2018, Scienceline Publication
World's Veterinary Journal
World Vet J, 8(4): 80-89, December 25, 2018
ISSN 2322-4568

Effect of Probiotics on Growth, Some Plasma Biochemical Parameters and Immunoglobulins of Growing Najdi Lambs

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ORGINAL ARTICLE
pii: S232245681800009-8
Received: 19 Oct 2018
Accepted: 25 Nov 2018

ABSTRACT

This study was performed at the governorate of Alkhurmah, Kingdom of Saudi Arabia. Twenty growing Najdi lambs aged six months with average body weight 35.22± 0.107 and 33.67± 0.107 kg for males and females, respectively were allotted based on their gender into two main groups (10 males and 10 females), each gender divided into two subgroups the first subgroup of each gender served as control while the second was supplemented with *Lactobacillus sporogenes* 37.50×10^3, *Saccharomyces cerevisiae* 625.0×10^3 CFU, 1g Alpha amylase and 20g sea wood powder / kg diet (concentrate feed mixture) for six months. The results indicated that lambs supplemented with probiotics in diet had better improvement ($P<0.05$) on growth performance indices (Average daily gain, growth rate and total weight gain) compared with control subgroups in both genders. Probiotics increased ($P<0.05$) the values of plasma total protein, glucose, urea nitrogen and aspartate aminotransferase compared with control group. On the other hand, total cholesterol concentration decreased significantly ($P<0.05$) in lambs supplemented with probiotics than control groups. The mean values of plasma immunoglobulin A did not differ in both control and treated groups during the study period, while plasma immunoglobulin G increased significantly ($P<0.05$) in lambs supplemented with probiotics compared with control groups in both genders. Plasma total lipids and aspartate aminotransferase concentrations remained relatively stable throughout the study period in both probiotics and control groups. In conclusion, probiotic supplementations can be used as the important biological additives for enhancing growth indices and immunity status of growing lambs.

Key words: Body weight, Immunoglobulin, Najdi lambs, Plasma metabolites, Probiotics, Sex

INTRODUCTION

Probiotics is defined by the food and agricultural organization of the united nations (FAO/WHO, 2002; Senok et al., 2005) as "live microorganisms used in adequate amounts, which afford a beneficial health effect on the host. Administration of probiotics strains separately and in combination was significantly improved feed intake, feed conversion rate, daily weight gains and total body weight in chicken, sheep, goat and cattle (Chiofalo et al., 2004; Salmi et al., 2007; Saleem et al., 2017), improve absorption of nutrients and thus reduce mortality and accelerated weaning of young animals. A positive effect of probiotics supplementation on intake, growth rate and fed conversion in ruminants has been reported by other workers (Antunovicc et al., 2005; Whitley et al., 2009). Probiotics are used in commercial animal production farms to adjust alter gastrointestinal flora, causes improving animal health and productivity. The major outcomes from using probiotics include enhance growth, reduce mortality rate, and increase feed conversion efficiency (Yirga H, 2015)

One of the most important functions of direct-fed probiotics is that they can play a role in the immune system as immunomodulators (Fang et al., 2000; Kaburagi et al., 2007). Immunoglobulin G plays an important role in systemic immune response and is the main antibody in the serum after ingestion of probiotic protein. Immunoglobulin A is a major antibody in the mucosal immunity, and the main function of immunoglobulin A (IgA) is to exert the immune exclusion of pathogenic bacteria by intimate cooperation with innate nonspecific defense mechanisms (Sun et al., 2010). Probiotics increased intestinal IgA secretion both in sows and piglets. Probiotics increase the speed of development of the rumen flora and fauna, enhance immunity (Aattouri et al., 2001), reduced the incidence of intestinal infections, restore an intestinal micro-flora and have a positive effect in cases of diarrhea (Musa et al., 2009). Sohini et al. (2018) reported that probiotic supplementation in rats provide protection against oxidative stress.

Therefore, the objective of this study was the investigating of the effect of *L. sporogenes* ($37.50\times10^{3)}$, *S. cerevisiae* SC-47 (625.0×10^3 CFU), 1g alpha amylase and 20g sea wood powder/kg diet on growth indices, some plasma biochemical parameters and immunoglobulin's levels of growing Najdi lambs.

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MATERIALS AND METHODS

Aim of the study

This experiment aimed at studying to evaluate the effect of *Lactobacillus sporogenes* ($37.50 \times 10^{3)}$, *Saccharomyces cerevisiae* SC-47 ($625.0 \times 10\ ^{3}$CFU), 1g Alpha amylase and 20 g sea wood powder / kg diet on growing Najdi lambs and their growth indices, some plasma biochemical parameters and immunoglobulins levels.

Ethical approval

This experiment was performed according to all ethics and animal rights (Ain Shams University, Egypt).

Animals and experimental design

Twenty growing Najdi lambs (one of the indigenous Saudi Arabia sheep breeds), with average age of six months, average body weight of 35.22± 0.107 and 33.67± 0.107 kg for males and females, respectively were used. Mineral salt blocks were distributed equally inside each yard. Lambs were allotted based on their sexes into two equal subgroups (10 lambs/each gender). Animals were housed in four shaded pens. The first group of each gender was served as control while the second group was supplemented with *Lactobacillus sporogenes* ($37.50\times10^{3)}$, *Saccharomyces cerevisiae* SC-47 (625.0×10^{3}cuf), 1g Alpha amylase and 20g sea wood powder/kg diet [concentrate feed mixture (CFM)] were subjected for six consecutive months. The level of probiotics was listed in table 1.

The experimental diet composed of 60% concentrate feed mixture plus 40 % alfalfa hay. Average daily ration was adjusted according to monthly body weight changes of lambs to achieve adequate growth. Concentrate feed mixture was always provided first. Drinking water was available ad libitum. Chemical analyses of dietary ingredients are reported in table 2.

Table 1. Level of Probiotics added to the experimental diets of Najady lambs

Component	**Content / kg diet**
Lactobacillus sporogenes	$37.50\ \times10^{3}$ CFU
Saccharomyces cerevisiae SC-47	$625.\ \times10^{3}$ CFU
Alpha amylase	1g
Sea wood powder	20g

Table 2. Chemical compositions of concentrate and alfalfa hay (on dry matter basis, %)

Item	**DM%**	**OM**	**CP**	**CF**	**EE**	**NFE**	**Ash**
Concentrate feed mixture	88.75	91.52	15.31	13.56	2.72	62.23	8.98
Alfalfa hay	92.42	85.35	11.74	31.26	2.39	45.68	11.64

DM= dry matter; OM= organic matter; CP= crude protein; CF= crude fiber; EE= ether extract; NFE= nitrogen free extract

Lambs were weighed monthly by using an aviary weighing–machine to the nearest 100 grams at 07:00 a.m. Furthermore, growth performance indices were calculated as follows: average daily gain (ADG, g/lamb/d) was calculated by subtracting the initial live body weight (ILBW) from final live body weight (FLBW) divided by the time period (180 days). Total weight gain (TWG, kg) was measured as the difference between final LBW and initial LBW. Growth rate (GR%) = (final LBW- initial LBW)/ (initial weight) *100.

Monthly, jugular blood samples were withdrawn from each animal. Plasma total proteins (TP, g/ dl), albumin (A, g/dl), Total Cholesterol (CHO, mg/dl), plasma urea nitrogen (PUN. mg/dl), and plasma alanine transferase (ALT) and aspirate transferase (AST, µ/l) concentrations were determined. The concentrations of IgA and immunoglobulin G (IgG) from plasma samples were determined using a sandwich ELISA detection kit for bovine Immunoglobulin A and G against standards, according to the manufacturer’s suggested protocol (CUSAbio Biotech Inc., Wuhan, China).

Statistical analysis was conducted using the general linear model (GLM) procedures of SAS (2008). A repeated measurements model was used. Body weight, plasma biochemical and immunoglobulin parameters were compared between the model factors according the following model. Distributed Duncan’s test (1955) was used to detect the differences ($P<0.05$) among different group means. The statistical model was:

$Y_{ijkl} = \mu + T_i + S_j + P_k\ (A_l) + eijkl$

Where;

μ = the overall mean

T_i = treatment effect, i = 1: 2

S_j = sex effect j= 1 or 2

$P_k\ (A_l)$ = animal within period effect k= 1-6 and l = 1-5

e_{ijkl} = error

RESULTS AND DISCUSSION

Animal growth performance

The initial and final body weight of Najdi lambs are presented in table 3. The results revealed that, lambs supplemented with *Lactobacillus sporogenes* (37.50×10^3), Saccharomyces *cerevisiae* SC-47 (625.0×10^3 CFU), 1g Alpha amylase and 20g sea wood powder/kg diet significantly (P<0.05) improved body weight in both genders compared to the control groups. Similar results were observed by Abas et al. (2007) and Ismaiel et al. (2010) that yeast culture increased average daily gain of lambs. Hussein (2014); Abdel-Salam et al. (2014) and Mohamed et al. (2016) reported that Najdi lambs supplemented with probiotics had better performance (P<0.05) in GR, ADG and TWG than control group. Recently, Saleem et al. (2017) found a positive effect of inclusion probiotics on growth performance by enhancing BW gain, TWG and GR of Saidi lambs during post-weaning period. This is a disagreement with Baranowski et al. (2007), Titi et al. (2008) and Whitley et al. (2009) that yeast supplementation had no effect on growth rate in lambs and goat kids.

Data presented in table 2 indicated that, at the end of experiment, GR, ADG and TWG were higher in male (19.32 %, 35.00 g/h/day and 6.30kg) and female (17.51%, 30.27 g/h/d and 5.45kg) lambs supplemented with *Lactobacillus sporogenes* (37.50 X 10^3), *Saccharomyces cerevisiae* SC-47 (625.0 X 10^3 CFU), 1g Alpha amylase and 20 g sea wood powder /kg diet than control groups male (15.29%, 27.77 g/h/day and 5.00 kg) and female (14.53%, 24.94 g/h/d and 4.49 kg), respectively. Similar results observed by Sarwar et al. (2010); Mukhtar et al. (2010); Khalid et al. (2011) and Adel and EL-Metwaly (2012).

With respect to the effect of gender, results in table 3 indicated that gender had a significant effect (P<0.05) where male lambs had the higher mean body weight at the beginning and end of study than females. Similar results were observed by Abbas et al. (2010); Abdel-Fattah et al. (2013) and Wielgosz-Groth et al. (2015). Who demonstrated that gender had significant effect on body weight which may be due to the secretion of sex hormones with advance in age.

Table 3. Means ± SE of body weight, growth rate, average daily gain and total weight gain of male and female Najdi lambs supplemented with probiotics in diets under Saudi Arabia environment during September 2017 to February 2018

Experimental groups	Males		Females	
Item	C	T	C	T
No. of animals	5	5	5	5
1st month, kg (Initial weight)	32.70^{a}	32.60^{a}	30.90^{a}	31.13^{a}
2nd month, kg	33.40^{b}	33.20^{a}	31.90^{b}	32.36^{a}
3rd month, kg	34.10^{b}	34.20^{a}	32.96^{b}	33.66^{a}
4th month, kg	35.20^{b}	35.60^{a}	33.82^{b}	34.61^{a}
5th month, kg	36.10^{b}	36.50^{a}	34.64^{b}	35.95^{a}
6th month (Final weight, kg)	37.70^{b}	38.90^{a}	35.39^{b}	36.58^{a}
± SE	0.19		0.20	
GR, %	15.29^{b}	19.32^{a}	14.53^{b}	17.51^{a}
ADG (g/h/d)	27.77^{b}	35.00^{a}	24.94^{b}	30.27^{a}
TWG, kg	5.00^{b}	6.30^{a}	4.49^{b}	5.45^{a}

C= control group= *Lactobacillus sporogenes* (37.50×10^3), *Saccharomyces cerevisiae* SC-47 (625.0×10^3 CUF), 1g Alpha amylase and 20g sea wood powder / kg diet; GR= growth rate, ADG= average daily gain; TWG= total weight gain; ^{a,b} within a row indicate a significant difference (P<0.05) between groups. SE= standard error.

Plasma proteins response

Means ± SE of total plasma protein (TP), albumin (A), globulin (G) concentrations and albumin/ globulin (A/G) ratio for treated and control groups of Najdi lambs are presented in table 4. Results indicated that, probiotics supplementation significantly increase (P<0.05) plasma TP, and, G concentrations, while plasma A and A/G ratio behaved the opposite trend. Figure 1 showed that the increase in plasma TP concentration was more pronounced from the third month till the end of experimental period. The present results may be related to the beneficial effect of probiotics supplementation on increasing protein digestibility through the enzymatic effect of protease and alteration amino acid profile of digesta due to increasing microbial protein synthesis (Williams, 1989; Abdel-Khalek et al., 2000).

Concerning the rate of change, results in table 4 revealed that, in both genders supplemented with probiotics recorded the higher rate of change in TP and G (12.71, 38.44 % for males and 11.09, 27.44% for females) compared with control group (4.05 and, 9.24 % for males and 5.87, 17.66% for females) at the end of experimental period. The corresponding values for plasma A and A/G ratio recorded (-10.61 and -36.04 % for males; 0.83 and -22.68% for females) of lambs supplemented with probiotics compared with control groups (-1.43 and -10.42 % for males; - 4.74 and -20.72% for females), respectively. These findings are in agreement with El-Shaer (2003) and El-Ashry et al. (2003) in sheep and Kholif (2001), Abu El-Ella and Kommonna (2013) in goats. They found that the Yeast Culture (YC)

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supplementation led to increase TP. In contrast, Abdel Rahman et al. (2012) reported that YC supplementation significantly increased albumin concentration, while it was not significantly affected plasma TP or globulin concentrations of sheep. Also, Hossein-Ali et al. (2014) found that lambs supplemented with probiotics decreased significantly (P<0.05) the levels of plasma TP and albumin concentrations compared with control group. Recently, Saleem et al. (2017) reported that no significant effects on plasma TP, A and G levels during post-weaning period of Saidi lambs fed diet supplemented with probiotics.

With respect to the effect of sex, statistical analysis of the obtained results indicated that, there were no significant (P<0.05) differences in TP, A, G and A/G ratio due to gender. In accordance, Carlos et al. (2015) found that the values of serum TP, A, G concentrations and A/G ratio were not significantly (P>0.05) affected by the gender of Morada Nova sheep. On the other hand, AL-Hadithy and Badawi (2015) found that there were significant (P<0.05) differences between males and females of Awassi sheep in serum TP, A and G concentrations where ewe lambs recorded the higher values compared with ram lambs.

Table 4. Means ±SE of plasma total proteins, albumin, globulin concentrations and A/G ratio of male and female Najdi lambs supplemented with probiotics in diets under Saudi Arabia environment during period from September 2017 to February 2018

Trait	Experimental groups	Males		Females		±SE
		C	T	C	T	
TP (g/dl)	Initial	7.16^b	7.24^b	7.32^b	7.39^b	0.17
	Final	7.45^a	8.16^a	7.75^a	8.21^a	0.15
	Change %	4.05	12.71	5.87	11.09	-
A (g/dl)	Initial	3.49^a	3.77^a	3.80^a	3.60^a	0.12
	Final	3.44^a	3.37^a	3.62^a	3.63^a	0.12
	Change %	- 1.43	- 10.61	- 4.74	0.83	-
G (g/dl)	Initial	3.68^b	3.46^b	3.51^b	3.79^b	0.15
	Final	4.02^a	4.79^a	4.13^a	4.83^a	0.13
	Change%	9.24	38.44	17.66	27.44	-
A/G ratio	Initial	0.96^a	1.11^a	1.11^a	0.97^a	0.06
	Final	0.86^b	0.71^b	0.88^b	0.75^b	0.05
	Change%	- 10.42	- 36.04	- 20.72	- 22.68	-

C= control group; T= *Lactobacillus sporogenes* (37.50 X $10^{3)}$, *Saccharomyces cerevisiae* SC-47 (625.0 X 10^3 CUF.), 1g Alpha amylase and 20 g sea wood powder / kg diet; TP= total protein; A= albumin; G= globulin; SE= standard error. A/G= Albumin/ globulin ratio, ^{a,b} in the same column are statistically (P<0.05) difference between groups

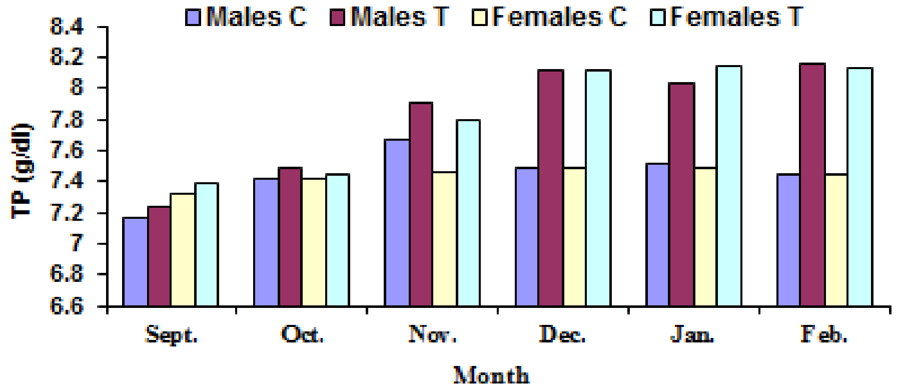

Figure 1. Effect of probiotics supplementation on plasma total proteins concentration of male and female Najdi lambs under Saudi Arabia environment during period September 2017 to February 2018

Plasma total cholesterol response

Means ± SE of plasma Total Cholesterol (CHO) concentration in Najdi lambs fed diet supplemented with probiotics are presented in table 5. The results indicated that male and female lambs supplemented with probiotics caused significantly (P<0.05) low plasma CHO compared with control groups. As shown in figure 2, plasma total CHO began to decrease from the second month of treatment till the end of experimental period. The significant (P<0.05) decrease in plasma total CHO concentration in treated groups in comparison to control groups are in agreement with those finding by Abu El-Ella and Kommonna (2013), Hossein-Ali et al. (2014) and Mozhgan et al. (2016) who reported that lambs supplemented with probiotics decreased significantly (P<0.05) the level of CHO concentration compared with control group. There are two proposed mechanisms for the reduction of plasma cholesterol concentration in animals fed

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with probiotics: (1) increase in degradation of cholesterol across the gastrointestinal tract (Zarate et al., 2002) and (2) simultaneous sediment of cholesterol and deconjugation of bile acids (Fernades et al., 1987). In addition, Ooi and Liong (2010) illustrated that cholesterol removed by probiotics by incorporation into the cellular membranes during growth. They added that the cholesterol converted to coprostanol in the intestines which excreted in feces, therefore this reduction in the cholesterol absorbed resulted in decreasing concentration of cholesterol in blood. Hossein-Ali et al. (2014) found that lambs supplemented by probiotics containing *Bacillus subtilis* and *Bacillus licheniformis* with the trade name of Bioplus 2B at two levels (0.5 and 1g Bioplus 2B/kg diets) decreased significantly (P<0.05) the level of cholesterol concentration compared with control group.

With respect the effect of gender, results indicated that there was no sex effect (P<0.05) on plasma CHO concentration. Similar finding was reported in the study conducted by Carlos et al. (2015). In contrast, Abdel-Fattah et al. (2013) reported that there were significant differences (P<0.01) between genders where plasma CHO, concentration was found to be higher in male Barki lambs than that of ewe lambs.

Table 5. Means ±SE of plasma cholesterol, urea nitrogen, alanine amino transferase and aspartate amino transferase concentrations of male and female Najdi lambs supplemented with probiotics in diets under Saudi Arabia environment from September 2017 to February 2018

Trait	Experimental groups	Males		Females		±SE
		C	T	C	T	
CHO (mg/dl)	Initial	87.44[a]	86.24[a]	87.52[a]	85.98[a]	1.09
	Final	86.92[a]	76.29[b]	86.29[b]	78.22[b]	1.08
	Change%	- 0.59	- 11.54	- 1.40	- 9.02	-
PUN (mg/dl)	Initial	40.10[b]	41.68[b]	42.01[b]	42.20[b]	0.77
	Final	43.95[a]	47.54[a]	43.81[a]	48.15[a]	0.79
	Change%	9.60	14.06	4.28	14.09	
ALT (µ/l)	Initial	8.19[a]	8.07[a]	7.16[a]	7.98[a]	0.38
	Final	8.06[a]	7.95[a]	7.17[a]	7.95[a]	0.40
	Change%	- 1.58	- 1.49	- 0.28	- 0.37	
AST (µ/l)	Initial	14.87[b]	14.59[b]	15.93[b]	15.81[b]	0.33
	Final	16.28[a]	16.15[a]	17.16[a]	17.46[a]	0.34
	Change%	9.48	10.69	7.72	10.44	-

C= control group; T= Lactobacillus sporogenes (37.50 X $10^{3)}$, *Saccharomyces cerevisiae* SC-47 (625.0×10^3 cuf), 1g Alpha amylase and 20g sea wood powder/kg diet; CHO= total cholesterol; PUN=plasma urea nitrogen; ALT= alanine amino transaminase; AST= aspartate amino transaminase;[a,b] in the same column are statistically (P<0.05) difference between groups; SE= standard error

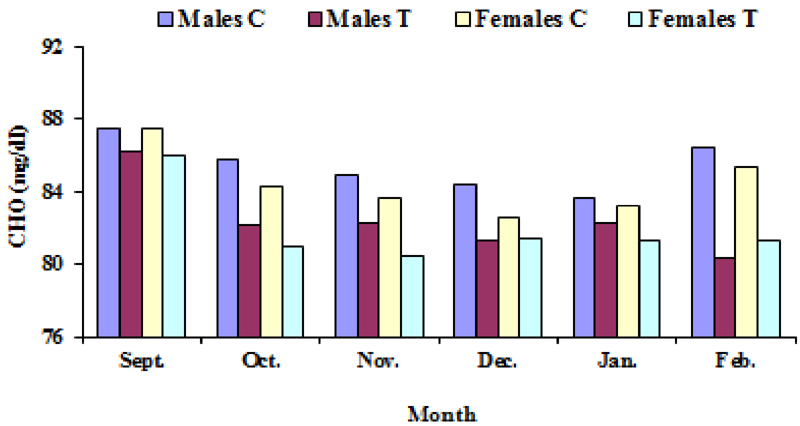

Figure 2. Effect of probiotics supplementation on plasma cholesterol concentration of male and female Najdi lambs under Saudi Arabia environment during period from September 2017 to February 2018

Plasma urea nitrogen (PUN) response

Table 4 summarizes the means ± SE of plasma urea nitrogen concentrations during the experiment period, results indicated that Plasma Urea Nitrogen **(**PUN) was increased (P<0.05) in male and female lambs supplemented with probiotics compared with control groups. Moreover, the rate of change was slightly higher in treated males (14.06%) and females (14.09%) compared with control males (9.60%) and females (4.28%), respectively. In agreement, Hillal et al. (2011) reported that high concentration of PUN may be due to incapacity of ruminal microflora to detain the ammonia optimally (Butler, 1998). Also, Abdel-Rahman et al. (2012) and Mousa et al. (2012) on sheep found that feeding diets treated with probiotic resulted in an increase of urea concentration. In contrast, no difference (P<0.05) was noticed in plasma urea nitrogen concentration of Kajli lambs due to protein sources and probiotics level (Sarwar et al. 2011). Antunovic et al. (2005) in weaned lambs received 0.1% probiotic and Antunovic et al. (2006), where the concentration of urea was lower in the experimental group (5.51:7.97 mmol/l). On the other hand, El-Ashry et al. (2003); Shakweer

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(2003) and Petr Dolezal et al. (2011) found lower concentration in serum urea nitrogen of cows in response to probiotic supplementation which suggested as an indicator of better nitrogen metabolism and utilization of protein. With respect the effect of sex, statistical analysis of the obtained results revealed that there was not significant (P>0.05) effect in plasma PUN concentrations due to sex. The results of Rabee et al. (2014) and Carlos et al. (2015) were in agreement with the present results. On the contrary, Sitmo (2014) reported that PUN concentration differed significantly between genders (P<0.05) where females tended to have higher values than males.

Plasma Alanine transferase (ALT) and Aspirate transferase (AST) response

Means± SE of plasma liver enzymes including ALT and AST are presented in table 5. The obtained results revealed that plasma ALT levels decreased significantly (P<0.05) in control and treated groups in both genders, this decrease was more pronounced in males (-1.5 and -1.49%) than females (-0.28 and -0.37%) for control and treated groups, respectively. On the other hand, plasma AST behaved the opposite trend where AST concentration increased significantly (P<0.05) in lambs supplemented probiotics compared with control groups of both genders. The results of Abdel-Khalek et al. (2012), Adel and El-Metwaly (2012); Abu El-Ella and Kommonna (2013) were in agreement with the present results. On the contrary, Afify et al. (2007) found a significant increase in serum ALT in calves treated with oxytetracycline and erythromycin (as growth promoter). EL-Ashry et al. (2003) found that supplementation of flavomycin (20mg/h/d) and *Saccharomyces cerevisiae* (5mg/h/d) increased (P<0.01) plasma ALT and AST than control groups of growing lambs. With respect the effect of sex, statistical analysis of the obtained results indicated that plasma enzymes (ALT and AST) not differed significantly (P<0.05) between males and females along the experimental period. In agreement, Kiran et al. (2012), Khan et al. (2013), Abdel-Fattah et al. (2013) and Sitmo (2014). While, Carlos et al. (2015) found that plasma levels of ALT recorded the higher (P<0.05) values for male than female of Morada Nova sheep.

Plasma immunoglobulins response

Concerning to the influence of probiotics supplementation on immune response, data in table 6 clearly indicated no significant difference (P<0.05) was recorded in plasma IgA concentrations among control and treated groups of both male and females. While the mean IgG concentration of lambs supplemented probiotics showed significantly (P<0.05) increase compared with control groups. These findings agree with several studies performed by Al-Saiady (2010), Sarker and Yang (2010), Sun et al., (2010) reported that no difference was observed in serum IgA whereas serum IgG was higher in the probiotic supplemented calves than in the control. Higgins et al. (2007) explained that, Direct Fed Microbial (DFM) have ability to enhance immunity by promoting the production of antibodies and cytokines and colonize the intestines, increasing phagocytosis of pathogens. McBeath et al. (1971) found that serum TP concentration was correlated (r= 0.72) with serum Ig concentrations in newborn calves. Also, Zachwieja and Dobicki (1997) found high (P<0.05) correlation between TP levels and immunoglobulins (IgA, IgG and IgM) levels in serum of the calves.

As shown in figure 3, on monthly plasma IgA concentration indicated that there was no significant difference (P<0.05) at any month along experimental period between treated and control groups and between genders. While figure 4 showed that lambs supplemented probiotics began to increase their plasma IgG from the third month till the end of experimental period in both genders. The rate of change in plasma IgA recorded - 0.10 and 0.00 vs. 0.41 and 0.63% for control and treated groups of both males and females, respectively. The corresponding values for plasma IgG recorded (0.09 and 3.85% vs. 0.16 and 3.62%) for control and treated groups of both males and females, respectively.

The results are disagreed with Patience (2015) found that DFM increased significantly (P<0.05) serum IgA levels than the control group, and this increase might be because feeding DFM elicits mucosal immunity and IgA is the dominant antibody of the mucosa. Regarding the effect of sex, statistical analysis of the obtained results indicated that plasma IgA and IgG levels not differed significantly (P<0.05) between males and females along the experimental period. Similarly, Kara (2009) found that no significant effect of calf sex on serum Ig concentrations after 24 h of birth.

Table 6. Concentrations of plasma immunoglobulin's (IgA and IgG) in male and female Najdi lambs supplemented with probiotics in diets under Saudi Arabia environment from September 2017 to February 2018

Experimental groups Trait		Males		Females		±SE
		C	T	C	T	
IgA (mg/dl)	Initial	964[a]	963[a]	959[a]	957[a]	1.28
	Final	963[a]	963[a]	963[a]	963[a]	1.30
	Change%	- 0.10	0.00	0.41	0.63	-
IgG (mg/dl)	Initial	1235.6[b]	1237.2[b]	1236.6[b]	1238[b]	2.46
	Final	1236.8[a]	1284.8[a]	1238.6[a]	1282.8[a]	2.45
	Change%	0.09	3.85	0.16	3.62	-

C= control group; T= *Lactobacillus sporogenes* (37.50 X $10^{3)}$, *Saccharomyces cerevisiae* SC-47 (625.0×10^3 cuf), 1g Alpha amylase and 20 g sea wood powder / kg diet; IgA=plasma immunoglobulin A; IgG= plasma immunoglobulin G. [a,b] in the same column are statistically (P<0.05) difference between groups; SE= standard error

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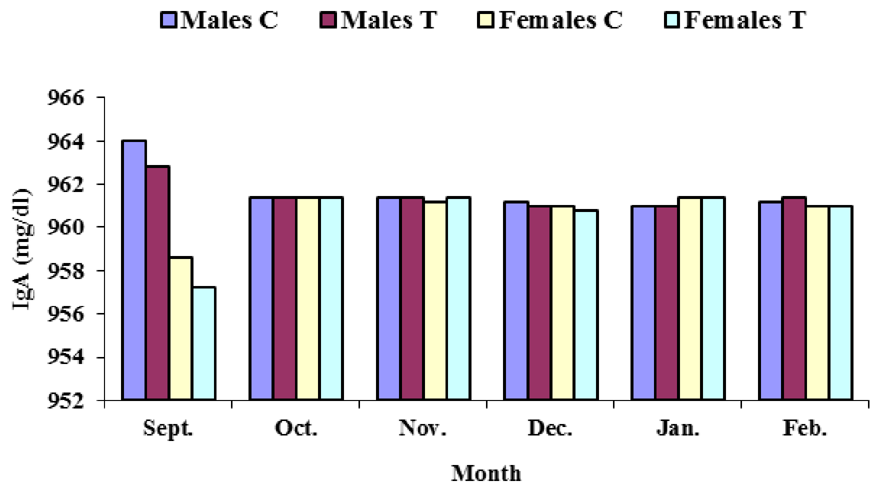

Figure 3. Effect of probiotics supplementation on plasma immunoglobulin A concentration of male and female Najdi lambs under Saudi Arabia environment during period from September 2017 to February 2018

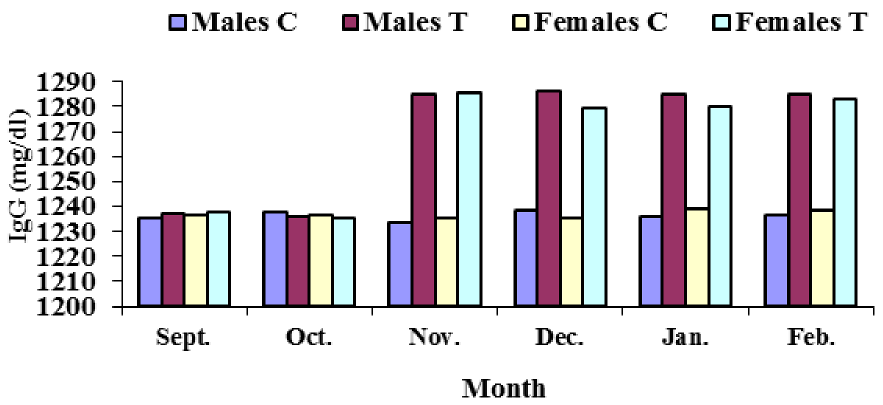

Figure 4. Effect of probiotics supplementation on plasma immunoglobulin G concentration of male and female Najdi lambs under Saudi Arabia environment from September 2017 to February 2018

CONCLUSION

The increase in growth indices (GR, ADG and TWG), plasma TP, G, PUN, GLU, IgG concentrations and the decrease in plasma CHO concentration of lambs supplemented with probiotics are all signs of improved health by potential beneficial effects of probiotics. Accordingly, the results recommended probiotics as one of the important biological additives for enhancing the growth indices and immunity in growing lambs without any side effect on plasma biochemical levels.

DECLARATIONS

Consent to publish

The author agrees to publish this paper in the journal of World's Veterinary Journal.

Competing interests

The author declares that he has no competing interests.

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To cite this paper: Hussein AF (2018). Effect of Probiotics on Growth, Some Plasma Biochemical Parameters and Immunoglobulins of Growing Najdi Lambs. *World Vet. J.* 8(4): 80-89. www.wvj.science-line.com

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