Effect of inclusion of lysolecithin or multi-enzyme in low energy diet of broiler chickens

Mohsen Mohammadigheisar, Hyun Soo Kim and In Ho Kim

Department of Animal Resource and Science, Dankook University, Cheonan, South Korea

ABSTRACT
A total of 672 one-d-old Ross 308 (mixed gender) broiler chicks with an average initial body weight of 34.1 ± 0.2 g were used in a 28-d feeding trial to investigate the effect of supplementing low energy diets with an emulsifier or multi-enzyme complex on broiler. Chickens were allocated to one of six treatments with seven pens/treatment and 16 birds/pen. Treatments were (1) PC (basal diet), (2) NC (PC-100 kcal ME/kg), (3) L05 (NC + 0.05% emulsifier), (4) L10 (NC + 0.10% emulsifier), (5) E05 (NC + 0.05% multi-enzyme), and (6) E10 (NC + 0.10% multi-enzyme). Results showed that supplementing low energy diet with 0.10% multi-enzyme or 0.10% emulsifier improved (P < .05) overall body weight gain. The relative weight of breast meat decreased (P < .05) by adding 0.10% multi-enzyme compared to chickens fed E05 diet. Feeding the chickens with E10 diet increased relative weight of abdominal fat. Chickens fed NC or L10 diets had the lowest (P < .05) relative weight of liver. The addition of emulsifier or multi-enzyme to the diets decreased drip loss (P < .05). Results indicated that supplementing low energy diet with multi-enzyme or emulsifier improved growth performance and alleviated negative effects of lowering dietary ME level on meat quality of broilers.

1. Introduction
Due to lack of endogenous non-starch polysaccharide degrading enzymes (NSPases) in poultry (Ward and Fodge 1996), some components of feedstuffs such as β-mannan, which is found in soybean meal (Hsiao et al. 2006), are considered as anti-nutritional factors (ANFs). To mitigate the negative effects of such ANF, results of previously conducted studies have shown that the supplementation of broiler feeds with multi-enzyme preparations resulted in improved body weight gain (BWG) and feed efficiency (Lee et al. 2003; Daskiran et al. 2004; Zou et al. 2006). Improving the digestibility of feedstuff by using NSPases has been shown to be positively effective, but in addition to the lack of NSP degrading enzymes, young chickens cannot digest lipids properly. Some studies have investigated different alternatives for improving fat digestibility and ME content of broiler diets containing oil and oilseeds (Meng et al. 2006; Slominski et al. 2007; Jia et al. 2008). Energy is the major dietary component responsible for differential utilization of nutrients and results in different rates of growth of animals (Cho and Kim 2013). Manilla et al. (1999) reported that carcass fatty acid composition was affected by diet fatty acid content, and the effect of dietary fat on the composition of breast meat was less pronounced than that for abdominal fat (Sanz et al. 1999).

The low level of lipolytic enzyme production in the young broiler (Krogdahl 1985) or piglet (Cera et al. 1988, 1989; Jensen et al. 1997) and the adaptation of their gastrointestinal system to the physicochemical properties of the feed can limit fat digestion considerably. Since fat is insoluble in water, it should first be emulsified before it can be digested by lipolytic enzymes (Gu and Li 2003). Therefore, it is hypothesized that supplementing diet of broiler with an emulsifier can increase the solubilization of fats and consequently maximize the effect of lipolytic enzymes on fat digestibility in broiler chickens. This study was conducted to investigate the effect of supplementing low energy diets of broilers with a multi-enzyme preparation and an emulsifier on growth performance, meat quality, relative organ weights, and blood characteristics.

2. Materials and methods
2.1. Animals, diets, and facility
The experimental protocol and procedures used in this study were approved by the Animal Care and Use Committee of Dankook University, Cheonan, South Korea. A total of 672 1-d-old Ross 308 (mixed gender) broiler chickens with an average initial body weight of 34.1 ± 0.21 g were used in a 28-d feeding trial. Broilers were allocated to 1 of 6 treatments and each treatment consisted of 7 replicates and 16 birds per replicate. Dietary treatments were (1) a positive control (PC; containing 3050 and 3200 kcal/kg ME in phases 1 and 2, respectively) diet, (2) a negative control diet (NC, 100 kcal/kg ME less than PC), (3) NC + 0.05% emulsifier (L05), (4) NC + 0.10% emulsifier (L10), (5) NC + 0.05% multi-enzyme (E05), and (6) NC + 0.10% multi-enzyme (E10). Broilers were housed in high raised battery cages in an environmentally controlled room (32–24°C and 65% humidity) and allowed free access to feed and water throughout the experimental period. All diets were formulated
Table 1. Ingredients and calculated chemical composition of diets, (%).

| Item                  | Phase 1 (1–2 wk) | Phase 2 (3–4 wk) | Phase 3 (5–8 wk) |
|-----------------------|------------------|------------------|------------------|
|                       | NC               | PC               | NC               |
| **Ingredients (%)**   |                  |                  |                  |
| Corn                  | 59.75            | 56.95            | 60.37            | 60.44            |
| Soybean meal          | 28.9             | 29.25            | 30.80            | 25.33            |
| Corn gluten meal      | 4.38             | 4.44             | 4.00             | 3.83             |
| Tallow                | 1.23             | 3.61             | 3.90             | 5.00             |
| Limestone             | 0.01             | 0.91             | 1.00             | 1.02             |
| Dicalcium phosphate   | 2.07             | 2.07             | 1.89             | 1.93             |
| Sodium chloride       | 0.31             | 0.32             | 0.37             | 0.37             |
| DL-methionine, 99%    | 0.33             | 0.33             | 0.41             | 0.37             |
| Lysine-HCl, 24%       | 1.68             | 1.68             | 0.85             | 1.28             |
| Threonine, 98.5%      | 0.18             | 0.18             | 0.16             | 0.18             |
| Vitamin premix        | 0.06             | 0.06             | 0.05             | 0.05             |
| Trace mineral premix   | 0.10             | 0.10             | 0.10             | 0.10             |
| Choline, 50%          | 0.10             | 0.10             | 0.10             | 0.10             |
| **Calculated values** |                  |                  |                  |
| AME, kcal/kg          | 2950             | 3050             | 3100             | 3200             |
| CP, %                 | 21.00            | 21.00            | 19.00            | 19.00            |
| Total Lys, %          | 1.40             | 1.40             | 1.20             | 1.20             |
| Ca, %                 | 0.00             | 0.00             | 0.90             | 0.90             |
| Total P, %            | 0.71             | 0.71             | 0.66             | 0.66             |

*Provided per kilogram of diet: 15,000 IU of vitamin A, 3750 IU of vitamin D₃, 37.5 mg of vitamin E, 2.55 mg of vitamin K₃, 3 mg of niacin, 1.5 mg of folic acid, 0.2 mg of biotin, and 13.5 mg of pantothenic acid.

Table 2. Effect of dietary emulsifier and multi-enzyme supplementation on growth performance in broiler chickens.

| Items            | PC  | NC  | L05  | L10  | E05  | E10  | SE  |
|------------------|-----|-----|------|------|------|------|-----|
| **Days 0–7**     |     |     |      |      |      |      |     |
| BWG, g/bird      | 127 | 133 | 130  | 132  | 131  | 131  | 3   |
| FI, g/bird       | 165 | 162 | 157  | 162  | 161  | 166  | 5   |
| FCR              | 1.30| 1.22| 1.21 | 1.23 | 1.22 | 1.27 | 0.1 |
| **Days 7–21**    |     |     |      |      |      |      |     |
| BWG, g/bird      | 641 | 638 | 642  | 667  | 644  | 672  | 15  |
| FI, g/bird       | 890 | 965 | 868  | 894  | 845  | 903  | 27  |
| FCR              | 1.39| 1.36| 1.35 | 1.34 | 1.31 | 1.34 | 0.1 |
| **Days 21–28**   |     |     |      |      |      |      |     |
| BWG, g/bird      | 649 | 587 | 646  | 655  | 653  | 644  | 22  |
| FI, g/bird       | 1045| 935 | 1051 | 957  | 1091 | 1030 | 65  |
| FCR              | 1.61| 1.59| 1.63 | 1.46 | 1.67 | 1.60 | 0.2 |
| **Days 0–28**    |     |     |      |      |      |      |     |
| BWG, g/bird      | 1417⁠*⁠| 1358⁠*⁠| 1419⁠*⁠| 1454⁠*⁠| 1429⁠*⁠| 1446⁠*⁠| 23  |
| FI, g/bird       | 2102| 1983| 2065 | 2022 | 2102 | 2101 | 74  |
| FCR              | 1.48| 1.46| 1.45 | 1.39 | 1.47 | 1.45 | 0.2 |

*Abbreviation: (1) PC (basal diet), (2) NC (PC – 100 kcal ME/kg), (3) L05 (NC + 0.05% emulsifier), (4) L10 (NC + 0.10% emulsifier), (5) E05 (NC + 0.05% multi-enzyme), and (6) E10 (NC + 0.10% multi-enzyme). BWG: body weight gain, FI: feed intake, FCR: feed conversion ratio.

2.3. Statistical analysis

Data were analysed by ANOVA using the general linear model procedure of SAS (SAS Institute 1996) for a completely randomized design. Differences among treatments were separated by Duncan’s multiple range tests (Duncan 1955). Mean values and standard errors (SEs) are reported. Probability values of less than .05 were considered significant.

3. Results and discussion

There was no treatment effect on FI and FCR, but the addition of 0.10% emulsifier or 0.10% multi-enzyme to the diets alleviated the negative effects of lowering dietary energy level (P < .05) on BWG. Suplementing the NC diet with 0.05% (L05) emulsifier and 0.05% multi-enzyme (E05) improved BWG (P > .05).
However, adding the emulsifier or multi-enzyme at 0.10% (i.e. diets L10 and E10) improved (<.05; Table 2) BWG.

Previous studies (Jackson et al. 2004; Zou et al. 2006; Kong et al. 2011) demonstrated that supplementing the diet of broilers with NSP degrading enzymes improves BWG in broilers, and therefore the results of current study are in agreement with these findings. Kong et al. (2011) reported that feeding broilers with a diet supplemented with NSP degrading enzyme lead to an improvement in apparent ileal digestibility of dry matter that explains the reason of improving BWG in the birds fed the diets supplemented with a multi-enzyme. However, the results of the current study contradict the data reported by Mussini et al. (2011) showing no effect of multi-enzyme supplementation on broiler growth performance. Results of a study conducted by Cho et al. (2012) showed that feeding broiler chickens with a low energy diet depressed growth performance and that these effects were ameliorated by supplementing the diet with an emulsifier to the extent that growth performance was similar with that of chickens fed high energy diets. Previous researchers (Sudipto and Ghosh, 2010) reported that reducing the level of dietary energy and supplementing the diets with NSP degrading enzyme improves ileal digestibility of dry matter that explains the reason of improving BWG in the birds fed the diets supplemented with NSP degrading enzyme and multi-enzyme at 0.10% (i.e. diets L10 and E10) improved (<.05; Table 2) BWG.

The data presented in Table 3 show that supplementing the low energy diet with different levels of emulsifier or multi-enzyme affected body organs differently. Chickens fed the PC diet and diets L05 and E05 had higher (<.05) relative breast meat weight compare to those fed the NC, L10, and E10 diets. The addition of 0.10% multi-enzyme to the low energy diet increased the percentage of abdominal fat remarkably (<.05; Table 3).

The findings of current study showed that feeding chickens with low energy diets will result in dramatic reduction in relative weight of breast meat, which is inconsistent with findings of other researchers (Barbour et al. 2006; Cho and Kim 2013). But the addition of emulsifier and/or multi-enzyme to low energy diets can improve energy utilization and alleviate the negative effects of feeding low energy diets.

The results presented in Table 4 showed that the percentage of drip loss was significantly increased (<.05) in birds fed NC diet compare to the PC, L05, L10, and E05 diets on day 1. On days 3 and 5, the percentage of drip loss in the NC was higher (<.05) than in the PC and E05 groups. In a study with pigs, Wang et al. (2009) had a similar experience. They supplemented low energy levels diets with an enzyme and reported that feeding pigs with supplemented diets did not lead to any significant effects on the percentage of drip loss, which is in contrast with the findings of current study. The results of current study showed that lightness of the breast meat was affected by dietary treatments and NC had the higher lightness (<.05). Redness and yellowness were not affected by dietary treatment which is not consistent with the results of current study. The meat was significantly more red (<.05) in birds fed NC diet compare to the PC, L05, L10, and E05 groups. In a study with pigs, Wang et al. (2009) had a similar experience. They supplemented low energy levels diets with an enzyme and reported that feeding pigs with supplemented diets did not lead to any significant effects on the percentage of drip loss, which is in contrast with the findings of current study.
results of Cho and Kim (2013) showing that feeding chickens with low energy diets resulted in a higher lightness value. However, the addition of a multi-enzyme to low energy diets reduced the lightness value which is in agreement with the findings of the current study. Similar to the results of Wang et al. (2009), dietary treatments had no effect on pH of breast meat.

There were no significant effects of diets on blood cells (Table 5); however, WBC and RBC counts in the NC treatment were lower than other experimental treatments (P > .05). In agreement with the findings of the current study, previous studies (Ao et al. 2010; Cho et al. 2012) also reported that WBC and RBC counts were not influenced by the addition of dietary emulsifier or multi-enzyme.

4. Conclusion

In conclusion, the results of this study showed that feeding broiler chickens with low energy diets resulted in a depression in their performance but supplementing low energy diets with an emulsifier or multi-enzyme alleviated the negative effects of feeding low energy diets and improved performance of broiler chickens without any negative effects on health status and meat quality of chickens. It is also concluded that lowering nutrients level (ME in current study) and the addition of enzymes or emulsifiers could be helpful in reducing the risk of environmental pollution and increasing profitability of animal agriculture.

Acknowledgements

This present research was conducted by the research fund of Dankook University.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Ao X, Meng QW, Yan L, Kim HJ, Hong SM, Cho JH, Kim IH. 2010. Effects of non-starch polysaccharide-degrading enzymes on nutrient digestibility, growth performance and blood profiles of growing pigs fed a diet based on corn and soybean meal. Asian Australas J Anim Sci. 23:1632–1638.

Barbour GW, Farran MT, Usayran NN, Darwish AH, Uwayjan MG, Ashkarian VM. 2006. Effect of soybean oil supplementation to low metabolizable energy diets on production parameters of broiler chickens. J Appl Poult Res. 15:190–197.

Cera KR, Mahan DC, Reinhart GA. 1988. Weekly digestibilities of diets supplemented with corn oil, lard or tallow by weanling swine. J Anim Sci. 66:1430–1437.

Cera KR, Mahan DC, Reinhart GA. 1989. Apparent fat digestibilities and performance responses of post-weaning swine fed diets supplemented with coconut oil, corn oil or tallow. J Anim Sci. 67:2040–2047.

Cho JH, Kim IH. 2013. Effects of beta-mannanase supplementation in combination with low and high energy dense diets for growing and finishing broilers. Livestock Sci. 154:137–143.

Cho JH, Zhao PY, Kim IH. 2012. Effects of emulsifier and multi-enzyme in different energy density diet on growth performance, blood profiles, and relative organ weight in broiler chickens. J Agri Sci. 4:161–168.

Daskiran M, Teeter RG, Fodge D, Hsiao HY. 2004. An evaluation of endo-β-D-mannanase (Hemicell) effects on broiler performance and energy use in diets varying in β-mannan content. Poult Sci. 83:662–668.

Duncan DB. 1955. Multiple range and multiple F test. Biometrics. 11:1–42.

Gy X, Li D. 2003. Fat nutrition and metabolism in piglets: a review. Anim Feed Sci Technol. 109:151–170.

Honikel KO. 1998. Reference methods for the assessment of physical characteristics of meat. Meatsci. 49:447–457.

Hsiao HY, Anderson DM, Dale NM. 2006. Levels of β-mannan in soybean meal. Poult Sci. 85:1430–1432.

Jackson ME, Geronian K, Knox A, McNab J, McCartney E. 2004. A dose-response study with the feed enzyme β-mannanase in broilers provided with corn-soybean meal based diets in the absence of antibiotic growth promoters. Poult Sci. 83:1992–1996.

Jensen MS, Jensen SK, Jakobsen K. 1997. Development of digestive enzymes in pigs with emphasis on lipolytic activity in the stomach and pancreas. J Anim Sci. 75:437–445.

Jia W, Slominski BA, Guenter W, Humphreys A, Jones O. 2008. The effect of enzyme supplementation on egg production parameters and omega-3 fatty acids deposition in laying hens fed fluaxseed and canola oil. Poult Sci. 87:2005–2014.

Jones DB, Hancock JD, Harman DL, Walker CE. 1992. Effects of exogenous emulsifiers and fat sources on nutrient digestibility, serum lipids, and growth performance in weanling pigs. J Anim Sci. 70:3473–3482.

Kong C, Lee HJ, Adeola O. 2011. Supplementation of β-mannanase to starter and grower diets for broilers. Can J Anim Sci. 91:389–397.

Kroghdahl A. 1985. Digestion and absorption of lipids in poultry. J Nutr. 115:675–685.

Lee JT, Bailey CA, Cartwright AL. 2003. β-Mannanase ameliorates viscosity-associated depression of growth in broiler chickens fed guar gum and hull fractions. Poult Sci. 82:1925–1931.

Manilla H, Husveth AF, Nemeth K. 1999. Effects of dietary fat origin on the performance of broiler chickens and composition of selected tissues. Acta Agriaria Kaposváriensis. 3:47–57.

Meng X, Slominski B, Campbell L, Guenter W, Jones O. 2006. The use of enzyme technology for improved energy utilization from full-fat oilseeds. Poult Sci. 85:1430–1432.

Mussini FJ, Coto CA, Goodgame SD, Lu C, Karimi AJ, Lee JH, Waldroup PW. 2011. Effect of β-mannanase on broiler performance and Dry matter output using corn-soybean meal based diets. International Journal of Poult Sci. 10:778–781.

NRC. 1994. Nutrient requirements of poultry. 9th rev. ed. Washington, DC: National Academic Press.

Roy A, Haldar S, Mondal S, Ghosh TK. 2010. Effects of Supplemental Exogenous Emulsifier on Performance, Nutrient Metabolism, and Serum Lipid Profile in Broiler Chickens. Veterinary Medicine International. doi:10.4061/2010/262604.

Sanz M, Flores A, Lopez-bote CJ. 1999. Effect of fatty acid saturation in broiler diets on abdominal fat and breast muscle fatty acid composition and susceptibility to lipid oxidation. Poult Sci. 78:378–382.

SAS. 1996. SAS user’s guide. release 6.12 editions. Cary, NC, USA: SAS Institute. Inc. Cary CON.

Slominski BA, Davie T, Nyachoti MC, Jones O. 2007. Heat stability of endogenous and microbial phytase during feed pelleting. Livestock Sci. 109:244–246.

Wang JP, Hong SM, Yan L, Yoo JS, Lee JH, Jang H D, Kim HJ, Kim IH. 2009. Effects of single or carbohydrates cocktail in low-nutrient-density diets on growth performance, nutrient digestibility, blood characteristics, and carcass traits in growing-finishing pigs. Livestock Sci. 126:215–220.

Ward NE, Fodge DE. 1996. Ingredients to counter anti-nutritional factors: soybean-based feeds need enzymes too. Feed Manage. 47:13–18.

Zou XT, Qiao XJ, Xu ZR. 2006. Effect of β-mannanase (Hemicell) on growth performance and immunity of broilers. Poult Sci. 85:2176–2179.