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Growth Performance and Feed Utilization during Fattening Period as Affected by Mannan-Oligo-Saccharides Addition to Californian Rabbits

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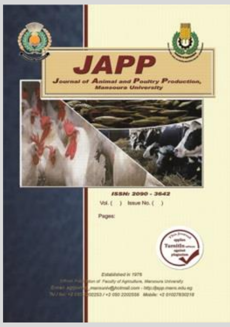

ABSTRACT

This survey aimed to examine the effect of mannan-oligosaccharides (MOS) addition to rabbit's diet as alternative antibiotics on growth performance and nutrients utilization of growing rabbits. A 60 of Californian rabbits aged six-wks, splinted randomly into equal five groups. The control group fed a basal diet without any supplement; the second group fed the basal diet after antibiotics supplementation (Oxytetracycline, 1.0 g/ kg diet), while the third, fourth and fifth groups were fed the basal diet after MOS addition with 0.50, 1.0 and 1.5 g /kg, respectively during the entire experimental period (6-11 wks of age).The results revealed that all rabbits fed MOS diets had higher ($P>0.05$) live body weight at 11 wks, while rabbits fed 0.50 g MOS/kg had ($P\leq0.05$) higher body weight gain during 6-11 wks of age comparing to the antibiotic and control groups. Moreover, feed conversion ratio were insignificantly ($P>0.05$) improved by feeding MOS/kg diets than the antibiotic group at the entire experimental period (6-11 wks) . All studied nutrients digestibility's coefficients improved by feeding 1.00 g MOS / kg compared to the antibiotic and the control diet with or without significant effects. Dressed carcass percentage not significantly changed for rabbits fed MOS diet in comparison with antibiotic and control group. Therefore, the addition of 0.50 or 1.00 g MOS / kg diet may be an alternative material of antibiotics in weanling rabbits to maximize their productivity and profitability without adverse effects during fattening period.

Keywords: rabbits, mannan oligosaccharides, growth performance, nutrients utilization

INTRODUCTION

A rising human population and improved financial status of people has led to an excess in the demand for animal protein. This excess demand calls for practical ways and alternative sources to enhance animal protein production in developing countries. So, the rabbits farming is an important emerging enterprise in these countries of the world because it could be used as a good substitution source of animal protein for humans (*Lukefahr and Cheeke, 1991*) as well as, their meat characterized with low fat and cholesterol, and high unsaturated fatty acids level (60% of all fatty acids) comparing with beef or veal meat (*Dalle, 2002*).

Weanling is one of the most crucial stages in rabbit production. At weanling, growing rabbits are subjected to a combination of stress factors that increment their susceptibility to post-weanling digestive disorders because of undeveloped gut immunity system, which often leads to serious gut diseases and subsequent death especially in 2–3 weeks after weanling that could increase up to or excess of 20% as a result of increasing diarrhea disease, bad feed conversion and lack appetite which resulted in a quite greater economic damages than a specific disease (*Fortunlamothe and Boullier, 2007*).

Dietary additives are products used in animal nutrition for improving feed quality and animal's performance and health by their effects on microflora composition in the digestive channel. A healthy and stable microflora prohibits the evolution of enteric diseases by increasing the fermentation in the cecum to increase volatile fatty acids (VFA) production which minimize the incidence of digestive unrests (*(Gidenne and Garcia, 2006)*. Due to the growing concern by using antibiotics in animal feeds, for this, it's fundamental to find substitutions for them in the feed industry, because the misapply of antibiotics can rise an accumulation of residues in animals (meat, milk and eggs), then, the excess of antibiotic resistance and allergies (*Gonzalez and Angeles, 2017*). Owing this, the World Health Organization (WHO) and multiple countries limited the using of antimicrobials for growth promotion (AGP) and disease prevention in animal feeds (*WHO, 2004; Maron et al., 2013*).

The prospect replacements include organic acids, probiotics, prebiotics (mainly oligosaccharides and polysaccharides products), plant extracts (essential oils), nucleotide and enzymes, etc. (*Cheng et al., 2014*). Prebiotics could be substitutive of antibiotics in livestock feeds (*Papatsiros et al., 2013; Brown et al., 2017*). A commercial prebiotic like mannan-oligosaccharide (MOS) comes from the outer cell wall of yeast and could use as a potential prebiotic to improve rabbits health (*Attia et al., 2015*) as a result of it improves gut microflora balance and has immune-modulatory properties. Moreover, MOS have favorable eff ects on growth and immune reaction of animals (*Tewoldebrhan et al., 2017, Silva et al. 2017*) , laying hens (*Hooge, 2004; Bozkurt et al., 2016; Ghasemian and Jahanian, 2016*) , broiler chickens (*Attia et al., 2014*), and rabbits (*Abdel-Hamid and Farahat, 2016*). Thus, this project aimed to evaluate the effect of mannan-oligosaccharides addition by different levels compared to antibiotic on rabbit performance and feed utilization of Californian rabbits (CAL) under the Egyptian condition.

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MATERIALS AND METHODSDS

This work carried out at private rabbit's farm. A 60 of Californian rabbits aged six-wks, splinted randomly into equal five groups having nearly equal live body weight. Each group contained 12 individual rabbit and assigned to one of five treatments as follows: the first group served as control (C) and fed the control diet without any addition, the second group fed the control diet after Oxytetracycline antibiotic addition (1.0 g/kg diet), while the third up to fifth groups fed were fed the control after mannan-oligosaccharides (MOS) addition with 0.50, 1.00 and 1.50 g / kg diet, respectively. All rabbits put on under the same managerial conditions and individually housed in galvanized wire cages contained a feeder and stainless steel nipple. Feed and water provided *ad-libtum* during the entire experimental period (6 up to 11 weeks). The chemical composition for the control diet was presented in Table 1.

Table 1. Basal diet composition and chemical analysis

Ingredients	%
Alfalfa (dehydrated)	40.0
Wheat bran	23.0
Barley	11.0
Soybean meal (44%)	12.0
Yellow corn	9.0
Molasses	3.0
Limestone	0.9
Salt	0.6
Vit.&min. premix*	0.5
Total	100.0
Chemical composition (DM basis) %**	
Dry matter	88.10
Crude protein	18.30
Ether extract	3.12
Crude fiber	14.50
Nitrogen free-extracts (NFE)	44.25
Ash	7.93
Digestible energy (DE) kcal/kg***	2656

*** Each 3 kg Premix of Vit. & Min. contains: vit. A, 12, million IU; Vit.D3, 2, 5 million IU; Vit. E, 10 g; Vit. K, 2.5g; Vit. B2, 5 g; Vit. B6, 1.5 g; Vit. B12, 10 mg; Biot, 50 mg; Folic, 1.0 g; Nicotc, 30 mg; Pantoth., 10 g; Antioxidant, 10 g; Mn, 60 g; Cu, 10 g; Zn, 55 g; Fe, 35 g; I, 1.0 g; Co, 250 mg and Se, 150 mg. ** NRC(1977). *** Perez et al. (1998).**

Data collection:

1- Growth parameters: body weight and feed intake recorded every week from 6 up to 11 weeks of age. Both daily weight gain (DWG) and feed intake (DFI) per rabbit calculated, also feed conversion ratio was estimated as g feed / g weight gain.

2- Digestion trial: At the end of the 11^{th} wks of age, three male rabbits from each treatment taken and kept in individual metabolic cages to conduct a digestibility trials. Feed and water offered daily all the time. Consumed feed was recorded. After 5 days as a preliminary period, faces were collected quantitatively for 5 consecutive days for each rabbit. Fecal samples for each individual rabbit were stored at -20 ºC immediately after collection, bulked and dried at 60 ºC for 24 hours, thereafter, they ground and kept for chemical analysis. Representative samples of feed offered and feces of each rabbit were chemically analysis according to *AOAC (1995).* Digestibility coefficient was calculated as: nutrient digested/nutrient intake x 100.

3- Slaughter test: At the end of 11 wk, three rabbits randomly taken from treatment and fasted for 12 hours before slaughtering, and then they weighed and slaughtered to determine carcass characteristics. Carcass parts immediately weighed, then total edible parts comprised empty carcass percentage of live weight.

4- **Statistically analysis:** The data analyzed using one-way ANOVA of GLM Procedure of SAS® (*SAS Institute, 2004*). Significant differences between means were detected according to *Duncan (1955*).

RESULTS AND DISCUSSION

Growth performance

Live body weight (LBW) of Californian rabbit's rabbits consumed mannan-oligosaccharides (MOS) diet recorded insignificantly higher (P>0.05) value than those consumed antibiotic diet at different studied ages (Table 2). Finally LBW of rabbits was increased by 9.53, 4.41and 6.25% by feeding 0.50, 1.0 and 1.5 g MOS/kg diet comparing to those consumed antibiotic diet, respectively, while these increases were recorded 5.29, 0.36 and 2.14%, respectively when compared to control group at 11 weeks.

However, daily DWG was (P≤0.05) improved by dietary MOS addition by 0.50 and 1.50 g / kg than antibiotic at the 11^{th} week of age, while this improvement was occurred by 0.50 g MOS/kg addition only at the entire experimental period (6-11 wks). Moreover, all groups fed different MOS diets had (P≥0.05) higher daily BWG at the 11^{th} week and the entire experimental period (6-11 wks) when compared with the control group. Generally, the group consumed 0.5 g MOS/kg diet recorded the best LBW and DWG than other groups at the final.

The improvement of LBW and DWG of growing Californian rabbits which fed diet supplemented with MOS during fattening period may be due to increasing volatile fatty acids in the caeca, decreasing the caecal ammonia concentration and reduced caecal pH *(Pinheiro et al., 2004),* also, it may stimulate the beneficial microflora of the gut then stimulate intestinal villi development (*Forchielli and Walker, 2005*), then preventing the adhesion of pathogens to the mucosa and stimulating the immune response (*Falçao-e-Cunha et al., 2007; Mourao et al., 2006*). These results agreement with *Fonseca et al. (2004), Volek et al. (2007)* and *Pinheiro et al. (2005)* who noted the inclusion of MOS in diet of rabbit not affect on body weight and gain. Also, *Mourao et al. (2006)* reported that using antibiotic as growth promoter (AGP) or different concentrations of MOS not change body weight and daily gain for rabbits at 32 - 67 days. *Piccolo et al. (2009*) found that body weight and daily gain not affected by MOS (0.5 or 1.0 g/kg) addition to rabbits diet comparing with AGP group. *Jamsheera et al. (2017)* found that the supplementation of MOS with 1.5 g and 3.0 g per kg diet did not improve body weight and gain. On contrary, *Bovera et al. (2010)* reported that rabbits consumed 1.0 g MOS /kg diet had better body weight gain (P ≤ 0.01) than those consumed antibiotic diet from weanling up to 60 days of age. Abdel-Hamid and Farahat (2016) found that dietary MOS supplementation (1.0 g/kg) elevated immunity, improved health, weights of rabbits. *Ewuola et al. (2011) and Oso et al. (2013)* reported that MOS addition resulted in higher (P<0.05) final weight compared to those fed with diet containing probiotics.

Table 2. Effect of Mannan-oligosaccharides addition to Californian rabbit's diet on body weight and daily weight gain at fattening period

Age, wks	Control	Antibiotic	Mannan-oligosaccharides (g/kg)		
			0.5	1.0	1.5
			Live body weight, g		
6	985.0±65.4	985.8±37.2	993.3±35.8	956.7±47.0	996.7±47.9
7	1208.3±65.9	1191.7±50.2	1228.3±35.2	1191.7±51.4	1220.0±50.7
8	1394.2±68.8	1368.3±60.2	1454.2±43.1	1415.0±58.3	1433.3±52.3
9	1627.5±76.1	1575.8±66.6	1690.0±43.7	1621.7±55.1	1640.0±47.6
10	1849.2±79.9	1787.5±70.8	1923.3±42.9	1843.3±64.7	1875.8±51.4
11	2065.8±78.7	1985.8±76.8	2175.0±45.0	2073.3±74.4	2110.0±51.1
			Daily body weight gain, g		
7th	31.91±2.32	29.41±2.85	33.58±1.78	33.45±1.60	31.91±1.91
8th	26.67±2.76	25.24±2.72	32.02±2.36	31.91±1.70	30.48±1.53
9th	33.21±1.62	29.64±1.51	34.88±1.63	29.52±2.12	30.71±1.84
10th	31.91±2.51	30.24±1.88	33.34±1.80	31.67±2.27	31.79±1.33
11th	30.95±2.16^{ab}	28.33±2.02^{b}	36.07±1.21^{a}	32.86±1.64^{ab}	34.64±1.54^{a}
6-11	30.88±1.50^{ab}	28.58±1.47^{b}	33.77±1.00^{a}	31.92±1.08^{ab}	31.81±0.87^{ab}

a,b: means in the same row within each item with different superscript are significantly different (P ≤ 0.05).

Feed intake (FI) was (P≤0.05) higher for the group consumed 1.00 and 1.50 g MOS/kg diet compared with groups consumed the control and antibiotic diet at 8 wk , while it (P≤0.05) increased by feeding 1.50 g MOS/kg diet only at 11 week of age comparing to the control group (Table 3). Generally, FI was (P≥0.05) higher by 11.59, 10.15 and 10.36% for groups fed 0.50, 1.00 and 1.50 g MOS/kg diet, respectively when compared with the antibiotic group diet at the entire experimental period (6-11 wks), while this elevation of FI was recorded 7.40, 5.63 and 6.22%, respectively than control group.

Table 3. Effect of Mannan-oligosaccharides addition to Californian rabbit's diet on feed intake and conversion.

Age, wks	Control	Antibiotic	Mannan-oligosaccharides (g/kg)		
			0.5	1.0	1.5
Daily Feed intake , g					
7th	86.9±5.2	78.6.±6.2	85.9±6.2	79.5±6.5	81.0±3.8
8th	87.9±6.5^{b}	85.0±6.1^{b}	101.6±5.9^{ab}	108.3±4.1^{a}	112.2±6.5^{a}
9th	109.1±4.8	106.8±7.4	116.9±6.0	113.3±7.4	108.8±6.2
10th	111.4±6.4	111.4±6.8	120.3±4.8	119.0±4.3	105.9±6.67
11th	112.3±6.3^{b}	116.5±9.5^{ab}	128.5±4.6^{ab}	124.9±6.7^{ab}	136.0±3.8^{a}
6-11	101.3±4.0	97.5±5.1	108.8±3.8	107.0±4.4	107.6±4.2
			Feed conversion ratio (g feed : g BWG)		
7th	2.94±0.34	2.74±0.19	2.51±0.14	2.37±0.19	2.57±0.14
8th	3.42±0.20	3.55±0.23	3.26±0.20	3.41±0.13	3.69±0.17
9th	3.33±0.18	3.62±0.25	3.43±0.25	4.01±0.21	3.60±0.23
10th	3.56±0.20	3.82±0.23	3.68±0.22	3.88±0.23	3.31±0.19
11th	3.67±0.16	3.99±0.18	3.90±0.25	3.83±0.18	4.11±0.18
6-11	3.33±0.14	3.45±0.14	3.24±0.13	3.36±0.10	3.39±0.11

a,b: means in the same row within each item with different superscript are significantly different (P ≤ 0.05).

Feed conversion ratio (FCR) of rabbits was better (P>0.05) by feeding 0.50 g MOS/kg comparing with antibiotic diet during varying experimental ages. Generally, FCR was preferable by feeding all MOS diets during the entire experimental period, while the FCR improvement recorded 6.09 and 2.70%, respectively for rabbits fed 0.50 g MOS/ kg diet than the antibiotic and control groups at the whole period (6-11 weeks). Improving feed conversion ratio by feeding MOS diet comparing to antibiotic supplementation may be due to the increase feed digestibility as a result to improvement intestinal histology which may augment villi height: crypt depth, and extend the absorption surface area of the intestine in growing rabbits *(Mourao et al., 2006).* Also, it may be due to the "picking" induced by MOS on cecal microflora, which is more efficacious in structural carbohydrate fermentation than that favored by antibiotics, while antibiotics prevent the viability and proliferation of not only some pathogens but also beneficial enteric microflora, whereas MOS prevent the attachment and colonization of some enteric bacteria, but don't kill them (*Ferket et al., 2002*). These results agree with *Mourao et al. (2006)* who stated that feed intake and conversion were not affected in rabbits consumed antibiotics compared to MOS (1.0, 1.5 and 2.0 g/kg) diet at 32 - 67 days of age. In contrary, the MOS addition resulted in a (P≤0.05) attenuate in feed conversion compared with the control group *(Mourao et al., 2006).* However, *Bovera et al. (2010)* reported that rabbits fed MOS at 0.50 or 1.00 g / kg had (P≤0.05) lower feed intake and better feed conversion (P≤0.01) compared to those fed antibiotic diet from weanling up to 60 days of age.

Results in Table 4 showed a significant differences between the experimental treatments in digestibility coefficients of crud protein and ether extract only, while other nutrients digestibility coefficients were not affected by dietary experimental treatments at 11 weeks of age. Digestibility coefficient of crud protein (CP) was insignificantly improved by feeding varying MOS diets comparing to the antibiotic and the control diet except of 1.50 g MOS /kg which recorded significant effect when compared with the antibiotic group only. However, EE digestibility coefficient was approximately similar by adding 0.50 or 1.00 g MOS/kg when compared with antibiotic or control groups without significant effect, while adding 1.50 g MOS/ kg resulted significant attenuation in EE digestibility than the antibiotic group. Both organic and dry matter (OM &DM) and nitrogen free extract (NFE) digestibility (%) were insignificantly higher by feeding 1.00 or 1.50 g MOS/ kg diets comparing to antibiotic or control groups. Also, crude fiber (FC) digestibility coefficient was not significantly affected due to treatment, but adding 1.0 g MOS/kg diet resulted in an elevation of CF digestibility while both 0.5 and 1.5g MOS/kg recoded the lowest CF digestibility comparing with both the antibiotic and the control groups. The higher values of nutrients digestibility coefficients by using MOS diets may be due to increasing the utilization of these nutrients in the intestines that contributes better feed conversion ratio than antibiotics and control groups.

These improvements may be due to MOS increased the length of villi at the ileum, possibly as a result of improving the intestinal environment compared to rabbits fed diet without additives (*Mourao et al., 2006*). The higher OM and DM digestibility by using 1.00 or 1.50 g MOS/kg diet could be due to the increase in the digestion of structural carbohydrates in growing rabbits. These results are in agreement with *Bovera et al. (2010)* who established that rabbits fed MOS at 0.50 or 1.00 g/kg had higher OM, CP, EE and CF digestibility with or without significant effect at 60 days of age.

Dressed percentage of rabbits carcass was recorded an elevation ($P \geq 0.05$) by feeding 1.00 and 1.50 g MOS/kg diet comparing with both antibiotic and control groups (Table 5). This is agree with the findings of *Piccolo et al. (2009)* who stated that dressing out percentage not affected by MOS addition than in AGP of rabbits. *Abdel-Hamid and Farahat (2016)* found that improving carcass weights of rabbits by dietary MOS addition (1.00 g/kg).

Table 4. Effect of Mannan-oligosaccharides addition to Californian rabbit's diet on digestibility coefficient of nutrients at 11 weeks of age.

Items	Control	Antibiotic	Mannan-oligosaccharides (g/kg)		
			0.5	1.0	1.5
DM	72.5±2.38	71.4±1.40	70.0±0.15	75.4±1.96	73.3±1.75
OM	73.5±2.58	72.4±1.36	71.2±0.03	76.4±1.96	74.4±1.76
CP	66.1±4.54^{ab}	63.8±2.49^{b}	67.3±2.11^{ab}	72.0±1.35^{ab}	75.2±3.55^{a}
EE	81.2±1.39^{ab}	84.4±1.05^{a}	81.5±0.44^{ab}	84.3±1.79^{a}	77.1±1.72^{b}
CF	30.8±5.32	33.8±3.98	23.2±3.93	38.8±6.25	23.8±5.66
NFE	82.6±1.17	81.3±1.10	80.5±1.03	84.5±1.52	83.9±0.50

a,b: means in the same row within each item with different superscript are significantly different ($P \leq 0.05$).

Table 5. Effect of Mannan-oligosaccharides addition to Californian rabbit's diet on dressed carcass percentage at 11 weeks of age.

Age, wks	Control	Antibiotic	Mannan-oligosaccharides (g/kg)		
			0.5	1.0	1.5
FW, g	2073.3±107.1^{cb}	2016.7±35.3^{c}	2393.3±107.4^{a}	2126.7±21.9^{cb}	2286.7±32.8^{ab}
Dress. %	61.4±0.72	60.8±1.09	60.2±1.38	62.3±0.06	62.9±1.22

a,b: means in the same row within each item with different superscript are significantly different ($P \leq 0.05$). FW: fasted weight

CONCLUSION

It could be advised that adding 0.50 or 1.00 g MOS / kg to growing rabbits diet after weanling may be an alternative material of antibiotics to maximize their productivity and profitability and nutrients utilization as well as dressed carcass percentage without adverse effects during fattening period.

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تأثير إضافة مانان اوليجوسكاريدز لعليقة أرانب الكاليفورنيا على أداء النمو والاستفادة من الغذاء خلال فترة التسمين

نها تاج الدين حسن تاج الدين

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يهدف هذا البحث إلى معرفة تأثير إضافة مانان اوليجوسكاريدز لعلائق الأرانب النامية كبديل للمضادات الحيوية على أداء النمو والأستفادة من الغذاء خلال فترة التسمين. حيث استخدم عدد ٦٠ أرنب كاليفورنيا عمر ستة أسابيع ، تم وزن الأرانب وتوزيعهم الى خمس مجموعات متساوية عشوائيا. تم تغذية المجموعة الأولى (الضابطة) على العليقة الأساسية دون أي اضافات بينما تغذت المجموعة الثانية على العليقة الأساسية مضاف لها المضادات الحيوية (١,٠ جم اوكسى تتراسيكلين/كجم عليقة) كما تم تغذية المجموعات الثالثة والرابعة والخامسة على العليقة الأساسية مضاف لها ٠,٥ ، ١,٠ ، ١,٥ جم مانان اوليجوسكاريدز / كجم عليقة على التوالي خلال الفترة التجريبية الكلية (٦- ١١ أسبوعًا من العمر).أظهرت النتائج زيادة فى وزن الجسم الحى لجميع الأرانب التي تغذت على العلائق المضاف لها مانان اوليجوسكاريدز بمستوياته المختلفة عند عمر ١١ أسبوعًا ، بينما سجلت الأرانب التي تغذت على ٠,٥ جم مانان اوليجوسكاريدز/ كجم عليقة أفضل معدل للزيادة في وزن الجسم خلال الفترة الكلية للتجربة (٦-١١ أسبوع من العمر) بالمقارنة بتلك التى تغذت على العليفة المضاف لها المضادات الحيوية والعليقة الضابطة (الكنترول). كما تحسن معامل التحويل الغذائي بدون معنوية باضافة مانان اوليجوسكاريدز للعليقة مقارنة باضافة المضادات الحيوية في الفترة الكلية للتجرية (٦ - ١١ أسبوعًا من العمر). كما تحسنت جميع معاملات هضم المواد العناصر الغذائية المدروسة باضافة ١,٠ جم مانان اوليجوسكاريدز/ كجم عليقة بالمقارنة مع مجموعتى المضادات الحيوية والضابطة. كما لم تتأثر نسبة تصافى الذبيحة معنويا للأرانب التي تغذت على العلائق المضاف لها مانان اوليجوسكاريدز بالمقارنة مع مجموعة المضادات الحيوية والضابطة.لذلك تشير النتائج الى امكانية إضافة ٠,٥ أو ١,٠ جرام مانان اوليجوسكاريدز لكل كجم لعليقة الأرانب النامية كبديل للمضادات الحيوية لتحسين أدائها الانتاجى والاستفادة من الغذاء دون أى آثار ضارة لها خلال فترة التسمين.