KKU Res.j. 2015; 20(4) : 419-427
http://resjournal.kku.ac.th

Effects of Supplementing Banana (*Musa* spp.) as Prebiotic, Probiotic (Toyocerin®) and Their Combination on Growth Performance, Carcass and Meat Quality in Broilers

Krittaphak Buranawit and Watchara Laenoi*

Division of Animal Science, School of Agriculture and Natural Resources, University of Phayao Phayao 56000, Thailand
**Correspondent author: krittaphak.bu@gmail.com*

Abstract

The aim of this study was to investigate the effects of dietary supplementing banana as prebiotic on growth performance, carcass characteristics and meat quality of broiler chickens and also to compare them with commercial probiotic and their combination. The experiment was conducted in 200 day-old male chicks. Birds were randomly allocated to 4 treatment groups (50 chicks per treatment). Dietary treatments consisted of basal diet (CON) or the basal diet with 0.5% of banana as prebiotic (PRE), 0.2% of commercial probiotic Toyocerin® (PRO) or 0.7% of their combination (SYN). The results showed that dietary supplementations significantly affected average daily gain and feed conversion ratio of broilers during the period of 0 to 21 days ($p<0.05$). A combination of banana and probiotic (SYN) showed the greatest potential to improve growth performance at the end of this trial. For carcass characteristics, carcass yield, relative weights of viscera and dressing percentage were not different among treatments ($p>0.05$). There were also no significant differences among dietary treatments in meat quality traits, i.e. pH values, drip loss and thawing loss ($p>0.05$). The results suggested that bananas could be used as a feed additive to improve growth performance of broiler chickens during 1- to 21-d of age without adverse effects on carcass and meat quality.

Keywords: *Banana, Broilers, Carcass, Prebiotic, Performance*

1. Introduction

Broiler chicken production is a rapidly developed livestock industry because chicken meat is an important protein source and can be consumed in no limits of religious preferences. Antibiotics have been used not only to treat sick birds, prevent infections, but also promote growth performance. However, the antibiotic residues and side

effects of antibiotics on both animals and consumers have been reported (1). Consequently, many countries concerned and tended to ban using antibiotics as a growth promoter. There are various studies that focused on supplementing non-antibiotic such as probiotic, prebiotic or synbiotic instead, including enhancement of broiler growth performance (2-5) and carcass and meat quality (6-8).

Phytogenic feed additives, originated from plants, herbs, spices or their extracts, were purposed to replace antibiotics (2,9). Banana (*Musa* spp.) is a well-known and widely consumed fruit in tropical and subtropical areas, especially in Thailand. It contains resistant starch that can assist in recovery from infectious diarrhea in humans and animals (10). Also including fructo-oligosaccharide, approximately 0.06 g/100 g of fresh banana sample (11), which beneficially affects animal performance (12). However, there is a limited study that focused on the effects of supplemental banana as prebiotic on growth performance and carcass and meat quality of broiler chickens that may not conclude exactly for further applications. Hence, this study aimed to investigate growth performance and carcass and meat quality characteristics of broilers fed diets supplementing banana as prebiotic and also to compare them with commercial probiotic and their combination.

2. Materials and Methods

2.1 Birds and management

All animals in the present study were cared for in accordance with the guideline of the Department of Livestock Development, Ministry of Agriculture and Cooperative, Thailand. Two hundred 1-d old male Arbor Acres broiler chickens were randomly divided into 4 treatment groups (5 replicates in each group, 10 chicks per replicate). Birds were reared in conventional housing (6×6 m), floor covered with rice husk. The photoperiod was 23L:1D and the thermal conditions depended on the ambient environment with 19.6°C of the average temperature. Birds were fed *ad libitum* with commercial diets (Betagro Public Co., Ltd, Thailand) for starter (0 to 21 days; 23% CP and 3200 kcal ME/kg) and grower (22 to 42 days; 20% CP and 3200 kcal ME/kg) periods with nutrient requirements according to NRC, 1994 (13) and had free access to water throughout the experiment. All birds were vaccinated for Newcastle disease and infectious bronchitis at 14-d of age.

2.2 Preparation and chemical analysis of banana

Unripe (green) bananas were sliced and placed in drying oven (Beschick-ung-Loading Modell 100-800, Memmert) at 75°C for 48 hours. Dried bananas were removed from the oven and ground by grinding machine. A sample of banana was randomly selected for analyzing chemical compositions following AOAC, 2011 (14). As a result, chemical compositions of banana were 91.84% of DM (0.54 kg of fresh unripe banana), 2.49% of CP, 5.14% of CF, 0.37% of EE, 2.28% of ash, and 81.56% of NFE.

2.3 Dietary treatments

Chickens in each group were assigned the following dietary treatments: basal diet as a control (CON), basal diet plus 0.5% of banana as prebiotic (PRE); basal diet plus 0.2% of commercial probiotic Toyocerin® (PRO) and basal diet plus 0.7% synbiotic (mixture of 0.5% banana and 0.2% probiotic, SYN).

2.4 Data collection and traits

Body weight and feed intake (FI) of each bird were recorded every 7 days throughout the experimental period. Average daily gain (ADG) and feed conversion ratio (FCR) were calculated based on those data. At the end of the trial, 5 chickens per treatment randomly sampled were fasted for 12 hours, weighed, slaughtered and dressed by Thai cutting style following Jaturasitha, 2007 (15). The following carcass characteristics were examined: carcass yield; relative weights of viscera; and percent dressing, which calculated as a percentage of the live weight.

For meat quality traits, samples of breast meat were measured pH value at 45-min and 24-h postmortem by pH meter (HI 99163, Hanna Instruments Inc., Hoonsocket, USA) and examined water holding capacity that considered as drip loss and thawing loss, according to the method of Jaturasitha, 2012 (16). Drip loss and thawing loss were calculated as a percentage of the initial weight and frozen weight, respectively.

2.5 Statistical analysis

The data were analyzed following completely randomized design by the ANOVA procedure of SAS program (17). Differences among treatment means were compared using the least significant difference test ($p<0.05$).

3. Results and Discussion

3.1 Growth performance

The growth performance of broilers in each dietary treatment is presented in Table 1. The ADG and FCR of chickens fed diet plus 0.5% of banana were better than control group ($p<0.05$) and also were greater than the other supplemented groups, even if they were not statistically significant, during the first 21 days of growth period. A possible reason for these results partly associated with properties of fructo-oligosaccharide in banana that could improve health status of the broiler chickens' gastrointestinal tract by increasing the number of *Bifidobacteria* and *Lactobacilli* and decreasing *E. coli* in the caecum and small intestine (18). The current findings were supported by several previous studies which reported that dietary inclusion of prebiotic significantly improved performance in the starter period (2,19-20). On the contrary, some publications revealed that no beneficial effect of prebiotic supplementation on broiler growth performance (6,21-22). The conflicts among the studies might be related to ingredient and dose of prebiotic used in each trial were different. However, our reported values of growth performance were low because the broilers were reared in the conventional housing, the thermal condition varied as the ambient environment, which could affect the worse performances than the EVAP housing. Considering the cost of production per chick, the significant difference was not observed between the treatments for all periods ($p>0.05$). Although, the results from this study showed that no significant differences in ADG, FI and FCR among dietary treatments ($p>0.05$) during the entire experimental period, supplementation of synbiotic trended to be the prominent additive that could promote the growth performance of chickens when compared to other groups. Due to the synergistic effect that the prebiotic possibly will promote the growth, colonization or activity of the

probiotic microorganisms in the gut (23). During the entire trial, mortality was very low with an average below 0.1% and did not depend on dietary variables (data not shown).

Table 1. The effects of supplemental diets on growth performance of broiler chickens

Trait[1]	Treatment[2]				SEM	p-value
	CON	PRE	PRO	SYN		
ADG (g)						
0 to 21 days	21.80 [b]	24.13 [a]	22.74 [ab]	23.03 [ab]	0.289	0.038
22 to 42 days	60.93	61.60	60.33	64.09	0.557	0.083
0 to 42 days	41.37	42.87	41.54	43.56	0.404	0.162
FI (g)						
0 to 21 days	816.88	807.81	813.92	804.78	10.797	0.979
22 to 42 days	2472.58	2473.40	2478.45	2483.80	20.746	0.997
0 to 42 days	3283.96	3280.15	3287.48	3287.04	30.479	0.100
FCR						
0 to 21 days	1.78 [a]	1.59 [b]	1.70 [ab]	1.66 [ab]	0.021	0.015
22 to 42 days	1.93	1.91	1.95	1.84	0.017	0.107
0 to 42 days	1.89	1.82	1.88	1.80	0.017	0.155
CPR (baht/head)						
0 to 21 days	27.43	27.42	27.88	27.86	0.169	0.642
22 to 42 days	52.63	53.04	54.21	54.69	0.336	0.100
0 to 42 days	64.98	65.44	67.01	67.52	0.488	0.198

[a, b] Different superscripts within each row are significantly different ($p<0.05$)

[1] ADG = average daily gain; FI = feed intake; FCR = feed conversion ratio; CPR = cost of production

[2] CON = basal diet (control); PRE = basal diet plus 0.5% of banana as prebiotic; PRO = basal diet plus 0.2% of commercial probiotic Toyocerin®; SYN = basal diet plus 0.7% of synbiotic

3.2 Carcass characteristics

The effects of dietary treatments on broiler carcass characteristics are demonstrated in Table 2. Supplementation of 0.5% of banana as prebiotic, 0.2% of probiotic Toyocerin® or 0.7% of combination of them to the diet did not significantly affect carcass yield ($p>0.05$). The current results are in agreement with several authors who reported that carcass yield of birds fed diet supplemented prebiotic, probiotic or synbiotic did not differ from their control group (5,20-21,23-24). However, some studies revealed the various effects of dietary supplementation on broiler carcass yield. Supplementation of synbiotic Biomin IMBO (25) or probiotic GalliPro, prebiotic Immonowall and synbiotic (6) could

increase carcass percentage of Ross 308 broiler chickens, whereas supplementation of commercial synbiotic Duolac affected lower carcass yield compared with the control group (26). These conflict findings might be explained by strain, amount and survivability of live microorganisms in probiotic, ingredients and dose of prebiotic and synergism of them.

In the current study, the relative weight of gizzard ranged from 1.93 to 2.28% that corresponded to the published ranges, i.e. 1.57 to 1.88% (19) and 2.24 to 2.30% (25), whereas some reported values were slightly low, ranging from 0.95 to 1.02%, (7) that might be due to their birds were slaughtered at a younger (28 days) than our trial. However, the relative weights of gizzard, liver, heart and intestines in this study did not show statistical significance among the treatment groups ($p>0.05$) which is consistent with other authors who indicated that supplemental feed additives did not lead to the differences of any viscera (23,25,27).

The means of the relative weight of breast in this study were similar to some reports (7,19). The statistical significances of the relative weights of breast and thigh were not found between treatments ($p>0.05$) that are in agreement with several studies (6,28-30). Also, no difference was observed in the percent wing among groups ($p>0.05$). Nevertheless, there are various results about using feed additives for enhancing carcass traits in chickens (3,5,9,24). These contraries might be caused by the differences of feed additives, dosages, dietary ingredients, farm management, including genetic background of chickens.

Table 2. The effects of supplemental diets on carcass characteristics of broiler chickens

Trait	Treatment[1]				SEM	p-value
	CON	PRE	PRO	SYN		
Carcass yield (%)	74.14	74.46	74.03	75.42	0.278	0.288
Viscera (%)						
Gizzard	1.93	2.28	2.05	1.98	0.058	0.136
Liver	3.37	3.14	3.36	3.26	0.049	0.333
Heart	0.57	0.68	0.74	0.57	0.029	0.099
Intestines	6.23	5.66	5.71	5.44	0.236	0.717
Dressing (%)						
Breast	18.38	17.60	18.60	18.69	0.284	0.548
Thigh	10.65	10.84	10.53	10.83	0.129	0.829
Wing	7.59	7.69	7.64	7.43	0.073	0.649
Drumstick	9.24	9.88	9.65	8.57	0.238	0.228
Shank	3.78	4.33	3.81	3.66	0.108	0.112

[1] CON = basal diet (control); PRE = basal diet plus 0.5% of banana as prebiotic; PRO = basal diet plus 0.2% of commercial probiotic Toyocerin®; SYN = basal diet plus 0.7% of synbiotic

3.3 Meat quality

The evaluation of pH value, water holding capacity and chemical composition of meat was summarized in Table 3. The meat pH at 45-min and 24-h postmortem ranged from 6.13 to 6.43 and 5.69 to 5.91, respectively, and no significant differences were observed for those values ($p>0.05$). There were published pH values at 45-min postmortem of Thai native chickens and imported extensive breeds (31) that were lower compared to the present trial. Whereas, the other investigation showed the slightly higher values than our study and a statistically significant difference among treatments (26). However, the pH at 24-h postmortem found in this study was in correspondence with previous ranges (19,26,31).

In the present study, the water holding capacity considered as drip loss and thawing loss of breast meat. The averages were 11.98% for drip loss and 1.68% for thawing loss. As shown in Table 3, broiler meat from each group was not significantly different in drip loss and thawing loss ($p>0.05$). Similarly, many researchers found that dietary supplementation did not affect drip loss (29-30,32) and thawing loss (28,32). Conversely, supplementation of probiotic, *Bacillus coagulans*, did not cause the significant difference of drip loss in Guangxi Yellow chicken meat (8) that might be related to breed of chicken, strain and level of live bacteria in probiotic, and experimental period that longer (90 days) than this study.

Table 3. The effects of supplemental diets on meat quality of broiler chickens

Trait	Treatment[2]				SEM	p-value
	CON	PRE	PRO	SYN		
pH value[1]						
pH0	6.13	6.43	6.13	6.26	0.055	0.165
pH24	5.91	5.82	5.75	5.69	0.057	0.629
Water holding capacity (%)						
Drip loss	12.16	12.22	11.61	11.94	0.246	0.840
Thawing loss	1.50	1.93	1.58	1.72	0.129	0.705

[1] pH0 and pH24 = pH at 45-min and 24-h postmortem, respectively
[2] CON = basal diet (control); PRE = basal diet plus 0.5% of banana as prebiotic; PRO = basal diet plus 0.2% of commercial probiotic Toyocerin®; SYN = basal diet plus 0.7% of synbiotic

4. Conclusions

Supplementation of 0.5% banana as prebiotic could promote ADG and FCR during the grower period of broilers, whereas the dietary inclusion of a combination of banana and probiotic tended to be a proper feed additive for improving the growth performance during the entire period. The diet supplemented with banana as prebiotic, probiotic or their combination did not affect

broiler carcass characteristics and meat quality. The results stated that bananas could be used as a feed additive to increase ADG and FCR of broilers during the first 21-d of growth period without negative effects on carcass characteristics and meat quality, however, no beneficial effect for all traits during the entire period. These investigations justify further detailed studies on the larger number of chickens and the above-mentioned additives in diverse dosages to achieve more exact conclusions.

5. Acknowledgement

This study received the probiotic support from Octa Memorial Co., Ltd., Thailand. The authors would like to thank undergraduate students and involved staffs for their help during the research.

6. References

(1) Boerlin P, Reid-Smith RJ. Antimicrobial resistance: its emergence and transmission. Anim Health Res Rev. 2008;9: 115-26.

(2) Ghasemi HA, Kasani N, Taherpour K. Effects of black cumin seed (*Nigella sativa* L.), a probiotic, a prebiotic and a synbiotic on growth performance, immune response and blood characteristics of male broilers. Livest Sci. 2014;164: 128-34.

(3) Khaksar V, Golian A, Kermanshahi H, Movasseghiand AR, Jamshidi A. Effect of prebiotic Fermacto® on gut development and performance of broiler chickens fed diet low in digestible amino acids. J Anim Vet Adv. 2008;7(3): 251-7.

(4) Mountzouris KC, Tsitrsikos P, Palamidi I, Arvaniti A, Mohnl M. Effects of probiotic inclusion levels in broiler nutrition on growth performance, nutrient digestibility, plasma immunoglobulins, and cecal microflora composition. Poult Sci. 2010;89: 58-67.

(5) Navidshad B, Adibmoradi M, Pirsaraei ZA. Effects of dietary supplementation of *Aspergillus* originated prebiotic (Fermacto) on performance and small intestinal morphology of broiler chickens fed diluted diets. Ital J Anim Sci. 2010;9(12): 55-60.

(6) Mokhtari R, Yazdani AR, Rezaei M, Ghorbani B. The effects of different growth promoters on performance and carcass characteristics of broiler chickens. J Anim Vet Adv. 2010;9(20): 2633-9.

(7) Park JH, Kim IH. Supplemental effect of probiotic *Bacillus subtilis* B2A on productivity, organ weight, intestinal *Salmonella* microflora, and breast meat quality of growing broiler chicks. Poult Sci. 2014;93: 2054-9.

(8) Zhou X, Wang Y, Gu Q, Li W. Effect of dietary probiotic, *Bacillus coagulans*, on growth performance, chemical composition, and meat quality of Guangxi Yellow chicken. Poult Sci. 2010;89: 588-93.

(9) Nasir Z, Grashorn MA. Effects of *Echinacea purpurea* and *Nigella sativa* supplementation on broiler performance, carcass and meat quality. J Anim Feed Sci. 2010;19: 94-104.

(10) Topping DL, Fukushima M, Bird AR. Resistant starch as a prebiotic and synbiotic: state of the art. Proc Nutr Soc. 2003;62: 171-6.

(11) Judprasong K, Tanjor S, Puwastien P, Sungpuag P. Investigation of Thai plants for potential sources of inulin-type fructans. J Food Compos Anal. 2011;24: 642-9.

(12) Tartrakoon W, Wuthijari K. Performances of weaner pigs fed diets containing the mixture of prebiotic prepared from banana starch, essential oil, and organic acid. Thai J Anim Sci. 2014;1(Suppl 1): 49-52. Thai.

(13) NRC. Nutrient requirement of poultry. 9th ed. Washington, DC: The National Academies Press; 1994.

(14) AOAC. Official methods of analysis of AOAC International. 18th ed. Gaithersburg (MD): AOAC International; 2011.

(15) Jaturasitha S. Meat management. 4th ed. Chiang Mai: Ming Muang; 2007. Thai.

(16) Jaturasitha S. Meat technology. 4th ed. Chiang Mai: Ming Muang; 2012. Thai.

(17) SAS Institute Inc. SAS/STAT® 9.1 user's guide. Cary (NC): SAS Institute Inc.; 2004.

(18) Hajati H, Rezaei M. The application of prebiotics in poultry production. Int J Poult Sci. 2010;9(3): 298-304.

(19) Ashayerizadeh A, Dabiri N, Mirzadeh Kh, Ghorbani MR. Effects of dietary inclusion of several biological feed additives on growth response of broiler chickens. J Cell Anim Biol. 2011;5(4): 61-5.

(20) Bozkurt M, Küçükyilmaz K, Çath AU, Çinar M. The effect of single or combined dietary supplementation of prebiotics, organic acid and probiotics on performance and slaughter characteristics of broilers. S Afr J Anim Sci. 2009;39(3): 197-205.

(21) Aristides LGA, Paião FG, Murate LS. The Effects of biotic additives on growth performance and meat qualities in broiler chickens. Int J Poult Sci. 2012;11(9): 599-604.

(22) Sohail MU, Hume ME, Byrd JA, Nisbet DJ, Ijaz A, Sohail A. Effect of supplementation of prebiotic mannan-oligosaccharides and probiotic mixture on growth performance of broilers subjected to chronic heat stress. Poult Sci. 2012;91: 2235-40.

(23) Endoğen Z, Endoğen S, Aslantaş Ö, Çelik S. Effects of dietary supplementation of synbiotics and phytobiotics on performance, caecal coliform population and some oxidant/antioxidant parameters of broilers. J Anim Physiol Anim Nutr. 2010;94: e40-8.

(24) Ashayerizadeh A, Dabiri N, Ashayerizadeh O, Mirzadeh KH. Effect of dietary antibiotic, probiotic and prebiotic as growth promoters, on growth performance, carcass characteristics and hematological indices of broiler chickens. Pak J Biol Sci. 2009;12(1): 52-7.

(25) Awad WA, Ghareeb K, Abdel-Raheem S, Böhm J. Effects of dietary inclusion of probiotic and synbiotic on growth performance, organ weights, and intestinal histomorphology of broiler chickens. Poult Sci. 2009;88: 49-55.

(26) Maiorano G, Sobolewska A, Cianciullo D, Walasik K, Elminowska-Wenda G, Sławińska A, et al. Influence of in ovo prebiotic and synbiotic administration on meat quality of broiler chickens. Poult Sci. 2012;91: 2963-9.

(27) Zhang ZF, Zhou TX, Ao X, Kim IH. Effects of β-glucan and *Bacillus subtilis* on growth performance, blood profiles, relative organ weight and meat quality in broilers fed maize–soybean meal based diets. Livest Sci. 2012;150: 419-24.

(28) Nopparatmaitree M , Lertchunhakiat K, Sri-onlerd J, Kitpipit W. Effects of probiotics (Bactosac®) supplementation in drinking water on apparent nutrient digestibility, intestinal histomorphology, carcass percentage and meat quality of broiler chickens. Khon Kaen Agr J. 2014;42(2): 221-30. Thai.

(29) Phonsaen K, Uriyapongson S, Tangkawattana P, Wanangkarn A. Effect of betaine supplementation on growth performance, carcass and meat quality of broilers. Khon Kaen Agr J. 2012;40(Suppl 2): 458-62. Thai.

(30) Raksasiri BV, Petum A, Paengkoum S, Poonsuk K, Thitisak P, Paengkoum P. Effects of jerusalem artichocke, curcuma white and sago palm supplementation in broiler diet on production performance, carcass quality and meat quality. Khon Kaen Agr J. 2015;43(Suppl 1): 202-7. Thai.

(31) Jaturasitha S, Srikanchai T, Kreuzer M, Wicke M. Differences in carcass and meat characteristics between chicken indigenous to Northern Thailand (black-boned and Thai native) and imported extensive breeds (Bresse and Rhode Island Red). Poult Sci. 2008;87: 160-9.

(32) Yang X, Zhang B, Guo Y, Jiao P, Long F. Effects of dietary lipids and Clostridium butyricum on fat deposition and meat quality of broiler chickens. Poult Sci. 2010;89: 254-60.