Global Veterinaria 19 (1): 465-471, 2017
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2017.465.471

Gum Arabic as Prebiotic in Growing Rabbits Diet

[1]Kh. Amber, [1]Fatma M. Abd El-Nabi, [2]W.A. Morsy and [2]Shama H.A. Morsy

[1]Department of Poultry Production, Faculty of Agriculture, Kafrelsheikh University, Egypt
[2]Animal Production Research Institute, Agricultural Research Center,
Ministry of Agriculture, Dokki, Giza, Egypt

Abstract: This study aimed to evaluate the effect of supplementing Gum Arabic (GA) as prebiotic on growth performance, blood parameters, carcass characteristics and economic efficiency of growing rabbits. Eighty APRI line rabbits were assigned equally into four experimental groups; each group contained 10 males and 10 females, 5 weeks old with an average body weight of 612±5.44 g. The first group was fed *ad libitum* a commercial pelleted diet and kept untreated and served as control. The other three groups were fed experimental diet with 0.5, 1.0 and 1.5% Gum Arabic for 8 weeks (from 5 to 13 weeks of age). All diets were iso-nitrogenous and iso-caloric on the basis of digestible energy and contained similar levels of micro elements. The results showed that rabbits fed 1.0 (2189.8 g) and 1.5% (2212.5 g) GA diets had the highest ($P<0.0001$) final body weight compared to control treatment (2075.8 g). Feed conversion ratio (g/g) was improved ($P<0.001$) with increasing GA level in diets. Rabbits received 1.0 (3.065) and 1.5 % (3.015) GA in diet had lower feed conversion ratio compared to control treatment (3.397 g FI/g DWG). Carcass percentage significantly increased ($P<0.05$) with supplementing GA in diets. Rabbits fed diet containing 1.0 (50.3%) and 1.5% (50.5%) GA recorded the highest ($P<0.05$) carcass weight percentage control diet recorded the lowest value (47.5%). Serum cholesterol ($P<0.01$) and triglyceride ($P<0.001$) decreased by increasing GA level in diet. Rabbits received 1.0% (112.6%) GA diet 1.5% GA diet (110.9%), attained the best relative revenue but the control group attained only 100%. Conclusively, Gum Arabic could be successfully incorporated in diet of growing rabbits up to 1.5%. However, GA 1.0% improved production performance and some physiological indices through alleviate post weaning stress with high profitability under Egyptian environmental conditions.

Key words: Rabbits · Gum Arabic · Carcass · Blood Parameters · Growth Performance

INTRODUCTION

Commercial rabbit production has been gaining much attention in recent years due to their high prolificacy, rapid growth rate, small body size and high meat yields. Rabbits can convert 20% of the protein they eat into edible meat, which is (8-12%) higher than beef [1]. It is well known that feed additives can be used safely in rabbit ration to improve their performance. Feed additives added to diets in very small quantities with the objective of obtaining some special effect. At around 18 days of age the suckling rabbit begins to eat solid food and decrease its milk intake and the caecum and colon develop faster than the rest of the digestive tract. Young rabbits start to consume significant amounts of solid feed and preference can be given from the age of 3 weeks. A diet more adapted to their requirements has been shown not only promote higher weaning weights, but also favor their intestinal health [2, 3]. Weaning as a crucial period for all young animals is associated with a lot of stress and increased sensitivity to diseases. Prevention or control of both pre-weaning and post weaning enteric diseases was shown to be achieved by the incorporation of antibiotics in the feed of the young animals [4, 5].

Prebiotics are possible alternative to antibiotics. Prebiotics can be either directly extracted from natural sources (plants, yeasts, milk), or be produced by partial acid or enzymatic hydrolysis of polysaccharides or by transglycosylation reactions [6]. Prebiotics was found to improve daily gain, feed conversion ratio and/or health status of farm animals but their effect tends to vary with the oligosaccharide and the conditions of utilization [7, 8].

Corresponding Author: Wael Awad, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt. E-mail: wawad74@yahoo.com.

Gum Arabic (GA) is a dried exudate obtained from the branches and stems of Acacia senegal and closely related species [9]. It is a complex polysaccharide of high molecular weight which contains neutral sugars as rhamnose, arabinose and galactose; in addition to acids such as glucuronic acid and also minerals such as calcium, magnesium, potassium, sodium and phosphorous [10, 11]. Arabic Gum has wide industrial uses as a stabilizer, thickening agent and emulsifier, mainly in the food industry also in the textile, pottery, lithography, cosmetics and pharmaceutical industries [12]. In folk medicine, GA has been reported to be used internally for the treatment of inflammation of the intestinal mucosa and externally to cover inflamed surfaces [13]. Some recent reports have claimed that GA possesses anti-oxidant, nephro-protecting effects [14]. El-khier *et al.* [15] found that gum Arabic (1%) increased feed intake and egg shell thickness by 5.98 and 31.58% respectively as compared to the control and also significantly increased albumin, Ca and P in blood serum and egg yolk. Moreover, Abd-Razig *et al.* [16] observed that the performance (Body weight egg and daily egg production) of laying hens showed significant increase with increasing dietary levels of Gum Arabic (0.1, 0.3, 0.5 and 1%). Therefore, the aim of this study was to investigate the effect of supplementing Gum Arabic as prebiotic on growth performance, some blood parameters, carcass characteristics and economic efficiency of growing rabbits.

MATERIALS AND METHODS

This study was carried out at the Rabbits Farm of Sakha Station, Animal Production Research Institute, Agriculture Research Center, Egypt.

Table 1: Composition and chemical analysis of experimental diets

		Gum Arabic level (%)		
Ingredient	Control	0.5	1.0	1.5
Berseem hay	30.05	30.2	30.5	30.8
Barley grain	24.6	24.5	24.4	24.2
Soybean meal (44% CP)	17.5	17.6	17.9	18.1
Wheat brain	21.5	20.8	19.8	19
Arabic Gum	0	0.5	1	1.5
Can Molasses	3	3	3	3
Limestone	0.95	0.9	0.9	0.8
Di-calcium phosphate	1.6	1.7	1.7	1.8
DL-Methionine	0.2	0.2	0.2	0.2
Sodium chloride	0.3	0.3	0.3	0.3
Mineral-vitamin premix(1)	0.3	0.3	0.3	0.3
Total	100	100	100	100
Chemical analysis (% as DM):				
Dry matter (%)	85.8	85.8	85.8	85.8
Ash (%)	5.81	5.81	5.82	5.83
Crude protein (%)	17.36	17.32	17.34	17.33
Ether extract (%)	1.61	1.58	1.55	1.53
Crude fiber (%)	13.45	13.43	13.44	13.46
Starch (%)(2)	16.6	16.5	16.2	16.0
Lysine (%)(2)	0.86	0.86	0.86	0.87
Methionine (%)(2)	0.45	0.45	0.45	0.45
Calcium (%)(2)	1.24	1.25	1.25	1.24
Phosphorus (%)(2)	0.81	0.82	0.81	0.82
Digestible energy (kcal/ kg)(2)	2412	2412	2414	2414

(1) One kilogram of mineral–vitamin premix provided: Vitamin A, 150, 000 UI; Vitamin E, 100 mg; Vitamin K3, 21mg; Vitamin B1, 10 mg; VitaminB2, 40mg; Vitamin B6, 15mg; Pantothenic acid, 100 mg; Vitamin B12, 0.1mg; Niacin, 200 mg; Folic acid, 10mg; Biotin, 0.5mg; Choline chloride, 5000 mg; Fe, 0.3mg; Mn, 600 mg; Cu, 50 mg; Co, 2 mg; Se, 1mg; and Zn, 450mg.

(2) Calculated according to De Blas and Mateos [18]

Eighty APRI line rabbits (Egyptian line selected for litter weight at weaning according to Abou Khadiga *et al.* [17] were assigned randomly into four equal experimental groups of 20 rabbits each (10 males +10 females) of 5 weeks of age with an average live body weight of 612±5.44 g. Rabbits were similar, with respect to body weight and sex. Four experimental diets were formulated to cover all essential nutrient requirements for growing rabbit according to De Blas and Mateos [18]. The first group was fed *ad libitum* a commercial pelleted diet and served as a control, while the other 3 groups were fed experimental diets with three levels of Gum Arabic (0.5, 1.0 and 1.5% of the diet). All diets were nearly iso-nitrogenous and iso-caloric on the basis of digestible energy and contained similar levels of micro elements. The formulation and nutrient composition of these diets (Table 1); Chemical composition of Arabic Gum is 87% DM, 3.71% CP, 0.43% EE, 2.73% ash and 3000 kcal/ kg DE. All rabbits were kept under the same managerial conditions. Feed and water were offered *ad libitum* throughout the experimental period (5 to 13 weeks of age). Live body weight, feed intake and number of dead rabbits were recorded. Daily weight gain, feed conversion rate and mortality rate were calculated. From this data economic efficiency was calculated according to Raya *et al.* [19]. Also, relative growth rate and performance index were calculated on a group basis:

Relative growth rate = [(W2 - W1) x100]/ [1/2 (W2+W1)]

where as: W1= the initial weight and W2 = the final body weight

Performance index = (Final live body weight (kg)/ feed conversion ratio) x 100 [20]

At the end of growing period (13 weeks of age), six rabbits (3 males + 3 females) of 13 weeks age were taken randomly from each treatment, fasted for 12 hrs, weighed and slaughtered to estimate some of carcass traits according to Blasco *et al.* [21]. Carcass parts were presented as a percent of live body weight. Blood samples were taken from 6 rabbits of each treatment to determine some blood constituents.

Blood serum total protein, albumin, glucose, triglycerides, cholesterol, AST (Aspartate aminotransferase), ALT (Alanine aminotransferase), creatinine and urea were colorimetrically determined by using commercial kits (Bio-Diagonosis Co., Cairo, Egypt), following the same steps as described by manufacturers. Globulin values were calculated by difference. Chemical analysis was carried out for diets according to A.O.A.C. [22] for ash, DM, CP, CF and EE.

Data of the growth performance, blood and carcass traits were statistically analyzed using the General linear Model Program of SAS [23]. Duncan's multiple range test was performed [24] to detect significant differences among means.

RESULTS AND DISCUSSION

Growth Performance: The effect of dietary Gum Arabic on growth performance from 5 to 13 weeks of age is presented in Table 2. It is clearly shown that no significant differences in body weight was detected in the initial body weight (5 weeks of age). From 6 weeks of age and up to the end of the growing period at 13 weeks of age rabbits fed 1.0 and 1.5% GA diets had the highest final body weight, while those received control treatment had the lowest final body weight in the whole growing period (2189.8 and 2212.5 g *vs.* 2075.8 g, $P<0.0001$, respectively). As for daily weight gain, there was a significant increase of body weight with supplementing GA in diets. Rabbits received 1.0 and 1.5% GA diets had higher ($P<0.001$) daily weight gain compared to those received control treatment (28.2 and 28.6 g *vs.* 25.8 g; $P<0.001$, respectively). Generally, it could be observed that relative growth rate increased significantly by increasing GA level in diets. The highest value of relative growth rate was recorded for rabbits received 1.5% GA diet, while the lowest value was observed for control treatment (113.3% *vs.* 108.4%; $P<0.001$).

Results reported here are in agreement with data obtained by Samia Tagldin *et al.* [25] who reported that New Zealand rabbits fed on the diet included 5% Gum Arabic showed higher body weight throughout the experimental period. Moreover, Bovera *et al.* [26] observed that concentration of 1.0 g/kg MOS in growing rabbit diet, could improve growth performance.

Dietary Gum Arabic level had no significant differences in feed intake (g/ d) during the experimental period. Feed conversion ratio (g/ g) was significantly improved with increasing GA level in diets. Experimental treatment received 1.0 and 1.5 GA in diets had lower feed conversion ratio as compared with those received control treatment (3.065 and 3.015 *vs.* 3.397 g FI/ g DWG; $P<0.001$, respectively) as shown in Table 2. Rabbits received 1.0 and 1.5% GA diets recorded the best performance index,

Table 2: Effect of dietary Gum Arabic on growth performance and carcass traits of growing APRI-line rabbits from 5 to 13 wks of age

		Gum Arabic level (%)				
Parameters	Control	0.5	1.0	1.5	SEM	Sig.
Initial body weight (g)	611.2	612.7	612.0	612.8	5.437	NS
Final body weight (g)	2075.8^{c}	2140.5^{b}	2189.8^{a}	2212.5^{a}	9.304	***
Daily weight gain (g)	25.8^{c}	27.3^{b}	28.2^{a}	28.6^{a}	0.175	***
Feed intake (g/d)	87.8	86.7	86.4	86.1	0.752	NS
Feed conversion ratio (g/ g)	3.397^{a}	3.181^{b}	3.065^{c}	3.015^{c}	0.026	***
Relative growth rate	108.4^{c}	111.0^{b}	112.7^{ab}	113.3^{a}	0.595	***
Performance index (%)	60.6^{c}	67.5^{b}	71.5^{a}	73.5^{a}	0.779	***
Mortality rate (%)(1)	15^{a}	10^{b}	10^{b}	5^{c}	-	-
Carcass traits:						
Carcass weight (%)	47.5^{b}	48.7^{ab}	50.3^{a}	50.5^{a}	0.777	*
Giblets Part (%)	4.11^{b}	4.27^{ab}	4.36^{ab}	4.72^{a}	0.163	*
Abdominal fat (%)	0.72^{a}	0.49^{b}	0.35^{c}	0.27^{c}	0.032	***
Gastrointestinal tract (%)	25.4^{a}	24.6^{ab}	23.6^{b}	23.1^{b}	0.496	*

SEM = Standard error of means, Sig.= Significance, *** : Significant at 0.1% level of probability, ** : Significant at 1% level of probability, * : Significant at 5% level of probability, NS: Non-significant.

a, b, …e, Means in the same row with different superscripts are significantly different (P<0.05). (1) Chi-square test

Table 3: Effect of dietary Gum Arabic on some blood parameters of APRI-line rabbits

		Gum Arabic level (%)				
Items	Control	0.5	1.0	1.5	SEM	Sig.
Total protein (g /dl)	5.48^{c}	5.98^{b}	6.26^{ab}	6.34^{a}	0.113	**
Albumin (g /dl)	3.50^{c}	3.76^{b}	3.90^{a}	3.93^{a}	0.038	***
Globulin (g /dl)	1.98^{b}	2.22^{ab}	2.37^{a}	2.41^{a}	0.113	*
Cholesterol (mg /dl)	32.5^{a}	30.7^{a}	28.5^{b}	27.8^{b}	0.608	**
Triglyceride (mg/ dl)	93.6^{a}	87.3^{b}	80.0^{c}	78.1^{c}	1.033	***
Glucose (mg/ dl)	114.6^{b}	119.9^{ab}	127.3^{a}	129.7^{a}	2.819	*
Creatinine (mg/ dl)	0.483	0.513	0.507	0.493	0.034	NS
Urea (mg/ dl)	47.7	45.2	44.2	45.4	2.441	NS
AST (U/L)	37.7	37.2	35.9	36.6	2.585	NS
ALT (U/L)	34.3	34.7	35.3	34.7	1.453	NS

SEM = Standard error of means, Sig.= Significance, **: Significant at 1% level of probability, * : Significant at 5% level of probability, NS: Non-significant

a, b, ….e, Means in the same row with different superscripts are significantly different (P<0.05)

while those received control treatment had the worst value (71.5 and 73.5% *vs*. 60.6%; P<0.001, respectively). The increase in performance index refers to the increase in final body weight and the decrease in the feed conversion ratio.

The principle effects of prebiotics have been reviewed by Cummings and Macfarlane [27] and included improvement of calcium and magnesium absorption, production of short-chain fatty acids and selective increases in the population of lactate producing bacteria like *Lactobacillus* and *Bifidobacterium.* It has been shown that increased lactate concentration often decreases intestine pH and is a potent anti-microbial substance to several pathogenic species such as *E. coli* [28]. Thus, prebiotic helps to balance the intestinal microflora of rabbit, consequently improved utilization of protein and energy in diet and increased feed intake leading to better performance criteria. This is in accordance with data observed by Nasir *et al*. [29] who found that GA treatment did not significantly modify food intake but increased fecal dry weight. GA treatment resulted in significant reduction of the urine volume despite constant fluid intake.

Using of GA in growing rabbits diet decreased mortality rate by 44.4% (As average), as compared with control diet. Rabbits received 1.5% GA diet had significantly the lowest mortality during the experimental period, as compared with those received the control treatment (5% vs. 15%, respectively). This reduction in mortality rate may be attributed to GA has been shown to displays antimicrobial activity and to stimulate intestinal absorption thus counteracting diarrhea [30].

Table 4: Effect of dietary Gum Arabic on economical traits of APRI-line rabbits at 13 wks of age

		Gum Arabic level (%)		
Items	Control	0.5	1.0	1.5
Average feed intake (kg /head)	4.915	4.856	4.836	4.819
Price /kg diet (L.E.)	4.380	4.560	4.750	4.930
Total feed cost (L.E.)	21.53	22.14	22.97	23.76
Average weight gain (kg/head)	1.447	1.528	1.578	1.600
Selling price (L.E.)(1)	36.17	38.20	39.44	39.99
Net revenue (L.E.)(2)	14.64	16.05	16.48	16.24
Relative revenue (%)	100	109.6	112.6	110.9

- Other conditions like management are fixed.

- Ingredients price (L.E. per ton) at 2016 were: 4600 barley; 2600 berseem hay; 4000 wheat bran; 7500 soybean meal (44%) ; 250 limestone; 9000 premix; 60000 methionine; 1000 di-calcium phosphate; 1000 molasses; 1000 salt; 20000 Bio-mos; 30000 Bio-plus; 40000 Gum Arabic.

- Adding 100 L.E. /ton for pelliting.

(1) Price of kg live body weight was 25 L.E.

(2) Net revenue = Selling price – total feed cost

Carcass Traits: Carcass percentage (Table 2) was significantly increased ($P<0.05$) by supplementing GA in diets. Rabbits diets containing 1.0 and 1.5% GA had the highest carcass weight percentage; while those fed control diet had the lowest value (50.3 and 50.5% *vs.* 47.5%, $P<0.05$, respectively). Giblets percentage significantly increased by increasing GA level in diets. Gastrointestinal tract and abdominal fat percentages were decreased ($P<0.001$, $P<0.05$, respectively) by increasing GA level in diets. The lower gastrointestinal tract percentage could be explained by the increase of the carcass percentage. This was also observed by Mohamed *et al.* [31] who reported that the highest abdominal fat percentage value was recorded for birds fed the control diet (2.21%) while the lowest value was recorded for birds fed the mannan oligosaccharide (MOS) supplemented diet (1.78%). No clear mechanisms have been reported responsible for the reduction of lipid synthesis by prebiotics and herb oligosaccharides. It might in part be due to increasing beneficial bacteria such as *Lactobacillus* that decrease the activity of acetyl-CoA carboxylase, which is the rate-limiting enzyme in fatty acids synthesis [32].

Some Blood Parameters: Serum total protein, albumin and globulin (Table 3) significantly increased with increasing GA level in the diet. This might be due to the higher digestibility of CP in these diets [33]. The same trend was observed for serum glucose, which increased ($P<0.05$) when supplementing GA in diets. This increase in serum glucose may be attributed to GA treatment significantly reduced urinary glucose excretion, Na+ excretion and urinary volume [34]. Serum cholesterol and triglyceride significantly decreased ($P<0.01$ & $P<0.001$, respectively) by increasing GA level in diet. The significant reduction in serum cholesterol of growing rabbits fed probiotic supplemented diet could be attributed to the reduced absorption and/or synthesis of cholesterol in the gastro-intestinal tract by probiotic supplementation [35, 36]. Also, there were no significant differences among treatments in liver function enzymes (AST, aspartate aminotransferase and ALT, alanine aminotransferase) or kidney function (Urea and creatinine). This is in agreement with Samia Tagldin *et al.* [25] who found that rabbits fed on the diet included 5% Gum Arabic showed significantly higher plasma glucose ($P = 0.07$). Moreover, Ali *et al.* [30] found that GA has been shown to decrease plasma cholesterol concentrations in rats.

Economic Efficiency: Economical traits (Table 4); such as total feed cost was found to increase by supplementing GA in diets, as a result of increasing feed intake. Also, selling price was increased by supplementing GA in diets. This increase in selling price may due to increase average weight gain (kg /head). The same trend was found in the net revenue and relative revenue, which were increased, as supplementing GA in diets. The best value of relative revenue was found in the rabbits received 1.0% GA diet (112.6%), followed by those received 1.5% GA diet (110.9%), but the poorest value was recorded for control group (100%). This in agreement with Abu El-Hassan [37] who indicated that feeding dietary 0.5% Gum Arabic improved economical efficiency and relative economic efficiency values of laying hens, as compared with control group.

CONCLUSIONS

Conclusively, the present study suggested that Gum Arabic could be successfully incorporated into the diet of growing rabbits up to 1.5%. However, Arabic Gum 1.0% improved production performance and some physiological indices through alleviate post weaning stress with high profitability, under Egyptian environmental conditions.

REFERENCES

1. Basavaraj, M., V. Nagabhushana, N. Prakash, M.M. Appannavar, P. Wagmare and S. Mallikarjunappa, 2011. Effect of Dietary Supplementation of Curcuma Longa on the Biochemical Profile and Meat Characteristics of Broiler Rabbits under Summer Stress. Veterinary World, 4(1): 15-18.
2. Xiccato, G., A. Trocino and N. Nicodemus, 2006. Nutrition of the young and growing rabbit: a comparative approach with the doe. In: Maertens, L. and Coudert, P. (eds) Recent Advances in Rabbit Sciences. COST and ILVO, Melle, Belgium, pp: 239-246.
3. Gidenne, T., J. De Dapper, A. Lapanouse and P. Aymard, 2007. Adaption du lapereau a un aliment fibreux distribue avant sevrage: comportement d'ingestion, croissance et sante digestive. In: Proceedings 12èmes Journées Recherche Cunicole, Le Mans. ITAVI, Paris, France, pp: 109-112.
4. Kritas, S.K. and R.B. Morrison, 2005. Evaluation of probiotics as a substitute for antibiotics in a large pig nursery. Vet. Rec., 2, 156(14): 447-448.
5. Berge, A.C., P. Lindeque, D.A. Moore and W.M. Sischo, 2005. A clinical trial evaluating prophylactic and therapeutic antibiotic use on health and performance of preweaned calves. J. Dairy Sci., 88(6): 2166-2177.
6. Oku, T., 1996. Oligosaccharides with beneficial health effects: a Japanese perspective. Nutr. Rev., 54(11): s59-s66.
7. Patterson, J.A. and K.M. Burkholder, 2003. Prebiotic feed additives: rationale and use in pigs. In Proc.: 9th Intern. Symp. on Digestive Physiology in Pigs, Banff, AB, Canada, pp: 319-331.
8. Lan, Y., S. Verstegen, S. Tamminga and B.A. Williams, 2005. The role of the commensal gut microbial community in broiler chickens. World´s Poultry Sci. J., 61(3): 95-104.
9. FAO, 1999. Food and Agriculture Organization of the United Nations. Gum Arabic. Food and Nutrition Paper, No. 52, addendum 7.
10. Osman, M.E., 1993. Fractionation and characterization of gum from acacia Senegal. In PhD thesis in chemistry and applied chemistry. Salford, pp: 11-24.
11. Tylor, V.E., L.R. Brady and J.E. Robbers, 1981. Carbohydrates and related compounds in: Pharmacognosy. 8th edition, (Ch 2): 45-46.
12. Verbeken, D., S. Dierckx and K. Dewettinck, 2003. Exudate gums: occurrence, production and applications. Appl. Microbiol. Biotechnol., 63(1): 10-21.
13. Gamal El-Din, A.M., A.M. Mostafa, O.A. Al-Shabanah, A.M. Al-Bekairi and M.N. Nagi, 2003. Protective effect of arabic gum against acetaminophen-induced hepatotoxicity in mice. Pharma. Res., 48: 631-635.
14. Ali, A.A., K.E. Ali, A. Fadlalla and K.E. Khalid, 2008. The effects of GA oral treatment on the metabolic profile of chronic renal failure patients under regular haemodialysis in Central Sudan. Nat. Prod Res., 22: 12-21.
15. El- Khier, M.K.S., K.E.A. Ishag, A. Abu Elgasim, A.A. Yagoub and Abu Baker, 2010. Supplementing laying hen diet with Gum Arabic (Acacia sengal).Effect on egg production, shell thickness and yolk content of cholesterol, calcium and phosphorus. Asian Journal of Poultry Science, 4(3): 143-148.
16. Abd- Razig, N.M., M.K. Sabahelkhier and O.F. Idris, 2010. Effect of Gum Arabic (Acacia sengal) on lipid profile and performance of laying Hens. Journal of Applied Bio. Sciences, 32: 2002-2007.
17. Abou Khadiga, G., Y.M.K. Youssef, K. Saleh, R.Y. Nofal and M. Baselga, 2010. Genetic trend in selection for litter weight in two maternal lines of rabbits in Egypt. World Rabbit Sci., 18: 27-32.
18. De Blas, J.C. and G.G. Mateos, 1998. Feed Formulation. In: De Blas C., Wiseman J. (Eds). The Nutrition of the Rabbit. CABI Publishing. CAB International, Wallingford Oxon, UK, pp: 241-253.
19. Raya, A.H., A.M. Abbas and M.A.A. Hussein, 1991. Comparative studies on the efficiency of some plant protein sources to replace soybean meal in rations for broiler chicks performance and economic efficiency. J. Agric. Sci., Mansoura Univ., 16: 2514-2527.
20. North, M.O., 1981. Commercial Chicken. Production Annual. 2nd Edition, Production 6 Ed. Interstate Printers and Publishers. INC., USA.

21. Blasco, A., J. Ouhayoun and G. Masoero, 1993. Hormonization of criteria and terminology in rabbit meat research. World Rabbit Sci., 1(1): 1-10.
22. A.O.A.C., 2005. Association of Official Analytical Chemists. Official methods of analysis. 18th Ed. Published by the AOAC, Washington, D. C., USA.
23. SAS Institute, Inc., 2000. SAS User's guide: Statistics. SAS Inst. Inc., Cary, NC.
24. Duncan, D.B., 1955. Multiple range and multiple F-Test, Biometrics, 11: 1-42.
25. Samia Tageldin, K.F. Elkhalifa and Khadija Abbas, 2006. The effects of Gum Arabic on body weight and some blood elements in New Zealand cross California and Baladi rabbits. Pakistan Journal of Biological Sciences, 9(1): 96-98.
26. Bovera, F., S. Nizza, S. Marono, K. Mallardo, G. Piccolo, R. Tudisco, L. De Martino and A. Nizza, 2010. Effect of mannan oligosaccharides on rabbit performance, digestibility and rectal Bacterial anaerobic populations during an episode of epizootic rabbit enteropathy. World Rabbit Science, 18: 9-16.
27. Cummings, J.H. and G.T. Macfarlane, 2002. Gastrointestinal effects of prebiotics. British Journal of Nutrition, 87S: 145-151.
28. Samli, H.E., N. Senkoylu, F. Koc, M. Kanter and A. Agma, 2007. Effects of Enterococcus faecium and dried whey on broiler performance, gut histomorphology and intestinal microbiota. Archive of Animal Nutrition, 61: 42- 49.
29. Nasir, O., F. Artunc, A. Saeed, M.A. Kambal, H. Kalbacher, D. Sandulache, K. M. Boini, N. Jahovic and F. Lang, 2008. Effects of gum arabic (Acacia senegal) on water and electrolyte balance in healthy mice. J. Ren. Nutr., 18: 230-238.
30. Ali, B.H., A. Ziada and G. Blunden, 2009. Biological effects of gum arabic: a review of some recent research. Food Chem. Toxicol., 47: 1-8.
31. Mohamed, M.A., H.M.A. Hassan and E.M.A. El-Barkouky, 2008. Effect of mannan oligosaccharide on performance and carcass characteristics of broiler chicks. Journal of Agriculture and Social Sciences, 4: 7-13.
32. Toghyani, M., M. Toghyani and S.A. Tabeidian, 2011. Effect of probiotic and prebiotic as antibiotic growth promoter substitutions on productive and carcass traits of broiler chicks. International Conference on Food Engineering and Biotechnology, pp: 82-86.
33. Amber, Kh., 2000. Effect of replacing mung beans (Phaseolus aureus) for soybean meal in diets for growing rabbits. Proc. of 7th World Rabbit Congress, Valencia, Vol. A, pp: 69-75.
34. Nasir, O., A.T. Umbach, R. Rexhepaj, T.F. Ackermann, M. Bhandaru, A. Ebrahim, F. Artunc, D.S. Kempe, G. Puchchakayala, B. Siraskar, M. Foller, A. Saeed and F. Lang, 2012. Effects of gum arabic (Acacia senegal) on renal function in diabetic mice. Kidney Blood Press. Res., 35: 365-372.
35. Mohan, B., R. Kadirvel, M. Natarajan and M. Bhaskaran, 1996. Effect of probiotic supplementation on growth, nitrogen utilization and serum cholesterol in broilers. British Poultry Science, 37: 395-401.
36. Mohan, B., R. Kadirvel, M. Bhaskaran and M. Natarajan, 1995. Effect of probiotic supplementation on serum/yolk cholesterol and on egg shell thickness in layers. British Poultry Science, 36: 799-803.
37. Abu El-Hassan, E.A.E., 2016. Utilization of Gum Arabic Powder as a Novel Prebiotic in Laying Hens Diets in Summer. Ph.D. Thesis, Fac. of Agri., Mansoura University, Egypt.