Research Article

Effects of pattern systems on production performance and egg quality of laying hen

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Abstract

The objective of the study was to evaluate the effects of pattern raising systems on production performance and egg quality of laying hens. One hundred twenty laying hens and 30 weeks of age were used in completely randomized design (CRD). The study was divided into 2 patterns: 1) conventional battery cage pattern; and 2) floor pen pattern. The conventional battery cage pattern had dimension of 30 × 40 × 37 cm with 2 laying hens each while in floor pen pattern was 5 m^2 with 10 laying hens each. Each treatment had 10 replicates (120 laying hens). All laying hens were provided with the same diet during 30 days of experimental period. The results showed that the laying hen pattern systems affected to egg production performance and egg quality. Feed intake and egg production of laying hens in the conventional battery cage pattern were significantly higher than those in the floor pen pattern ($p<0.05$). However, hens in floor pens showed better results of feed conversion ratio, egg weight and Haugh unit than those from conventional pattern ($p<0.05$).

Keywords: Laying hen, pattern systems, production performance, egg quality

Introduction

Nowadays, the consumers give attention to the product source, and focus on the raising the animals with animal hygienic and welfare, with keeping the better quality. For the point of view, some of the consumers are willing to pay more for those hygienically and specially raised animals so that they will receive better food for their health and the animals for the food must receive good treatments for their own wellbeing with good and safe natural environments. The specific consumers are classified in a segmentation market or niche market. Therefore, in order to give quick response those growing trends, so several of laying chicken farm owners have turned their focuses on some specific methods to raise and produce the so-called happy laying chicken to support those markets.

Some of the processes for this are producing eggs without cages or cage-free eggs. There are many of styles of them such as raising the chicken by letting them run freely or putting them together in on huge barn (floor pen egg), then the eggs will be called “free-range eggs” and “organic eggs”. The cage-free style system becomes more popular, especially in European countries nowadays. In Thailand, the system has been caring more among those health-concerned consumers and it seems growing widely to some other types of consumers. In the same time, many of the well-educated teams have studied such alternative chicken raising processes in the hope that they will find more suitable and more applicable styles for each farm in different agricultural areas. [1-5]

From all above, the patterns or the processes are considered an outside factor affecting the quality of the eggs. When keeping the chickens in cages, those chickens are inside the cages at all the time to produce the eggs. This will make it easy for the chicken owners to manage the procedures like feeding the chickens, collecting the eggs, cleaning the cages, controlling the diseases and keeping the low costs. However, that pattern also has some disadvantages such as the chickens cannot move well nor can express any feelings. That is bad for the animal well-being or welfare. Thus, the study was to evaluate the effects of laying hen pattern systems on production performance and egg quality.

Material and Method

Animals, experimental design and management

The experiment procedure was approved by the Ethical Committee of the Pibulsongkram Rajabhat University Animal Ethics Committee, Phitsanulok Province, Thailand (Approval number: PSRU-AG-2018-003).

The trial was experimented in the livestock farm at Animal Science Program, Faculty of Food and Agriculture Technology, Pibulsongkram Rajabhat University, Thailand. A total of 120 Roman Brown laying hens, 30 weeks old were conducted in a completely randomized design, with 2 patterns (1) conventional battery cage pattern and (2) floor pen pattern. In conventional battery cage pattern, 2 laying hens were reared in a cage (30×40×37 cm) with 10 replications including 20 laying hens while in floor pen pattern, 10 laying hens were kept in a floor of 5 m^2 10 replications totally 100 laying hens. The experiment lasted for 30 days after 2 weeks of acclimation period.

All of animals were placed in the same open housing at under a photoperiod of 16 hours light: 8 hours darkness. Rice husk was used for litter materials in this study. Birds in all patterns were provided with identical care and management throughout the experimental period.

During the entire experimental period (October to November 2018), laying hens had ad libitum access to water and diets. The laying hens received diets which were formulated to meet nutrient requirements according to the NRC, [6] the ingredients of the feed mixtures are listed**. (Table 1)**

Recording production performance and egg quality

Eggs were collected daily, whereas the production performance parameters were calculated weekly. The following production performance variables were feed intake (g/head/day), hen-day egg production (%), feed conversion ratio, and egg weight (g). Feed intake and egg weight were recorded weekly by using electronic balance with 0.01 g sensitive scale. Feed conversion ratio was calculated by dividing the total egg mass to the total feed intake in the same week. Rate of lay was expressed as the average percentage hen-day egg production based on the average values following the method of Hunton as follow; [7]

% hen-day egg production = (number of eggs collected per day/number of hens present that day)*100

Table 1 Ingredients and analyzed chemical composition of basal diet (%)

Items	Basal diet
Ingredients (g/kg)	
rice broken	16.70
rice bran	18.00
soybean meal 44%	10.45
maize meal	21.20
cassava bran	2.60
leucaena leaf meal 12.9%	5.25
corn bran	20.70
fish meal 58%	3.80
premix*	0.44
dicalcium phosphate 18%	0.50
DL-methionine	0.31
lysine	0.05
Analyzed chemical composition (g/kg)	
metabolizable energy (kcal/kg)	2,900.02
dry matter (%)	10.31
crude protein (%)	17.90
crude fat (%)	3.04
crude fiber (%)	6.08
methionine (%)	0.83
lysine (%)	0.67

Note *provided (per kilogram of diet): vitamin A 15,000 IU; vitamin D3 - 3,000 IU; vitamin E 25 IU; vitamin K3 - 5 mg; vitamin B1 - 2.5 mg; vitamin B2 - 7 mg; Vitamin B6 - 4.5 mg; vitamin B12 - 25 µg; pantothenic acid 35 mg; folic acid 0.5 mg; biotin 25 µg; nicotinic acid 35 mg; choline chloride 250 mg; Mn 60 mg; Zn 45 mg; Fe 80 mg; Cu 1.6 mg; I 0.4 mg; Se 0.15 mg

The analysis of eggs quality was taken once a week throughout the experimental period. The eggs were collected from each replicate and two of them were randomly selected (avoiding broken, cracked or dirty eggs) to be analyzed.

The egg quality was assessed using the variables such as yolk color, yolk weight (g), shell thickness (mm), shell weight (g), albumen weight (g), albumen height (mm) and Haugh unit. The yolk color, albumen height and Haugh unit were measured using by Egg Multi Tester Machine (EMT-7300). Yolk weight, albumen weight and shell weight were recorded weekly by using electronic balance with 0.01 g sensitive scale. And the egg shell thickness (the average at both ends and at the middle, including shell membranes) was evaluated with a micrometer (Mitutoyo: 395 series).

Statistical analysis

The data was analyzed using one-way analysis of variance (ANOVA) with the General Linear Models (GLM) using procedures in SAS software. [8] Duncan's Multiple Range Test used to identify the significant difference (at α = 0.05) between the treatment means. [9]

Results and Discussion

Production performance characteristics

The production performance characteristics were significantly (p<0.05) influenced by the laying hen pattern systems. **(Table 2)** The conventional battery cage pattern had higher feed intake and hen-day egg production than those in the floor pen pattern (107.02 ± 2.11 g/head/day vs 102.17 ± 2.04 g/head/day, and 85.25 ± 1.20% vs 82.73 ± 1.16%, respectively). On the other hand, the laying hen pattern systems in floor pen pattern increased the egg weight (55.42 ± 0.53 g) more than conventional battery cage pattern (52.88 ± 0.51 g), and feed conversion ratio (1.97 ± 0.01) better than conventional battery cage pattern (2.03 ± 0.01).

Table 2 Effect of laying hen pattern systems on production performance

Characteristics	Group of treatments		*p*-value
	Conventional battery cage pattern	Floor pen pattern	
Feed intake (g/head/day)	107.02 ± 2.11[a]	102.17 ± 2.04[b]	<0.05
Hen-day egg production (%)	85.25 ± 1.20[a]	82.73 ± 1.16[b]	<0.05
Feed conversion ratio	2.03 ± 0.01[a]	1.97 ± 0.01[b]	<0.05
Egg weight (g)	52.88 ± 0.51[b]	55.42 ± 0.53[a]	<0.05

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

The laying hen pattern systems influenced the production performance in many parameters. The conventional battery cage pattern showed higher results of feed intake and hen-day egg production as compared to those of floor pen pattern. However, better results of feed conversion ratio and egg weight were obtained in floor pen pattern as compared to the conventional battery cage pattern. The results were in agreement with that reported by who found that floor pen pattern had lower values of hen-day egg production than conventional battery cage pattern, [10] because laying hen that reared in floor pen pattern condition had affected by ammonia on the ground floor. They were relatively guarded against air pollution and pathogenic organisms. This made their birds used more energy to disease and immune responses protection. [11] But a study from Turkey found that the free range hens produced the higher amount of egg compared to indoor ones. [12] For example, in March 2015 season, free range hens' egg production reached 100% hen-day production while indoor hens' highest egg production was 91.23% only. Moreover, a study in Czech Republic [4] reported that the highest hen-day egg production was recorded from the enriched (92.20%) and conventional (91.30%) cages, compared with the litter housings (79.80%) and aviaries (71.80%). And the housing in the enriched cage and alternative system (aviary and litter) increased the daily feed consumption (137, 131, and 136 g). Additionally, a Chinese study reported that laying hen reared under conventional battery cage pattern condition had higher hen-day egg production than floor pen pattern. It was due to laying hen reared under floor pen pattern more movement including running, nesting, and dust bathing, which could require more energy and reduce the productivity of layers. [13] Even though some studies found that laying hen reared under floor pen pattern had high feed intake but still have more activity. This could be attributed to greater mobility of the birds thereby resulting in more energy utilization at the expense of production and decrease egg weight. [10]

The result from feed conversion ratio in the study was different from who found that laying hens housed in cages had better feed conversion ratio than laying hens housed in floor pen pattern. [14] But the finding was similar to the report by who showed the hens that were housed on litter had by approximately 10% better feed consumption per day than hens from cages. [15] Moreover, it revealed that higher feed intake in cage-free pattern than in the cage. [16] This occurred because their birds need more energy to use for activity due to decrease feed conversion ratio. While, the several studies explained that lower results were obtained in cage-free pattern (body weight and feed conversion ratio) compared to in the cage because of loss energy for activity. [13,17] In addition, higher feed intake in the cage could be caused by the limit area for the laying hens. They cannot look for feed that it made their try to eat in the cage more than laying hens reared in floor pen pattern. [13]

The results of egg weight in current study was similar to those reported by who stated that laying hens reared in floor pen pattern had higher weight of egg than in the cage pattern. [2] In contrast, a few studies reported that laying hens reared in the cage pattern had higher weight of egg than in floor pen pattern because of loss energy for life of activity. [10,12] In contrast, the other studies showed laying hens in the cage and floor pen pattern did not affect the weight of egg. [14,18]

Egg quality

The effect of laying hen pattern systems on egg quality was presented. **(Table 3)** There were no significant differences between the laying hen pattern systems with respect to shell thickness, yolk color, shell weight, yolk weight, albumen weight and albumen height (p>0.05), except for Haugh unit (p<0.05). The shell thickness was no significantly (p>0.05) higher in eggs from the hens that was housed in conventional battery cage pattern. The result was in agreement with that reported by who found that shell thickness was not influenced by the housing system. [14] In contrast, the egg shell thickness was lower in eggs that were produced in cages, and the egg shell strength was higher. [19] Moreover, a couple of studies reported free range hens produced higher shell thickness compared to indoor hens. [2,12] Although a study indicated that normal egg shell thickness is between 0.30-0.35 mm. [12] But the eggs in the study had shell having 0.40 to 0.42 mm, much thicker than that from above studies. Moreover, several studies focused on egg shell quality indicated a higher quality of eggs from cages. [20-22]

Table 3 Effect of laying hen pattern systems on egg quality

Characteristics	Group of treatments		p-value
	Conventional battery cage pattern	Floor pen pattern	
shell thickness (mm)	0.42 ± 0.05	0.40 ± 0.05	>0.05
yolk color	7.54 ± 0.66	7.67 ± 0.59	>0.05
shell weight (g)	8.48 ± 0.99	8.13 ± 0.94	>0.05
yolk weight (g)	24.46 ± 2.06	24.99 ± 2.79	>0.05
albumen weight (g)	66.53 ± 2.96	67.41 ± 2.48	>0.05
albumen height (mm)	7.41 ± 1.31	7.50 ± 1.52	>0.05
Haugh unit	82.71 ± 12.84^{b}	85.11 ± 12.61^{a}	<0.05

Note ^{a,b} Different superscripts within row are significantly different (p<0.05)

However, the hens housed on the floor pen pattern had higher yolk weight than those in the conventional battery cage pattern. This result was in agreement with the study by who found that the housing in the free-range hens increased the egg weight, yolk weight and albumen weight. [2] Conversely, several studies reported that the hens in conventional battery cage had the highest yolk weight (p<0.001 and p<0.05, respectively). [4,5]

In the present study, higher yolk color, albumen weight, albumen height and Haugh unit of eggs were laid in floor pen pattern than conventional battery cage pattern. These results were similar to these reported in literatures. [1,5,12,23] On the other hand, it revealed that a higher quality of egg shell and albumen was found in cages. [4] However, the other studies reported higher values of Haugh units and albumen indices, as well as yolk indices in eggs from cage system. Additionally, eggs which have higher yolk index were laid in aviaries and conventional cages. [24,25]

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