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Effect of mentha extract (*Mentha piperita*) supplementation in drinking water on performance, plasma lipoproteins, carcass charasteristic and liver color index or weight in broiler chickens

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ABSTRACT

Mixed day-old broiler chicks (160) in 4 groups were used to investigate the effects of mentha extract (*Mentha piperita*) on performance, carcass characteristics, plasma lipoproteins and liver indices. All the chickens were fed the similar starter (day 1–21 of age) and grower (day 22–42 of age) diets in pellet form, but received 0.0 (ZM), 0.2 (LM), 0.4 (MM) and 0.6% (HM) alcoholic extract of *Mentha piperita* in drinking water during the experimental period (day 1 to day 42 of age). Performance (feed intake, body weight gain and feed conversion ratio), hot carcass and proportional weights of thigh, wing and abdominal fat were not affected by mentha consumption. But breast proportional weight increased linearly as the mentha extract level increased. Positive and negative quadratic regression models were observed between mentha extract level with the liver colour index and liver proportional weight respectively. Mentha extract supplementation decreased plasma total cholesterol, triglyceride, LDL- C and VLDL- C quadrically. It was concluded that mentha extract consumption in drinking water can have beneficial effects on plasma lipoproteins and breast proportional weight. Moreover it decreased the synthesis of lipids in liver and consequently decreased the liver proportional weight and increased the liver colour index.

Key words: Broiler chickens, Carcass characteristics, Liver colour, Liver weight, *Mentha piperita*

Animal products with a high fat content, which is a risk factor for cardiovascular diseases, are not welcomed by consumers (Dong *et al*.2007). Medicinal plants have a beneficial effects on the plasma lipids and are used in many parts of the world (Abdulkarimi *et al.*2011). *Mentha piperita*, one of the world's oldest medicinal herbs and used in both Eastern and Western traditions, has phenolic properties of menthol, menthone and menthyl acetate (Escop 2003). Flavonoids, polymerized polyphenols, carotenes, tocopherols, saponin and choline are the other compounds found in *Mentha piperita* (Murray 1995). In broiler chickens, dietary supplementation of *Mentha piperita* improved the performance and dressing percentage (Galib *et al.* 2010) and reduced plasma lipids in rats (Hosseini- Mansoub 2011). Barbalho *et al.* (2009) reported that it reduced the plasma lipids in rats. Abdulkarimi *et al*. (2011) observed a relationship between plasma total cholesterol and proportional liver weight or liver color intensity in broiler chickens. Lee *et al*. (2003) and Trampel *et al*. (2005) observed difference in liver colour depending on presence or absence of cholesterol in diet. So this experiment was conducted to reveal the effect of *Mentha pipperita* extract consumption on plasma triglyceride and lipoproteins in broiler chickens. Moreover we assessed the relationship between the level of mentha pipperita extract consumption and the liver color index or weight as the indicators for the lipid content in meat.

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MATERIALS AND METHODS

A total of 160 mixed day-old broiler chicks (Ross 308, 45±3 g) purchased commercially, were weighed on arrival and randomly allocated to 16 pens (1 m×1 m) of 10 birds each. Equal numbers of male and female chicks (5 from each gender) were distributed in each pen. Water and feed were provided *ad lib*. All the chickens were fed the similar starter (day 1–21 of age) and grower (day 22–42 of age) diets in pellet form (Table 1), but received 0.0 (ZM), 0.2 (LM), 0.4 (MM) and 0.6% (HM) alcoholic extract of *Mentha piperita* (0.03% menthol and pH=5.5) in drinking water during the

Table 1. Composition of experimental diets

	Starter (0–21 d)	Grower (21–42 d)
Ingredients (%)		
Corn	54.87	61.78
Soybean meal (44 CP%)	36.72	26.36
Fish meal (60 CP%)	1.31	4.50
Vegetable oil	3.00	4.00
Limestone	1.15	1.05
Dicalcium phosphate	1.94	1.49
Vit. and min. premix[1]	0.50	0.50
Salt	0.30	0.30
DL-methionine	0.21	0.02
Total	100.00	100.00
Analysis result		
ME (kcal/kg)	2937	3100
CP (%)	21.44	19.37
DM (%)		
Calcium (%)	1.05	1.00
A. phosphorus (%)	0.51	0.50
Sodium (%)	0.16	0.14
Arginine (%)	1.41	1.23
Methionine + cystine (%)	0.91	0.69
Lysine (%)	1.20	1.10
Tryptophan (%)	0.31	0.26

[1] Provide per kg of diet: retinol, 15, 000 U; colecalciferol, 8000 U; menadione, 3 mg; cyanocobalamin 15 µg; niacin, 32 mg; choline, 840 mg; biotin, 40 µg; thiamine, 4 mg; riboflavin, 6.6 mg; pyridoxine, 5 mg; folic acid, 1 mg; zinc, 80 mg; manganese, 100 mg; selenium, 200 mg; iron, 80 mg; magnesium, 12 mg; copper, 10 mg; calcium, 15 mg; iodine, 1 mg.

experimental period. *Mentha piperita* alcoholic extract was prepared using a standard maceration method (Zhang *et al.*2005). In this method, vegetative parts were shade dried. *Mentha piperita* full bloom stage were crushed and soaked in ethanol 80% in 1:5 ratios (w/v) for 72 h on a shaker. The extract was strained and its menthol content was determined by TLC (thin layer chromatography) method. pH value of extract assessed by a pH meter instrument.

The average body weight gain (BWG) and average feed intake (FI) were determined during the experimental period and feed conversion ratio (FCR) for this period was also calculated. At days 21 and 42 of age, 2 birds / pen (1 male and 1 female) were selected, weighed and killed by decapitation to obtain the blood samples, liver colour index, liver weight and carcass characteristics (proportional abdominal fat, breast, thigh and wing). Liver, abdominal fat, breast, thigh and wing were removed, weighed and their proportional (percentage of live body weight) weights were reported. Immediately after slaughter, the colour of liver surface area was grouped into 5 grades of 1 (light), 2 (reddish light), 3 (red), 4 (dark red) and 5 (dark) visually (Abdulkarimi *et al.* 2011). The liver colour data were considered non-parametric and transformed to "x+0.5". The transformed data were used for statistic analyses. Blood samples were collected in anticoagulant tubes (citrate sodium 3.6% solution) during a 40 min period. Blood plasma was separated and plasma triglyceride, total cholesterol and lipoproteins were determined by enzymatic method using a commercial kit technique. Means of all variables for both samples of 21 and 42 days of age were calculated and used for statistic analyses. Regresion models (linear and quadratic calculated by SAS (2002, statistical package, version 9.1) were used to determine the optimal dietary mentha extract level on performance, carcass characteristics, liver indices and plasma lipoproteins.

RESULTS AND DISCUSSION

Our results showed higher proportional breast weight, darkened liver, lower proportional liver weight and lower plasma triglyceride and lipoproteins by increasing the level of mentha extract in drinking water.

Performance and carcass characteristics: BWG, FI and FCR were not affected (P>0.05) by mentha consumption during whole the experimental period (day 1 to 42 of age) (Table 2). In the same way, mentha extract supplementation in drinking water did not affect the hot carcass and proportional weights of thigh, wing and abdominal fat (P>0.05) (Table 3). Mentha extract supplementation only affected the breast proportional weight (P= 0.03). Breast

Table 2. Total feed intake, weight gain and fed conversion ratio of broiler chickens received 0.0 (ZM), 0.2 (LM), 0.4 (MM) and 0.6% (HM) mentha extract in drinking water

Treatment	Feed intake (g/d/bird)	Weight gain (g/d/bird)	Feed conversion ratio (g/g)
ZM	91.1	49.6	1.83
LM	93.5	53.8	1.73
MM	89.6	52.2	1.71
HM	87	48.8	1.78
Pooled SEM	1.5	0.96	0.02
Linear	0.24	0.64	0.37
Quadratic	0.37	0.11	0.09

Table 3. Hot carcass and proportional weights of breast, thigh, wing and abdominal fat in broiler chickens received 0.0 (ZM), 0.2 (LM), 0.4 (MM) and 0.6% (HM) mentha extract in drinking water

Treatment	Hot carcass	Breast	Thigh	Wing	Abdominal fat
ZM	71.2	24.1	20.3	7.7	2.1
LM	72.5	24.8	20	8.2	2.4
MM	70.7	25.5	19	7.7	2
HM	75.3	26.3	21.1	8	2.3
Pooled SEM	0.79	0.4	0.27	0.12	0.12
Linear	0.14	0.03	0.82	0.72	0.63
Quadratic	0.1	0.11	0.96	0.81	0.08

proportional weight increased linearly as mentha extract level increased in drinking water. Higher breast weight in mentha consumed birds could be related to higher availability of lysine amino acid for breast development. Lysine content in breast muscle is relatively higher than other amino acids. Dietary lysine inadequacy reduces the breast meat yield (Tesseraud *et al.*1996). Relation between the lysine levels and breast weight was demonstrated in poultry (Kerr *et al.*1999, Nasr and Kheiri 2011). The principal component of *Mentha piperita* is menthol (Foster 1996, Escop 2003) and bactericidal effects of this component against harmful bacteria *in vitro* and intestinal tract were reported (El-Naghy *et al.* 1992, El-Kady *et al.* 1993, Pattnaik *et al.* 1997, Saeed and Tariq 2005). Antimicrobial effect of mentha and its ability for inhibition of harmful bacteria to decomposition of lysine is possibly the main reason. Lee *et al.* (2003) indicated that intestine harmful bacteria can promote the lysis of amino acids and di-aminasion process. This phenomenon possibly caused the better availability of lysine for growth of the breast meat. Nobakht *et al.* (2011) supported this result as they indicated that supplementation of diet with 0.5, 1, 1.5 and 2% *Mentha pulegium* enhanced breast relative weight of birds compared with control group. Although, a mixture of essential oil extract (blend of oregano, cinnamon, and pepper oils) or labiatae extract (blend of sage, thyme, and rosemary extracts) have had no effect on crude protein digestibility in broiler chickens (Hernandez *et al.*2004). Of course, the difference in the way of consumption (diet or drinking water) and treatment (alone or in combination to other plants) should be considerated as the reasons.

The low pH (5.5) of mentha extract and resulted lumen acidity could be the another reason. Organic acids and probiotics can improve the microflora and reduce the harmful bacteria of the gut and consequently produce an appropriate acidity pH (Huang *et al.* 2004, Roser 2006, Skrivanova and Marounek 2007). Therefore mentha extract consumption probably provides a favorable pH in the gut and declined the harmful bacteria such as *Salmonella* and *E. coli.* This process may have increased the bioavailability of amino acids in lumen and enhanced the breast proportional weight.

Plasma lipoproteins and triglyceride: Mentha extract supplementation affected the plasma triglyceride and all the lipoproteins but HDL-c (Table 4). Plasma triglyceride, total cholesterol, LDL-c and VLDL-c decreased linearly as *Mentha piperita* extract increased to 0.4% in drinking water. But no additional responses were observed for these parameters by increasing the *Mentha piperita* extract from 0.4 to 0.6%, because quadratic responses were indicated for plasma triglyceride, total cholesterol, LDL-c and VLDL-c.

Depressing effects of mentha extract supplementation on plasma total cholesterol, LDL-c, VLDL-c and triglyceride in recent experiment possibly related to the reduced activity of HMG-CoA reductase by active components of mentha extract (menthol and menthon). Saponin components of mentha extract (Kumar *et al.* 2011) possibly is the other reason for its lowering effects on plasma lipids. Saponins form insoluble complexes with cholesterol in the digesta and inhibit the intestinal absorption of endogenous and exogenous cholesterol (Oakenfull and Sidhu 1990).

Liver indices: Mentha extract supplementation in drinking water significantly affected the liver colour index and proportional weight in broiler chickens ($P<0.05$). As the drinking water mentha extract level increased to 0.2% in drinking water, liver proportional weight decreased linearly ($Y= 9.3 – 2.65x$, $R^2= 0.32$, $P= 0.0006$) whereas additional decrease was observed for this parameter by increasing the level of drinking water to above the 0.2% ($Y= 2.96+ 0.44x + 0.053x^2$, $R^2= 0.52$, $P= 0.0001$) (Fig. 1). Opposite trend was depicted for liver colour index. It increased linearly as the mentha extract increased to 0.2% ($Y= –1.62+ 1.54x$, $R2= 0.29$, $P= 0.001$) in drinking water while no more response was indicated by increasing the level of the extract to 0.4 or 0.6% ($Y= 1.54+ 0.38x –0.048x^2$, $R^2= 0.53$, $P= 0.0001$) (Fig. 2).

The negative quadratic response of plasma lipoproteins in recent experiment by increasing the mentha extract

Table 4. Plasma triglyceride, total cholesterol, high density lipoprotein (HDL-c), low density lipoprotein (LDL-c) and very low density lipoprotein (VLDL-c) of broiler chickens received 0.0 (ZM), 0.2 (LM), 0.4 (MM) and 0.6% (HM) mentha extract in drinking water

Treatments	Triglyceride (mg/dl)	Total cholesterol (mg/dl)	HDL-c (mg/dl)	LDL-c (mg/dl)	VLDL-c (mg/dl)
ZM	47.2	231.3	94.4	127.5	9.4
LM	45	169.5	98.1	62.4	9
MM	42.8	153.2	96.5	48	8.1
HM	43.4	153	92.2	52	8.6
Pooled SEM	0.43	6.21	1.82	6.49	0.13
Linear	<0001	<0001	0.62	<0001	<003
Quadratic	<0001	<0001	0.49	<0001	<001

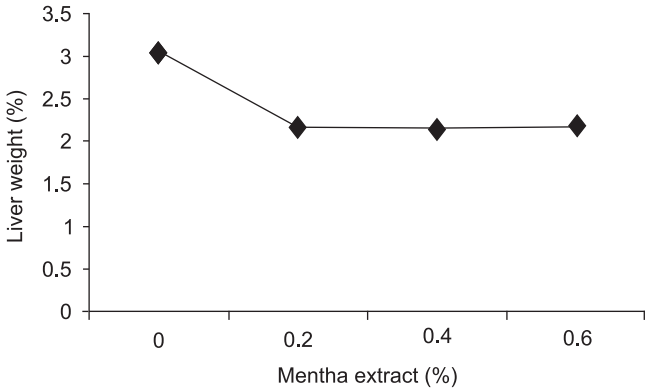

Fig. 1. The relationship between the level (%) of *Mentha piperita* extract supplementation in drinking water and liver relative weight ($y =2.96–0.44 x + 0.053 x^2$; $P < 0.05$; $R^2 = 0.52$) in broiler chicks.

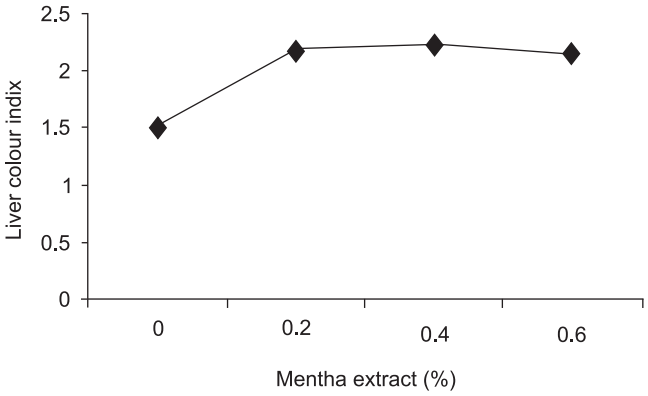

Fig. 2. The relationship between the level (%) of *Mentha piperita* extract supplementation in drinking water and liver colour intensity in broiler chicks. ($y = 1.54 + 0.38\ x - 0.48\ x^2$; $P < 0.05$; $R^2 = 0.53$).

consumption level is consistent with negative quadratic response for liver weight. This could be related to lower synthesis of fats in the liver of mentha consumed birds which was confirmed with darker colour of liver in these birds, because a positive quadratic response was observed for liver color by increasing the level of mentha extract consumption. In agreement with these results, we observed lower plasma lipids and liver weight (%) and higher liver colour intensity by consumption of thyme extract in drinking water in our previous research (Abdulkarimi *et al.* 2011). This result was supported by Galib *et al.*(2010) who showed significant lowering effect of *Mentha piperita* on liver weight (%) in broiler chickens. Darkened colour of liver or its lower proportional weight in mentha extract consumed birds of this experiment, may be related to mentha's hypocholestemic effect. Trampel *et al*. (2005) indicated the higher weight and lighter colour for liver of broiler chickens fed high dietary lipids and the redder colour for liver of low cholesterol fed birds. In the other study, Lee *et al.* (2003) observed higher plasma and liver cholesterol, and liver weight in broiler chickens fed 1% dietary cholesterol. Moreover, they observed the yellowish livers in cholesterol fed broilers and pinkish livers in birds fed the control diet (without cholesterol).

In conclusion, 2% mentha extract consumption in drinking water is enough to decrease the plasma lipoproteins, diminish the liver weight and darken the liver colour and hence meat quality. Furthermore, higher proportional breast weight in mentha consumed birds is possibly because of the better availability of lysine.

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