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Egg quality traits of laying hens reared in organic and conventional systems

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ABSTRACT - This study aims to compare the physico-chemical properties of eggs (weight, eggshell breaking strength, Haugh index, yolk colour, lipid, cholesterol, protein, ash and dry matter) laid either by hens reared according to the organic method or by caged hens kept in conventional system. More than 1,400 eggs have been analysed at the beginning, in the middle and at the end of the laying cycle in organic and conventional farms. The egg obtained from the organic system were lighter (64.4 *vs* 66.2 g) being yolk, albumen and eggshell weights statistically lower in comparison with those produced in conventional system. The yolk/albumen ratio resulted lower in the organic eggs (0.38 *vs* 0.39). The percentage of eggshell was not affected by the hen rearing system while the eggshell strength resulted higher in the eggs produced in the conventional system (3.265 *vs* 3.135 kg). The organic yolks were paler than the conventional ones. Organic eggs showed significantly higher contents of protein (17.1% *vs* 16.7%) and cholesterol (1.26% *vs* 1.21%).

Key words: Laying hen, Organic and conventional systems, Egg, Physico-chemical properties.

INTRODUCTION - Taking into account the current consumer's demands for animal products with high quality standards, new production systems of laying hens have been adopted in order to guarantee better welfare condition of birds, higher food safety while reducing the environmental impact of the farms. In poultry production the organic farming, ruled by the Council Regulation (EC) 1804/99, allows the hens to have access to outdoor pens (4 m^2/hen), to be kept at a low density (6 hens/m^2 of poultry house) in very small units (3,000 hens/house). Moreover, the feed must be formulated by using only organic raw materials without including solvent extracted meals, synthetic supplements such as aminoacids, growth promoters, antioxidants and, as imposed by the Italian legislation in force, also vitamins and allied (D.M. 29/03/2001).

The aim of this study was to compare the physico-chemical properties of eggs laid either by hens reared according to the organic method or by caged hens kept in conventional system.

MATERIAL AND METHODS - The organic hens were kept according to the Council Regulation (EC) 1804/99 whereas for the conventional system the hens were reared in cages providing 550 cm^2 of floor per bird. The hens of both the rearing systems, Hyline brown, received commercial diets normally adopted in practice respectively for organic and conventional systems. More than 1,400 eggs have been collected in three different phases of the hen laying cycle: at the beginning (28-32 weeks of hen age), in the middle (47-50 weeks) and at the end (70-73 weeks) in different organic and conventional farms located in the North of Italy. Eggs were singularly weighted as well as their components (shell, albumen and yolk), albumen height was measured and the Haugh index was calculated. The yolk colour was measured by the Minolta colorimeter CR-300 by using the L*a*b* scale and calculated the Colour Number (CN= -0.21 x L* + 0.31 x a* + 21.83). On a total of 120 pools of 5 yolks each (40 pools per each laying phase) the following parameters were determined: dry matter by oven drying the sample at 100°C for 18 h, total lipids (Folch *et al*., 1957), protein, ash (AOAC, 1990) and cholesterol (Meluzzi *et al.*, 1993). On a total of 1,200 eggs (400 per each laying phase) the eggshell breaking strength was determined by using an Eggshell Force Gauge (Robotmation Co. Ltd.). All data were analysed by two-way ANOVA with interaction using the GLM procedure of SAS (1989) with the main factors being rearing system and laying phase.

Table 1. Weight of egg and of its components in relation to the rearing system and laying phase.

	Egg (g)	Yolk (g)	Egg shell (g)	Albumen (g)	Yolk/albumen (%)
Rearing system (RS)					
Cage	66.2^{A}	16.7^{A}	6.21^{A}	43.3^{A}	0.39^{A}
Organic	64.4^{B}	15.8^{B}	6.11^{B}	42.4^{B}	0.38^{B}
Laying phase (LP)					
28-32 weeks	62.0^{C}	14.5^{B}	6.00^{C}	41.5^{C}	0.35^{B}
47-50 weeks	66.0^{B}	17.0^{A}	6.16^{B}	42.9^{B}	0.40^{A}
70-73 weeks	67.3^{A}	17.1^{A}	6.29^{A}	43.8^{A}	0.39^{A}
EMS	*26.23*	*2.598*	*0.425*	*17.04*	*0.002*
RS	0.0001	0.0001	0.0040	0.0002	0.0001
LP	0.0001	0.0001	0.0001	0.0001	0.0001
RS x LP	0.0001	0.0001	n.s.	0.0009	0.0001

$^{A, B, C}$: P<0.01.

RESULTS AND CONCLUSIONS - The egg weight in the organic system were lighter (64.4 *vs* 66.2 g; P<0.01) being the yolk, the albumen and the eggshell weights statistically lower in comparison with those produced in conventional system. Also the yolk/albumen ratio resulted lower in the organic eggs (0.38 *vs* 0.39; P<0.01) (Table 1). The albumen and egg weight increased significantly (P<0.01) with the hen ageing whereas yolk weight and yolk/albumen ratio increased till 50 weeks of hen age and remain constant afterwards (Table 1). The percentage of eggshell was not affected by the hen rearing system while the eggshell breaking strength resulted higher in the eggs obtained in the conventional system (3.265 *vs* 3.135 kg, P<0.01) (Table 2). Our data are in accordance with the findings of Van Den Brand *et al.* (2004). On the contrary Hughes *et al.* (1985) found a higher thickness and better breaking strength in eggshell of laying hens kept in outside pens but fed conventional diets.

The Haugh index resulted significantly lower in conventional eggs (70.9 *vs* 78.6, P<0.01) and it might be related to the effect of the higher concentration of ammonia in conventional cage system that enhances the albumen pH affecting thus its consistency (Sauveur, 1988). The yolk colour showed a significantly higher lightness and yellowness in organic eggs but a significantly lower redness (-1.75 *vs* 10.2, P<0.01). From the Colour Number evaluation emerged that the organic yolks are paler than the conventional ones (Table 2).

The lower yolk pigmentation of organic egg is mainly due to dietary factors: such as the lack of synthetic pigments normally added to the feeds of hens kept in conventional systems and the exclusion in organic diets of the natural pigment coming from the pasture of outdoor pens. Indeed, because of the restrictions imposed by the Commission Decision 2005/745/EC for the avian flu crisis, the hens in organic systems were kept indoor for the whole laying cycle. The percentage of the egg shell was significantly higher in the first phase of the egg deposition cycle and gradually worsened from the second phase onwards (Table 2).

The chemical composition of egg yolk showed significantly higher contents of protein (17.1% *vs* 16.7%; P<0.01) and cholesterol (1.26% *vs* 1.21%, P<0.01) in organic eggs. The egg collected at the end of the deposition cycle showed lower percentages of lipids and dry matter whereas the cholesterol content was lower in egg of the second laying phase (Table 3). Although the statistical analysis of data showed some significant interactions between the rearing system and the laying phase, however the analysis of the separated effects of the main factors (data not shown) confirmed the significance obtained from the two way ANOVA.

In conclusion, hens of the same breed and age laid lighter eggs and yolks with lower yolk/albumen ratio if kept following the organic method in respect to those kept in conventional system.

This might be partly due to the rearing system but mostly to the different feeding regimen that does not support the birds with an adequate levels of micronutrients needed to maximise their production. Moreover the lower content of micronutrients in organic hen diets, particularly pigments and vitamins, as imposed by the Italian regulation in force, impacts also on yolk pigmentation and on eggshell breaking strength.

Table 2. Eggshell traits, Haugh index and yolk colour (L* a* b* and Colour Number) in relation to the rearing system and laying phase.

	Shell/egg (%)	Breaking force (kg)	Haugh index	L*	a*	b*	CN
Rearing system (RS)							
Cage	9.51	3.265^{A}	70.9^{B}	57.1^{B}	10.23^{A}	48.0^{B}	13.02^{A}
Organic	9.42	3.135^{B}	78.6^{A}	61.9^{A}	-1.75^{B}	50.9^{A}	8.28^{B}
Laying phase (LP)							
28-32 weeks	9.69^{A}	3.457^{A}	82.6^{A}	61.5^{A}	-0.95^{C}	49.6^{B}	8.62^{B}
47-50 weeks	9.34^{B}	3.307^{B}	72.8^{B}	58.9^{C}	4.81^{B}	49.1^{B}	10.94^{A}
70-73 weeks	9.39^{B}	2.943^{C}	71.2^{B}	59.4^{B}	5.15^{A}	50.6^{A}	10.97^{A}
EMS	*0.867*	*0.557*	*124.01*	*6.477*	*3.986*	*19.40*	*0.615*
RS	n.s.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
LP	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
RS x LP	0.0006	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

$^{A, B, C}$: P<0.01.

Table 3. Chemical composition (%) of egg yolk in relation to the rearing system and laying phase.

	Dry matter	Lipid	Protein	Ash	Cholesterol
Rearing system (RS)					
Cage	50.7	31.0	16.7B	1.63	1.21B
Organic	51.1	31.0	17.1A	1.61	1.26A
Laying phase (LP)					
28-32 weeks	51.1A	31.1A	16.5B	1.56B	1.27A
47-50 weeks	51.2A	31.2A	17.1A	1.69A	1.21B
70-73 weeks	50.5B	30.6B	17.1A	1.60AB	1.24AB
EMS	*0.839*	*0.758*	*0.140*	*0.029*	*0.005*
RS	0.0166	n.s.	0.0001	n.s.	0.0094
LP	0.0030	0.0074	0.0001	0.0051	0.0032
RS x LP	n.s.	n.s.	0.045	n.s.	n.s.

$^{A, B}$: P<0.01.

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