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Effects of Multi Strain Probiotics on Egg Production and Quality in Laying Hens Fed Diets Containing Food Waste Product

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Abstract: The objective of the present study was to evaluate the effects of multistrain probiotics (MP) supplementation to diets containing 40% food waste product (FWP) on egg production and quality. Forty wk-old Lohmann Brown were allocated to 4 dietary treatments with 5 replicates and 2 birds/cage in completely randomized design. A basal diet formulated to contain corn, soybean meal and FWP and 3 additional diets were prepared by adding 0.1, 0.2, or 0.4% of MP. During the 3-wk feeding period, the addition of 0.4% MP showed the least egg production (75.4%) compared with 0 (85.5%) or 0.2% (81.4%) MP addition ($p<0.05$), but the egg production was not different between 0.1 and 0.4% MP addition. The BW changes as well as feed intake were not different among the dietary treatments. The BD supplemented with 0.4% MP showed greatest Haugh units (60.4, $p<0.05$) compared with other treatments. There was no significant difference in yolk color among the treatments with the exception of dietary group with 0.4% added probiotics in which the least Roche color index (8.4, $p<0.05$) was observed. In conclusion, the present study indicated that the addition of probiotics to diets containing 40% FWP improved the egg protein quality but did not affect productivity of laying hens.

Key words: Egg production, egg quality, food waste, layers

INTRODUCTION

It has been reported that there are improvements in hen performance including feed efficiency, egg production and egg quality when probiotics supplemented to diets for laying hens (Nahashon *et al*., 1994; Mohan *et al*., 1995; Abdulrahim *et al*., 1996; Haddadin *et al*., 1996; Panda *et al*., 2003). Additionally, improvement in nutrient digestibility was also observed (Nahashon *et al*., 1996; Jin *et al*., 1997).

Food waste product (FWP) as an ingredient for animal feed has been extensively evaluated for swine and poultry diets (Rivas *et al*., 1995; Myer *et al*., 1999; Chae *et al*., 2000; Farhat *et al*., 2001; Moon *et al*., 2004). Supplementation of 10% dried food waste did not show any detrimental effect on growth performance of broiler and egg production of laying hens (Cho *et al*., 2004a, b). However, there is limited information on the effect of multistrain probiotics (MP) on egg production and egg quality in laying hens fed diets containing FWP. Therefore, the objective of the present study was to evaluate the effects of MP supplementation to diets containing FWP on egg production and egg quality.

MATERIALS AND METHODS

Animals and diets: Forty 40-wk-old Lohmann Brown laying hens were used for 3-wk feeding trial. The birds were placed in wired-cages (90 x 90 cm), allotted to 4 dietary treatments with 5 replicates and 2 birds/cage in completely randomized design. Lighting program was 16L:8D and water was provided on an *ad libitum* basis. A MP product was prepared to contain 5 microbial species including *Aspergillus oryzae*, *Bacillus subtilis*, *Saccharomyces cerevisiae*, *Lactobacillus plantarum* and *Rhodopseudomonas capsulate* (Table 1). A basal diet (BD) was formulated to contain 39.7% corn, 6% soybean meal and 40% FWP and the contents of nutrients in the BD was met or exceeded NRC (1994) recommendation (Table 2). Three additional diets were prepared by supplementing 0.1, 0.2, or 0.4% MP to the BD.

Egg productivity and quality: Hen productivity was derived from production records which included egg production (number of eggs/number of hen-housed x 100, %), body weight (BW) change (g/day) and feed intake (g/day). Every 4 days after the beginning of the experiment, 5 eggs/treatment were randomly collected to evaluate egg quality which included eggshell strength, eggshell thickness, yolk color and Haugh units (HU). Eggshell strength was measured using a texture analyzer. To determine eggshell thickness, 3 different parts of eggshell (upper and lower ends and middle) were measured by a micrometer. Yolk color was determined according to the Roche Yolk color fan (Roche Co., Basel, Switzerland; 1, light yellow; 15, orange). Haugh unit was calculated as follows (Card and Nesheim, 1972):

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Haugh units (%): 100 x log (H+7.57-1.7W$^{0.37}$)

where, H is the height of the albumen in millimeters and W is the weight of the egg in grams.

Statistical analysis: Statistical analysis of data was achieved by using the GLM procedure of SAS (SAS Institute Inc., Cary, NC, USA). Two hens in a cage served as the experimental unit. Level of significance was set at 5% and when a significant effect was indicated, treatment means then were separated using Duncan's multiple range test.

RESULTS AND DISCUSSION

The effects of MP supplementation to the BD on productivity of laying hens were presented in Table 3. Layers fed the BD supplemented with 0.4% MP showed the least egg production (75.4%, $p<0.05$) compared with layers fed BD+0 (85.5%) or 0.2% (81.4%) MP, but egg production did not differ between BD+0.4 and 0.1% MP (79.1%) supplementation. Reducing egg production with increasing concentration of supplemented MP in FWP diets was reported by Yang *et al.* (2003), which is partly in agreement with the present study. In analogy, Zhang *et al.* (2012) observed that the addition of heat-inactivated *Lactobacillus salivarius+Bacillus subtilis* significantly increased egg production. Similarly, Kalavathy *et al.* (2005) reported the significant improvements in egg production when 20-wk-old layers were fed diets supplemented with a mixture of probiotics. Inconsistent results between experiments may be due to different bacterial composition of probiotics used as well as age of birds (Zhang *et al.*, 2012). During the overall period, the changes of BW as well as feed intake did not differ among dietary treatments. This is in support with the results reported by Zhang *et al.* (2012) who found no significant changes in feed consumption with the addition of various probiotics.

The egg quality analysis data is shown in Table 4. There was no significant difference in egg weight, egg shell strength and egg shell thickness among the dietary treatments and there results are in agreement with the results reported by Haddadin *et al.* (1996) and Zhang *et al.* (2012). The HU is an indicator of egg protein quality and is based on the height of egg white. In general, there is positive correlation between HU and the quality of albumen (Eisen *et al.*, 1962). In the present study, the BD supplemented with 0.4% MP showed greatest ($p<0.05$) HU compared with other treatments. The consistent result was reported by Zhang *et al.* (2012) who found that birds fed diets supplemented with inactivated *Lactobacillus* or *Bacillus subtilis* showed greater HU compared with control groups. Yang *et al.* (2003) observed the quadratic effect of graded concentration of supplemental probiotics on yolk color.

Table 1: Chemical and microbial composition of mixed probiotics

Items	Composition (%)
Moisture	25
Crude protein	15
Crude fiber	5
Crude ash	10
Microbial species	**Contents (CFU/g)**
Aspergillus oryzae	1.0 x 10^9
Bacillus subtilis	1.0 x 10^9
Saccharomyces cerevisiae	1.0 x 10^9
Lactobacillus plantarum	1.0 x 10^9
Rhodopseudomonas capsulata	1.0 x 10^7

Table 2: Ingredients and chemical composition of experimental diets (as-fed basis)

Ingredients (%)	BD[1]	BD+MP 0.1	BD+MP 0.2	BD+MP0.4
Food-recycled feed	40.0	40.0	40.0	40.0
Corn grain	39.7	39.7	39.7	39.7
Soybean meal	6.0	6.0	6.0	6.0
Wheat bran	6.0	5.9	5.8	5.6
Molasses	0.5	0.5	0.5	0.5
Dicalcium phosphate	0.2	0.2	0.2	0.2
Limestone	4.0	4.0	4.0	4.0
Blood meal	3.0	3.0	3.0	3.0
L-Lysine	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0.2
Mineral mix[2]	0.1	0.1	0.1	0.1
Vitamin mix[3]	0.1	0.1	0.1	0.1
Mixed-Probiotics[4]	0.0	0.1	0.2	0.4
Total	100	100	100	100
Calculated nutrient and energy				
Moisture (%)	10.45			
Crude protein (%)	18.65			
Ether extract (%)	6.21			
Crude fiber (%)	5.17			
Crude Ash (%)	11.85			
Ca (%)	2.73			
Available P (%)	0.64			
TMEn[5] (kcal/kg)	2.798			

[1]BD, corn-soybean meal based diet contained 40% of food waste product
[2]Mineral premix supplied per kilogram of diet: Fe, 40 mg; Zn, 65 mg; Mn, 87 mg; Cu, 66 mg; I, 1.5 mg; Se, 0.1 mg
[3]Vitamin premix supplied per kilogram of diet: vitamin A, 7,269 IU; vitamin D3, 726 IU; vitamin E, 52.8 IU; vitamin K activity, 7.2 mg; menadione, 2,412 μg; vitamin B12, 42.3 μg; riboflavin, 8.4 mg; d-pantothenic acid, 27 mg and niacin, 39 mg
[4]MP, mixed probiotics
[5]TMEn, nitrogen corrected true metabolizable energy

Table 3: Effect of food-recycled feed with various levels of Mixed-Probiotics on productivity of laying hens*

Feed	Egg production (%)	Body weight change (g/bird/day)	Feed intake (g/bird/day)
BD[1]	85.5±2.9[a]	-4.16±5.39	115.7
BD+0.1MP[2]	79.1±2.6[ab]	5.0±3.33	114.1
BD+0.2MP	81.4±4.7[a]	5.0±4.78	114.2
BD+0.4MP	75.4±2.8[b]	2.5±4.85	101.1

*Each least squares mean represents 5 observation
[a-b]Values within a column without a common superscript letter differ ($p<0.05$)
[1]BD, corn-soybean meal based diet contained 40% of food waste product
[2]MP, mixed probiotics

Table 4: Effect of food-recycled feed with various levels of Mixed-Probiotics on egg quality of laying hens*

Feed	Egg weight (g)	Egg shell strength (kg/cm^2)	Egg shell thickness (mm)	Haugh unit (HU)	Yolk color (R.C.F)
BD[1]	56.3±1.4	3.5±0.3	35.2±1.0	52.7±1.4^b	8.8±0.1^a
BD+0.1MP[2]	58.0±1.1	3.4±0.1	35.6±0.7	53.6±1.2^b	8.8±0.1^a
BD+0.2MP	58.8±0.7	3.5±0.1	34.8±0.7	57.0±2.0^{ab}	8.8±0.2^{ab}
BD+0.4MP	56.6±0.8	3.4±0.2	35.0±0.7	60.4±1.5^a	8.4±0.1^b

*Each least squares mean represents 5 observation

$^{a-b}$Values within a column without a common superscript letter differ ($p<0.05$)

[1]BD, corn-soybean meal based diet contained 40% of food waste product

[2]MP, mixed-probiotics

Similarly, Mikulski *et al.* (2012) reported that yolk color was improved when hens were fed diets supplemented with *Pediococcus acidilactici* from 23 to 46 wk. However, there was no significant difference in yolk color among treatments in the present study with the exception of dietary group with 0.4% added MP in which the least Roche color index (8.4, $p<0.05$) was observed compared with other treatments. In conclusion, the present study indicated that the addition of probiotics to diets containing 40% FWP improved the quality of egg albumen but did not affect productivity of laying hens.

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