EFFECT OF GREEN TEA POWDER AS AN ALTERNATIVE OF ANTIBIOTIC ON GROWTH PERFORMANCE, MEAT QUALITY AND BLOOD LIPID PROFILE OF BROILER

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ABSTRACT

A study was conducted with green tea powder to evaluate the effect on broiler growth, meat quality and the development of internal organ. The broiler growth, meat quality and the blood profile have been improving day by day by using green tea powder with poultry feed. The experiment design should be well planned. Biosecurity of experimental design was maintained properly. Feed intake, feed conversion ratio is efficient in experiment birds. The live weight gain was significantly (P<0.05) higher in the group of Green Tea in the feed. The initial body weights of group T₀, T₁, T₂, T₃ and T₄ day of the experiment were 176.8 ±1, 184.2±1.3, 185.1±1, 190.2±084, 180.2±1.22 gm respectively and after 35th day of experiment final body weight were 1972±3.22, 1992±2.77, 1940±3.17, 1778±3.52, 1918±2.81 gm respectively. The net body weight gains were respectively 3058± 4.23, 2971±4.01, 2995±5.57, 3208±4.3 and 3226±5.25 and increase body weight. Here the total cholesterol was higher in the group of broiler supplied green tea 0.5% and compare to other group of GT and antibiotic group. Triglyceride level showed significant (P<0.01) differences among different groups where highest level was found in T₁ and lowest in T₄ groups due to green tea powder concentration of blood plasma of broiler chicken.

Keywords: Green tea powder, broiler, antibiotic

INTRODUCTION

The green tea is the most important medicinal plant. Green tea powder (GTP) is obtained from green tea leaves (Camellia sinensis), stems and fruits (Uuganbayar et al. 2005, 2006). Green tea leaves contain many polyphenolic compounds such as epicatechin (EC), epicatechin 3 gallate (ECG), epigallocatechin (EGC), and epigallocatechin 3 gallate (EGCG) (Biswas and Wakita, 2001). They contain certain anti-viral and anti-bacterial properties that inhibit growth. In this study, 1% green tea and modified lipophilic green tea polyphenols (GTP and LTP) were used in combination with the most commonly prescribed antibiotics to study their effects on gram-positive, gram-negative, and acid-fast bacteria. The results indicated that 1% GTP and 1% LTP provided different synergistic effects on several antibiotics in various bacteria. These results suggest that 1% GTP and 1% LTP provide beneficial effects on selected antibiotics against microbial growth and are able to reverse the antibiotic resistance to susceptible. Green tea polyphenols could serve as natural alternatives to combat against antibiotic resistance pathogens (Haghjoo et al. 2013).

Green tea which is also popular beverage is taken from a non-oxidized and unfermented leaves of the evergreen plant Camellia sinensis that produce mainly in tropical and subtropical climates (Cao et al. 2005; Kundo, 2005). The chemical composition of poultry meat has a crucial role for a health driven market or gourmet market due to this color changes, fat contents are an important factor influencing the quality and acceptability of meat and meat products (Carpenter et al. 2007). Therefore, a common approach to maintain host health is to increase the number of desirable bacteria in order to inhibit colonization of invading pathogens (Guo et al. 2004). It was reported that green tea and its chemical components show antibiotic-like effects of non-selectively decreasing total counts of all micro-flora (Cao et al. 2005). Considering above circumstances, the present research aimed to examine the effect of different levels of green tea powder as a substitute for an antibiotic in broilers diets on productivity, carcass and meat quality, to evaluate the effect of powder of green tea on lipid profile of blood plasma of broiler chicken and to find out appropriate green tea probiotics for chicken.
MATERIALS AND METHODS

The birds were reared in a personal farm at Kornia, adjacent to the HSTU campus, Basherhat, Dinajpur. The required laboratory works were done with proper management at operation theater, Faculty of veterinary medicine HSTU, Dinajpur.

Experimental birds

Hundred day old broiler chicks of “Cobb 500” strain were purchased from the dealer of Nourish poultry Hatchery Ltd. The chicks were properly exposed to heat that means brooding and management was carefully maintained as the company manual for up to 7 days. The birds were assigned to treatments with 4 replications having 5 chicks in each using completely randomized designed (CRD).

| Control  | Head | Treatment                          | No of Chicks per replication |
|----------|------|------------------------------------|-------------------------------|
| T<sub>0</sub> | 20   | Basal feed without additive        | R<sub>1</sub>: 5; R<sub>2</sub>: 5; R<sub>3</sub>: 5; R<sub>4</sub>: 5 |
| T<sub>1</sub> | 20   | Basal feed with Green tea 0.5%     | R<sub>1</sub>: 5; R<sub>2</sub>: 5; R<sub>3</sub>: 5; R<sub>4</sub>: 5 |
| T<sub>2</sub> | 20   | Basal feed with Green tea 1%       | R<sub>1</sub>: 5; R<sub>2</sub>: 5; R<sub>3</sub>: 5; R<sub>4</sub>: 5 |
| T<sub>3</sub> | 20   | Basal feed with Green tea 2%       | R<sub>1</sub>: 5; R<sub>2</sub>: 5; R<sub>3</sub>: 5; R<sub>4</sub>: 5 |
| T<sub>4</sub> | 20   | Basal feed with Oxytetracyclin 0.1gm/kg | R<sub>1</sub>: 5; R<sub>2</sub>: 5; R<sub>3</sub>: 5; R<sub>4</sub>: 5 |
| Total    | 100  |                                    |                              |

Total 100 of seven (07) days old “Cobb 500” broilers were randomly divided into five (5) equal groups (5×20) and each group is divided into 4 replication i.e. 4×5, then the group was numbered as group T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>. Group T<sub>0</sub> was considered as control and fed with only commercial ration. Group T<sub>1</sub> was treated with supplementation of 5 gm of Green Tea per kg of feed, Group T<sub>2</sub> was treated with supplementation of 10 gm of Green Tea per kg of feed Group T<sub>3</sub> was treated with supplementation of 20 gm of Green Tea per kg of feed and Group T<sub>4</sub> was treated with supplementation of 0.1 gm of Oxytetracyclin per kg of feed. Initial body weight of each bird was recorded (at day 07) before separation of birds in bamboo made floor (Macha). In every week the Body weight gain and feed intake was recorded up to the end of the experiment (i.e. 35 days of bird age) and total 10 birds were sacrificed for taking visceral organ weight and collect blood sample for hematological test (Total cholesterol, Triglyceride, LDL and HDL).

Research diets

T<sub>0</sub> = Control Group (Basal diet with supplement) + Fresh Drinking water
T<sub>1</sub> = Basal diet + 0.5 % GT powder+ fresh Drinking water
T<sub>2</sub> = Basal diet + 1 % GT powder+ fresh Drinking water
T<sub>3</sub> = Basal diet + 2 % GT powder+ fresh Drinking water
T<sub>4</sub> = Basal diet + Oxytetracycline 0.1gm/kg+ fresh Drinking water

Formulation of broiler ration

Experimental diets were formulated to meet the nutrient requirement of broiler suggested national research centre Govt. (NRC 1998). The starter diet vied for this study was ME 3000 Kcal/kg and CP 21.50% and the finisher diet was ME 3070 kcal/kg and CP 19% and another nutrient requirements are CF, EE, Ca, P, Lysine and methionine.

General management practices

Bach Bamboo cage was 2.5 ft × 2ft was allotted for 5 birds in the shed. After 10 days the litter materials were removed regularly. Ad libitum drinking water was supplied, required temperature and humidity was maintained for the chicks. The chicks are properly vaccinated at schedule time. Biosecurity of the farm was maintained properly.

Measurement of live weight

The live weight of each bird was measured with digital balance of day old chicks and after 7 days. Subsequently every 7 days interval the birds were weighted and recorded up to 35 days of bird age total 10 birds were sacrificed, processed and then weights (live, Heart, spleen, Bursa).
Blood Collection
Blood was collected from wing vein from each group in sterile syringe for hematological measurement as soon as possible of blood collection.

Total cholesterol (TC) determination procedure
At first blood sample was collected from wing vein of the experimental birds. Then the sample was centrifuged in the centrifugal machine at 1000 rpm for 15 minutes. Then the blood serum was separated from test tube. Cholesterol reagent was added in the serum test tube. Incubate the test tube for 10 minutes in room temperature. Optical density was measured. Then the concentration was determined. Finally the result was wrote down and analyzed.

Determination of HDL
The High Density lipid (HDL) reagent was added in blood serum in test tube. Then the test tube was centrifuged in the centrifugal machine at 1000 rpm for 15 minutes. Then the blood serum was separated from test tube.

RESULTS
Live weight and live weight gain
The effects of feeding green tea as an alternative to antibiotic growth promoter in broiler diet are presented below:

Table 1. Live weight and live weight gain

| Age (wk) | T0  | T1  | T2  | T3  | T4  | significance |
|----------|-----|-----|-----|-----|-----|--------------|
| 1st week | 176.8 ±1.00<sup>c</sup> | 184.2±1.3<sup>b</sup> | 185.1±1.00<sup>b</sup> | 190.2±0.84<sup>a</sup> | 180.2±1.22<sup>c</sup> | NS            |
| 2nd week | 434.80±1.41<sup>a</sup> | 465.0±1.34<sup>b</sup> | 484.8±1.0<sup>d</sup>  | 424.2±1.00<sup>c</sup> | 427.0±1.14<sup>d</sup> | NS            |
| 3rd week | 794.24±1.51<sup>i</sup> | 815.0±1.92<sup>i</sup> | 897.0±1.14<sup>i</sup> | 763.0±1.58<sup>i</sup> | 832.4±1.64<sup>i</sup> | NS            |
| 4th week | 1296.0±2.95<sup>c</sup> | 1266.0±2.58<sup>e</sup> | 1266.0±2.17<sup>e</sup> | 1225.0±1.58<sup>d</sup> | 1276.0±2.95<sup>b</sup> | NS            |
| 5th week | 1972.0±3.22<sup>b</sup> | 1992.0±2.77<sup>c</sup> | 1940.0±3.17<sup>e</sup> | 1778.0±3.52<sup>c</sup> | 1918.0±2.81<sup>d</sup> | *             |

Body weight gain (g/bird)

| Age (wk) | T0  | T1  | T2  | T3  | T4  | significance |
|----------|-----|-----|-----|-----|-----|--------------|
| 1st week | 131.8±1.44<sup>i</sup> | 142.2±1.51<sup>e</sup> | 142.1±3.22<sup>a</sup> | 144.2±1.64<sup>d</sup> | 136.2±2.21<sup>e</sup> | NS            |
| 2nd week | 258.0±1.87<sup>b</sup> | 280.8±3.22<sup>b</sup> | 299.7±2.28<sup>b</sup> | 234.2±1.31<sup>e</sup> | 246.8±1.87<sup>d</sup> | *             |
| 3rd week | 359.4±3.05<sup>e</sup> | 350.0±3.72<sup>e</sup> | 412.2±3.11<sup>d</sup> | 338.8±2.70<sup>c</sup> | 405.4±1.92<sup>d</sup> | *             |
| 4th week | 501.8±2.88<sup>e</sup> | 451.0±1.92<sup>c</sup> | 369.0±2.62<sup>d</sup> | 462.0±2.38<sup>d</sup> | 443.6±1.37<sup>d</sup> | NS            |
| 5th week | 676.0±3.42<sup>c</sup> | 726.0±2.70<sup>c</sup> | 674.0±2.34<sup>c</sup> | 553.0±2.62<sup>d</sup> | 642.0±1.87<sup>c</sup> | *             |

** = Significant at 1% level of significance.
* = Significant at 5% level of significance.
NS = Non significant
a,b,c,d,e Values with different superscripts in the same row differ significantly (P<0.05).

Live weight and live weight gain
The live weight and live weight gain of broilers supplemented with different levels of green tea and antibiotic compared with the control group were presented in Table 1. Here T0 was control group, T1 was 0.5% of GT powder, T2 was 1.0% of GT powder, T3 was 2.0% of GT powder and T4 was 0.1 gm of OTC per kg feed. The live weight was significantly higher in T1 group in compared with other groups. The live weight were almost similar (P>0.05) in all group from 2<sup>nd</sup> to 4<sup>th</sup> weeks of age. At 5<sup>th</sup> weeks of age, the body weight among the groups were significantly varied. Live weight gain did not significantly differed at 1<sup>st</sup> and 4<sup>th</sup> weeks of experiment but differed at 2<sup>nd</sup>, 3<sup>rd</sup> and 5<sup>th</sup> weeks of age. The live weight gain was significantly(P<0.05) higher in the group of Green Tea @ 0.5% (T1- 451 gm) compared to control, antibiotic as well as other tea groups. At the end of 5<sup>th</sup> weeks of age, the highest (P<0.05) body weight and total body weight gain were found in broilers supplemented with green tea compared to the antibiotic and control group. Highest body weight was observed in the GT@ 0.5% (1992 g/b) group followed by GT@ 1.0% (1940 g/b), GT@2% (1778 g/b) and control group (1972 g/b) and antibiotic(1874g/b) respectively.
**Feed intake**

Feed consumption of birds during the experimental period is shown in Table 2. Here the feed intake of broilers at 1st and 3rd weeks of age was similar (P>0.05). Significant differences of feed intake were found among the groups at 2nd, 4th and 5th weeks of age. At the end of the experiment, higher total feed intake was observed in the antibiotic group compared to the control groups (P<0.05). The feed intake of these groups were control (T0=3058 g/b), Green Tea @0.5% (T-2971g/b), Green Tea @ 1.0% (2995g/b), Green Tea @ 2% (3208 g/b) and antibiotic (3226 g/b) respectively.

**Table 2. Feed intake (g/bird)**

| Age (wk) | T0     | T1     | T2     | T3     | T4     | significance |
|----------|--------|--------|--------|--------|--------|--------------|
| 1st week | 144.0±1.58 a | 145.0±2.30 b | 160.0±2.63 a | 145.0±2.88 a | 143.0±2.07 ab | NS           |
| 2nd week | 446.0±2.91 a | 468.0±3.05 ab | 500.0±2.77 ab | 490.0±2.42 a | 457.0±2.75 a | *            |
| 3rd week | 1010.0±7.07 a | 975.0±5.01 a | 1011.0±5.57 a | 1019.0±3.41 a | 1027.0±3.86 a | NS           |
| 4th week | 1876.0±12.97 a | 1831.0±7.67 ab | 1848.0±6.06 ab | 1892.6±22.35 a | 1894.2±22.35 a | *            |
| 5th week | 3058.0±6.15 a | 2973.0±9.22 c | 2997.0±10.15 c | 3214.0±6.04 a | 3230.0±9.03 a | *            |

**= Significant at 1% level of significance.
* = Significant at 5% level of significance.
NS = Non significant.

a,b,c,d,e Values with different superscripts in the same row differ significantly (P<0.05).

**Feed conversion ratio (FCR)**

Feed conversion ratio (FCR) of birds during the experimental period is presented in Table 3. Feed conversion ratio did not differ among the dietary groups at 2nd week. Significant differences of feed conversion ratio varied significantly among the treatment groups and control group at 1st, 3rd, 4th and 5th weeks of age. Lowest but best FCR was obtained in group supplemented with 1% green tea.

**Table 3. Feed conversion ratio (FCR) (feed/gain)**

| Age (wk) | T0     | T1     | T2     | T3     | T4     | Level of significance |
|----------|--------|--------|--------|--------|--------|------------------------|
| 1st week | 0.81±0.003 b | 0.79±0.003 c | 0.86±0.002 a | 0.76±0.001 c | 0.79±0.003 c | NS                     |
| 2nd week | 1.02±0.012 bc | 1.01±0.003 c | 1.03±0.008 ac | 1.16±0.005 ab | 1.06±0.029 b | NS                     |
| 3rd week | 1.271±0.08 a | 1.196±0.04 b | 1.27±0.06 a | 1.315±0.08 a | 1.23±0.08 a | NS                     |
| 4th week | 1.286±0.52 a | 1.425±0.037 a | 1.296±0.043 a | 1.416±0.59 a | 1.38±0.28 a | *                      |
| 5th week | 1.55±0.065 bc | 1.491±0.058 bc | 1.54±0.048 bc | 1.8±0.66 a | 1.68±0.059 ab | *                      |

**= Significant at 1% level of significance.
* = Significant at 5% level of significance.
NS = Non significant.
a,b,c,d,e Values with different superscripts in the same row differ significantly (P<0.05).

**Carcass yield**

Weight of different internal organs such as thigh, breast, liver and heart of the birds of T0, T1, T2, T3 and T4 are shown in the Table-4. Statistical analysis of the data did not show any difference between breast weights of the birds of different feeding groups.

Dressing percentage, thigh, liver and heart weight differed significantly (p>0.05) among the experimental birds. These parameters are significantly higher in tea supplemented and antibiotic group compared to control group.
Table 4. Carcass characteristics of broilers fed with Green Tea and antibiotic

| Age (wk) | T0        | T1        | T2        | T3        | T4        | Level of significance |
|----------|-----------|-----------|-----------|-----------|-----------|-----------------------|
| Carcass wt. (g) | 1950.00 ± 18.16 * | 1970.00 ± 2.00 b | 1910.00 ± 2.94 b | 1750.00± 3.67 b | 1900.00 ± 1.22 b | *                      |
| Dressing yield | 1267± 0.45 a | 1300± 0.58 a | 1279± 0.59 a | 1370± 0.46 a | 1235± 0.56 ab | NS                    |
| Thigh wt. (g) | 221.90± 1.87 a | 276.00 ± 1.51 a | 234.00 ± 3.16 b | 225.00 ± 1.81 c | 213.00± 3.14 c | *                      |
| Breast wt. (g) | 345.00± 3.53 a | 386.00± 3.84 a | 388.00 ± 1.64 d | 357.00± 4.78 b | 385.00± 1.84 d | NS                    |
| Liver wt. (g) | 60± 0.01 a | 53± 0.01 b | 56± 0.02 b | 63± 0.02 a | 57± 0.02 b | NS                    |
| Heart wt. (g) | 14± 0.01 ab | 16± 0.01 a | 15± 0.01 a | 18± 0.02 a | 12± 0.01 b | NS                    |

** = Significant at 1% level of significance. * = Significant at 5% level of significance. NS = Non significant

Blood parameters

Hematological parameters of the experimental birds were shown in Table-5. It was found Green Tea has an effect on the blood profile. The cholesterol level did not vary significantly (P>0.05) in different groups. However, total cholesterol is lower in the group of broiler supplied green tea @ 0.5% compared to other groups of green tea and antibiotic groups. Green Tea to broiler has no effect on LDL of blood profile. All results are near to normal level.

Triglyceride level showed significant (P<0.01) differences among different groups where highest level was found in T1 and lowest in T4 groups.

Muramatsu et al. (1986) observed that tea leaves have an effect on the cholesterol level. Minimum cholesterol level was found in the liver muscle (51.553mg/100g).

Table 5. Blood parameters of broilers fed diet with Green Tea @ 0.5, 1 and 2%, OTC @ 0.1 gm/kg feed.

| Parameters | T0        | T1        | T2        | T3        | T4        | Level of significance |
|------------|-----------|-----------|-----------|-----------|-----------|-----------------------|
| Total Cholesterol (mg/dl) | 157.0± 2.77 c | 145.0± 1.92 ab | 217.0± 2.77 a | 215.0± 2.16 a | 198.0± 1.64 b | NS                    |
| HDL (mg/dl) | 17.0± 1.12 c | 25.0± 1.00 b | 25.0± 1.41 b | 30.0± 2.07 b | 32.0± 1.51 b | NS                    |
| LDL (mg/dl) | 110.0± 4.59 c | 145.0± 1.76 b | 167.0± 2.42 a | 168.0± 2.62 a | 145.0± 2.40 b | NS                    |
| Triglyceride (mg/dl) | 120.0± 4.46 c | 140.0± 4.34 b | 125.0± 2.05 s | 85.0± 1.64 s | 100.0± 2.98 s | **                    |

** = Significant at 1% level of significance. * = Significant at 5% level of significance. NS = Non significant

a,b,c,d,e Values with different superscripts in the same row differ significantly (P<0.05).

DISCUSSION

It has been reported that tea catechins have antibacterial activity against various pathogenic bacteria. The results indicate that 1% GTP and LTP provide different synergistic effects on several antibiotics in various bacteria. It was found that 1% GTP works the best synergistically against enterobacter aerogenes, making the resistant strain susceptible to 8 out of 12 antibiotics used. 1% LTP appeared to inhibit E.coli, E. aerogenes, S. marescens and M. smegmatis which are gram-negative microorganisms (Bobak Haghjoo et al., 2013).

Antibiotic growth promoters (AGP) are used for improving feed utilization, increasing general health of chickens and subsequently improving their productive performances through different dose of action (Nasir and Grashorn, 2008). Although high dose of antibiotic use negative effects on environment and human health (AL-Harthi, 2002; Nasir and Grashorn, 2008). Although minimal dose of OTC the effect of weight gain compared
with those feed of the control diet. Green tea phytochemicals are of pharmacologically active ingredients such as catechins, flavanols, flavodiols, flavonoids and phenolic acids (Katiyar and Mukhtar, 1996; Ahmad et al., 1998; Lin et al., 1998). Chicken received GTP supplemented diets had significantly (p<0.05) greater body weight at 35 days of age than those fed the un-supplemented control diet. This increase was (T1 = 451 gm. & 726 gm.) at 35 days of age. This result indicated that 0.05 gm. /Kg diet had a similar potential to those of OTC suggesting that GTP may be a useful non-AGP. This improvement could be attributed to phytochemicals due to their high content of pharmacologically active ingredients (Muramatsu et al., 1986; Toda et al., 1989). Feed consumptions of broilers significantly decrease due to supplementation with either level of GTP or OTC compared to the control diets only during 1-35 days. For the whole period 0.05gm /Kg feed significantly increase feed consumption by compare to that of the control group. Different internal organs like thigh muscle, liver, heart, breast muscle, carcass and dressing percentage can be measured. No significant differences breast muscle supplementing diet compared to the control group. There was significant interaction between carcass percentage, dressing yield, thigh muscle, liver, heart (Biswas and Wakita, 2001; Kaneko et al., 2001).

Green tea has an effect on the blood plasma constituents. Triglyceride level showed significant (p<0.01) difference among different groups at the age of 35 days. Similarly (Muramatsu et al., 1986) indicated that high cp diets enhanced lipid utilization by increased plasma triglyceride concentration.

CONCLUSIONS
From the above experiment we can conclude that green tea is considered for the prevention and treatment of many poultry diseases. It improves poultry health and increases farm production. Experimental broiler has good FCR and higher body weight gain during rearing with green tea powder. Experimental design must be more accurate and scientific for future research. More research studies are needed to conduct for drawing a right condition especially on green tea powder because of limited works are done in this potential supplement. All poultry farmers should be aware of the great impact of green tea powder on poultry health and poultry production for economic development of Bangladesh.

REFERENCES
1. Ahmad N, Katiyar SK and Mukhtar H (1998). Cancer chemoprevention by tea polyphenols. In: Ioannides C, ed. Nutrition and Chemical Toxicity. West Sussex-England: John Wiley & Sons: 301-343
2. AL-Harthi MA (2002). Performance and carcass characteristics of broiler chicks as affected by different dietary types and levels of herbs, and spices as non classical growth promoters. *Egyptian Poultry Science Journal* 22: 325-343.
3. Biswas AH and Wakita M (2001). Effect of dietary Japanese green tea powder supplementation on feed utilization and carcass profiles in broilers. *Japanese Poultry Science* 38: 50-57.
4. Bobak Haghjoo, Lee H, Umme Habiba, Hassan Tahir, Moe Olabi and Tin-Chun Chu (2013). The synergistic effects of green tea polyphenols and antibiotics against potential pathogens. *Advances in Bioscience and Biotechnology* 4: 959-967.
5. Cao BH, Karasawa Y and 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-Australian Journal of Animal Science* 18: 85-89.
6. Carpenter R, O'Grady MN, O'Callaghan YC, O'Brien NM and Kerry JP (2007). Evaluation of the antioxidant potential of grape seed and bearberry extracts in raw and cooked pork. *Meat Science* 76: 604-610.
7. Hara-Kudo Y, Yamasaki A, Sasaki M, Okubo T, Minai Y, Haga M, Kondo K and Sugita-Konishi Y (2005). Antibacterial action on pathogenic bacterial spore by green tea catechins. *Journal of the Science of Food and Agriculture* 85: 2354-2361.
8. Kaneko K, Yamasakil K, Tagawa Y, Tokunaga M, Tobisa M and Furuse M (2001). Effects of dietary Japanese green tea powder on growth, meat ingredient and lipid accumulation in broilers. *Journal of Poultry Science* 38: 77-85.
9. Katiyar SK and Mukhtar H (1996). Tea in chemoprevention of cancer: epidemiologic and experimental studies. *International Journal of Oncology* 8: 221-238.
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10. Guo FC, Williams BA, Kwakkel RP, Li XP, Luo JY, Li WK and Verstegen MWA (2004). Effects of mushroom and herb polysaccharides, as alternatives for an antibiotic, on the cecal microbial ecosystem in broiler chickens. *Poultry Science* 83: 175-182.

11. Lin CY, Pan CM, Chen TF and Tseng HC (1998). The effect of feeding biocozamycin, enramycin and kitasamycin on the growth performance and tissue residues in male ducks. *Journal of Taiwan Livestock Research* 31: 323-335.

12. Mukhtar H and Ahmad N (2000). Tea polyphenols Prevention of cancer and optimizing health. *The American Journal of Clinical Nutrition* 71(6 Suppl): 1698S-1702S.

13. Muramatsu K, Fukuyo M and Hara Y (1986). Effect of green tea catechins on plasma cholesterol level in cholesterol-fed rats. *Journal of Nutritional Science and Vitaminology* 32: 613-622.

14. Nasir Z and Grashorn MA (2008). Alternatives to antibiotics: Do we really have some alternatives In Proceeding XXIII World's Poultry congress 2008.- *World's Poultry Science Journal* 64: 165.

15. Toda M, Okubo S, Ohnishi R and Shimamura T (1989). Antibacterial and bactericidal activities of Japanese green tea. *Japanese Journal of Bacteriology* 44: 669-672.

16. Uuganbayar D, Bae HI, Choi KS, Shin IS, Firman JD and Yang CJ (2005). Effects of green tea powder on laying performance and egg quality in laying hens. *Asian-Australian Journal of Animal Science* 18: 1769-1774.

17. Uuganbayar D, Shin IS and Yang CJ (2006). Comparative performance of hens fed diets containing Korean, Japanese and Chinese green tea. *Asian-Australian Journal of Animal Science* 19: 1190-1196.