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INCLUSION OF GUAR KORMA MEAL (*Cyamposisteragonoloba*) IN GROWING RABBIT DIETS ON MEAT QUALITY AND SOME BLOOD CONSTITUENTS

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The current experiment was aimed to study the effect of feeding Guar Korma Meal (GKM) with different levels upon meat traits, meat lipid peroxidation, antioxidative status, thiobarbituric acid reactive substances (TBARS) and some blood constituents of growing rabbits. Two hundred and twenty-five, 42 days-old New Zealand White rabbits were distributed among 5 experimental groups. The control group fed the basal diet, while the other 4 groups fed diet containing 2.5, 5.0, 7.5, 10.0% GKM as replaced of soybean meal (SBM). All experimental treatments were lasted from 6 to 14 weeks of age. Animals were provided with feed and water ad-libitum. The obtain results showed:

1. *GKM could included in rabbit diets from weaning to slaughter age without negative effects on meat causing no alterations in lipid percentages and pH as compared to the control group.*
2. *Feeding on diets contained low levels (2.5 and 5.0%) of GKM increased (P<0.05) the protein percentage of meat, while the high levels (7.5 and 10.0%) reduced (P<0.05) the protein percentage as related to the control group.*
3. *Both tenderness and water holding capacity increased in all treated groups compared to control group.*
4. *There were no significant effect on the antioxidant status of meat due to inclusion 2.5 and 5.0% GKM in rabbit diets, on the other hand, the high levels of GKM (7.5 and 10.0%) decreased the antioxidant status of meat.*
5. *Rabbits fed diets contained 5.0% GKM had the highest total blood plasma protein, albumin and globulin, whereas the levels of triglycerides and cholesterol were decreased.*

Conclusively, *it could be concluded that rabbit diets included 5% of GKM had no negative effects on meat traits, antioxidant status, TBARS and blood plasma constituents as compared to control.*

Key words: Guar korma meal, meat quality, antioxidant status, thiobarbituric acid reactive substances, blood constituents.

Guar Korma Meal (GKM) is a relatively inexpensive high protein meal produced as a by-product of guar gum manufacture, with a protein content of approximately 380 g/kg (Nagpal *et al*., 1971). It is a mixture of germs and hulls at an approximate ratio of 25% germ to 75 % hull (Lee *et al*., 2004). Guar korma meal contains 92.9% DM, 49.22% CP, 8.53% CF, 5.1% EE, 5. 63% Ash and 24.42% NFE(Salama *et al*., 2014)

Guar korma meal contains 13-18% residual galactomannan gum (Nagpal *et al*., 1971 and Lee *et al*., 2004). The high amino acid content of the guar korma meal makes it a useful protein source (Mishra, *et al*., 2013). Approximately 88% of the nitrogen content in guar korma meal is true protein that makes it potentially useful as an ingredient for feed (Lee *et al*., 2005). Nadeem *et al.*, (2005) reported that amino acids availability ranged from 64 to 93% for residual guar korma meal, a highly viscous galactomannan polysaccharide, is probably the primary factor responsible for the reported ill effects (Verma and Mc-Nab 1982), although other antinutritional factors such as saponins (Curl *et al*., 1986) and polyphenols (Kaushal and Bhatia 1982) have been reported to cause liver, kidney, and intestinal damage in mice and rats (Diwan *et al*., 2000).

The residual gum present in the hull fraction (and to a lesser extent in the germ) is thought to be the main cause of the antinutritional effects of guar korma meal. The gum increases intestinal viscosity, preventing the correct mixing of digesta and their contact with digestive secretions. It also causes watery and sticky feces (Lee *et al*., 2009). The effects on animal performances of other antinutritional factors present in guar korma meal, notably anti-trypsin inhibitors, are less certain (Lee *et al*., 2004).

Therefore, the objective of this study is to determine the effect of using guar korma meal (GKM) as a feed ingredient on meat quality and some blood plasma constituents of growing rabbits.

MATERIALS AND METHODS

Two hundred and twenty-five, 42 days-old unsexed New zeland rabbits were randomly distributed among 5 experimental groups of 15

rabbits each. All rabbits were fed diets formulated according to NRC (1977). Rabbits were fed basal diets (the control group) without using of GKM (G_1). Groups G_2, G_3, G_4 and G_5 are fed diets contained GKM as a feed ingredient at levels of 2.5, 5.0, 7.5 and 10.0%, replaced from SBM, respectively. The chemical composition of the basal diets and other treatment were presented in Table 1.

Rabbits were raised in cages. All cages were provided with a manual feeder and clean fresh water was available continuously through an automatic system of nipple drinkers. The commercial pelleted diet was offered *ad-libitum*. Rabbits were kept under the same hygienic and environmental conditions during the experimental period.

On day 98 of age, three rabbits from each treatments were randomly taken and slaughtered. Blood samples were collected in clean heparinized tubes. Plasma was obtained by blood centrifugation at 3000 rpm for 20 min for analysis the blood biochemical parameters. After bleeding, rabbits were skinned, weighed and the carcasses were eviscerated. Samples of meat were taken individually from each slaughtered rabbit and chemical compositions and physical characteristics of meat were determined. Meat chemical composition was determined according to AOAC (1995).

Water-holding capacity (WHC) and meat tenderness were measured according to Volvoinskiaa and Kelman (1962). pH was measured by pH meter as described by Aitken *et al*., (1962). Two of hind legs of each rabbit carcasses were taken for analysis, then stored in the dark at 4ºC to determine the oxidative stability of muscle lipids (TBARS). Rate of lipid oxidation of refrigerated (4, 8 days) frozen muscles, as thiobarbituric acid-reactive substance (TBARS) test according to AOAC (1995). Malondialdehyde (MDA) was calculated by the thiobarbituric acid reactive substances manual method as described by Yagi (1998).

Three blood samples per each treatment groups were collected after slaughter in heparinized glass tubes and separated by centrifugation at 3000 rpm for 20 minutes. Blood plasma total protein, albumin, triglycerides, total cholesterol, calcium, creatinine, uric acid and liver enzymes activity (ALT & AST) were estimated by using commercial Kits. The globulin values were obtained by subtracting the values of albumin from the values of total proteins.

Data were statistically evaluated using General Linear Model (GLM) procedure of the statistical analysis system of SAS Institute (SAS 2001) using one way ANOVA. 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

Table 1: The ingredients and chemical composition of the basal diets**.**

Ingredients	Treatments groups				
	Control	**G_1 2.5% GKM**	**G_2 5% GKM**	**G_3 7.5%GKM**	**G_4 10% 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. *****	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.

Duncan's Multiple Range test (Duncan's 1955) was used to separate means when separation was relevant. Statistical significance was accepted at probability level of ($P<0.05$).

RESULTS AND DISCUSSION

The effect of inclusion GKM on growing rabbit diets on the meat traits are presented in Table 2. These results indicated that the percentages of dry matter, lipids, ash and pH in meat were not significantly changed with feeding GKM as a feed ingredient. Protein percentages were higher in

Table 2. Effect of using GKM as a feed ingredient on meat traits of growing rabbits.

Items	Experimental groups					MSE
	G_1 0% GKM	G_2 2.5% GKM	G_3 5% GKM	G_4 7.5% GKM	G_5 10% GKM	
Dry matter (%)	27.35	27.50	27.49	27.35	27.31	0.14
Protein (%)	21.64 [b]	22.05 [a]	22.01 [a]	21.94 [ab]	21.91 [ab]	0.19
Lipids (%)	4.01	4.03	3.98	3.92	3.94	0.04
Ash (%)	1.38	1.38	1.38	1.39	1.41	0.06
pH	6.01	6.02	5.97	6.04	6.06	0.17
Tenderness (cm2,g)	2.59 [b]	2.72 [a]	2.73 [a]	2.76 [a]	2.79 [a]	0.06
WHC (cm2/g)	5.33 [b]	5.77 [a]	5. 78 [a]	5. 92 [a]	5.87 [a]	0.01

a, b Means in each row with different superscripts are significantly different.
WHC water holding capacity;

the groups fed low levels of GKM (2.5 and 5.0%), and lower in the groups fed high levels of GKM (7.5 and 10%) than the control. This results is in agreement with Abu-Hafsa *et al*., (2015) who found that protein percentages in meat decreased in high GKM levels diets. The negative effects of adding high level of GKM on protein percentages might be attributed to that GKM contains 5-13% of dry matter triterpenoid guar saponin (Hassan *et al*., 2007) and 13-18% guar gum, residual galactomannan gum (Bakshi *et al*., 1964 and Lee *et al*., 2004).

Results shows that GKM increased ($P<0.05$) the tenderness and water holding capacity (WHC) of meat as related to the control group. This is may be due to that the residual gum in GKM increased intestinal viscosity (Lee *et al*., 2009), preventing the correct mixing of digesta and their contact with digestive secretions.

Effect of using GKM as a feed ingredient on the antioxidant status in rabbits muscle are shown in Table 3. The T-SOD activities of rabbit muscle of the treatment groups did not differ from the control group. There were no significantly different in MDA concentrations, GSH-Px activities and GSH contents of muscles among G_2 and G_3 groups and the control, whereas, G_4 and G_5 were significantly lower than the control. The high level of GKM decreased the antioxidant status in rabbits muscle, and this is may be due to that GKM contain trypsin inhibitor, saponin, haemagglutinins, hydrocyanic acid and polyphenols (Verma and Mc-Nab, 1982; Gutierrez *et al*., 2007), which increases intestinal viscosity, which reduces growth and feed efficiency (Burnett, 1966 and Lee *et al*., 2003).

Table 3. Effect of using GKM as a feed ingredient on the antioxidant status in growing rabbits muscle.

Items	Experimental groups					MSE
	G_1 0% GKM	G_2 2.5% GKM	G_3 5% GKM	G_4 7.5% GKM	G_5 10% GKM	
T-SOD (U/mg)	57.00	59.20	56.73	55.30	55.40	0.09
MDA (nmol/mg)	3.84^{a}	4.13^{a}	3.78^{a}	2.76^{b}	2.78^{b}	0.19
GSH-Px (U/mg)	119.80^{a}	120.00^{a}	118.40^{ab}	109.90^{b}	110.00^{b}	1.83
GSH (mg /g)	2.50^{ab}	3.36^{a}	3.27^{a}	1.90^{b}	1.69^{b}	0.001

a, b Means in each row with different superscripts are significantly different.
T-SOD: Total superoxide dismutase; MDA: Malonaldehyde; GSH-Px: Glutathione peroxidase; GSH: glutathione.

Using GKM as a feed ingredient did not influenced the formation of TBARS in meat stored for 4 and 8 days at 4°C (Table 4). The increase in the dietary GKM level from 0 to 10% did not affected oxidation of lipids expressed as production of TBARS, therefore, in rabbits the supra-nutritional GKM supply has a limited potential for increasing the oxidative stability of meat.

Table 4. Effect of using GKM as a feed ingredient on thiobarbituric acid reactive substances (TBARS) development in growing rabbit muscle

	TBARS refrigerated storage					
Day	G_1 0% GKM	G_2 2.5% GKM	G_3 5.0% GKM	G_4 7.5% GKM	G_5 10.0% GKM	MSE
0	4.58	5.55	3.33	5.27	4.16	0.01
4	13.59	10.40	8.88	12.07	9.15	0.011
8	17.06	10.68	9.43	14.01	11.37	0.002

a, b Means in each row with different superscripts are significantly different.

As shown in Table 5, adding the GKM to rabbits diet significantly ($P<0.05$) increased concentration of total protein, albumen, globulin and calcium compared with control group (G_1). However, the highest values of total protein, globulin and calcium were recorded in G_3 as compared to other treatments or control groups. On the other hand, adding GKM to rabbits

Table 5: Effect of using GKM as a feed ingredient on blood biochemical parameters of growing rabbits.

Items	Experimental groups					MES
	G_1 0% GKM	G_2 2.5% GKM	G_3 5.0% GKM	G_4 7.5% GKM	G_5 10.0% GKM	
Total protein (g/dl)	5.38^{c}	7.22^{b}	8.55^{a}	8.47^{a}	7.90^{ab}	1.069
Albumin (g/dl)	1.99^{b}	2.48^{a}	2.52^{a}	2.53^{a}	2.23^{a}	0.245
Globulin (g/dl)	3.39^{c}	4.74^{b}	6.03^{a}	5.94^{a}	5.67^{ab}	0.950
Triglycerides (mg/dl)	153.83	120.05	130.63	149.55	126.35	23.244
Total cholesterol (mg/dl)	81.66	68.05	77.28	78.66	66.44	12.703
Calcium (mg/dl)	3.13^{c}	3.92^{b}	5.52^{a}	3.94^{b}	4.35^{ab}	0.512
Creatinine (mg/dl)	3.08^{a}	1.64^{b}	1.58^{b}	1.88^{b}	2.36^{b}	0.615
Uric acid (mg/dl)	10.38^{a}	8.13^{b}	7.18^{b}	6.22^{b}	5.15^{c}	2.020
Activity of AST (IU/ml)	39.63	44.76	41.98	46.32	38.97	1.009
Activity of ALT (IU/ml)	33.18	29.52	31.87	28.08	27.45	2.001

a, b Means in each row with different superscripts are significantly different.

diets numerically decreased plasma triglycerides and total cholesterol especially G_2 and G_5 compared with other treatments and control, that mean GKM play important role in lipid metabolism in growing rabbit. Liver enzymes (AST and ALT) were not significantly affected with inclusion of different level of GKM in diets.

Adding GKM to rabbit diets decreased ($P \leq 0.05$) plasma concentrations of creatinine and uric acid compared to the control group, this indicated that GKM improved kidney function in treatment groups than control. Our results are in agreement with that of Mohammad and Kazem (2012) who found that the control and low GKM groups, had the lower plasma triglycerides and total cholesterol than other treatments groups, but conversely Ahmed (1998) reported that there were insignificant differences due to inclusion GKM in diets on serum total protein and cholesterol concentrations of broiler chicks. Shahbazi (2012) reported that level of cholesterol was increased. some studies have been reported that blood plasma cholesterol was decreased (Ou *et al*., 2001 and Abu-Hafsa *et al*., 2015), and this is may be due to that the high viscosity of GKM may

contribute to some beneficial physiological functions including decreasing plasma cholesterol (Ou *et al*., 2001).

Conclusively, it can be concluded that GKM can be used as a feed ingredient in low levels (2.5 and 5.0%) from weaning to slaughter age of rabbits without negative effects on tenderness and water holding capacity in meat did not change TBARS in meat. Also, causing no alterations in some blood plasma constituents as compared to high levels of GKM (7.5 and 10.0%) and the control group.

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تأثير إضافة مستويات مختلفة من كسب الجوار على جودة اللحم وبعض مكونات الدم للأرانب النامية

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** قسم بحوث تغذية الدواجن - معهد بحوث الانتاج الحيوانى – مركز البحوث الزراعية – الجيزة- مصر.

تهدف هذه الدراسة إلي معرفة تأثير تغذية الأرانب النامية علي عليقة تحتوي علي كسب الجوار على جودة اللحم ومحتوي اللحم من بيروكسيدات الليبيدات وحالة التأكسد و التفاعل مع حمض الثيوباربيوتريك TBARS وبعض مكونات الدم. وقد تم توزيع ٢٢٥ أرنب عمر ٤٢ يوم علي ٥ مجاميع. مجموعة المقارنة والتي غذيت علي العليقة القاعدية، في حين غذيت الأربع مجاميع الأخرى علي علائق تحتوى علي ٢,٥، ٥، ٧,٥، ١٠٪ كسب جوار بدلا من كسب الصويا. وقد غذيت الأرانب علي

هذه العلائق. من عمر ٦ أسابيع وحتى عمر ١٤ أسبوع. وكان إمداد الأرانب بالماء والعلائق بشكل دائم. **وقد أظهرت النتائج أن:**

١. من الممكن أن تحتوي علائق الأرانب من الفطام وحتى الذبح علي كسب الجوار بدون حدوث تأثير سيء علي اللحم حيث أنه لم يحدث تغيير في نسب الليبيدات ودرجة pH مقارنة بالمجموعة المقارنة.
٢. التغذية علي علائق منخفضة في كسب الجوار (٢,٥، ٥٪) أدي لزيادة نسبة البروتين باللحم مقارنة بالمجموعة المقارنة، في حين أن المجموعات المغذاة علي مستويات مرتفعة من كسب الجوار انخفض نسبة البروتين باللحم مقارنة بالمجموعة المقارنة.
٣. ارتفع معدل الطراوة ودرجة الاحتفاظ بالماء في كل المجاميع التي تحتوي علي كسب الجوار مقارنة بالمجموعة المقارنة.
٤. لا يوجد أي تأثير معنوي علي الحالة التأكسدية للحم الأرانب المغذاة علي عليقة تحتوي علي كسب الجوار بنسب (٢,٥، ٥٪). من ناحية اخري المستويات العالية من كسب الجوار (٧,٥، ١٠٪) تقلل من الحالة التأكسدية للحم.
٥. سجلت الأرانب المغذاة على ٥٪ كسب جوار أعلى تركيزات للبروتينات الكلية والألبيومين والجلوبيولين، بينما انخفضت الدهون الثلاثية والكوليسترول في بلازما الدم.

التوصية : لذلك يمكن أن نستنتج أن كسب الجوار يمكن استخدامه بعليقة الأرانب من الفطام وحتى عمر الذبح بنسبة تصل إلي ٥٪ بدون حدوث تأثيرات سيئة علي صفات اللحم وحالة التأكسد و TBARS وبعض مكونات بلازما الدم مقارنة بالمجموعة المقارنة.