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Effect of Garlic Extract Supplementation on Growth Performance, Nutrient Digestibility and Some Blood Serum Biochemical Changes of Fattening Lambs

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ABSTRACT

Twentyfour growing lambs, which were apparently healthy, of nearly the same body weight (approx. 22.29kg) were used in this study to investigate the effect of garlic extract supplementation on growth performance, nutrient digestibility and some blood serum parameters of growing lambs. Lambs were allotted into two equal groups, first group fed on the basal diet without any supplement while 2nd group fed on the basal diet and garlic extract (garlin) in drinking water for continuous 12 weeks. It was found that allicin supplementation non-significantly improved body weight of growing fattening lambs at the end of the experiment by about 0.52% when compared with control. Moreover. Statistical analysis of the obtained data indicated that garlic extract supplementation (62.5 mg allicin/L water) non significantly improved total body gain of growing lambs by about 4.9%, improved feed conversion ratio by about 5.1%, moreover, garlic extract supplementation improve TDN and digestible protein conversion ratio by about 16.1% and 17.2% respectively when compared with control. Also, garlic extract supplementation had no effect on nutrient digestibility, while non-significantly increased blood serum total protein, globulin and glucose concentrations and had no effect on calcium and phosphorus blood serum concentration when compared with the control. On the other hand, it can be concluded that garlic extract supplementation in drinking water for growing lambs may be slightly reduce efficiency of kidney and liver function through numerical higher creatinine, GOT and GPT blood serum concentrations throughout the whole experimental period when compared with the control and non-significantly reduced blood serum triglycerides and total cholesterol. Generally, garlic extract had no significant effect on growth performance of growing lambs and no effect on economic efficiency of production.

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1. INTRODUCTION

Over the last decades, antibiotic as growth promoters have been included successfully in ruminant animal diet additives to improve animal performance besides reducing diseases probabilities (Tedeschi *et al.*, 2003 and Chaveset al., 2008). Nevertheless, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) have drawn attention to the threat of the transfer of antibiotic resistant pathogens to humans beside the hazard of their residues in meat and milk on human health (FAO/OIE/WHO, 2004). Therefore, the European Union has prohibited their use (EC, 2003).

In recent years, aromatic plants and their extracts have received increased attention as potential alternatives to growth promoters. Garlic (*Allium sativum*) has been used as spice and folk medicine since antiquity (Rivlin, 2001). Bioactive components of garlic, including several sulfur-containing compounds such as alliin, diallylsulfides and allicin, may partly account for some effects of garlic (Amagase et al., 2001). In this regard, effects of garlic and its bioactive components have been partly demonstrated on rumen manipulation (*e.g.* defaunation, decreased methane production, decreased ruminal degradation of dietary proteins, reducing the proportion of acetate and increasing that of pro-pionate) and consequently on animal production and performances (Kholif et al., 2012).

This experiment was conducted to investigate the effect of garlic extract prebiotics water supplementation on growth performance, nutrient digestibility and some blood serum biochemical alterations of fattening lambs under field or traditional conditions.

2. MATERIAL AND METHODS

2.1. Animal used and housing: Twenty four growing lambs, which were apparently healthy, of nearly the same body weight (approx. 22.29 kg) and within the same age (average 8 months) were used in this study. Each group was housed in a separate open yard (10m^2 meter), with sandy ground and provided with suitable umbrella of iron sheets, one basin for fresh water and one stilts for feeding. Mineral salt blocks were distributed equally inside each yard (Fe, 3850 mg/kg, Mg 970 mg/kg, Mn 860 mg/kg, ZnO 800 mg/kg, Cu 150 mg/Kg, I 50 mg/kg. Co, 40 mg/kg, Se 30 mg/kg and NaCl up to 100 g).

2.2. Experimental diets and feeding plain:
Lambs fed on different mentioned feedstuffs (Corn grain, berseem hay and wheat straw were the basal feeds offered to lambs throughout this experiment. The ingredient proximate chemical analysis are shown in table 1), during the experimental period (lasted for continuous 10 weeks) as in the following table (2). Corn grain was offered in two meal (In the morning and at evening), while berseem hay and wheat straw was offered afternoon.

2.3. Experimental design: After an observation period of 3 days, the used lambs were allotted on body basis into two equal groups. the first group served as control while the second was theexperimental group, which fed on the basal diet with supplementation of garlic extract (Garlin " A natural product produced by Hefel Royal Eagle Imp &Exp Co., ltd (China) and it is consider garlic extract contain 25% allicin.") at 1g /4 liter water for continuous 12 weeks and named latter, (treated group).

2.4. Growth performance and feed efficiency measurements:

Blood samples: At 6th weeks of the experiment and at the end (12th weeks) of the experimental period, blood samples were taken from 5 lambs of each groups. Each blood sample was left to coagulate at roomtemp. Separation of serum was carried out bycentrifugation of coagulated blood at 3000 rpm for 10 min. The clear serum was transferred carefully to clean and dry vials and kept in deep freezer until analysis for determination of serum glucose, total serum protein, albumin, globulin, calcium, phosphorus, creatnine, uric acid, urea, triglycerides, cholesterol, HDL. LDL, GOT and GPT according to Trinder (1969), Doumas*et al.* (1981), Reinhold (1953) and Coles (1974) respectively.

Digestibility coefficient: Digestibility of nutrients is one of the most important parameters in feed evaluation studies. At 12 weeks old of the experimental period, digestibility trials were carried out to determine the apparent digestibility coefficients of different nutrients. Five animals from each group of both experiment were used. Fecal samples were collected by hand from each lamb at 12 A.M for five successive days then dried in a hot air oven at 105^{o}C for 5 hours.

Table (1): Proximate chemical analysis of feedstuffs used in the experiment (as fed basis).

Items	Corn	Berseem hay	Wheat straw
DM%	87.6	88.1	89.6
CP%	7.8	16.9	3.8
EE%	3.1	2.70	0.9
Ash%	2.3	12.5	18.6
CF%	2.1	30.9	36.9
NFE%*	72.3	25.1	29.4
Ca%	0.03	1.4	0.23
P%	0.29	0.12	0.07
TDN**	85	54	36

*NFE (calculated by difference) = 100 – (Moisture% + CP% + EE% + Ash% + CF%).
**TDN: calculated according to NRC for sheep (1985).

Table (2): Quantity of different feedstuffs (g/lamb/day) during different experimental period.

Experimental period	Quantity (g/lamb/day)		
	Corn	Green Berseem	Wheat straw
0 – 2 weeks	250	400	200
2 – 4 weeks	375	500	200
4 – 12 weeks	500	500	200

After complete drying, the average dry matter content was calculated and the dried fecal samples were mixed for each animal and saved for chemical analysis and nutrient digestibility was calculated according to the following formula: Nutrient digestibility = 100 – (100x % acid insoluble ash in feed/% acid insoluble ash in feces) x %nutrient in feces/ % nutrient in feed).

2.5. Chemical analysis:

Dry matter and crude nutrients: Analytical DM contents of feed and fecal samples were determined by oven-drying at 105°C for 48 h (AOAC, 1990; method 930.15). Ash contents of feed and feces samples were determined by incineration at 550°C overnight, and the OM content was calculated as the difference between 100 and the percentage of ash (AOAC, 1990; method 942.05). Crude fiber were determined by digestion of the sample for 30 min. by using 1.25% H_2SO_4 after hot water washing, digested for 30 min. by using 1.25% NaOH, washing and filtration into the crucible, dried and ignition. Crude protein in feed and fecal samples were determined by using Kjeldahl method according to Randhir and Pradhan (1981) and ether extract was determined according to Bligh and Dyer (1959) technique as modified by Hanson and Olly (1963).

2.6. **Statistical analysis:** The analysis of variance for the obtained data was performed using Statistical Analysis System (SAS, 1996) to assess significant differences.

3. RESULTS and DISCUSSION

3.1. Body weight development: Effect of garlic extract supplementation on body weight development of growing lambs is presented in table 3. Statistical analysis of the obtained data revealed that no significant in body weight at the start of the experimental period between control and allicin treated groups. Moreover, it was observed that allicin supplementation at 6.25mg/L water had no significant ($P \geq 0.05$) effect on lamb body weight during different experimental period when compared with the control on. On the other hand, allicin supplementation non significantly improved body weight of growing fattening lambs at the end of the experiment by about 0.52% when compared with control. The present data are in harmony with those obtained by Özdoğan et al. (2011) who stated that the body weights of male and female lambs in the end of the experiments were similar between C group and essential oil treated group. There have been a great number of literatures on commercial essential oil compounds and their blends for usage in ruminant nutrition (McIntosh et al. and Hart et al., 2008). Besides, essential oil compounds have been used to cure nutrition diseases in the digestive system (Benchaar et al., 2008 and Hart et al., 2008), it was explained that they could positively affect fattening performance, carcass characteristics and blood parameters of animals in medicine, animal feeding and veterinary books at human and animal history.

Nowadays, different essential oils or their blends have been investigated on fattening performance and carcass quality in animal feeding (Meyer et al., 2009). When scrutinizing the previous studies related to steers consuming a blend of essential oil compounds, there were no significant effects of commercial essential oil compounds on the growth. No other research is available to compare feedlot lamb performance when fed these essential oils.

Table (3). Effect of garlic extract supplementation on body weight development (kg/lamb) of growing fattening lambs.

Weeks	Experimental groups	
	Control	Treated
0	22.42±2.39[a]	22.17±2.16[a]
2	21.80±4.76[a]	21.14±2.74[a]
4	23.83±3.35[a]	22.45±2.98[a]
6	25.25±3.67[a]	24.38±3.74[a]
8	27.25±3.74[a]	26.92±3.50[a]
10	29.38±3.95[a]	30.08±3.85[a]
12	30.92±4.27[a]	31.08±3.65[a]
Relative to control	100	100.52

Values are means ± standard error. Mean values with different letters at the same raw differ significantly at ($P \leq .05$).

3.2. Growth performance parameters: Effect of garlic extract supplementation on body weight gain of growing lambs are presented in table 4.Statistical analysis of the obtained data indicated that garlic extract supplementation (62.5 mg allicin/L water) non significantly improved total body gain of growing lambs by about 4.9%, improved feed conversion efficieny (FCE) of dry matter (DM) by about 5.1%, moreover, garlic extract supplementation improve FCE of TDN and digestible protein by about 16.1% and 17.2% respectively when compared with control.

The improvement in body gain and feed efficiency may have a number of explanations. As, the inclusion of garlic in the diet may result in an improved gut environment and microflora. This effect is attributed to the fact that the susceptibility of pathogenic gram positive bacteria to the antibacterial components of garlic is higher than that of the physiologically desirable intestinal bacteria. The beneficial bacteria are believed to be unaffected by the presence of garlic as they are less sensitive to its inhibitory effects. Furthermore, garlic may have a prebiotic effect due to its classification as a fructo oligosaccharide (Gibson, 2001). Also, Ahmed et al. (2009) reported that using garlic, onion and lemonade juice as natural feed additive at the rate 2.5, 5% and 7.5%/kg ration for growing buffalo calves improved utilization of nutrients, better blood constituents, improved growth rate, destroy harmful bacteria and cause some improvement of economic efficiency. Moreover, the diets containing essential oil compounds improved slightly the fattening performance of lambs, it was said that the addition of essential oils can shift the microbial fermentation in the rumen, modifying the production of volatile fatty acids by increasing the acetate to propionate ratio, inhibiting deamination, and the direct inhibition of methane production (Busquet et al., 2006; Castillejos et al., 2007).

3.3. Nutrient digestibility

Effect of garlic extract supplementation on nutrient digestibility of growing fattening lambs are presented in table 5. Statistical analysis of the obtained data indicated that garlic extract supplementation in drinking water for growing lambs had no significant effect on dry matter (DM), organic matter (OM), crude protein CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE), calcium (Ca) and phosphorus (P) apparent digestibilities when compared with control group. However, it is clear that garlic more improved crude fiber digestibility by about 7.1% when compared with control.

Table (4). Effect of garlic extract supplementation on growth performance parameters of growing fattening lambs.

Items	Experimental Groups	
	Control	Treated
Initial body weight (Kg/lamb)	22.42±2.39[a]	22.17±2.16[a]
Final body weight (Kg/lamb)	30.92±4.27[a]	31.08±3.65[a]
Total body gain (Kg/lamb)	8.50±1.50[a]	8.92±1.55[a]
Average daily gain (Kg/lamb)	0.101	0.106
Total dry matter intake (Kg/lamb)	65.04	65.04
FCE of DM (Kg DM intake/Kg gain)*	7.29±0.5[a]	6.92±0.4[a]
FCE of TDN (Kg TDN intake/Kg gain)	9.48	7.95
FCR of DCP (Kg DCP intake/Kg gain)	0.99	0.82

*FCE= Feed conversion efficiency. Values are means ± standard error. Mean values with different letters at the same raw differ significantly at (P≤.05).

Table (5): Effect of garlic extract supplementation on nutrient digestibility of growing fattening lambs.

Items	Experimental groups	
	Control	Treated
Dry matter	82.3±3.42[a]	83.1±4.41[a]
Organic matter	85.7±3.43[a]	86.2±5.73[a]
Crude protein	78.8±3.42[a]	79.8±4.25[a]
Ether extract	86.2±3.45[a]	88.9±2.91[a]
Crude fiber	52.1±3.47[a]	55.8±2.43[a]
NFE	85.3±3.49[a]	84.93±6.03[a]
Calcium	54.2±3.44[a]	53.5±1.23[a]
Phosphorus	67.3±3.42[a]	68.8±2.46[a]

Values are means ± standard error. Mean values with different letters at the same raw differ significantly at (P≤.05).

Table (6): Effect of garlic extract supplementation on some blood serum parameters of growing fattening lambs:

Parameters	6th weeks of the experiment		At the end of the experiment		Average	
	Control group	Treated group	Control group	Treated group	Control group	Treated group
Total protein (g/dl)	5.84±0.02[a]	5.96±0.04[a]	6.17±0.07[b]	6.43±0.08[a]	6.01	6.20
Albumin (g/dl)	3.98±0.02[a]	3.86±0.04[a]	3.86±0.04[a]	3.80±0.02[a]	3.92	3.83
Globulin (g/dl)	1.86±0.03[a]	2.10±0.05[a]	2.30±0.05[b]	2.63±0.04[a]	2.08	2.37
A/G ratio*	2.17±0.07[a]	1.85±0.09[a]	1..7±0.05[a]	1.45±0.03[b]	1.94	1.65
Glucose (g/dl)	54.40±0.16[a]	59.10±0.4[a]	53.37±0.21[a]	58.93±0.28[a]	53.89	59.02

Values are means ± standard error. Mean values with different letters at the same raw differ significantly at (P≤.05).*A/G ratio = Albumin/Globulin ratio.

These results agree with the results of Benchaar et al, (2006),t hey were supplemented diets of lactating Holstein cows with essential oils (0 vs. 2 g/d; EO) and monensin (0 vs. 350 mg/d; MO). They show that apparent digestibility's of dry matter, organic matter and neutral detergent fiber were similar among treatments, but apparent digestibility of acid detergent fiber was increased when diets were supplemented with EO (48. 9 vs. 46. 0%). Also, the present data are supported by those obtained by Khalesizadeh et al. (2011) they indicated that Total apparent digestibility's of DM, OM, CP, NDF, NFC, EE and ADF were not influenced by garlic oil, monensin and turmeric powder supplementation compared with control.

In similar study, yang et al., (2007) reported that total digestibility's of DM, Om, NDF and ADF were not influence in Holstein cows fed diets with 5mg/d of garlic oil but ruminal digestibility's of dry matter, organic matter increased.

3.4. Blood serum units: Effect of water garlic extract supplementation on some blood parameters of growing fattening lambs are presented in table 6. Statistical analysis of the obtained that indicated that allicin supplementation non-significantly (P≥0.05) increased total protein blood serum concentration at 6th weeks and at the end of the experimental period by about 2.1% and 4.2% respectively when compared with untreated group. Moreover, garlic extract supplementation increased average total protein blood serum concentration throughout the whole experimental period by about 3.2% when compared with the control. Moreover, it was observed that garlic extract supplementation slightly decreased blood serum albumin throughout the whole experimental period by about 2.3%, while increased blood serum globulin concentration by about 13.9% when compared with untreated lambs group.

The present data are in agreement with those obtained by Pirmohammadi et al., (2014) they indicated that total protein and albumin concentrations were not affected by dietary garlic treatments at pre-parturition period. However, is in contrast with Kholif*et al*. (2012) who found higher serum albumin and total protein values in garlic oil supplemented lactating goats. This discrepancy might be explained by differences in the experimental procedure kind of animals, physiological status and various garlic compounds used. The improvement in serum total protein, globulin and albumen/globulin ration are agreement with those reported by El-Ashry et al.(2006) and Abo El-Nor et al.(2007) who found that the mean values of blood metabolites were higher in treated animals with medicinal herbs than control.

Regarding blood serum glucose concentration, it was observed that garlic extract supplementation non significantly (P≥0.05) increased serum glucose concentration at 6th weeks, at the end of the experiment and average throughout the whole experimental period by about 8.6%, 10.4% and 9.5% respectively when compared with the control. These responses are in agreement with the finding of **Chaves*el al. (2008)***who reported no significant difference in serum glucose concentration of growing lambs fed with diets supplemented with garlic compared with control ration. The numerical increased of blood serum glucose concentration might be due to the enhancement of gluconeogenesis process by garlic supplemented diet. As reported previously, ruminal propionate is considered the most important single precursor of glucose when its availability is high (Bergman, 1990). Garlic appear to have great potential for improving of propionate to acetate ratio without affecting nutrient utilization**.**

3.4. a. Blood serum mineral concentrations: Effect of garlic extract supplementation on blood serum calcium and phosphorus concentrations of growing fattening lambs are presented in table 7. Statistical analysis of the obtained data revealed that garlic extract supplementation had no significant effect on calcium and phosphorus blood serum concentrations at 6th weeks of experimental period and at the end of the experiment when compared with the control. Mahusoon*et al*. (2004) reported marked breed differences in mineral metabolism in lambs and goats. Blood levels of minerals have a high diagnostic value in determining the nutritional status of animals due to their low variability in blood (Amer et al., 1999). In the current study profiles of calcium and phosphorous concentrations in blood serum did not exhibit any changes. There is no information on effects of feeding garlic or its constituents on blood mineral concentration through the growing period in fattening lambs. In agreement with Amer et al. (1999)who observed any changes in serum calcium and phosphorous levels during postpartum period in Saudi Ardy goats. Also, the present data are supported by Pirmohammadi et al., (2014) reported that garlic supplementation had no significant effect on blood serum calcium, inorganic phosphorus, sodium and potassium concentrations in pre-partum period of goats. Also, Zakeri et al. (2014) did not observe any significant effect of garlic supplementation on blood concentrations of calcium, inorganic phosphorus, sodium and potassium in lactating goats.

3.5. Kidney function parameters: Effect of garlic extract supplementation on blood serum parameters concentration for kidney function of growing fattening lambs are presented in table 8. Statistical analysis of the obtained data revealed that no significant difference in uric acid and creatinine blood serum concentrations between control and garlic extract treated group at 6th weeks or at the end of the experimental period. In contrast, it was observed that garlic extract supplementation significantly (P≤0.05) increased blood serum urea concentration at 6th weeks or at the end of the experimental period by about 40.3% and 82.3% respectively when compared with control group. It can be concluded that garlic extract supplementation in drinking water for growing lambs may be slightly reduce efficiency of kidney function through numerical higher creatinine blood serum concentration throughout the whole experimental period when compared with the control.

Greater blood urea N of steers fed cinnamaldehyde suggests an increased absorption of ruminal NH3-N or a decrease in protein requirements, or both. Suspected increased absorption of ruminal NH3-N was likely with increasing garlic extract supplementation. Results from previous studies do not support an increase in ruminal NH3-N concentration due to essential oils supplementation. Concentration of NH3-N was reduced (Fraser et al., 2007) or not affected (Cardozo et al., 2004) by CIN supplementation. Supplementation of diets with EO is thought to decrease ruminal proteolysis by inhibiting the conversion of AA to NH3 (Calsamiglia et al., 2007; Benchaar et al., 2008). The net effect is to provide a greater flow of AA from undegraded feed protein to the duodenum.

Table (7): Effect of garlic extract supplementation on some blood serum mineral concentration of growing fattening lambs.

Items	Experimental groups	
	Control	Treated
	6th weeks of the experiment	
Calcium)mg/dl)	10.60±0.06^{a}	11.03±0.02^{a}
Phosphorus (mg/dl)	3.86±0.09^{a}	4.13±0.19^{a}
	At the end of the experiment	
Calcium)mg/dl)	9.83±0.06^{a}	9.99±0.04^{a}
Phosphorus (mg/dl)	3.52±0.17^{a}	3.23±0.09^{a}
	Average values	
Calcium)mg/dl)	10.21	10.51
Phosphorus (mg/dl)	3.69	3.68

Values are means ± standard error. Mean values with different letters at the same raw differ significantly at (P≤.05).

Table (8): Effect of garlic extract supplementation on blood serum parameters concentration for kidney function of growing fattening lambs.

Items	Experimental groups	
	Control	Treated
	6th weeks of the experiment	
Uric acid (µg/dl)	5.83±0.55[a]	5.73±0..78[a]
Creatinine (µg/dl)	0.25±0.01[a]	0.85±0.02[a]
Urea (µg/dl)	29.44±2.44[b]	41.29±4.12[a]
	At the end of the experiment	
Uric acid (µg/dl)	5.67±0.91[a]	5.82±0.34[a]
Creatinine (µg/dl)	1.07±0.11[a]	0.87±009[a]
Urea (µg/dl)	32.43±4.23[b]	59.11±5.86[a]
	Average values	
Uric acid (µg/dl)	5.75	5.78
Creatinine (µg/dl)	0.66	0.86
Urea (µg/dl)	33.94	50.20

Values are means ± standard error. Mean values with different letters at the same raw differ significantly at (P≤.05).

Table (9): Effect of garlic extract supplementation on blood serum parameters concentration for liver function of growing fattening lambs.

Items	Experimental groups	
	Control	Treated
	6th weeks of the experiment	
GOT	42.0±4.99[a]	46.33±6.32[a]
GPT	11.0±1.22[a]	21.33±3.21[a]
	At the end of the experiment	
GOT	33.33±2.98[a]	39.33±4.23[a]
GPT	5.0±1.02[a]	13.0±2.21[a]
	Average values	
GOT	37.5	42.83
GPT	8.0	17.17

Values are means ± standard error. Mean values with different letters at the same raw differ significantly at (P≤.05).

3.6. Liver function parameters: Effect of garlic extract supplementation on blood serum parameters concentration for liver function of growing fattening lambs are presented in table 9. Statistical analysis of the obtained data revealed that garlic extract supplementation non significantly (P≥0.05) increase blood serum GOT and GPT concentrations at 6th weeks and at the end of the experimental period by about (10.3% and 18%) and (93.9% and 160%) respectively when compared with the control. In spite of the well-established pharmacological potential of garlic extract, serum hepatic enzymes GOT and GPT concentrations were not significantly altered among treatments ranging 37.5 – 42.83 and 8.0 – 17.17 µ/L, respectively throughout the whole experimental period (Table 15). These results were in accordance with Vakili*et al.* (2013) who confirmed that addition of essential oils compounds had no effect on hepatic enzymes. Also, Alsaht et al. (2014) who indicated that thymol and cinnamaldehyde mixture (TCM) supplementation had no significant effect on blood serum hepatic enzymes concentrations when compared with control. Also, the present data are supported by those obtained by (Kholif*et al.*, 2012).

3.7. Blood serum Lipids: Effect of garlic extract supplementation on blood serum lipids concentration of growing fattening lambs are presented in table 10. Statistical analysis of the obtained data revealed that garlic supplementation non significantly increased blood serum triglycerides concentration at 6th weeks of the experiment by about 2.7% when compared with control, however, reduced (P≥0.05) at the end of the experiment by about 7.7%. Moreover, garlic extract supplementation had no significant effect on blood serum triglycerides concentration throughout the whole experimental period. Regarding blood serum cholesterol concentration, it was found that garlic extract supplementation non significantly reduced cholesterol concentration at 6th weeks, at the end of the experiment and the average throughout the whole experimental period when compared with the control.

The hypolipidemic effect (triglycerides and cholesterol lowering properties) of garlic has been proved in previous studies in humans (Mahmoodi et al., 2006) and rats (Ali et al., 2000) as well as in laying hens (Yalçın et al., 2006). This effect is probably due to the inhibition of enzymes involved in fatty acid and cholesterol synthesis (Eidi et al., 2006). However, the results of the present study showed that garlic supplementation had no influences on the concentrations of triglycerides in serum. These results were in agreement with the previous reports in lambs and dairy goats, Chaves et al. (2008). When energy balance is negative, animals always mobilize the lipids stored in adipose tissues, mainly in the form of NEFA. As previously reported, garlic had a potential to alter rumen ecology and increase propionate synthesis in sheep and in dairy goats (Kholif et al., 2012) which in turn might promote gluconeogenesis and insulin secretion. Therefore, the anti-lipolytic effect of insulin should decrease plasma NEFA and reduce hepatic conversion to triglycerides and ketones in garlic treated animals.

The lower serum total cholesterol in treated groupscould be ascribed to garlic which is thought to have various pharmacologic properties. For example, it has been found to lower serum and liver cholesterol (Qureshi et al., 1983), inhibit bacterial growth [38], inhibit platelet growth and reduce oxidative stress (Horie et al., 1992.

3.8. Economic efficiency: Effect of garlic extract supplementation on economic efficiency of lamb production is presented in table 11. The obtained data revealed that garlic extract supplementation had no effect on total return per lamb. This may be related to non-significant effect of garlic extract supplementation on final body weight of the treated group when compared with control. Moreover, it was observed that garlic extract supplementation had no effect on benefit/cost ratio% and net incoe/total cost % from 113.29% and 13.29% of the control to 113.82% and 13.81% of the treated group respectively. Finally garlic extract supplementation in the drinking water for growing lambs had no clear effect on economic efficiency of production.

4. CONCLUSION

The obtained data concluded that garlic extract supplementation in drinking water for growing lambs had no significant effect on body weight and weight gain of growing lambs, however, slightly improve feed efficiency and blood serum lipids concentration. On the other hand garlic extract slightly reduce efficiency of kidney and liver function through numerical higher creatinine, GOT and GPT blood serum concentrations and had no effect on economic efficiency of lamb production. So this study could suggest these additive as promising feed additive as an alternative for antibiotic use in ruminant nutrition.

Table (10). Effect of garlic extract supplementation on blood serum lipids concentration of growing fattening lambs.

Items	Experimental groups	
	Control	Treated
	At 6th weeks	
Triglyceride (mg/dl)	200.7±17.32[a]	206.17±20.33[a]
Total cholesterol (mg/dl)	197.43±19.32[a]	191.86±15.22[a]
HDL	41.33±3.21[a]	38.33±2.49[a]
LDL	115.69±19.33[a]	112.3±10.22[a]
	At the end of the experiment	
Triglyceride (mg/dl)	194.46±23.22[a]	179.5±21.44[a]
Total cholesterol (mg/dl)	199.86±21.22[a]	187.8±20.34[a]
HDL	28.0±2.45[a]	27.27±2.41[a]
LDL	132.97±19.22[a]	124.46±15.55[a]
	Average	
Triglyceride (mg/dl)	197.58	192.84
Total cholesterol (mg/dl)	198.65	189.83
HDL	34.67	32.8
LDL	124.33	118.38

Values are means ± standard error. Mean values with different letters at the same raw differ significantly at (P≤.05).

Table (11). Effect of garlic extract supplementation on economic efficiency of lamb production.

Items	Control group	Treated group
No. of lamb used	12	12
Animal price (LE per lamb)	785	776
Total feed cost (LE/lamb)	120	120
Additives cost (LE/lamb)	0.0	10
Other cost (LE)*	50	50
Total cost (LE/Lamb)	955	956
Total return (LE/lamb)	1082	1088
Net income (LE)	127	132
Benefit/cost ratio %	113.29	113.81
Net inco./T. cost %	13.29	13.81

*Managemental cost including veterinary care, drug used, workers and housing.

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