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Influence of two dietary probiotic oligosaccharides supplementation on productive performance and carcass traits with special attention to their biochemical alterations in two rabbit breeds

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ABSTRACT

One-hundred and twenty weaned male rabbits (New Zealand White and APRI) of 45 days of age and 737±17 g body weight were allotted randomly into six groups (20 rabbits each) in factorial arrangement to investigate the effects of dietary supplementation of two prebiotic oligosaccharides (Mannan-oligosaccharides and Isomalto-oligosaccharides) on their growth performance and carcass traits. The results of the present work showed that dietary supplementation of prebiotic oligosaccharides, in particular Mannan-oligosaccharides (MOS) and Isomalto-oligosaccharides (IMO) significantly accelerated body weight gain (BWG) in rabbits, and reduced feed conversion ratio (FCR). There are some differences in growth performance traits due to breed effect. The interaction between prebiotics supplementation and breed was significant on BWG and FCR. supplementation of (IMO) revealed significant differences in most of studied carcass traits, except in forequarter percentage. The highest dressing percentages were noticed with dietary supplementation either with MOS or IMO compared to control group and represented (55%, 56% vs. 53%, respectively). Supplementing rabbits with MOS and IMO did not alter liver and kidney enzymes but supplementing (IMO) only increased blood total protein, albumin, while supplementing (MOS and IMO) improved A/G ratio significantly. In conclusion, Dietary supplementation of prebiotic oligosaccharides (MOS and IMO) provided beneficial effects on growth performance of rabbits, moreover, the recommended dose for supplementation of (MOS and IMO) in growing rabbits represented (3 and 0.5 kg /ton of ration respectively.

Keywords: Prebiotics; Oligosaccharides; Growing rabbits; Productive; Carcass; Blood parameters

1. Introduction

In developing countries, increasing human population and improved financial status of people has led to an increase in the demand for animal protein. This increased demand calls for practical ways and alternative sources to enhance the supply of animal protein. It is possible, that rabbits can be used as a good alternative source of animal protein for humans in these countries (Lukefahr and Cheeke 1991).

The use of dietary antibiotics resulted in common problems such as development of drug-resistant bacteria (Sorum and Sunde, 2001), drug residues in the body of the birds (Burgat, 1999), and imbalance of normal microflora (Andremont, 2000). As a consequence, it has become necessary to develop alternatives using either beneficial microorganisms (probiotics) or non-digestible ingredients (prebiotics) that enhance beneficial microbial growth. Prebiotic was defined as non-digestible food ingredient that beneficially affects the host, selectively stimulating the growth or activity, or both, of one or a limited number of bacteria in the colon (Gibson and Roberfroid, 1995). There are many oligosaccharides that can be considered as having prebiotic properties. Two of these are Mannan-oligosaccharides (MOS) and Isomalto-oligosaccharides (IMO) as reported by (Playne and Crittenden, 1996; Rycroft et al., 2001; Pennacchia et al., 2006).

Prebiotic oligosaccharides when added to the rabbit diets, resulted in an improvement in the health of the intestine and the immune system as well as the performance of animals such as broilers (Hooge 2004a), turkeys (Hooge 2004b) and piglets (Miguel et al., 2004). on the other hand, the results were disparate in rabbits, where some authors did not notice an improvement in performance (Bersenyi and Gippert 1995; Girard et al., 1997; Mourão et al., 2006), although others observed an improvement in performance with the addition of MOS compared with oxytetracycline (Fonseca et al., 2004). To our knowledge, we have not found previous studies on these effects in New Zealand White and APRI rabbits And almost all the literature on the effects of prebiotic oligosaccharides as growth promoters on productive performance, blood biochemical and carcass traits, have been carried out on single breed and rarely two or more.

APRI line is a new maternal line (APRI) established from Egyptian Baladi Red (BR) and a Spanish line (V) rabbits was started in 2002 at the Sakha experimental rabbitry, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. The APRI line was founded by crossing Baladi Red bucks with V line does to produce F1 (½B½V) stock, followed by two generations of inter- se matings to achieve performance stability (Youssef et al., 2008; Abou Khadiga et al., 2010a, 2010b).

Therefore, the objectives of the present study were to investigate the effects of two dietary supplementation of prebiotic oligosaccharides (MOS) and (IMO) in two breeds of weanling rabbits adapted to survive in Egypt (New Zealand White and APRI line) on the growth performance and carcass traits with special attention to their biochemical alterations.

2. Material and methods

2.1. Animals, management and experimental design

All procedures were implanted according to the Local Experimental Animal Care Committee and approved by the ethics of the institutional committee of Damanhour University, Egypt. This experiment was carried out in a private farm in which one-hundred and twenty rabbits about 45 days of age and 737±17 g body weight were allotted randomly into six groups divided equally; sixty New Zealand White sixty APRI weaned male rabbits (20 control, 20 MOS treated, and 20 IMO treated) per each breed. Rabbits were raised in a semi-closed Rabbitry of 180 m^2 (6 m width and 30 m length) with wire-netted windows in eastern and western sides for natural ventilation. Windows oriented with an elevation of 160 cm from floor. Floor of Rabbitry was concrete with moderate slope to middle to facilitate drainage of water and waste liquids towards large

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Table 1. Ingredients and chemical composition (%) of the basal diet

Ingredients	%
Yellow corn	9.5
Soybean meal 44%	15.0
Wheat bran	17.0
Barley	21.7
B. Hay	34.5
Dicalcium phosphate*	1.2
Ground limestone**	0.25
DL-Methionine	0.05
Common salt	0.5
Vitamin + Mineral premix***	0.3
Total	100
Chemical composition of the basal diet	
Dry matter	87.8
Moisture	12.2
Crude protein	17.9
Crude fiber	13.75
Ether extract	3.6
Nitrogen-free extract (NFE)*	42.75
Ash	9.8
Digestible Energy DE (Kcal/kg)**	2677.97

* Di-calcium phosphate: contain 20% Phosphorus and 25% calcium
** Limestone: contain 34% calcium
* NFE was calculated by difference = 100 – (moisture % + CP% + EE% + CF% + Ash %). ** DE was calculated according to values given in the feed composition tables of the NRC (1977).
***Every 1kg of ration contains the following vitamins and minerals: Vitamin A – 12000 IU; vitamin D3 – 900 IU; vitamin E- 50 mg; vitamin k3 – 2 mg; vitamin B1 – 2 mg; vitamin B2 6 mg; vitamin B6 – 2 mg; vitamin B12 – 0.01 mg; Biotin – 0.2mg; pantothenic – 20 mg; niacin – 50 mg; folic acid – 5 mg; manganese – 8.5 mg; Zinc – 70 mg; iron – 75 mg; Copper – 5 mg; Iodine 0.75 mg; Selenium – 0.1 mg.

Table (2a). Means ± their standard errors (M±SE) for the breed and treatment effect and their interaction on the body weights (g / wk.) of rabbits

Item		0 week	1st week	2nd week	3rd week	4th week
Breed						
APRI		768.33±25.13	898.4±25.20	1031.4±25.2	1253.6±25.9 [a]	1461.3±27.8 [a]
New Zealand White		702.08±26.66	831.08±26.7	967.7±26.08	1164.9±27.5 [b]	1362.4±29.5 [b]
Treatment						
Mannan oligosaccharides (MOS)		732.81±31.7	861.4±31.8	998.9±31.9	1215.8±32.7	1426.1±32.7
Isomalto oligosaccharides (IMO)		738.16±31.7	876.5±31.8	1006.6±31.9	1221.2±32.7	1438.4±32.7
Control		434.65±31.7	856.3±31.8	993.2±31.9	1191.7±32.7	1371.07±32.7
Breed*treatment						
APRI	MOS	760.00±43.5	879.1±34.6	1014.4±43.7	1244.4±44.9	1455.5±48.3
	IMO	774.44±43.5	917.5±34.6	1050.7±43.7	1285.8±44.9	1510.7±48.3
	Control	770.55±43.5	898.7±34.6	1029.2±43.7	1230.6±44.9	1417.7±48.3
New Zealand	MOS	705.62±43.5	843.7±46.3	983.5±46.4	1187.2±47.7	1396.7±51.2
	IMO	701.87±43.5	835.5±46.3	962.5±46.4	1156.6±47.7	1366.1±51.2
	Control	698.75±43.5	814.00±46.3	957.3±46.4	1150.8±47.7	1324.3±51.2

Means within the same column under the same category carry different superscripts are significantly different

Table (2a). continued

Item		5th week	6th week	7th week	8th week
Breed					
APRI		1680.1±31.5 [a]	1848.3±30.5	2001.6±32.1 [a]	2142.7±30.5
New Zealand White		1553.3±33.4 [b]	1738.7±32.3	1927.08±34.1 [b]	2078.5±32.3
Treatment					
Mannan oligosaccharides (MOS)		1627.2±39.8	1825.4±38.5	1992.2±40.6	2139.7±38.5
Isomalto oligosaccharides (IMO)		1640.5±39.8	1818.9±38.5	1985.3±40.6	2133.8±38.5
Control		1582.4±39.8	1736.2±38.5	1915.5±40.6	2058.3±38.5
Breed*treatment					
APRI	MOS	1683.8±54.6	1878.3±52.9	2029.4±55.7	2173.3±52.8
	IMO	1715.5±54.6	1881.6±52.9	2045.00±55.7	2188.3±52.8
	Control	1641.1±54.6	1785.00±52.9	1930.5±55.7	2066.6±52.8
New Zealand	MOS	1570.6±57.9	1772.5±56.1	1955.00±59.1	2106.2±56.04
	IMO	1565.6±57.9	1756.2±56.1	1925.6±59.1	2079.3±56.04
	Control	1523.7±57.9	1687.5±56.1	1900.6±59.1	2050.00±56.04

Means within the same column under the same category carry different superscripts are significantly different

Table (2b). Means ± their standard errors (M±SE) for the breed and treatment effect and their interaction on the body weights gain (g / wk.) of rabbits

Item		Week							
		0 -1st	1st-2nd	2nd –3rd	3rd-4th	4th -5th	5th -6th	6th-	7th- 8th
Breed									
APRI		130.14±3.18	133.00±4.2	222.18±10.1	207.70±9.6	218.81±8.97 ^{a}	168.14±7.32	153.3±7.89 ^{b}	141.1±6.63
New Zealand White		129.00±3.37	136.70±4.5	197.12±10.7	197.50±10.1	190.91±9.51 ^{b}	185.41±7.77	188.3±8.37 ^{a}	151.4±7.03
Treatment									
Mannan oligosaccharides (MOS)		128.6 ±4.01 ^{ab}	137.5±5.43	216.8±12.78	210.3±12.15	201.1±11.3	198.1±9.23 ^{a}	166.8±9.96	147.5±8.37
Isomalto oligosaccharides (IMO)		183.3±4.01 ^{a}	130.1±5.45	214.6±12.76	217.2±12.13	202.1±11.3	178.3±9.24 ^{ab}	166.3±9.97	148.5±8.35
Control		121.7±4.01 ^{b}	136.9±5.43	197.4±12.78	180.3±12.15	211.3±11.3	153.8±9.25 ^{b}	179.3±9.96	147.7±8.37
Breed*treatment									
APRI	MOS	119.1±5.51 ^{bc}	135.3±7.4	230.6±17.5	211.1±16.6	228.3±15.5	194.4±12.6 ^{a}	151.1±13.6 ^{b}	143.8±11.4
	IMO	143.1±5.51 ^{a}	133.2±7.4	235.1±17.5	224.8±16.6	204.7±15.5	166.1±12.6 ^{ab}	163.3±13.6 ^{b}	143.3±11.4
	Control	128.2±5.51 ^{abc}	130.4±7.4	201.4±17.5	187.1±16.6	223.3±15.5	143.8±12.6 ^{b}	145.5±13.6 ^{b}	136.1±11.4
New Zealand	MOS	138.1±5.8 ^{c}	139.7±7.8	203.7±18.5	209.5±17.6	173.8±16.4	201.8±13.4 ^{a}	182.5±14.5 ^{ab}	151.2±12.1
	IMO	133.8±5.8 ^{ab}	127.00±7.8	194.1±18.5	209.5±17.6	199.5±16.4	190.6±13.4 ^{a}	169.3±14.5 ^{b}	153.7±12.1
	Control	115.2±5.8 ^{c}	143.3±7.8	193.5±18.5	173.5±17.6	199.3±16.4	163.7±13.4 ^{ab}	213.1±14.5 ^{a}	149.3±12.1

Table (2c). Means ± their standard errors (M±SE) for the breed and treatment effect and their interaction on the feed conversion ratio (g feed/ g gain) of rabbits

Item		1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week
Breed									
APRI		3.03±0.071	2.96±0.088	2.47±0.138	3.13±0.151	4.46±0.169	4.62±0.181	4.63±0.180 ^{a}	4.72±0.180
New Zealand White		3.08±0.076	2.93±0.094	2.80±0.146	3.35±0.160	3.91±0.179	4.12±0.192	3.89±0.191 ^{b}	4.38±0.191
Treatment									
Mannan oligosaccharides (MOS)		3.05±0.090 ^{ab}	2.87±0.112	2.63±0.174	3.10±0.190 ^{ab}	3.83±0.213	3.99±0.228 ^{b}	4.39±0.229	4.54±0.227
Isomalto oligosaccharides (IMO)		2.87±0.090 ^{b}	3.02±0.112	2.50±0.174	2.99±0.190 ^{b}	3.66±0.213	4.25±0.228 ^{ab}	4.34±0.229	4.58±0.227
Control		3.24±0.090 ^{a}	2.94±0.112	2.79±0.174	3.63±0.190 ^{a}	3.57±0.213	4.87±0.228 ^{a}	4.05±0.229	4.53±0.227
Breed*treatment									
	MOS	3.35±0.123 ^{a}	2.99±0.153	2.41±0.238	3.006±0.261 ^{ab}	3.51±0.293	4.07±0.313 ^{b}	4.69±0.31 4 ^{a}	4.83±0.312
	IMO	2.70±0.123 ^{b}	2.86±0.153	2.25±0.238	2.85±0.261 ^{b}	3.57±0.293	4.56±0.313 ^{ab}	4.44±0.314 ^{a}	4.54±0.312
APRI	Control	3.05±0.123 ^{ab}	3.04±0.153	2.76±0.238	3.53±0.261 ^{ab}	3.31±0.293	5.23±0.313 ^{a}	4.77±0.31 4 ^{a}	4.79±0.312
	MOS	2.75±0.131 ^{b}	2.75±0.162	2.84±0.253	3.19±0.277 ^{ab}	4.16±0.310	3.91±0.332 ^{b}	4.09±0.333 ^{ab}	4.26±0.331
	IMO	3.05±0.131 ^{ab}	3.18±0.162	2.76±0.253	3.12±0.277 ^{ab}	3.76±0.310	3.95±0.332 ^{b}	4.24±0.333 ^{ab}	4.62±0.331
New Zealand	Control	3.43±0.131 ^{a}	2.85±0.162	2.81±0.253	3.73±0.277 ^{a}	3.82±0.310	4.51±0.332 ^{ab}	3.33±0.333 ^{b}	4.27±0.331

Means within the same column under the same category carry different superscripts are significantly different

Table (3). Means ± their standard errors (M±SE) for the breed and treatment effect and their interaction on the carcass traits (%) of rabbits.

Item		Forequarter	Loin	Hindquarter	Gastrointestinal	Giblets	Dressing
Breed							
APRI		0.183±0.002	0.148±0.003	0.215±0.002	0.140±0.003 ^{b}	0.018±0.001 ^{b}	0.546±0.004
New Zealand White		0.184±0.002	0.149±0.003	0.216±0.002	0.150±0.003 ^{a}	0.020±0.001 ^{a}	0.550±0.004
Treatment							
Mannan oligosaccharides		0.183±0.003	0.152±0.003 ^{ab}	0.213±0.002 ^{b}	0.146±0.004 ^{ab}	0.021±0.001 ^{a}	0.549±0.005 ^{b}
Isomalto oligosaccharides		0.188±0.003	0.154±0.003 ^{a}	0.222±0.002 ^{a}	0.136±0.004 ^{b}	0.017±0.001 ^{b}	0.564±0.005 ^{a}
Control		0.179±0.003	0.140±0.003 ^{b}	0.211±0.002 ^{b}	0.152±0.004 ^{a}	0.019±0.001 ^{a}	0.530±0.005 ^{c}
Breed*treatment							
	MOS	0.179±0.004 ^{b}	0.148±0.005	0.213±0.003 ^{b}	0.139±0.005 ^{ab}	0.017±0.001 ^{bc}	0.540±0.007 ^{bc}
APRI	IMO	0.194±0.004 ^{a}	0.154±0.005	0.219±0.003 ^{ab}	0.124±0.005 ^{b}	0.019±0.001 ^{ab}	0.567±0.007 ^{a}
	Control	0.177±0.004 ^{b}	0.144±0.005	0.212±0.003 ^{b}	0.155±0.005 ^{a}	0.017±0.001 ^{bc}	0.533±0.007 ^{c}
	MOS	0.188±0.004 ^{ab}	0.157±0.005	0.214±0.003 ^{b}	0.152±0.005 ^{a}	0.024±0.001 ^{a}	0.558±0.007 ^{ab}
New Zealand	IMO	0.182±0.004 ^{b}	0.155±0.005	0.226±0.003 ^{a}	0.149±0.005 ^{a}	0.015±0.001 ^{c}	0.562±0.007 ^{ab}
	Control	0.182±0.004 ^{b}	0.137±0.005	0.210±0.003 ^{b}	0.150±0.005 ^{a}	0.022±0.001 ^{a}	0.528±0.007 ^{c}

Means within the same column under the same category carry different superscripts are significantly different

Table (4). Means ± their standard errors (M±SEM) for the breed and treatment effect and their interaction on the biochemical parameters of rabbits

Items		TP (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G ratio	ALT (U/L)	AST (U/L)	Uric acid (mg/dl)	Creatinine (mg/dl)
Breed									
New Zealand White		7.05	3.85	3.20	1.21	40.25	34.80	2.15	1.56
APRI		6.91	3.79	3.12	1.22	34.11	31.02	2.46	1.72
SEM		0.070	0.056	0.050	0.028	2.235	1.702	0.111	0.053
P value		0.332	0.610	0.123	0.883	0.195	0.289	0.189	0.157
Treatment									
Mannan oligosaccharides (MOS)		6.65 ^{b}	3.68 ^{b}	2.96 ^{b}	1.25 ^{a}	35.61	30.43	2.55	1.75
Isomalto oligosaccharides (IMO)		7.31 ^{a}	4.19 ^{a}	3.11 ^{b}	1.35 ^{a}	35.99	34.03	1.96	1.68
Control		6.98 ^{ab}	3.58 ^{b}	3.40 ^{a}	1.06 ^{b}	39.91	34.26	2.41	1.48
SEM		0.070	0.056	0.050	0.028	2.235	1.702	0.111	0.053
P value		0.008	0.002	0.012	0.004	0.693	0.601	0.119	0.139
Breed*treatment									
APRI	MOS	6.78 ^{bc}	3.80 ^{bc}	2.98 ^{b}	1.28 ^{ab}	39.97	36.63	2.60	1.66
	IMO	7.55 ^{a}	4.39 ^{a}	3.16 ^{ab}	1.39 ^{a}	41.27	36.43	1.76	1.57
	Control	6.82 ^{bc}	3.36 ^{c}	3.46 ^{a}	0.97 ^{c}	39.50	31.34	2.09	1.44
New Zealand White	MOS	6.51 ^{c}	3.57 ^{bc}	2.95 ^{b}	1.22 ^{ab}	31.26	24.23	2.49	1.84
	IMO	7.07 ^{abc}	4.00 ^{ab}	3.07 ^{ab}	1.30 ^{ab}	30.73	31.64	2.16	1.79
	Control	7.15 ^{ab}	3.81 ^{bc}	3.34 ^{ab}	1.15 ^{bc}	40.33	37.19	2.72	1.52
SEM		0.070	0.056	0.050	0.028	2.235	1.702	0.111	0.053
P value		0.016	0.003	0.066	0.014	0.585	0.284	0.188	0.274

Means within each column for each division with no common superscript letters are significantly different ($p < 0.05$).
SEM = standard error of the means.

gutters outside Rabbitry. During cold, windy and at night day's window was closed for protection from severe atmosphere.

Rabbits were identified by plastic ear tags. Fresh water was offered ad libitum to rabbits all time. Rabbits were fed on a standard pelleted ration offered ad libitum twice daily at 8 am and 2 pm. The pellets were 1 cm length and 0.4 cm diameter. 20 Rabbits per each breed were fed the basal diet (Table 1) contained 2677.97 Kcal digestible energy/Kg, 17.9% crude protein and 13.75 % crude fiber. While, 40 Rabbits from each breed represented as treated groups were allotted into 2 equal groups (20 rabbits each); first group fed ration with Mannan-oligosaccharides (Shanghai Renyoung Pharmaceutical Co. Ltd.), and the second group fed ration with Isomalto-oligosaccharides (Xi'an Wanfun Biotech Co. Ltd.). The recommended dose used in the experiment was 3 kg/ton of ration (0.3%) for Mannan-oligosaccharides (MOS) and 0.5 kg/ton of ration (0.05%) for Isomalto-oligosaccharides (IMO).

2.2. The experimental diet

The basal experimental diet (Table 1) was formulated and pelleted to cover the nutrient requirements of rabbits according to NRC (1977) recommendations. Ingredients needed for formulation of the experimental diets were finely ground by using hammer mill screen size 3.0 mm, then weighing of different ingredients at required amount for the experimental diets, thoroughly mixed and pelleted (3.5 mm size).

2.3. Data collection and measurements

Rabbits were individually weighed at the beginning (6 weeks) for recording initial body weight and at the end of experiment (finishing weight), then daily weight gain was calculated during the whole period. Weighing was done in the early morning before receiving any feed or water. Daily feed consumption per rabbit was recorded weekly. Residues and wasted feed were weighed daily and then subtracted from the offered amounts to obtain the actual accumulated feed consumed, and then feed conversion ratio (FCR) was calculated.

At the end of the experimental period, three rabbits from each group were randomly taken to estimate the carcass traits. Rabbits were fasted for approximately 6 hours before slaughtering and then individually weighed (pre-slaughter weight) and slaughtered by severing the neck with a sharp knife according to Islamic religion. Carcass was eviscerated after skinning and giblets (liver, heart, and kidneys) were separately and weighed to determine the dressing weight and the dressing percentage. The blood, viscera, lungs, skin, limbs, and tail were termed as the offal's weight. All records were expressed as percentage to the live body weight. Dressing percentage was calculated as (hot carcass weight × 100/fasted weight). Carcass was separated for the following three cuts: (1) the two fore legs (including thoracic insertion muscles), (2) Loin (including the abdominal wall and the ribs after the 7th thoracic rib) and (3) Hind legs (including the sacral bone and the lumber vertebra after the 6thlumber vertebra) according to (Blasco and Ouhayoun, 1996).

After slaughtering, blood samples were collected then tubes were left in slope position till serum samples were separated through centrifugation at 1000 g for 20 minutes. The sera were collected and preserved in a deep freezer at (-20oC) until the time of analysis.

Serum total protein, albumin, globulin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatinine, and uric acid were measured using commercial kits (purchased from Bio-diagnostic, Cairo, Egypt, www.bio-diagnostic.com) according to the manufacturers' instructions. Serum globulin concentration was calculated by the difference between total protein and albumin, and the albumin/globulin ratio was calculated.

2.4. Statistical analysis

The current data were normally distributed and were subjected to statistical analysis using the general linear model (GLM) of the SAS program (SAS Institute, SAS® 2009). The following model was fitted: Yijk = μ +Si+ Ej+ SEij+ eijK. Where: Yijk = observed value of the concerned treatment. μ = observed mean for the concerned treatment. Si = effect due to breed. Ej= effect due to prebiotic oligosaccharides supplementation. SEij = interaction effect due to breed and prebiotic oligosaccharides supplementation. eijk = the error related to individual observation. Differences between means due to effect of the breed and treatment separately were tested with Duncan's multiple range test at the level of α = 0.05 (Duncan, 1955), while differences between means due to the interaction between breed and treatment were tested using LSMEANS/PDIFF. The percentages of the studied traits were transformed to Arcsine values and then re-transformed to the original values after analysis.

3. Results

3.1 Growth performance

Results of Dietary supplementation of prebiotic oligosaccharides, in particular Mannan-oligosaccharides (MOS) and Isomalto-oligosaccharides (IMO), breed effect and interaction between breed and treatment on growth performance (BW, BWG and FCR) are presented in Table (2 a, b &c). Dietary supplementation of prebiotic oligosaccharides, in particular (MOS) and (IMO) accelerated BWG in rabbits especially during 1st, and 6th week of experimental period (128.6±4.01; 183.3±4.01 vs. 121.7±4.01, respectively), during 1st week when compared with control, and (198.1±9.23; 178.3±9.24 vs. 153.8±9.25, respectively) during 6th week of experiment. Moreover, there was significant difference between rabbits supplemented with (IMO) when compared with the control group in 1st week while, between (MOS) and control group during the 6th week. Supplementing (MOS) and (IMO) improved FCR especially during 1st, 4th and 6th week of experimental period (3.05±0.09; 2.87±0.09 vs. 3.24±0.09, respectively) during 1st week when with control, respectively; (3.10±0.19; 2.99±0.19 vs. 3.63±0.19, respectively) during 4th week of experiment, and (3.99±0.23; 4.25±0.23 vs. 4.78±0.23, respectively) during 6th week of experiment. There is a remarkable difference in all of growth performance traits due to breed effect. The interaction between prebiotic oligosaccharides supplementation and breed revealed significant differences on BWG during the most of experimental periods and FCR and the highest gain and the lowest FCR were recorded in each breed when interacted with either MOS or IMO (Table 2).

Regarding to breed effect, there are some improvement in growth performance traits, carcass traits due to breed effect, without a negative impact on both liver and kidney function enzymes. APRI line recoded better growth performance than New Zealand White rabbits under Egyptian environmental conditions.

3.2. Carcass traits

Findings of carcass traits showed positive differences in all of carcass traits studied due to dietary supplementation of prebiotic oligosaccharides, (MOS andIMO), and their interaction with breed (Table 3). Regarding to breed effect, it was noticed that there were non-significant differences in all studied carcass traits except gastrointestinal tract % and total giblets% (liver, spleen and heart), and the highest carcass traits percentages were noticed in each breed where interacted with either MOS or IMO.

3.3. Blood biochemical parameters

Dietary supplementation of rabbits with prebiotic oligosaccharides (MOS and IMO) did not revealed negative alterations on both liver and kidney function enzymes but increased blood total protein and albumin and improved A/G (Table 4)

4. Discussion

The primary role of a diet is not only to provide enough nutrients to fulfill metabolic requirements of the body but also to modulate various functions of the body. Probiotics, prebiotics, and symbiotic are either beneficial microorganisms or substrates that facilitate the growth of these microorganisms, which can be suitably harnessed by the food manufacturers and hold considerable promise for the health care industry (Awad et al., 2009).

Prebiotics such as oligosaccharides, are a class of carbohydrates that are not absorbed or digested in the small intestine of animals. However, they are easily fermented by the intestinal microflora, causing possible alteration in this flora with an increase in beneficial bacteria and decrease in harmful bacteria (Quigley, 2004). Mannan-oligosaccharides (MOS), derived from the outer cell wall of yeast Saccharomyces cerevisiae, which is made up of mannan element, is similar in structure to carbohydrates on the animal intestinal wall. Therefore, the harmful and pathogenic microbes will adhere to the mannans of MOS instead of mannans of the gut wall, and consequently protect the mucosal receptors and be washed out of the intestines. Finally, the animal health and growth will improve as a result of the disposal of these pathogens (Quigley, 2004).

The current study aimed at investigating the beneficial effects of supplementation of prebiotic oligosaccharides, in particular Mannan-oligosaccharides and Isomalto-oligosaccharides (MOS and IMO) in growing rabbit diets using two breeds (New Zealand White and APRI), as well as, the interaction between the breed and treatments. In the present work, dietary supplementation of (MOS) or (IMO) provided some positive effects on growth performance and health status. The obtained findings confirmed the previous results of the other investigators (Awad et al., 2009; Attia et al., 2015; Bovera et al., 2019).

It has been supposed that some of the benefits in growth performance of rabbits may be due to the benefits impacts of prebiotic oligosaccharides on the intestinal health as dietary MOS supplementation (2.0 and 1.0 g/kg MOS) stimulated intestinal villi development and caecal volatile fatty acid concentrations and reduced caecal pH (Pinheiro et al., 2004). Likely, Guedes et al., (2009) found that addition of 2.0 g/kg MOS to the diet increased VFA concentration in the caecum of growing rabbits. Additional beneficial effects of prebiotics on physiological aspects include enhancement of mineral absorption, reduction in serum lipid levels, reduction in production of putrefactive substances and inhibition of gut pathogens (Cummings and Macfarlane, 2002; Marteau and Boutron-Ruault, 2002). On the other hand, the supplementation of New Zealand White rabbit with probiotic or prebiotic or combination of both with organic acid had no effect on their feed intake (Eiben et al., 2008; Chrastinova et al., 2010; Ewuola et al., 2011).

Our results are on contrary with those obtained by Mourão et al., (2006) showed that the addition of MOS resulted in similar performance compared to an antibiotic growth promoter. Similarly, other studies completed by Thitaram et al., (2005) reported that no differences in feed consumption, feed conversion, or feed efficiency for birds fed IMO compared with the control group were observed; however, the result showed a significant reduction in weight for birds fed 1% IMO diet compared with those fed the control diet.

In other studies, Biggs et al., (2007) focused on the effect of feeding chicks with feed with addition of 5 different oligosaccharides (inulin, oligofructose, MOS, short-chain oligosaccharide and Transgalacto-oligosaccharides), they reported that no significant increase in body weight was observed in any case. Moreover, the study demonstrated that excessively high prebiotic dose may have a negative impact on the gastrointestinal system and delay the process of growth of animals. Similarly, other studies completed by Jung et al., (2008) on broiler chickens demonstrated that administration of feed with an addition of Galacto-oligosaccharides at various concentrations for 40 days of rearing had no effect on the feed conversion index, body weight and consumption of feed. Results of studies on the effect of prebiotics on animal health are often contradictory, which is a result of high specificity of individual compounds, various doses and time of application.

Moreover, Kritas et al., (2008) showed that probiotic-treated rabbits were heavier than control group (54 g and 123 g) at the end of the growing and finishing phases, respectively, with higher average daily gain and better feed conversion ratio ($p<0.05$), in addition, Sarat Chandra et al., (2015) reported that supplying diet with probiotics had a positive effect on body weight gain of weaning rabbits (28 days) in New Zealand White, Grey Giant, and Flemish Giant.

There are some differences in all of growth performance traits and more pronounced in body weights due to breed effect. our findings are partially consistent with, Nasr et al., (2017) found that purebred NZW rabbits had significantly higher body weight and ADG at week 10 of age than the RX breed. Also, El-Aziz et al., (2012) who observed great variations in all growth performance due to breed effect. In contrast, Maj et al., (2009) did not report significant variations in the final body weight and average daily gain between NZW and RX rabbits. In an earlier study, the significant effects of genetic structure on body weight, ADG, feed intake, and feed efficiency in broiler rabbits had been reported (Anitha, 2007).

Regarding to carcass traits findings, the present results are consistent with those obtained by Attia et al., (2015) who observed that Mannan-oligosaccharides administered intermittently increased dressing percentage as compared to control. These findings were also coincided with Abdel-Hamid and Farahat (2015) who stated that carcass traits such as live weight, hot and reference carcass weight ($P<0.001$), percentage of periscapular, and perirenal fat relative to reference carcass weight ($P<0.05$) were significantly affected by the dietary MOS supplementation. Our results are on contrary with those obtained by Ewuola et al., (2011) reported that addition of growth promoting additives (dietary prebiotics and probiotics a symbiotic) had no significant effect on the carcass characteristics measured except the right arms of rabbits. Özsoy and Yalçin (2011), Rotolo et al., (2014) who observed non-significant differences in carcass traits of growing rabbits due to dietary prebiotic oligosaccharides. In the same line, Ahmed et al., (2015) reported non-significant differences in dressing percentage of broiler chicks as affected by different dietary levels of Saccharomyces cerevisiae probiotics.

Regarding to breed effect on carcass traits, it was noticed that there were non-significant differences in all carcass traits except gastrointestinal tract % and total giblets% (liver, spleen and heart), and the highest carcass traits percentages were noticed in each breed where interacted with either MOS or IMO. The non-significant differences between NZW and RX for carcass traits were previously observed by Nasr et al., (2017). In the current study, the absence of significant differences in the hot carcass weight and dressing percentage between the genetic groups has supported the findings of previous studies (Ortiz-Hernandez and Rubio-Lozano 2001; Ouyed et al., 2011).

Concerning the biochemical findings, dietary supplementation of rabbits with prebiotic oligosaccharides (MOS and IMO) did not alter liver and kidney function enzymes but increased blood total protein and albumin and improved A/G ratio. The results are not in a harmony with those obtained with El-Sawy et al., (2014) who reported that orally administration of yeast beta-glucan did not alter serum protein, albumin and globulin of chicks in comparison with control chicks. Within the treated groups of chicks there were no significant differences in serum protein, albumin and globulin of at 42 days from drug administration. There were no significant differences in albumin/globulin ratio between all treated groups of chicks and control chicks. Likewise, Attia et al., (2015) who concluded that blood parameters of growing rabbits were not significantly changed due to dietary supplementation of Mannan-oligosaccharides and zinc-bacitracin.

In conclusion, supplementation of rabbits diet with prebiotic oligosaccharides, in particular Mannan-oligosaccharides (MOS) and Isomalto-oligosaccharides (IMO) resulted in an enhancement for growth performance parameters, carcass traits with no a negative impact on both liver and kidney function enzymes. With regarding to breed, APRI line recoded some better growth performance especially body weight than New Zealand White rabbits under Egyptian environmental conditions.

Competing Interests

The authors have no conflict of interest.

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