, 0.126, 0.079 and 0.064 kg/h/d, respectively. The feed conversion by lambs was 8.69, 6.28, 10.05 and 13.23 kg DMI/kg gain. The economical efficiency was 0.09, 0.12, 0.08 and 0.06 for rations 1, 2, 3 and 4, respectively. The current study showed that the replacement of CSM by 33 % of JJM is better than the other rations regarding feed conversion and economic efficiency to increase feed resources . The more studies are needed to improve the nutritive value of JJM to use it as a protein source in ruminants' rations.

Keywords: Jojopa meal, cotton seed meal, Ruminal fermentation, digestibility, nitrogen balance, performance of lambs.

INTRODUCTION

Agro-industrial and Agricultural by-products can play an important role in animal production in developing countries. The jojoba plant (*Simmondsia chinensis*) is a native oilseed shrub of the Sonoran Desert, including parts of Arizona, California, and Mexico. The principal product extracted from the seeds is a liquid wax with characteristics similar to sperm whale oil (Verbiscar and Banigan, 1978). The liquid wax also has applications in cosmetics, pharmaceuticals, and numerous other products. Since demand for this product currently exceeds supply, large-scale cultivation of jojoba has begun. The meal remaining after the wax has been extracted has received relatively little attention. Jojoba oil is used as an additive in mineral oils cosmetics (Bagby, 1988). Deoiled jojoba meal represents a potential ingredient for animal feed or feed supplement due to its high protein content (30 %). However, supplementing feed with deoiled jojoba meal reduces feed intake in rats (Booth *et al.*, 1974; Cokelaere *et al.*, 1993); Chickens (Ngou Ngoupayou *et al.*, 1982; Arnouts *et al*, 1993), ewes (Manos *et al.*, 1986) and rodent (Sherbrooke, 1976 ; Ngou Ngoupayou *et al.*, 1985). Verbiscar *et al.* (1980 and 1981) reported that treatment with *Lactobacillus* not only renders jojoba meal nontoxic to mice, poultry, sheep, and cattle but also increases the palatability of the deoiled meal that would otherwise be poorly accepted in animal rations. These findings were also confirmed by Swingle *et al.* (1985) with beef cattle. Various methods of detoxification of jojoba meal have also been reported to improve its acceptability to lambs (Nelson *et al.*, 1979). In feeding trials with lambs, deoiled and nondetoxified jojoba meal in the ration reduced feed intake (Trei *et al.*, 1979). However, the meal contains toxic constituents, namely simmondsin (Booth *et al.*, 1974) and as many as three other related (cyanomethylene) cyclohexyl glycosides (Elliger *et al.*, 1973; Verbiscar and Banigan, 1978; Verbiscar *et al.*, 1980) including simmondsin 2-ferulate, 5-desmethylsimmondsin, and 4,5 didesmethyl simmondsin. Microorganisms in the rumen of sheep also detoxify simmondsin in jojoba meal (Verbiscar *et al.*, 1980). Trei *et al.* (1979) reported that simmondsin was metabolized by rumen microorganisms in vitro and that only trace amounts of the major toxicants could be detected in feces of lambs fed diets containing 10 % JJM. There were very few studies with diets supplemented with jojoba meal conducted with broiler chicks (Ngou Ngoupayou *et al.*, 1982), rabbits (Ngou Ngoupayou *et al.*, 1985), lambs (Verbiscar *et al.*, 1980, 1981 and Trei *et al.*, 1979) and cattle (Swingle *et al.*, (1985). Therefore, this study was conducted to examine the replacement of CSM by JJM and its effect on the digestibility, ruminal activity and growth performance of lambs.

MATERIALS AND METHODS

Animals and feeding management (growing lambs trials)

The experiment was carried out at the Agricultural Experimental Station, Animal Nutrition Laboratory, Animal Production Dept., Faculty of Agriculture, Alexandria University, Alexandria, Egypt. Twenty Rahmany growing ram lambs (Egyptian native breed), weighed 37±1.37 kg, were used in the present study for 100 days. Animals were divided into four similar groups (on the basis of body weight) and received one of the four rations tested. Four concentrate mixtures were formulated (Table 1) to replace cottonseed meal (CSM) by jojoba meal (JJM) at 0 % (ration 1, 0 % JJM of total mixed ration), 33 % (ration 2, 6 % JJM), 50 % (ration 3, 9 % JJM) and 100 % (ration 4, 18 % JJM) of CSM. Forming four dietary treatments along with wheat straw . Chemical analysis of wheat straw and concentrate mixtures as a total mixed ration is shown in Table (2). The offered ration was 70 % of concentrate mixture and 30 % of wheat straw. The rations were offered twice daily at 9 : 00 and 16 : 00 h. Drinking water was available all times. The quantity of feed offered, refused and feed intake was recorded throughout the feeding period. Animals were weighed every ten days.

Digestibility coefficient and nitrogen balance trials

A metabolism trial was conducted at the end of experimental feeding, lasted for 8 days in metabolism cages (i.e. 3 days adaptation in metabolic cages followed by 5 days of sample collection) with facility of quantitative collection of feces and urine separately. The feed offered and refusals for each animal were weighed and recorded daily. Samples of feed and refusals were taken daily and composted until the end of collection period, dried at 70°C for 24 h, ground through a 1mm screen and used for chemical analysis. Daily fecal excretions were collected at 08:00 h, weighed and recorded. Aliquots (10 %) of the sample from each animal were sampled daily. A portion of daily feces was dried for 24 h at 70 °C for DM determination. The remaining fecal sample was composted for each sheep and kept in refrigerator. Urine was collected into buckets containing sulphuric acid (10 %), measured and stored frozen until analysis. Aliquots (10 %) of the well-mixed sample was taken daily in labeled bottles, preserved with 2–3 ml of concentrated sulphuric acid and stored in refrigerator.

Rumen fermentation

Rumen liquor samples from experimental animals were collected at 0, 1, 3 and 6 h post-feeding, using stomach tube according to the Langston University, animal care committee (Puchala *et al*, 2004) at the end of the feeding experiment. The pH was measured in whole rumen liquor immediately using a digital pH meter (Digital pH meter, SANTA ANA, CA. 927705 USA). Rumen liquor samples strained through four layers of cheese cloth and stored frozen pending analysis. Samples were analyzed for ammonia nitrogen (Gips and wibbens-Alberts, 1968) and total volatile fatty acids (Warner, 1964).

Chemical Analysis

Feed and feces were dried at 70°C for 24 h, then ground through a 1 mm screen. Samples of feed and feed refusals were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF) and ash according to AOAC (1995). Urine samples were analyzed for nitrogen (N).

Statistical analysis

The data were analyzed according to SAS (1999) including differences between significant means.

RESULTS AND DISCUSSION

Digestibility and nitrogen balance trials

The formulation of concentrate mixtures and chemical analysis of rations which offered to lambs are shown in Tables (1, 2). The chemical analysis of the experimental rations [four concentrate mixtures that formulated to replace cottonseed meal (CSM) by jojoba meal (JJM) at 0 %, ration 1 {control ration} ; 33 %, ration 2; 50 %, ration 3 and 100 %, ration 4 which each along with wheat straw at 70:30 %] did not affected by replacement of CSM by JJM.

Table (3) shows the digestibility coefficients of the experimental rations. The digestibility coefficient of DM ranged from 61.60 to 74.60 %, and there were significant differences ($P<0.05$) between the rations. The highest value was 74.60 % for ration 3 followed by ration 2 (71.47 %), and the lowest value was 61.60 % for ration 1 followed by ration 4 (68.16 %). The same trend of DM digestibility was observed with the digestibility of organic matter (OM), crude protein (CP), ether extract (EE) and nitrogen free extract (NFE) (Table 3), but the highest value of CF digestibility was (81.26 %) for ration 1 followed by 70.23, 69.55 and 67.09 % for rations 2, 3 and 4, respectively. The replacement of CSM by JJM till 50 % of it enhanced the digestibility coefficients of DM, OM, CP, EE and NFE. As for CF digestibility, when CSM was replaced by JJM, the digestibility decreased by the presence or the level of replacement. The present results are not agreed with Swingle *et al.* (1985) they found that digestibility of N of steers was decreased by 10 % ($P<0.05$) with a diet contained acidophilus-treated jojoba meal (TJM) compared to the cotton seed meal (CSM) diet and digestibility of dry matter, organic matter and gross energy were also lower ($P<.05$) in the TJM diet.

A similar trend was found with the results of total digestible nutrients (TDN) and digestible crude protein (DCP) (Table 3). The highest value of TDN was 68.88 % for ration 3 and the lowest value was 61.75 % for ration 1. The highest value of DCP was 8.03 % for ration 3, and the lowest value was 6.09 %, ration 1. The increase of TDN and DCP with the replacement of CSM by JJM till 50 % of it may due to the increment of digestibility coefficient of nutrients. Dry matter intake (DMI) of mixed rations is shown in Table 3. There was ($P<0.05$) significantly reduced in DMI when JJM was replaced in the rations. Supplementing feed with deoiled jojoba meal reduces feed intake in rats (Booth *et al.*, 1974; Cokelaere *et al.*, 1993), chickens (Ngou Ngoupayou *et al.*, 1982; Arnouts *et al*, 1993), and rodent (Sherbrooke 1976; Ngou Ngoupayou *et al.*, 1985). In rats, this effect is mainly caused by simmondsin, simmonsin 2-ferulate, and related cyanomethylene glycosides (Elliger *et al.*, 1974; Cokelaere *et al.*, 1992). Cokelaere *et al.* (1995) demonstrated that simmondsin exerts its food intake reducing effect by inducing satiation and not by its toxicity. Simmondsin and its analogues inhibit food intake (Booth *et al.*, 1974; Cokelaere *et al.*, 1992). In adult rats, food intake inhibition causes the same emaciation as in rats pair-fed to rats treated with pure simmondsin (Cokelaere *et al.*, 1992). In young rats, the food intake inhibition caused by supplementation of food with deoiled jojoba meal induces a more pronounce growth retardation than in pair- fed rats. This reduced feed intake of JJM points again to an unpalatable taste effect of the jojoba meal (Cokelaere *et al.*, 1992). There is a conclusion that jojoba meal reduces feed intake by its unpalatable taste rather than by inducing satiation, in contrast to the results obtained in rats by Cokelaere *et al.* (1995).

The nitrogen balance (NB) of the present study is shown in Table (4). The values of NB were 1.00, 0.81, 0.40 and 0.29 g N/day for rations 1, 2, 3 and 4, respectively. The highest value of NB was 1.00 g N/day for ration 1, and the lowest value was 0.29 g N/day for ration 4. The increase of NB with the ration 1 may be due to the increase in nitrogen intake and the decrease in NB when JJM was added might be due to the decrease in nitrogen intake and decrease in the execration of nitrogen in urine (Table 4). Swingle *et al.* (1985) found that N retention as a percentage of N intake of steers fed the TJM diet was lower ($P<.05$) for the TJM diet than the CSM diet, while grams of N retained/d and N retention as a percentage of N absorbed were similar for the two diets.

Ruminal fermentation

The values of pH, ammonia nitrogen (NH_3-N) and total volatile fatty acids (VFA) concentrations are presented in Tables 5, 6, 7. There were no significant ($P>0.05$) differences in pH among all rations for all sampling times (0, 1, 3 and 6 h after feeding). The average values of pH ranged from 6.31 to 6.37 (Table 5). JJM did not affected pH in the rumen when it included in the rations.

As for NH_3-N concentrations, there were no significant differences at zero time and after 1h of incubation (Table 6), although the mean values at 3h and there after were significantly ($P<0.05$) higher for ration 1 (without JJM). The highest mean value was 15.57 mg/100 ml rumen liquor (RL) for ration 1, and the lowest mean value was 12.12 mg/100 ml RL for ration 3. The replacement of JJM in the rations decreased NH_3-N and hence could be more utilized by rumen microorganisms. The lower ammonia concentrations were mainly due to the reduction in proteolysis, degradation of peptides and deamination of amino acids in the rumen (Dinius *et al.*, 1976; Van Nevel and Demeyer, 1979; Wallace *et al.*, 1981; Whetstone *et al.*, 1981; Newbold *et al.*, 1990).

The same trend was observed with VFA concentrations (Table 7). The mean values of VFA were 10.89, 8.69, 7.49 and 7.75 meq/100 ml RL for rations 1, 2, 3 and 4, respectively. The decrease of VFA when JJM was replaced in the rations with the decrease of NH_3-N in the rumen of lambs could be due to the more microbial N synthesis although it was not determined in this study. In the present study, the utilization of NH_3-N and VFA by lambs was confirmed by the positive results of the digestibility of CP and NFE, and also by TDN and DCP when CSM was replaced by JJM. In addition, the higher supply of undegradable protein (UDP) by means of treated protein might have increased the supply of proteins and essential amino acids to the lower tract, and thus, caused an increase in the efficiency of protein utilization (Chatterjee and Walli, 2003). It is important to measure the quantity of protein degraded in the rumen and the quantity that by-passes the rumen and reaches the small intestine, where amino acids are absorbed. Generally, protein, in the form of amino acids available for absorption from the small intestine of ruminants originates from microbial protein synthesized in the rumen, rumen undegradable protein (RUP) of feeds and endogenous protein secreted into the digestive tract. Although the small intestinal digestibility (SID) of microbial protein is relatively constant, at 80–85%, the digestibility of RUP can vary considerably depending on the type of feedstuff and also the treatments received during processing (Hvelplund and Madsen, 1990). Therefore, more studies are needed for using JJM as a protein source in the ration of ruminants.

Growing trials

Daily gain, feed intake, feed conversion and economical efficiency of lambs consumed different tested rations are presented in Table (8). The average values of dry matter intake (DMI) were 1.182, 0.791, 0.794 and 0.847 kg/head,h/day,d for lambs consumed rations 1, 2, 3 and 4, respectively. These results confirmed by the observations of Trei *et al.* (1979) with sheep, and Swingle *et al.* (1985) with cattle. Lambs appeared to be more sensitive to, the appetite-depressing factors in JJM than were steers (Swingle *et al.* 1985). The average daily gains (ADG) of lambs were 0.136, 0.126, 0.079 and 0.064 kg/h/d, for rations 1, 2, 3 and 4, respectively. Steers consuming the TJM diet had 18% lower daily gains than those receiving the CSM diet and consequently required a longer feeding period (168 vs 140 d) to reach the desired final weight (Swingle *et al.* 1985). Manos *et al.* (1986) suggested that the ewes fed the 5 % jojoba ration showed a weight gain numerically lower than the corresponding controls. The wethers fed 5 or 10 % jojoba meal showed numerically lower weight gain than the control wethers (Manos *et al.*, 1986). The feed conversion by lambs was 8.69, 6.28, 10.05 and 13.23 kg DMI/kg gain for rations 1, 2, 3 and 4, respectively. The economical efficiency was 0.09, 0.12, 0.08 and 0.06 for rations 1, 2, 3 and 4 respectively. The present results indicated that the decrease in DMI when JJM was replaced may due to its toxicity and also this reduction in feed intake of JJM points again to an unpalatable taste effect of the jojoba meal, Cokelaere *et al.* (1995). The decrease in ADG when JJM was replaced in rations might be due to the decrease in DMI, whereas the best ration for economical efficiency was 0.12 for ration 2 when JJM was replaced by 33% of CSM, followed by 0.09 for ration 1 (control ration), 0.08 for ration 3 (CSM was replaced by 50% of JJM) and 0.06 for ration 4 (CSM was replaced by 100% of JJM). The results of ADG (Table 8) were confirmed by the results of N retention (Table 4). Interestingly, the replacement of JJM saved the feed cost as calculated by

63, 94 and 209 L.E. /Ton for rations 2, 3 and 4, respectively, compared to ration 1 (control ration), and decreased the daily feed cost by 33, 34 and 36% for rations 2, 3 and 4, respectively compared to control ration (ration 1). Generally, more studies and efforts are needed to examine JJM with the microorganisms, the toxicity of it and with the performance of animal to use it as a protein source in ruminant rations.

Table (1): Formulation of the concentrate mixtures:

Items	Ration 1	Ration 2	Ration 3	Ration 4
Yellow Corn	43	43	43	43
Wheat Bran	22	22	22	22
Soybean Meal	10	10	10	10
Cottonseed Meal	18	12	9	---
Jojoba Meal	---	6	9	18
Molasses	4	4	4	4
Lime Stone	2	2	2	2
Salt	1	1	1	1
Cost L.E. / Ton*	1399	1336	1305	1190

*According to the prices of 2006.

Table (2): Chemical composition (%) of the tested rations consumed by lambs:

Items	DM	OM	CP	CF	EE	NFE	Ash
Ration 1	90.84	84.02	12.12	16.26	4.65	50.99	6.82
Ration 2	90.65	83.51	11.77	15.73	3.96	52.05	7.14
Ration 3	90.83	83.61	11.98	16.06	4.60	50.97	7.22
Ration 4	90.69	82.75	11.84	15.36	3.97	51.58	7.94

Concentrate mixture: wheat straw (70: 30%). DM, dry matter ; OM, organic matter ; CP, crude protein ; CF, crude Fiber ; EE, ether extract ; NFE, nitrogen free extract .

Table (3): Average of digestibility coefficients, nutritive values and dry matter intake of different tested rations consumed by lambs (Mean ±SE)

Items	Ration 1	Ration 2	Ration 3	Ration 4
Digestibility Coefficients,% :-				
Dry matter	61.60±0.06^{d}	71.47±0.02^{b}	74.60±0.06^{a}	68.16±0.05^{c}
Organic matter	65.03±0.05^{d}	73.84±0.23^{b}	76.98±0.08^{a}	70.78±0.61^{c}
Crude protein	50.26±4.03^{c}	60.21±2.91^{b}	67.02±1.03^{a}	58.96±0.65^{b}
Crude fiber	81.26±1.79^{a}	70.23±2.18^{b}	69.55±1.06^{b}	67.09±1.80^{b}
Ether extract	55.87±0.69^{c}	74.67±1.11^{b}	80.49±0.85^{a}	78.68±4.66^{b}
Nitrogen free extract	71.66±1.04^{d}	79.00±0.70^{b}	81.12+0.63^{a}	74.85±1.68^{c}
Nutritive values, % :-				
TDN[1]	61.75±1.89^{c}	65.91±1.73^{b}	68.88±0.89^{a}	62.92±2.20^{b}
DCP[2]	6.09±0.22^{b}	7.09±0.25^{a}	8.03±0.13^{a}	6.98±0.22^{ab}
Total DM intake, kg/h/d.	1.182±0.28^{a}	0.791±0.14^{b}	0.794±0.09^{b}	0.847±0.14^{b}

[abcd] Means within the same rows with different superscript are significantly different (P<0.05).
[1] Total Digestible Nutrients.
[2] Digestible Crude Protein.

Table (4): Average values of nitrogen utilization of lambs fed on different tested rations (Mean± SE).

Items	Ration 1	Ration 2	Ration 3	Ration 4
Nitrogen Intake, g/d.	22.92±0.06^{a}	14.90±0.04^{c}	15.22±0.03^{b}	16.05±0.06^{b}
Extracted N., g/d :-				
Feces .	11.41±0.92^{a}	5.94±0.44^{bc}	5.02±0.16^{c}	6.65±0.09^{b}
Urine .	10.51±0.99^{a}	8.15±0.39^{b}	9.80±0.24^{a}	9.11±0.08^{a}
Digested N., g/d .	11.51±0.92^{a}	8.96±0.43^{b}	10.20±0.15^{a}	9.40±0.09^{b}
N. Balance, g/d .	1.00±0.07^{a}	0.81±0.09^{b}	0.40±0.08^{c}	0.29±0.02^{c}

[abc] Means within the same rows with different superscript are significantly different (P<0.05).

Table (5): Average values of pH in rumen liquor of lambs fed different tested rations (Mean ± SE).

Sampling times (hrs)	Ration 1	Ration 2	Ration 3	Ration 4
0	6.79±0.09	6.77±0.12	6.58±0.07	6.56±0.10
1	6.45±0.11	6.40±0.11	6.32±0.05	6.37±0.05
3	6.20±0.05	6.23±0.07	6.26±0.10	6.23±0.08
6	6.04±0.08	5.99±0.09	6.07±0.12	6.12±0.04
Mean	6.37±0.28	6.35±0.28	6.31±0.18	6.32±0.16

Table (6): Average values of NH_3-N* concentrations in rumen liquor (mg/100 ml RL) of lambs consumed different tested rations (Mean ± SE).

Sampling times (hrs)	Ration 1	Ration 2	Ration 3	Ration 4
0	9.91±0.64^{a}	9.92±0.52^{a}	10.03±1.10^{a}	10.34±1.10^{a}
1	15.93±1.29^{a}	13.72±0.64^{a}	14.96±1.18^{a}	15.94±1.69^{a}
3	22.34±1.00^{a}	17.59±0.23^{b}	12.87±1.84^{c}	13.45±0.8^{c}
6	14.11±0.48^{a}	12.37±1.41^{ab}	10.62±1.4^{b}	9.95±1.19^{b}
Mean	15.57±4.48^{a}	13.40±2.78^{bd}	12.12±1.95^{cd}	12.42±2.44^{c}

^{abcd}Means within the same rows with different superscript are significantly different (P<0.05).
* Ammonia nitrogen

Table (7): Average values of VFA* concentrations in rumen liquor (meq/100 ml RL) of lambs consumed different tested rations (Mean ± SE).

Sampling times (hrs)	Ration 1	Ration 2	Ration 3	Ration 4
0	9.41±1.27^{a}	6.69±1.61^{a}	7.15±0.33^{a}	6.76±0.51^{a}
1	11.88±1.11^{a}	11.73±0.21^{a}	8.05±0.47^{b}	9.63±0.82^{ab}
3	8.45±0.94^{a}	8.64±1.22^{a}	7.81±0.45^{a}	8.16±1.18^{a}
6	7.69±0.93^{a}	7.68±1.64^{a}	6.96±0.4^{a}	6.43±1.01^{a}
Mean	10.89±2.56^{a}	8.69±1.89^{ab}	7.49±0.45^{c}	7.75±1.27^{bc}

^{abc} Means within the same rows with different superscript are significantly different (P<0.05).
* volatile fatty acids.

Table (8): Average values of feed intake, daily gain, feed conversion and economical efficiency of lambs consumed different tested rations (Mean ± SE).

Items	Ration 1	Ration 2	Ration 3	Ration 4
Experimental period, day	100	100	100	100
Animal No.	5	5	5	5
Initial body wt., kg	37.6±6.11	36.0±4.03	38.4±6.74	39.8±8.49
Final body wt., kg	51.2±5.84^{a}	48.6±2.15^{b}	46.3±6.83^{b}	46.2±7.14^{b}
Total gain, kg	13.6±1.55^{a}	12.6±2.19^{a}	7.9±1.87^{b}	6.4±2.58^{b}
Daily gain, kg	0.136±0.02^{a}	0.126±0.02^{b}	0.079±0.02^{c}	0.064±0.03^{c}
Total DM intake, kg/h/d	1.182 ±0.28^{a}	0.791 ±0.14^{b}	0.794 ±0.09^{b}	0.847 ±0.14^{b}
TDN intake, kg/h/d	0.730 ±0.053^{a}	0.521 ±0.031^{b}	0.547 ±0.008^{b}	0.533 ±0.024^{c}
DCP intake, kg/h/d	0.072±0.006^{a}	0.056±0.003^{a}	0.064±0.002^{a}	0.059±0.004^{b}
Feed conversion efficiency, kg/kg gain :-				
DM	8.69	6.28	10.05	13.23
TDN	5.37	4.13	6.92	8.33
DCP	0.52	0.44	0.81	0.92
Feed cost, LE/h/d	1.58	1.06	1.04	1.01
Economical efficiency	0.09	0.12	0.08	0.06

^{abcd} Means within the same rows with different superscript are significantly differ (P<0.05).
Economic efficiency = output of daily weight gain/cost of daily feed consumed.

CONCLUSION

From the current study it could be concluded that the replacement of CSM by the cheap protein source (JJM) enhanced the digestibility coefficient of nutrients, nitrogen balance and ruminal fermentation, and hence improved the daily gain when compared to economical efficiency. The use of JJM saved the feed cost as were calculated by 63, 94 and 209 L.E. /Ton for rations when JJM replaced 33, 50 and 100% of CSM, respectively, compared to control ration (without JJM). The current study concluded that the replacement of CSM by 33 % (6% of total mixed ration) of JJM is recommended. However, furthure studies are needed to evaluate the nutritive value and biological value of JJM as a protein source in different species of ruminants.

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تقييم كسب الهوهوبا كمصدر للبروتين في الأغنام

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تهدف هذه الدراسة إلى بحث تأثير كسب الهوهوبا كبديل لكسب القطن على الهضم و نشاط الكرش وأداء الحملان . أستخدم عشرون حمل رحمانى بمتوسط وزن ٣٧±١,٣٧ كجم لمدة ١٠٠ يوم . وقد قسمت الحيوانات الى أربع مجموعات وتم إستخدام أربعة مخاليط مركزة بالإضافة لتبن القمح . وقد إستخدم كسب الهوهوبا فى العلائق بنسبة صفر% بالعليقة الأولى ، ٣٣ % فى العليقة الثانية ، ٥٠ % فى العليقة الثالثة ، ١٠٠ % فى العليقة الرابعة وذلك بدلا من كسب القطن . حيث كانت العلائق المقدمة للحيوانات مكونة من ٧٠ % مخلوط مركز + ٣٠ % تبن قمح . وقد أجريت تجارب هضم وتجارب تخمر للكرش.

أوضحت النتائج أن التحليل الكيماوى للعلائق الأربعة لم يتأثر بنسبة الاستبدال المستخدمة. وقد تراوح معامل هضم المادة الجافة بين ٦١,٦ ـ ٧٤,٦ % ووجدت إختلافات معنوية بين العلائق. وقد لوحظ نفس الإتجاه فى هضم المادة الجافة و المادة العضوية و البروتين الخام و المستخلص الإيثيرى والمستخلص الخالى من الأزوت.

وقد تبين أن إستبدال كسب القطن بكسب الهوهوبا بنسبة ٥٠ % أعطى معاملات هضم عالية للمادة الجافة و المادة العضوية و البروتين الخام و المستخلص الإيثيرى و المستخلص الخالى من الأزوت. وبالنسبة لمعامل هضم الألياف الخام انخفض بإنتظام مع زيادة نسبة الإستبدال ، وزاد مجموع المواد الغذائية المهضومة والبروتين الخام المهضوم مع نسبة إستبدال ٥٠ % وقد وجد إنخفاض معنوى فى المادة الجافة المأكولة عند إستخدام كسب الهوهوبا فى العلائق. كما لم توجد إختلافات معنوية فى رقم الـ pH فى مختلف العلائق فى جميع مواعيد العينات. وكانت أعلى قيمة لمتوسط تركيز الأمونيا ١٥,٥٧ مجم/ ١٠٠ مل سائل كرش فى العليقة الأولى وأقل قيمة كانت ١٢,١٢ مجم/١٠٠ مل سائل كرش فى العليقة الثالثة. كما أن قيمة الأحماض الدهنية الطيارة كانت ١٠,٨٩ ، ٨,٦٩ ، ٧,٤٩ ، ٧,٧٥ ملليمكافئ /١٠٠ مل سائل كرش و متوسط الزيادة اليومية للحملان كانت ٠,١٣٦ ، ٠,١٢٦ ، ٠,٠٧٩ ، ٠,٠٦٤ كجم/رأس/يوم بينما معدل تحويل الغذاء كان ٨,٦٩ ، ٦,٢٨، ١٠,٠٥ ، ١٣,٢٣ كجم مادة جافة مأكولة/كجم نمو أما الكفاءة الإقتصادية كانت ٠,٠٩ ، ٠,١٢ ، ٠,٠٨ ، ٠,٠٦ وذلك للعلائق الأولى ، الثانية ، الثالثة ، الرابعة على الترتيب.

من نتائج الدراسة يمكن الاستنتاج بإمكانية إستخدام كسب الهوهوبا بنسبة ٣٣% بدلا من كسب القطن ، ورغم ذلك فهناك إحتياج لمزيد من الدراسة لتحسين القيمة الغذائية لكسب الهوهوبا وإستخدامه كمصدر للبروتين بعلائق المجترات.