Journal of Animal and Veterinary Advances 10 (18): 2470-2473, 2011
ISSN: 1680-5593

Effects of Bamboo Charcoal Including Vinegar Liquid on Growth Performance and Meat Quality in Chinese Indigenous Breed During Fattening

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Abstract: To investigate effects of a mixture of bamboo powder including vinegar liquid (BV) supplementation on growth performance, meat quality and antioxidant property in broilers during fattening, 300 15 weeks old Wenchang broilers, a Chinese indigenous breed were randomly allotted to two treatments and fed the basal diet supplemented with 0.5% BV or not (control group). Each treatment includes three replicates of 50 birds fed. The experiment lasted for 3 weeks. Although, the weight gain was not significantly different, the growth performance tended to be improved in 0.5% BV supplemented group. Besides, drip loss and pH after 12 h post-mortem were significantly decreased ($p<0.05$). Total Antioxidant Capability (T-AOC) also showed obvious increase in breast muscle, heart, spleen and kidney ($p<0.05$). The results suggested that BV may act as a natural source of feed additive for broilers fattening.

Key words: Bamboo powder, vinegar liquid, Wenchang broilers, meat quality, total antioxidant capability

INTRODUCTION

As in other animal species, the qualitative properties of poultry meat are now of major importance for poultry breeding, since poultry meat is now-a-days widely consumed as cuts or as processed products rather than as whole carcasses. As already reported in other species (Wang *et al*., 2011; Owens *et al*., 2000), meat quality refers to several meat properties in cluding water-holding capacity (i.e., drip loss during storage), muscle pH post-mortem and fatty content, etc. However, broiler meat quality is now withstanding muscle fiber, poor tasty and drug residue, etc. Therefore, much attention has been focused on the soundness pathway on how to improve the broiler quality with no negative impact on growth, more importantly can also improve the immunity therefore with least drug usage (Bihan-Duval *et al*., 2008; Fanatico *et al*., 2008).

Bamboo (*Phyllostachys pubescens*) grows particularly well in south-eastern Asia and represents a traditionally important commodity that is used for building material in traditional medicine and as a source of food. It is believed that bamboo vinegar can act as insecticide, a bactericide, a deodorant for treating malodour from pets and also as a folk medicine. The main component of bamboo vinegar compound liquid is acetic acid, one of the main short chain fatty acids produced by intestinal microbes which can affect intestinal functions and metabolism. The bioactivity of bamboo vinegar has been studied widely (Chuyen *et al*., 1982). Flavonoids, bioactive polysaccharides, phenolic acids, anthraquinone, coumarin lactone, special amino acids, aromatic components and several trace elements have been identified in bamboo extracts and have been evaluated *in vitro* for free radical scavenging and antioxidant activities (Hu *et al*., 2000). Studies have reported that the supplementation of powdered of wood vinegar compounds and amorphous charcoal carbon elicited positive responses in animal production (Samanya and Yamauchi, 2001; Mekbungwan *et al*., 2008). The addition of wood vinegar compounds to diets induced significant increases in hen day egg production and feed conversion ratio and in broiler hatchability. However, no growth performance of animals fed BV has yet traced.

Therefore, the major purpose in the present study was access the effectiveness of BV in the growth performance, meat quality and antioxidant property in broilers when fed as an additive in the Huainan partridge broiler, an indigenous breed during fattening period.

MATERIALS AND METHODS

BV extraction: The raw wood vinegar and extraction from Hickory shell, cultivated in Ningguo city of P.R. China were obtained by methods developed by previous reports (Wei *et al*., 2010; Loo *et al*., 2007). Briefly,

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dried shell powder was carbonized, condensate of smoke from temperature 90-280°C was collected. The raw wood vinegar was filtered through Whatman No. 1 filter paper to eliminate solid particles and dust and then concentrated to a 6:1 volume ratio using a rotary evaporator at 80°C to vaporize the water in raw wood vinegar. The concentration of wood vinegar, a thicker brown liquid was then exhaustively extracted with a same volume of ethyl acetate using a separatory funnel. The organic layer, collected for 5 times extraction with ethyl acetate was to eliminate ethyl acetate by a rotary evaporator at 85°C and the wood vinegar extraction was then collected. The total phenolic content in wood vinegar was expressed as mg of Gallic acid equivalents per gram of sample. The wood vinegar compounds were then absorbed into amorphous bamboo charcoal powder (1:4).

Birds and experimental design: The broilers used were an indigenous Chinese breed, the Wenchang chicken. Three hundred physically healthy and unrelated males were obtained from Feixi the Old Hens Farming Co., Ltd. at 120 days of age. Body weights were measured weekly between 8:00-10:00 using a digital balance (ACS-30, Dayang, China). Broilers weighing between 1300-1600 g were randomly divided into two groups (150 per group), three replicates (50 replicate^{-1}) in each group. Broilers in control group were housed with *ad libitum* access to water and a commercial diet (metabolizable energy: 12.18 MJ kg^{-1}, crude protein: 181.6 g kg^{-1}) (Table 1). Broilers in experimental group were supplemented with 0.5% bamboo vinegar in an addition except for basal diet mentioned in control group. Body weight was recorded in each week. After 3 weeks experiment, 15 broilers were randomly selected in each replicate for slaughtering.

pH measurement: The pH value was determined 8 and 16 h postmortem in the right pectoralis major with a pH meter (S40 SevenMulti, Mettler-Toledo Inc., Columbus, USA).

Table 1: Dietary composition and nutrient levels

Ingredients	Percent
Maize	61.50
Bran	5.50
Soybean meal	20.00
Soil bean oil	3.50
Bone meal	4.50
Premix 5%[a]	5.00
Total	100.00
Calculated chemical composition	
Crude Protein (CP)	18.16
Calcium	1.00
Non-phytate phosphorus	0.57
Methionine	1.13
Lysine	0.43
Metabolizable energy (MJ kg^{-1})	12.18

[a]Premix 5%: CP = 40%; lysine = 3.3%; methionine = 2.4%; Ca = 8%; p = 2.05%

IMF content determination: Intramuscular fat content was determined as follows. Approximately, 1.5 g samples of breast and leg muscles was cut into pieces and dried in a freezing drier, ground into powder and extracted for lipids with petroleum ether extract using the Soxtec 2055 fat extraction system (SER 148 solvent extractor, Italy VELP Co., Ltd.).

Drip loss: Broiler pectoralis major was taken from the carcass. Samples were trimmed to 5×2×1 cm size, blotted to remove the surface water and the initial breast muscle weight was determined. Samples were placed in a plastic bag filled with air and fastened to avoid evaporation and left at 4°C, the final breast muscle weight was determined 24 and 48 h postmortem. Percentage of drip loss was calculated by 100×(initial breast muscle weight final muscle fillet weight)/initial weight. Muscle fiber direction of the samples was horizontal to gravity, not vertical.

Tissue SOD and T-AOC determination: About 1 g of frozen tissue in 9 mL of homogenization buffer (0.9% sodium chloride) was homogenized on ice with a homogenizer (FA25, FLUKO equipment Shanghai Co., Ltd.) for 10 sec at 8,000 rpm. The homogenate was centrifuged at 4,000 rpm for 15 min at 4°C and the supernatant was used for analysis. The SOD activity was measured by the nitrite method as described by Li *et al.* (2004). The total antioxidant capability (T-AOC) was examined by commercial kits (Nanjing Jiancheng Bioengineering Institute, Nanjing, Jiangsu, People's Republic of China). The spectrometric method was applied to evaluate T-AOC.

Statistical analysis: All data collected for body weight gain, meat quality were statistically analyzed by using the one-way Analysis of Variance (ANOVA) and significant differences between the treatments were determined with Duncan's multiple range test using the SAS 9.1 in 2001 program (Statistical Analysis Systems Institute Inc., Cary, NC, USA). Differences at $p<0.05$ were considered as significant.

RESULTS AND DISCUSSION

Growth performance and carcass traits: The body weight gain of Wenchang chickens was measured weekly in control and 0.5% BV supplemented groups (Table 2).

Table 2: Effects of BV addition on growth performance

	Weeks			
Items	15	16	17	18
Control group	1480±290	1578±220	1697±210	1795±225
0.5% BV	-	1619±200	1786±220	1911±210

Table 3: Effects of 0.5% BV supplementation on the percentage of drip loss and pH value of breast muscle in broilers

	Drip loss			pH value		
Items	24 h	48 h	45 min	12 h	24 h	Intramuscular fat (%)
Control	3.12±0.07[a]	3.65±0.12[a]	5.88±0.51	5.67±0.48	5.52±0.57	1.28±0.12
0.5% BV	2.89±0.08[b]	3.08±0.09[b]	5.76±0.43	5.72±0.42	5.70±0.45	1.43±0.15
Time*BV	p>0.05			p>0.05		

Table 4: Effects of 0.5% BV supplementation on Total Antioxidant Capability (T-AOC) in tissues of broilers (U mg^{-1} protein)

Items	Breast muscle	Heart	Liver	Spleen	Kidney
Control	1.35±0.12[a]	4.22±0.14[a]	3.25±0.24	2.98±0.30[a]	3.31±0.18[a]
0.5% BV	1.61±0.21[b]	4.50±0.15[b]	3.37±0.35	3.85±0.42[b]	3.99±0.26[b]

After 3 weeks fattening breeding, the body weight gain in the 0.5% BV addition group showed no significant different in comparison of control group ($p>0.05$). However, an obvious increasing trend in body weight gain was observed after each week fattening in 0.5% BV this addition group. After 3 weeks fattening, broilers weight in 0.5% BV addition group was 116 g higher than control group. This might suggest that 0.5% BV addition could effectively promote the body weight gain.

There was significant difference in meat quality traits (e.g., pH value and IMF) between the control and BV addition group (Table 3). The drip loss at 24 and 48 h post-mortem was lower ($p<0.05$) in broilers supplemented with 0.5% BV when compared with the control broilers. The 45 min, 12 and 24 h postmortem pH value of breast muscle was significantly affected by time ($p<0.05$) but not affected by 0.5% BV supplemented groups although 0.5% BV groups showed slightly higher. The IMF content showed no significant difference ($p>0.05$) between broilers supplemented with 0.5% BV and the control group (Table 4).

SOD and T-AOC activities: Dietary BV supplementation did not affect the concentration of SOD in breast muscle of broilers (data not shown). However, supplementation with 0.5% BV increased ($p<0.05$) the activities of T-AOC in breast muscle, heart, spleen and kidney and no difference in the liver ($p>0.05$).

At present, non-nutritional sorptive substances are known to elevate the plant production and have shown some promise in reducing the effects of toxins on chicken growth performance (Samanya and Yamauchi, 2001, 2002). The promoting effects of BV, a by-product solution from charcoal production have been reported in enhancing intestinal calcium absorption and increasing hen-day egg production and feed conversion ratio (Park *et al*., 2009). Therefore, the main purpose of this study was to investigate whether the growth performance of Wenchang broilers fed dietary BV could be much more improved during fattening period. We failed to obtain a significant increase of body weight gain in the BV-fed broilers. However, the body weight gain of 0.5% BV group was 5.8% heavier than that of the control group. As the present groups were studied in the same environmental conditions except the dietary BV addition, the slightly increased growth performance might be induced by the BV supplementation.

The main component of wood vinegar is acetic acid with pH3. In addition, it also contains 280 different organic acids, 12 minerals and 13 micro-elements responsible for various physiological functions in animals (Yoo *et al*., 2005). These might the main for the promotion of the growth of broilers.

Many researchers reported that meat quality improved significantly after bamboo vinegar supplementation (Kook *et al*., 2005; Kook and Kim, 2003a, b). It is well known that the main components in BV are flavonoids, bioactive polysaccharides, phenolic acids, anthraquinone, coumarin lactone, special amino acids, aromatic components and several trace elements, etc., these were evaluated *in vitro* for free radical scavenging and antioxidant activities and has been found to be effective in elevating antioxidant even under adverse environment (Chen *et al*., 2011). This might the major contribution for the obvious elevation of meat quality and T-AOC level in BV supplemented group.

On the other hand, bamboo extract mixed with wood vinegar induces a powerful effective stimulation on intestinal functions and therefore in duces a cascade of reactions as to growth performance and health performance. Thus charcoal and vinegar and other natural substances from various local plants could be potential additives for animal growth promotion as cheap substance.

CONCLUSION

In the study, BV, mentioned in this study could effectively enhance antioxidant status and reducing drip loss in broilers during fattening and may act as a natural source of feed additive for broilers.

ACKNOWLEDGEMENTS

This research was financially supported by the Emerging Industries of Strategy (11010301017) and Hefei University of Technology Innovation Foundation (2010HGZX0021).

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