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Effects of *Z. officinale* and Propolis Extracts on the Performance, Carcass and Some Blood Parameters of Broiler Chicks

[1]Ahmet Tekeli, [2]Hasan Rüstü Kutlu and [2]Ladine Çelik
[1]Department of Animal Science, Faculty of Agriculture, Yuzuncu Yil University, 6500, Van, Turkey
[2]Department of Animal Science, Faculty of Agriculture, Cukurova University, 01330, Adana, Turkey

Corresponding Author: Dr. Ahmet Tekely, Department of Animal Science, Faculty of Agricultural, Yuzuncu Yil University, 6500 Van-Turkey Tel/Fax: +904322251024/2626

ABSTRACT

The purpose of this study is to explore the potential uses of *Z. officinale* and propolis extracts as growth promoters in broilers. One-day-old, Ross 308 male broiler chicks were used in the experiment. At the beginning of the experiment, seven treatment groups [negative control, positive control, *Z. officinale*, propolis and three different combinations of *Z. officinale*+propolis (0.5+0.5, 1+1 and 1.5+1.5)] were used as treatment groups of similar body weight, consisting of 15 birds each. Groups were subjected to *ad libitum* feeding for 42 days. The feed was supplemented with the combination of *Z. officinale* and propolis extracts, which proved to improve live body weight gain, feed consumption, feed conversion efficiency and efficiency index as well as weight and length of the digestive system in broiler chicks. The groups receiving 240 ppm *Z. officinale* or 1000 ppm propolis extracts have particularly performed similar to the group fed antibiotic growth promoter. The amount of 240 ppm *Z. officinale* or 1000 ppm propolis extracts had similar plasma cholesterol, glucose and triglycerids levels to those of antibiotic.

Key words: Broiler, *Z. officinale*, propolis, performance, digestive system, blood parameters

INTRODUCTION

Antibiotics are microbial metabolites produced by fungi and algae which have low molecule weight and can inhibit the growth of other microorganisms even in low concentrations (Nir and Ve-Senkoylu, 2000). While antibiotics have prevalently been used as growth promoters in animal nutrition, European Community has prohibited the use of antibiotics in animal nutrition as growth promoters from January 1, 2006 (Anonymous, 2005). As a result of the ban of antibiotic growth promoters due to the demands from medicine and consumers; explorations on alternative products have started. Consequently, studies on natural products such as plant extracts have recently gain a great attention (Wenk, 2000).

It is stated that the plant extracts can continuously be used in rations without any need for their removal and that they do not induce any resistance to antibotics (Gill, 1999). At present, phytogenic products can be classified as sweeteners and appetizers without a requirement for the determination of their minimum residue levels (Kamel, 2002). On the other hand, there is a misbelief that "all plant extracts are beneficial since they are natural and organic". For example,

the plant "EPHEDRA" was prohibited at the end of the year 2003 since it damages nervous system and leads psychosis, memory loss and even death (Anonymous, 2004). Animals, poultry in particular, are very sensitive to pathogenic bacteria such as *Escherichia coli, Salmonella* sp. *Clostridium perfringens* and *Campylobacter sputorum*. The pathogenic microbial flora in the small intestine compete with host for nutrients while at the same time inhibiting the binding of the bile acids to the pertinent substances, they decrease the digestion of fats and fat-soluble vitamins. This leads to a decrease in performance and increase in disease rate. Antibiotics, which have been used as growth promoters in poultry feed for a long time, improve the growth performance by stabilizing the microbial flora in the intestine and preventing some specific intestine pathogens (Gunal *et al*., 2006).

Another increasingly important recent natural product is propolis. Propolis is a glue-like substance that honey bees collect from plant seedlings and buds. It is obtained as a result of the biochemical alteration of the resinous materials and plant secretions by the enyzmes secreted from the glands of the bees. It has a colour ranging from dirty yellow to dark brown, a strong and nice odor, is water-insoluble and semi-solid in room temperature (Hepsen *et al*., 1996; Sahinler, 2000). Since the chemical composition of propolis is highly complex and its composition varies according to the plant, region, season and colony; its colour, odor and medical characteristics vary accordingly (Kutluca, 2003). The composition of raw propolis is generally composed of 50% resin and vegetal balsam, 30% beeswax, 10% essential and aromatic oils, 5% pollen and 5% other organic substances (Kumova *et al*., 2002; Dodologlu *et al*., 2003; Silici, 2003).

Undoubtedly, plant extracts and propolis which are considered as alternatives to antibiotics have a wide range of potential uses. Therefore, the determination of the effects of these products on human and animal health are of significant importance at present due to the increasing practice of organic agriculture and increasing importance attached to safe nutrient production. This study, which is inspired by these thoughts, aims to determine the most appropriate utilization levels of propolis and plant extracts either as separate or in combination and their associated effects on animal performance.

MATERIALS AND METHODS

One hundred and five, one-day-old male broiler chicks (Ross 308) were divided into seven treatment groups of 15 birds each and randomly assigned to seven treatment diets. The groups were as follows: 1. Negative control (not including antibiotic), 2. Positive control (including antibiotic), 3. *Zingiber officinale* (240 ppm), 4. Propolis 1000 ppm, 5. *Zingiber officinale* 120 ppm+Propolis 500 ppm combination, 6. *Zingiber officinale* 240 ppm+Propolis 1000 ppm combination, 7. *Zingiber officinale* 360 ppm+Propolis 1500 ppm combination. The composition of the basal diet is presented in Table 1. Birds were given starter diet from the first day to 10 days, a grower diet from 11 to 21 days, thereafter a finisher diet to 42 days. Each group was fed *ad libitum* its own diet for a period of 42 days. Twenty four hours light was provided per day. *Zingiber officinale* essential oils were purchased from Ege Lokman San. Tic. Company, Manisa, Turkey. Propolis (ethanol extracted) was obtained from Erciyes University, S. Cikrikcioglu Junior Technical College-KAYSERI. Major components of *Z. officinale* essential oil and propolis were analysed using MSGC and are given in Table 2.

The live body weight gains of birds were measured individually and feed consumption and feed conversion efficiency (g feed:g gain) were measured weekly. The efficiency index was calculated

Table 1: The ingredient and chemical composition (g/kg) of starter, grower and finisher diets

Item	Starter diet (1-10 days)	Grower diet (11-21 days)	Finisher diet (22-42 days)
Ingredients			
Maize	471.09	493.19	553.13
Full-fat soyabean	180.00	170.00	190.00
Soya bean meal (%46 CP)	156.78	130.14	89.77
M.Gluten meal (%55 CP)	70.88	48.73	13.15
Chicken meal (%52 CP)	40.00	45.00	40.00
Meat-bone meal (%32 CP)	28.98	33.23	26.86
Fish meal (%70 CP)	25.00	39.10	42.72
Crude Cotton oil	12.05	29.69	34.50
Dicalcium phosphate (%18 P)	3.00	-	0.49
Salt	1.00	-	-
Soda	1.58	2.55	2.56
Lysine	2.53	1.53	1.00
Methionine (Alimet)	2.11	1.84	2.32
Vitamin premix[1]	3.00	3.00	2.00
Mineral premix[2]	2.00	2.00	1.50
Total	1000.00	1000.00	1000.00
Analyses (%)			
ME kcal/kg	3028.52	3175.00	3260.00
Dry matter	88.56	88.69	88.54
Crude protein	25.77	24.66	21.80
Ether extract	8.17	10.00	10.70
Crude cellulose	3.49	3.35	3.38
Crude ash	6.35	6.17	5.72
Lysine	1.52	1.43	1.29
Methionine + Cystine	1.06	1.00	0.94
Calcium	1.01	1.04	0.91
Available phosphorus	0.48	0.47	0.45

[1]Vitamin premix per 2.5 kg of premix: 12 000 000 IU Vitamin A. 3 500 000 IU Vitamin D3. 100 g Vitamin E. 3 g Vitamin K3. 2.5 g Vitamin B1. 6 g Vitamin B2. 25 g Niacin. 12 g Ca-D-Pantotenat. 4 g Vitamin B6. 15 mg Vitamin B12. 1.5 g Folic Acid. 150 mg D-Biotin. 100 g Vitamin C. 450 g Choline Chloride. [2]Mineral premix per kg: 100 mg Mn; 25 g Fe; 65 g, Zn; 15 g, Cu; 0.25 g, Co; 1 g, I; 0.2 g Selenyum

by dividing post-experiment live body weight gain (g) by post-experiment feed conversion efficiency. At the end of the experimental period, five birds of similar live body weight from each treatment group were slaughtered to determine blood parameters, carcass weight and dressing percentage, abdominal fat weight and digestive system sections for weight and length. After being stored at refrigerator at +4°C for 24 h, the blood samples were subjected to biochemical (cholesterol, triglycerids and glucose) analysis. CHOD-PAP Method is employed for cholesterol, GPO-PAP Method is employed for triglycerids and Hexokinase Calorimetric-Enzymatic Method was employed for glucose. All analyses were performed by modular DPP device (Roche-Germany). The data obtained in the experiment were subjected to one way analyses of variance to evaluate treatment and random effects using the GLM (General Linear Model) procedure of SAS (1987) in a complete randomized design with seven treatments of 15 replicates. Treatment means were separated using Duncan's New Multiple Range Test.

Table 2: *Zingiber officinale* and Propolis essential oil and major components (%)

Zingiber officinale	%	Propolis and componenets	%
Cis 2-Nonenal	1.75	Flavonoids	
(E,E) 2,4-Decadienal	13.79	Chrysin	5.33
Ar-Curcumene	8.93	Naringenin	2.67
Zingiberene	15.77	2-methoxy-4-vinylphenol	0.47
α-Farnsene	3.27	4-vinylphenol	0.44
Valancene	1.29	Hexanoic acid	0.64
β-Bisavolene	7.68	4-pentenoic acid	0.25
β-Sesquiphellandrene	11.97	2-Propenoic acid	0.38
1,3,5-Cyclooctatriene	0.70	3-hydroxy-4-methoxy cinnamic acid	0.56
Zingerone	4.63	Hexadecanoic acid	1.21
Viridiflorol	0.72	9-Octadecanoic acid	0.55
β-Copanen-4,α ol	10.98	Alifatik,, aromatic and fatty acids	
Linoleic Asit	0.50	Ferulic acid	2.26
Oleic Asit	0.62	Esters	
n-Hekza Dekonoik Asid	1.04	Benzyl cinnamate	1.35
Retinol	0.54	Terpens	
Monopalmitin	3.19	d-Limonene	0.28
Retinol Acetate	0.22	β-eudesmol	1.00
Stearoik Asit	4.06	α-eudesmol	0.89
Linoleyl Choloride	4.19	Aldehid, keton and others	
Squalene	0.38	Crysophanol	22.07
-(6-Hydroksi, 3,7 Dimethy-octa 2,7, dieniyl)		4-H-1-benzopyran-4-one	13.51
-4-Methozy fenol	1.73		
Octadecane, 3-ethy-5-(2-ethylbutryl)	0.71		
Lucerin 2	0.42		
n-Heptacosane	0.91		

RESULTS AND DISCUSSION

The data obtained at the experiment regarding cumulative feed consumption, body weight gain, feed conversion efficiency and efficiency index are given in Table 3 on weekly basis. Although treatment effects were not significant ($p>0.05$), according to Duncan's test a significant difference ($p<0.05$) was determined among the groups with respect to feed consumption at the end of the 3rd and 6th week of the experiment. At the end of the experiment, all treatment groups revealed a higher feed consumption pattern ($p>0.05$) compared to negative control group.

In this study, 240 ppm *Z. officinale*, 1000 ppm propolis and combination of both had a positive effect on feed consumption with respect to negative control group. This positive effect can be evaluated on the basis of different perspectives. The first of these is the appropriateness of the extract levels for the broilers and associated improvement in the feed taste. The second one is the quicker digestion and passage of the nutrients through the digestive system attributed to the digestive effects of these natural products. Due to this fact, digestive system will have been emptied earlier and feed consumption will have been promoted. These affirmative findings on feed consumption are similar to the previous findings stating that essential oils significantly increase feed consumption in broilers (Alcicek *et al*., 2004) and that broilers supplemented with propolis had higher feed consumption (Shalmany and Shivazad, 2006).

At the end of the experiment, all treatment groups have experienced higher body weight gains compared to negative control group. These differences were found statistically significant ($p<0.05$).

Table 3: Effects of *Z. officinale* essential oil ve propolis supplemental on feed consumption, live body weight gain and feed efficiency of broiler on days 21 and 42

	Feed Consumption (g/bird)		Body Weight Gain (g/bird)		Feed Conver. Eff. (g/ feed: g gain)		Efficiency index
Treatment group	0-21 days	0-42 days	0-21 days	0-42 days	0-21 days	0-42 days	42 day
Negative Control (No Additive)	859.79b	3334.86b	582.64	1973.71b	1.48	1.7	1171.86b
Positive Control (Antibiotic)	941.07ab	3970.13a	640.87	2389.13a	1.47	1.66	1439.14a
Z. officinale 240 ppm	977.69a	3909.71a	656.79	2342.80a	1.5	1.67	1413.51a
Propolis (1000 ppm	929.07ab	3925.23a	606.3	2319.48a	1.55	1.7	1372.30a
Z. officinale 120 + Propolis 500 ppm	906.87ab	3804.86a	603.41	2239.37a	1.51	1.71	1332.97ab
Z. officinale 240 ppm+ Propolis 1000 ppm	875.87ab	3801.43a	580.28	2228.06a	1.52	1.72	1310.58ab
Z. officinale 360 ppm + Propolis 1500 ppm	923.00ab	3832.57a	602.33	2244.90a	1.54	1.71	1320.63ab
SED	14.031	46.502	10.737	30.963	0.01	0.01	22.82
Significance (p=)	0.2831	0.006	0.355	0.0109	0.3888	0.6436	0.0424

Means within same column having different letters are significantly different ($p<0.05$). SED: Standard error of difference between means

Botsoglou *et al.* (2002) reported that feed supplemented with 50 and 100 mg kg^{-1} oregano essential oil did not have any effect on the growth performance of broiler chicks. Similarly, Demir *et al.* (2003) determined that plant extracts composed of oregano, dusacch, quiponin, garlic and thymol used against antibotic growth promoters did not have any remarkable effect on the body weight gain of broiler chicks. While it was stated that thymol, cinnamaldehyde and CRINA® Poultry, a commercial essential oil mixture, did not affect body weight gain of female broiler chicks (Lee *et al.*, 2003b). Another study proved that antibiotic, probiotic and Genex, a mixture of plant extracts-organic acid, did not have any effect on body weight gain of broiler chicks (Gunal *et al.*, 2006). Considering the studies about the use of propolis in poultry, Biavatti *et al.* (2003), Sahin *et al.* (2003), Ziaran *et al.* (2005) also reported that propolis supplementation did not have any effect on live body weight gain. Contrary to all these studies, there are also studies indicating the positive effects of plant extracts and/or propolis on live body weight gain (Jamroz and Kamel, 2002; Alcicek *et al.*, 2003, 2004; Eclache and Besson, 2004; Hernandez *et al.*, 2004; Sirvydis, 2004; Roodsari *et al.*, 2004; Shalmany and Shivazad, 2006). The findings of our study are also in agreement with those of the mentioned researchers and proved that the two natural products *Z. officinale* and propolis, significantly improved body weight gain compared to negative control groups. The similar performance of these two natural additives as antibiotic growth promoters is attributed to the decreased number of pathogenic bacteria. Due to the active ingredients in these additives, the formation of a more stable intestinal flora (Tekeli, 2007) and improved feed conversion efficiency in consequence of a better digestion.

At the end of the experiment, no statistically significant differences were determined among the groups with respect to feed conversion efficiency rate ($p>0.05$). However, when the feed conversion efficiencies of the groups with antibiotic and 240 ppm *Z. officinale* supplementation were compared with that of the control group, a numerical increase was identified in the former groups. It is supposed that the improvement in feed conversion efficiency is resulted from the increase in appetite due to the stimulation of salivary and gastric glands by *Z. officinale* extract; the decrease in pathogenic bacteria; formation of a more stable intestinal flora and hence, a better digestibility. Eclache and Besson (2004) revealed that oleo plant extract and avilamycinin had no effect on feed conversion efficiency of broilers. Similarly, there are other findings showing that ration

supplemented with plant extract and propolis additives did not have any significant effect on the improvement of feed conversion efficiency of poultry (Demir *et al*., 2003; Botsoglou *et al*., 2004; Acikgoz *et al*., 2004; Ziaran *et al*., 2005; Gunal *et al*., 2006). The findings of these researchers are in agreement with those of our study. Roodsari *et al*. (2004) reported that feed conversion efficiency of broilers has improved along with increased levels of propolis. Quail rations supplemented with 1000 ppm propolis (Denli *et al*., 2005) and similarly, broiler chick rations supplemented with 200 and 250 ppm propolis alcohol extract (Shalmany and Shivazad, 2006) proved to improve feed conversion efficiency. The unagreement of these findings with those of our study can be attributed to bird material, the amount of propolis used and the different geographic region where it was collected.

With respect to the efficiency index, which is calculated as a component of feed conversion efficiency and live body weight gain; the highest index was recorded in the antibiotic, *Z. officinale* and 1000 ppm propolis groups, whereas the lowest was recorded in negative control group. These results proved that *Z. officinale* and propolis additives –though being less effective- performed like anbiotic to certain extent and have a great potential to be utilized as an alternative. The improvement in the performance parameters of 240 ppm *Z. officinale* and 1000 ppm propolis groups can be explained by the decrease in total erobic mesophilic and coliform bacteria in the jejunum, the increase in lactic acid bacteria and improvement in villi length (Tekeli, 2007).

The findings on the slaughter and carcass characteristics of the birds by the end of the experiment are given in Table 4. Although treatment effects were not significant ($p>0.05$), according to Duncan's test a significant differences ($p<0.05$) were recorded among groups with respect to hot and cold carcass weights. While the highest hot and cold carcass weights were identified in antibotic group, the lowest hot and cold carcass weights were seen in negative control group. *Z. officinale* and propolis groups performed almost similiar to antibiotics with respect to these parameters. The differences among the groups in carcass weights resulted from the differences in live body weight gains by the end of the experiment. It was identified that different treatments did not have any significant effect on carcass yield ($p>0.05$). Since there was not any difference among groups with respect to carcass yield, it is considered that feed additives do not have such effect in this regard. Alcicek *et al*. (2003) reported that an additive of essential oils above 48 ppm (oregano, daphne, sage, myrtle, fennel and citrus oil) did not affect the carcass yield of the broilers. Avci

Table 4: Effects of *Z. Officinale* essential oil and propolis supplemental on carcass characteristics of broiler chicks

	Parameters				
Treatment groups	Hot carcass weight (g/bird)	Cold carcass weight (g/bird)	Carcass yield (%)	Abdominal fat weight (g/bird)	Abdominal fat (%)
Negative control (No Additive)	1476.22b	1459.67b	73.54	19.44b	1.25b
Positive Control (Antibiotic)	1830.44a	1815.56a	74.72	30.78ab	1.70ab
Z. officinale 240 ppm	1755.11ab	1739.22ab	74.05	32.89a	1.86a
Propolis 1000 ppm	1753.71ab	1741.29ab	74.10	30.00ab	1.70ab
Z. officinale 120 ppm + Propolis 500 ppm	1649.00ab	1634.88ab	73.54	23.25ab	1.37ab
Z. officinale 240 ppm + Propolis 1000 ppm	1663.00ab	1649.22ab	74.26	24.44ab	1.46ab
Z. officinale 360 ppm + Propolis 1500 ppm	1661.44ab	1642.78ab	73.83	22.89ab	1.39ab
SED	39.106	39.003	0.270	1.439	0.071
Significance (P=)	0.2332	0.2240	0.8806	0.0862	0.1643

Means within same column having different letters are significantly different ($p<0.05$). SED: Standard error of difference between means

(2004) mentioned that plant extracts of thyme, fennel, ginger, rosemary, nigella and their combination did not have any effect on carcass yield. According to a study of Erener *et al.* (2005), in broiler chicks, control and carvacrol groups had higher carcass weights compared to menthol group ($p<0.05$), but no significant difference was determined among groups with respect to carcass yield. In similar manner, Denli *et al.* (2005) revealed that the propolis supplement in quail rations significantly improved carcass weight compared to control and flavomycin groups while having no effect on carcass yield.

The findings of these researchers are in agreement with the present findings. The difference among the groups with respect to abdominal fat weight and abdominal fat amount % was significant ($p<0.05$). In this experiment, the lowest abdominal fat weight (19.44 g) was determined in negative control group and the highest abdominal fat weight (32.89 g) was recorded in *Z. officinale* group. This study showed that the ration additive *Z. officinale* extract did not decrease, but rather increased the abdominal fat amount compared to the control group. Compared to negative control group, *Z. officinale* extract generated a significant difference in abdominal fat weight since it possibly promotes fat deposition along with live body weight gain or since the increase in live body weight gain is possibly accompanied by increased fat deposition. It was proved by Erener *et al.* (2005) that in broilers, carvacrol additive increased abdominal fat weight compared to control and menthol groups. On the other hand, Denli *et al.* (2005) reported that supplemental propolis in quail rations did not have a significant effect on abdominal fat weight.

It was determined that antibiotic, *Z. officinale* and propolis extracts had significant effects on some digestion system parameters compared to negative control group ($p<0.05$) (Table 5). While

Table 5: Effect of Z. Officinale essential oil and propolis supplemental on digestive system, liver and heart at 42.days pf broiler shick

Parameters	Criteria	Negative control	Positive control	Z. o 240 Ppm	Propolis 1000 ppm	Z. o 120 + Prop 500 ppm	Z. o 240 ppm + Prop 1000 ppm	Z. o 360 ppm + Prop 1500 ppm	SED	Significance (p=)
Oesophagus+ crop	W, g	13.26	14.72	12.86	12.73	13.8	13.48	14.91	0.458	0.7098
	L, cm	9.24	8.76	9.76	9.62	9.78	9.84	10.20	0.192	0.4148
Proventriculus	W, g	8.18	8.92	9.23	8.92	8.77	9.60	9.27	0.184	0.3962
	L, cm	3.84	3.96	4.04	4.00	3.94	3.88	3.80	0.060	0.8941
Gizzard	W, g	36.86b	45.90a	42.17ab	43.57ab	41.18ab	38.68b	47.23a	0.908	0.0220
	L, cm	5.44ab	5.74a	5.58ab	5.40ab	5.46ab	4.96b	5.58ab	0.086	0.2418
Duodenum	W, g	16.34	17.21	17.38	16.23	15.93	15.72	17.57	0.378	0.6598
	L, cm	14.26	15.20	14.22	14.60	13.74	13.20	14.00	0.291	0.5472
Jejunum	W, g	25.09b	31.28ab	30.49ab	31.10ab	28.72ab	30.09ab	35.50a	0.951	0.1123
	L, cm	60.7	66.9	67.10	59.90	63.30	63.3	67.80	1.388	0.4811
Ileum	W, g	22.40b	25.38ab	28.30a	29.87a	27.27ab	26.74ab	25.50ab	0.656	0.0563
	L, cm	65.90b	73.20ab	75.80a	73.00ab	70.60ab	70.40ab	70.40ab	1.189	0.3256
Small intestine	W, g	63.82b	73.86ab	76.17a	77.20a	71.92ab	72.55ab	78.57a	1.524	0.1277
	L, cm	140.86	155.30	157.12	147.50	147.64	146.90	152.20	2.191	0.3535
Cecum	W, g	5.20ab	6.60a	5.56ab	4.98ab	4.95ab	6.08ab	4.56b	0.244	0.2072
	L, cm	18.20	18.20	18.00	18.00	16.80	18.90	19.00	0.315	0.4804
Large intstine	W, g	3.08b	4.00a	3.66ab	3.78ab	3.78ab	3.40ab	3.40ab	0.110	0.2502
	L, cm	6.90	7.50	7.80	7.80	8.40	7.00	6.90	0.210	0.2836
Total	W, g	130.40b	154.01a	149.64a	151.18a	144.39ab	143.80ab	157.95a	2.213	0.0234
	L, cm	184.48b	199.46ab	202.30a	192.32ab	192.02ab	191.48ab	197.68ab	2.192	0.2753
Liver	W, g	38.22c	47.61a	44.40ab	46.71a	40.94bc	44.25ab	46.99a	0.694	0.0028
Heart	W, g	11.7	14.76	14.03	14.91	15.23	12.92	15.26	0.479	0.2491

Means within same column having different letters are significantly different ($p<0.05$). SED: Standard error of difference between means

ileum and small intestine weights showed an increase in *Z. officinale* and propolis supplemented groups, cecum and large intestine weights increased in antibiotic supplemented groups. The longest total digestive system length (202.30 cm) was determined in *Z. officinale* group and the shortest length (184.48 cm) was observed in negative control group. In similar manner, the highest digestive system weight was determined in treatment groups with respect to negative control group. As also reported by Tekeli *et al.* (2006, 2008), the additives of antibiotic, *Z. officinale* and propolis extracts affect the weights and/or lengths of the digestive system. The improvement in such parameters of the digestive system is attributed to the stimulatory and promotive effects of these extracts on the gastric juices and the digestive system. Liver weight was observed to increase in antibiotic and propolis supplemented groups as well as the group supplemented with a 1.5:1.5 combination of propolis and *Z. officinale* ($p<0.05$). Alcicek *et al.* (2004) expressed that herbal essential oil mixtures decreased intestine weights. In a study by Sarica *et al.* (2005), antibiotic, garlic and thymol when combined with enyzme was reported to lead a significant decrease in small intestine weight and small intestine length significantly increased in control and garlic groups. Cabuk *et al.* (2006) stated that essential oil mixtures did not have any effect on small intestine weight in broilers. The findings of these researchers are not in agreement with the findings of the subject study. The differences among the findings possibly result from the different plant extracts used, additional enzyme supplementation in the ration and the particular focus of these researchers on a certain portion of the digestive system. Erener *et al.* (2005) and Cabuk *et al.* (2006) reported that essential oil mixtures did not have any effect on the weights of either renewable internal organs or pancreas.

The findings on plasma cholesterol, glucose and triglycerids concentrations are presented in Table 6. The difference among groups with respect to plasma cholesterol, glucose and triglycerids values was regarded as significant ($p<0.05$). The highest plasma cholesterol content (136.40 mg dL^{-1}) was recorded in antibiotic supplemented group. The lowest plasma cholesterol contents, on the other hand, were determined respectively in negative control group (113.60 mg dL^{-1}) and the group supplemented with 240 ppm *Z. officinale* (118.75 mg dL^{-})[1] The findings of the subject study showed that antibiotic increased plasma cholesterol level. This can be explained by the higher live body weight gain induced by antibiotic relative to control group and increased fat deposition due to high calorie intake associated with increased feed consumption.

Table 6: Effect of *Z. Officinale* essential oil and propolis supplemental on some blood parameters of broiler chicks

	Parameters		
Treatment groups	Cholesterol (mg dL^{-1})	Glucose (mg dL^{-1})	Triglyceride (mg dL^{-1})
Negative Control (No Additive)	113.60b	254.30a	50.60a
Positive Control (Antibiotic)	136.40a	249.80ab	42.40ab
Z. officinale 240 ppm	118.75b	242.10ab	45.00ab
Propolis 1000 ppm	124.60ab	253.10ab	39.60ab
Z. offcinale 120 ppm + Propolis 500 ppm	127.70ab	250.00ab	30.40b
Z. officinale 240 ppm + Propolis 1000 ppm	124.20ab	246.70ab	34.10b
Z. officinale 360 ppm + Propolis 1500 ppm	127.00ab	240.70b	37.50ab
SED	1.81	1.57	1.89
Significance (P=)	0.0308	0.1289	0.0729

Means within same column having different letters are significantly different ($p<0.05$). SED: Standard error of difference between means

While the highest plasma glucose and triglycerids concentrations were identified in control group, the lowest plasma glucose concentrations was observed in the group supplemented with (1.5:1.5) *Z. officinale* and propolis combination. Similarly, the lowest serum triglycerids concentration was reported in the groups supplemented with (1/2:1/2 and 1:1) *Z. officinale* and propolis combinations. It was expressed in the findings of diverse studies that plant extract and propolis intake lead to a decrease in the level of plasma cholesterol, glucose and triglycerids concentrations (Lee *et al*., 2003a; Al-Homidan, 2004; Kaya *et al*., 2004; Fuliang *et al*., 2005; El-Bagir *et al*., 2006). 240 ppm *Z. officinale*, 500, 1000 ppm propolis and the combinations of these two extracts were particularly effective on lowering plasma triglycerids concentrations. This lowering effect can be attributed to the regulatory mechanism of the flavanoids-as one of the ingredients in these natural products- for blood circulation and stimulation of triglycerids use for energy generation. In the group supplemented with (1.5:1.5) *Z. officinale* and propolis combination, a decrease in plasma glucose level was noted which possibly resulted from the stimulatory effect of the extracts at this amount on insulin release. It is reported that essential oils are the secondary metabolites of the plants enhancing release of insulin or insulin-like substances (Greathead, 2003). Insulin stimulates glucose transport into liver cells and leads to a decrease in the level of blood glucose. Subsequently, the glucose entered in the liver cells is firstly converted to pyruvate and then to acetyl-CoA, and utilized as substrate in the synthesis of fatty acids. This means increased fat deposition (Guyton and Hall, 2001). Abdominal fat weight was reported to increase in all treatment groups compared to negative control group. Contrary to the findings of this study, Demir *et al*. (2003), Lee *et al*. (2003a) and Biavatti *et al*. (2003) expressed that plant extracts used as growth promoters had no effect on plasma lipid and glucose concentrations. The differences in research findings can possibly be explained by the differences in plant extracts and propolis utilized for the studies as well as the differences in their doses.

Three main remarks can be made on the basis of the findings obtained in this study and their assessment in accordance with the findings of the former studies. The remarks are as follows:

- Extract combinations such as 240 ppm *Z. officinale* and 1000 ppm propolis, performed similar to antibiotics on live body weight gain, feed consumption and feed conversion efficiency of broiler chicks. The combinations proved superior to antibiotics in terms of lowering plasma cholesterol, glucose and triglycerids levels, and hence, have great potential to replace antibiotic growth promoters
- *Z. officinale* and propolis –as alternatives to antibiotics- are valuable natural products since they can continuously be used in the ration until slaughter, do not induce any resistance to antibotics, are harmless in apppropriate amounts and are risk-free in terms of residue-formation. The findings are considered important also for the gathering of ecological products
- For a thorough assessment of the studies on the usage of plant extracts and propolis in mixed feed of broiler chicks, it is important to know the location where the extracts are collected, the time of their collection as well as the methods of their extraction. The information on these parameters are crucial in order to further clarify the similarities and differences among the findings of the studies and derive at more precise/undisputed results. Since the effective ingredients in the extracts vary according to the above-mentioned parameters, the active components should be specifically determined through analyses

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