Use of yeast cell walls and Yucca schidigera extract in layer hens' diets

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Abstract

This research was conducted to determine the impact of diet supplementation with yeast cell walls (YCW) and Yucca schidigera extract (YE) on performance, egg weight, specific gravity, body weight, and intestinal tissue histology in layer hens. White, 48-week-old, Hy-line hybrid hens (n=320) were divided into four main groups, each comprising eight groups of 10 hens: (1) control, (2) 500 mg/kg YCW added, (3) 500 mg/kg YE added and (4) 250 mg/kg YE plus 2500 mg/kg YCW added. While the egg production and feed intake of the hens was significantly affected, overall feed efficiency, damaged-egg ratio, dirty-egg ratio, egg weight and specific gravity did not differ between the control group and the YCW, YE or YCW+YE groups. Final body weight was higher in the YCW, YE and YCW+YE groups than in the control group. There were differences in the width, muscle layer thickness and height/depth ratio of the duodenal villus and the width of the ileal villus among the four groups. It can be concluded that YCW and YCW+YE supplementation for layer hens are beneficial for egg production.

Materials and methods

Experimental design and animals

A total of 320 hybrid laying hens (Hy-Line W-36), aged 48 weeks, were placed in a completely enclosed, fan-ventilated, light- (15L:9D) and temperature- (20°C) controlled room. The hens were housed in metal cages (55×45×40 cm) with five hens in each cage (two cages per replication). Layer hens were randomly allocated to four experimental groups with eight replications (10 birds per replication, giving 80 hens per experimental group). Feed and water were provided ad libitum. The experimental period lasted 90 days.

Diets and feeding

The hens were fed a complete diet that was specially formulated to meet their requirements, which comprised 11.63 MJ/kg metabolisable energy and 16% crude protein, according to the Hy-Line W-36 Commercial Management Guide (Table 1); the diet was unchanged throughout the experimental period. The diets in four of the experimental groups were supplemented with 500 mg/kg YCW (Global Nutritech, Turkey), 500 mg/kg YE (Global Nutritech, Turkey) and 250 mg/kg YCW plus 250 mg/kg YE.

Egg weight and eggshell parameters

Egg weight and specific gravity were determined monthly using the methods described by Hamilton (1982) and Hempe et al. (1988). Five eggs were taken from each replication at 0, 30, 60 and 90 days.

Feed analyses

All feed samples were analysed for dry matter (934.01; AOAC, 1990), ash (942.05; AOAC, 1990), nitrogen (Kjeldahl procedure: 988.05; AOAC, 1990), ether extract (920.39, AOAC, 1990), crude fibre (962.09, AOAC, 1990), cal-
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Body weight

Data for the 90 days evaluation period are presented in Table 2. Final body weight was higher in the YCW, YE and YCW+YE groups than in the control (P<0.05).

Mortality rate

The mortality rate throughout the trial did not differ (P>0.05) significantly among the treatments (Table 2).

Intestinal histomorphometry

Table 3 shows the effect of YCW and YE on the intestinal histomorphometry of layer hens. The width of the duodenal villus was higher (P<0.05) in the control and YCW+YE group than in the YCW and YE groups. The muscle layer thickness of the duodenal villus was higher (P<0.05) in the control group than in the YCW, YE and YCW+YE groups. The crypt depth of the duodenal villus was higher (P<0.05) in the control, YCW and YCW+YE groups than in the YE group. The villus height/crypt depth ratio of the duodenum was higher (P<0.05) in the YE and YCW+YE groups than in the control and YCW groups. The width of the ileal villus was higher (P<0.05) in the YCW, YE and YCW+YE groups than in the control group.

Discussion

The addition of YCW, YE and YCW+YE to the diets affected the egg production (days 1-30, 1-90), feed intake (days 1-30, 60-90, 1-90) and final body weight of the hens. However, there were no differences in damaged-egg ratio, dirty-egg ratio, feed efficiency, egg weight and specific gravity among the four groups. The best results were found in the YCW group in

Table 1. Components and chemical composition of the diet.

| Components | Control | YCW | YE | YCW+YE |
|------------|---------|-----|----|--------|
| Corn, %    | 53.70   | 53.75 | 53.75 | 53.75 |
| Soybean meal, % | 5.27 | 5.54 | 5.54 | 5.54 |
| Full-fat soybean, % | 12.00 | 12.00 | 12.00 | 12.00 |
| Sunflower soapstock, % | 2.00 | 2.00 | 2.00 | 2.00 |
| Sunflower meal, % | 8.03 | 7.66 | 7.66 | 7.66 |
| DDGS, %    | 5.00    | 5.00  | 5.00  | 5.00 |
| Fish meal, % | 1.50 | 1.50  | 1.50  | 1.50 |
| Dicalcium phosphate, % | 1.04 | 1.04  | 1.04  | 1.04 |
| Limestone, % | 10.58 | 10.58 | 10.58 | 10.58 |
| Salt, %    | 0.23    | 0.23  | 0.23  | 0.23 |
| Vitamin and mineral premix*, % | 0.25 | 0.25  | 0.25  | 0.25 |
| Methionine, % | 0.11 | 0.11  | 0.11  | 0.11 |
| Lysine, %   | 0.04    | 0.04  | 0.04  | 0.04 |
| Sode, %     | 0.20    | 0.20  | 0.20  | 0.20 |
| Toxin binder, % | 0.05 | 0.05  | 0.05  | 0.05 |
| YCW, %      | -       | 0.05  | -    | 0.025 |
| YE, %       | -       | -    | 0.05  | 0.025 |
| YCW+YE, %   | -       | -    | -    | - |

Estimated composition* (Vitamin-mineral premix contains, per 2.5 kg, 3.6 mg retinyl acetate, 0.05 mg cholecalciferol, 30 mg tocopherol acetate, 3 mg menadione dimethylpyrimidinol bisulphite, 3 mg thiamin, 6 mg riboflavin, 5 mg pirdoksain, 0.015 mg cyanocobalamin, 25 mg niacin, 0.04 mg biotin, 8 mg carotenoïd (carophyl red, carophyl yellow), 1 mg folasin, 300 mg choline chloride, 50 mg ascobic acid, 80 mg manganese, 35 mg iron, 50 mg zinc, 5 mg copper, 2 mg iodine, 0.4 mg cobalt; calculated according to the European table of energy values for poultry feedsstuffs (WPSA, 1988); calculated based on the basis of chemical analysis of components and mixtures. YCW, yeast cell wall; YE, Yucca schidigera extract; DDGS, distillers’ grains with solubles.)

| Components | Control | YCW | YE | YCW+YE |
|------------|---------|-----|----|--------|
| Dry matter, % | 88.86 | 88.86 | 88.86 | 88.86 |
| Ash, %      | 14.43   | 14.46 | 14.46 | 14.46 |
| Crude protein, % | 16.00 | 16.00 | 16.00 | 16.00 |
| Crude fat, % | 7.18   | 7.18  | 7.18  | 7.18 |
| Crude fibre, % | 4.06 | 4.01  | 4.01  | 4.01 |
| Calcium, %  | 4.25    | 4.25  | 4.25  | 4.25 |
| Total phosphorus, % | 0.70 | 0.70  | 0.70  | 0.70 |
| Metabolisable energy, MJ/kg | 11.63 | 11.63 | 11.63 | 11.63 |

Results

Performance

YCW and YCW+YE supplementation increased egg production during days 1-90 and feed consumption during days 1-30, 60-90 and 1-90 (P<0.05). There were no differences in feed efficiency, damaged-egg ratio and dirty-egg ratio among the four groups (Table 2). The feed intake was higher (P<0.05) in the YCW, YE and YCW+YE groups on days 1-30, 60-90 and 1-90 (Table 2). The feed efficiency parameter throughout the trial did not differ (P>0.05) significantly among the treatments (Table 2).

Egg weight and specific gravity

The addition of YCW, YE and YCW+YE did not change the egg weight and specific gravity (P>0.05) (Table 2).
terms of egg production and in the YE group in terms of final body weight. On the contrary, Shashidhara and Devегowda (2003) found that MOS, which is present in YCW supplementation, had no influence on egg production of broiler breeders. Similarly, previous studies (Guerrero, 1995; Berry and Lui, 2000; Stanley et al., 2000) reported considerable improvement in egg production in the MOS-fed birds. In another study (Parks et al., 2001), addition of MOS to the layer hens’ diets improved body weight and feed conversion rate and did not affect egg production. Park et al. (2008) reported that addition of BG in YCW increased egg production and decreased feed efficiency and feed consumption.

Supplementation of YCW to the layer hens’ diets can improve egg production and final body weight. It may be hypothesised that YCW can have an effect on nutrient utilisation in the gastrointestinal tract (Savage et al., 1996; Kumprecht et al., 1997). Several studies showed that dietary supplemental YE can improve body weight and feed efficiency of broilers and layers and also egg production of layers. Rowland et al. (1976) showed that dietary supplementation of YE can increase egg production of layer hens. In studies with broilers, Kutlu et al. (1998) and Preston et al. (1999) reported that addition of YE improved live weight gain and feed conversion efficiency. These results are, in term of body weight gain, in agreement with the results of our study.

Improvement of final body weight may be related to positive effects of steroid saponins in YE on nutrient absorption from the gastrointestinal tract. In addition, studies have demonstrated that steroid saponins can improve the absorption of nutrients by the small intestine (Montagne et al., 2003; Gurбuz et al., 2010). In our study, villus height/crypt depth ratio of the duodenum was higher in the YE group than the control, YCW and YCW+YE groups, and the villus width in the ileum was higher in the YCW, YE and YCW+YE groups than the control group, which would have affected intestinal absorption. In line with this is the finding of an increment in body weight in the YCW, YE and YCW+YE groups at the end of the 90-day period. In agreement with several reports (Santin et al., 2001; Zhang et al., 2005; Alfaro et al., 2007; Morales-Lopez et al., 2009), the addition of YCW and YE to diets in our study positively affected the intestinal mucosal histology.

Table 2. Effect of YCW, YE and YCW+YE added to diets of layer chicks on growth performance.

| Parameters                  | Control       | YCW           | YE            | YCW+YE        | SEM   | P   |
|-----------------------------|---------------|---------------|---------------|---------------|-------|-----|
| Egg production, %/hen/d     |               |               |               |               |       |     |
| Pre-trial period            | 0.97          | 82.08         | 82.22         | 81.67         | 0.53  | 0.470 |
| 1-30 d                      | 81.83         | 87.38         | 84.42         | 84.13         | 0.69  | 0.002 |
| 30-60 d                     | 80.73         | 81.57         | 81.60         | 81.53         | 0.62  | 0.029 |
| 60-90 d                     | 78.61         | 81.58         | 80.17         | 81.99         | 0.57  | 0.139 |
| 1-90 d                      | 80.39         | 83.51         | 82.06         | 82.55         | 0.35  | 0.012 |
| Damaged eggs, %             |               |               |               |               |       |     |
| Pre-trial period            | 0.51          | 2.19          | 1.19          | 1.75          | 0.23  | 0.060 |
| 1-30 d                      | 2.17          | 2.60          | 2.07          | 3.20          | 0.30  | 0.548 |
| 30-60 d                     | 2.02          | 3.57          | 2.44          | 3.30          | 0.39  | 0.489 |
| 60-90 d                     | 2.66          | 1.59          | 2.89          | 2.96          | 0.28  | 0.206 |
| 1-90 d                      | 2.27          | 2.58          | 2.46          | 3.15          | 0.16  | 0.254 |
| Dirty eggs, %               |               |               |               |               |       |     |
| Pre-trial period            | 0.69          | 0.16          | 0.50          | 0.66          | 0.16  | 0.290 |
| 1-30 d                      | 0.54          | 0.48          | 0.67          | 0.45          | 0.07  | 0.708 |
| 30-60 d                     | 0.68          | 0.51          | 0.58          | 0.48          | 0.11  | 0.561 |
| 60-90 d                     | 0.59          | 0.83          | 0.45          | 0.70          | 0.10  | 0.183 |
| 1-90 d                      | 0.80          | 0.61          | 0.57          | 0.54          | 0.05  | 0.512 |
| Feed consumption, g/hen/d   |               |               |               |               |       |     |
| 1-30 d                      | 102.45        | 113.02        | 109.99        | 107.62        | 1.34  | 0.012 |
| 30-60 d                     | 100.68        | 102.93        | 104.54        | 104.87        | 1.01  | 0.377 |
| 60-90 d                     | 101.86        | 108.80        | 104.62        | 105.05        | 0.83  | 0.013 |
| 1-90 d                      | 101.68        | 108.25        | 106.06        | 105.84        | 0.54  | 0.000 |
| Feed efficiency, kg/egg     |               |               |               |               |       |     |
| 1-30 d                      | 1.95          | 1.99          | 2.01          | 2.01          | 0.02  | 0.815 |
| 30-60 d                     | 1.97          | 1.99          | 2.02          | 2.01          | 0.02  | 0.863 |
| 60-90 d                     | 2.03          | 2.06          | 2.03          | 1.99          | 0.01  | 0.483 |
| 1-90 d                      | 1.99          | 2.02          | 2.02          | 2.00          | 0.01  | 0.543 |
| Egg weight, g               |               |               |               |               |       |     |
| 1 d                         | 63.78         | 64.43         | 64.15         | 63.89         | 0.34  | 0.545 |
| 30 d                        | 64.16         | 64.84         | 64.31         | 64.33         | 0.36  | 0.552 |
| 60 d                        | 63.63         | 64.38         | 63.60         | 63.31         | 0.02  | 0.729 |
| 90 d                        | 64.22         | 65.97         | 64.53         | 64.09         | 0.43  | 0.431 |
| Specific gravity, g/cm      |               |               |               |               |       |     |
| 1 d                         | 1.072         | 1.0774        | 1.0767        | 1.0745        | 0.07  | 0.183 |
| 30 d                        | 1.0755        | 1.0740        | 1.0766        | 1.0760        | 0.05  | 0.068 |
| 60 d                        | 1.0733        | 1.0739        | 1.0726        | 1.0734        | 0.02  | 0.746 |
| 90 d                        | 1.0646        | 1.0692        | 1.0678        | 1.0685        | 0.11  | 0.073 |
| Initial weight, mean g/hen  | 1573.19       | 1606.13       | 1606.94       | 1580.63       | 9.65  | 0.274 |
| 1579.79                     | 1655.79       | 1667.81       | 1607.31       | 12.38         | 0.032 |
| Mortality, mean %           |               |               |               |               |       |     |
| 0-90 d                      | 0.00          | 1.25          | 0.00          | 0.00          | 0.205 | 0.391 |

Data are mean values for 80 hens for each treatment; YCW, yeast cell walls at 500 mg/kg of feed; YE, Yucca schidigera extract at 500 mg/kg of feed; YCW+YE, yeast cell walls at 250 mg/kg + Yucca schidigera extract at 250 mg/kg of feed. *Means within the same row bearing different superscripts differ significantly (P<0.05).
Table 3. Effect of YCW, YE and YCW+YE added to diets of layer hens on intestinal histomorphometry.

| Parameters                        | Control | YCW | YE | YCW+YE | SEM  | P   |
|-----------------------------------|---------|-----|----|--------|------|-----|
| Duodenum                          |         |     |    |        |      |     |
| Villus width, µm                  | 205.51a | 164.61b | 177.90a | 213.85a | 5.00  | 0.001 |
| Villus height, µm                 | 1954.46 | 1835.25 | 1937.86 | 1908.04 | 29.09 | 0.513 |
| Muscle layer thickness, µm        | 193.42a | 163.56b | 140.95a | 168.00b | 4.18  | 0.000 |
| Crypt depth, µm                   | 279.94a | 271.64a | 220.00b | 249.58a | 7.23  | 0.013 |
| Villus height/crypt depth         | 7.17a   | 7.32a | 9.13a | 8.20a   | 0.23  | 0.008 |
| Jejunum                           |         |     |    |        |      |     |
| Villus width, µm                  | 136.84a | 129.38 | 123.75 | 121.84 | 2.96  | 0.284 |
| Villus height, µm                 | 897.26  | 1078.21 | 1056.23 | 983.62 | 20.31 | 0.293 |
| Muscle layer thickness, µm        | 188.49a | 198.65 | 214.96 | 183.38 | 6.80  | 0.351 |
| Crypt depth, µm                   | 153.11a | 165.76 | 169.60 | 166.26 | 3.93  | 0.487 |
| Villus height/crypt depth         | 6.70a   | 6.74a | 6.69a | 6.03a   | 0.18  | 0.415 |
| Ileum                             |         |     |    |        |      |     |
| Villus width, µm                  | 139a    | 180.84a | 172.45a | 169.63a | 4.56  | 0.008 |
| Villus height, µm                 | 756.50  | 831.46 | 753.82 | 762.03 | 14.16 | 0.177 |
| Muscle layer thickness, µm        | 323.49  | 333.49 | 381.05 | 375.89 | 10.77 | 0.138 |
| Crypt depth, µm                   | 209.52a | 197.40 | 183.81 | 185.08 | 4.57  | 0.161 |
| Villus height/crypt depth         | 3.78    | 4.42 | 4.25 | 4.28    | 0.12  | 0.296 |

Data are mean values for 80 hens for each treatment; YCW, yeast cell walls at 500 mg/kg of feed; YE, Yucca schidigera extract at 500 mg/kg of feed; YCW+YE, yeast cell walls at 250 mg/kg + Yucca schidigera extract at 250 mg/kg of feed; **Means within the same row bearing different superscripts differ significantly (P<0.05).

Conclusions

The present study showed improvement in egg production and final body weight owing to YCW and YCW+YE supplementation, which possibly may be the effect of increased feed intake and increased ileal villus width. Future studies should investigate the effects of more doses of YCW and YE on performance, egg quality and digestive physiology and metabolism in hens.

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