The effects of dietary supplementation of microencapsulated *Enterococcus faecalis* and the extract of *Camellia oleifera* seed on growth performance, immune functions, and serum biochemical parameters in broiler chickens

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**ABSTRACT:** This experiment was conducted to investigate the effects of microencapsulated *Enterococcus faecalis* (MEF) and the extract of *Camellia oleifera* seed (ECOS) on growth performance, immune functions, and serum biochemical parameters in broiler chickens. A total of 240 1-d-old male broilers were randomly allotted into 6 treatments with 8 replicates/treatment and 5 broilers in each cage. The dietary treatments included 1) a basal diet without antibiotic (group A), 2) the basal diet + 1 g MEF/kg diet (1 × 10^10 cfu/g MEF; group B), 3) the basal diet + 300 mg ECOS/kg diet (group C), 4) the basal diet + 300 mg ECOS/kg diet + 1 g MEF/kg diet (group D), 5) the basal diet + 500 mg ECOS/kg diet (group E), and 6) the basal diet + 500 mg ECOS/kg diet + 1 g MEF/kg diet (group F). The feeding experiment included 2 phases: the starter phase from Day 1 through 21 and the grower phase from Day 22 through 42. The results showed that a diet supplemented with MEF and ECOS had no significant effect on ADG, ADFI, feed conversion ratio, and average BW during the whole experimental period (P > 0.05), but group F showed an improving trend in growth performance. Serum IL-2, IgA, and IgG levels and spleen index were significantly affected by dietary treatment (P < 0.05). Serum IgA and IgG levels and spleen index in group F were significantly higher than in the group A (P < 0.05), and the IL-2 level was significantly decreased (P < 0.05) on Days 21 and 42. Compared with the group A, diets supplemented with MEF and ECOS can significantly decrease total cholesterol, low-density lipoprotein cholesterol, triglycerides, and blood urea nitrogen levels (P < 0.05) and increase the high-density lipoprotein cholesterol level on Days 21 and 42. Concentrations of serum biochemical parameters were significantly increased in group F (P < 0.05). In summary, the results indicated that dietary supplementation of MEF and/or ECOS had no significant effect on growth performance but significantly increased spleen index and the levels of serum IgA and IgG and improved serum lipid metabolism. The 1 g MEF/kg diet (1 × 10^7 cfu/g diet) plus 500 mg ECOS/kg diet was the optimum supplemental dose in this experiment.

**Key words:** biochemical parameter, broiler, extract of *Camellia oleifera* seed, growth performance, immune function, microencapsulated *Enterococcus faecalis*

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**INTRODUCTION**

At present, antibiotic-resistant pathogens and antibiotic residues caused by antibiotic abuse have become extremely serious problems. Since 2006, the European Union has banned antibiotic growth promoters as feed additives (Steiner, 2006). This situation has prompted animal nutritionists to research and apply new alternatives to antibiotics in feed (Ganguly, 2013). Previous studies reported that dietary supplementation of probiotics had beneficial effects in broilers (Mountzouris et al., 2010; Rocha et al., 2012; Hassan and Ryu, 2012; Waititu et al., 2014; Zhang and Kim, 2014). However, the beneficial effects of probiotics depend on their ability to tolerate adverse environments during feed processing, storage, and feed digestion in the gastrointestinal tract of the animal (Ross et al., 2005). Microencapsulation technology has been considered

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as an effective method to protect probiotic vitality (Han et al., 2013). Microencapsulation consists of enclosing a biologically active material within a polymeric matrix surrounded by a semipermeable membrane. The membrane allows the bidirectional diffusion of nutrients, oxygen, and waste products and protects the inner cells from potentially harmful mechanical stress and toxic compounds (Orive et al., 2003). It has been frequently used in the production and intestinal delivery of therapeutical agents from genetically modified food-grade microorganisms (Qi et al., 2006).

*Camellia oleifera* is an important source of edible oil in tropical and subtropical regions of Asia (Shen et al., 2008; Chen et al., 2010). The extract of *C. oleifera* defatted seeds contains a mixture of saponins and polysaccharides. Saponins consist of a sugar moiety containing glucose, galactose, glucuronic acid, xylose, rhamnose, or methylpentose glycosidically linked to a hydrophobic aglycone (sapogenin), which may be triterpenoid or steroidal in nature (Francis et al., 2002). It has been reported that saponins have many physiological functions, such as immunostimulant, hypcholesterolaemic, antibacterial, antioxidant, and anticarcinogenic properties (Francis et al., 2002; Liu et al., 2011, 2014; Hu et al., 2012).

Han et al. (2013) and Zhang et al. (2015) reported that dietary supplementation of microencapsulated *Lactobacillus* can improve growth performance and increase the diversity and composition of beneficial intestinal microbes in broilers. Khalaji et al. (2011) reported that dietary supplemented with 0.5 g/kg of Longjing *Camellia sinensis* plant extract decreased BW, feed intake, and the feed conversion ratio throughout the experiment in broilers. Therefore, the aim of the present study was to investigate the effects of dietary supplementation of microencapsulated *Enterococcus faecalis* and the extract of *C. oleifera* seed, independently or in combination, on growth performance, immune functions, and blood biochemical parameters in broiler chickens.

**MATERIALS AND METHODS**

Broiler care and handling was in compliance with the Animal Ethics Committee Guidelines of the Academy of State Administration of Grain (Beijing, P. R. China).

**Preparation of Microencapsulated *Enterococcus faecalis***

The microencapsulated probiotic products were prepared as described by Qi et al. (2006). The *E. faecalis* strain was stored in the China General Microbiological Culture Collection Center (collection number 2516; GenBank accession number for 16S rRNA gene: BankIt1547707 Seq1 JX241472; Beijing, P. R. China). The microencapsulated product was analyzed to contain $1.0 \times 10^{10}$ cfu/g product.

**Preparation of Extract of *Camellia oleifera* Seed**

The product was provided by the Oil and Fat Chemistry Research Group, Academy of State Administration of Grain (Beijing, P. R. China). The extract of *C. oleifera* seed was prepared by the aqueous enzymatic method, which is a new, environmental, efficient oil processing technology. This method can synchronously obtain high-quality oil and unsaponifiable lipid by using enzymes (protease, amylase, pectinase, and cellulase) to disintegrate the cell walls of oilseeds and hydrolyze the lipoprotein in the cells (de Moura and Johnson, 2009). The raw materials and pectinase were ground twice to improve extraction efficiency. Under the optimum conditions, the product was obtained with a light brown color and contained 30% total glucose, 30% tea saponin, 8% CP, and 25% crude ash.

**Experimental Design and Diets**

The animal experiment was performed at the Shisanling experiment base of the Academy of State Administration of Grain (Changping district, Beijing, P. R. China).

A total of 240 healthy, 1-d-old male Arbor Acres broilers were obtained from a commercial hatchery (Huadu Broiler Breeding Farms, Beijing, P. R. China). The broilers were randomly assigned to 6 groups with 8 replicates/group and 5 broilers/replicate. Dietary treatments included 1) a basal diet without antibiotic (group A), 2) the basal diet + 1 g microencapsulated *Enterococcus faecalis* (MEF)/kg diet (1 $\times 10^{10}$ cfu/g MEF; group B), 3) the basal diet + 300 mg extract of *Camellia oleifera* seed (ECOS)/kg diet (group C), 4) the basal diet + 300 mg ECOS/kg diet + 1 g MEF/kg diet (group D), 5) the basal diet + 500 mg ECOS/kg diet (group E), and 6) the basal diet + 500 mg ECOS/kg diet +1 g MEF/kg diet (group F). The basal diet was formulated to meet the nutrient requirements of Chinese feeding standards of chickens (NY/T 33-2004, 2004). The composition and nutrient levels of the basal diet are presented in Table 1.

The broilers were housed in cages with wire mesh floors with 23 h fluorescent illumination per day throughout the trial period. The stocking density was 560 cm²/bird. Feed and water were provided ad libitum. The temperature of room was maintained at 33°C for the first week and then gradually reduced to 24°C until the end of the trial. All broilers were vaccinated with Newcastle vaccine on Day 7 and 28 and inactivated infectious bursal vaccine on Day 14 and 21.
Table 1. Ingredients and nutrient composition of the basal diet (g/kg diet, as-fed basis)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Starter (d 1–21)</td>
</tr>
<tr>
<td>Corn</td>
<td>587.4</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>272.8</td>
</tr>
<tr>
<td>Cottonseed meal (50.5% CP)</td>
<td>80.0</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>20.4</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>18.7</td>
</tr>
<tr>
<td>Limestone</td>
<td>11.0</td>
</tr>
<tr>
<td>Salt</td>
<td>3.0</td>
</tr>
<tr>
<td>Choline chloride (50%)</td>
<td>2.6</td>
</tr>
<tr>
<td>Vitamin premix 1</td>
<td>0.2</td>
</tr>
<tr>
<td>Minerals premix 2</td>
<td>2.0</td>
</tr>
<tr>
<td>l-Methionine</td>
<td>1.3</td>
</tr>
<tr>
<td>l-Lysine HCl</td>
<td>0.6</td>
</tr>
<tr>
<td>Total</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Calculated chemical composition. g/kg diet (as-fed basis)

1 ME, MJ/kg  12.50  12.92
2 CP  221  207
3 Calcium  10.9  10.1
4 Total phosphorus  7.2  6.9
5 Lysine  12  11.1
6 Methionine  5.0  3.9

1The vitamin premix provided the following per kilogram of diet: 9,500 IU vitamin A, 62.5 μg vitamin D3, 2.65 mg vitamin K3, 0.025 mg vitamin B12, 6 mg vitamin B6, 30 IU vitamin E, 0.0325 mg biotin, 1.25 mg folic acid, 12 mg pantothenic acid, and 50 mg nicotinic acid.

2The mineral premix provided the following per kilogram of diet: 8 mg Cu, 75 mg Zn, 80 mg Fe, 100 mg Mn, 0.15 mg Se, and 0.35 mg I.

**Growth Performance**

On Day 21 and 42, after broilers were fasted for 12 h, BW and feed intake were recorded on a cage basis. Average daily gain, ADFI, and feed conversion ratio (FCR) were calculated during Day 1 through 21, Day 21 through 42, and Day 1 through 42. The mortality was calculated during the whole feeding trial.

**Organ Index**

On Day 42, after collecting blood samples, the birds were killed by jugular bleeding. The bursa, spleen, and liver were weighed to calculate the bursa index, spleen index, and liver index. The organ index was calculated as the organ weight (g)/BW (kg).

**Serum Biochemical Parameters**

On Day 21 and 42, 1 bird was randomly selected from each cage and blood samples were collected into pro-coagulation tubes from the wing vein. Blood samples were centrifuged at 4,000 × g for 15 min at 4°C. The serum samples were stored at −20°C until analyzed. Serum total protein (TP), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), and blood urea nitrogen (BUN) were measured by an automatic biochemical analyzer (BS-200; Mindray, Wuhan, P. R. China). The concentration of TP was determined by biuret test (catalog number A045-1). Serum TC was measured using a cholesterol oxidase-peroxidase method (catalog number A111-1). TG was determined by a Glycerol phosphate oxidase-peroxidase method (catalog number A110-1). LDL-C (catalog number A113-1) and HDL-C were measured using a direct method (catalog number A112-1), and BUN was measured by a urease-glutamate dehydrogenase method (catalog number C013-2). All the commercially available diagnostic kits were purchased from Nanjing Jiancheng Bioengineering Institute (Nanjing, P. R. China).

The concentrations of serum IL-2 (catalog number CK-E00014C), IgA (catalog number CK-E000168C), IgG (catalog number CK-E00170C), and IgM (catalog number CK-E00169C) were determined according to the protocols of ELISA kits (Beijing Dongge Bioengineering Institute, Beijing, P. R. China). A double antibody sandwich ELISA was used in the kits.

**Data Analysis**

The statistical analysis was performed with SPSS 17.0 software (SPSS Inc., Chicago, IL). No interactions for all measurements were observed, so data were analyzed by 1-way ANOVA for the diet treatment as the main source of variation. Significant differences among means of treatments were compared by Duncan’s new multiple range test. Differences were considered statistically significant at $P \leq 0.05$.

**RESULTS**

**Growth Performance**

The effects of dietary supplementation of MEF and ECOS on growth performance are shown in Table 2. Dietary addition of MEF and ECOS had no significant effect on average BW, ADG, ADFI, and FCR ($P > 0.05$) during the whole experiment, but group F showed an improving trend in ADG ($P = 0.062$) and ADFI ($P = 0.061$). No mortality was observed in the whole period.

**Organ Index**

The results of the organ index are shown in Table 3. There was no significant effect on the bursa index or liver index, but the spleen index was significantly increased in group F compared with the other groups ($P < 0.05$).
Serum Immune Performance

As shown in Table 4, dietary supplementation of MEF and ECOS had no significant effect on serum IgM level but significantly affected serum IL-2, IgA, and IgG levels \((P < 0.05)\). Compared with the group A, the serum IL-2 level was significantly decreased by dietary MEF and ECOS supplementation on Day 21 and 42. Immunoglobulin A and IgG levels were significantly increased compared with the group A on Day 21 and 42. Besides, group F had the most significant effect in decreasing IL-2 level and increasing IgA and IgG levels.

Serum Biochemical Parameters

The results of serum biochemical parameters are shown in Table 5. The serum TP level tended to decrease \((P = 0.070)\), but the levels of serum TC, LDL-C, HDL-C, TG, and BUN were significantly affected by dietary supplemented with MEF and ECOS. The levels of TC, LDL-C, TG, and BUN were significantly decreased and HDL-C was significantly increased in groups C, D, E, and F \((P < 0.05)\) on Day 21 and 42, and group F had the most significant effect among these groups.

DISCUSSION

Probiotics are classified as zootechnical feed additives (European Commission, 2003) and constitute a functional nutritional approach, whereby the maintenance of a healthy gastrointestinal environment and improved intestinal function is pursued through the intake of a sufficient quantity of live, beneficial microorganisms (FAO/WHO, 2002). Several studies have reported that dietary supplementation with *Lactobacillus* can improve growth performance (Han et al., 2013; Zhang and Kim, 2014) and nutrient digestibility (Mountzouris et al., 2010). However, other studies showed that probiotics had no or slight effect on growth performance in broilers (Mountzouris et al., 2007; Lee et al., 2010; Zhang et al., 2011). This inconsistency can partly be attributed to the strain, survivability, and additive amount of probiotics (Kabir, 2009; Lee et al., 2010). Microencapsulation has been considered as an effec-
Probiotic, *Camellia oleifera* seed extract in chick

Poujad et al. (2013) reported that probiotics can significantly increase bursa and thymus relative weight. Khalaji et al. (2011) reported that the Longjing (*C. sinensis*) plant extract had no effect on spleen and bursa relative weight. The current result showed that dietary supplementation of 1 g MEF/kg and 500 mg ECOS/kg diet significantly increased the spleen index but had no significant effect on the bursa index on Day 42. Hu et al. (2012) reported that dietary supplementation of *Lactobacillus* or Longjing (*C. sinensis*) plant extract could improve immunity in broilers. This study indicated that dietary addition of MEF and/or ECOS had no effect on the serum IgM level but significantly increased IgA and IgG levels. Group F was higher than other groups. This same result was observed by Huang et al. (2004), who reported that *Lactobacillus acidophilus* and *Lactobacillus casei* can increase IgA and IgG concentrations. The serum IL-2 level has significant effects on the nature of immune responses and can regulate the immune system in favor of T-helper 1 and T-helper 2 type immune responses (Choi and Lillehoj, 2000). This current result showed that dietary addition of MEF and ECOS decreased the serum IL-2 level. But Rajput et al. (2013) reported that *E. faecalis* can effectively induce immunity through cytokine production in broilers. The current results suggested that dietary addition of MEF and ECOS can increase the spleen index and serum IgA and IgG levels but decrease the serum IL-2 level.

The TC, LDL-C, HDL-C, and TG levels can reflect the lipid metabolism. Some studies reported that dietary supplementation with probiotics significantly decreased serum TC and TG levels in broilers (Mansoub, 2010; Sohail et al., 2010) and in layers (Zhang et al., 2012). In this study, compared with the group A, MEF supplementation had no significant effect on the levels of TC, HDL-C, and TG but significantly decreased the LDL-C level. Some specific bacteria (such as *Bacillus subtilis*) could prevent bile salts from reabsorption and convert them to the second type. At the same time, specific bacteria could synthesize esterase enzymes, converting free fatty acids to their esterified forms, which differ from TG in the intestinal tract (Zhang et al., 2012). Therefore, cholesterol and TG were less absorbed into the serum. Besides, the levels of TC, LDL-C, TG, and BUN were significantly decreased and the HDL-C level was significantly increased in groups fed with ECOS and MEF + ECOS. This may be that the body’s inter-

### Table 4. Effects of dietary supplementation with microencapsulated *Enterococcus faecalis* and/or extract of *Camellia oleifera* seed on IL-2, IgA, IgM, and IgG in broilers

<table>
<thead>
<tr>
<th>Item</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
<th>Group 6</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-2, pg/mL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>277(a)</td>
<td>250(b)</td>
<td>256(b)</td>
<td>218(c)</td>
<td>214(c)</td>
<td>190(d)</td>
<td>5.23</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>42</td>
<td>280(a)</td>
<td>242(b)</td>
<td>242(b)</td>
<td>204(ad)</td>
<td>211(c)</td>
<td>187(d)</td>
<td>5.28</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>IgA, μg/mL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>280(a)</td>
<td>303(d)</td>
<td>308(cd)</td>
<td>339(bc)</td>
<td>357(ab)</td>
<td>388(a)</td>
<td>6.90</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>42</td>
<td>274(a)</td>
<td>322(c)</td>
<td>317(c)</td>
<td>346(bc)</td>
<td>360(bc)</td>
<td>395(c)</td>
<td>7.49</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>IgG, μg/mL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>1,859(b)</td>
<td>2,290(b)</td>
<td>2,025(c)</td>
<td>2,384(b)</td>
<td>2,486(b)</td>
<td>2,657(a)</td>
<td>51.6</td>
<td>&lt;0.001</td>
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<tr>
<td>42</td>
<td>2,008(b)</td>
<td>2,228(bc)</td>
<td>2,164(bc)</td>
<td>2,528(ab)</td>
<td>2,415(b)</td>
<td>2,523(a)</td>
<td>45.6</td>
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<tr>
<td>IgM, μg/mL</td>
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<td></td>
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<td>21</td>
<td>512</td>
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<td>556</td>
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<td>558</td>
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<td>0.922</td>
</tr>
<tr>
<td>42</td>
<td>591</td>
<td>524</td>
<td>524</td>
<td>522</td>
<td>493</td>
<td>534</td>
<td>14.0</td>
<td>0.491</td>
</tr>
</tbody>
</table>

\(a-d\) Means within a row with different letters differ significantly \((P<0.05)\).

1. Group A: basal diet; group B: basal diet + 1 g microencapsulated *E. faecalis* kg; group C: basal diet + 300 mg extract of *C. oleifera* seed/kg; group D: basal diet + 1 g microencapsulated *E. faecalis* kg + 300 mg extract of *C. oleifera* seed/kg; group E: basal diet + 500 mg extract of *C. oleifera* seed/kg; group F: basal diet + 1 g microencapsulated *E. faecalis* kg + 500 mg extract of *C. oleifera* seed/kg.

2. Each mean represents 8 individual broilers.
nal environment was improved by ECOS, which will further facilitate the adoption of cholesterol and TG by *Lactobacillus* bacteria (Sohail et al., 2010). These results verified the important role of microorganisms in the recycling of lipids in the gastrointestinal tract. The results were in accordance with the findings of Beski and Al-Sardary (2015), who stated that serum cholesterol and LDL-C concentrations were significantly reduced at Day 42 due to the dietary supplementation of synbiotic in broilers. The possible reasons were that some probiotics had the ability to utilize cholesterol, depress the cholesterol absorption from gastrointestinal tract (Mohan et al., 1995), and inhibit the activity and hydroxymethyl glutaryl CoA involves in the cholesterol synthesis (Fukushima and Nakano, 1995). Blood TP and BUN levels are important indexes to reflect protein metabolism. This study indicated that no significant difference was found on the TP level but that the BUN level was significantly decreased when the diet was supplemented with MEF and/or ECOS. This result may indicate that MEF and ECOS can promote the anabolism of protein.

In summary, the current study suggested that dietary supplementation of microencapsulated *E. faecalis* and/or the extract of *Camellia oleifera* seed had no significant effect on growth performance but significantly increased the spleen index and the levels of serum IgA and IgG and improved serum lipid metabolism. One gram MEF/kg diet (1 × 10^7 cfu/g diet) plus 500 mg ECOS/kg diet was the optimum supplemental dose in this experiment.

### Table 5. Effects of dietary supplementation with microencapsulated *Enterococcus faecalis* and/or extract of *Camellia oleifera* seed on total protein (TP), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), and blood urea nitrogen (BUN) levels in broilers

<table>
<thead>
<tr>
<th>Item</th>
<th>Group1</th>
<th>Group2</th>
<th>Group3</th>
<th>Group4</th>
<th>Group5</th>
<th>Group6</th>
<th>SEM2</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP, g/L</td>
<td>21 64.0 62.8</td>
<td>42 64.0 63.4</td>
<td>21 5.62a 5.58a</td>
<td>42 5.29a 5.47a</td>
<td>21 3.29a 2.60b</td>
<td>42 3.57a 3.19b</td>
<td>21 1.50c 1.62c</td>
<td>42 1.62c 1.67bc</td>
</tr>
<tr>
<td>TC, mmol/L</td>
<td>21 5.62a 5.58a</td>
<td>42 6.29a 6.32a</td>
<td>21 4.78b</td>
<td>42 4.89b</td>
<td>21 2.70b</td>
<td>42 2.98b</td>
<td>21 1.77b</td>
<td>42 1.79b</td>
</tr>
<tr>
<td>LDL-C, mmol/L</td>
<td>21 5.62a 5.58a</td>
<td>42 6.29a 6.32a</td>
<td>21 4.78b</td>
<td>42 4.89b</td>
<td>21 2.70b</td>
<td>42 2.98b</td>
<td>21 1.77b</td>
<td>42 1.79b</td>
</tr>
<tr>
<td>HDL-C, mmol/L</td>
<td>21 5.62a 5.58a</td>
<td>42 6.29a 6.32a</td>
<td>21 4.78b</td>
<td>42 4.89b</td>
<td>21 2.70b</td>
<td>42 2.98b</td>
<td>21 1.77b</td>
<td>42 1.79b</td>
</tr>
<tr>
<td>TG, mmol/L</td>
<td>21 5.62a 5.58a</td>
<td>42 6.29a 6.32a</td>
<td>21 4.78b</td>
<td>42 4.89b</td>
<td>21 2.70b</td>
<td>42 2.98b</td>
<td>21 1.77b</td>
<td>42 1.79b</td>
</tr>
<tr>
<td>BUN, mmol/L</td>
<td>21 5.62a 5.58a</td>
<td>42 6.29a 6.32a</td>
<td>21 4.78b</td>
<td>42 4.89b</td>
<td>21 2.70b</td>
<td>42 2.98b</td>
<td>21 1.77b</td>
<td>42 1.79b</td>
</tr>
</tbody>
</table>

*Means within a row with different letters differ significantly (P < 0.05).*

1 Group A: basal diet; group B: basal diet + 1 g microencapsulated *E. faecalis*/kg; group C: basal diet + 300 mg extract of *C. oleifera* seed/kg; group D: basal diet + 1 g microencapsulated *E. faecalis*/kg + 300 mg extract of *C. oleifera* seed/kg; group E: basal diet + 500 mg extract of *C. oleifera* seed/kg; group F: basal diet + 1 g microencapsulated *E. faecalis*/kg + 500 mg extract of *C. oleifera* seed/kg.

2 Each mean represents 8 individual broilers.

### LITERATURE CITED


Probiotic, Camellia oleifera seed extract in chick


