Effects of organic farming on egg quality and welfare of laying hens.

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In the present paper are shown the results of a trial carried out during the first year of the project concerning the influence of housing system (outdoor vs battery cages) and feeding (conventional vs. organic diets) on some egg qualitative characteristics. During a four month-period, four groups of 27 Warren Isa Brown (8.5-9-month-old) laying hens were studied: AT (in which hens were kept outdoor and fed a conventional diet); AO (in which hens were kept outdoor and fed an organic diet); GT (in which hens were kept into battery-cages and fed a conventional diet) and GO (in which hens were kept into battery-cages and fed an organic diet). The diets were formulated so as to supply the same amount of protein and energy. Freshly laid eggs were collected at the beginning of the trial and every three weeks up to the end of the trial to determine some physical and qualitative parameters. Feed intake and egg production of groups AT and GT were, on the whole, higher than those of group AO+GO. All the eggs were classified into the category L, with a weight comprised between 63.00 and 72.99 g (Regulation EC No. 2295/2003, modified by Regulation EC No. 1515/2004). The experimental conditions did not effect the bird's health and mortality rate was very low. No behaviorale anomalies were observed. At the end of the trial, the heavier eggs were observed in groups fed the conventional diet, while the higher percentage of eggshell was detected in eggs of group AT+AO. The natural daylight and motor activity of outdoor animals were supposed to increase mineral metabolism leading to a better mineral deposition into eggshell. Haugh index and pH values were improved in eggs deriving from hens allocated in cages. Yolk from groups AT and AO was heavier and more intensively coloured, owing to the possibility to eat feeds containing xanthophylls, such as grass, herbs and insects. The comparison between the type of diets (conventional vs organic) did not pointed out any significant difference. Based on these results, we can conclude that some egg quality characteristics can be significantly influenced by the housing system and only at a slightly extent by the diet.

Keywords: laying hens; egg quality; organic farming; animal welfare

Introduction

Among the various challenges confronting the poultry industry, in particular as regards egg production, legislative developments in this sector reflect the necessity of implementing EC Directive 74/99, which requires all member states to ensure that the practice of rearing laying hens in battery cages is prohibited by 2012, except where suitable litter, perches and nests are provided. A further challenge arises from the need, also as a consequence of domestic economic strategies, to promote the territory and uniqueness of products and rely on organic farming as an alternative means of producing added value. It is obvious, however, that the transition from battery cages to so-called free-range systems entails additional costs, which would be offset by an increase in the value of production (ISMEA, 2005). Among the numerous claims put forth, it is argued that better rearing practices enhance animal welfare and result in an improvement in the quality of production. The technical basis of this theory lies in the application of the concept of the five freedoms of farm animals, i.e. freedom

from hunger and thirst, from discomfort, from pain, injury or disease, from fear and distress and freedom to express normal behaviour (Verga, 2000; Verga and Ferrante, 2001). In response to the H5N1 avian flu epidemic originating in Asia, the European Economic Community has recently issued regulation no. 699/2006, which envisages the possibility of organic farmers being allowed to keep poultry indoors in the case of health emergencies. This paper presents the data of an experimental trial on laying hens aimed at evaluating the main production parameters and quantitative and qualitative characteristics of the eggs produced in relation to the type of feed administered (traditional or organic) and the rearing system, in cages or free-range.

Materials and methods

After a pre-trial period of adaptation to the environment and diet, 108 Warren- Isa Brown laying hens aged 8.5-9 months were divided into 4 groups of 27 hens each. The hens were allocated so as to obtain groups with homogeneous characteristics in terms of weight and egg production. Two groups were reared in 50 cm x 50 cm x 50 cm battery cages, each housing 3 hens. The cage sizes fell within the limits established by Italian Law Decree no. 267 of 29 July 2003. During the trial, the following environmental conditions were applied and automatically controlled within the housing facility: temperature 22°- 26°C, humidity 75%. The lighting regime provided for 16 h of natural and artificial light and 8 h of darkness. The remaining two groups were allocated to two outdoor areas of 40 m2 each, each furnished with henhouses containing nests, feed troughs and nipple drinkers. The hens were clinically monitored throughout the trial period and their behaviour was constantly observed. Feed was administered *ad libitum* and formulated using "traditional" or "organic" raw materials. The diets were isoenergetic and isonitrogenous and drinking water was always available. The trial groups were as follows: AT- free-range, traditional feed; AO- free-range, organic feed; GT- reared in battery cages, traditional feed; GO- reared in battery cages, organic feed,. The trial lasted four months; feed intake and egg production were calculated over the entire trial period. Three days before the start of the trial and thereafter every 21 days until the end of the trial period, eggs were collected for three consecutive days and submitted to the following analyses: egg, shell, albumen and yolk weight, shell colour, yolk colour (measured using a Minolta Chromometer Reflectance CR 200/08 with D65 Illuminant CIE colour), shell thickness, Haugh units and albumen pH. The colour number (CN) was determined according to the methods proposed by Scholtyssek (1995). The same eggs were used to form pools consisting of one egg per cage for each treatment (GT and GO) and three eggs from the outdoor areas (AT and AO); the pools were submitted to chemical analysis to determine the makeup of the yolk and albumen and cholesterol content of the yolk. The data relating to all observed parameters were processed according to a factorial model (diet x environment) using the statistical package SPSS/PC + (1986).

Results and discussion

During the trial period no relevant health problems were observed in the hens. The zootechnical parameters, the quality and chemical characteristics of the eggs are summarized in Table 1. Feed intake and egg laying showed to be significantly different in the caged group receiving organic feed (GO) compared to group GT (table 1). No such difference was found between the free-range groups AT and AO, though group AO showed a tendency toward a reduction in both intake and production. Overall, the groups administered traditional feed (AT+GT) revealed a significant difference as regards dietary intake and egg production for the whole of the trial period. All eggs produced during the trial fell within the grade A category, unwashed eggs for human consumption, and were weight-graded as L, i.e. large eggs weighing from 63.00 to 72.99 g (EC Regulation no. 2295/2003, as amended by EC Regulation no. 1515/2004).

At the start of the trial, no differences could be observed among the four groups with respect to egg quality, but at the subsequent collection several significant differences ($P<0.05$ and 0.01) came to light, for example as regards the shell percentage, Haugh units and pH: the first two parameters were

higher and the third lower in group GO compared to group GT. At the end of the 16-week trial, differences were also found between the parameters considered for the two groups GT and GO allocated to cages: egg weight, shell percentage and thickness and yolk colour intensity were significantly higher in the eggs of group GT compared to GO, whereas the latter showed higher values in terms of albumen percentage and Haugh units: the latter parameter is important to consumers, who prefer a more compact albumen. Cage rearing of hens fed an organic diet, a method of rearing not envisaged under Regulation 1804/1999, negatively influenced egg weight and shell thickness. Egg weight was higher on average for hens receiving a traditional diet ($P < 0.05$). The average albumen and yolk percentages show no significant differences among groups, though a higher presence of albumen was found in eggs from hens receiving organic feed ($P < 0.05$).

Egg weight being equal, the shell percentage (table 2) and thickness were higher in groups AT+AO (0.385 mm *vs* 0.322 mm) compared to groups GT+GO. This difference is important in that, as previously noted, eggshell breaking strength might be improved by increasing the shell thickness. A number of studies (Pavlovski *et al*., 1981; Hughes *et al*., 1985; Mostert *et al*., 1995; Leyendecker *et al*., 2001) have shown that eggs laid by free-range hens have a thicker and consequently more robust shell. Such findings could be explained in some cases by the quantity of calcium and phosphorous available in feed, but where the diets administered contain equivalent amounts of these elements it may be hypothesized that sunlight and the motor activity of hens housed in larger spaces serve to increase mineral metabolism, resulting in a better deposition of minerals in the shell. The comparison between the two groups housed in cages (GT+GO) and the free-range groups (AT+AO) revealed differences in reflectance with respect to shell colour, a factor that is mainly linked to genetic factors but which may be influenced by the metabolism and catabolism of several molecules: in hens reared outdoors the reflectance percentage of the shells of laid eggs showed to be lower, that means a darker colour ($P < 0.01$).

The yolk percentage of groups AT+AO showed to be greater overall and the yolks were also more deeply coloured compared to those of the other groups; this is probably related to the fact that hens allocated to outdoor enclosures had the possibility of ingesting, in addition to feed, other raw materials which supply pigments, such as grass and insects.

Table 1. Zootechnical and egg parameters at the end of the trial.

Group		AT	AO	GT	GO	AT+AO *vs* GT+GO	AT+GT *vs* AO+GO	[4]SEM
Feed intake (g/d/hen)		139,99	131,51	149,65	121,21	ns	P < 0.01	4.11
Egg production (%)		84,85	72,73	84,47	61,54	ns	P < 0.01	3.42
Egg weight (g)		69.15	68.72	70.41	65.85	ns	P < 0.05	0.71
Shell (% of egg)		11.74	11.43	10.50	9.85	P < 0.01	P < 0.05	0.16
Albumen (% of egg)		62.46	63.10	64.71	66.14	ns	P < 0.05	0.55
Yolk (% of egg)		25.69	25.46	24.80	24.01	P < 0.01	ns	0.50
Shell thickness (mm)		0.384	0.386	0.344	0.315	P < 0.01	ns	0.01
Shell colour (%)		29.50	30.50	34.0	33.40	P < 0.01	ns	0.94
pH albumen		8.27	8.45	8.24	8.21	P < 0.01	ns	0.03
Haugh index		79.24	79.22	83.78	90.76	P < 0.01	ns	1.35
CN		12.16	11.47	11.31	10.34	P < 0.01	P < 0.01	0.21
Yolk	[1]CP (% [2]DM)	32.87	32.58	32.61	32.84	ns	ns	0.16
	[3]EE (% DM)	57.07	60.02	59.08	58.01	ns	ns	0.87
	Ash (% DM)	3.14	3.18	3.20	3.12	ns	ns	0.05
	Cholesterol (mg/yolk)	235.63	216.68	218.24	233.09	ns	ns	7.33
Albumen	CP (% DM)	83.14	84.21	84.18	83.44	ns	ns	0.27
	Ash (% DM)	5.80	5.67	5.71	5.76	ns	ns	0.09

[1]CP = crude protein; [2]DM= dry matter; [3]EE = ether extract; [4]SEM= Standard error of the mean

Haugh units and the albumen pH were respectively higher and lower in the caged groups GT+GO, suggesting that such parameters may be linked to the rearing system, as was also evidenced by the studies of Pavloski *et al.* (1994) and Muthusamy and Viswanathan (1999). Pavloski *et al.* (1981) found significantly higher Haugh unit values in eggs produced by free-range hens, in contrast with the findings of Mostert *et al.* (1995). Based on the observations reported by Van Den Brand *et al*. (2004)

the height of the albumen decreases with age in hens reared in cages, whereas in free-range hens the variations in this parameter do not appear to be correlated with age.

A comparison between the qualitative parameters of the eggs produced by the groups administered, respectively, traditional feed (AT+GT) and organic feed (AO+GO) revealed a slight increase in egg weight ($P< 0.05$) reduction in albumen percentage ($P< 0.05$) and more intense yolk colour in AT+GT ($P< 0.01$).

The data regarding the chemical characteristics of the yolks and albumens, such as water, protein, fats, ash and fatty acid and cholesterol content of all eggs produced during the trial, were not affected by the rearing system or diet. This confirms the frequent observation that it is difficult to influence the nutritional characteristics of eggs, when in any case the rearing and dietary parameters fall within the range of what may be defined as good rearing practices in which hens' dietary needs are duly met. All the birds showed a good health standard. Hens (focal birds) kept in conventional cages had a lower "plumage score" whilst outdoor reared birds had the possibility of expressing a larger number of natural behaviours such as dust-bathing and ground-pecking. Based on our observations, we may conclude that the parameters tied to egg quality depend not so much on diet – traditional versus organic – as on the rearing system, where a general improvement may be seen in some parameters for eggs produced by free-range hens, such as shell percentage and thickness, which are important for reducing breakage during handling, percentage of yolk, an egg component that is rich in nutrient substances and vitamins, and the more orange colour of the yolk, preferred by consumers. The Haugh units and the albumen pH, observed to be lower in the free-range groups compared to the other two groups, nonetheless showed values consistent with eggs of excellent quality.

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