Comparative effects of Chinese green tea (*Camellia sinensis*) extract and powder as feed supplements for broiler chickens

Keyvan Jelveh\(^a\), Behrouz Rasoulia, Alireza Seidavi\(^a\) and Siaka Seriba Diarra\(^b\)

\(^a\)Department of Animal Science, Rasht Branch, Islamic Azad University, Rasht, Iran; \(^b\)School of Agriculture and Food Technology, The University of the South Pacific, Apia, Samoa

**ABSTRACT**

The comparative effects of green tea extract (GTE) and powder (GTP) on performance of broilers were studied. A total of 405-day-old male Ross 308 broiler chicks were randomly assigned to 9 groups containing 3 replicates of 15 chicks each. The treatments consisted of a control and diets supplemented with 4 levels (10, 20, 30 and 40 g/kg) of GTP and GTE. Feed intake and body weight gain were suppressed (\(P < .05\)) by GTP supplementation (\(P < .05\)). The best feed conversion ratio was observed on the GTE supplemented group. The highest mortality rate was recorded on the control and the lowest on the GTP groups (\(P < .05\)). The best economic index was achieved with GTE supplementation of the diet (\(P < .05\)). Relative weights of carcass, breast and drumstick were significantly reduced on GTP compared to GTE (\(P < .05\)). GTE up to 40 g/kg diet will maintain growth and feed utilization but inclusion of the powder even as low as 10 g/kg the diet may compromise feed intake, growth performance and carcass traits. Differences in the polyphenol content of the extract (10.2%) and powder (14.9%) may be reasons these performance results. Further studies on green tea source and method of processing are recommended.

**ARTICLE HISTORY**

Received 13 July 2017
Accepted 13 April 2018

**KEYWORDS**

Natural products; green tea; broiler performance

### 1. Introduction

The gradual ban of commercial antioxidants in animal feed due to their health hazards to both the animal and human consumer of animal products (Yamashita et al. 2009) has increased research interest in natural products with antioxidant activities (Ahmad et al. 2012). Several promising natural antioxidants including green tea (GT) are now available to the feed industry. Green tea supplementation has been shown to improve body weight gain in broilers (Biswas and Wakita 2001) and pigs (Hossain et al. 2012). The beneficial effects of GT by-products (Yang et al. 2003; Cao et al. 2005), extract (Shomal et al. 2012; Farahat et al. 2016) and powder (Biswas and Wakita 2001; Alimohammadi-Saraei et al. 2014) on performance and health of poultry have been reported. These effects of dietary green tea have been mainly attributed to its polyphenols (Ninomiya et al. 1997; Gramza et al. 2005; Khan 2014) which are reported to have antioxidant (Molan et al. 2009; Sahin et al. 2010) and antimicrobial (Jang et al. 2007; Erener et al. 2011; Khan 2014) activities. However, studies comparing the effects of green tea extract (GTE) and powder (GTP) on broiler performance are limited. The present study tested the hypothesis that GTE and GTP may differently influence the growth and carcass traits of broiler chickens.

### 2. Materials and methods

The study was approved by the Animal Ethic Committee of the Islamic Azad University, Iran, and conducted in respect of the International Guidelines for research involving animals (Directive 2010/63/EU).

#### 2.1. Source of green tea products

The green tea products used in the study were prepared from autumn harvest of Chinese green tea (*Camellia sinensis*) from The Langeroud’s Nooshineh Company (http://www.nooshinehco.com/Default_en.aspx), Iran. The tea extract was prepared by boiling 100 g of dry tea leaves with 200 ml of distilled water at 80°C for about 10 min as described by Bombik et al. (2012). The dry tea leaves were ground and sieved to pass through 0.5 mm to obtain green tea powder (GTP). Tea extract (GTE) and powder (GTP) were contained 10.2% and 14.9% total polyphenols, respectively.

#### 2.2. Experimental birds and husbandry

A total of 405-day-old male Ross 308 broiler chicks were randomly assigned to 9 groups/treatments containing 3 replicates of 15 chicks each housed in floor cages (1.2 x 1.2 m²). The treatments consisted of a control and diets supplemented with four levels (10, 20, 30 and 40 g/kg) of GTP and GTE. The extract was sprayed onto a small quantity of the feed and mixed thoroughly. The remaining feed was then added gradually and mixed to ensure a uniform distribution of the extract. All diets for formulated to meet the NRC (1994) requirements of broilers. The birds were reared on a three growth phase,
namely, starter (1–10 d), grower (11–24 d) and finisher (25–42 d) periods (Table 1). The temperature of the house was adapted to the stage of growth (Aviagen 2014). Lighting regime was 23 h from day 1 to day 7 and 20 h from day 8 to the end of the experiment. Feed and water were provided ad libitum throughout the experimental period.

2.3. Data collection

Data were collected on growth performance (feed intake, weight gain and feed: gain), carcass and organ weights. Feed intake and weight gain were monitored by weekly weighing and feed conversion ratio (FCR) calculated as:

\[ \text{FCR} = \frac{\text{feed consumed}}{\text{weight gained}}. \]

Mortality was recorded per pen as it occurred. At the end of the experiment (42 d), two birds randomly selected per pen were fasted overnight and euthanized by decapitation for carcass and gut measurements. Slaughtered birds were scalded in hot water (50°C) for about 1 min, plucked manually, eviscerated and dressed. Carcass and cut up parts (breast meat, drumstick) and abdominal fat pad were weighed and expressed as percentages of the eviscerated weight. The weights of full gut segments (gizzard, proventriculus and intestine) and organs (heart and liver) were also taken using a digital scale sensitive to 0.1 g and expressed as percentages of the dressed weight.

2.4. Statistical analysis

The experiment was laid in a completely randomized design with nine treatments containing three replicates each. Data were subjected to a one-way analysis of variance (Steel and Torrie 1980) using the SPSS software. Pen was the experimental unit for growth and feed consumption while carcass traits and organ weights were taken on individual birds. Treatment means were tested for significant differences using the least significant difference (LSD) at 5% probability and contrast testing was done (control vs. GTP; control vs. GTE; GTP vs. GTE).

3. Results

The growth performance results of the birds are presented in Table 2. During the starter (1–21 d), finisher (22–42 d) and overall (1–42 d) growth periods, feed intake was significantly reduced (\( P < .05 \)) on the GTP supplemented group compared to the control. GTP supplementation markedly reduced body weight gain (\( P < .05 \)). The best FCR and economic index were observed on the GTE supplemented groups (\( P < .05 \)). Supplementation of diets with GT significantly reduced bird mortality with the lowest rate on GTP (\( P < .05 \)).

From the results in Table 3, the relative weights of carcass, breast and drumstick were significantly reduced on GTP compared to GTE (\( P < .05 \)). Carcass, breast and drumstick weights did not differ (\( P > .05 \)) between the control and GTP groups. A significantly heavier proventriculus was recorded on GTP (\( P < .05 \)) compared to the control. Intestine weight was heavier on the 30 g/kg GTP fed group compared to the GTE fed groups (\( P < .05 \)) but did not differ (\( P > .05 \)) among control and GTE. The weights of abdominal fat, gizzard, heart and liver were not affected by dietary treatment (\( P > .05 \)).

4. Discussion

Feed intake and weight gain were improved on GTE and depressed on GTP supplemented birds during both phases of growth. The polyphenol content of GTE and GTP used in the current study were 10.2% and 14.9%, respectively. The mean polyphenol intake (calculated) was 4.9 ± 0.063 and 6.01 ± 0.510 g/kg on GTE and GTP respectively. This difference in polyphenol intake may be a possible reason for the poorer growth performance (feed intake and weight gain) of the GTP supplemented birds. The negative effects of high dietary concentration of polyphenols on feed intake and nutrient utilization have been reported (Jansman et al. 1994). Kojima and Yoshida (2008) also observed that performance of laying hens was reduced above 10 g/kg Japanese GTP. Contrary to our findings however, Uuganbayar et al. (2005) observed that feed intake of laying hens was significantly improved at 15 g/kg and performance was maintained up to 20 g of Korean GTP/kg diet. The present study used Chinese green tea in broiler chickens. The source and composition (total, hydrolysable and condensed polyphenols) of green tea, class and age of birds and performance parameters measured may all be possible reasons for differences in performance of birds fed green tea products. In another study, Uuganbayar et al. (2006) also reported differences between the Chinese, Japanese and Korean green teas on different performance parameters of laying hens. The lower mortality observed on the GT treated groups compared to the control and further reduction on GTP (higher polyphenol intake) compared to GTE was not clear but improved health due to antimicrobial properties of GT products (Jang et al. 2007) could be speculated.

Studies on the inclusion of green tea products in broiler diets are still limited. Contrary to our results, Alimohammadi-Saraee

---

Table 1. Ingredient and calculated composition of the experimental diets (g/kg; as fed basis).

| Ingredients                      | Starter (1–10 d) | Grower (11–24 d) | Finisher (25–42 d) |
|----------------------------------|------------------|------------------|-------------------|
| Corn                             | 579.3            | 587.4            | 617.4             |
| Soybean meal (44% CP)            | 367.1            | 354.7            | 316.6             |
| Soybean oil                      | 16.0             | 22               | 31.7              |
| Limestone                        | 12.6             | 12.4             | 10.9              |
| Di calcium phosphate             | 15.6             | 13               | 11.5              |
| NaCl                             | 2                | 2.5              | 3.2               |
| Mineral and vitamin premix a     | 5                | 5                | 5                 |
| DL-Methionine                    | 2                | 2.5              | 3                 |
| L-Lysine hydrochloride           | 0.4              | 0.5              | 0.7               |
| Calculated composition           |                  |                  |                   |
| Energy (ME) (kcal/kg)            | 2915             | 2982             | 3041              |
| Crude protein                    | 21.5             | 20.4             | 18.8              |
| Crude fat (%)                    | 2.42             | 4.64             | 2.86              |
| Linoleic acid (%)                | 2.81             | 2.13             | 1.46              |
| Calcium (%)                      | 0.94             | 0.87             | 0.78              |
| Available phosphorus (%)         | 0.42             | 0.38             | 0.35              |
| Sodium (%)                       | 0.19             | 0.17             | 0.15              |
| Lysine (%)                       | 1.30             | 1.10             | 1.10              |

*Calcium pantothenate: 4 mg/g; niacin: 15 mg/g; vitamin B₁₂: 13 mg/g; Cu: 3 mg/g; Zn: 15 mg/g; Mn: 20 mg/g; Fe: 10 mg/g; K: 0.3 mg/g; vitamin A: 5000 IU/g; vitamin D₃: 500 IU/g; vitamin E: 3 mg/g; vitamin K₂: 1.5 mg/g; vitamin B₆: 1 mg/g.
et al. (2014) observed no effects of green tea supplementation on the relative weights of carcass, breast muscle but there was a significant treatment effect on abdominal fat deposition in 42-day-old broiler chickens. These authors, however, added fish oil to the diet. The source of green tea as earlier mentioned, processing method and diet composition may all affect the response of poultry to dietary green tea products. The pattern of the weights of proventriculus and intestine in this study was not clear but probably due to improved feed digestion and nutrient utilization by the control and GTE birds and poor feed utilization resulting from high intake of polyphenol in the GTP supplemented group. High dietary polyphenol is reported to decrease the digestibility of dry matter (Elkin et al. 2014) observed no effects of green tea supplementation on the relative weights of carcass, breast muscle but there was a significant treatment effect on abdominal fat deposition in 42-day-old broiler chickens. These authors, however, added fish oil to the diet. The source of green tea as earlier mentioned, processing method and diet composition may all affect the response of poultry to dietary green tea products. The pattern of the weights of proventriculus and intestine in this study was not clear but probably due to improved feed digestion and nutrient utilization by the control and GTE birds and poor feed utilization resulting from high intake of polyphenol in the GTP supplemented group. High dietary polyphenol is reported to decrease the digestibility of dry matter (Elkin et al. 2014).

5. Conclusion

In conclusion, Chinese GTE up to 40 g/kg diet maintains growth and improves feed utilization by broilers but inclusion of the powder even as low as 10 g/kg the diet may compromise feed intake, growth performance and carcass traits probably due to differences in the polyphenol content of the extract (10.2%) and powder (14.9%). More research on the inclusion level, green tea source and processing method that will maintain broiler performance is recommended.

### Disclosure statement

No potential conflict of interest was reported by the authors.

### Funding

This work was supported by Rasht Branch, Islamic Azad University [grant number 4.5830].

### References

Ahmad H, Jinke T, Wang J, Wang Y, Zhang L, Khan MA, Wang T. 2012. Effect of dietary sodium selenite and selenium yeast on antioxidant enzymes and oxidative stability of chicken breast meat. J Agri Food Chem. 60 (29):7211–7220.

Alimohammadi-Saraee MH, Seidavi AR, Dadashbeiki M, Laudadio V, Tufarelli V. 2014. Effect of dietary supplementation with different levels of green tea powder and fish oil or their combination on carcass characteristics in broil chickens. Pakistan J Zool. 46(6):1767–1773.
Aviagen. 2014. Ross broiler management handbook. Alabama, USA: Aviagen Group; p. 11–53.

Barros F, Awika JM, Rooney LW. 2012. Interaction of tannins and other sorghum phenolic compounds with starch and effects on in vitro starch digestibility. J Agric Food Chem. 60(11):609–611, 617.

Biswas AH, Wakita M. 2001. Effect of dietary Japanese green tea powder supplementation on feed utilisation and carcass profile in broilers. J Poult Sci. 38:50–57.

Bombik T, Bombik E, Frankowska A, Trawińska B, Saba L. 2012. Effect of herbal extracts on some haematological parameters of calves during rearing. Bull Vet Inst Pulawy. 56:655–658.

Cao BH, Karasawa Y, Guo YM. 2005. Effects of green tea polyphenols and fructo-oligosaccharides in semi-purified diets on broilers’ performance and caecal microflora and their metabolites. Asian-Australas J Anim Sci. 18:85–89.

Elkin RG, Rogler JC, Featherston WR. 1978. Influence of sorghum grain tannins on methionine utilization in chicks. Poult Sci. 57:757–762.

Erener G, Ocak N, Altop A, Cankaya S, Aksoy HM, Ozturk E. 2011. Growth performance, meat quality and caecal coliform bacteria count of broiler chicks fed diet with green tea extract. Asian-Australas J Anim Sci. 24(8):1128–1135.

Farahat M, Abdallah F, Abdel-Hamid T, Hernandez-Santana A. 2016. Effect of supplementing broiler chicken diets with green tea extract on the growth performance, lipid profile, antioxidant status and immune response. Br Poult Sci. 57(5):714–722.

Gramza A, Korczak J, Amarowicz R. 2005. Tea polyphenols – their antioxidant properties and biological activity – a review. Pol J Food and Nutr Sci. 14/55:219–235.

Hossain ME, Seok YK, Chul JY. 2012. Dietary supplementation of green tea by-products on growth performance, meat quality, blood parameters and immunity in finishing pigs. J Medic Plant Res. 6(12):24-58-2467.

Jang SI, Jun MH, Lillehoj HS, Dalolui RA, Kong IK, Kim S, Min W. 2007. Anticoccidial effect of green tea-based diets against Eimeria maxima. Vet Parasitol. 114:172–175.

Jansman AJM, Frohlich AA, Marquardt RR. 1994. Production of proline-rich proteins by the parotid glands of rats is enhanced by feeding diets containing tannins from faba beans (Vicia faba L.). J Nutr. 124:249–258.

Khan SH. 2014. The use of green tea (Camellia sinensis) as phytogenic substance in poultry diets: review article. Onderst J Vet Res. 81:1–8.

Kojima S, Yoshida Y. 2008. Effects of green tea powder feed supplement on performance of hens in the late stage of laying. Int J Poult Sci. 7(5):491–496.

Mitjavila S, Lacombe C, Carrera G, Derache R. 1977. Tannic acid and oxidized tannic acid on the functional state of rat intestinal epithelium. J Nutr. 107:217–223.

Molan AL, De S, Meacher L. 2009. Antioxidant activity and polyphenol content of green tea flavan-3-ols and oligomeric proanthocyanidins. Int J Food Sci Nutr. 60:497–506.

Ninomiya M, Unten L, Kim M. 1997. Chemical and physicochemical properties of green tea polyphenols. In: Yahamoto LR, Juneja DC, Chu M, editors. Chemistry and application of green tea. New York (NY): CRC; p. 23–35.

NRC. 1994. Nutrient requirements of poultry. 9th revised ed. Washington (DC): National Academy Press.

Sahin K, Orhan C, Tuzcu M, Ali S, Sahin N, Hayirli A. 2010. Epigallocatechin-3-gallate prevents lipid peroxidation and enhances antioxidant defence system via modulating hepatic nuclear transcription factors in heat-stressed quails. Poult Sci. 89:2251–2258.

Sannamani PG. 2002. Feeding value of sorghum grains vis-a-vis yellow maize for broiler chicks [MVSc thesis]. Izatnagar: IVRI(Deemed University).

Shomal T, Najmeh M, Saeed N. 2012. Two weeks of dietary supplementation with green tea powder does not affect performance, D-xylose absorption, and selected serum parameters in broiler chickens. Comp Clinic Pathol. 21(5):1023–1027.

Steel RGD, Torrie JH. 1980. Principles and procedures of statistics: a biometrical approach. 2nd ed. New York (NY): McGraw Hill.

Tomasik P, Schilling CH. 1998. Complexes of starch with organic guests. Adv Carb Chem. Biochem. 53:345–426.

Uuganbayar D, Bae IH, Choi KS, Shin IS, Firman JD, Yang CJ. 2005. Effects of green tea powder on laying performance and egg quality in laying hens. Asian-Australas J Anim Sci. 18(12):1769–1774.

Uuganbayar D, Shin IS, Yang CJ. 2006. Comparative performance of hens fed diets containing Korean, Japanese and Chinese green tea. Asian-Australas J Anim Sci. 19(8):1190–1196.

Yamashita Y, Katagiri T, Pirarat N, Futami K, Endo M, Mata M. 2009. The synthetic antioxidant, ethoxyquin, adversely affects immunity in tilapia (Oreochromis niloticus). Aqua Nutr. 15:144–151.

Yang CJ, Yang JY, Oh DH, Bae IH, Cho SG, Kong IG, Uuganbayar D, Nou IS, Choi KS. 2003. Effect of green tea by-product on performance and body composition in broiler chicks. Asian-Australas J Anim Sci. 16:867–872.