Scientific Papers. Series D. Animal Science. Vol. LX, 2017
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

CHEMICAL AND NUTRITIONAL CHARACTERIZATION OF RAW MATERIALS USED TO PRODUCE EGGS AS A FUNCTIONAL FOOD AND THEIR IMPACT ON THE BIO-PRODUCTIVE PERFORMANCE OF LAYING HENS

Vasile BUNDUC, Iulia Lucia NISTOR (COTFAS), Ioan Mircea POP

University of Agricultural Sciences and Veterinary Medicine of Iași,
3, Mihail Sadoveanu Alley, Iaşi, Romania

Corresponding author email: adrian_vb14@yahoo.com

Abstract

Nutritional manipulation is relatively simple in the poultry field as long as the raw material of the laying hens is identified that ensures the bioavailability of the desired nutrient to be enriched in the egg.
The purpose of this study is to characterize the nutritional and chemical ingredients of the recipe for laying hens and its effect on egg quality and the bio-productive performance of the hen. Thus, with regard to the chemical composition of the recipe used which was improved with 2 carotenoid additives with 2% lutein and zeaxanthin, respectively with 5% lutein and zeaxanthin compared to the control recipe, and the administration of these recipe to hens gives a better specific consumption compared to group M; With regard to the quality indices of the eggs obtained, a weight of 65.47 g was observed in the group of birds fed with AC1 2% and 65.25 g in the group in whose recipe AC1 was used 5% compared to the control group Where the average weight of the eggs was 64.13g. In terms of yolk colour, it had average values of 3.78 for group E1 and 4.14 for group E2. Thus, due to the use of raw materials enriched in lutein and zeaxanthin the colour intensity of the yolk was significantly higher compared to the M group (3.61%).

Key words: *nutrition, quality indicators, egg, lutein, zeaxanthin.*

INTRODUCTION

Knowing that on a national and international level there is a special emphasis on superior capitalization of crop plants and of the spontaneous flora, of the natural resources in general, depending on their chemical composition, knowledge of the biologically active substances is a priority for those who want to produce functional foods. Only by knowing the chemical composition of the plants, the biochemical mechanisms underlying the biological phenomena will be obtained feedings for poultry with high content in biologically active substances, which increase the biological value of egg yolk by the high intake of lutein and zeaxanthin (Breithaupt et al., 2007; Hadden et al., 1999; Herke et al., 2014). There are studies that demonstrate that lutein and zeaxanthin help to: maintain heart health by reducing the risk of atherosclerosis; Reduce the development of conditions that compromise immunological status; Can inhibit cellular proliferation, cellular transformation, and modulate expression of genetic determinants in the prevention of certain cancers (Leeson et al., 2004; Martinez et al., 2012; Moros et al., 2002).
Given that a laying hen is a true "egg factory" (Al-Shami Mutahar și colab., 2011) which produces an egg almost daily, the food ration must be elaborated according to rigorous scientific principles, because a small deficit of one or more food components, in within a few days, unbalance the functions of the entire organism, making it receptive to disease and diminishing its production capacity (Al-Haweizy et al., 2007; Perry et al., 2009). The concentration of lutein in eggs is dependent both on the content of carotenoids in the feed administered and on the growing conditions, as it is shown that hens grown on the ground have twice the yolk in yolk than those grown in batteries (Güçlu et al., 2004; Hesterberg et al., 2012; Marin et Pogurschi, 2006). Alfalfa is an rich ingredient in xanthophylls with a high content of protein and vitamins, also corn-rich diets can contain up to 10 mg of lutein and about 5 mg of zeaxanthin. Thus, alfalfa and red corn diets are improving the concentration of

lutein and zeaxanthin in egg yolk (Laudadio et al., 2014; Lokaewmanee et al., 2011; Navid et al., 2011).

MATERIALS AND METHODS

The experiment was conducted for 5 weeks on 170 hens, 35 weeks old. Birds were weighed individually at the beginning of the experiment, being weight-based, in three groups (M, E1, E2). Husked animals were housed with 2 birds / cage in a 3-layer structured battery, allowing for daily logging and food scraps. Water and mixed fodder were administered *ad libitum*. The incandescent lighting of the hall was done according to the growth guide. Birds of the 3 batches were fed with compound feeds that had the same basic structure. In addition to the conventional raw materials used to prepare a mixed feed for the control group (M), a herbal mixture (AC1) was used in the 2 experimental recipes (E1, E2). The rate of inclusion of the two mixtures was 2% and 5% respectively.

A number of accredited methods have been used in line with current standards.

The dry matter, crude protein, crude fat, cellulose and ash content of the fodder were determined in accordance with the provisions of Regulation (EC) No. 152/2009 .

The content of lutein and zeaxanthin was determined by high performance liquid chromatography (HPLC).

Average daily consumption (g NC / head / day), specific consumption (kg NC / kg egg), mean weight of eggs (g), laying rate (%), calculated on the basis of daily production records eggs. In terms of egg analyzes, these included weight of the eggs and their components, colour of the yolk using La Roche scale, thickness of the shell was determined using Egg Shell Thickness Gauge and shear breaking force of shell using Egg Force Reader. The data obtained were statistically processed to assess significance of the statistical differences.

RESULTS AND DISCUSSIONS

Table 1 shows the structure of the carotenoid additive used, with 40% alfalfa being used in its composition, which is used at low concentrations in poultry feed due to its fibre content (2), red corn red corn is found with an 20%, pumpkin and tagetes are in concentration of 15% and marigold 10%.

The experiment was aimed at testing the capacity of the added vegetable mixture in different proportions (2% and 5%), enriching egg yolk in lutein and zeaxanthin.

Table 1. Structure of the carotenoid additive AC-1

Carotenoid additive AC-1	Rate
Alfalfa - meal (dry-milled)	40%
Red corn (dry, milled)	20%
Pumpkin - fruit pulp (dry, ground)	15%
Tagetes - flower (dry milled)	15%
Marigold - flowers (dry milled)	10%

The structure of the experimental recipes is presented in Table 2, being set up in accordance with NRC nutritional requirements and the hybrid growth guide.

Table 2. Structure of experimental recipes used

Specification	M1	E1 (AC1 2%)	E2 (AC1 5%)
Maize, (%)	53.23	51.23	49.67
Soybean meal, (%)	15.71	15.98	15.56
Sunflower seed, (%)	15	15	15
AFC 5, (%)	-	2	4
Oil, (%)	3.21	3.18	3.17
Lysine, (%)	0.09	0.08	0.09
Methionine, (%)	0.12	0.11	0.11
Calcium, (%)	9.85	9.64	9.64
Phosphat, (%)	1.34	1.33	1.32
Salt, (%)	0.4	0.4	0.39
Colina, (%)	0.05	0.05	0.05
Premix A6, (%)	1	1	1
Total raw materials	100	100	100

It can be seen in table 2 that quality parameters have been ensured in all 3 combined fodder that have been produced, which allowed the health status and the production process to be unaffected during the experiment. From the combined feed samples, determinations were made on the chemical composition, with slight differences in crude protein content, respectively, the content of lutein and zeaxanthin, and it was found that the recipe of the 5% AC1 group had the highest xanthophyl content, followed by those of the 2% AC1 and M1 groups, as shown in table 3.

Table 3. Chemical composition of recipes used

Specification	M	E1	E2
Dry matter, (%)	92.27	91.22	92.28
Crude protein, (%)	16.99	16.45	17.56
Crude fat (%)	5.01	4.91	4.98
Cellulose, (%)	6.14	6.48	6.62
Ash, (%)	14.33	13.79	14.14
Lutein + zeaxanthin, (mg / kg)	5.257	13.268	19.791

Bio-productive performances (table 4) show that in E1 group (AC1 2%) the eggs had, on average/experiment, a significant weight (P≤0.05) lower than the other groups. Of the experimental groups, the eggs harvested from the chickens of the E2 group (AC1 5%) had a weight of eggs comparable to that recorded in group M. The data on the laying intensity indicates 96.19% in the control group (M) while in experimental groups E1 and E2 it was 97.06% and respectively 95.37%.

Table 4. Bio-productive performances

Specification	M	E1	E2
Daily average consumption (g MF / head / day)	120.63±5.50 b	116.64±6.17 a,d	118.32±4.22
Specific consumption (kg MF / kg egg)	2.02±0.26	1.97±0.23	2.00±0.21
Average egg weight (g)	63.09±0.96 b,e	61.98±0.55 a,c,e	63.13±3.48 b,e
Laying intensity (%)	96.19±11.3	97.06±10.91	95.37±8.58

* Where: a, b, c, d are significant differences (P≤0.05) from M, E1, E2

Regarding physical parameters, respectively, increase of the yolk colour in the experimental group compared to control, it was made under the influence of addition of carotenoid additive in the combined feed, so that it was 3.61 for the group M, respectively 3.78 for E1 group, and 4.14 for E2 group. The colour of yolk showed proportional increases for the batches analyzed for both the thickness of the shell and its bursting force (table 5).

Table 5. Eggs quality parameters (mean values / experiment)

Specification	M	E1	E2
Yolk color	3.61±0.65	3.78±0.42	4.14±0.64
Egg shell thickness (mm)	0.343±0.029	0.344±0.028	0.354±0.026
Shell breaking force (Kgf)	3.898±0.519	3.964±0.522	4.042±0.562

Regarding variation in weight of egg components, we notice an increase in white proportion 2.05% and a decrease in yolk proportion by 0.3% (fig. 1).
The results obtained from xanthophylls studies in fresh yolk samples indicate mean values of 14.66 mg/kg for group E2, 9.41 mg/kg for group E1 and only 6.65 mg/kg for control group.

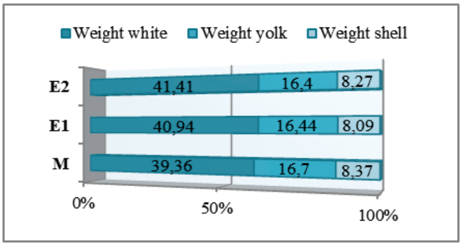

Figure 1. Weight of components in structure of eggs obtained in experiment (average values / experiment)

The administration of compound feed enriched in xanthophylls by the inclusion of carotenoid additives resulted in an increase in xanthophylls content of yolk as well.

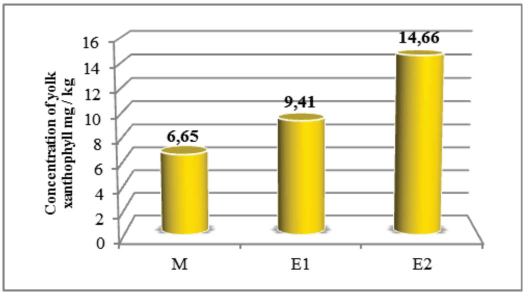

Figure 2. Concentrations of xanthophylls in fresh yolk samples

As expected, the colour of yolk has influenced the decision of consumers who, in an increasing crisis, are looking for quality products with improved nutritional characteristics that help maintain health and provide functionality through daily consumption.

CONCLUSIONS

- carotenoid additives (AC1) used in structure of the compound feed fed to the hens brought a significant improvement in lutein and zeaxanthin;
- the advantages obtained by using AC1 having a high concentration of xanthophylls in compound feed have intensified the colour of the yolk of obtained eggs;
- the use of AC1 in compound feeds administered to laying hens has affected some bio-productive performances and some physical quality parameters, laying strength and egg weight.

REFERENCES

Al-Haweizy A. Arshad, S. Yasin Al-Sardary, 2007. Effect of Dehydrated Alfalfa and Ageon eggweight, egg mass, feed intake, and feed conversion efficiency in Hy-line W-98 layers; Slovak J. Anim. Sci., 40(1):19 - 23

Al-Shami Mutahar A., Salih Mohamed E. and Abbas Talha E., 2011. Effects of dietary inclusion of alfalfa (Medicago sativa L.) leaf meal and xylamenzyme on laying hens' performance and egg quality; Res. Opin. Anim. Vet. Sci., 2(1), 14-18.

Breithaupt D.E., 2007. Modern application of xanthophylls in animal feeding - a review. Trends in Food Science & Technology, 18 (10): 503-506

Güçlu B.K., K.M. Işcan, F. Uyanik, M. Eren, A.C. Ağca, 2004. Effect of alfalfa meal in diets of laying quails on performance, egg quality and some serum parameters. Arch. Anim. Nutr. 58:255–263.

Hadden W.L., Watkins R.H., Levy L.W., Regalado, E., Rivadeneira, D.M., van Breemen R.B., Schwartz S.J., 1999. Carotenoid composition of marigold (Tagetes erecta) flower extract used as nutritional supplement. J. Agric. Food Chem., 10 (47): 4189-4194

Herke R., Gálik B., Bíro D.I, Rolinec M., Šimko M., Juráček M., Majlát M., Arpášová H., 2014. The effect of pumpkin and flaxseed oils on selected parameters of laying hens performance. Acta fytotechn. zootechn., 17, (3): 96–99.

Hesterberg, K., Schanzer, S., Patzelt, A., Sterry, W., Fluhr, J.W., et al., 2012. Raman spectroscopic analysis of the carotenoid concentration in egg yolks depending on the feeding and housing conditions of the laying hens. J Biophotonics 5: 33–39.

Laudadio V., Ceci E., Lastella N. M. B., Introna M., Tufarelli V., 2014. Low-fiber alfalfa (Medicago sativa L.) meal in the laying hen diet: Effects on productive traits and egg quality. Poultry Science 93:1868–1874

Leeson, S., Caston, L, 2004. Enrichment of eggs with lutein. Poult. Sci. 83: 1709–1712

Lokaewmanee, K. et al., 2011. Enhancement of Yolk Color in Raw and Boiled Egg Yolk with Lutein from Marigold Flower Meal and Marigold Flower Extract. In Journal of Poultry Science, vol. 48, no. 1, pp. 25–32. DOI: http://dx.doi.org/10.2141/jpsa.010059

Marin Monica, Pogurschi Elena, 2006. Researches concerning the influence of canthaxantin in the combinated fodder of hens on the quality of the eggs for hatching. Lucrări ştiinţifice Zootehnie şi Biotehnologii, vol.XXXIX, 99-104, Timişoara, ISSN 1221-5287.

Martínez Y., Valdivié M., Solano G., Estarrón M., Martínez O., Córdova J., 2012. Effect of pumpkin (Cucurbita maxima) seed meal on total cholesterol and fatty acids of laying hen eggs. Cuban Journal of Agricultural Science, Vol. 46, No. 1, 73:78.

Moros, E.E., Darnoko, D., Cheryan, M., Perkins, E. G., Jerrell, J., 2002. Analysis of xanthophylls in corn by HPLC. Journal of agricultural and food chemistry, 50(21), 5787-

Navid H. M., 2011. Effect of different level of Alfalfa extract on performance, Egg Quality and some Blood parameters of Laying Hens , Scholars Research Library , Annals of Biological Research, 2 (6):384-388.

Perry, A., Rasmussen, H., Johnson, E. J. 2009. Xanthophyll (lutein, zeaxanthin) content in fruits, vegetables and corn and egg products. Journal of Food Composition and Analysis, 22 (1), 9-15.

COMMISSION REGULATION (EC) No 152/2009 of 27 January 2009 laying down the methods of sampling and analysis for the official control of feed.