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Green Tea Level on Growth Performance and Meat Quality in Finishing Pigs

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Abstract: This study was designed to determinate the effects of green tea on growth performance and meat quality of finishing pigs. Ninety crossbreed "Landrace x Large White" pigs were assigned to 5 treatments a completely randomized design. The five dietary treatments were control (no green tea), antibiotic (30 ppm chlortetracycline) and 0.5, 1.0 and 2.0% of green tea added. The weight gain of pigs fed diets containing 2.0% green tea supplementation was significantly lower than that of the antibiotic supplemented ($p < 0.05$). However, the feed intake and feed conversion ratio did not differ among treatments by dietary green tea addition ($p > 0.05$). Crude protein in the carcass of pig showed significantly highest value in 1.0% green tea than control and other green levels ($p < 0.05$) but similar value with antibiotic. The carcass grade was significantly increased in 0.5 and 1.0% green tea treatments ($p < 0.05$) while Thiobarbituric Acid (TBA) value of pork was significantly decreased by 2.0% green tea supplementation ($p < 0.05$).

Key words: Pigs, green tea, feed intake, thiobarbituric acid value

INTRODUCTION

It is common practice to add antibiotics to pig diets to improve pig health and productivity. However, it is generally accepted that the use antibiotics may potentially affect human health due to their ubiquitous presence (Levy, 1987; Schwarz *et al.*, 2001). But its may result in proliferation of antibiotics-intensive bacteria and thus a decrease in the therapeutic effectiveness of antibiotics used to treat a variety of bacterial infections in humans. This threat to human health has urged European countries to ban antibiotics and alternatives to antibiotics are currently being encouraged (World Health Organization; cited by Humphrey *et al.*, 2002). Green tea (*Camellia sinensis*) has been considered as a natural product that is non-toxic. The catechins, the main components of green tea, have many biological and biochemical effects such as anti-carcinogenesis (Mukhtar and Ahmad, 1999), anti-mutation (Okuda *et al.*, 1984) and anti-oxidation (Weisburger *et al.*, 2001). It has been reported that catechin, a major components of tea polyphenol, has various polyphenol, physiologic modulative activities, such as antibacterial effects, radical scavenging action and inhibitory effect on allergic reactions. Several mechanisms of EGCG's anti-allergic effects have been suggested, such as the inhibition of histamine release from basophilic cells, but the precise mechanisms still remain unclear.

Besides the human consumption, the low graded green tea and green tea wastes were used as feed ingredients for fish (Kono *et al.*, 2000), broiler (Kaneko *et al.*, 2001; Cao *et al.*, 2005), calves (Ishihara *et al.*, 2001) and pigs

(Suzuki *et al.*, 2002) and the positive effects of green tea on animal performance have been discovered already. Yang and Koo (1997) reported that green tea feeding reduced the serum and liver cholesterol contents in rats. Biswas and Wakita (2000) reported that green tea supplementation to layer diet was reduced the cholesterol content of the egg yolk. However, there is limited information available about to using a green tea as feed supplement for pigs, particularly in finishing pigs. Therefore, the objective of this study was to investigate the effects of green tea on growth performance and meat quality in finishing pigs and determine the optimal addition level of green tea to finishing pig diet.

MATERIALS AND METHODS

Animals and design: Ninety crossbreed (Landrace x Yorkshire) finishing pigs with both sexes averaged (70.81±0.14) kg of initial body weight were housed in semi-open concrete floor pens. The pigs were assigned to 5 treatments in a completely randomized design. Each treatment had 3 replicates with 6 pigs per replication. The five dietary treatments were control (no green tea), antibiotic (30 ppm chlortetracycline) and 0.5, 1.0 and 2.0% green tea powder added diets. All diets were formulated to meet or exceed nutrient requirements of finishing pigs, NRC (1994). The formula and chemical composition of basal diet used in this experiment are given in Table 1. The diets and drinking water were supplied *ad libitum*. At the end of the experiment, pigs reached at 110 kg of body weight were

Table 1: Formula and chemical composition of basal diet (%) (as fed basis)

Ingredients	(%)
Yellow corn	45.15
Wheat (13%)	25.00
Wheat bran	4.00
Soybean meal (40%)	16.00
Limestone	0.78
Calcium phosphate-25/18	1.10
Salt	0.25
Vit-min. premix ¹	0.55
Animal fat	2.50
Molasses	4.50
L-Lysine	0.17
Total	100
Chemical composition²	
ME (kcal/kg)	3,160
C. Protein (%)	15.00
C. Fat (%)	4.86
Lysine (%)	0.80
Ca (%)	0.78
Avail. P (%)	0.55

¹Vit-min. premix : vit A, 6,000IU; vitamin D₃, 800IU; vitamin E, 20IU; vit K₃, 2mg; thiamin, 2mg; riboflavin, 4mg; vitamin B₆, 2mg; vitamin B₁₂, 1mg; pantothenic acid, 11mg; niacin, 10mg; biotin, 0.02mg; Cu, 21mg; Fe, 100mg; Zn, 60mg; Mn, 90mg; I, 1.0mg; Co, 0.3mg; Se, 0.3mg. ²Calculated value

transported to the slaughter house located in Naju city, Gwangju, Korea.

Catechin components of green tea: Before mixing green tea to pig diet, the catechin contents of green tea was determined according to the method devised by Ikeda *et al.* (2003). Approximately 100 mg green tea powder was dissolved into 100 ml double distilled water and heated in a water bath at 80°C for 30 min. After cooling, it was filtered through Whatman No.1 paper. Then filtrate was transferred to a separating funnel and the chloroform was added. After washing 3 times with chloroform, the solution was separated into 2 layers. After collected water layer, the catechin component was fractionated with 25 ml of ethyl acetate. Then ethyl acetate fraction was evaporated at 30°C in a rotary evaporator under the nitrogen flow and concentrate was dissolved in methanol and passed through a membrane filter (0.45 µm polyvinylidene difluoride) and Sep-Pack C₁₈ cartridge. Finally, the catechin components of green tea powder were isolated by HPLC (Model 501, Waters, Milford, USA). The catechin components of green tea were as follows: total catechin 16.16%, of which Catechin 0.94%, Epicatechin 1.41%, Epigallocatechin 1.67%, Epicatechin gallate 2.46% and Epigallocatechin gallate 9.68% in dry matter basis.

Measurements and chemical analysis: The body weight of pigs was measured every two weeks from the initial day to the final day of the experiment for calculate the body weight gain. The feed intake of pigs was recorded by offering weighed quantity of feed and weighing their residues in biweekly basis. The feed conversion ratio was calculated on the basis of unit feed

consumed to unit the body weight gain of pigs. Carcass quality traits in terms of slaughter weight, back fat thickness, carcass grade were determined according to the methods of Korean Meat Evaluation System procedure. The carcass composition was analyzed by common methods of AOAC (1990). Tiobarbituric Acid (TBA) value of pork was assayed through the methods of Vernon *et al.* (1970). Sensory evaluation of pork meat was organoleptically evaluated by a panel of trained judges on the three point hedonic scale as juiciness, tenderness and flavor.

Statistical analysis: The data from this study was preformed by SAS Package Program (1990) to estimate variance components for completely randomized design. Duncans' multiple comparison tests (1955) were used to compare the significant differences between treatment means. Differences were statistically assessed at p<0.05.

RESULTS AND DISCUSSION

Growth performance: Effects of green tea on growth performance in finishing pigs are shown in Table 2. Throughout the first week of experiment, there were no significant differences in weight gain, feed intake and feed conversion ratio of pigs fed diet containing 0.5-2.0% green tea and antibiotics supplementation (p>0.05). At 4-6 week of the experiment, the feed intake of pigs was significantly decreased by dietary supplementation of 2.0% green tea (p<0.05). However, the feed conversion ratio of pigs was significantly higher in 1.0% green tea treatment than that of the control of (p>0.05). In over all periods, the weight gain of pigs was significantly lowered in 0.5 and 2.0% green tea added treatments (p<0.05) except 1.0% green tea which didn't differ from the antibiotic treatment (p<0.05). This significant reduction of weight gain for 0.5 and 2.0% green tea treatment due to the gradually decrease of weight gain throughout the experiment period and the lower final body weight obtained from pigs fed diets containing 0.5 and 2.0% green tea supplementation. Sayama *et al.* (2000) reported that 2.0 and 4.0% Japanese green tea supplementation to the diet was reduced a body weight in rats. Kaneko *et al.* (2001) reported that 0.5% green tea extracts mixed to the drinking water had reducing effects on weight gain of the broilers. However, El-Deek and Al-Harhi (2004) reported that 0.5% of green tea addition to the broiler diet had no adverse effects on weight gain, feed intake of the broilers.

Results of our experiment demonstrated that the feed intake and FCR of pigs was significantly increased in 2.0% green tea treatments compared to that of the antibiotic treatment (p<0.05). Similar results were observed by Biswas and Wakita (2001) who reported that supplemental green tea powder for broiler chicks tended to decrease feed intake and body weight gain with a higher dose, also improved the feed conversion ratio of broilers. Some researchers stated that the

Table 2: Effects of green tea on growth performance in finishing pigs

Treatments	Green tea				
	Control	Antibiotics	0.5%	1.0%	2.0%
0~2 weeks					
Weight gain (kg)	12.28	13.67	14.17	13.33	12.94
Feed intake (kg)	41.22	43.94	43.22	41.17	39.72
FCR (feed/gain)	3.35	3.26	3.06	3.09	3.09
2~4 weeks					
Weight gain (kg)	13.28	15.39	14.22	14.22	13.44
Feed intake (kg)	46.11	51.44	47.83	48.17	46.67
FCR (feed/gain)	3.56	3.37	3.37	3.40	3.55
4~6 weeks					
Weight gain (kg)	13.83	13.22	12.89	12.22	12.61
Feed intake (kg)	52.11 ^{ab}	56.67 ^a	52.50 ^{ab}	51.94 ^{ab}	48.67 ^b
FCR (feed/gain)	3.76 ^b	4.32 ^a	4.07 ^{ab}	4.25 ^a	3.86 ^{ab}
0~6 weeks					
Weight gain (kg)	39.39 ^b	42.28 ^a	41.28 ^{ab}	39.78 ^{ab}	39.00 ^b
Feed intake (kg)	139.44	152.06	143.56	141.28	135.06
FCR (feed/gain)	3.54	3.60	3.48	3.55	3.46

^{a,b,c}Means with different superscripts within same row are significantly different (p<0.05)

Table 3: Effects of green tea on meat quality profiles in finishing pigs

Treatments	Green tea				
	Control	Antibiotics	0.5%	1.0%	2.0%
Slaughter wt (kg)	83.00	84.78	85.17	83.83	82.06
Back fat (mm)	25.33 ^a	23.67 ^{ab}	21.94 ^{bc}	22.11 ^{bc}	21.22 ^c
Carcass grade	3.00 ^b	3.44 ^{ab}	3.50 ^a	3.67 ^a	3.22 ^{ab}
Shear value (kg)	3.37	3.33	3.86	5.02	2.94
Heating loss (%)	32.01	32.88	33.07	34.64	31.64
Meat color					
Lightness (L)	53.44	52.99	48.97	52.12	51.97
Redness (a)	8.66	8.80	7.39	7.69	7.58
Yellowness (b)	4.77	5.03	2.73	3.72	4.08
Sensory evaluation					
Juiciness	4.00	3.93	3.53	3.83	4.13
Tenderness	4.43	4.10	4.17	4.13	4.93
Flavor	4.40	4.17	4.40	4.00	4.47

^{a,b,c}Means with different superscripts within same row are significantly different (p<0.05)

catechin contents of green tea, mainly Epigallocatechin Gallate (EGCG) could inhibited a digestive lipase activity and affect on the lipid metabolism of animals (Yang and Koo, 1997; Sayama *et al.*, 2000; Weisburger *et al.*, 2001) so, thus reduction of body weight and weight gain in finishing pigs by green tea powder supplementation to the pig diet might be ascribed to green tea catechins. Green tea catechins may favor the slow digestion of carbohydrates which prevents sharp spikes of insulin in the blood and favors fat-burning over fat-storage and prove a reduction body weight and weight gain of animals with ingestion of green tea and their components (INPR, 2000).

Meat quality parameters: Effects of green tea on pig meat quality parameters are presented in Table 3. There were no significant differences in slaughter weight of pigs diets containing 0.5-2.0% green tea and antibiotic supplementations (p>0.05). The back fat of thickness was significantly decreased in 1.0 and 2.0% green tea treatments compared to that of the control (p<0.05). This

reduction on back fat thickness for green tea feeding, clearly caused by low weight gain obtained from pigs fed 1.0 and 2.0% green tea diets. The carcass grade was significantly higher in 0.5 and 1.0% green tea treatments than that of the control (p<0.05). Although, there were no significant differences in shear value and heating loss of meat from pigs fed diets containing 0.5-2.0% green tea and antibiotic supplementations (p>0.05). There were no significant differences in meat color changes (lightness, redness and yellowness) and sensory evaluation traits in terms of juiciness, tenderness and flavor in different level of green tea and antibiotic treatments (p<0.05). Lee (2005) reported that 0.02% green tea addition to diet had no effects on back fat and carcass grade and meat color of the beef cattle (Lee, 2005). However, 2.0% green tea inclusion to layer diet increased the yellowness of the egg yolk.

Carcass composition: The moisture content of Longissimus Muscle (LM) from pig fed a diet containing 1.0% green tea supplementation was significantly

Table 4: Effects of green tea on carcass composition in finishing pigs (%)

Items	Treatments		Green tea		
	Control	Antibiotics	0.5%	1.0%	2.0%
Moisture	73.07 ^{ab}	71.66 ^b	72.84 ^{ab}	73.33 ^a	72.76 ^{ab}
Crude protein	22.01 ^b	23.15 ^{ab}	22.13 ^b	24.02 ^a	22.13 ^b
Crude fat	2.06	2.02	1.65	1.82	1.25
Crude ash	2.09 ^b	2.58 ^a	2.04 ^b	1.86 ^c	1.83 ^c

^{a,b,c}Means with different superscripts within same row are significantly different (p<0.05)

Table 5: Effects of green tea on TBA value of meat in finishing pigs (µmol MDA/100g)

Weeks	Treatments		Green tea		
	Control	Antibiotics	0.5%	1.0%	2.0%
Fresh	1.08	1.17	1.11	1.11	0.98
1 week	1.91 ^{ab}	2.12 ^a	2.00 ^{ab}	1.82 ^b	1.75 ^b
2 week	2.89 ^{ab}	2.92 ^a	2.86 ^{ab}	2.83 ^{ab}	2.74 ^b
3 week	4.09 ^a	4.12 ^a	4.03 ^a	3.82 ^b	3.51 ^b

^{a,b}Means with different superscripts within same row are significantly different (p<0.05).

TBA-Thiobarbituric Acid Value, MDA- Malondialdehyde

higher (p<0.05) than that of the antibiotics treatment (Table 4). However, the crude protein of LM was significantly increased in 1.0% green tea treatment compared to that of the control (p>0.05). The crude fat content tended to decrease with increasing level of green tea addition but without significant differences (p>0.05). Ikeda *et al.* (1992) reported that the catechin components of green tea have an inhibitory effect in lipid metabolism in rats. The oolong tea supplementation rat to diet had an inhibition on pancreatic lipase activity and reducing the fat adipose in rats. The crude ash content of pork was significantly lower in 1.0 and 2.0% green tea treatments than that of the antibiotic treatment (p>0.05).

Lipid oxidation of pig meat: Effects of green tea on Thiobarbituric Acid (TBA) value of pork meat are shown in Table 5. Green tea studies showed that green tea extracts had a dose-dependent inhibitory activity against end stage lipid peroxide decomposition product formation and early lipid oxidation (Pearson *et al.*, 1998; Yamane *et al.*, 1999). Results of present study demonstrated that TBA value of meat was significantly decreased by dietary 1.0 and 2.0% green tea supplementation (p<0.05) at 4°C for one week of storage. After the 2 week of storage at same temperature, the TBA value of meat was significantly lower in 2.0% green tea treatment (p>0.05) although the values were significantly lower in 1.0 and 2.0% green tea treatments than that of the antibiotic treatment (p<0.05) after preservation of 3rd week. Yoshino *et al.* (1994) stated that the TBA value of blood plasma was reduced by 10% dietary green tea supplementation in rats.

Conclusion: The supplementation of 0.5 and 2.0% green tea to the pig diet slightly reduced the weight gain in finishing pigs. The results of current study indicated that

up to 2.0% inclusion level of green tea to pig diet showed adverse effects on growth performance and meat quality characteristics in finishing pig. The incorporation of 1.0-2.0% green tea to pig diet had reducing effects on oxidation degree (TBA value) of pig meat. Based on the results of our study, it can be suggested that 1.0% of dietary addition of green tea is effective in improving growth performance and meat quality in finishing pigs.

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