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Research Article
Effect of using Guar Korma Meal as a New Source of Protein on Productive Performance of Buffalos

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Abstract

Background and Objective: Guar korma meal (*Cyamopsis tetragonoloba*) is one of some nutritional sources of feed proteins which contain high protein, approximately 50% or more. This study aimed to evaluate the effect of using Guar Korma Meal (GKM) as a new source of protein in rations on productive performance for Egyptian buffalos. **Materials and Methods:** The first trial was carried out to determine the *in vitro* disappearance gas production of dry and organic matter (IVDMD and IVOMD) of the different experimental Concentrate Feed Mixtures (CFM) containing different levels of GKM instead of Sunflower Meal (SM). The second trial, depending on the results of first experiment 20 buffalos averaging 450 kg Live Body Weight (LBW) were chosen into four similar groups in the same lactation season. Animal groups were receive four experimental rations containing CFM which included GKM at the rate of 0, 6, 8 and 10% in rations R1, R2, R3 and R4 replacement with SM. **Results:** The results obtained from the first experiment revealed that the IVDMD and IVOMD in gas production increased with increasing the replacement level of GKM in concentrate feed mixture. The second experiment indicated that the digestibility of Dry Matter (DM), Organic Matter (OM), Crude Protein (CP) and nutritive value expressed as Total Digestible Nutrients (TDN) increased ($p<0.05$) with increasing the replacement level of GKM in the rations. Average actual milk and Fat Corrected Milk (FCM) yield were increasing with increasing level of GKM. Blood parameters were within normal range and improve lipid profile. Average feed cost per kilogram milk yield decreased with increasing GKM levels. **Conclusion:** Conclusively, it could be recommended that substitution SM by GKM in Egyptian buffalo's rations seems to be the best for the digestibility, improve lipid profile and productive performance.

Key words: Guar korma meal, Egyptian buffalos, digestibility, blood, milk production, economic efficiency

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

One of the principal limiting factors affecting on ruminant productivity in the semi-arid areas of West Asia and North Africa is the shortage of forage. This leads to increasing pressure on range lands and therefore to a rapid deterioration of plant cover in many areas of West Asia and North Africa. Additionally, the frequent occurrence of drought in many countries of West Asia and North Africa results in widening the gap between the feed supply and nutrient requirements of ruminants.

Guar is hardy and drought-tolerant. It is well adapted arid and semi-arid climates with hot temperatures but can grow in sub-humid conditions, from sea level upto 1000 m. Guar responds well to irrigation during dry periods but does not tolerate water logging. Excessive rainfall and humidity affect fertilization, pod development and seed quality. In high rainfall areas, guar is leafier and more suitable as a green manure and fodder crop. Guar grows well under a wide range of soil conditions and is tolerant of low fertiliy, soil salinity and alkalinity. It performs best on fertile, medium-textured and sandy loam alluvial soils but does not tolerate heavy black soils[1-3].

As a primary product of a fodder plant called guar (*Cyamopsis tetragonoloba*), guar gum is extensively used as emulsifier, thickener and stabilizer in food and oil industries. After the gum is extracted, guar meal is processed by toasting the guar seeds at high temperature to remove the natural trypsin inhibitor, thus enhancing its nutritive value and digestibility[4].

Guar Meal (GM) as the by-product usually remains as a source of protein for use in animal feeds. Usually sells for almost half that of soybean meal and is most commonly used in cattle feedlot operations. Increased production of guar beans may offer expanded opportunities for use in least cost poultry feeds. The crude protein content of GM varies from 35-47.5% on a dry matter basis[5-8].

Moreover, anti-nutritional components like guar gum (β-mannan), saponins and trypsin inhibitors limit the use of guar meal in broiler diets. These anti-nutritional factors have been reported to depress growth in birds but at lower levels some of these (β-mannan and saponins) have positive effects on bird health and performance. Therefore, β-mannan is considered a major anti-nutritional factor when higher levels of guar meal are used in poultry. To improve the utilization of such feeds, β-mannanases are used. This study found some benefits and drawbacks regarding the use of guar meal in poultry diets and how to improve its feeding value. But on large animals has no effect[9].

Guar meal is a relatively inexpensive high protein meal produced as a by-product of guar gum manufacture. The protein content of guar meal ranges between 33-45% depending on fraction type[2,10,11].

However, raw guar meal can constitute up to 25% of cattle rations. Processed meal can be used as the sole protein component of cattle diets. Few nutritive values have been determined: N degradability for expanded guar meal is in the 65-75% range and is influenced by the amount of heat treatment. Nitrogen degradability for unprocessed meal[7] was 85%.

In dairy cattle, guar meal is a highest protein containing animal feed in its group. It is having upto 50% of protein with a high digesting content, which improves digesting system of cows or buffaloes. As it is very high in protein it gives extra fat in its milk and also increases the quantity of milk[7].

Therefore, the objectives of this study to evaluate the effect of using different levels of guar korma meal as a new sources of protein in the rations for dairy buffalos on digestibility, nutritive value, some blood parameters, productive performance, milk production and economic efficiency.

MATERIALS AND METHODS

Two experiments were conducted in this study, the first one was carried out at the Laboratory of Animal Nutrition Department, Animal Production Research Institute, Ministry of Agriculture, in order to determine the *in vitro* disappearance of dry and organic matter digestibility (IVDMD and IVOMD) of the different experimental Concentrate Feed Mixture (CFM) containing different levels of gaur korma meal as a replacement with sunflower meal.

The second experiment was carried out at Mehallat Mousa Station, Kafer El-Shike governorate, Animal Production Research Institute, Ministry of Agriculture in order to study the effect of feeding rations containing different levels of GKM on milk yield of buffaloes.

First experiment: At the 1st experiment, 6 concentrate feed mixture containing 6 percentage of GKM were made as a source of protein instead of sunflower meal (Table 1). *In vitro* dry matter and organic matter disappearance were carried out by using Menke and Steingass[12] method.

Second experiment: Depending on the results of the first experiment, 20 buffalo averaging 450 kg LBW were chosen and divided into four similar groups depending on season lactation (2nd and 3rd). The groups of animals were

Table 1: Feed ingredients (%) of experimental concentrate feed mixtures containing GKM (Percentage on dry matter basis) using in different treatments

	Treatments					
Items	T1	T2	T3	T4	T5	T6
Wheat bran	39	38	38	38	38	38
Yellow corn	30	32	32	32	37	38
Sunflower meal	26	22	18	16	10	7
Gaur korma meal	-	2	4	6	8	10
Molasses	2	3	5	5	4	4
Limestone	2	2	2	2	2	2
Salt	1	1	1	1	1	1

T1: Control, T2: 15% of protein SM was replaced by GKM, T3: 30% of protein SM was replaced by GKM, T4: 45% of protein SM was replaced by GKM, T5: 60% of protein SM was replaced by GKM, T6: 75% of protein SM was replaced by GKM

Table 2: Chemical composition (%) of feedstuffs and experimental rations

		DM basis (%)					
Items	DM	OM	CP	CF	EE	Ash	NFE
CFM	89.20	88.60	15.70	12.10	1.60	14.40	59.20
GKM	89.82	92.80	50.00	10.80	2.86	4.15	32.19
Clover hay	89.20	79.21	12.01	28.56	2.41	9.98	47.04
Rice straw	90.50	75.30	2.32	33.63	1.48	15.20	47.37
R1	88.20	80.80	16.00	11.50	3.22	7.40	61.88
R2	88.94	81.79	16.00	9.56	3.23	7.29	63.92
R3	87.15	80.12	16.00	6.97	3.36	8.4	65.27
R4	90.80	84.00	16.00	7.88	3.39	6.88	62.85

randomly assigned to receive four experiment rations containing CFM which included gaur korma meal at rate of 0, 6, 8 and 10% in rations R1, R2, R3 and R4. This percentage of GKM covers 0, 45, 60 and 75% of CFM protein content as a replacement with sunflower meal (T1, T4, T5 and T6) in Table 2. All animal received CFM, clover hay and rice straw at the rate of 40:30:30 respectively according to Kearl[13]. The feeding trial tasted 120 days.

The CFM was individually weight for each animal and offerd twice daily at 7 am and 4 pm in each group while the roughage was offered at 8 am and 5 pm. Daily feed intake was recorded and feed efficiency was calculated. Milk production of each buffalo was recorded daily in the morning and in the night. Feed allowance was adjusted biweekly according to the change in milk production.

Blood samples were collected after morning feeding from jugular vein of each animal in the first and in the last day of feeding trail. The obtained serum was stored at -8°C till analysis for triglycerides (TG), Total Cholesterol (TC), High Density Lipoprotein (HDL) and Low Density Lipoprotein (LDL) concentration were evaluated according to the instruction by Friedewald *et al.*[14]. Creatinine was determined spectrophotometrically using special kits according to the method described by Folin[15]. Urea was determined by enzymatic colourimetric, urease salycilate method according to Patton and Crouch[16] using the commercial kits from Sentinel CH, aspartic transeaminase (AST) and alanine transeaminase (ALT) were assayed in the plasma as described by Rettman and Frankel[17]. Immunoglobulin G (IgG) and immunoglobulin M (IgM) were valuated according to the instruction by Naessens[18].

For digestibility trials buffalos were fed their daily feed allowances according to experimental design assignment of each group over the feeding trial. Acid Insoluble Ash (AIA) was used as a natural internal marker as described by Thonney *et al.*[19]. Milk samples from consecutive evening and morning milking were taken in three times during the experimental period at the beginning, in the middle and in the end of experimental period and mixed in proportion to milk yield. Composite milk sample were analyzed for fat, protein, Solids Not Fat (SNF), lactose and Total Solids (TS) by milkoscan, model 133B. Ash was determined by different and Corrected Fat Milk (CFM) 7% was calculated according to Raafat and Saleh[20].

Data were statistically according to SAS[21] and differences among means were determined by using Duncan[22] test.

RESULTS AND DISCUSSION

First experiment

Effect of different levels of GKM on chemical composition of experimental rations: The effect of different levels of GKM on chemical composition is presented in Table 3. Data indicated that there are increases in percentage of DM, OM and EE and decrease in percentage of CF and ash by increasing the level of guar meal in the concentrate feed mixtures. This may be attributed to the chemical composition of guar meal. Concerning, the percentage of concentration of anti-nutritional (cellulase, hemicellulase and β-mannanase) compounds, it was observed that treatment with heat had positive effect in decreasing concentration of anti-nutritional compounds. These results are in agreement with those by Rajput *et al.*[23], Lee *et al.*[24] and Hassan *et al.*[25] reported that heat treatment decreased the concentrate of trypsin inhibitors, saponin, haemagglutinins, hydrocyanic acid and polyphenols.

Effect of different levels of GKM on DM and OM digestibility: The effect of different levels of GKM on Gas Production (GP), *in vitro* dry matter (IVDM) and *in vitro* digestibility organic matter intake (IVDOMI) all of these parameter revealed that the inclusion of GKM (75%) showed significantly ($p<0.05$) the highest values compared to anther levels, followed by the level of 60% and control had the lowest gas production.

Table 3: *In vitro* gas production of experimental concentrate feed mixtures containing different levels of GKM

	Experimental concentrate feed mixtures						
Items	T1	T2	T3	T4	T5	T6	±SE
DM	33.93[c]	39.55[b]	45.53[b]	54.82[a]	59.76[a]	81.57[a]	5.56
Gp mmol/200 g dm	42.23[b]	46.36[ab]	50.42[a]	54.18[a]	64.11[a]	67.51[a]	3.61
DOM (%)	65.23[b]	70.25[ab]	70.36[a]	74.15[a]	81.56[a]	84.10[a]	2.69
IVDDCPI (g day^{-1})	117.22	140.37	152.32	164.34	183.09	210.60	24.55
IVDOMI (mmol mL^{-1} gas)	338.69[b]	432.2[a]	678.2[a]	732.7[a]	995.4[a]	1039.9[a]	98.49

[a-c]Means of different letters in the same row are significant different (p<0.05)

Table 4: Nutrients digestibility and feeding value of buffloes fed the different experimental rations

	Experimental rations				
Items	R1	R2	R3	R4	±SE
Nutrients digestibility coefficients (%)					
DM	52.69	47.98	49.07	53.35	0.32
OM	56.21[c]	58.93[b]	63.57[a]	64.02[a]	1.03
CP	19.74[b]	22.52[b]	23.19[b]	35.61[a]	1.91
CF	101.2	95.93	75.31	124.60	8.76
EE	88.92	63.34	80.63	81.42	5.10
NFE	39.87	49.60	65.25	43.66	4.26
Nutritive value (%)					
TDN	66.98	67.10	69.27	71.51	0.77
DCP	11.58[b]	11.54[b]	11.50[c]	11.59[a]	0.01
DE (Mcal kg^{-1} DM)	2.953	2.958	3.054	3.153	0.34

[a-c]Means of different letters in the same row are significant different (p<0.05)

Table 5: Milk yield of buffalos fed the different experimental rations in the experiment period

	Experimental rations				
Items	R1	R2	R3	R4	±SE
Lactation period	120	120	120	120	
Milk production					
Milk yield (kg)	1048.83[c]	1494.40[b]	1550.00[a]	1572.50[a]	64.70
Milk yield (kg day^{-1})	8.56[c]	12.44[b]	12.91[a]	13.10[a]	0.56
7% FCM yield (kg day^{-1})	8.29[c]	12.26[b]	13.59[a]	14.11[a]	0.22

[a-c]Means of different letters in the same row are significant different (p<0.05)

So, the values of all parameters were slightly increased with increasing the replacement level of guar meal concentrate in the concentrate feed mixtures. This results agreement with those reported by Jahani-Azizabadi *et al.*[26] and Etman *et al.*[27] who reported that the increasing guar korma level in the experimental rations tended to significantly (p<0.05) increase DM, OM, CP, EE and CF digestibilities and there were significant (p<0.05) increase in TDN and DCP with increasing guar korma levels in the rations.

Second experiment

Effect of different levels of GKM on digestion coefficients and feeding values of the experimental ration: Table 4 clearly indicated that buffaloes fed on ration (R4) contain 75% GKM recorded higher digestibility value of DM, OM, CP, EE, percentages and feeding value expressed as TDN than those fed control ration (R1), R2 which contain 60% GKM and R3 which contain 45% GKM, differences were significant (p<0.05). Generally, results showed that there was liner increase in all digestibility nutrients of the tested ration with increasing GKM level of buffalos fed on (R2, R3 and R4) rations which recorded lower (p<0.05) values compared with the control ration (R1) however difference were significant and results are agreement with these reported by Asad *et al.*[28] and Salehpour *et al.*[4].

In addition, Shwerab *et al.*[29] showed higher digestibility coefficients and nutritive value with increasing dried distiller grain with solubles (DDGS) in sheep rations. The same results were obtained with Ibrahim *et al.*[30]. They found that using DDGS as a source of protein in rations formulation of buffalo calves increased digestibility coefficients of all nutrients and feeding values and agreement with Etman *et al.*[27] who found that using GKM as a source of protein in rations formulation of growing buffalo calves increased and improvement digestibility coefficients of all nutrients and feeding values.

Effect of using GKM at different levels on milk yield and its composition: Average milk yield expressed as actual milk yield are presented in Table 5. Data revealed that both actual milk and Fat Corrected Milk (FCM) yield increasing with increasing GKM levels in the rations being 8.29, 12.26, 13.59 and 14.11 kg day^{-1} versus with animal fed rations R1, R2, R3 and R4, respectively.

The results showed that increasing GKM levels from 0-75% had significant increase in both milk yield and 7% FCM yield but these results don’t agree with Salehpour *et al.*[4] who reported that in dairy cows, but no significant difference were found among FCM 4%.

On the other hand, there were significant (p<0.05) difference in fat, protein and SFN percentage in the end of experimental period (Table 6) being lower fat percentage and lower for the protein percentage and increased with increasing GKM levels compared with control ration (p<0.05) but these results agree with Salehpour *et al.*[4] who reported that in dairy cows, milk fat and protein percentage and yields were highest for 50% guar meal.

Table 6: Milk analysis of buffalos fed the different experimental rations during the experiment period

		Experimental rations				
Items	Time	R1	R2	R3	R4	±SE
Fat	0	6.7	6.75	6.43	6.66	0.06
	1	6.86[b]	6.91[b]	6.85[a]	6.90[a]	0.05
	2	6.99[b]	7.08[b]	7.50[a]	7.60[a]	0.09
Protein	0	3.62	3.65	3.57	3.59	0.02
	1	4.26[b]	4.28[b]	4.21[a]	4.21[a]	0.02
	2	4.35[c]	4.56[b]	4.82[a]	4.80[a]	0.064
Lactose	0	4.9	4.91	4.80	4.67	0.06
	1	5.4	5.41	5.32	5.27	0.04
	2	5.52	5.47	5.81	5.83	0.099
TS	0	15.95	16.01	15.75	14.28	0.42
	1	17.13	16.87	16.90	16.90	0.46
	2	17.38	17.50	17.60	17.79	0.13
SNF	0	9.25	9.26	9.08	8.29	0.24
	1	10.27	10.3	10.13	10.19	0.03
	2	10.47[c]	10.87[b]	10.81[ab]	11.19[a]	0.087

TS: Total solid, SNF: Solids not fat, [a-c]Means of different letters in the same row are significant different (p<0.05)

Table 7: Blood parameters of buffalos fed the different experimental rations during the experiment period

		Experimental rations				
Items	Time	R1	R2	R3	R4	±SE
Createin (g dL^{-1})	0	1.17	1.0867	1.23	1.01	0.02
	1	1.25[a]	1.11[a]	1.20[a]	0.80[b]	0.05
Urea-N (mg dL^{-1})	0	41	39.67	40.33	39.33	0.357
	1	41.67	40.00	39.67	36.00	0.82
ALT (IU L^{-1})	0	28.67	31.00	29.67	29.00	0.71
	1	29.33	30.33	28.67	28.00	0.81
AST (IU L^{-1})	0	30	32.00	32.33	28.67	0.68
	1	30	32.00	33.00	29.67	0.70
IgG	0	1083	1017.00	960.00	1183.00	47.40
	1	1166.67	1017.00	943.00	1167.00	50.40
IgM	0	142.3	162.00	150.00	154.70	7.26
	1	143	162.70	152.00	158.30	7.03
Cholesterol (g dL^{-1})	0	176	187.00	175.00	169.00	2.22
	1	179.67[a]	177.70[a]	159.3[b]	156.00[b]	3.38
Triglycerides (g dL^{-1})	0	130.7	140.30	124.7	118.30	2.71
	1	129.7[a]	131.00[a]	115.3[b]	106.00[b]	3.51
HDL	0	42	41.30	40.88	38.00	0.53
	1	45.33	45.33	42.33	45.33	0.62
LDL	0	107.8	117.60	109.17	107.30	1.68
	1	108.4[a]	106.13[a]	93.93[b]	89.4[b]	2.77
VLDL	0	26.13	28.06	24.93	23.66	0.54
	1	25.9[a]	26.20[a]	23.06[b]	21.2[b]	0.70

[a-c]Means of different letters in the same row are significant different (p<0.05)

Table 8: Economic efficiency of different experimental rations

	Experimental rations				
Items	R1	R2	R3	R4	±SE
Daily feed cost (LE day^{-1})	18.38[c]	20.36[b]	19.27[a]	19.29[a]	0.562
Price of milk (LE day^{-1})	69.92[c]	99.52[b]	103.32[a]	104.87[a]	0.350
Feed cost per kilogram milk yield	3.82[b]	4.90[a]	5.36[a]	5.44[a]	0.220
Relative economic efficiency (%)	100	128.25	140.28	142.20	

Economic efficiency based on local price of year 2015 of CFM, clover hay, rice straw and average selling of kilogram fresh milk and assuming that the relative economic efficiency of control ration equal 100%

However, there no significant difference in TS. These results are agreement with Shahbazi[7] who reported that milk fat (%) was increased for diets containing guar meals compared with control diet (p<0.05) but milk protein concentration was the lowest for diet contain 50% guar meal replaced by cotton seed meal. Also, Ibrahim *et al*.[30] found that using dried distiller grains with soluble (DDGS) as a source of protein in Friesian cows at the rate of 27% appeared higher milk yield or 7% CFM yield (11.56 kg compared to 11.29 kg) than control ration.

The improvement is due in the proportion of protein in milk to increase the proportion of protein and contains the most essential amino acids and this is consistent with Heo *et al*.[31] who reported that guar meal had 3.22% lysine, 0.79% cystine, 1.94% threonine, 3.62% arginine, 3.7% leucine, 0.73% methionine, 1.51% meth+cystine, 0.68% tryptophan, 2.31% isoleucine and 2.35% valine.

Milk lactose concentration was highest for R4 than R3, R1 and R2 but these results disagree with Shahbazi[7] who reported that no significant difference was found between milk lactose and calcium.

Effect of using GKM at different levels on blood parameters: Table 7 showed that the values of blood serum content are within the normal range and no significant differences between all of groups in the beginning and in the end of the experiment period also the values of blood serum content are within the normal range.

But there significant differences between all of groups in lipids profile which its decrease with increasing GKM level of buffaloes fed. These results are agreement with Ibrahim *et al*.[30], using DDGS as a source of protein in Friesian cows. They showed no effected on blood parameters.

Effect of using GKM at different levels on economic efficiency: Table 8 showed that the feed cost per kilogram milk yield was increased with increasing GKM levels. Corresponding values of daily feed cost for CFM yield were decreased with increasing GKM levels.

However, buffaloes fed on control ration (R2) appeared the worst feed conversion efficiency compared with other rations. The improvement in feed conversion efficiency for R4 group might be attributed mainly to the higher milk production (13.1 kg day^{-1}) and nutrients digestibility. These results agreed with those reported by Shahbazi[7]. Etman *et al*.[27] reported that with increasing GKM level in experimental rations increased economic efficiency.

CONCLUSION

Guar Korma Meal (GKM) could be used at the rate of 10% in CFM as a new source of protein in ration formulation of lactation buffalos. Increasing GKM at the rate of 75% in CFM in buffalo calves rations significantly increased nutrients digestibility, nutritive values as TDN and DCP, milk yield improved feed utilization efficiency, decreased feed cost per kilogram milk yield and increased both the revenue and economic efficiency. Moreover, using GKM in ration formulation of lactation buffalos had not affected liver and kidney functions and improves lipids profile which its decrease with increasing GKM level of buffaloes fed. However, further study is needed to determine the optimum level of GKM to be used in rations of lactation buffalos, to achieve maximum performance.

SIGNIFICANCE STATEMENTS

- Guar korma meal is a good new source of protein in animal rations
- Guar korma meal improves the productive performance of the Egyptian buffalos
- Guar korma meal improves the economic efficiency

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