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FEED EVALUATION OF CHEMICALLY OR BIOLOGICALLY TREATED JOJOBA MEAL.

M.S. Khalel, A.A. Hassan, A.M. Shwerab and Amany A. Khayyal

Animal Production Research Institute, Agriculture Research Center, Dokki ,Giza, Egypt.

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SUMMARY

The present study was conducted to study the effect of biological (fungus or bacteria), heat or chemical (isopropanol) treatments of Jojoba meal (JM) on concentration of anti-nutritive compounds, rumen fermentation characteristics and degradability of JM and the consequently sheep performance was studied. The concentrate feed mixtures (CFM's) were: 1- CFM-control; 2- CFM with 10% JM (CFMU), 3- CFM with 10% fungus treated JM (CFMF), 4- CFM with 10% heated JM (CFMH), 5- CFM with 10% JM treated with lactic acid bacteria (CFMB) and 6- CFM with 10% isopropanol JM (CFMI). Digestibility, in-situ and feeding trials with sheep were also conducted. All treatments, showed a positive effect in decreasing concentration of anti-nutritive compounds. Ration with fungus treated JM had highest feeding values, nitrogen utilization, higher ammonia-N and VFA's concentrations. Microbial nitrogen was ranged between 12.58 and 22.46 (gm/day) for untreated JM and fungus treated JM containing rations with significant differences. Effective degradability "ED" (%) of DM and OM were highest ($P< 0.05$) for ration contained fungus treated JM. While, no significant differences were detected among rations for EDCP. Highest daily gain was recorded with ration contained fungus treated JM. The lowest daily gain was recorded by sheep fed ration contained untreated JM. The economic cash return (L.E/h/d) was more profit for ration contained fungus treated JM than other rations. It could be concluded that the fungal treated JM could be used at 10% of CFM in sheep rations. Chemically treated JM by isopropanol could be also used at 10% of CFM without any adverse effects on sheep performance.

Keywords: Jojoba meal, detoxification, sheep, digestibility, degradability, Growth performance.

INTRODUCTION

In Egypt there is a serious problem resulting from a shortage of protein sources used for animal feed, which results in high feed costs. Therefore, there is a need to evaluate alternative protein sources to alleviate the shortage problem. Jojoba (*Simmondsia chinensis*) is a dioeciously desert shrub that grow on arid or semi arid regions is being cultivated to provide a renewable source of a unique high- quality oil (Sabien *et al.*, 1997). Several advantages are favoring Jojoba seed to be grown in Egypt such as limited water

requirements, high seed yield in new reclaimed soils and relatively high oil content, 50% (Wisniak, 1987). The meal remaining after the oil has been extracted contains high protein content approximately 30% and therefore should be interest for livestock producers as a feed supplement (Motawe, 2005). The major problem with using jojaba meal is the high level of anti-nutritive compounds; these compounds can be mitigated by various treatments. However, this is attributed by most workers to the presence of the cyanogenic compounds simmondsin and simmondsin-2-ferulate (Van Boven *et al.*, 2000). Other compounds than simmondsin including poly phenolics, phytic acid and trypsin inhibitors, may be contributing to impaired food intake and body weight gain of animal fed rations (Abbott *et al.*, 2004).

Bellirou *et al.* (2005) reported that elimination of Jojoba seed meal could be occurred by different methods, it includes solvent extraction, heat, chemical treatments and microbial fermentation. Simmondsin (Di methyl simmondsin) is a naturally compound in the seed of jojoba plant found to suppress the appetites of animals when it incorporated in food formulas. Simmondsin and several of its analogs are present at 5-7% in Jojoba seed and remain in the press cake.

The purpose of this study was to investigate the effect of biological (fungus or bacteria), heat and chemical (isopropanol) treatments on degrading simmondsin and related cyanogenic toxin compounds in Jojoba meal and their effect on lambs performance.

MATERIALS AND METHODS

The experimental work of the present study was conducted at Noubaria Experimental Station, Animal Production Research Institute, Agriculture Research Center .Jojoba mea (JM) samples were graciously supplied by the Egyptian Natural Oil Company (Private Sector).

Detoxification methods:

Fungal treatment:

Pure strain of *Trichoderma reesei* (ATCC28217) obtained from Microbiology Research Center (MIRCEN) ,Faculty of Agriculture Ain Shams University , maintained on potato-dextrose-agar (PDA) medium was activated in a sterilized conical flasks kept in shaker water bath at 28-32°C for 96 hr. The active liquid fungal medium was used to inoculate an amount of ground moistened JM at 10% (v/w) of the Jojoba weight and the whole treated amount was kept under aerobic condition for six days to obtain a sufficient amount of a solid state fermented JM. The scaling up of the fungal biomass under the farm condition was carried out as described by EL-Badawi *et al.* (2007).

Heat treatment:

Jojoba meal was heated in boiling water for 15 min to inactivate the anti-nutritional compounds, treated sample was air dried at room temperature (Gorrill *et al.*, 1974), then they stored in plastic containers until used.

Lactic acid bacteria (LAB) treatment:

Jojoba meal was treated with pioneer brand inoculants supplied by pioneer Hi-Bred international, Inc. at rate of 1g/100kg (JM), stored in plastic containers for 21 days at room temperature, then it dried to about 6% moisture and was ground to pass a 2 mm screen.

Isopropanol (70%) treatment:

Jojoba meal was sprayed by aqueous solution of isopropanol at the rate of 10% (v/w) to inactivate the anti- nutritional compounds, then they stored in plastic containers for 21 days at room temperature. The treated JM was aerated, then ground to pass a 2 mm screen as described by Medina and Gonzalez (1990).

Anti-nutritional compounds analysis:

Simmondsin was quantified by high performance liquid chromatography using a μ-porasil C_{18} column (whatman, 300x4.6 mm) eluting with methanol/ water (25:75) at a flow rate of 1.5 ml/min and detected at 217 nm as described by Verbiscar and Banigan (1978). Total phenolics were determined by the Folin-Denis colorimetric method using tannic acid as a standard (Joslyn and Goldstein 1964). Phytic acid concentration was measured according to the method of Wheeler and Ferrel (1979).

Six concentrate feed mixtures (CFM's) were formulated to be isonitrogenous isoenergetic:

1. control (CFM), 2) with 10% untreated JM (CFMU), 3) with 10% fungus treated JM (CFMF), 4) with 10% heated JM (FCMH), 5) with 10% JM treated with lactic acid bacteria (CFMB) and 6) with 10% JM treated with Isopropanol (CFMI) (Table .1).While, rice straw was used as roughage. Chemical analyses of CFM's and rice straw are shown in Table (2).

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

Ingredients	CFM	CFMU	CFMF	CFMH	CFMB	CFMI
Yellow corn	40	40	40	40	40	40
Soybean	13	9	7	9	9	9
Wheat bran	37	31	33	31	31	31
Untreated Jojoba meal	-	10	-	-	-	-
Jojoba meal treated with fungi	-	-	10	-	-	-
Jojoba meal treated with heat	-	-	-	10	-	-
Jojoba meal treated with LAB	-	-	-	-	10	-
treated Jojoba meal with isopropanol	-	-	-	-	-	10
Molasses	6	6	6	6	6	6
Limestone	2	2	2	2	2	2
Salt	1.5	1.5	1.5	1.5	1.5	1.5
Mineral premix	0.5	0.5	0.5	0.5	0.5	0.5

CFM: Control
CFMU: CFM containing untreated Jojoba meal.
CFMF: CFM containing treated Jojoba meal with fungi.
CFMH: CFM containing treated Jojoba meal with heat.
CFMB: CFM containing treated Jojoba meal with lactic acid bacteria.
CFMI: CFM containing treated Jojoba meal with isopropanol.

Table (2): Chemical composition (%) of concentrate feed mixtures and rice straw (on dry matter basis).

Item	CFM	CFMU	CFMF	CFMH	CFMB	CFMI	Rice Straw
OM	91.60	91.89	91.72	91.91	91.88	91.86	87.09
CP	14.01	14.09	14.02	14.05	14.11	14.08	3.91
CF	5.83	6.61	6.12	6.63	6.24	6.58	34.62
EE	3.84	4.19	4.39	4.35	4.21	4.14	1.48
NFE	68.92	67.00	66.19	66.88	67.32	67.06	52.92
Ash	8.40	8.11	8.28	8.09	8.12	8.14	12.91

Digestibility and nitrogen balance trials :

Six digestibility and nitrogen balance trials were carried out using three rams (42± 1.20 kg, in average) for each ration consequently. Each trial lasted for four weeks; the first three weeks were as a preliminary period, followed by one week for feces and urine collection.

Animals were fed twice daily at 8 am and 8 pm Water was offered freely. Each animal was offered the tested CFM's at the rate of 2/3 of their daily requirements (NRC, 1994) plus 1/3 rice straw. Chemical composition of feeds, feces and urine were determined according to A.O.A.C (1995) methods.

Rumen fermentation and In situ trials:

Three ruminally-canulated female sheep were used for rumen fermentation and *in situ* trials. Rumen samples were withdrawn before feeding and 1, 3 and 6 hrs after feeding for *in vitro* incubation using the zero rate technique as described by Carrol and Hungate (1954). Ruminal pH value measured using digital pH meter (Orian 680). Ammonia-N was carried out using MgO distillation method (AL-Rabbat *et al*., 1971).Total VFA's were determined by steam distillation as described by Warner (1964). The purine derivatives (PD) were determined according to the procedure of Chen *et al* (1990). The procedure based on measuring xanthine and hypoxanthine as uric acid after treatment of urine sample with xanthine oxidase. From the daily excretion of PD, the corresponding amount of microbial purine (Pa mmol/day) absorbed by the animal was estimated. The supply of microbial N was then calculated from Pa by assuming that: digestibility of microbial purines equals 0.83 and the purine-N: total microbial N ratio 0.116:1.00.

Thus microbial N supply (g/day) = «Pax70/ (0.83x0.116x1000) » = Pax0.727, where 70 is the N content (mg/mmol) of purines (Chen *et al*., 1991).

Nylon bags technique was used to determine degradability of DM, OM and CP for CFM's degradability Two polyester bags (7 X 15 cm) with pore size of 45 µm were used for each incubation time. Approximately 5 g of air-dried CFM's (ground to 2 mm) were placed in each bag. All bags were incubated in the rumen of each sheep, then they were withdrawn after 3, 6, 12, 24, 48 and 72 h, rinsed in tap water until the water became clear, then they were squeezed gently Microorganisms attached to the residual sample were eliminated by freezing at - 20°C (Kamel *et al*., 1995). Zero-time washing losses (a) were determined by washing 2 bags in running water for 15 min. The degradation kinetics of DM, OM and CP were estimated (in each bag) by fitting the disappearance values to the equation $P = a + b (1- e^{-Ct})$, as proposed by Ørskov and McDonald (1979), where P represents the disappearance after time t Least-squares estimated of soluble fractions are

defined as the rapidly degraded fraction (a), slowly degraded fraction (b) and the rate of degradation (c).

The effective degradability (ED) for tested rations were estimated from the equation of M.Donald (1981), where ED = a + bc/ (c + k), where k is the out flow rate assumed to be (0.05 / h for concentrate) under the feeding condition in this study.

Growth performance trials:

Thirty male growing lambs, with an average initial live body weight 22.5 ±1.30kg and 4-5 months of age were used. Lambs were randomly divided into six similar groups according to body weights (five lambs in each treatment). Animals were weighed biweekly. They were fed the six rations in group feeding in tow equal meals / day (8 am and 4 pm) for 120 days. All lambs were given CFM to cover 2/3 of daily requirements according to NRC (1994), while rice straw was fed to cover the other 1/3. Water was offered freely .Feed intake was daily recorded and then feed conversion was calculated.

Statistical analyses: .

Collected data were subjected to one way analysis of variance as described by Steel and Torrie (1980). Significant differences among means were separated using LSD test according to Duncan (1955). Statistical processes were carried out using the General Linear Models adapted by SAS (2000) for PC.

RESULTS AND DISCUSSION

Chemical analyses of untreated and treated Jojoba meal:

Treatment JM with fungus was resulted in an increase in CP content by about 22%, but it increased by about 4% with LAB treatment. While CP content was decreased by about 2% in other treatments. On the other hand, CF content was decreased by about 37% and 22% with treatment JM with fungus and LAB, respectively. Other treatments had quite similar CF content. Ash content was increased by about 53% and 34% with treatment JM with fungus and LAB, respectively (Table 3). However, the increase in N Level was apparently due to the overall loss of weight by JM during treatment, due to conversion of carbohydrates to carbon dioxide (Verbiscar *et al.*, 1980; Medina and Gonzalez, 1990; Swezey *et al.*, 2000 and EL-shennawy, 2005).

Concentration of anti-nutritive compounds:

Data in Table (3) showed that all treatments had positive effect in decreasing concentration of anti-nutritive compounds. Which considered as inhibitors and negative effect compounds on appetite (Swingle *et al.*, 1985; Bellirou *et al.*, 2005 and EL-shennawy, 2005). Fungi treatment decreased concentration of simmondsin as the major toxicant compound by about 98% and polyphenolics by about 71%. Heat treatment decreased the concentration of simmondsin and poly phenolics by about 95% and 63%, respectively. Verbiscar *et al.* (1980) and Ahmed and Satti (2002) reported that moist heating of JM has an effect on lowering levels of toxicants. Incubation of JM with LAB decreased concentration of simmondsin and poly phenolics by about 97% and 73%, respectively.

Swezey *et al.* (2000) confirmed that, fermentation of JM with LAB effectively reduced concentration of simmondsin. Aqueous mixture of isopropanol was found to be an effective treatment in improving JM as it decreased concentration of simmondsin and poly phenolics by about 99% and 86%, respectively. Also, Medina *et al.* (1988) noticed that treatment was extracted 86% of poly phenolic compound in JM. However, phytic acid concentration was not detected, in all treatments.

Table (3): Chemical composition (%) and concentration of anti nutritive compounds (on dry matter basis) of treated and untreated Jojoba meal.

Item	Untreated	Treated			
	JM	JMF	JMH	JMB	JMI
Chemical composition(%):					
OM	96.72	94.99	96.86	95.59	96.45
CP	26.04	31.88	25.60	27.01	25.57
CF	17.12	10.79	17.31	13.43	16.83
EE	15.40	16.78	16.92	15.64	14.80
NFE	38.16	35.54	37.03	39.51	39.25
Ash	3.28	5.01	3.14	4.41	3.55
Concentration of anti nutritive compounds:					
Simmondsin(%)	4.82	0.12	0.26	0.15	0.06
Poly phenolics(%)	6.52	1.87	2.41	1.75	0.92
Phytic acid(mg/g)	0.074	ND	ND	ND	ND

JM : Untreated Jojoba meal.
JMF: Treated Jojoba meal with fungi.
JMH: Treated Jojoba meal with heat.
JMB: Treated Jojoba meal with lactic acid bacteria.
JMI : Treated Jojoba meal by isopropanol
ND:Not detectable

Digestibility and nitrogen balance trials:

The highest ($P<0.05$) digestibility value of nutrients was recorded for ration contained fungus treated JM followed by ration contained LAB treated JM, while the lowest value were obtained for ration contained untreated JM in comparison with control values (Table4). Heating JM showed less effect in improving nutrients digestibility compared to other treatments. However, these results were reflected on dry matter intake and feeding values of experimental rations. Sheep fed rations contained fungus treated JM, control and isopropanol treated JM were showed quite the same daily feed intake, followed by those fed LAB containing ration. While lowest ($P< 0.05$) feed intake was noticed for sheep fed untreated JM containing ration, than those fed heated JM. The improvement in nutrients digestibility followed the biological and chemical treatments could be a result of better feed intake and nutritive value. Nelson *et al.* (1979) reported that fermentation of JM clearly improved its palatability, acceptability and digestibility coefficients to ruminants. The mechanism by which simmondsin decreased the feed intake is unknown. Some authors considered simmondsin as a toxic compound.

Table (4): Digestibility coefficients of the experimental rations fed to sheep.

Digestibility coefficients (%)	Experimental rations						±SE	Sig.
	CFM	CFMU	CFMF	CFMH	CFMB	CFMI		
DM	62.33^{d}	57.73^{f}	69.71^{a}	60.88^{e}	66.02^{b}	63.08^{c}	0.41	*
OM	67.82^{d}	63.09^{f}	74.89^{a}	65.97^{e}	70.94^{b}	68.84^{c}	0.54	*
CP	52.73^{d}	45.93^{f}	65.72^{a}	50.30^{e}	60.15^{b}	55.06^{c}	0.50	*
CF	57.93^{cd}	56.94^{e}	69.58^{a}	59.03^{bd}	65.37^{b}	62.38^{c}	0.83	*
EE	63.24^{d}	63.58^{d}	69.71^{a}	63.94^{cd}	65.76^{cb}	66.13^{b}	1.13	*
NFE	73.57^{c}	67.81^{e}	78.33^{a}	70.88^{d}	74.87^{b}	73.27^{c}	0.57	*

a, b, c,d,e and *f*, Means in the same row with different superscripts are significantly differ (P< 0.05).
*Significant 5%

Table (5): Dry matter intake (g/h/d), nutritive value and nitrogen utilization of the experimental rations fed to sheep.

Item	Experimental rations						±SE	Sig.
	CFM	CFMU	CFMF	CFMH	CFMB	CFMI		
DMI (g/h/d):	1364.02^{ab}	1106.63^{d}	1378.79^{a}	1228.07^{c}	1325.35^{b}	1358.89^{ab}	11.89	*
Nutritive value (%)								
(TDN	62.57^{d}	59.16^{e}	69.07^{a}	61.75^{d}	66.17^{b}	63.81^{c}	0.58	*
(DCP	4.88^{d}	4.22^{e}	6.01^{a}	5.09^{cd}	5.71^{b}	5.38^{bc}	0.23	*
Nitrogen utilization:								
N-intake (g/d)	20.22^{a}	17.75^{c}	20.39^{a}	19.18^{b}	20.18^{a}	20.30^{a}	0.29	*
N-absorbed (g/d)	10.51^{d}	8.79^{f}	13.36^{a}	9.71^{e}	12.07^{b}	11.10^{c}	0.14	*
N-balance (g/d)	3.20^{d}	2.56^{e}	5.84^{a}	3.08^{d}	5.06^{b}	4.14^{c}	0.30	*
N-balance as % of N-intake	15.83^{d}	14.42^{e}	28.64^{a}	16.06^{d}	25.07^{b}	20.39^{c}	0.49	*
N-balance as % of N-absorbed.	30.45^{cd}	29.12^{d}	43.71^{a}	31.72^{c}	41.92^{a}	37.30^{b}	1.08	*

a,b,c,d,e and *f*, Means in the same row with different superscripts are significantly differ (P<0.05).
*Significant 5%

The presence of tannins and phytate in JM induces an increase in plasma thyroid hormone concentration reducing feed efficiency (Manos *et al.*, 1988 and Sabien *et al.*, 1997). Level of polyphenolics in JM diet was more than 30 mg/g, reflected less feed intake. Tan *et al.* (1983) reported that sorghum, which contains 30 mg/g polyphenolics was consumed by animals at a regular basis, so this level is assumed to be safe for consumption. The TDN and DCP values for fungus treated JM containing ration recorded significantly the highest value (Table 5). Lowest values were obtained with untreated JM containing ration. Less (P< 0.05) N-intake was noticed for sheep fed untreated JM containing ration, this could be due to the effect of the anti – nutritional substances content of JM in depressing feed intake. Nitrogen balance showed the same trend. Biological value of dietary-N was higher for fungus and LAB treated JM.

Ruminal fermentation:

Ruminal pH values were not significantly affected by the dietary treatments (Table 6). Bargo *et al.* (2001) reported that ruminal pH was not affected by level or source of protein. Ruminal NH_3 – N concentration values 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 sheep fed heated JM was lower than other rations. The effect could be generally caused by Millard reaction as an irreversible binding between aldehyde groups of the sugar and free amino acid groups. As a result, protection of protein by heat is often accompanied by corresponding reduction in digestibility.

Volatile fatty acids concentrations, in the present study were lies in range suggested by Bruggeman and Giescke (1976). This means that the energy and ammonia releases are nearly synchronized and enhance microbial production.

High VFA's concentration for biological treatment may be related to the more utilization of the dietary energy and positive fermentation in the rumen.

Table (6): Rumen parameters of sheep fed the experimental rations.

Item	Experimental rations						±SE	Sig.
	FM	CFMU	CFMF	CFMH	CFMB	CFMI		
pH	6.29	6.36	6.34	6.40	6.31	6.38	0.11	NS
NH_3-N mg\100mlR.L	13.69^{c}	14.37^{b}	16.41^{a}	13.05^{d}	13.42^{c}	14.23^{b}	0.41	*
VFA meq/100mlR.L	12.14^{c}	10.55^{d}	14.01^{a}	10.89^{d}	13.21^{b}	12.63^{c}	0.22	*

a, b, c and *d*, Means in the same row with different superscripts are significantly differ (P< 0.05).
*Significant 5%

Purine derivatives execration and microbial N synthesis:

There are significant (P< 0.05) increases in the purine derivatives in the urine when JM was treated with fungus. It significantly increases the calculated flow of microbial nitrogen from the rumen (Table 7). Weinberg *et al.* (2003) and Borhami *et al.* (2007) reported an increase in protein flow from the rumen in sheep fed biologically treated rations. However, Keady and Murphy (1997) did not find significant effects on microbial nitrogen leaving the rumen with feeding biologically treated materials.

Table (7): Urinary purine derivatives and microbial nitrogen leaving the rumen of sheep fed the experimental rations.

Item	Experimental rations						±SE	Sig.
	CFM	CFMU	CFMF	CFMH	CFMB	CFMI		
Pa(mmol/d)	22.15^{c}	17.30^{e}	30.89^{a}	19.19^{d}	29.70^{b}	22.40^{c}	0.54	*
PDe(mmol/d)	20.61^{c}	16.53^{e}	27.95^{a}	18.12^{d}	26.95^{b}	20.82^{c}	0.37	*
Ae(mmol/d)	15.36^{c}	12.32^{e}	21.13^{a}	13.53^{d}	19.97^{b}	15.57^{c}	0.49	*
UAe(mmol/d)	3.46^{b}	2.82^{c}	4.32^{a}	3.40^{b}	4.55^{a}	3.38^{b}	0.17	*
X+H(mmol/d)	1.79^{b}	1.39^{c}	2.50^{a}	1.19^{d}	2.43^{a}	1.87^{b}	0.06	*
MN(g /d)	16.11^{b}	12.58^{d}	22.46^{a}	13.95^{c}	21.59^{a}	16.32^{b}	0.52	*

a,b,c and *d*, Means in the same row with different superscripts are significantly differ (P< 0.05).
Pa : purine absorbed (mmol/d). PDe: Purine Derivative excretion (mmol/d).
Ae : Allantoin excretion (mmol/d). UAe: Uric Acid excretion (mmol/d).
X+H : Xanthin and hypoxanthin (mmol/d). MN : Microbial N yield (g /d).

Degradation kinetics:

Estimates of ruminal degradation contents (a, b and c) fitted with rates of DM, OM and CP disappearance of concentrate feed mixtures (CFM's) are presented in Table (8).

Table (8): Degradation kinetics of DM, OM and CP for concentrate feed mixtures in sheep fed the experimental rations.

Item	Experimental rations						±SE	Sig.
	CFM	CFMU	CFMF	CFMH	CFMB	CFMI		
				DM				
a	25.60^{b}	21.98^{c}	29.24^{a}	22.43^{c}	28.14^{a}	25.93^{b}	1.03	*
b	53.83^{a}	48.06^{b}	53.10^{b}	49.91^{b}	52.53^{a}	52.18^{a}	1.26	*
c	0.060^{a}	0.039^{c}	0.058^{a}	0.043^{b}	0.058^{a}	0.040^{b}	0.004	*
EDDM	55.04^{a}	43.04^{c}	57.76^{a}	45.51^{c}	56.35^{a}	50.93^{b}	7.70	*
				OM				
a	24.97^{ab}	21.59^{c}	25.40^{a}	22.87^{b}	24.22^{ab}	24.35^{ab}	0.73	*
b	53.78^{a}	48.60^{c}	53.83^{a}	50.60^{b}	53.89^{a}	51.40^{b}	0.67	*
c	0.051^{a}	0.035^{c}	0.052^{a}	0.046^{b}	0.050^{a}	0.052^{a}	0.004	*
EDOM	52.13^{a}	42.87^{c}	52.40^{a}	47.12^{b}	51.17^{a}	50.55^{a}	8.88	*
				CP				
a	19.82	19.81	19.93	19.69	19.83	19.61	0.37	NS
b	60.77^{b}	62.61^{a}	62.94^{a}	61.80^{b}	61.26^{b}	61.61^{b}	0.43	*
c	0.053^{b}	0.056^{a}	0.053^{b}	0.054^{ab}	0.056^{a}	0.054^{ab}	0.002	*
EDCP	51.09	52.88	52.32	51.78	52.19	51.60	0.38	NS

a, b and *c*, Means in the same row with different superscripts are significantly differ (P< 0.05).
a: soluble fraction (%).
b: potentially degradable fraction (%)
c: rate of degradation (% h^{-1}).
ED:effective degradability= a + [bc/c + k], where k is the out flow rate assumed to be 0.05/ hr.

It illustrated that washing loss fraction "a", degradable fraction "b", rate of degradation "c" and effective degradability " ED " of DM and OM for CFM's were less (P< 0.05) in untreated JM and heating JM. However, higher values were obtained for CFM's containing biologically and chemically treated JM. The decrease of degradability of CFM's containing untreated JM may be due to the negative effect of simmondsin on ruminal microorganisms. Azoear and Cler (1990) concluded that simmondsin content of JM as well as other anti-nutritional compounds affecting digestibility. No significant differences were detected among rations on the final value obtained for EDCP, the explanation of these finding is not clear, as digestibility of CP was less for untreated JM ration (Table 4). Lower soluble fraction (%) and rate of degradation were noticed with untreated JM ration for DM and OM degradation compared to the control and other expremental rations. These could be related to the less digestibilites of them in the rumen, and may be to the effect of anti-nutritive substances, which lead to less feed intake as well.

Growth performance:

The highest final weight, total gain and daily gain were recorded with diet contained fungus treated JM. While the lowest values were recorded with ration contained untreated

JM (Table 9). Results of feed intake showed that JM treated with various methods and control significantly increased compared with untreated JM containing ration. Arnouts *et al.* (1993) and Van Boven *et al.* (1994) reported that the growth retardation caused by JM supplementation was provoked by an inhabitation of appetite linked with the simmondsin content of JM as well as other anti-nutritional compounds affecting digestibility. Best feed conversion was observed with rations contained fungus treated JM, followed by those treated with LAB, then isopropanol. Fungus, heating, LAB and isopropanol treated JM rations were cheaper than the control ration. The economic cash return (L.E/h/d) was more pronounced with ration contained fungus treated JM than other rations (Table 10).

Table (9): Effect of feeding experimental rations on lamb performance and feed efficiency.

Item	Experimental rations						±SE	Sig.
	CFM	CFMU	CFMF	CFMH	CFMB	CFMI		
Initial BW(kg/h)	21.30	21.40	21.60	21.50	21.40	21.20	0.97	NS
Final BW(kg/h)	34.74^{c}	31.54^{d}	38.88^{a}	35.06^{bc}	37.24^{b}	36.44^{bc}	1.62	*
Total gain (g/h)	13.44^{c}	10.14^{d}	17.28^{a}	13.56^{c}	15.84^{b}	15.24^{b}	0.92	*
Average daily gain(g/h)	112.00^{c}	84.50^{d}	144.00^{a}	113.00^{c}	132.00^{b}	127.00^{b}	7.68	*
Feed Intake(g/h/d)								
concentrate	682.02^{a}	624.03^{c}	690.21^{a}	642.06^{bc}	668.13^{ab}	684.70^{a}	10.14	*
Roughage	277.04^{a}	244.10^{b}	280.12^{a}	273.11^{a}	276.03^{a}	278.23^{a}	2.87	*
C : R ratio	71 : 29	72 : 28	71 : 29	73 : 27	71 : 29	71 : 29		
DMI	959.06^{ab}	868.13^{c}	970.33^{a}	915.17^{b}	944.16^{ab}	962.93^{ab}	11.09	*
TDNI	600.08^{b}	513.59^{d}	670.21^{a}	565.12^{c}	624.75^{ab}	614.45^{ab}	10.41	*
DCPI	46.80^{c}	36.64^{d}	58.32^{a}	46.58^{c}	53.91^{b}	51.80^{b}	2.97	*
Feed Conversion								
Kg TDNI/ Kg gain	5.36^{b}	6.08^{a}	4.65^{d}	5.00^{c}	4.73^{cd}	4.84^{cd}	0.24	*

a, b, c and *d*, Means in the same row with different superscripts are significantly differ ($P<0.05$).

Table (10): Effect of incorporation of Jojoba meal on the economic efficiency of growing Barki lambs.

Item	Experimental rations					
	CFM	CFMU	CFMF	CFMH	CFMB	CFMI
Average daily feed cost (L.E)	1.26	1.06	1.16	1.11	1.14	1.17
Price of daily gain(L.E)	2.46	1.85	3.16	2.49	2.90	2.79
Economical return((L.E /h/d)	1.20	0.79	2.00	1.36	1.76	1.62
Economic efficiency (%)	1.95	1.75	2.72	2.24	2.54	2.38

Calculation based on the following price in Egyptian pound (L.E.) per ton at 2007, Rice straw =140 L.E/ton, concentrate feed mixture (CFM) (control) =1600 L.E/ton, CFM containing untreated Jojoba meal =1470 L.E/ton, CFM containing treated Jojoba meal with fungi=1480 L.E/ton, CFM containing Jojoba meal treated with heat=1480 L.E/ton, CFM containing Jojoba meal treated with lactic acid bacteria=1480 L.E/ton, CFM containing Jojoba meal treated with isopropanol =1480L.E/ton.The price of one kg of live body weight was 22.00 L.E.

$$\text{Economic efficiency (\%)} = \frac{\text{Price of daily gain (L.E)}}{\text{Average daily feed cost (L.E)}}$$

CONCLUSION

The major problem with utilizing JM as a feed source has been stated for its toxicity. This is attributed by to the presence of the anti-nutritive compounds. However the methods applied in this study were proved to have positive effect on better feed intake and performance of animals.

The elimination of simmondsin and phenolic compounds by either treatment with fungus or LAB improved the utilization of JM as a new protein source. However, further studies needed for long run trials in order to define the metabolic compounds could be found in the end products (meat and milk) of animals fed such JM.

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التقييم الغذائى لكسب الجوجوبا المعامل كيماويا أو بيولوجيا

محمد سمير محمود خليل ـ أيمن عبد المحسن حسن ـ عمرو محمد حلمى شويرب ـ أمانى أمين خيال.

معهد بحوث الإنتاج الحيوانى – مركز البحوث الزراعية ـ دقي ـ جيزة ـ مصر.

استهدفت الدراسة التقييم الغذائى لكسب الجوجوبا غير المعامل أو المعامل كيماويا أو بيولوجيا بالفطر أو البكتريا أو بالمعامله الحرارية. وقد أشتمل التقييم تقدير معاملات هضم المواد الغذائية ونسبة الأستفادة من نيتروجين العلائق المختبرة باستخدام ثلاثة كباش برقى (لكل عليقة) بينما استخدمت ثلاثة نعاج مزودة بفستيولات الكرش لقياس نشاط الكرش لتقدير معدل التحلل للمادة الجافة والعضوية والبروتين فى الكرش. وتمت تغذية الحيوانات على قش أرز مقطع بمعدل ٣/١ من مقررات الحيوان اليومية بينما أعطى العلف المركزالمختبر بمعدل ٣/٢ من هذة المقررات. تم أستخدام ٥ ذكور حملان برقى ناميه (لكل عليقه) بمتوسط وزن ٢٢.٥٠ كجم فى تجارب التغذيه والنموالتى أستمرت ١٢٠ يوما.

و كانت العلائق المستخدمه كما يلى :

١. قش أرز+علف مركز (كنترول).
٢. قش أرز+علف مركزيحتوى على ١٠٪كسب الجوجوبا غير المعامل.
٣. قش أرز+علف مركزيحتوى على ١٠٪كسب الجوجوبا معامل بالفطر(تريكوديرما) .
٤. قش أرز+علف مركز يحتوى على ١٠٪كسب الجوجوبا معامل حراريا (بالغليان).
٥. قش أرز+علف مركز يحتوى على ١٠٪كسب الجوجوبا معامل باللقاح البكتيرى (بكتريا حامض اللاكتيك).
٦. قش أرز+علف مركز يحتوى على ١٠٪كسب الجوجوبا معامل كيماويا(بالايزوبروبانول).

وقد أشارت النتائج إلى ما يلى :

- أدت كل المعاملات المستخدمه الى خفض تركيزات المواد المثبطة للتغذية الى الحدود الأمنه لاستخدامها فى علائق المجترات.
- المعامله البيولوجيه سواء بالفطر أو باللقاح البكتيرى أدت الى زيادة البروتين الخام بنسبة ٢٢٪ و ٤٪ على التوالى بينما أدت المعامله الحراريه و الكيماويه الى خفض البروتين الخام بنسبة حوالى٢٪. وأن جميع المعاملات أدت الى خفض نسبة الألياف الخام فيما عدا المعامله الحراريه.

- زيادة معاملات هضم المركبات الغذائيه و القيمه الغذائيه و ميزان الأزوت للعلائق المحتويه على كسب الجوجوبا المعامل بالفطر بينما أقل قيمه وجدت فى حالة كسب الجوجوبا غير المعامل بفروق معنويه.
- بالنسبه لتركيزات الأمونيا فى الكرش فقد تراوحت بين ١٣.٠٥ – ١٦.٤١(مجم أزوت/١٠٠مل سائل كرش) فى العلائق المحتويه على كسب الجوجوباالمعامل حراريا والمعامل بالفطر على التوالى أما بالنسبه لتركيزات الأحماض الدهنيه الطياره فى الكرش فقد تراوحت بين ١٠.٥٥ – ١٤.٠١ (مليمكافئ /١٠٠مل سائل كرش) فى العلائق المحتويه على كسب الجوجوبا غير المعامل واالمعامل بالفطر على التوالى.
- كان أعلى معدل لانتاج الأزوت الميكروبى فى العلائق المحتويه على كسب الجوجوبا المعامل بالفطر و المعامل باللقاح البكتيرى (٢٢.٤٦ و ٢١.٥٩ جم/يوم على التوالى).
- معدل تحلل المادة الجافة و العضوية لمخاليط العلف المركز فى الكرش كان أعلاها فى العليقة المحتوية على كسب الجوجوبا المعامل بالفطر وأقلها فى حالة العليقة المحتوية على كسب الجوجوبا غير المعامل.
- معدل النمو اليومى للحملان تراوح بين ٨٤.٥٠ - ١٤٤(جم /رأس / يوم) حيث كان أعلى معدل للنمو مع الحملان التى تغذت على العليقة المحتوية على كسب الجوجوبا المعامل بالفطر و أقل نمو مع الحملان التى غذيت على العليقة المحتوية على كسب الجوجوبا غير المعامل مع وجود فروق معنويه
- ومن الوجهه الإقتصادية أدت المعاملات البيولوجية سواء بالفطر أو باللقاح البكتيرى و كذلك المعامله الكيماويه إلى خفض تكلفة العليقة.

وبصفة عامه يمكن القول أن المعاملات البيولوجية و كذلك المعاملة بالايزوبروبانول تعتبر من الطرق المناسبه للتخلص من التركيزات الضاره للمواد المثبطه للتغذيه الموجودة فى كسب الجوجوبا وتحسين قيمته الغذائيه والأستفاده منه كمصدر غير تقليدى للبروتين والذى يمكن احلاله حتى ١٠٪ من مكونات مخاليط الاعلاف المركزه دون حدوث أضرار على انتاجيه وصحة الحيوانات بصفه عامه. مع التوصية بمزيد من الدراسات على المدى الطويل عند التغذية على هذه العلائق لتتبع المركبات الميتابوليزمية الناتجة عنها فى الدم واللبن واللحوم فى الحيوانات المغذاة عليها.