Effects of summer shield supplementation on growth performance, nutrient utilisation, and plasma lipid profiles in broiler chickens

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ABSTRACT: This study was conducted to evaluate the effects of herb mixture (summer shield) supplementation on growth performance, nutrient utilisation, and plasma lipid profiles in broiler chickens. Thirty-six male chicks at 15 days of age were divided into three groups with three replicates of four birds. The control group of chicks was fed a basal diet and the remaining two groups of chicks were fed the basal diet supplemented with summer shield at a concentration of 1 g/kg or 2 g/kg, respectively, until 37 days of age. Although feed intake was not different among the three groups, both body weight gain and breast muscle weight were increased in chicks fed a summer shield-supplemented diet. Summer shield supplementation decreased abdominal fat weight and consequently feed efficiency was improved. Both protein and fat utilisation was improved in chickens fed a summer shield-supplemented diet although dry matter content was not influenced. In addition, summer shield supplementation improved plasma lipid profiles, i.e., total cholesterol, triglyceride, and low-density lipoprotein cholesterol were decreased, whereas high-density lipoprotein cholesterol was increased. Furthermore, summer shield supplementation increased total protein, albumin, and globulin levels in plasma, while neither glutamate oxaloacetate transaminase nor glutamate pyruvate transaminase were affected. These results suggest that summer shield supplementation has positive effects on growth performance, nutrient utilisation, and plasma lipid profiles in broiler chickens.

Keywords: summer shield; antibiotics; broilers; nutrient utilisation; growth performance; plasma lipid profiles

Since broiler chickens are sensitive to pathogens (Adams 2004), antimicrobial additives such as antibiotics are used to reduce the levels of harmful microorganisms in the intestine and to improve growth rate and feed efficiency (Jin et al. 1997). However, routine antibiotic usage as a feed additive has been banned in many countries in recent years (Leeson 2007), e.g., the European Union has restricted their usage since 2006.

Many herbs with pharmacological effects are widely used in traditional medicine. Also, in human nutrition, herbs play an important role as flavours and food preservatives. In animal nutrition, a wide range of herbs have been examined with respect to their antimicrobial, coccidiostatic, anthelminthic and immunostimulatory effects as well as their effects on feed intake (Panda et al. 2006). Therefore, at present, many herbs are accepted as feed additives for domestic animals by the European Union.

Summer shield is a mixture of seven herbs and contains 35% *Mentha spicata* (spearmint), 15% *Mangifera indica* (mango), 10% *Coriandrum sativum* (coriander), 10% *Cucumis sativus* (cucumber), 10% *Aegle marmelos* (bael), 10% *Centella asiatica* (gotu kola), and 10% *Allium cepa* (onion). Each component of summer shield is known to have health benefits, e.g., spearmint is used as an anti-spasmodic, choleretic and carminative (Al-Kassie 2010) and mango is a good source of soluble carbohydrate (Diarra and Usman 2008). Coriander has anti-fungal (Basilico and Basilico 1999), anti-oxidant (Chithra and Leelamma 1999), hypolipidemic (Chithra and Leelamma 2000) and anti-microbial (Delaquis et al. 2002) properties. Cucumber, meanwhile, plays anti-oxidant and anti-inflammatory roles (Tang et al. 2010; Nema et al. 2011), and bael exerts various effects including anti-inflammatory and anti-hyperlipidaemic activities (Jyoti et al. 2011). Furthermore, *Centella asiatica* contains active substances such as asiaticoside that accelerate enzymatic and non-enzymatic antioxidant activities of newly growing tissues (Sahin and Sahin 2002) and increase wound curability in rats (Shukla et al. 1999). It has also been reported that onion extracts harbour anti-oxidant, anti-microbial, and anti-allergic properties (Helen et al. 2000; El-Meleigy et al. 2010).

Thus, while the individual components of summer shield have well-described benefits such as anti-microbial and anti-inflammatory activity, there have been very few reports on the use of summer shield as a feed additive alternative to antibiotics in poultry feed. The aim of this study was to evaluate growth performance and nutrient utilisation in broiler chickens fed summer shield. In addition, since some components of summer shield have hypolipidaemic and/or anti-hyperlipidaemic effect, we also examined the effects of summer shield supplementation on plasma lipid profiles.

MATERIAL AND METHODS

Animals and experimental design. This experiment was conducted in accordance with the Guidelines of the Department of Poultry Production, Faculty of Agriculture, Kaferelsheikh University, Egypt. Thirty-six, one-day-old male Lohman broiler chickens were housed in an electrically heated battery brooder, and provided with water and commercial starter diet (corn and soybean meal-based diet containing 23% crude protein and 3200 kcal/kg ME) until 12 days of age. The chicks were housed in individual cages and fed a basal diet from 12 to 15 days of age and were randomly divided into three groups with three replicates of four birds to equalise the average body weight in each group. The control group was fed the basic diet as powder feed, and the two remaining groups were fed the basic diet supplemented with summer shield at a concentration of 1 g/kg or 2 g/kg, respectively. The nutrient composition of the basal diet (CP 21.65%, 3145 kcal/kg ME) is shown in Table 1. The summer shield was kindly provided by Kohkin Chemical Co., Ltd. (Osaka, Japan), and the composition of summer shield is shown in Table 2. The experiment was conducted on an open door farm with 18 h light: 6 h dark cycle. The temperature and humidity of the animal room were controlled at 24–26 °C by using a fan and hood throughout the experiment. The chicks were housed individually and had access to feed and water *ad libitum*. The birds were given each experimental diet from 15 to 37 days of age. Body weight was recorded every week, and feed intake was recorded daily during the experimental period. At the end of the experimental period, the birds were weighed and slaughtered

Table 1. Composition and nutrient analysis of the basal diet

Ingredients	(g/kg)
Corn	565.2
Soybean meal	300.0
Corn gluten meal	60.0
Premix[1]	3.0
Soy oil	40.0
Dicalcium phosphate	18.0
Limestone	10.0
Salt	3.8
Calculated values[2]	
CP (%)	21.65
ME (kcal/kg)	3145.00
Crude fibre (%)	3.05
Ether extract (%)	6.60
Ca (%)	0.89
P (%)	0.48

[1]Each 3 kg of vit. and min. in Premix contain: 600 000 IU vit. A, 900 000 IU vit. D3, 40 000 mg vit. E, 2000 mg vit. K, 2000 mg vit. B1, 4000 mg vit. B2, 2000 mg vit. B6, 10 mg vit. B12, 50 000 mg niacin, 10 000 mg pantothenic acid, 50 mg biotin, 3000 mg folic acid, 250 000 mg choline, 50 000 mg Zn, 8500 mg Mn, 50 000 mg Fe, 50 000 mg Cu, 200 mg I, 100 mg Se, and 100 mg Co

[2]According to NRC (1994)

Table 2. Summer shield composition*

Botanical name (English common name)	Content (%)
Mentha spicata (spearmint)	35.0
Coriandrum sativum (coriander)	10.0
Mangifera indica (mango)	15.0
Cucumis sativus (cucumber)	10.0
Aegle marmelos (bael)	10.0
Centella asiatica (gotu kola)	10.0
Allium cepa (onion)	10.0

*Confirmed by AROSOL chemical on 2011. Listed in European Union Register of feed additives pursuant to regulation (EC) No 1831/2001, 114 ed., released on 30 March 2011

Table 3. Effect of feeding summer shield on growth performance in broilers

	Control	Summer shield (1 g/kg)	Summer shield (2 g/kg)
BWG (g/22 day)	1581 ± 23[b]	1615 ± 20[ab]	1637 ± 19[a]
FI (g/22 day)	2935 ± 38	2923 ± 48	2881 ± 33
Feed conversion ratio	1.86 ± 0.71[a]	1.81 ± 1.01[ab]	1.76 ± 0.82[b]
BMW (g/100 g BW)	23.9 ± 0.72[b]	25.8 ± 0.81[ab]	27.5 ± 0.55[a]
Liver (g/100 g BW)	3.13 ± 0.33	3.19 ± 0.32	3.18 ± 0.40
Abdominal fat (g/100 g BW)	1.81 ± 0.09[a]	1.51 ± 0.15[b]	1.49 ± 0.14[b]

Values are expressed as means ± standard error. Data were analysed by two-way analysis of variance and Tukey's multiple test. BW = body weight, BWG = body weight gain, BMW = breast muscle weight, FI = feed intake

[a–b]means within the same row with different superscripts differ ($P < 0.05$)

by decapitation, dissected to determine the weights of breast muscle, liver and abdominal fat. Blood samples were collected from *v. jugularis* into heparinised test tubes and quickly centrifuged (3000 rpm for 20 min at 5 °C) to separate the plasma. Plasma was stored at –20 °C pending analysis.

During the last three days of the experiment, excreta were collected from each bird and weighed. Then, the samples were dried in an oven at 60 °C for 24 h. The whole dried samples were then homogenised and finely ground for analysis according to AOAC (1994). Crude protein content in diet and excreta was measured to determine nitrogen retention using the Kjeldahl method and crude fat was measured using the Soxhlet method. The calculations were as follows; nitrogen retention (%) = (total nitrogen intake – total nitrogen excreted)/ total nitrogen intake × 100.

Biochemical analysis. Triglyceride (TG), total cholesterol level, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, glutamic oxalacetic transaminase (GOT), glutamate pyruvate transaminase (GPT), glucose, glutathione peroxidase (GPx), total protein, albumin and globulin were measured colourimetrically using commercial kits (Diamond Diagnostics, Egypt) according to the procedure outlined by the manufacturer.

Statistical analysis. The differences between the treatment groups and the control group were analysed with a General Linear model using SPSS Statistics 17.0 (Statistical Packages for the Social Sciences, released 23 August 2008). Tukey's multiple comparison test was used to identify which treatment conditions were significantly different from each other at a significance level of $P < 0.05$.

RESULTS

The effects of feeding summer shield on body weight gain, feed intake, feed conversion ratio, breast muscle weight, liver weight and abdominal fat weight are summarised in Table 3. Summer shield supplementation significantly increased body weight gain, while feed intake was not altered among the three experimental groups. Consequently, the feed conversion ratio was decreased by summer shield supplementation. An increased weight of breast muscle and decreased weight of abdominal fat were observed in chickens fed a summer shield-supplemented diet, whereas liver weight was not affected.

Table 4 shows nutrient utilisation in chickens fed the summer shield-supplemented diet. Dry matter utilisation was not affected by feeding the summer shield-supplemented diet. Although crude protein utilisation and crude fat utilisation in chickens fed

Table 4. Effect of feeding summer shield on coefficients of nutrient utilisation

	Control	Summer shield (1 g/kg)	Summer shield (2 g/kg)
DMD (%)	71.4 ± 5.2	73.5 ± 5.1	74.7 ± 5.2
CPU (%)	69.5 ± 3.2[b]	72.6 ± 4.0[ab]	75.8 ± 3.3[a]
CFU (%)	56.6 ± 5.1[b]	59.6 ± 4.3[b]	63.3 ± 4.1[a]

Values are expressed as means ± standard error. Data were analysed by two-way analysis of variance and Duncan's multiple range test. Means within a row not sharing a common superscript significantly differ from each other. NS = not significant, DMD = dry matter utilisation, CPU = crude protein utilisation, CFU = crude fat utilisation

[a–b]means within the same row with different superscripts differ * $P < 0.05$

Table 5. Effect of feeding summer shield on blood traits in broilers

	Control	Summer shield	
		(1 g/kg)	(2 g/kg)
TG (mg/dl)	26.3 ± 1.13[a]	24.2 ± 0.8[ab]	21.08 ± 1.1[b]
Total cholesterol (mg/dl)	137.6 ± 3.1[a]	128.9 ± 2.3[b]	114.7 ± 3.1[c]
HDL (mg/dl)	73.2 ± 1.8[b]	75.2 ± 2.3[b]	82.9 ± 1.3[a]
LDL (mg/dl)	63.1 ± 3.8[a]	51.7 ± 2.2[b]	22.8 ± 3.1[c]
GOT (IU/I)	182.0 ± 12	181 ± 16	179 ± 13
GPT (IU/I)	25.8 ± 5	23 ± 3	22 ± 2
Glucose (mg/dl)	189 ± 21[a]	175 ± 18[b]	163 ± 17[c]
GPx (mg/dl)	452 ± 45[c]	495 ± 34[b]	555 ± 33[a]

Values are expressed as means ± standard error. Data were analysed by two-way analysis of variance and Tukey's multiple test. TG = triglyceride, HDL = high density lipoprotein, LDL = low density lipoprotein, GOT = glutamic oxalacetic transaminase, GPT = *glutamate pyruvate transaminase, GPx* = Glutathione peroxidase

[a–c] means within the same row with different superscripts differ ($P < 0.05$)

the 1 g/kg summer shield-supplemented diet were not different from the chickens fed the control diet, feeding the 2 g/kg summer shield-supplemented diet increased both these parameters compared to the control diet.

Table 5 shows the plasma concentrations of TG, total cholesterol, HDL-cholesterol, LDL-cholesterol, GOT, GPT, glucose and GPx. Plasma TG, total cholesterol, LDL-cholesterol, and glucose were decreased by feeding the 2 g/kg summer shield-supplemented diet compared to the control diet, while plasma HDL-cholesterol and GPx levels were increased. Neither plasma GOT nor GPT levels were affected by feeding summer shield. Plasma total protein, albumin, globulin and albumin/globulin ratio were increased in chicken fed the summer shield-supplemented died compared with the chickens fed the control diet (Table 6).

DISCUSSION

The results of the present study indicate that the consumption of a summer shield-supplemented diet results in increased body weight gain and breast muscle weight and decreased feed conversion ratio and abdominal fat weight. The reason for this might be due to the growth promoting effects of some of the ingredients of summer shield, e.g. an increase in body weight gain and muscle weight was observed in chickens fed a diet containing either onion (Aji et al. 2011), or coriander (Hamodi et al. 2010). Similarly, feeding spearmint increases feed intake and consequently improves growth in chickens (Amasaib et al. 2013), although feeding the summer shield-supplemented diet decreased feed intake in this study. One possible explanation for the discrepancy between the consumption of a single herb and of the herb-mix summer shield might be the presence of anti-microbial components in the summer shield formulation. It is well known that the microflora of the gastrointestinal tract affects digestibility of feed and consequently influences the growth performance of broiler chickens (Metzler et al. 2005). Essential oils derived from coriander seeds were described to negatively affect both gram-positive and gram-negative bacteria (Delaquis et al. 2002), while intestinal health

Table 6. Effect of feeding summer shield on some immune parameters in broilers

	Control	Summer shield	
		(1 g/kg)	(2 g/kg)
Plasma total protein (mg/dl)	3.01 ± 0.21[b]	3.54 ± 0.31[ab]	3.75 ± 0.31[a]
Plasma albumin (mg/dl)	1.05 ± 0.05[b]	1.35 ± 0.09[a]	1.45 ± 0.04[a]
Plasma globulin (mg/dl)	1.94 ± 0.11[b]	2.12 ± 0.15[ab]	2.21 ± 0.13[a]
Plasma albumin/globulin (mg/dl)	0.54 ± 0.01[b]	0.64 ± 0.02[a]	0.66 ± 0.04[a]

Values are expressed as means ± standard error. Data were analysed by two-way analysis of variance and Tukey's multiple test

[a–b]means within the same row with different superscripts differ ($P < 0.05$)

and growth performance were improved through the increased digestibility of feed (Guler et al. 2005). Similarly, Cabuk et al. (2003) reported that linalool, one of the essential oils from *coriander* seeds, inhibited the growth of *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Staphylococcus aureus*, *Clostridium botulinum* and *Clostridium perfringens*. These results suggest that anti-microbial components of summer shield such as coriander may modulate the microflora in the gastrointestinal tract. Consequently, the digestibility of feed and/or growth performance in chickens fed the summer shield-supplemented diet might be improved.

In this study, feeding the summer shield-supplemented diet increased plasma parameters related to immunity (i.e. total protein, albumin, and globulin, respectively). This suggests that the function of the immune system might be enhanced. Indeed, Giles and Czuprynski (2003) reported a novel role for albumin in innate immunity. Since it has been reported that both cucumber and bael have anti-inflammatory effects (Tang et al. 2010; Jyoti et al. 2011; Nema et al. 2011), it is possible that cucumber and/or bael might directly elicit increases in immune-related parameters. In addition, augmenting the immune response to microbes and/or fungi is positively correlated with growth performance in broiler chickens (Huang et al. 2004). Furthermore, an enhanced response of the immune system to microbes and/or fungi resulted in an increase in oxidant levels in the gastrointestinal tract of broiler chickens. Coriander has anti-microbial effects (Cabuk et al. 2003; Tabance et al. 2003) as well as anti-fungal effects (Soliman and Badea 2002), and both coriander and onion contain anti-oxidants that decrease lipid oxidation (Al-Mamary 2002). Indeed, in this study, feeding summer shield-supplemented diet increased the levels of the antioxidant enzyme GPx in plasma. Therefore, coriander and onion might also contribute to eliciting increases in immune-related parameters.

Essential oil mixtures can create a healthier gut microflora, aiding optimum digestion and improving bird performance (Cruickshank 2001). The stimulation of digestive enzymes is another possible mode of action of summer shield; bioactive compounds extracted from the herpes content in summer shield could affect the activity of digestive enzymes. Xu et al. (2003) reported that dietary supplementation of fructooligosaccharides improved daily body weight gain in male broiler chickens by increasing the activities of amylase and protease. Such substances may act as growth promoters (Al-Ankari et al. 2004), or may improve the digestion and absorption of nutrients (Brander 1985).

The positive effect of dietary coriander seed on body weight gain and feed conversion ratio could be related to the increased efficiency of feed utilisation and/or altered carcass composition. Ather (2000) reported an improved performance in broilers when a poly-herbal premix which contained five herbs was used. In agreement with these data, similar results were observed in recent studies which reported that essential oils exerted inhibitory effects on pathogens in the digestive system (Alcicek et al. 2003), and improved feed intake, feed conversion ratios and carcass yields (Basset 2000; Hertrampt 2001; Giannenas et al. 2003). Wenk (2003) reported that herbs, spices and their extracts can stimulate appetite and endogenous secretions such as enzymes; further, they can have antimicrobial, coccidiostatic or anthelminthic activities in monogastric animals and may improve food digestibility. Thus, the improved growth performance and digestibility observed in the present study in summer shield-supplemented chicks may be due to the antimicrobial and anti-fungal effects of summer shield ingredients. Like most antimicrobial agents, the bioactive substances from summer shield exert their effects by modulating the cellular membrane of microbes (Kamel 2000). *In vitro* studies of Kamel (2001) indicate that the minimum inhibitory concentration (MIC50) and minimum bactericidal concentration (MBC50) are linked to the level of active substance and purity of the plant extract. Furthermore, a strong increase in hydrophobicity of the microbial species in the presence of some plant extracts may influence the surface characteristics of microbial cells and thereby affect the virulence properties of the microbes (Kamel 2001).

In conclusion, the results obtained in this study indicate that feeding summer shield at a concentration of 2 g/kg clearly improves growth performance, digestibility, and plasma lipid profiles.

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