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EFFECTS OF DIETARY SUBSTITUTION WITH GUAR KORMA MEAL (*Cyamposis tetragonoloba*) ON PRODUCTIVE PERFORMANCE, NUTRIENTS DIGESTIBILITY, CARCASS CHARACTERISTICS AND HEMATOLOGICAL BLOOD PICTURE OF GROWING RABBITS

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ABSTRACT

This study was conducted to evaluate the effect of feeding guar korma meal (GKM) as a partial replacement of soybean meal (SBM) on growth performance, nutrients digestibility coefficients, carcass characteristics and hematological blood parameters of growing rabbits. Two hundred and twenty-five New Zealand White rabbits about 6 weeks of age with 538g average body weight were randomly divided into five dietary groups with three replicates per each (15 rabbits). Rabbit were fed on diets containing none, 2.5, 5.0, 7.5, 10.0% GKM, respectively. Diets were formulated to be nearly iso-caloric and iso-nitrogenous.

Final weight and average daily gain of rabbits were significantly decreased with increasing the level of GKM to 7.5 and 10.0%, while feed intake and feed conversion ratio were not significantly affected. Also, increasing dietary GKM level beyond 5.0% of the diets resulted in significant further decreases in DM, OM, CP, CF and NDF digestibility coefficients and in the nutritive values of the diets in terms of digestible CP (DCP) and total digestible nutrients (TDN). Moreover, 5.0% GKM in the diet significantly improved carcass weight and dressing percentage. Hemoglobin, RBC's and WBC's were significantly higher in GKM groups compared to the control.

***Conclusively,** it is concluded that GKM can be included in growing rabbit diets at level 5.0% without adverse effects on growth performance, nutrients digestibility coefficients, carcass traits and hematological blood picture.*

Key words: Rabbits, guar korma meal, growth performance, nutrients digestibility, carcass characteristics, blood constituents.

The price of guar korma meal (GKM) is about half of soybean meal price. Guar is a multi-purpose plant, mostly used today as a source of galactomannan gum, which is used as a thickener and stabilizer in foods. The gum and the water-soluble resin extracted from the seeds are also used in other industries (Wong and Parmar 1997). Guar germ is one of industrial by-product that remains after separating galactomannan gum from the guar seed. It is considered a cheap protein source for the ruminants and poultry nutrition. It has a potential value as a feed to animals with a high protein content ranging between 45–55% as reported by Subramanian and Parpia (1975). The high content of the meal protein offers a good source of essential amino acids (Smith *et al*., 1959). Besides, approximately 88% of the nitrogen content in GKM was true protein (Verma and Mc-Nab 1984).

According to Salama *et al*., (2014) GKM contains 92.9% DM, 49.22% CP, 8.53% CF, 5.1% EE, 5. 63% Ash and 24.42% NFE, while Abu-Hafsa *et al*., (2015) concluded that GKM contained 88.59% DM, 43.87% CP, 6.11 % CF, 2.64 % EE, 5.89 % Ash and 41.49 % NFE.

Guar korma meal contains about 12-18 % gum residue (Lee *et al.,* 2005), which increases viscosity in the intestine that results in decreasing the nutrient absorption in gastrointestinal tract (Rainbird *et al.,* 1984), which in turn resulting in lower digestibility and growth performance (Lee *et al*., 2009). Also, GKM contains other types of antinutritional factors such as trypsin inhibitors, saponin, haemagglutinins, hydrocyanic acid and polyphenols have been identified (Gutierrez *et al*., 2007). However, anti-trypsic activity was found to be lower than in heat-treated soybean meal and therefore it is not the main cause of antinutritional effects in poultry (Lee *et al*., 2004). The large saponin content of guar seed (up to 13% DM) could have both anti-nutritional effect and a positive antimicrobial activity (Hassan *et al*., 2010). Also, the germ fraction of GKM contains energy, protein, methionine and phosphorus in higher levels than that in soybean meal (Kamran *et al*., 2002).

Salama *et al*., (2014) reported that GKM can replace up to 25% of the soybean meal in rabbit diets without adverse effects on growth performance, blood lipids or economical efficiency, however more high levels of GKM had deleterious effect on growth performance.

Therefore, this study was conducted to evaluate the effect of inclusion GKM in growing rabbit diets on growth performance, digestibility coefficient, carcass characteristics and hematological blood picture.

MATERIALS AND METHODS

This study was carried out at Sakha, Kafr El-Sheikh Government, Animal Production Research Institute, Ministry of Agriculture, Egypt.

Animals, rations and treatments:

A total of 225 New Zealand White rabbits of about 538g average body weight at 6 weeks-old were randomly divided into 5 groups, each group contain 3 replicates (15 rabbits). Growth trail was lasted for 8 consecutive weeks. Diets were formulated according to **NRC (1977)**. Rabbits were kept under the same management system. Diets and water offered *ad-libitum*. The chemical composition of the diets are presented in Table 1. Guar korma meal was used at the rate of none, 2.5, 5.0, 7.5 and 10.0% of the complete diets.

Growth performance:

Live body weight and feed intake were recorded weekly, while total weight gain, average daily gain, average daily feed intake and feed conversion ratio were calculated. Mortality number was recorded throughout the experimental period.

Digestibility trails and nutritive value of the diets:

At the end of the experiment, three rabbits of each experimental group were allocated to determine the digestibility coefficients of nutrients. The proximate chemical composition of the diets and excreta were done according to AOAC (1996).

The nutritive values of the experimental diets as DCP and TDN values were determined according to Cheeke (1987).

Carcass characteristics:

At termination of the growth experiment, three rabbits of each treatment were randomly taken and fasted for 12 hrs., then weighted and slaughtered according to the standard technique of Blasco and Ouhayoun (1996) to determine hot carcass, liver, kidney, heart, lungs, spleen, head, bile and dressing weight percentages. Also, intestinal impiety weight, length (cm) and intestinal thickness were determined, and the latter was calculated by divided intestinal weight (%) on intestinal length (cm).

$$\text{Intestinal thickness} = \frac{\text{Intestinal weight (\%)}}{\text{Intestinal length (cm)}} \times 100$$

Table 1: Ingredients and chemical composition of the experimental diets:

Ingredients	***Experimental diets***				
	Control	**2.5% GKM**	**5.0% GKM**	**7.5% GKM**	**10.0% GKM**
Yellow corn	11.40	11.50	12.20	12.60	13.00
Soybean Meal (44% CP)	17.65	14.85	11.80	8.90	6.00
Guar korma meal	0.00	2.50	5.00	7.50	10.00
Barely	20.00	20.00	20.00	20.00	20.00
Alfalfa hay	27.00	27.20	27.00	27.00	27.00
Wheat bran	17.50	17.50	17.50	17.50	17.50
Molasses	3.00	3.00	3.00	3.00	3.00
Dicalcium Phosphate.	1.90	1.90	1.95	1.95	1.95
NaCl	0.30	0.30	0.30	0.30	0.30
Vit & Min Premix	0.30	0.30	0.30	0.30	0.30
DL-Methionine	0.20	0.20	0.20	0.20	0.20
Limestone	0.75	0.75	0.75	0.75	0.75
Total	**100**	**100**	**100**	**100**	**100**
Calculated contents:					
Crude Protein %	17.14	17.18	17.12	17.13	17.13
Digestible Energy (DE) kcal/kg	2547.08	2543.05	2543.46	2542.45	2541.44
Crude Fiber %	12.75	12.62	12.55	12.53	12.52
Ether extract %	2.37	2.51	2.66	2.81	2.95
Calcium %	1.19	1.19	1.19	1.18	1.18
Total Phosphorus %	0.80	0.80	0.80	0.79	0.79
Lysine %	0.89	0.88	0.88	0.84	0.84
Methionine %	0.50	0.50	0.50	0.50	0.50
Met + Cys %	0.79	0.78	0.78	0.78	0.78

* **Each kilogram contains:** Vit A: 6000 IU; Vit D_3 2200 IU; Vit E: 11.9m g; Vit K3: 2mg; Vit B1: 1.0mg; Vit B2: 4.0mg; Vit B6: 1.5mg; Vit B12: 0.001mg; Pantothenic acid: 6.67mg; 50mg; Vit B5: 6.67mg; Vit B8: 0.07mg; B9: 1.67mg; Folic acid, 10mg; Choline chloride: 133.4mg; Zinc: 10mg; Manganese: 1.67mg; Iron: 22.3mg; Copper: 5mg; Iodine: 0.25mg; Selenium: 0.33mg.

Blood hematological:

At slaughtering, three blood samples from rabbits of each experiment were collected to determine hematological blood picture. Hemoglobin concentration (g/dl) was determined of fresh blood samples using hemoglobinometers as the method described by Tietz (1982). Red blood cells were counted on bright line hemocytometer using light microscope at 40×10 magnification. RBC'S were counted and WBC'S were counted using a light microscope at 10x10 magnification according to the method of Hawkeye and Dennett (1989). For WBC'S differentiation blood smears was

prepared according to Schalm *et al*., (1975). Percentage values for each types of cells were calculated.

Statistical Analysis:

Statistical analyses of the obtained results were carried out by GLM procedure of the SAS program **(SAS, 2001)** using one way ANOVA. Dietary treatments (T) were assigned as the main factor. The statistical model performed was as follow:

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

Where, Y_{ik} = An observation, μ = Overall mean, T_i = Effect of treatments (i = 1,2….5), e_{ik} = Random error

The differences between treatment means were separated using Duncan's (1955) new multiple range test at a probability level of 0.05.

RESULTS AND DISCUSSION

Growth performance:

Effect of dietary GKM level on live body weight and body weight gain are shown in Table 2. Final live body weight, total weight gain and average daily gain were significantly affected by dietary treatments. The high content GKM groups (7.5 and 10.0%) had the lowest final body weight and average daily gain. This results agree with Salama *et al*., (2014) who found that GKM replacing 25 and 50% of SBM significantly decrease average daily gain of the rabbits.

Results indicated that there were no significant effect of on total feed intake with incorporating GKM in the rabbit rations. These results are in disagreement with Salama *et al*., (2014), who found that total feed intake was decreased, on the other hand, Mohamed (2014) found that total feed intake was increased with using GKM as a feed ingredient. Feed conversion ratio was not significantly affected with incorporating GKM in the rations.

The mortality number of the experimental groups is shown in Table 2. The mortality number of the control group and the one contained 2.5% GKM were the same (3 rabbits). Group fed diet contained 5.0% GKM recorded no mortality. Group fed with 10.0% GKM recorded the highest mortality number (10 rabbits out of 45). In this connection, Verma and Mc-Nab (1982) reported that feeding relatively high levels of GKM increased mortality rate.

Table 2: Effect of dietary GKM level on growth performance of growing rabbits.

Items	Experimental groups					Pooled SE
	None	2.5% GKM	5.0% GKM	7.5% GKM	10.0% GKM	
Initial live weight (g)	544	529	542	535	539	17.6
Final live weight (g)	1633^{a}	1620^{ab}	1607^{ab}	1578^{b}	1574^{b}	28.9
Total weight gain (g)	1089^{a}	1091^{a}	1065^{ab}	1043^{b}	1034^{b}	32.4
Average daily gain (g)/day	17.3^{a}	17.3^{a}	16.9^{ab}	16.6^{b}	16.4^{b}	0.51
Total feed intake (g)	3159	3148	3139	3112	3113	22.2
Aver.DFI	50.0	49.9	49.8	49.4	49.4	0.36
FCR	2.95	2.90	2.99	3.03	3.05	0.09
Mortality no (out of 45)	3	3	0	6	10	

$^{a, b,...}$ Means within each row have no similar letters are significantly different ($P \leq 0.05$)
Feed conversion ratio (kg feed/kg gain): FCR, Average daily feed intake (g)/day: Aver.DFI

The negative effect of high inclusion levels of GKM in diets on performance was reported in rabbits (Salama *et al*., 2014), and in poultry (Kamran *el al*., 2002) and in Egyptian local strain chicks (Anshas) (Nasrala *et al*., 2015). The negative effects of adding high level of GKM on body weight, might be attributed to the presence of *β*-mannan, saponins and trypsin inhibitors (Hassan *et al*., 2007) which depress growth. Also, GKM contains residual galactomannan gum (Lee *et al*., 2005), which increase intestinal viscosity and decrease the nutrient absorption in gastrointestinal tract (Rainbird *et al.,* 1984), which lower growth performance (Lee *et al*., 2009). So, GKM could be used at levels not exceeds 5.0% of rabbit diet without adverse effect on growth performance.

Nutrient digestibility coefficients and nutritive values:

The effect of using GKM as a feed ingredient on nutrient digestibility coefficients and nutritive values in growing rabbit rations are presented in Table 3. The digestibly coefficient of DM, OM CP, CF and NFE were significantly decreased with increasing dietary GKM level. Also, total digestible nutrients (TDN) and digestible crude protein (DCP) were significantly decreased with increasing the level of GKM in the ration. There was no significant effect on EE digestible coefficient. This result is agree with Salama *et al*., (2014) who found that using GKM in rabbit ration up to 50% of SBM significantly decreased CP, CF, EE, NFE and TDN digestibility coefficient.

Table 3: Effect of dietary GKM level on nutrient digestibility coefficients and nutritive values of growing rabbits

Items	Experimental groups					Pooled SE
	None	2.5% GKM	5.0% GKM	7.5% GKM	10.0% GKM	
Nutrient digestibility coefficients						
DM	66.2[a]	66.0[a]	65.5[ab]	64.8[b]	64.6[b]	0.31
OM	77.9[a]	76.6[ab]	75.6[ab]	73.8[b]	73.9[b]	2.1
CP	75.5[a]	75.4[a]	73.3[ab]	72.6[ab]	70.6[b]	3.2
CF	55.9[a]	55.4[ab]	52.3[bc]	51.6[c]	49.2[c]	3.5
EE	61.3	61.1	61.4	61.5	61.4	2.5
NFE	81.0[a]	80.4[a]	80.5[a]	79.1[ab]	77.3[b]	1.1
Nutritive values						
DCP	13.1[a]	13.4[a]	12.6[b]	12.4[b]	12.1[b]	0.10
TDN	58.3[a]	58.6[a]	57.5[a]	55.6[b]	54.1[c]	0.40

[a, b....] Means within each row have no similar letters are significantly different ($P \leq 0.05$)

The reduction in digestion coefficients may be due to GKM contains residual gum (Lee *et al*., 2005), which increases viscosity in the intestine (Lee *et al*,. 2003 a,b) resulting in lower digestibility (Lee *et al*., 2009) and decreases the nutrient absorption in gastrointestinal tract (Rainbird *et al.*, 1984). Moreover, the residual gum increases the thickness of the unstirred water layer in rabbit jejunum, which reduced the rate of absorption of nutrients (Cerda *et al*. 1987).

Carcass characteristics:

Data of carcass characteristics are presented in Table 4. It is noted that rabbits received diet contained 5.0% GKM significantly had the highest carcass and dressing compared to those fed other dietary treatments.

Rabbits fed diet contain 10.0% GKM significantly had the highest liver percent as compared to other groups. The highest spleen, impiety intestinal weight values were recorded in rabbits received 5.0 and 7.5% GKM. The highest values of kidneys was recorded for rabbits fed on 2.5 and 5.0% GKM diets compared to the other treatments. Also, these two groups showed the highest intestinal length (cm) compared to other groups. However, percentages of heart and head were not affected by the dietary treatments. Intestinal thickness was not significantly affected by the dietary treatments. Kamran *et al*. (2002) reported a decreased in

Table 4: Effect of dietary GKM level on carcass characteristics (% of live body weight) of growing rabbits

Items	Experimental groups					MSE
	None	2.5% GKM	5.0% GKM	7.5% GKM	10.0% GKM	
Carcass weight (%)	39.47 [c]	40.43 [b]	43.98 [a]	41.25 [b]	40.88 [b]	1.64
Liver weight (%)	4.73 [b]	4.48 [b]	4.91 [b]	3.73 [c]	5.84 [a]	0.509
Kidneys weight (%)	0.75 [b]	1.02 [a]	0.92 [a]	0.75 [b]	0.68 [b]	0.111
Heart weight (%)	0.29	0.35	0.32	0.34	0.36	0.04
Lungs weight (%)	0.55	0.61	0.64	0.74	0.62	0.11
Spleen weight (%)	0.03 [b]	0.04 [b]	0.06 [a]	0.07 [a]	0.05 [b]	0.02
Head weight (%)	5.86	6.24	6.62	6.38	6.37	0.18
Bile weight (%)	0.02 [b]	0.03 [b]	0.06 [a]	0.04 [b]	0.02 [b]	0.01
Dressing weight (%)	45.24 [c]	46.27 [b]	50.13 [a]	46.07 [b]	47.76 [b]	1.45
Impiety intestinal weight (%)	0.75 [b]	0.71 [b]	0.91 [a]	0.51 [b]	0.87 [a]	0.12
Intestinal length (cm)	60.00 [b]	59.33 [b]	70.00 [a]	54.33 [b]	69.33 [a]	2.65

[a, b....] Means within each row have no similar letters are significantly different ($P \leq 0.05$)
Dressing %=[weight (g) of carcass+ liver + kidneys + heart/preslaughter (g)] x 100.

dressing percentage in birds fed on diets containing GKM. Mishra *et al*., (2013) found that there was a subtle effect of feeding GKM on carcass traits. Ahmed (1998) reported that there was a decrease in dressing percentage of the chicks with the increase in the levels of GKM in rations, where the chicks raised on 8% GKM diet showed higher liver and pancreas weights than those fed on 4 and 6% GKM. On the other hand, Mohammad and Kazem (2012) found that there was no significant effect due to GKM feeding on relative weights of carcass and giblets except abdominal fat, in the control and low guar meal groups, relative weights of carcass and giblets were better than other treatments. Lee *et al*., (2005) reported that use of low levels of guar meal in broiler's feeding resulted in higher carcass weight and breast weight than that fed with higher levels of GKM.

Increased intestinal viscosity induced by the galactomannan of GKM may be the reason for the longer GI tract (Smits *et al*., 1997). The high inclusion level content of GKM (7.5 and 10.0%) decreased intestinal weight and length. This is may be due to GKM contains residual gum (Lee *et al*., 2005), which increases the thickness of the unstirred water layer in rabbit jejunum, which reduced the rate of absorption of certain nutrients (Cerda *et al*. 1987).

Blood hematological:

Table 5 shown a significant (P≤0.05) increased in the hemoglobin concentration and the counts of erythrocytes (RBC's) and leukocytic (WBC's), and percentages of eosinophils, basophils and steff, but no significant differences were detected in each of lymphocytes, monocytes and neutrophil percentages due to included GKM to the diet. There were no significant effect on N/L ratio among the groups, but numerically N/L ratio increased in groups contained high GKM levels (7.5 and 10.0%), N/L ratio is a good index of response to a stressor (Mugnai *et al*., 2011). The differences among Hb concentration in rabbits on diets containing different levels of GKM were not significant.

Table 5: Effect of dietary GKM level on hematological blood picture of growing rabbits

Items	Experimental groups					Pooled SE
	None	2.5% GKM	5.0% GKM	7.5% GKM	10.0% GKM	
Hemoglobin(g/dl)	8.1^{b}	9.8^{a}	10.0^{a}	9.9^{a}	9.6^{a}	0.20
Red blood cells ($N\times10^{6}/cmm^{3}$)	3.1^{b}	3.8^{a}	4.0^{a}	3.7^{a}	3.7^{a}	0.06
White blood cells ($N\times10^{3}/cmm^{3}$)	6.95^{b}	7.32^{a}	7.99^{a}	7.67^{a}	7.68^{a}	0.51
Neutrophil (N) (%)	38.0	37.7	38.7	41.0	42.3	1.7
Lymphocytes (L) (%)	52.3	53.0	51.3	50.3	50.7	1.8
N/L ratio	73.1	72.0	77.7	81.8	84.0	5.6
Monocytes (%)	5.0	4.0	5.0	5.0	4.0	0.41
Eosinophils (%)	2.7^{b}	4.0^{a}	4.3^{a}	3.4^{a}	4.0^{a}	0.41
Basophils (%)	0.33^{c}	0.67^{ab}	0.67^{ab}	0.40^{b}	1.00^{a}	0.21
Steff (%)	0.45^{c}	0.67^{b}	0.71^{b}	1.00^{a}	1.00^{a}	0.26

$^{a, b....}$ Means within each row have no similar letters are significantly different (P ≤ 0.05)

Conclusively, from these results *it could be concluded that* Guar korma meal could be included in growing rabbit diets at rate of 5.0% of the diet without any adverse effect on growth performance, nutrient digestibility, carcass traits and hematological blood picture, so inclusion GKM in rabbit diets may be a good protein source to decrease the feed costs.

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تأثير إضافة مستويات مختلفة من كسب الجوار على الآداء الإنتاجى ومعامل الهضم وصفات الذبيحة وصورة الدم للأرانب النامية

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أجريت هذه الدراسة لتقييم الإحلال الجزئي لكسب الجوار بدلا من كسب فول الصويا في علائق الأرانب النامية على الأداء الإنتاجي وكفاءة الهضم وصفات الذبح وبعض قياسات الدم. تم توزيع مائتين وخمسة وعشرين أرانب نيوزيلاندى في عمر ٦ أسابيع بمتوسط وزن ٥٣٨ جرام بشكل عشوائي إلى خمس مجموعات لكل مجموعة ثلاثة مكررات كل مكرر به ١٥ أرنب. غذيت الأرانب علي علائق تحتوي على بنسب صفر، ٢,٥، ٥، ٧,٥، ١٠٪ كسب الجوار، علي التوالي. تحتوي جميع المجموعات علي نسب متساوية من الطاقة والبروتين على أساس المادة الجافة.

وكانت اهم النتائج المتحصل عليها انه يقل الوزن النهائي والوزن الناتج بصورة معنوية بزيادة مستوي كسب الجوار في العليقة إلي ٧,٥ و ١٠٪، بينما لم يتأثر كل من الغذاء المأكول ومعامل التحويل الغذائي بصورة معنوية. أيضاً زيادة مستوى كسب الجوار في العليقة لأكثر من ٥٪ أدي إلي نقص معامل هضم المادة الجافة والمادة العضوية والبروتين الخام والألياف الخام ومستخلص الازوت الخالي من النيتروجين كما ادي لنقص القيمة الغذائية لمعامل هضم البروتين ومجموع المركبات الغذائية المهضومة. بالاضافة إلي ذلك استخدام كسب الجوار بنسبة ٥٪ ادي إلي تحسن وزن الذبيحة وزيادة نسبة التصافي. كما زادت عدد كرات الدم الحمراء وكرات الدم البيضاء والهيموجلوبين في المجموعات التي تحتوى علي الجوار مقارنة بالمجموعة المقارنة.

التوصية: نستخلص من هذه النتائج أنه يمكن استخدام كسب الجوار في علائق الأرنب النامية بمستوى ٥٪ دون حدوث تأثيرات سلبية على الأداء الإنتاجي ومعامل هضم المواد الغذائية وصفات الذبيحة وصور الدم.