Effects of acidifier supplemented diets on egg quality and performance

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Acidifiers are considered the most potential antibiotic alternative with no residue, no drug resistance and no toxic side effects. As feed costs account for more than 70% of total costs in the poultry industry, improving efficiency of feed utilisation is an important method to improve the economic benefits for poultry farms.

The study of Luo et al showed that acidifier supplemented in feed could enhance digestive enzyme activity, promote digestion and absorption of nutrients and improve the efficiency of feed utilisation and reduce the costs in poultry farms.

Eggshell quality is another important factor that influences breeding benefits. The study showed that acidifier supplemented feed could promote the absorption of calcium and phosphorus, improve eggshell thickness, improve the Haugh unit, and effectively reduce broken and dirty egg production.

There is no study about the effect of acidifier supplemented diets on production performance and egg quality in laying hens at laying peak.

To provide a scientific basis for the use of acidifier in feed mills and poultry farms, Menon studied the effect of Menacid 330 (our compound acidifier) on the production performance and egg quality of laying peak hens.

Materials and methods

● Materials

Menacid 330 microencapsulated acidifier was provided by Menon Animal Nutrition Technology Co Ltd. It is a mixture of white to yellow particles, with the main ingredients of fumaric acid, formate and calcium propionate etc.

● Experimental design

Some 640 32-week-old Jinghong layers were randomly divided into two treatments with five replicates (64 hens per replicate). The control group was fed the regular diet and the experiment group had an addition of 800g/t acidifier. The whole period was about eight weeks. The feed used in this study was corn-soybean meal based diets which was consistent with the China Chicken Feeding Standard (2004). The composition and nutrient levels of the basal diets is shown in Table 1.

● Management

The experiment was conducted in Jiangsu Province. The hens were kept in three layers around ladder cages, four or five hens per cage. Hens had free access to water and feed. Faeces were cleaned with a mechanical scraper for each of the three days. The hens were cared for following commercial management procedures. The feed was provided twice a day (6:30 and 14:00). Eggs were collected at 9:00.

Item	Content		Nutrient levels
Corn	64.0	Crude protein	16.8
Soybean meal	24.0	Ca	3.54
Stone powder (Calcium carbonate)	7.0	Total P	0.62
5% premix*	5.0	Available P	0.41
		Salt	0.38
		Lys	0.828
		Met	0.36
		Metabolic energy (KCal)	2638

Table 1. Composition and nutrient levels of basal diets (%). (*5% premix consisted of vitamin, trace elements, methionine, fish meal, dicalcium phosphate, phytase, salt, powder, antioxidant and carrier).

Measurements

● Performance

The initial laying rate and egg weight was recorded three days before the beginning of the trial. The first week was considered as a pre-feeding stage, and feed intake, egg weight, egg number, dead hens, broken eggs and dirty eggs (more than $1cm^2$ of the stain area of eggshell surface was considered as dirty eggs) were recorded for every five days from the second week.

● Egg quality

On the last day of the trial, the automatic egg analyser was used to examine the eggshell thickness, eggshell strength, egg shape index, and albumen height of 10 eggs randomly selected from every replicate in every treatment at the Poultry Institute, Chinese Academy of Agricultural Sciences.

● Statistics

All the statistical analysis was performed using SPSS 17.0. One-way ANOVA was used to determine statistical significance. $P<0.05$ was considered statistically significant.

Calculation

- Death rate = number of deaths of hens/total number of hens
- Total number of eggs = the sum of daily eggs number
- Total weight of eggs = the sum of daily eggs weight
- Average weight of eggs = total weight of eggs/total number of eggs
- Broken eggs rate = total number of broken eggs/total number of eggs
- Dirty eggs rate = total number of dirty eggs/total number of eggs
- Average laying rate = total number of eggs/(number of days x number of hens in replicate)
- Feed-gain ratio = total feed intake/total weight of egg

Results

As shown in Table 2, the laying rate was increased by 0.32% ($P>0.05$) in the Menacid 330 treatment compared with the control. Menacid 330 supplemented in diets decreased feed intake ($P<0.01$), ratio of feed to egg ($P<0.05$) and broken eggs (34.21%) compared with the control group. The mortality in the Menacid 330 group was 0.

As shown in Table 3, the egg quality was enhanced when Menacid 330 was supplemented in diets. The eggshell thickness, eggshell strength, albumen height and Haugh unit were enhanced by 2.05, 1.82, 14.59 and 10.26% respectively.

Discussions

By providing exogenous H+, the acidifier plays a role in reducing digesta pH in the stomach, protein denaturation and activation of pepsinogen. The protein hydrolysate and acid digesta from the stomach stimulates intestinal release of cholecystokinin releasing peptide and secretin. After entering the small intestine, acid digesta stimulates intestinal secretion of enterogastrone, which inhibits gastric motility, slows down the rate of gastric emptying and is conducive to protein digestion in the stomach.

Hansen (2007) found that the dry matter ratio in the stomach increased after compound acidifier (lactic acid and formic acid) was added to the diets. The results of Manzanilla's (2004) study showed that 0.5% formic acid supplemented in diets increased the residence time of the stomach contents and reduced the gastric emptying rate of dry matter for early weaned piglets.

The acidifier can achieve the regulation of digestive tract microflora balance function by the following patterns. Importantly, the acidifier decreased the residual nutrients entering the latter part of the intestine, which were required by patho-

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Index	Control	Menacid 330	P-value
Laying rate (%)	92.92 ± 1.37	93.24 ± 1.17	0.702
Egg weight (g)	59.32 ± 0.394	59.02 ± 0.387	0.272
Feed intake (g/d)	110.1[a] ± 0.94	107.2[b] ± 1.49	0.006
Ratio of feed to egg	1.999[a] ± 0.037	1.947[b] ± 0.016	0.021
Broken eggs rate (%)	0.43[a] ± 0.12	0.24[b] ± 0.16	0.042
Dirty eggs rate (%)	0.38 ± 0.44	0.25 ± 0.11	0.535
Mortality (%)	1.59 ± 1.98	0.00 ± 0.00	0.110

Table 2. Effect of Menacid 330 on performance during the peak laying period.

Index	Control	Menacid 330	P-value
Eggshell thickness (mm)	0.390 ± 0.006	0.398 ± 0.013	0.297
Eggshell strength (kg/cm2))	3.742 ± 0.198	3.810 ± 0.129	0.543
Eggshell (%)	9.8 ± 0.1	9.9 ± 0.3	0.425
Yolk (%)	24.7 ± 0.6	25.2 ± 0.3	0.112
Albumen height (mm)	4.922 ± 0.943	5.640 ± 0.540	0.178
Haugh unit	65.249 ± 8.47	71.942 ± 5.44	0.176
Yolk colour	4.218 ± 0.074	4.222 ± 0.063	0.937

Table 3. Effect of Menacid 330 on egg quality during the peak laying period.

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genic bacteria for growth, reproduction and to produce potentially toxic substances through fermentation.

On the other hand, the acidifier inhibits harmful bacteria growth and reproduction by reducing pH in the digestive tract or plays a bactericidal effect as a small molecule form.

Formulated by a variety of acids, Menacid 330 improved the utilisation rate of nutrients by denaturing the protein in the poultry crop and stomach and activating the pepsinogen, as well as stimulating pancreatic secretion through the protein hydrolysate and acid digesta.

As the foundation of production performance, animal intestinal health is intestinal microbial flora. Dietary organic acid and its salts can inhibit the growth of micro-organisms in the feed, thereby regulating the balance of intestinal microflora.

Menacid 330 regulated the digestive tract microflora balance, reduced bacterial diseases, improved the degree of faeces forming and reduced the occurrence of dirty eggs.

As shown in Li et al's study, acidifier supplementation significantly enhanced the metabolic rate of crude protein and dry matter in layer diets. The study conducted by Li et al showed a similar pattern.

Dou et al reported that acidifier supplementation at 2-3kg/t reduced the mortality of 1.8-3.7%. Shao et al demonstrated the dirty eggs rate fell 8.68% after acidifier supplementation. In this study, performance in the Menacid 330 group was consistent with above reports. In addition, the decreased feed intake in the Menacid 330 group might be due to enhanced digestibility of feed nutrition being enough for laying hens to meet the demands of laying.

The low pH caused by the acidifier was beneficial to improving the solubility of minerals and mineral elements and can also be easily absorbed by the complex, thus enhancing their utilisation rate.

Shao et al conducted a study on the effects of dietary acidifier on 44-week-old Hyline Brown laying hens, and found that the eggshell thickness increased by 0.01mm in acidifier treatment, which is consistent with this study (acidifier supplemented feed enhanced the eggshell thickness by 2.1%).

The protein in egg originated from the transformation of dietary protein after digestion and absorption. Li et al showed that for the laying hens with the acidifier supplemented diets, the apparent utilisation ratio of crude protein, dry matter, organic matter, calcium and phosphorus was increased by 4.77, 6.22, 4.79, 4.91 and 4.65% respectively.

In this study, the albumen height was higher than in the control group, suggesting that the protein digestibility increased through acidifier supplementation. The Haugh unit showed the protein thin degree, indicating protein quality. It was affected by egg storage time and the age of hens. The Haugh unit reduced when the egg storage time grew, especially at high temperature. The older laying hens produced more eggs with a low Haugh unit.

Table 4. Economic benefits of adding Menacid 330 to the diet of hens during the peak laying period.

Index	Control	Menacid 330
Total egg weight (kg/d)	548.3	549.0
Total feed intake (kg/d)	1101	1072
The price of basal diets (RMB/kg)	2.80	2.80
The cost of Menacid 330 (RMB/kg)	0	0.02
The price of diet (RMB/kg)	2.80	2.82
The price of eggs (RMB/kg)	8.0	8.0
Economic benefits (RMB/d)	1303	1369
Percentage increased (%)	5.06	

The study showed that in the first 24 hours the protein quality decreased sharply. Albumen height decreased by 1.5mm on the first day and by 1mm the following day.

The low Haugh unit was due to more than 24 hours before measurement, as well as the high temperature in the summer.

However, the Haugh unit was higher in the Menacid 330 group than the control group, suggesting that Menacid 330 could prolong the storage time of eggs.

Taking a 10,000-laying hen farm as an example, 800g/t supplemented Menacid 330 could increase 66 RMB income every day and increase economic benefits by 5.06% compared with control diets.

Conclusions

It was demonstrated that Menacid 330 supplemented at 800g/t during the peak laying period decreased the ratio of feed to egg and broken eggs rate significantly, and also improved laying rate, dirty eggs rate and mortality at different degrees, showing significant effects in promoting the production performance of laying hens.

The product also improved egg shell thickness, egg shell strength, yolk percentage and Haugh unit at different degrees, showing a good effect in improving the egg quality of laying hens and thereby enhancing economic benefits. ■