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Bio-Detoxification of Jojoba Meal by *Aspergillus oryzae* and Impact of its Utilization in Ewes and Lambs' Feeding

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ABSTRACT

The present study was conducted at Maryout Research Station, Desert Research Center, Egypt. Jojoba meal (JM) was treated biologically with *Asperglus orgyzae* Fk-923 to study its effects on performance, digestibility coefficient, nutritive value, blood metabolites, and rumen characteristic of sheep. Total of 30 Barki ewes aged 3- 4 years old with an average weight of 33.46 kg were randomly allotted into three experimental treatments (10 ewes of each) to study the reproductive traits of Barki sheep. The experiment lasted for 150 days to cover the pregnancy period. After weaning eighteen growing lambs with average live body weight of 15.41kg, were used in feeding trial 210 days (six lambs of each). The experimental rations (R1, R2 and R3) of treated jojoba meal (TJM) at level of (0, 7% and 14%) as a replacement of cotton seed meal, respectively. The results indicated that the analysis of experimental rations' components demonstrated that the experimental rations were similar in its chemical composition but there was a slight increase in the crude protein content with increasing the percentage of jojoba meal (for the slight decrease in CF content). During early pregnancy, ewes consumed 14% of treat jojoba meal had lower total crude fiber intake than those of R1 (control) and R2 groups. During late pregnancy, the intake levels of total dry matter, crude protein and crude fiber were higher in lambs feed the control ration compared to both 7 and 14% (TJM). During the early pregnancy and late pregnancy, changes in body weight of sheep were not significantly affected by type of diets. Digestibility coefficients by lambs fed 14% JM (R3) showed numerically higher digestion values of DM, OM, CP, CF, NFE and NDF followed by those feed 7% JM (R2) than the R1 (control). Lambs fed jojoba meal had higher TDN and the digestible crude protein (DCP) improved with increasing percentage of JM. Also nitrogen balance as % of nitrogen intake was higher in animals fed R3 and the lowest value was in R2. Feed conversion values as DM, TDN and DCP were improved for lambs fed the control followed by rations containing 7 and 14% JM treated with fungi, respectively. Providing treated JM with fungi (R2 and R3) improved the pH values. The opposite trend was observed for rumen ammonia concentrations (NH_3-N) and total volatile fatty acids values (TVFA's), which found to be low before feeding, then increased at 3 hrs. post feeding and returned to decrease at 6 hrs. post feeding but NH_3-N levels increased at 6 hrs. post feeding for R1 and R3. There were no significant ($P>0.05$) differences in creatinine, total protein, albumin, globulin, AST, ALT, T3 and T4 levels. The economic parameters for R3 was the best followed by R2 compared with control ration (R1). It could be concluded that 14% treated JM with fungus can be used in growing lambs' ration.

Keywords: Jojoba meal, lambs, digestibility, productive performance, blood metabolites.

INTRODUCTION

The agro-industrial by-products are becoming now available to use in the formulation of animals diet, either due to a plenty of these by- products or to alleviate apart of higher cost of diet. Therefore, it plays an important role in the total cost of feeding. Several advantages are favoring jojoba seed to be grown in Egypt (such as limited water requirements, high seed yield and relatively high oil content, Wisniak, 1987) in new reclaimed soils. Jojoba (*Simmonasia chinensis*) is a dioeciously desert shrub that grows in arid and semi-arid regions, is being cultivated to provide a renewable source of a unique high quality oil (Sabien *et al*., 1997). Jojoba meal, the by- product, is obtained from the oil extraction of the seeds contains from 26 to 33% crude protein (Verbiscar *et al*., 1980 and Nasser *et al*., 2007) and would increase the economic value of this crop if it used as a feed ingredient. From this bright side, Bellirou *et al*. (2005) reported that elimination of anti-nutritional factors in jojoba seed meal could be achieved by different methods, including solvent extraction, heat, chemical treatment and microbial fermentation. Jojoba meal, as a by-product of jojoba seeds, is a promising feedstuff after being detoxified (Motawe*,* 2006). El-Damrawy *et al*. (2015) found that biological treatment of jojoba meal by *Lactobacillus acidophilus* and *Tricoderma ressie* may eliminate the anti- nutritional factors. The most important glycosidic component is simmondsin which reduces food intake and body weight, affects biochemical parameters and fertility and increases the mutagenic activity (Verbiscar *et al*., 1980; Charles, 1988 and Cokelaere *et al*., 1993). Also, the presence of toxic or anti-nutritive compounds or both make it unsuitable for livestock feeding. Indeed, feeding it to lambs (Manos *et al*., 1986) resulted in impaired body weight gain, reduction in feed intake, and impaired feed efficiency. However, there is a few published data on the response of sheep to diet containing jojoba meal. Consequently, these series of experiments were initiated to determine the relative acceptability of diets containing 7% and 14% treated jojoba meal with *Asperglus orgyzae* and its effects on productive performance, digestibility, nutritive value, blood metabolites and rumen liquor parameters of lambs.

MATERIALS AND METHODS

The present study was conducted at the Maryout Research Station (located at 35Km South West of Alexandria), Desert Research Center, Egypt. Jojoba meal (JM) treated biologically with *Asperglus orgyzae* Fk-923 was replaced at 0, 7 and 14% instesd of undecorticated cotton seed meal of ration R1, R2 and R3, respectively. Jojoba meal (JM) was supplied by the Egyptian Natural oil Company.

Anti –nutritional factors (ANF) analysis:

Qualitative and quantitative estimations of condensed tannins (CT), saponin and simmondosin as the main anti- nutritional factors (ANF) in all feed ingredients were determined according to Porter *et al*. (1986).

Biological detoxification:

Pure strain of (*Asperigullis oryzae* Fk-923) was obtained from Microbiological Chemistry Department, National Research Centre, Dokki, Giza, Egypt. The cultures were maintained on-potato-dextrose medium (Czabexs Dox Agar) according to Oxoid (1982). It was activated in sterilized conical flasks kept in shaker water bath at 28 to 32°C for 96 hours. Fresh liquid culture of *Aspergllus oryzae* was obtained by growing on nutrient broth $(1x10)^2$ cfu. It was mixed with diluted molasses. All components were mixed well and then bagged and pressed into clean plastic bags holding 50Kg then they were sealed and kept for 30 days at room temperature. At the end of incubation period, the treated materials were solar dried to stop activity of fungi and decrease moisture content to reach less than 10%, then packed and stored until used in feeding trials.

Animal, diets and management:

Trial 1: Ewes feeding experiment:

Total of 30 Barki ewes aged 3- 4 years old with an average weight of 33.46± 2.36 kg were randomly allotted into three experimental treatments (10 ewes of each) to study the feed utilization and performance traits of Barki sheep. Concentrate feeds were calculated and formulated depending on the physiological status of ewes according to Kearl (1982). The experiment lasted for 150 days to cover the pregnancy period. The rations of ewes are represented in Table 1. Ewes were weighed at the beginning then biweekly before and after lambing as well as their new born lambs.

Trial 2: Lambs feeding experiment:

After lambs weaning at 3 months old, eighteen growing lambs with average live body weight of 15.41±0.717 kg were used in a feeding trial for 210 days. Lambs were randomly divided into three similar experimental groups; according to their live body weights (six lambs of each). The amount of ration was offered and changed biweekly depending on the live body weight till the end of the experimental period. The experimental rations (R1, R2 and R3) of treated jojoba meal (TJM) at level of (0, 7% and 14%) as a replacement of cotton seed meal, respectively and components of concentrate feed mixture are represented in Table 1. All groups were offered berseem hay as a source of roughage. The data of chemical analysis of the experimental ration, roughage, untreated jojoba meal and treated jojoba meal with fungi was represented in Table 2. Fresh water was available at all times.

Table 1. Feed ingredients (%) of experimental concentrate feed mixtures (% on dry matter basis)

Item	R1	R2	R3
Cotton seed	20	13	6
Jojoba meal treated with fungi	-	7	14
Yellow corn	53	53	53
Soybean meal	10	10	10
Wheat bran	10	10	10
Molasses	4	4	4
Salt	1.2	1.2	1.2
Limestone	1.5	1.5	1.5
Mineral premix	0.3	0.3	0.3

DM: dry matter, OM: organic matter, CP:crude protein, CF:crude fiber, EE:ether extract, NFE: nitrogen free extract,
NDF: neutral detergent fiber, ADF: acid detergent fiber, ADL: acid detergent lignin.

Table 2. Chemical analysis and concentration of anti-nutritional factors of the experimental rations, UJM, TJMF and roughage (% on dry matter basis)

Items	DM	Ash	OM	CP	CF	EE	NFE	NDF	ADF	ADL	C.T mg%	Si	Sap%
R1	92.75	6.20	93.8	16.70	6.52	4.51	66.07	41.02	11.13	3.58	0.086	-	0.845
R2	92.71	6.88	93.12	17.24	5.69	4.26	65.96	40.20	9.31	2.23	ne	-	1.625
R3	93.81	6.46	93.54	17.40	4.48	4.39	67.63	41.57	4.43	2.85	1.037	-	traces
Berseem hay	89.76	14.75	85.25	15.32	28.51	1.47	39.98	47.50	34.98	16.39	1.58	-	ne
UJM	93.86	3.09	96.91	27.78	9.56	10.19	49.38	35.91	33.54	16.29	7.18	5	8.45
JMF	90.72	5.88	94.12	28.45	6.97	13.81	44.89	26.99	13.44	6.83	4.24	0.17	2.79

DM: dry matter, OM: organic matter, CP: crude protein, CF:crude fiber, EE:ether extract, NFE: nitrogen free extract, NDF: neutral detergent fiber, ADF: acid detergent fiber, ADL: acid detergent lignin.
R1: Control: concentrate feed mixture (CFM), R2: CFM containing 7% treated jojoba meal with fungi, R3: CFM containing 14% treated jojoba meal with fungi, untreated jojoba meal (UJM), treated jojoba meal with fungi (TJMF), CT: condensed tannin; n.e: not evaluated, Sap: Saponins g%, Si: Simmondsine%.

Digestibility, nutritive value and nitrogen balance:

At the end of the feeding trial, all lambs were used in digestibility trials, placed individually in metabolic cages for 14 days as a preliminary period followed by 5 days as a collection period. The concentrate feed mixture (CFM) was offered daily at 8.00 am and berseem hay at 12.00 pm. During the collection period, feces and urine were quantitatively collected, sampled and kept for analysis. Dry matter intake and water consumption were estimated.

Analytical procedures:

Representative samples of feed ingredients and feces were analyzed for summative analysis according to A.O.A.C. (2000). Fiber constituents (neutral detergent fiber, NDF, acid detergent fiber, ADF and acid detergent lignin, ADL were determined according to Goring and Van Soest (1970).

Sampling of rumen liquor:

At the end of the 210 days of feeding period, rumen fluid samples were collected from each animal at zero time (before morning feeding) and 3 and 6 hours after feeding by a stomach tube. Ruminal pH was determined using a digital pH meter, NH_3-N was determined according to Abou-Akkada and El-Shazly (1964). Ruminal total volatile fatty acids (TVFA's) concentrations were determined by steam distillation according to Kromann *et al*. (1967).

Blood sampling:

After the digestibility trials, blood samples were collected from the jugular vein of all animal before feeding. Blood serum was obtained after clotting by centrifugation at 3000 rpm. for 20 min. and stored at -20 °C until analysis. Serum total protein and albumin were determined using Biuret method as described by Doumas *et al*. (1971). Globulin values were obtained by subtracting albumin values from total protein values. Aspartate amino transferase (AST) and alanine amino transferase (ALT) activities were determined calorimetrically by Wilkison *et al*. (1972). Creatinine and urea were determined according to Folin (1994) and Patton and Grouch (1977). Sera were also analyzed for thyroid hormones; triiodothyronine (T3) and thyroxin (T4) using enzyme immunoassay test kits, according to Braveman (1996).

Economic evaluation:

Economic efficiency expressed as the ratio between the price of total live weight gain and the price of feed consumed, was estimated on the basis of the following prices in Egyptian pound per ton during 2016. The general equation by which the costs of one kg of live body weight gain was calculated as follows:

The cost for one kg gain= Total cost of feed intake / total gain (kg)

Statistical analysis:

The data was statistically analyzed using SAS (2000). The significance among experimental diets, time sampling and periods means were tested by Duncan's multiple ranges Test (1955), when the main effect was significant.

RESULTS AND DISCUSSION

Chemical Composition:

The data of chemical composition presented in Table 2 showed that biological detoxification of jojoba meal led to decrease OM, CF, NDF, ADF and ADL contents by about 94.12, 6.97, 26.99, 13.44 and16.39%. While the biological treatments led to increase ash and CP contents by about 28.45 and 5.88%, respectively compared with untreated jojoba meal. These results are in a agreement with data reported by Molawe (2006), El-Kady *et al*. (2008), Khalel *et al*. (2008) and Abdou and El-Essawy (2018). Ether extract (EE) of treated JM was higher (13.81%) than most of published values (Verbiscar *et al*., 1980 and Ngou Ngoupayou *et al*., 1982) and lower than that obtained by Sobhy *et al*. (2003). These differences could be owing to methods and degree of oil extraction, size of seed and/or varieties of cultivars (El-Sherbiny, 1994). The chemical analysis of experimental rations demonstrated that the rations were very close in its chemical composition but there was a slight increase in the crude protein content with increasing the percentage of jojoba meal. A slight decrease in CF content might be attributed to replacement cotton seed meal with jojoba meal (Table 2). Similar findings were reported by El- Kady *et al*. (2008), Khalel *et al*. (2008) and Abdou and El-Essawy (2018).

Anti –nutritional factors:

Data in Table 3 showed that all groups had a positive effect in decreasing concentration of anti-nutritive compounds. Fungal treatment decreased the concentration of simmonds as the major toxicant component, condensed tannins and saponins by 96.6, 40.95 and 66.98 %, respectively. These results are in agreement with those reported by Nelson *et al*. (1979) and Verbiscar *et al*. (1980) who found that JM incubated with fungus decreased concentration of simmondsin, condensed tannins and saponins. Various attempts for the detoxification of jojoba meal have been reported. Bellirou *et al*. (2005) extracted both simmondsin and oil with water at 90°C from ground jojoba seeds. This method removed both the oil and simmondsin in one step. Solvent extraction, heat water washing treatments and microbial methods resulted in reduced simmondsin levels (Verbiscar *et al*., 1980 and 1981). Proportional replacement undecorticated cotton seed meal by 7% and 14% detoxified JM with fungus (in groups R2 and R3) revealed that highest removal level of condensed tannin in R3 was comparable with that of R1 (control) and R2. However, saponin was high with R2 compared with those of R1 and R3.

Table 3. Live body weight changes of ewes during pregnancy period and voluntary intake during early and late pregnancy period as affected by different type of rations

Items	R1	R2	R3
Initial of body weight Kg	35.31±2.40	32.46±2.62	32.62±2.07
Average body weight of Early pregnancy (3 months Kg)	39.85±2.40	37.84±2.62	38.08±2.07
Voluntary intake early pregnancy (g/kg BW):			
Total DM intake	20.57	20.65	20.50
Total CP intake	3.30	3.37	3.36
Total CF intake	3.45	3.48	3.24
Total digestible nutrients intake (TDNI)	12.83	13.05	13.30
Protein Digestible crude intake (DCPI)	2.01	2.12	2.16
Average Body weight of late pregnancy (Kg)	41.03	39.42	40.65
Voluntary intake late pregnancy (g /kg BW):			
Total DM intake	25.02	24.81	24.65
Total CP intake	4.03	4.10	4.10
Total CF intake	3.57	3.61	3.26
Total digestible nutrients intake (TDNI)	15.60	15.68	16.00
Protein Digestible crude intake (DCPI)	2.44	2.55	2.60
Body weight just before lambing kg	45.88±2.69	43.16±2.94	42.57±2.32
Body weight just after lambing kg	38.61±2.36	35.78±2.58	35.76±2.04
Body weight changes (kg): early pregnancy	4.54±0.492	5.380±539	5.460±426
Body weight changes (kg): Late pregnancy	6.03±0.642	5.32±0.703	4.49±0.556
Body weight changes (kg): Overall average	10.57±0.791	10.70±0.867	9.95±0.685
Weight loss just after lambing kg	7.27±0.856	7.38±0.938	6.81±0.741
% of weight before lambing	15.84±1.72	17.10±1.88	15.99±1.49

R1: Control: concentrate feed mixture (CFM) + berseem hay, R2: CFM containing 7% treated jojoba meal with fungi+ berseem hay,
R3: CFM containing 14% treated jojoba meal with fungi+ berseem hay.

Ewes feeding trial:

Effect of inclusion treated jojoba meal in ewes ration on their performance:

Feed intake:

Data of voluntary feed intake of ewes fed different levels of jojoba meal are summarized in Table 3. During early pregnancy, there were no differences among experimental treatments of total dry matter and crude protein intake. However, ewes consumed 14 % of treat jojoba meal had lower total crude fiber intake than those of R1 and R2 groups. This might be attributed to the higher percentage of cotton seed replacement in R3. The values of TDN and DCP intake increased with increasing of the replacement percentage of cotton seed meal by treated jojoba meal. The present results are in accordance with those reported by Abdou (2018) and Abdou and El-Essawy (2018). On the other hand, during late pregnancy, the intake levels of total dry matter, were numerically higher in ewes feed on control ration compared to both 7 and 14% (TJM). The intake levels of total crude protein was similar in ewes feed on R2 and R3 and higher than control ration, this may be due to increased crude protein in R2 and R3. While the lower total crude fiber intake in ewes fed R3 compared to other treatments might be due to decreasing of crude fiber level in R3 followed by R1 and R2. The present results showed that the total digestible nutrients intake increased with increasing TJM in tested rations, being 15.60, 15.68 and16.00, respectively. The same trend was observed for digestible crude protein intake, being 2.44, 2.55 and 2.60 (g/kg Bw) in the same order. The higher TDNI and DCPI (g/kg Bw) during early and late pregnancy were recorded for R3 than those of R2 and control ration. These results are in agreement with those obtained by Abdou (2018) who reported that dry matter intake (DMI) and crude protein intake were higher for sheep fed ration supplemented with 30 % (TJM). Khalel *et al.* (2008) reported that feed intake increased significantly when diet contained 10% treated jojoba meal by *Trichoderma reesei*.

Body weight changes:

Body weight (BW) changes of ewes during pregnancy period as affect by different type of rations are presented in Table 3. Initial body weight was comparable in all treatments. The resulted revealed that there were no significant differences among the experimental groups in early, late pregnancy and after lambing weights. These results are in agreement with those recorded by EL-Ashry *et al*. (2003). The present results are in complete agreement with those of EL-Saidy *et al*. (2008) and Eid (2013). Weight loss at lambing is the summation of the weight of the off-spring, placenta and fetal fluid. Since lambing weight of ewes was not affected by type of rations, most differences among lambs might be due to the increase in both fetal fluids and placentas. The highest value of weight loss just after lambing was recorded for R2 (7.38 kg) followed by R1 (7.27kg) and R3 (6.81 kg). While, lambing body weight of lambs decreased and the loss weight were 15.84, 17.10 and 15.99 % for those fed R1, R2 and R3, respectively.

Feed intake, digestion coefficients and water consumption by lambs:

Adjusted data in Table 4 showed the total DM intake from rations increased to 1.48% and 5.56% g/kg BW in R2 and R3, respectively. Total values of dry matter, and CP intakes g/kg BW did not differ significantly. These data was confirmed with the observation of Swingle *et al*. (1985), they found that steers fed diets with 10% of untreated JM for over 60 days showed no detrimental effects. Also, Cokelaere *et al*. (1995) concluded that simmondsin induced feed intake reduction. Trei *et al*. (1979) reported that simmondsin was metabolized by rumen microorganisms *in vitro* and that only trace amount of the major toxicants could be detected in feces of lambs fed diets containing 10% JM. Data in Table 4 demonstrated that digestibility coefficients of lambs fed 14% TJM (R3) showed numerically higher digestion values DM, OM, CP, CF, NFE and NDF followed by those fed 7% TJM (R2) than the R1 (control). These results might be due to the lack of differences among groups in the chemical composition of rations. It is clearly indicated that lambs fed 14% TJM (R3) showed significantly ($P<0.05$) the highest digestibility coefficients of OM, CP, and NFE compared to those fed control ration (R1) but not significantly differ with R2. While digestion coefficients of ADF and ADL were lower in R3 compared to R2 and R1. These data are in agreement with those of El-kady *et al.* (2008) and Abdou (2018) who showed that sheep fed control ration and ration content 20% treated jojoba meal with fungi recorded higher ($P<0.05$) DM, CP, OM, NDF and ADF digestibility compared to other diets. Regarding the water intake values, data of drinking water revealed that replacing cotton seed meal by jojoba meal with fungus (TJM) in lambs ration at 7 % and 14 % led to non-significant effect in water intake (ml/head/day) while feeding lambs the ration containing TJM reflected significant ($P<0.05$) increase in drinking water (ml/g DM intake) by about 10.47% and 12.1% for R2 and R3 in comparison with R1. Also, water intake (ml/kg BW) was increased by about 11.88 and 18.15% for R2 and R3 compared with R1. The effect of dietary treatment on water intake was not related to change in dry matter intake which was almost constant but it might be related to the increase of JM in R3. The increase of water intake in TJM rations was entirely due to the feed intake.

Nutritive value and nitrogen utilization:

The obtained resulted demonstrated that lambs fed jojoba meal had higher TDN (%) values than those of control ones (Table 4), that may be attributed to better digestibility results of most nutrients recorded by this group. Digestible crude protein (DCP %) improved ($P<0.01$) with increasing percentage of JM. The highest values were observed for lambs fed 14% JM followed by those fed 7% while the lowest value was recorded for control group which might be due to the increase of nitrogen intake in R3 and high crude protein of jojoba meal as a result of the improvement in nutrient digestibility by fungal treatment which resulted in increased nutritive value. These results are on the line with those reported by El- Kady *et al.* (2008) and Abdou (2018). Concerning the nitrogen intake, excretion and balances, no significant

(P>0.05) differences were observed among experimental groups. These data matched those reported by Khalel *et al.* (2008). However, the nitrogen intake results coincided with CP intake results (Table 5). Values of total nitrogen excretion clearly indicated that lambs fed the R3 had higher (P<0.05) values which may be attributed to the rapid hydrolysis of CP in the rumen which led to accumulation of ammonia and increase of urinary nitrogen excretion. Indeed, Getachew *et al*. (2008) found that digestibility of NDF and nitrogen was reduced by all levels of tannic acid compared with control. Nitrogen balance as % of nitrogen intake was higher in animals fed R3 and the lowest value was in R2. However, when nitrogen balance calculated as % of digested nitrogen, control animals recorded the highest percentage followed by those of R3 and R2, respectively, due to the high nitrogen intake in R3 and R1. Abdou (2018) reported that increase in nitrogen balance as g/day, nitrogen utilization as percentage of either nitrogen intake and nitrogen utilization of digested with 20% treated jojoba meal compared to control ration and 10% treated jojoba meal.

Table 4. Effect of TJM inclusion in lambs' ration on nutrients digestibility, feeding values, nitrogen balance and water intake

Item	R1	R2	R3	±SE
Nutrient digestibility (%):				
DM	63.76	65.78	65.89	0.802
OM	66.52[b]	67.96[ab]	69.28[a]	0.679
CP	60.83[b]	62.06[ab]	64.02[a]	0.978
CF	47.19	49.10	50.80	1.324
EE	64.70	64.56	64.35	1.008
NFE	74.36[b]	75.60[ab]	76.95[a]	0.639
NDF	57.22	57.63	58.19	1.105
ADF	35.05	37.63	34.68	1.168
ADL	39.01	39.63	37.66	1.728
Drinking water (ml/head/day)	2421.16	2474.0	2725.0	101.68
(ml/kg BW)	66.89[b]	74.84[a]	79.03[a]	2.53
(ml/ g DM intake)	346.93[b]	383.25[a]	388.62[a]	11.86
TDN%	62.37[b]	63.22[ab]	64.87[a]	0.606
DCP %	9.77[b]	10.28[a]	10.54[a]	0.137
Nitrogen intake (g/head/day)	17.84	17.09	18.43	0.438
Feces nitrogen (g / head/ day)	7.02	6.44	6.60	0.214
Urine nitrogen (g/head/day)	5.68	5.87	6.33	0.554
Nitrogen balance (g/head/day)	5.19	4.79	5.51	0.449
(% of nitrogen intake)	29.01	28.44	29.99	2.79
(% of nitrogen digested)	47.81	45.56	46.05	---

a, b: values with different letters in the same row statistically differ significantly at P<0.05.
R1: control group fed (CFM+ berseem hay), R2: group fed CFM containing 7% treated jojoba meal with fungus+ berseem hay, R3: group fed CFM containing 14% treated jojoba meal with fungus+ berseem hay.

Table 5. Growth performance, voluntary intake and feed conversion ratio of lambs fed the experimental rations

Item	R1	R2	R3	±SE
Birth weight, Kg	2.80	3.06	2.96	0.262
Initial body weight, at 3 month, kg	15.66	15.19	15.40	0.717
body weight, at 5 month, kg	24.94	24.34	24.23	0.606
body weight, at 7 month, kg	34.24	33.44	33.63	0.878
TDMI intake, kg	1379.9	1306.26	1343.11	-
TDN intake, kg	860.64	825.81	871.28	-
DCP intake, kg	134.81	134.28	141.56	-
Final body weight, kg	35.68	34.58	35.94	1.088
Total average daily gain, g	156.57	150.09	157.04	5.18
Relative daily gain, g	100	95.86	100.30	---
Relative growth,% of final body weight	56.11	56.07	57.15	---
Feed conversion, kg intake/ kg gain:				
DM intake	8.85	8.70	8.55	0.303
TDN	5.50	5.50	5.54	0.192
DCP	0.861	0.894	0.901	0.031

R1: control group fed (CFM+ berseem hay), R2: group fed CFM containing 7% treated jojoba meal with fungus+ berseem hay, R3: group fed CFM containing 14% treated jojoba meal with fungus+ berseem hay.

Growth performance and feed conversion:

Birth weights of lambs did not significantly differ among groups. Data of Table 5 showed also insignificant differences (P>0.05) in initial body weight, 3, 5, and 7 month and final body weight among the three experimental rations. They showed that 14% jojoba meal replacement instead of cotton seed didn't affect TDMI, where all intakes of the experimental ration were almost similar but TDMI after 7 month was higher in R1 followed by R3 and R2. This result indicated that using jojoba meal as alternative source of protein didn't affect voluntary intake of ruminants. The highest value of TDN intake recorded by R3 (871.28) and DCP intake (141.56) at 7 month was due to the improvement of nutrients digestibility of R3 compared with other groups. Results concerning growth performance of lambs (Table 5) showed no significant differences among all rations in total average daily gain (TADg). Generally, R3 recorded the highest total average daily gain compared to control ration and R2. This result might be due the highest nutrients digestibility and nutritive value with R3 compared with other rations. Abdou and El- Essawy (2018) found that the best values of average daily gain and DMI showed a descending trend for lambs fed jojoba meal treated with Iso-propanol, control, lambs fed the untreated JM then lambs fed JM treated with lactic acid bacteria. The results showed that there were not significant effects of jojoba meal on feed conversion. Concerning the feed conversion ratio, expressed as the amount of intake of DM, TDN and DCP per kg gain was almost similar among different rations. Lambs in R3 group appeared to have a better feed conversion (DMI/gain) compared to those in other groups (R1 and R2). Improved feed conversion ratio (DMI/gain) for R3 group might be attributed mainly to the difference in daily gain and nutrients digestibility. Lambs fed R3 had the highest feed conversion from (DCP intake/gain) followed by R2 and R1 may be for increased crude protein and protein digestion. Khalel *et al*. (2008) reported that feed conversion ratio was improved in lambs fed diets containing 10% of JM treated with *Trichoderma reesei*. Providing treated jojoba meal increased the body weight gain and adequate food consumption (Wisniak, 1977). Cokelaere *et al.* (1998) and Flo *et al*. (1998) reported that the reduction of body weight is due to presence of simmondsin substances.

Rumen Fluid parameters:

Results of Table 6 concerning the sampling time, values of pH before feeding was found to be higher and then decreased at 3 hrs. post feeding then returned to increase at 6 hrs. post feeding for all experimental groups. There were no significant differences among groups in the mean of pH values, being 6.93, 7.11 and 7.08 for R1, R2 and R3, respectively. Providing treated JM with fungus (R2 and R3) improved the pH values (Table 6). Similar results were reported by Abdou and El- Esswee (2018) where the ruminal pH did not affected significantly by the dietary treatments at zero time and slightly affected after 3 and 6 hours with non-significant differences among treatments' groups. Bargo *et al*. (2001) reported that ruminal pH was not affected by level or source of protein. Ammonia-N (mg/100ml) and TVFA'S (meq/100ml) indicated the opposite trend, since rumen ammonia (NH_3-N) and volatile fatty acids values (TVFA's) were low before feeding, then increased at 3 hrs. post feeding and returned to decrease at 6 hrs. post feeding for all experimental rations but it was noticed that TVFA increased at 6 hrs. post feeding in R3 and increased NH_3-N at 6 hrs. post feeding for R1 and R2. While, there were significant differences among groups (Table 6). The reduction of NH_3-N might be due to the result of incorporation of NH_3-N into microbial protein and it was considered as a direct result of stimulated microbial growth (Barrios-Urdaneta *et al*., 2003). Ruminal NH_3-N concentrations revealed that it was sufficient for microbial growth as described by Lu *et al*. (1990). The overall mean of NH_3-N concentration in the rumen of lambs fed ration content 20% JM R3 was higher than other rations. Volatile fatty acid concentrations, in the present study lie in range suggested by Bruggeman and Giescke (1976). High TVFA'S concentration for biological treatment may be related to the more utilization of the dietary energy and positive fermentation in the rumen. Stewart (1995) reported that certain yeasts and aerobic fungi are normal inhabitants of the rumen, but most species are considered to be transient and non–functional. They usually enter the rumen via the feed. The beneficial responses from the addition of fungi to the rumen environment have centered on the activity of *Saccharomyces cerevisiae* when used as a dietary supplement to the diets of cattle and sheep by Stewart (1995).

Table 6. Rumen parameters of lambs fed the experimental rations

Item	R1	R2	R3	+SE
PH:				
Zero hr	7.10	7.33	7.33	0.079
3 hr	6.66	6.85	6.78	0.113
6 hr	7.03	7.16	7.13	0.112
Overall Mean	6.93	7.11	7.08	0.073
NH3-N (mg/100ml):				
Zero hr	22.31^{b}	25.09^{b}	30.15^{a}	1.360
3 hr	30.60^{b}	36.22^{a}	34.77^{a}	0.980
6 hr	37.81^{ab}	32.90^{b}	39.42^{a}	1.91
Overall Mean	30.24^{b}	31.41^{b}	34.78^{a}	1.009
TVFA'S (meq/100ml):				
Zero hr	8.03a	5.51^{b}	5.32^{b}	0.507
3 hr	9.31^{a}	8.76^{a}	6.64^{b}	0.526
6 hr	7.97	7.61	7.13	0.605
Overall Mean	8.44^{a}	7.29^{b}	6.36^{b}	0.378

a, b: values with different letters in the same row statistically differ significantly at P<0.05.

R1: control group fed (CFM+ berseem hay), R2: group fed CFM containing 7% treated jojoba meal with fungus+ berseem hay,

R3: group fed CFM containing 14% treated jojoba meal with fungus+ berseem hay.

Blood parameters:

Blood serum of urea was significantly (P<0.01) affected by treatments. The higher value of urea was recorded for R2, whereas the lowest value was recorded for R1 (Table 7). The increase of urea could be explained by a relative protein shortage due to the feeding JM rations. There are contradictory findings regarding the effect of jojoba meal on blood urea nitrogen. Manos *et al*. (1986) recorded a significant decrease in blood urea nitrogen in lambs fed 10% jojoba meal, while Sobhy *et al*. (2003) reported a significant increase in the same parameter in rats fed 3 and 6% JM diets. Furthermore, Cokelaere *et al*. (1993) found that, the urea concentration increased in animals treated with 3% jojoba meal. There were no significant (P<0.05) differences in creatinine, total protein, albumin and globulin levels. Higher creatinine, TP and globulin values were recorded for R2 (7% treated JM) than those of other treatments (Table 7) which might be attributed to the presence of simmondsin and trypsin inhibitor in defatted jojoba meal inducing a reduction in feed intake and a loss of essential amino acids and thus decreases in the protein synthesis (Verbiscar *et al*., 1980; Coketaere *et al*., 1993; Sobhy *et al*., 2003 and Abd El-Maksoud., 2011). The liver enzymes, aspartate (AST) and alanine (ALT) aminotransferases were not affected by experimental treatments. Lambs fed ration contained 7% and 14% treated JM showed the highest values of ALT namely increased by increasing the replacement of cotton seed meal by supplemented jojoba meal. However, the lowest activity of AST was obtained for ration contained 7% treated JM (R2). EL-Kady *et al*. (2008) found that the activity of AST was higher (P<0.05) in lambs fed the 20 and 30% JM rations. The present results showed that levels of total lipids increased significantly (P<0.05) by increasing the replacement of cotton seed meal by supplemented jojoba meal. Concentrations of total lipids demonstrated that the highest value was obtained for lambs fed 14% of treated JM (R3) than the other ones (Table 7).

As shown in Table 7, thyroid hormones, triiodothyronine (T3) and thyroxin (T4) did not differ significantly as a result of providing treated JM at both levels. These findings are in agreement with those of Abdou, (2018) and Abdou and El-Essawy (2018). This indicated that no negative effects were observed on blood parameters when cotton seed meal was partially replaced by supplemented jojoba meal.

Table 7. Blood serum constituents of lambs fed the experimental rations

	R1	R2	R3	+SE
Urea-N (mg/dl)	34.25[b]	41.31[a]	39.51[a]	1.25
Creatinine (mg/dl)	1.143	1.289	1.013	0.116
Total protein (g/dl)	6.57	6.77	6.54	0.319
Albumin (g/dl)	3.459	3.291	3.278	0.106
Globulin (g/dl)	3.110	3.480	3.263	0.261
AST (μ/l)	91.74	90.06	96.68	4.061
ALT (μ/l)	17.79	26.90	23.36	3.10
Total lipids (mg/dl)	309.34[b]	307.69[b]	414.16[a]	20.02
T_3 (ng/ml)	1.247	1.244	1.247	0.006
T_4 (ng/ml)	1.415	1.416	1.415	0.001

a, b: values with different letters in the same row statistically differ significantly at P<0.05.

R1: control group fed (CFM+ berseem hay), R2: group fed CFM containing 7% treated Jojoba meal with fungus+ berseem hay,

R3: group fed CFM containing 14% treated jojoba meal with fungus+ berseem hay.

Economical evaluation:

Results of Table 8 showed that the economic efficiency of control rations recorded the highest total daily feed cost and feed cost gain compared with R2 and R3. Moreover, lambs fed R3 recorded the lowest feed cost/kg gain followed by lambs group fed R2. The control (R1) was the most expensive ration (feed cost/kg gain). The economic parameters for R3 was the best followed by R2 compared with control ration (R1). This finding was in agreement with that obtained by Khalel *et al*. (2008) and Abdou and El-Essawy (2018) where treated jojoba meal with fungus gave the best economic efficiency and relative economic efficiency compared with the control.

Table 8. Economic indicators of the experimental rations fed to Barki lambs

Item	R1	R2	R3
Daily CFM intake (fresh, kg)	0.408	0.380	0.385
Daily roughage intake (fresh, kg)	0.356	0.335	0.345
Total of daily intake (fresh, kg)	0.764	0.715	0.730
Value of one kg roughage (LE)	2.1	2.1	2.1
Value of one kg CFM (LE)	3.885	3.605	3.325
Total daily feeding cost (LE)[a]	2.333	2.071	2.004
Average daily gain (g)	156.57	150.09	157.04
price of daily gain (LE/h)[b]	15.66	15.01	15.70
Feed cost (LE/kg gain)	14.90	13.80	15.28
Daily return (LE/h)	13.32	12.94	13.70
Economic feed efficiency, %	671.2	724.77	764
Relative economic feed efficiency, %	100	107.98	113.82

a Based on prices of Egyptian market during the experimental period (2016).

Value of the prices of one tone concentrate feed mixture and berseem hay:

Berseem hay = 2000L.E/ton - cotton seed=5500 L.E/ton - yellow corn=3500 L.E/ton - wheat bran=3100L.E/ton jojoba meal=1000 L.E / ton - molasses=3 L.E/kg - soy bean meal=5000 L.E/ton - fungi =50 L.E.

b Value of one kg live body weight equals 100 L.E (2016).

Feed economic efficiency = Money output (price of total live weight gain) x 100

Money input (price of feed consumed)

c Economic efficiency =value of daily gain*100/daily feeding cost.

d Assuming that the relative economic efficiency of control diet equals 100.

CONCLUSION

The elimination of simmondsin and phenolic compounds by the treatment with fungus improved the utilization of JM as a new protein source. Adding jojoba meal to animal's ration led to increase nutrients digestibility, improve animal general health and viability, improve metabolic process through increasing protein anabolism and decreasing protein degradation as indicated in data of blood metabolites. It could be concluded that 14% treated JM with fungus can be used in growing lambs ration.

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إزالة سُمية كُسب الجوجوبا بيولوجيا بمُعاملته بفطر الأسبرجيلس أوريزا ومدى الاستفادة منه فى تغذية النعاج والحوالى

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تم استخدام كسب الجوجوبا المُعامل بيولوجيا بفطر الأسبرجيلس أوريزا، واستخدم فى هذه الدراسة 30 نعجة برقى بمتوسط عُمر 3-4 سنوات ومتوسط وزن 33.46كجم، وتم تقسيم الحيوانات الى ثلاثة مجاميع متساوية (10 حيوانات فى كل معاملة) لدراسة الأداء الإنتاجى للنعاج البرقى لمدة 150 يوما فى فترة الحمل، ثم بعد الولادة أُخذت الحملان بعد الفطام (أى بعد 3 شهور) بمتوسط وزن15.41لمدة 210يوما، وتم تقسيم الحيوانات الى ثلاثة مجاميع (فى كل معاملة 6 حيوانات): المعاملة الأولى كنترول، المعاملة الثانية تم فيها استبدال 7% كسب جوجوبا بدلا من كسب القطن، وفى المعاملة الثالثة تم استبدال 14% كسب الجوجوبا بدلا من كسب القطن. وكانت أهم النتائج كما يلى : التركيب الكميائى للبروتين الخام يزيد زيادة بسيطة مع زيادة الجوجوبا فى العليقة، ولكن تقل مكونات الألياف الخام. فى أول الحمل تنخفض الألياف الخام المأكولة فى المعاملة الثالثة بالمقارنة بمجموعة الكنترول والمعاملة الثانية .فى آخر الحمل لُوحظ أن المأكول من المادة الجافة والبروتين الخام والألياف الخام كان عاليا فى الحملان المغذاه على عليقة الكنترول بالمقارنة بالمعاملة الثانية والمعاملة الثالثة. أثناء أول وآخر الحمل كانت التغيرات فى الجسم غير معنوية لمختلف العلائق، وكذالك وزن الميلاد. مُعاملات هضم المادة الجافة والمادة العضوية والبروتين الخام والألياف الخام وNDF كانت قيمها عالية فى المعاملة الثالثة وتلتها المعاملة الثانية ثم المعاملة الأولى كنترول . ميزان النيتروجين والنيتروجين المأكول كان مرتفعا فى المعاملة الثالثة وأقل قيمة فى المعاملة الثانية . معدل الكفاءة الغذائية فى المعاملة الثالثة كان أفضل فى المادة الجافة الماكولة بالمقارنة بالمعاملة الأولى والثانية. درجة الحموضة تحسنت مع المعاملة الثانية والمعاملة الثالثة، وكذلك تركيزات الأمونيا والأحماض الدهنية الطيارة زادت بعد الأكل بـ3 ساعات، وتركيزات الأمونيا زادت أيضا بعد 6 ساعات، أما تركيزات الأحماض الدهنية الطيارة فقد انخفضت بعد 6 ساعات. قياسات الدم كانت معظمها غير معنوية باستثناء اليوريا والدهون الكلية. الكفاءة الاقتصادية كانت أفضل فى المعاملة الثالثة بالمقارنة بالمعاملة الثانية والكنترول، لذلك فإن استخدام كسب الجوجوبا المُعاملة بالفطر بمستوى 14% استبدال من كسب القطن فى العلائق كان مناسبا لنمو الحملان البرقى.