Egg production in laying hens receiving different forms of red ginseng and fermented red koji blend

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ABSTRACT

The aim of this study was to evaluate egg production in 40-week-old Hyline brown laying hens fed different forms of red ginseng marc (RGM) and fermented red koji (FRK) blend for 8 weeks. Two hundred and forty laying hens were distributed into four treatments (control, 1% RGM powder mixed with FRK, pelleted 1% RGM with FRK and coated pellets of 1% RGM with FRK) with six replicates of ten birds each in a completely randomized design. Improvement in egg production was done by measuring hen-day egg production (HDP), egg weight (EW), feed intake (FI), feed conversion ratio (FCR), egg mass (EM) and Haugh unit (HU). There were significant differences (P<0.05) among all treatments for HDP and FCR after 8 weeks, for EW and EM after 6 and 8 weeks and for FI and HU from 4 weeks onward until 8 weeks of the experimental period. It was concluded that feeding coated pellet diet of 1% RGM with FRK to laying hens of 40 weeks of age improves their egg production (HDP, FCR, EM and HU) at the end of the laying period.

Key words: Egg production, Fermented red koji, Haugh unit, Red ginseng marc.

INTRODUCTION

Red ginseng marc occurs as a byproduct of red ginseng extract. Recent studies have shown the use of red ginseng marc as a potential bioactive and immune-stimulant additive to animal feed because of the presence of saponins (ginsenoside) in the final product (Lim *et al*., 2004; Kang *et al*., 2016). Dietary supplementation of red ginseng extracts may improve egg production in laying hens (Yildirim *et al*., 2013). Jang *et al*. (2007) reported that supple mentation of laying hen diets with 2.5% and 5% fermented wild-ginseng culture byproduct had no adverse effect on egg production and quality.

Red koji has been used as a fermentation source, dietary staple and food additive as it contains bioactive compounds such as monacolin K, γ-aminobutyric acid and dimerumic acid (Aniya *et al*., 2000; Su *et al*., 2003). Hence, processing of red koji by fermentation with Monascus can be adopted as an alternate approach for improving egg production and egg quality in laying hens. Chung and Choi (2016) carried out initial studies on the effects of using red ginseng marc with fermented red koji as a feed additive on the growth performance and fatty acid profiles of broilers. However, the use of red ginseng marc and fermented red koji has limited beneficial effects on productivity performance and egg quality of hens. Considering the benefits of using these products, there is a possibility of combining red ginseng marc with fermented red koji as a feed additive for laying hens. Pellet feeding is another factor known to improve poultry performance by reducing feed wastage in broilers, laying hens and turkeys. It is therefore essential to identify the most favorable feed additive type (pelleting and coating) for improving egg production of laying hens. Hence, the effects of different forms of red ginseng marc and fermented red koji blend on egg production in laying hens over the experimental period were assessed.

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MATERIALS AND METHODS

Red ginseng marc (RGM) and fermented red koji (FRK) purchased from Yusim Co. (Yeongju, Korea) were processed in two drying stages. To begin with, wet RGM by-product was air-dried at room temperature for 12 h, then in an oven at 50-60°C continuously for seven days until the final moisture contents reduced to about 10-12%. Subsequently, it was ground for obtaining a finely powdered RGM. The RGM powder was thoroughly mixed with FRK in 9:1 ratio and converted into pellets using a pellet machine. Finally, these pellets were sprayed with canola oil using a small hand pump and dried for 7 days to produce coat type pellet with RGM with FRK. The three different feed additives of RGM with FRK were immediately stored in a plastic bag under refrigerated conditions until the experiment started.

Forty weeks old Hyline brown laying hens (n = 240) were housed under uniform housing, feeding, and lighting conditions. They were housed in 24 wire-caged pens (30 cm width × 80 cm length × 50 cm height) in a windowed poultry house under a 16/8 h light/dark regime at a temperature of 22°C. The pens were equipped with shared-through feeders and nipple drinkers with a provision for automatic control of the ventilation and temperature systems. Feed and fresh water were supplied *ad libitum* during the 8-week experimental period (Kaya *et al*., 2013). The standard commercial diets for layers contained 2,800 kcal/kg metabolizable energy, 17.5% crude protein and 3.8% calcium.

They were fed one of the four treatments; control (a basal diet), T1 (a basal diet + 1% RGM powder mixed with FRK), T2 (a basal diet + pelleted 1% RGM with FRK) and T3 (a basal diet + coated pellets of 1% RGM with FRK) and evaluated for their effects on laying performance and Haugh unit from 40 to 48 weeks of age.

Eggs from each replicate were collected once a day (between 09:00 and 11:00 h) and weighed using an electronic balance on the same day for calculating hen-day egg production (HDP), average egg weight (EW) and egg mass (EM) from 40 to 48 weeks of age (Yildirim *et al*., 2018). HDP and EW were recorded daily while the feed intake (FI) and feed conversion ratio (FCR) were recorded weekly. Data on egg production were documented every 2 weeks (weeks of 0, 2, 4, 6 and 8) from 40 to 48 weeks. Especially, hen-day egg production (HDP) was calculated as:

HDP (%) =
(total eggs produced/number of birds alive) x 100

Egg weight (EW, g) was determined by weighing all the eggs produced per experimental unit, and thereafter calculating their average. FI per bird/day was calculated as per the formula given by Ahmad *et al*. (2010) where by.

Feed intake (g/day/hen) =
(weekly feed consumption by a replicate/number of birds in a replicate during that week)/7

Feed conversion ratio (FCR, g/g) was calculated for each replicate as a ratio of the weight of feed consumed (g) to daily egg weight (g). The egg mass (EM, g/d/hen) on daily basis was computed as per the formula given by Hussein *et al*. (2015) where average EW was multiplied with percent HDP for each replicate.

For Haugh unit (HU), five eggs per replicate were randomly collected and done in weeks 0, 2, 4, 6 and 8 of the experimental period and the values were automatically analyzed using multi-functional egg quality analyzer (Japan) as shown in the formula presented below.

$$HU = 100 \log [H - (1.7\times W)^{0.37}+7.6],$$

where H is albumen height (mm) and W is egg weight (g).

Completely randomized design was used for the experiment where each pen was used as an experimental unit. Data were analyzed by ANOVA using a GLM (SAS Institute, 2008). When significant differences were detected among treatments, Tukey's honestly significant difference test was used for pair-wise comparisons. Results presented as means ± SEM with P < 0.05 were considered significant.

RESULTS AND DISCUSSION

Laying Performance

For laying performance, no significant differences for 0 through 6 weeks were found in HDP among treatments (Table 1). Also, there were also no remarkable differences in HDP among three forms of RGM and FRK during 8-week feeding trial. However, the means amongst treatments at 8 weeks were significantly higher (P<0.05) for HDP of coated pellets of 1% RGM with FRK in comparison to other treatments. Similarly, Jang *et al*. (2007) found that there was an improvement in HDP (86%) compared with controls (84%), for 6 weeks, on addition of both 2.5% and 5% fermented wild ginseng culture by-product. On the other hand, Ao *et al*. (2011) found that different concentrations of fermented red ginseng extract had little effect on egg production of laying hens, which might be attributed to the use of different ginseng sources or differences in procedure for fermenting ginseng products used in their study.

For EW, the means amongst different forms of RGM with FRK diets in laying hens were not significantly different (P>0.05) at 0, 2 and 4 weeks, except for at 6 and 8 weeks (P<0.05) of the experiment. Our results suggested that EW is not influenced for up to 4 weeks by the dietary supplementation of RGM and FRK, although there were statistical significant differences after 6 and 8 weeks. These results are consistent with the findings of Yildirim *et al*. (2013) for laying hens fed different levels of Korean ginseng (Panax ginseng C.A. Meyer) root extract (PGRE). Ao *et al*. (2011) found no benefit of dietary supplementation with FRGE on EW. The means for FI among treatments, were significantly different (P<0.05) during the experimental period. However, the three forms of feed additives supplemented with RGM and FRK had no effect on FI up to 2 weeks of experimental trial. This finding is consistent with that of Kang *et al*. (2016), who reported no effect of red ginseng by-product on FI in laying hens. On the contrary, Jenkins and Atwal (1994) demonstrated adverse effects of dietary saponins, which are main bioactive compounds in ginseng, on growth performance and FI of chicks. Further more, there are other reports showing adverse effects of dietary saponins on growth, feed consumption and egg production in poultry (Terapunduwat and Tasaki, 1986; Potter *et al*., 1993). These adverse effects could be due to the different characteristics of saponins. For example, the reduction in feed intake can either be explained by the astringent and irritating taste of saponins or by the reduction in intestinal motility and protein digestibility because of their damage to the intestinal membrane and inhibition of nutrient transport (Klita *et al*., 1996). In this study, the reasons for no effect on FI are not clear and require further investigation.

As shown in Table 1, there was no significant effect

Table 1: Performance in laying hens fed diets with different types of red ginseng marc and fermented red koji during 8 weeks.

Week	Treatment[1]					
	Control	T1	T2	T3	SEM[2]	*p*-value
Hen-day egg production (g/d/hen)						
0	89.82	91.30	91.18	91.48	0.38	0.9691
2	79.75	89.73	92.38	89.10	2.76	0.2088
4	89.64	93.87	89.81	89.19	1.09	0.6897
6	93.68	94.86	95.06	93.96	0.33	0.9898
8	92.40[b]	94.87[a]	94.95[a]	95.15[a]	0.65	0.0310
Egg weight (g)						
0	58.83	58.42	59.25	58.92	0.17	0.7976
2	66.00	63.75	65.08	64.92	0.46	0.6597
4	65.58	64.25	63.17	65.92	0.63	0.5412
6	63.08[b]	66.42[a]	63.17[a]	65.83[a]	0.87	0.0032
8	66.83[a]	64.92[b]	63.58[c]	65.67[a]	0.68	0.0305
Feed intake (g/d/hen)						
0	110.65	112.26	110.85	112.26	0.43	0.0705
2	110.88	113.40	112.63	113.38	0.59	0.1620
4	116.48[a]	114.00[ab]	111.78[b]	112.66[b]	1.02	0.0099
6	111.77[b]	113.79[ab]	111.95[ab]	114.89[b]	0.75	0.0308
8	116.40[a]	113.48[ab]	110.88[b]	111.86[b]	1.21	0.0007
Feed conversion ratio (g/g)						
0	2.10	2.12	2.06	2.09	0.01	0.9299
2	2.14	2.00	1.90	1.98	0.05	0.4100
4	2.00	1.91	1.98	1.93	0.02	0.8621
6	1.93	1.81	1.87	1.86	0.02	0.7497
8	1.89[a]	1.85[a]	1.84[a]	1.80[b]	0.02	0.0387
Egg mass (g/d/hen)						
0	52.89	53.31	54.00	53.86	0.26	0.9537
2	52.63	57.17	60.20	57.97	1.59	0.2722
4	58.89	60.38	56.64	58.85	0.77	0.7696
6	59.10[c]	63.06[a]	60.08[b]	61.87[ab]	0.89	0.0441
8	61.78[b]	61.57[b]	60.38[c]	62.57[a]	0.45	0.0458

[a-c]Means in the same rows with no common superscript are significantly different (P <0.05).

[1]Control: basal diet; T1: basal diet + 1% red ginseng marc powder mixed with fermented red koji; T2: basal diet + pelleted 1% red ginseng marc with fermented red koji; T3: basal diet + coated pellets of 1% red ginseng marc with fermented red koji.

[2]Values are expressed as means ± standard errors.

Table 2: Haugh unit in laying hens fed diets with different types of red ginseng marc and fermented red koji during 8 weeks.

Week	Treatment[1]					
	Control	T1	T2	T3	SEM[2]	*p*-value
0	94.80	92.57	94.08	94.12	0.47	0.6906
2	92.39	95.05	95.63	94.51	0.71	0.0738
4	92.74[b]	94.13[a]	93.67[a]	94.67[a]	0.41	0.0340
6	93.13[b]	96.06[ab]	96.67[ab]	97.56[a]	0.96	0.0297
8	92.09[c]	94.33[bc]	95.08[b]	100.07[a]	1.68	0.0001

[a-c]Means in the same rows with no common superscript are significantly different (P < 0.05).

[1]Control: basal diet; T1: basal diet + 1% red ginseng marc powder mixed with fermented red koji; T2: basal diet + pelleted 1% red ginseng marc with fermented red koji; T3: basal diet + coated pellets of 1% red ginseng marc with fermented red koji.

[2]Values are expressed as means ± standard errors.

(P>0.05) of the treatments on FCR throughout the experimental period, except at 8 weeks. Kang *et al*. (2016) also reported that FCR was not affected by supplementation of RGEs in the diet of laying hens. In the present study, the improvement in FCR by T3 diet after 8 weeks of the trial may be explained by the interaction of RGM and FRK that is associated with the presence of bioactive ingredients, the utilization of canola oil as an essential oil and the different forms of the feed additive such as (powder, pellets and coated pellets). For example, it is generally accepted that pelleted or coated feed or feed additives enhances the economic production by improving the growth response in poultry, as described by Behnke and Beyer (2002). In this study, an increase in EM was observed over time. The form of RGM and FRK had no significant effect (P>0.05) on EM up to 4 weeks, but significant effects were noted at 6 and 8 weeks (P<0.05). Yildirim *et al*. (2013) found no significant effects of on EM among the groups (Korean ginseng root extract). In our study, the highest and the lowest EM were observed after 8 weeks of the experimental period for T3 (coated pellets of 1% RGM with FRK) and T2 (pelleted 1% RGM with FRK), respectively and may be explained by the difference between hen-day egg production and egg weight observed among various forms of RGM and FRK diets.

Haugh Unit (HU)

Egg HU was significantly different (P<0.05) only on the 4, 6 and 8 weeks of the experimental period among treatments (Table 2). The HU values increased with time in all the forms of RGM and FRK diets in comparison to the controls. In particular, the means in T3 for 8 weeks were significantly higher in comparison to other treatments. The higher HU in our study is possible due to the freshness of eggs, young age of hens and/or the presence of bioactive ingredients found in forms of RGM and FRK. On the contrary, Ao *et al*. (2011) observed no positive effects on HU as a function of time while studying the influence of FRGEs on egg quality in laying hens. Other studies on egg quality have established the use of HU as a standard method for determination of the quality of the albumen (Menezes *et al*., 2012; Khadda *et al*., 2017). A study by USDA (2000) demonstrated a direct relationship of HU values with quality of eggs and based on the HU values classified them into four groups: AA (100 to 72), A (71 to 60), B (59 to 30) and C (below 29). Based on this classification, the HU of eggs in our study (Table 2) was classified as AA.

CONCLUSION

The knowledge of factors influencing the performance of laying hens or the quality of the egg produced by commercial layers is crucial for the production of high quality eggs. Further research is needed to determine the optimal levels of RGM with FRD (blends) supplementation for improving laying performance and egg quality of hens over longer periods. However, based on our results, it can be concluded that the different forms (powder, pellet and coated pellet) of the RGM plus FRD supplementation for 8 weeks improves the laying performance and HU in 40 weeks old Hyline hens.

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