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INFLUENCE OF DIFFERENT TREATMENTS OF GUAR KORMA MEAL ON SHEEP PERFORMANCE

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SUMMARY

The present study was conducted to study the effect of heat, soaking, chemical (ethanol) or biological (bacteria) treatments of Guar korma meal (GKM) on concentration of anti-nutritive compounds, rumen fermentation characteristics, microbial counts, degradability of tested TMR's, the blood picture and the consequently sheep performance was also studied. The total mixed rations (TMR's) were: 1- TMR without GKM (control); 2- TMR with 10% untreated GKM (TMRU), 3- TMR with 10% heated GKM (TMRH), 4- TMR with 10% soaking GKM (TMRS), 5- TMR with 10% GKM treated with ethanol (TMRE) and 6- TMR with 10% GKM treated with lactic acid bacteria (TMRB). Digestibility trials were conducted with Barki rams, while rumen fermentation trials were conducted with fistulated Barki ewes. Feeding trials were applied with thirty male growing lambs, whereas they were randomly divided into six similar groups according to their body weights for a feeding period of 120 days, where weight was recorded and blood samples were collected. All treatments, showed a positive effect in decreasing concentration of anti-nutritive compounds. TMRB had highest feeding values, nitrogen utilization, higher VFA's concentration and higher rates of ammonia-N and VFA's productions, while, lowest ammonia-N concentration was recorded with TMRH. Total bacteria count was increased with all treatments comparing with TMRU, while protozoa counts were decreased with incorporating untreated or treated GKM in TMR's comparing with control. Microbial protein was ranged between 54.16 and 100.62 (gm/day) for untreated GKM and LAB treated GKM containing TMR's with significant differences. Effective degradability "ED" (%) of DM were higher ($P< 0.05$) for TMR's containing biologically and chemically treated GKM. Highest effective degradability of CP was recorded with TMRB with significant differences with other TMR's. However, lower effective degradability of CP was recorded with TMR's containing GKMH and GKMU. Highest daily gain was recorded with LAB treated GKM containing TMR. The lowest daily gain was recorded by sheep fed ration contained untreated GKM. The economic cash return (L.E/head/d) was more profit for ration contained GKMB and GKME than other total mixed rations. Except for cholesterol, total protein, albumin, globulin and their ratio the other serum metabolites of the experimental lambs were not significantly influenced by the dietary treatments. It could be concluded that the lactic acid bacteria treated GKM could be used at 10% in TMR for sheep. Chemically treated GKM by ethanol could be also used at 10% without any adverse effects on sheep performance. However, it is important to carry out further research on long term feeding of sheep to follow metabolites compounds consequential in blood, milk and meat.

Keywords: *guar korma meal, detoxification, sheep, digestibility, rumen fermentation, microbial count, degradability, blood analyses, growth performance.*

INTRODUCTION

In Egypt there is a serious problem resulting from a shortage of protein sources gives every scope to search for alternate protein sources for sustaining production and reducing the cost of animal feed. Therefore, there is a need to evaluate alternative protein sources. Guar (*Cyamopsis tetragonoloba L.*), which is a drought resistant annual legume predominantly grown in semi-arid and sub-tropical areas in India and Pakistan (APEDA, 2011). Khalil (2001) cited that in Egypt nowadays several attempts for planting guar were successfully carried out and the yield amounted to about 1.2 tones per acre. Such production is similar to faba bean (Nassib *et al.*, 1991). The plant is primarily grown for its galactomannan polysaccharide gum, which has numerous industrial and food processing applications (Mishra *et al.*, 2013). Guar meal (GM), a by-product of guar gum isolation, contains 33 to 45% protein, which is valued by livestock producers (Salehpour and Qazvinian, 2011). It is a mixture of germs and hulls at an approximate ratio of 25 % germ to 75 % hull (Turki *et al.*, 2011). Kamran *et al.* (2002)

reported that the high amino acid content of the GM protein makes it a useful protein supplement. This is mostly used as a source of protein in ruminant and monogastric animals (Jahani-Azizabadi *et al.*, 2010). Since the germ fraction of GM contains energy, protein, methionine and phosphorus in higher levels than that in soybean meal (Kamran *et al.*, 2002). Nutritive values have been determined: N degradability for expanded GM is in the 65-75 % range and is influenced by the amount of heat treatment. N degradability for unprocessed meal was 85% (Lund *et al*., 2008). Approximately 88% of the nitrogen content in GM was true protein with arginine content approximately twice that of soybean meal. Currently, GM is sold at about half the price of soybean meal, making it an appealing potential source of protein in animal feeds (Shahbazi, 2012). It is used as a feed ingredient but may require processing to improve palatability and remove anti nutritional factors (Turki *et al.,* 2011). Although this by-product meal contains protein concentrations that range from 36 to 45% protein, early research with guar meal revealed deleterious effects on feed consumption; feed conversion and body weight gain of animal fed rations (Huston and Shelton, 1971 and Rajput *et* al., 1987). These effects were attributed to the high level of anti-nutritive compounds such as saponins; trypsin inhibitor; poly phenolics, phytic acid; tannins and residual gum (Lee *et al.,* 2004; Ahmed *et al.*, 2006; Tran, 2013 and Nidhina and Muthukumar, 2015). Hussain et *al.* (2012) reported that inclusion of GM in rations can be maximized by adopting proper processing techniques and by the use of certain additives. Anti-nutritive compounds can be mitigated by various treatments. Tasneem and Subramanian (1990) cited that elimination of GM could be occurred by different methods, it includes solvent extraction, heat, soaking and microbial fermentation. The aim of this study was to investigate the effect of heat, soaking, chemical (ethanol) and biological (bacteria) treatments on degrading toxin compounds in guar korma meal, on rumen fermentation characteristics and their effect on lambs performance.

MATERIALS AND METHODS

This experiment was conducted at Noubaria Experimental Station, Animal Production Research Institute, Agriculture Research Center. Regular non roasted guar korma meal (GKM) obtained from the commercial Egyptian company.

Detoxification methods:

Heat treatment:

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

Soaking treatment:

Guar korma meal was soaked in distilled water (1:3 w/v) for 12 h at room temperature. The soaking solution was drained off and rinsed twice with distilled water, the soaked meal was dried and stored until used.

Ethanol (70%) treatment:

Guar korma meal was sprayed by aqueous solution of ethanol at the rate of 10% (v/w), then stored in plastic containers for 21 days at room temperature. The treated GKM was aerated, then ground to pass a 2 mm screen as described by Tasneem and Subramanian (1990).

Lactic acid bacteria (LAB) treatment:

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

Anti-nutritional compounds analysis:

Approximately 200 mg (DM) of ground samples of Guar korma meal was extracted in 10 ml of aqueous acetone (7:3 v/v) in a water bath maintained at 39–40 ◦C for 90 min (Makkar, 2000). Saponnins were extracted and isolated according to Ahmad *et al.* (1990). Quantitative estimation of tannin for each sample was determined according to Makkar, (2000). Total phenolic components were assayed by Folin-Ciocalteu-reagent 2N (Sigma®–Aldrich, El-Safua Co., Alexandria, Egypt) based on known concentrations of tannic acid as the calibration curve (Sigma®–Aldrich) according to Makkar and Becker

(1993). Phytic acid concentration was determined by a colorimetric procedure described by Vairtrash and Laptera (1988). The trypsin inhibitor activity was determined by the method of Smith *et al.* (1980).

Six total mixed rations (TMR's) were formulated to be isonitrogenous and isoenergetic as follow 1) without GKM (control) (TMR), 2) with 10% untreated GKM (TMRU), 3) with 10% heated GKM (TMRH), 4) with 10% soaking GKM (TMRS), 5) with 10% GKM treated with ethanol (TMRE) and 6) with 10% GKM treated with lactic acid bacteria (TMRB). Compositions and chemical analysis of the tested TMR's are presented in Table (1) and Table (2), respectively.

Table (1): Feed ingredients (%) of the experimental total mixed rations (on dry matter basis).

Feed ingredients, %	TMR	TMRU	TMRH	TMRS	TMRE	TMRB
Yellow corn	32	40	40	40	40	40
Soybean meal	14	5	5	5	5	4
Wheat bran	15	6	6	6	6	7
Untreated guar korma meal	-	10	-	-	-	-
Guar korma meal treated with heat	-	-	10	-	-	-
Guar korma meal treated with soaking	-	-	-	10	-	-
Guar korma meal treated with ethanol	-	-	-	-	10	-
Guar korma meal treated with LAB	-	-	-	-	-	10
Chopped rice straw	30	30	30	30	30	30
Molasses	5	5	5	5	5	5
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

TMR: Total mixed ration (control).
TMRU: TMR containing untreated guar korma meal.
TMRH: TMR containing treated guar korma meal with heat.
TMRS: TMR containing treated guar korma meal with soaking.
TMRE: TMR containing treated guar korma meal with ethanol.
TMRB: TMR containing treated guar korma meal with lactic acid bacteria.

Table (2): Chemical analysis (%) of the experimental total mixed rations (on dry matter basis).

Item	TMR	TMRU	TMRH	TMRS	TMRE	TMRB
OM	89.17	89.54	89.57	89.58	89.51	89.46
CP	12.16	12.17	12.09	12.11	12.08	12.06
CF	14.92	14.42	14.44	14.32	14.40	14.15
EE	2.66	3.14	3.22	3.34	3.08	3.17
NFE	59.43	59.81	59.82	59.81	59.95	60.08
Ash	10.83	10.46	10.43	10.42	10.49	10.54

Digestibility and nitrogen balance trials:

Six digestibility and nitrogen balance trials were carried out using three rams (44 ± 1.30 kg, in average) for each TMR. Each trial lasted for four weeks; the first three weeks were as a preliminary period, followed by one week for feces and urine collection. Sheep were fed twice daily at 8 am and 4 pm. Water was offered freely. Each animal was offered the tested TMR's according to NRC (1994). Chemical analysis of feeds, feces and urine were determined according to A.O.A.C (1995) methods.

Rumen fermentation and In situ trials:

Three ruminally-canulated Barki ewes were used for testing the rumen fermentation and *in situ* trials for each TMR. Rumen samples were withdrawn before feeding and 1, 3 and 6 h after feeding for *in vitro* incubation using the zero rate techniques 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). Rumen volume was determined by colorimetric method of cr-EDTA before, 3 and 6 h after feeding (El-Shazly *et al.*, 1976). Total bacteria count was carried out according to Difco (1984). Count of protozoa was carried out according to Galyean (1989) based on the use of a hemacytometer (Hausser Scientific, Horsham, PA). The microbial protein synthesis (g MP/day) in the rumen of sheep fed the experimental TMR's was calculated using the model equation by Borhami *et al.* (1992) as follow: g

MP/day = mole VFA produced / day × 2 × 13.48 ×10.5 × 6.25 / 100 where one mole VFA yield about 2 mole ATP (Walker, 1965), one mole ATP produce 13.48 Y_{ATP} (g DM microbial cell) (Borhami *et al.*, 1979), N % of dry microbial cell = 10.5 (Hungate, 1965). Nylon bags technique (Mehrez and Ørskov, 1977) was used to determine DM and CP degradability for TMR's. Two polyester bags (7X15 cm) with pore size of 45 µm were used for each incubation time. Approximately 5g of air-dried ration (ground to 2 mm) were placed in each bag. Bags were incubated in the rumen of each sheep and withdrawn after 3, 6, 12, 24, 48, 72 and 96 h. After the bags were withdrawn from the rumen, they were 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 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 soluble fractions are defined as the rapidly degraded fraction (a), slowly degraded fraction (b) and the rate of degradation (c), respectively. The effective degradability (ED) for tested TMR were estimated from the equation cited by McDonald (1981), where ED = a + bc / (c + k), k is the out flow rate.

Growth performance trials:

Thirty male growing lambs, with an average initial live body weight 21.4 ±1.20 kg and 4-5 months of age were used. Lambs were randomly divided into six similar groups according to their body weights (five lambs in each TMR). Animals were weighed biweekly. They were fed the six TMR's in group feeding in tow equal meals / day (8 am and 4 pm) for 120 days. All lambs were offered TMR's according to NRC (1994).Water were offered freely .Feed intake was daily recorded and then feed conversion was calculated.

Blood analyses:

Blood samples were taken every four weeks before morning feeding from the external jugular vein of each male lamb. Serum was obtained by centrifugation of blood at 4000 rpm for 15 min and was stored at -18°C until the time of analysis. Various chemical parameters were calorimetrically determined using commercial kits; following the same steps as described by manufactures. Glucose concentration was determined according to Trinder (1969); total proteins was measured as described by the Biuret method according to Henry *et al.* (1974); albumin (A) was assayed according to Doumas *et al.* (1971); Globulin (G) was calculated by subtracting the albumin value from total protein value; urea was detected according to Berthelot (1959); creatinine was measured according to Faulkner and King (1976); Cholesterol was detected according to Stein (1986). Liver function was assessed by measuring the activities of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) according to Reitman and Frankel (1957).

Statistical analyses:

Collected data were statistically analyzed using the method of least squares analysis of variance using General Linear Models (GLM) procedure (SAS, 2000). The model used was as follow:

$Y_{ij} = \mu + T_i + e_{ij}$

Where: Y_{ij} = an observation taken on the j^{th} individual, µ=overall mean, T_i = a fixed effect of the i^{th} treatment (i=1 to 6), e_{ij} = A random error assumed to be normally distributed with mean = 0 and variance = σ^2. Significant differences among means were separated using LSD test according to Duncan (1955).

RESULTS AND DISCUSSION

Chemical analyses of untreated and treated Guar korma meal:

The chemical analysis of GKM used in this experiment is presented in Table (3). GKM had a high CP content so; it can be used as good protein source for animal feed. Findings of the present study were supported by Mishra *et al*. (2013) and Sharif et *al*. (2014). It had higher contents of crude fiber 8.79% and ether extract 6.34% if it compared with soybean meal (5.34 and 1.35%, respectively), which is consistent with the finding of Mathur and Mathur (1989). Treatment GKM with LAB resulted in an increase in CP content by about 4%, while it was decreased by about 2% with heating and ethanol treatments. On the other hand, CF content was decreased by about 34% and 7% with treatment GKM with LAB and soaking, respectively. Other treatments had quite similar CF content. Ash content was increased by about 10 and

5% with treatment GKM with LAB and ethanol, respectively, while it was decreased by about 4% in soaking treatment.

Concentration of anti-nutritive compounds:-

The screening of anti-nutritive compounds in the untreated and treated Guar korma meal revealed the presence of saponins; tannins; poly phenolic components; phytate and trypsin inhibitor. Data in Table (3) showed that all treatments had positive effect in decreasing concentration of anti-nutritive compounds. These considered as inhibitors and negative effect compounds on appetite of livestock feeds and reduce the nutrient utilization and/or food intake (Shanthakumari *et al.*, 2008; Soetan and Oyewol, 2009 and Gemede and Ratta, 2014). Heat treatment decreased the concentration of saponins; tannins; poly phenolic components; phytate and trypsin inhibitor by about 49, 47, 57, 51 and 69%, respectively. Ahmed *et al.* (2006) reported that moist heating of guar seed has an effect on lowering levels of toxicants. Nidhina and Muthukumar (2015) when compared to the guar churi and guar korma fractions found that both showed the presence of different antinutritional factors, such as trypsin inhibitor, phytate, tannins and saponins, heat treatments significantly reduced these antinutritional factors and functional properties of different fractions of industrial guar meal. Soaking was found to be less effect in improving GKM as it decreased the concentration of saponins; tannins; poly phenolic components; phytate and trypsin inhibitor by about 43, 42, 53, 44 and 41%, respectively. Shi *et al.* (2009) showed that the soaking times and seed-to-water ratios significantly influenced the quantity of saponins leached out from the beans' matrix during the soaking processes. Ethanol treatment decreased the concentration of saponins; tannins; poly phenolic components; phytate and trypsin inhibitor by about 70, 59, 64, 81 and 71%, respectively. Also, Tasneem and Subramanian (1990) noticed that the free poly phenol content was lower for detoxified guar meal by aqueous alcohol extracted. Incubation of GKM with LAB was found to be an effective method in improving GKM as it decreased concentration of saponins; tannins; poly phenolic components; phytate and trypsin inhibitor by about 74, 62, 71, 83 and 72%, respectively. So, LAB had more influence in that respect, whereas, it resulted in reduction of toxic and anti-nutritional than the critical percentages compound. These could be explained by the role of LAB in solubilization of such chemicals in the fermentation process (Rattanachaikunsopon and Phumkhachorn, 2010).

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

Item	Untreated	Treated			
	GKM	GKMH	GKMS	GKME	GKMB
Chemical analysis (%):					
OM	93.87	93.98	94.13	93.57	93.26
CP	43.26	42.48	42.71	42.43	44.97
CF	8.79	9.03	8.14	8.58	5.84
EE	6.34	7.11	8.07	5.67	6.42
NFE	35.48	35.36	35.21	36.89	36.03
Ash	6.13	6.02	5.87	6.43	6.74
Concentration of anti nutritive compounds:					
Saponins (%)	8.840	4.516	5.022	2.673	2.324
Tannins (%)	1.760	0.938	1.102	0.714	0.676
Poly phenolic (%)	2.980	1.281	1.401	1.072	0.864
Phytic acid (%)	0.535	0.262	0.302	0.103	0.092
Trypsin Inhibitor Activities TIU/g*	3520	1085	2074	1021	1003

TIU/g = trypsin inhibitor units per gram.*
GKM : Untreated guar korma meal.
GKMH: Treated guar korma meal with heat.
GKMS: Treated guar korma meal with soaking.
GKME: Treated guar korma meal by ethanol.
GKMB: Treated guar korma meal with lactic acid bacteria.

Digestibility and nitrogen balance trials:

Except for NFE digestibility the highest ($P< 0.05$) digestibility value of nutrients was recorded for TMR contained LAB treated GKM followed by TMR contained ethanol treated GKM, while the lowest value of DM, OM and CP digestibility's were obtained for TMR contained untreated GKM in comparison with control values (Table 4). The digestibility of CP for TMR contained untreated GKM was lower than digestibility of CP for TMR's contained treated GKM as a result to the high content of trypsin inhibitor

and other anti-nutritional compounds on untreated GKM. Soaking of GKM 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 TMR contained LAB treated GKM was recorded highest (P< 0.05) daily feed intake followed by ethanol treated GKM, while, TMR contained heating treated GKM and control were showed quite the same daily feed intake. However, TMR's contained untreated GKM and soaking treated GKM were recorded less daily feed intake. The improvement in nutrients digestibility followed the biological and chemical treatments could be a result of better feed intake and nutritive value. The presence of saponins, glycosides, tannins, alkaloids, conjugates of protein with phytin or hemicellulose and substances inhibiting the action of digestive enzyme trypsin in different food legumes adversely affect their digestibility as these substances are antagonistic to digestion (Gupta, 1987). Saponins, in high concentrations, impart a bitter taste and astringency in dietary plants and reduce palatability of livestock feeds (Gemede and Ratta, 2014). In addition, saponins were found to reduce the bioavailability of nutrients and decrease enzyme activity and it affect protein digestibility by inhibit various digestive enzymes such as trypsin and chymotrypsin (Liener, 2003). Some authors considered saponins as a toxic compound. However, saponins contents below 3% reported by Kumar (1991) which could be responsible for cattle weight losses when they grazed on alfonibrilla *(Drymaria arenaroides)*. Gemede and Ratta (2014) concluded that some anti-nutritional factors as well as their breakdown products may possess beneficial health effects if present in small amounts. The TDN and DCP values for LAB treated GKM containing ration were recorded significantly the highest value (Table 5). Lowest values were obtained with untreated GKM containing ration. Less (P< 0.05) N-intake was noticed for sheep fed untreated GKM containing ration, this could be due to the effect of the anti-nutritional substances content of GKM in depressing feed intake. Nitrogen balance showed the same trend. Biological value of dietary-N was higher for LAB treated GKM.

Table (4): Digestibility coefficients of the experimental TMR's fed to sheep.

Digestibility coefficients (%)	Experimental TMR's							
	TMR	TMRU	TMRH	TMRS	TMRE	TMRB	SEM	Sig.
DM	61.05^{b}	58.65^{c}	60.79^{b}	59.55^{bc}	63.53^{a}	64.04^{a}	0.45	*
OM	65.85^{abc}	62.88^{c}	64.76^{bc}	63.82^{c}	67.60^{ab}	68.31^{a}	0.58	*
CP	59.19^{c}	57.14^{d}	58.98^{c}	57.94^{cd}	63.50^{b}	65.25^{a}	0.74	*
CF	58.35^{c}	57.78^{c}	60.92^{b}	60.08^{bc}	62.29^{b}	64.90^{a}	0.49	*
EE	66.13^{b}	67.70^{ab}	67.52^{ab}	66.16^{b}	70.75^{a}	70.81^{a}	0.61	*
NFE	69.08	65.03	66.71	65.62	69.54	69.59	0.66	NS

** P< 0.05 and N.S = Not significant.*
a, b, c, and d, means in the same row with different superscripts are significantly differ (P< 0.05).
SEM: standard error of mean; Sig.: significant.

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

Item	Experimental TMR's							
	TMR	TMRU	TMRH	TMRS	TMRE	TMRB	SEM	Sig.
DMI (g/h/d):	1239.7^{c}	1147.17^{d}	1223.19^{c}	1198.50^{d}	1264.36^{b}	1308.72^{a}	9.45	*
Nutritive value:								
(TDN %)	60.91^{ab}	58.96^{b}	60.72^{ab}	59.99^{b}	62.25^{ab}	63.91^{a}	0.52	*
(DCP %)	7.20^{c}	6.95^{d}	7.13^{cd}	7.02^{cd}	7.63^{b}	7.87^{a}	0.08	*
Nitrogen utilization:								
N-intake (g/d)	24.12^{ab}	22.34^{c}	23.66^{abc}	23.22^{bc}	24.44^{ab}	25.25^{a}	0.28	*
N- absorbed (g/d)	14.28^{c}	12.77^{d}	13.95^{c}	13.45^{cd}	15.43^{b}	16.48^{a}	0.32	*
N-balance (g/d)	5.35^{bc}	4.51^{c}	5.14^{bc}	4.92^{c}	5.95^{ab}	6.58^{a}	0.19	*
N-balance as % of N intake	22.10^{ab}	20.26^{b}	21.75^{b}	21.22^{b}	24.39^{ab}	26.08^{a}	0.65	*
N-balance as % of N-abso.	37.29^{ab}	35.47^{b}	36.85^{b}	36.63^{b}	38.59^{ab}	39.97^{a}	0.68	*

** P< 0.05*
a, b, c, and d, means in the same row with different superscripts are significantly differ (P<0.05).
SEM: standard error of mean; Sig.: significant.

Ruminal fermentation:

Ruminal pH values were not significantly affected by the dietary TMR's (Table 6). This was agreed with the finding of Bargo *et al*. (2001) who reported that ruminal pH was not affected by level or source of protein. The rumen pH values in the present study are within the normal range reported for sheep, which is suitable for maximal cellulytic activity and microbial protein synthesis (Salem, 2006). The overall mean of NH_3– N concentration in the rumen of sheep fed heated GKM was lower (P< 0.05) than other TMR's. 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. Ruminal NH_3– N concentration values revealed that it was sufficient for microbial growth as described by Lu *et al*. (1990). Both GKMH and GKME containing TMR's had quiet similar rate of production. TMR contained GKMB has the higher (P < 0.05) rate of NH_3-N production. While those containing control; GKMU and GKMS were showed the lower rate of NH_3-N production. 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 protein production. High VFA's concentration and rate of production (P < 0.05) for biological treatment may be related to the more utilization of the dietary energy and positive fermentation in the rumen. Lowest total bacteria and protozoa counts were recorded with UGKM containing ration. This finding was agreed with Avato *et al.* (2006); Ma *et al.* (2007); Hassan *et al.* (2010) and Wina (2012) they reported that various biological effects of saponins and phenolic component are antibacterial and antiprotozoal. Lila *et al.* (2005) cited that the saponins is also inhibitory for some of the rumen ciliate protozoa and bacteria. However, saponins below critical level have received considerable attention due to their beneficial effects on animal health (Hassan *et al.,* 2013). Thalib *et al.* (1996) studied the effect of saponins of *Sapindus rarak* fruit on rumen microbes of sheep and reported that the methanol extract of seeds caused a 57% reduction in the number of protozoa and 69% increase in bacterial population which resulted in improved feed conversion efficiency and better gain in body weight of the animals. The overall mean revealed that a high (P < 0.05) rate of out flow from the rumen was obtained with sheep fed TMR; TMRU and TMRS compared to other three TMR's which showed almost similar rate of out flow. The rate of out flow observed in this study with TMRB could be considered as suitable rate of out flow for efficient MP synthesis. There are significant (P< 0.05) increases in the microbial protein synthesis when GKM was treated with lactic acid bacteria (Table 6). It significantly increases the calculated flow of microbial nitrogen from the rumen. Nkosi *et al.* (2011) and Basso *et al.* (2014) reported an increase in nitrogen retention and protein flow from the rumen in sheep fed biological treated (LAB) rations. However, biological treatment could be reasonably for good MN synthesis in the rumen. Subsequently, the limitation upon the cellulolytic bacteria could influence on fiber fermentation, digesta outflow, and feed intake (Gilbery *et al.* 2006).Ultimately; this alteration of bacterial functionality may affect the amount of energetic substrates (VFA) and AA available to the ruminant animal.

Table (6): Rumen parameters of sheep fed the experimental TMR's.

Item	Experimental TMR's							
	TMR	TMRU	TMRH	TMRS	TMRE	TMRB	SEM	Sig.
pH value	6.41	6.38	6.33	6.36	6.35	6.26	0.12	NS
NH_3-N concentration (mg/100ml)	13.63^{a}	13.61^{a}	13.08^{b}	13.49^{a}	13.43^{a}	13.71^{a}	0.09	*
Rate of NH_3-N production(g/100ml/h)	2.83^{c}	2.91^{c}	3.29^{b}	2.96^{c}	3.42^{b}	3.68^{a}	0.08	*
VFA's concentration (meq/100 ml)	11.47^{c}	10.67^{d}	12.14^{ab}	11.31^{c}	12.34^{ab}	12.66^{a}	0.19	*
Rate of VFA's production(meq/100ml/h)	3.86^{d}	3.19^{e}	4.18^{c}	3.83^{d}	4.47^{b}	4.76^{a}	0.11	*
Total bacteria counts, $\times 10^8$ cfu/ml	1.28^{b}	1.17^{c}	1.28^{b}	1.26^{b}	1.37^{a}	1.39^{a}	0.02	*
Total protozoa counts, $\times 10^6$cfu /ml	4.84^{a}	3.96^{c}	4.19^{b}	4.15^{b}	4.17^{b}	4.13^{b}	0.07	*
Rumen volume (L)	3.34^{d}	3.19^{d}	3.65^{c}	3.32^{d}	3.88^{b}	4.06^{a}	0.08	*
Rate of out flow (%h)	6.22^{a}	6.49^{a}	5.56^{b}	6.27^{a}	5.43^{b}	5.21^{b}	0.13	*
Microbial Protein Synthesis, (g/head/day)	67.22^{d}	54.16^{e}	78.99^{c}	65.37^{d}	89.32^{b}	100.62^{a}	3.83	*

** P< 0.05 and N.S = Not significant.*

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

SEM: standard error of mean; Sig.: significant.

Degradation kinetics:

Estimated ruminal degradation kinetics constants (a, b and c) fitted with rates of DM and CP disappearance for experimental TMR's are presented in Table (7).

Table (7): Degradation kinetics of DM and CP for total mixed rations in sheep fed the experimental TMR's.

Item	Experimental TMR's							
	TMR	TMRU	TMRH	TMRS	TMRE	TMRB	SEM	Sig.
				DM				
a	23.16^{b}	21.08^{c}	23.29^{b}	23.24^{b}	24.85^{a}	25.92^{a}	0.29	*
b	46.92^{b}	44.16^{c}	47.13^{b}	47.28^{b}	49.17^{a}	49.83^{a}	0.74	*
c	0.039^{b}	0.036^{c}	0.040^{b}	0.039^{b}	0.042^{a}	0.042^{a}	0.002	*
EDDM	43.71^{b}	39.56^{c}	44.23^{b}	44.19^{b}	47.29^{a}	48.65^{a}	0.86	*
				CP				
a	18.60^{a}	19.62^{b}	19.49^{b}	20.66^{a}	20.69^{a}	20.83^{a}	0.14	*
b	53.89^{a}	49.38^{c}	49.04^{c}	49.88^{bc}	51.02^{b}	51.36^{b}	0.41	*
c	0.055^{b}	0.0500^{c}	0.0500^{c}	0.0520^{bc}	0.053^{bc}	0.059^{a}	0.001	*
EDCP	46.83^{b}	44.31^{c}	43.99^{c}	46.08^{bc}	46.94^{b}	48.63^{a}	0.48	*

** P< 0.05.*
a, b and c, means in the same row with different superscripts are significantly differ (P< 0.05).
SEM: standard error of mean; Sig.: significant.
a: soluble fraction (%).
b: potentially degradable fraction (%).
c: rate of degradation (% h-1).
ED: effective degradability= a + [bc/c + k], where k is passage rate.
EDDM: effective degradability of dry matter.
EDCP: effective degradability of crude protein.

It illustrated that washing loss fraction "a", degradable fraction "b", rate of degradation "c" and effective degradability " ED " of DM for TMR's were less (P< 0.05) in untreated GKM compared with the control TMR . While it was higher (P< 0.05) for TMR's containing biologically and chemically treated GKM as compared with untreated one and other TMR's. As a result of these treatments increased DMD than other treatments. The decrease of degradability of TMR containing untreated GKM may be due to the negative effect of saponnins and trypsin inhibitor as well as other anti-nutritional on ruminal microorganisms. This finding is agreed with Abo El-Fadel *et al.* (2011) who concluded that the decrease of degradability of CFM's containing untreated Jatropha Meal (JM) may be due to the negative effect of trypsin inhibitor and lectin on ruminal microorganisms. Also, Rakshit *et al.* (2008) concluded that trypsin inhibitor content of JM as well as other anti-nutritional compounds are affecting digestibility. However, ruminal degradation constants (a, b and c) and effective degradability "ED" of CP for TMR's were less (P< 0.05) in untreated GKM and heated GKM. Salehpour and Qazvinian (2011) reported that decreasing blood urea nitrogen with increasing guar meal percentage of diets may have affected low rumen degradable CP of guar meal, concentration ammonia in rumen or decrease microbial protein synthesis. On the mean time, the degradability of CP with ethanol and bacteria treatments were higher than heat treatment, which may be as a result to the over protection with heat treatment. Lower washing loss fraction "a", degradable fraction "b", rate of degradation "c" and effective degradability " ED " were noticed with untreated GKM containing ration for DM and CP degradation compared to the control and other experimental TMR's. These could be related to the less digestibilities 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 TMR contained LAB treated GKM .While the lowest values were recorded with TMR contained untreated GKM (Table 8). Huston and Shelton (1971) reported that where raw guar meal (RGM) was included in the ration of lambs, performance was significantly depressed. Palatability may have been reduced due to the strong odor of RGM, but it is likely that also other factors were involved and contributed to the observed reduction in feed intake. There was a tendency for the lambs fed guar meal to poor performance especially early in the feeding period. Results of feed intake showed that with heating, chemically and biologically treated GKM and control significantly increased compared with untreated GKM containing ration, while no differences

between TMRU and TMRS. Best feed conversion was observed with TMR contained LAB treated GKM, followed by those treated with ethanol, then heating. Total mixed rations containing heating, soaking, ethanol and LAB treated GKM were the cheaper than the control. Sharif *et al.* (2014) found that guar (GM) meal based diet was more economical than diets containing cotton seed cake (CSC) and CSC+GM. Mahdavi *et al.* (2010) pointed out that replacing protein sources with cheaper guar meal resulted in better economic efficiency. The economic cash return (L.E/h/d) was more pronounced with TMR contained LAB treated GKM than other rations (Table 9).

Table (8): Effect of feeding experimental TMR's on lamb performance and feed efficiency.

Item	Experimental TMR's							
	TMR	TMRU	TMRH	TMRS	TMRE	TMRB	SEM	Sig.
Initial BW(kg/h)	21.50	21.60	21.30	21.40	21.50	21.30	0.04	NS
Final BW(kg/h)	36.74^{bc}	35.28^{d}	36.72^{bc}	35.92^{cd}	37.82^{ab}	38.82^{a}	0.32	*
Total gain (g/h)	15.24^{c}	13.68^{d}	15.42^{c}	14.52^{cd}	16.32^{b}	17.52^{a}	0.79	*
Average daily gain (g/h)	127.00^{c}	114.00^{d}	128.50^{c}	121.00^{cd}	136.00^{b}	146.00^{a}	2.69	*
Feed Intake(g/h/d)								
DMI	$981.00b^{c}$	916.00^{d}	958.00^{c}	929.00^{d}	987.00^{b}	1015.00^{a}	8.69	*
TDNI	597.53^{c}	540.07^{f}	581.70^{d}	557.59^{e}	614.41^{b}	648.69^{a}	8.85	*
DCPI	70.63^{c}	63.66^{e}	68.31^{d}	65.22^{e}	75.31^{b}	79.88^{a}	1.38	*
Feed Conversion								
Kg DMI/ Kg gain	7.73^{ab}	8.05^{a}	7.47^{b}	7.68^{ab}	7.26^{bc}	6.96^{c}	0.11	*
Kg TDNI/ Kg gain	4.71^{a}	4.74^{a}	4.53^{b}	4.61^{ab}	4.52^{b}	4.45^{b}	0.10	*

** P< 0.05 and N.S = Not significant.*
a, b, c, d,e and f, means in the same row with different superscripts are significantly differ (P<0.05).
SEM: standard error of mean; Sig.: significant.
DMI: dry matter intake.
TDNI: total digestible nutrients intake.
DCPI: digestible crud protein intake.

Table (9): Effect of incorporation of guar korma meal on the economic efficiency of growing Barki lambs.

Item	Experimental TMR's					
	TMR	TMRU	TMRH	TMRS	TMRE	TMRB
Average daily feed cost (L.E)	1.67	1.43	1.51	1.47	1.56	1.58
Price of daily gain(L.E)	4.19	3.76	4.24	3.99	4.49	4.82
Economical return((L.E /h/d)	2.52	2.33	2.73	2.52	2.93	3.24
Economic efficiency (%)	2.51	2.63	2.81	2.71	2.88	3.05

Calculation based on the following price in Egyptian pound (L.E.) per ton at 2014, total mixed ration (TMR) (control) =1700 L.E/ton, TMR containing untreated guar korma meal =1565 L.E/ton, TMR containing guar korma meal treated with heat =1580 L.E/ton, TMR containing guar korma meal treated with soaking=1580 L.E/ton, TMR containing guar korma meal treated with ethanol=1580 L.E/ton, TMR containing guar korma meal treated with lactic acid bacteria =1560 L.E/ton. The price of one kg of live body weight was 33 L.E.

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

Blood biochemical and serum constituents:

The results of blood serum constituents in Barki lambs fed the experimental TMR's are presented in Table (10). Except for cholesterol, total protein, albumin, globulin and their ratio the other serum metabolites were not significantly (P> 0.05) influenced by the dietary treatments. Lower (P< 0.05) value of cholesterol was obtained with TMRU may be due to the high saponins concentration. Saponins have the effect of lowering serum cholesterol levels in sheep (Cerci *et al.*, 2011). Saponins form insoluble complexes with cholesterol in the digestive system. Therefore, they inhibit the intestinal absorption of endogenous and exogenous cholesterol and the raising of the bile acid and neutral sterols by fecal defecation (Lima *et al.*, 2012; Singh *et al.*, 2012 and Elseed *et al.*, 2013). The obtained serum total protein

values for the treated guar meal containing rations showed that the tannins level of the treated guar meal is safe and beneficial, and not detrimental, because tannins at low levels are beneficial as they impact some qualities of rumen undegradable protein, thus improving protein availability and utilization. Also, our findings were in consistent with Lohakare *et al.* (2006) who reported that blood glucose levels were not influenced by different dietary protein treatments in crossbred cows. Moreover, they were within the normal average as described by Gudev *et al.* (2005). Generally the values obtained of blood constituents in this study indicate normal physiological and healthy status of both lamb groups.

Table (10): Blood serum parameters of male lambs fed the experimental TMR's.

Item	Experimental TMR's							
	TMR	TMRU	TMRH	TMRS	TMRE	TMRB	SEM	Sig.
Glucose mg/dl	58.73	57.26	58.03	57.48	59.68	59.81	0.95	NS
Total protein (TP), g/dl	7.63^{a}	6.57^{b}	7.15^{ab}	7.11^{ab}	7.68^{a}	7.74^{a}	0.12	*
Albumin(A), g/dl	4.08^{ab}	3.38^{c}	3.81^{b}	3.76^{b}	4.17^{a}	4.22^{a}	0.08	*
Globulin(G), g/dl	3.55^{a}	3.19^{b}	3.34^{ab}	3.35^{ab}	3.51^{a}	3.52^{a}	0.04	*
A / G ratio	1.149^{bc}	1.059^{d}	1.140^{c}	1.122^{c}	1.188^{ab}	1.198^{a}	0.01	*
Urea, mg/dl	28.91	27.03	27.64	27.41	28.04	28.23	0.42	NS
Creatinine, mg/dl	1.12	1.02	1.03	1.06	1.08	1.10	0.11	NS
Cholesterol mg/dl	105.18^{a}	78.11^{d}	92.42^{b}	85.97^{c}	94.13^{b}	93.71^{b}	2.04	*
AST, u/l	29.88	30.36	30.04	30.02	29.96	29.83	0.43	NS
ALT, u/l	18.79	19.03	18.12	18.27	17.86	17.75	0.79	NS

** P< 0.05 and N.S = Not significant.*
a, b,c and d, means in the same row with different superscripts are significantly differ (P< 0.05).
SEM: standard error of mean; Sig.: significant.

CONCLUSION

The major problem with utilizing GKM 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 saponins and other anti-nutritive compounds by either treatment with LAB or ethanol improved the utilization of GKM as a good 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 GKM.

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تأثير المعاملات المختلفه لكسب الجوارکورما على أداء الأغنام.

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أستهدفت الدراسة التقييم الغذائى لكسب الجوارکورما غير المعامل أو المعامل حرارياً او بالنقع او كيماوياً أو بيولوجياً بالبكتريا و دراسة تأثير المعاملات على تركيز المواد المثبطة للتغذية وخصائص تخمرات الكرش والعد الميكروبى ومعدل التحلل فى الكرش وتقدير قياسات الدم وكذلك الأداء الإنتاجى للأغنام .

و كانت مخاليط العلائق المتكاملة المستخدمة كما يلى :

1. مخلوط علف متكامل (كنترول).
2. مخلوط علف متكامل يحتوى على 10%كسب جوارکورما (غير معامل).
3. مخلوط علف متكامل يحتوى على 10%كسب جوارکورما معامل حرارياً (بالغليان).
4. مخلوط علف متكامل يحتوى على 10%كسب جوارکورما معامل (بالنقع).
5. مخلوط علف متكامل يحتوى على 10%كسب جوارکورما معامل كيماوياً (بالإيثانول).
6. .مخلوط علف متكامل يحتوى على 10%كسب جوارکورما معامل باللقاح البكتيرى (بكتريا حامض اللاكتيك).

تم أجراء تجارب الهضم لمخاليط العلائق المختبرة بإستخدام الكباش البرقى (ثلاثة لكل عليقة) بينما أستخدمت ثلاثة نعاج مزودة بفستيولات الكرش لقياس نشاط الكرش و لتقدير معدل التحلل للمادة الجافة والبروتين فى الكرش. و تم أستخدام ثلاثون من ذكور حملان برقى نامية وزعت عشوائيا على ستة مجاميع بناءاً على وزن الجسم (خمسه لكل مجموعة) فى تجارب التغذية والنمو والتى غذيت لمدة 120 يوم مع تسجيل الأوزان وأخذ عينات الدم .

وقد أشارت النتائج إلى ما يلى :-

- أدت كل المعاملات المستخدمة الى خفض تركيزات المواد المثبطة للتغذية الى الحدود الأمنة لإستخدامها فى علائق المجترات.

- المعاملة البيولوجية باللقاح البكتيرى أدت الى زيادة معاملات هضم المركبات الغذائية و القيمه الغذائية و الأستفادة من النيتروجين.

- بالنسبة لتركيزات الأحماض الدهنية الطيارة فى الكرش ومعدل إنتاجها ومعدل إنتاج الأمونيا سجلت أعلى قيم معنوية مع المعاملة البيولوجية باللقاح البكتيرى بينما سجلت المعاملة الحرارية أقل تركيز للأمونيا فى الكرش.

- لوحظ زيادة العد البكتيرى الكلى مع مخاليط الأعلاف المتكاملة المحتوية على كسب الجوارکورما المعامل مقارنةً بالمخلوط المحتوى على الجوارکورما غير المعامل فى حين أنخفضت أعداد البروتوزوا عند التغذية على مخاليط الأعلاف المتكاملة المحتوية على الجوارکورما سواء المعامل أو غير المعامل مقارنة بالعليقه الكنترول.

- تراوح إنتاج البروتين الميكروبى ما بين 54.16 و 100.62 (جم/ يوم) فى مخاليط الأعلاف المتكاملة المحتوية على كسب الجوارکورما غيرالمعامل و المعامل باللقاح البكتيرى على التوالى مع وجود فروق معنويه.

- سجلت مخاليط الأعلاف المتكاملة المحتوية على الجوارکورما المعامل بيولوجياً أو كيماوياً أعلى معدل تحلل للمادة الجافة فى الكرش بينما نجد أن معدل تحلل البروتين فى الكرش كان أعلاها مع المعاملة البيولوجية مع وجود فروق معنوية مع باقى المخاليط وأقلها فى حالة المخاليط المحتوية على كسب الجوارکورما المعامل حرارياً و غير المعامل.

فيما عدا الكوليسترول والبروتين الكلى والألبيومين والجلوبيولين والنسبه بينهم نجد أن باقى المركبات الميتابوليزميه فى سيرم دم الحملان لا تتأثرمعنوياً بإختلاف المعاملات.

- معدل النمو اليومى للحملان تراوح بين 114- 146(جم / رأس / يوم) حيث كان أعلى معدل للنمو مع الحملان التى تغذت على العليقة المحتوية على كسب الجوارکورما المعامل باللقاح البكتيرى و أقل نمو مع الحملان التى غذيت على العليقة المحتوية على كسب الجوارکورما غير المعامل مع وجود فروق معنوية.

- ومن الوجهه الإقتصادية أدت المعاملات البيولوجية باللقاح البكتيرى و كذلك المعاملة الكيماوية إلى خفض تكلفة العليقة مقارنة بباقى العلائق.

وبصفة عامه يمكن القول أن المعاملة باللقاح البكتيرى و كذلك المعاملة بالإيثانول تعتبر من الطرق المناسبة للتخلص من التركيزات الضارة للمواد المثبطة للتغذية الموجودة فى كسب الجوارکورما وتحسين قيمتة الغذائية والأستفادة منه كمصدر غير تقليدى للبروتين والذى يمكن إحلالة حتى 10% من مكونات مخاليط الأعلاف المتكاملة دون حدوث أضرار على إنتاجية وصحة الحيوانات بصفه عامة. 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.