PhD THESIS ABSTRACT

Keywords: *energy value heavy metals, nitrates/nitrites, pesticides, DON, Salmonella*.

The PhD dissertation called ***"Assessment of laying hens feeding for organic eggs production"*** is structured in two parts: the literature survey and the original research plus conclusions and recommendations.

The literature survez contained four chapters:

✓ *chapter I* describes the current situation of organic fodder production for laying hens with the legal issues comprising this branch of agriculture, nationally and internationally organic production statistics as well as data on agricultural land used for organic production of feed for laying hens;

✓ *chapter II* describes the principles for feeding birds with issues related to feeding of laying hens based on mixed fodder, energy, protein, mineral and vitamins intake precum and issues related to systems and methods of feeding specific to hens;

✓ *chapter III* contains data on the nutritional value of the main categories of feed (mixed fodder, green fodder represented by natural pasture and *fauna available on organic pasture*) and estimation of feed intake form pasture and nutritive value;

✓ *chapter IV* describes certain categories of pollutants (*heavy metals* - Pb, Cd, Cu and Zn, *pesticides* - organochlorine and organophosphorus, *nitrate*, *nitrite*, *mycotoxins* - *deoxynivalenol, bacteria - Salmonella spp)* and their concentration in certain types of soil and fodder used in laying hens specifying sources of contamination in feed and the maximum allowable limits of these pollutants.

The original research part is structured in five chapters as follows:

✓ *chapter V* describes the purpose of the research and the materials and methods used to achieve goals, presents the research framework, the experimental scheme and the institutional and organizational framework which hosted the research;

✓ *chapter VI* presents original research results and their discussion on gross chemical composition, energy value, heavy metals content - Pb, Cd, Cu, Zn, nitrates, nitrites content, contamination with pesticides, DON and *Salmonella* of mixed fodder samples analyzed in three periods of the laying hens curve in 2012 - 2013 (the beginning of the laying – the 4th week lay, peak lay - the 9th week lay and finally lay - the 36th week lay) from the two production systems (organic and conventional);

✓ *chapter VII* presents original research results and their discussion on gross chemical composition, energy value, heavy metals content - Pb, Cd, Cu, Zn, nitrates, nitrites content, contamination with pesticides of green fodder (represented by natural pasture) collected and analyzed in three periods of the laying hens curve (the beginning of the laying – the 4th week lay, peak lay - the 9th week lay and finally lay - the 36th week lay) with the second scythe stage of vegetation, scythe third and beginning of flowering, in the organic production system.

✓ *chapter VIII* presents original research results and their discussion on additional dietary intake estimation of laying hens diet from organic system chemical composition and energy value of the crop and gizzard that finally estimate the total dietary intake.

✓ *chapter IX* presents original research results and their discussion on gross chemical composition, heavy metals content - Pb, Cd, Cu, Zn, nitrates, nitrites content, contamination with pesticides, *Salmonella* and some physical features of eggs (weight of the eggs and of their components, Haugh index and intensity of yolk coloration) in samples eggs (albumen, yolk and mixture) collected and analyzed in three periods of the laying hens curve (the beginning of the laying – the 4th week lay, peak lay - the 9th week lay and finally lay - the 36th week lay) from the two production systems (organic and conventional).

Research goal and objectives were to evaluate the quality of fodder and eggs from organic and comparison with fodder and eggs from conventional systems through the set out indicators. For evaluation of idetntificate fodder quality in conventional and ecological system were followed: *gross chemical composition, energy value, concentration in certain mineral, content of certain heavy metals, nitrates, nitrites, degree of pesticides contamination, Salmonella and DON mycotoxin contamination*. For evaluation of eggs quality derived conventional and ecological system were followed: *gross chemical composition, energy value, concentration in certain mineral, content of certain heavy metals, nitrates, nitrites, degree of pesticides contamination, Salmonella contamination and certain physical analysis (weight of the eggs and of their components, Haugh index, intensity of yolk coloration).*

Research design. To achieve proposed goal were identified two production systems (conventional one „**C**" and organic one „**E**") where, in three different periods of the laying cycle between 2012 -2013 (beginning lay - 4th week of laying, peak lay - 9th week of laying and the end lay - 36th week of layin) were collected and analyzed samples. The research was conducted in the following units: specialized units in exploiting of laying hens in conventional system (identified as „*Unit C*") respectively in organic system („*Unit E*"), *University of Agricultural Sciences and Veterinary Medicine* "Ion Ionescu de la Brad" from Iaşi (*Forage Quality Control Laboratory – Faculty of Animal Husbandry and Plant and Soil Analysis*

Laboratory - Faculty of Agriculture) and *Analysis laboratories in the D.S.V.S.A. Iaşi* (*Laboratory of residues and microbiological*).

For a better interpretation of the results was taken into account characterize the growth and exploitation conditions of laying hens in organic and conventional system (norms and technology of growth and exploitation, stocking density, front feeding and watering, number of nests, temperature, humidity and lighting duration during laying).

Norms of growth and exploitation in "**Unit E**" have complied with guide the of growth of the hybrid unit (Lohmann Brown) free range conditions, the 2011 edition and regulations on organic production (*Regulation (EC) no. 834/2007 and Regulation (EC) no. 889/2008*).

Technology of growth and exploitation of organic hybrid was on the ground permanent litter inside the hall, with a density of 6 bird/m^2 and with free access to an area of natural pasture of 4m^2/bird, consisting of *Dactylis glomerata* (orchard grass) and *Medicago sativa* (alfalfa).

Other conditions provided both in the hall and the outdoor paddock in the organic unit were considered: feeding a front of 10 cm/bird and watering of 4 cm/bird, one nest for 5 birds, temperature during laying inside the hall was between 21 – 22°C and the the outside environment between 14.2 – 16.1°C, relative humidity from hall was between 55 – 75% and lighting duration was 14 hours (in the hall) and access to the grassy paddock by light program during the summer and winter.

The recipe composition of organic fodder were used as feed materials from certified organic agriculture.

Norms of growth and exploitation in "**Unit C**" complied with guide the of growth of the hybrid unit (ISA Brown), the 2011 edition.

Technology of growth and exploitation of conventional hybrid was on the ground permanent litter, with a density of 9 birds/m^2.

Other conditions provided in the conventional unit were considered: feeding a front of 10 cm/bird, one watering for 10 birds and one nest for 7 birds. Temperature during laying inside the hall was between 23 – 24°C, relative humidity from hall was between 65 – 75% and lighting duration was for 15 hours.

Research material and methods. For determining indicators set a total of 258 laboratory samples were analyzed; *mixed fooder:* organic and conventional – 30 samples, *green fooder:* organic natural grassland – 15 samples, *invertebrate available on organic pasture* – 30 samples; crop and gizzard (content) – 18 samples; *eggs (albumen, yolk and mixture)*: organic and conventional – 180 samples.

Sampling was made in accordance with inforce standards and legislation (Order ANSVSA no. 147/23-12-2005, SR EN ISO 6497:2005, SR ISO 13690:2007, STAS 9597/1-74, SR ISO 6498:2001, Regulation (EC) no. 178/2010 and method 925.29 AOAC, 1990).

Determination of chemical composition of analised samples was performed using standardized techniques and modern devices calibrated to minimize the possible errors that can occur during analysis, thus ensuring the scientific value of the results.

For chemical determinations the following standards were used: for dry matter and moisture: SR ISO 711:1999, SR ISO 6496:2001 and SR ISO 712:2010, for crude ash SR EN ISO 2171:2010 and AOAC, 1990, for crude protein SR EN ISO 5983 1:2006/AC:2009, SR EN ISO 20483:2007 and AOAC, 1990, for crude fat SR ISO 6492:2001 and method 925.32 AOAC, 1990, crude fiber to SR EN ISO 6865:2002, for mineral composition SR EN ISO 6869:2002, SR EN ISO 14082:2003, for the determination of pesticides SR EN ISO 14181:2001, SR EN ISO 14182:2001 și A.O.A.C.,1990 and for nitrates and nitrites determination SR 13175:1993.

To identify bacteria of the genus Salmonella samples follow the standard SR EN ISO 6579:2003/AC 2009 and Regulation (EC) no. 2073/2005.

Original research results. After statistical processing of data resulted from chemical analyzes in the three periods of analysis, during research 2012 – 2013 on studied samples, we obtained significant differences between the two types of systems (organic and conventional) where appropriate; they are presented below in groups of analyzed indicators (*chemical composition* - dry matter (DM), crude ash (Ash), organic matter (OM), crude protein (CP), crude fat/ether extract (EE), crude fiber (CF), nitrogen free extract (NFE), calcium (Ca), phosphorus (P), magnesium (Mg) and sodium (Na), *energy value* - kcal ME/kg, *heavy metal content* - Pb, Cd, Cu and Zn, *nitrates* (NO_3^-) *and nitrites* (NO_2^-) concentration and degree of contamination with *pesticides*, with *mycotoxin DON* and bacteria of the genus *Salmonella*, *nutritional intake of feed*, *physical characteristics of egg quality* – egg weight and their components, Haugh index and yolk color intensity) for each category of samples analyzed (*mixed fooder*, *additional fodder identified in organic unit* – green fooder, invertebrates, *crop and gizzard contents of laying in the organic unit*, *eggs* – albumen, yolk and mixture).

A. Assessing the quality fodders used in conventional vs.organic system

Gross Chemical composition

❖ **mixed fooder**

Differences very statistically significant (*$p<0.001$)* between the two systems (conventional vs. organic) were recorded for the content in: *DM* - 89.57 vs. 93.06 %/kg at the beginning of the laying, *CP* - 17.92 vs. 18.59 %/kg at the beginning of the laying, 16.13 vs. 17.23 %/kg in peak lay and 16.1 vs. 16.85 %/kg at finally lay, *GB* - 3.3 vs. 4.53 %/kg at the beginning of the laying, 3.66 vs.

4.39 %/kg in peak lay, *NFE* - 61.37 vs. 59.4 %/kg at the beginning of the laying, 60.7 vs. 58.85 %/kg in peak lay and 60.15 vs. 59.1 %/kg at finally lay and *Mg* - 0.33 vs. 0.29 %/kg at the beginning of the laying, 0.28 vs. 0.26 %/kg in peak lay and 0.32 vs. 0.3 %/kg at finally lay;

Differences distinct statistically significant ($p<0.01$) between the two systems (conventional vs. organic) were recorded for the content in: *DM* - 90.14 vs. 90.68 %/kg at the beginning of the laying, *OM* - 86.91 vs. 86.64 %/kg at the beginning of the laying and *EE* - 3.91 vs. 4.18 %/kg at finally lay;

Differences statistically significant ($p<0.05$) between the two systems (conventional vs. organic) were recorded for:content in: *DM* - 90.74 vs. 91.28 %/kg at finally lay, *Ash* - 13.09 vs. 13.36 %/kg at the beginning of the laying and 14.31 vs. 14.46 %/kg in peak lay;

Differences statistically insignificant ($p>0.05$) between the two systems (conventional vs. organic) were recorded for the content in *Ash* (at finally lay), *OM* (in peak lay and at finally lay), *CF, Ca, P* and *Na* (in all three periods of analysis).

There tend to contain higher in DM, Ash, CP and EE and lowered in OM, CF (for samples from beginning and end of laying period), NFE and minerals analyzed in mixed fodder possible explanation is the influence of dependent some factors in achieving quality parameters of fodder: cultivated variety through genetic potential, quality conditions to ensure all elements of culture technology and pedoclimatic due the natural landscape of the area.

❖ **organic green fooder - *natural pasture***

After analyzing the chemical composition were obtained the following average values between: 21.98 ÷ 25.15 % for content in *DM*, *Ash* - 9.02 ÷11.85 %DM, *OM* - 88.15 ÷ 90.98 %DM, *CP* - 15.12 ÷28.08 %DM, *EE* - 2.01 ÷2.26 %DM, *CP* - 21.9 ÷ 30.09 %DM, *NFE* - 35.91 ÷ 43.76 %DM, *Ca* - 1.26 ÷ 1.3 %DM, *P* - 0.49 ÷ 0.57 %DM, *Mg* - 0.139 ÷ 0.155 %DM and *Na* - 0.198 ÷ 0.219 %DM.

After chemical composition of green fodders (natural pasture) of organic systems differ from one period of analysis to another depending on the stages of plant vegetation. When the plant aging is recorded on the one hand, a decrease in protein content, ash, fat and minerals and on the other hand, there is an increase in the percentage of dry matter, organic matter, nitrogen-free pulp and extractive substances

❖ **invertebrate available on organic pasture**

After analyzing the chemical composition were obtained the following average values between: 18.4 ÷ 22.6 % for content in *DM, Ash* - 4.8 ÷ 6.2 %DM, *OM* - 93.8 ÷ 95.2 %DM, *CP* - 53.2 ÷ 65.16 %DM, *EE* - 2.4 ÷ 3.3 %DM, *CF* - 2.2 ÷ 3.1%DM, *NFE* - 23.14 ÷ 35.9 %DM, *Ca* - 0.3 ÷ 0.41 %DM, *P* - 0.7 ÷ 0.82 %DM, *Mg* - 0.02 ÷ 0.028 %DM and *Na* – 0.29 ÷ 0.33 %DM.

Chemical composition invertebrate available on organic pasture had average values vary from one period of analysis to another depending on their activity (which can be influenced by temperature, humidity, season) or accessibility topsoil (which may be influenced by the degree of compaction of the soil).

❖ **crop content of hens in organic unity**

After analyzing the chemical composition were obtained the following average values between: 94.26 ÷ 94.31 % for content in *DM*, *Ash* - 24.69 ÷ 27.93 %DM, *OM* - 72.07 ÷75.31 %DM, *CP* - 10.49 ÷ 11.6 %DM, *EE* - 1.96 ÷ 2.09 %DM, *CF*- 4.43 ÷ 5.55 %DM, *NFE*- 54.07 ÷ 57.66 %DM.

❖ **gizzard content of hens in organic unity**

After analyzing the chemical composition were obtained the following average values between: 95.09 ÷ 95.24 % for content in *DM*, *Ash* - 36.23 ÷ 45.27 %DM, *OM* - 54.73 ÷ 63.77 % DM, *CP* - 7.5 ÷ 9.33 % DM, *EE* - 1.73 ÷ 2.02 % DM, *CF* - 6.6 ÷ 7.98 %SU, *SEN* - 38.77 ÷ 44.44 %SU.

There were statistical differences between mean values of crop and gizzard content harvested in three periods of the laying curve gross chemical composition was influenced by the amount and the kind of feed consumed according to the preferences of hens for feed.

Energy value

❖ **mixed fodder** had a metabolizable energy of 2750 Kcal/kg conventional mixed fodder vs. 2780 Kcal/kg organic mixed fodder which remained the same in the three periods analyzed, different values between energy systems can be attributed to the recipes used in the two units.

❖ For **additional feed from organic systems**, the energy value of **green fodder** varied according to the stage of vegetation, with maximum metabolizable energy (2836 kcal ME/kg DM) during the beginning of flowering (April 21-May 4) after which the value falls due to the continuous increase in cellulose content (2673 kcal ME/kg DM) during the third scythe stage of vegetation (October 21 to 27). The mean content in ME (kcal/kg DM) of available **invertebrate** on the organic pasture ranged from 1991 ÷ 2461 kcal ME/kg DM.

❖ **the crop and gizzard content of hens in organic unity** had a metabolizable energy with values between 2539 ÷ 2588 Kcal/kg DM (crop content) and 979 ÷ 1148 kcal ME/kg DM (gizzard contents).

Heavy metals content - Pb, Cd, Zn and Cu

❖ **mixed fodder**

Differences very statistically significant ($p<0.001$) between the two systems (conventional vs. organic) were recorded in all three periods analyzed for heavy metals analyzed. Thus intervals set were average values for content in: *Pb* – 0.43 ÷ 0.63 vs. 0.11 ÷ 0.19 mg/kg, *Cd* – 0.031 ÷ 0.035 vs. 0.027 ÷ 0.031 mg/kg, *Cu* – 1.69 ÷ 1.8 vs. 4.84 ÷ 5.12 mg/kg and *Zn* – 3.117 ÷ 3.79 vs. 2.061 ÷ 2.088 mg/kg.

❖ **organic green fodder - *natural pasture***

There were statistical differences between mean values of green fodders harvested in the three periods of the laying curve (for the beginning of laying corresponded scythe second stage of vegetation, for laying peak corresponded to the third stage scythe of vegetation and the end of laying vegetation corresponded beginning flowering stage). The chemical analysis were obtained the following average values between: *Pb* - 0.29 ÷ 0.44 mg/kg DM, *Cd* - 0.021 ÷ 0.028 mg/kg DM, *Cu* - 2.53 ÷ 2.64 mg/kg DM and *Zn* - 2.828 ÷ 2.961 mg/kg DM.

All values obtained for the concentration of toxic heavy metals (Pb and Cd) were below the maximum allowed by law (10 mg Pb/kg feed and 1 mg Cd/kg feed). In the case of the concentration of potentially toxic metals studied (Cu and Zn) values obtained were within the range allowed by the norms of 8 mg Cu/kg mixed fodder, recommended value for the conventional (Technology guide for ISA Brown, 2011) and 5 mg Cu/kg mixed fodder, recommended value for organic systems (Free-range technology guide for Lohmann Brown, 2011) and 60 mg Zn/kg mixed fodder, recommended value for both systems.

Nitrates (NO_3^-) and nitrites (NO_2^-) content

❖ **mixed fooder**

Differences very statistically significant (*$p<0.001$)* between the two systems (conventional vs. organic) were recorded in all three periods analyzed for nitrite and nitrate. Thus intervals set were average values for content in: NO_3^- - 18.6 ÷ 56.96 vs. 27.92 ÷ 30.87 ppm and NO_2^- - 1.6 ÷ 1.98 vs. 0.39 ÷ 0.7 ppm.

❖ **organic green fodder - *natural pasture***

After chemical analysis were obtained the following average values between 363.12 ÷ 377.64 ppm for NO_3^- content and 0.61 ÷ 0.83 ppm for NO_2^- content.

All samples analyzed for nitrate content was below the maximum allowable 15 ppm NO_2^- feed provided by Regulation 574/2011. Also, the nitrate content of all samples analyzed were below the recommended values found to be safe to eat animals, 4400 ppm NO_3^- (*Limin, 2007*).

Degree of contamination with pesticides

Gas chromatographic analysis of organochlorine and organophosphorus pesticides concentrations in mixed fooder samples (collected from both systems), green fodder (collected from organic system) and egg samples (collected from both systems) showed that pesticide residues were below the limit of quantification of the device (LOQ = 0.01 mg/kg DM) and below the maximum allowable of 0.05 mg/kg for organochlorine to 0.001 mg/kg organophosphorus pesticides.

Degree of contamination with mycotoxin deoxynivalenol (DON) of mixed fooder

After determinations carried out on mixed fodder samples from both systems DON content not exceeding of the allowable limits set out in EU regulations, although all samples were contaminated; average values determined (organic vs. conventional) were in the range 0.119 ÷ 0.142 vs. 0.1 ÷ 0.129 mg/kg.

Presence of Salmonella spp.

The microbiological determinations carried out on mixed feed samples collected from both systems have demonstrated the absence of *Salmonella* bacteria at each of the three periods of analysis.

B. Daily feed intake in conventional and organic system

The average daily feed consumption in the conventional and organic system

- Average daily consumption of *mixed fooder*: *in conventional system* – 107 ÷ 132 g and *in organic system* – 110 ÷ 115 g.
- Average daily consumption of *ddition*al *fodder from organic system*: *green fooder* – 2.91 ÷ 3.05 g SU and *inevertebrates* – 1.34 ÷ 1.74 g SU.
- Total average daily consumption of laying hens from organic system determined by *crop content* – 40.6 ÷ 41.58 g DM and *gizzard content* – 31.61 ÷ 34.62 g DM.

Total daily feed intake from the conventional vs. organic system

- in energy: *in conventional system* – 294 ÷ 363 kcal ME/hen/day, *in organic system* – 306 ÷ 320 kcal EM/cap/zi (by mixed fooder), 7,88 ÷ 8,33 kcal ME/hen/day (by green fooder) and 2,67 ÷ 4,28 kcal ME/hen/day (by invertebrates);
- in nutrients: *CP* - 19.19 ÷ 23.36 vs. 17.36 ÷ 21.85 g/hen/day, *EE* - 2.98 ÷ 3.92 vs. 5.05 ÷ 5.51 g/hen/day, *CF* - 3.55 ÷ 6.76 vs. 5.34 ÷ 6.72 g/hen/day, *Ca* - 3.33 ÷ 4.11 vs. 3.35 ÷ 3.74 g/hen/day, *P* - 0.29 ÷ 0.37 vs. 0.3 ÷ 0.39 g/hen/day, *Mg* - 0.31 ÷ 0.4 vs. 0.29 ÷ 0.38 g/hen/day and *Na* - 1.92 ÷ 2.51 vs. 1.94 ÷ 2.2 g/hen/day.

Dietary intake in organic system necessitated energy and nutrients derived mainly from mixed fodder and less from consumption of green fodder and invertebrates.

C. Assessing the quality eggs produced in conventional vs.organic system

Gross chemical composition

Differences very statistically significant (*$p<0.001$)* between the two systems (conventional vs. organic) were recorded for:

- albumen for content in: *EE* - 0.17 vs. 0.1 %DM at the beginning of the laying and 0.04 vs. 0.03 %DM in peak lay, *Ca* - 3.9 ÷ 4.02 vs. 5.2 ÷ 6.08 mg/100g fresh product (in all three periods of analysis), *P* – 10.89 ÷ 12.6 vs. 11.66 ÷ 14.16 mg/100g fresh product, *Mg* – 8.2 ÷ 10.01 vs.

9.91 ÷ 11.5 mg/100g fresh product și *Na* – 96.22 ÷ 132.21 vs. 166.12 ÷ 198.42 mg/100g fresh product (in all three periods of analysis);

- yolk for content in: *EE* – 56.3 vs. 56.6 %DM at finally lay, *Ca* - 137.82 vs. 98.21 mg/100g fresh product in peak lay, *P* - 226.07 vs. 312.11 mg/100g fresh product at the beginning of the laying and *Mg* - 5.05 vs. 6.54 mg/100g fresh product at finally lay;
- mixture for content in: *NFE* – 5.19 vs. 2.23 %DM at finally lay, *Ca* – 42.25 ÷ 52.16 vs. 68.11 ÷79.49 mg/100g fresh product, *P* – 163.8 ÷ 182.17 vs. 173.78 ÷ 196.72 mg/100g fresh product, *Mg* – 9.5 ÷ 11.6 vs. 11.2 ÷13.9 mg/100g fresh product and *Na* – 119.5 ÷ 129 vs. 129.1 ÷ 142.03 mg/100g fresh product (in all three periods of analysis);

Differences distinct statistically significant (*p<0.01*) between the two systems (conventional vs. organic) were recorded for:

- albumen for content in: *EE* – 0,09 vs. 0,07 %DM at finally lay;
- yolk for content in: *NFE* – 1,19 vs. 0,61 %DM at finally lay, *P* - 329,09 vs. 402,71 mg/100g fresh product in peak lay, *Mg* - 6,22 vs. 7,12 mg/100g fresh product in peak lay and *Na* – 37,9 ÷ 42,6 vs. 41,6 ÷ 51,2 mg/100g fresh product (in all three periods of analysis);
- mixture for content in: *NFE* - 9,74 vs.7,28 %DM at the beginning of the laying.

Differences statistically significant (*p<0.05*) between the two systems (conventional vs. organic) were recorded for:

- albumen for content in: *NFE* – 3.92 ÷ 5.92 vs. 3.42 ÷ 4.98 %DM (in all three periods of analysis);
- yolk for content in: *NFE* – 8.78 vs. 6.7 %DM at the beginning of the laying and 4.4 vs. 3.52 %DM in peak lay, *Ca* - 108.79 vs. 102.6 mg/100g fresh product at the beginning of the laying and 122.79 vs. 109.1 mg/100g fresh product at finally lay, *P* - 481.23 vs. 512.08 mg/100g fresh product at finally lay and *Mg* - 7.8 vs. 8.33 mg/100g fresh product at the beginning of the laying;
- mixture for content in: *SEN* – 6.34 vs. 5.94 %DM in peak lay.

Differences statistically insignificant (*p>0.05*) between the two systems (conventional vs. organic) were recorded for:

- albumen for content in: *DM, Ash, OM* and *CP* (in all three periods of analysis);
- yolk for content in: *DM, Ash, OM* and *CP*(in all three periods of analysis) and *EE* (at the beginning and in peak of the laying);
- mixture for content in: *DM, Ash, OM, CP* and *EE* (in all three periods of analysis).

The results on the quality of eggs showed differences printed by two farming systems (organic and conventional), with good levels in yolk for proteins and lipids, for albumen proteins and minerals both albumen and yolk from eggs laid of chickens reared organically in all three periods analyzed.

The level of fodders minerals analyzed was influenced by several features related to the plant, which also points out genetic differences, botanical composition, stage of vegetation, different parts of the plant, the chemical form of mineral salts, climate, season. Generally with increasing of the growing decreases the plants content in certain minerals such as P, Na, Zn and increases Mg, Ca. Young plants contain the most assimilable form.

Heavy metals content - Pb, Cd, Zn and Cu

Differences very statistically significant (*p<0.001)* between the two systems (conventional vs. organic) were recorded for:

- albumen for content in: *Pb* – 0.11 ÷ 0.15 vs. 0.1 ÷ 0.14 mg/kg fresh product and *Cd* – 0.007 ÷ 0.011 vs. 0.006 ÷ 0.009 mg/kg fresh product (in all three periods of analysis);
- yolk for content in: *Pb* – 0.2 ÷ 0.24 vs. 0.18 ÷ 0.21 mg/kg fresh product and *Cd* – 0.009 ÷ 0.011 vs. 0.006 ÷ 0.009 mg/kg fresh product (in all three periods of analysis);
- mixture for content in: *Pb* – 0.29 ÷ 0.35 vs. 0.26 ÷ 0.32 mg/kg fresh product and *Cd* – 0.008 ÷ 0.013 vs. 0.006 ÷ 0.011 mg/kg fresh product (in all three periods of analysis).

Differences distinct statistically significant (*p<0.01*) between the two systems (conventional vs. organic) were recorded for:

- albumen for content in: *Cu* – 1.3 vs. 1.19 mg/kg fresh product at finally lay.

Differences statistically significant (*p<0.05*) between the two systems (conventional vs. organic) were recorded for:

- albumen for content in: *Cu* – 1.33 vs. 1.24 mg/kg fresh product at the beginning of the laying.

Differences statistically insignificant *(p>0.05*) between the two systems (conventional vs. organic) were recorded for:

- albumen for content in: *Cu* - in peak lay and *Zn* - in all three periods of analysis;
- yolk for content in: *Cu* and *Zn* - in all three periods of analysis;
- mixture for content in: *Cu* and *Zn* - in all three periods of analysis.

For all samples analyzed the values for toxic heavy metals were below the limit of 0.205 mg Pb/kg and below the maximum of 0.018 mg Cd/kg, values suggested by EFSA (*EFSA, 2009b; ESFA, 2010*).

For concentration of heavy metals analyzed average values determined for all samples taken from the ecological system were lower than the mean values determined for samples from the conventional system.

Nitrates (NO_3^-) and nitrites (NO_2^-) content

Differences very statistically significant (*p<0.001)* between the two systems (conventional vs. organic) were recorded for:

- albumen for content in: NO_3^- – 2.642 ÷ 2.75 vs. 0.742 ÷ 0.94 mg/kg fresh product and NO_2^- – 0.06 ÷ 0.104 vs. 0.241 ÷ 0.359 mg/kg fresh product (in all three periods of analysis);
- yolk for content in: NO_3^- – 8.151 ÷ 14.989 vs. 5.54 ÷ 5.894 mg/kg fresh product and NO_2^- – 0.202 ÷ 0.31 vs. 0.12 ÷ 0.27 mg/kg fresh product (in all three periods of analysis);
- mixture for content in: NO_3^- – 5.317 vs. 4.017 mg/kg fresh product at the beginning of the laying and 5.621 vs. 5.209 mg/kg fresh product at finally lay and NO_2^- – 0.132 vs. 0.193 mg/kg fresh product in peak lay and 0.141 vs. 0.202 mg/kg fresh product at finally lay.

Differences distinct statistically significant (*p<0.01*) between the two systems (conventional vs. organic) were recorded for:

- mixture for content in: NO_3^- - 5.531 vs. 5.118 mg/kg fresh product in peak lay and NO_2^- - 0.127 vs. 0.139 mg/kg fresh product at the beginning of the laying.

All egg samples analyzed in the three periods of analysis for nitrite content were below the levels allowed in food (of animal and vegetal origin) from 10 mg NO_2^-/kg and 100 mg rarely NO_2^-/kg (*FAO/WHO, 1995*).

Higher nitrite content in albumen and mixture samples from organic system may be due to birds access to the paddock covered by grass and green fodder consumption of up to 3.24 g of fresh content, this analysis showed an average content up to 0.83 mg/kg.

Degree of contamination with pesticides

Gas chromatographic analysis of organochlorine and organophosphorus pesticides concentrations in eggs samples (collected from both systems) showed that pesticide residues were below the limit of quantification of the device (LOQ = 0.01 mg/kg DM) and below the maximum allowable of 0.1 mg/kg fresh product for lindane, aldrin and dieldrin and 0.5 mg/kg fresh product for DDT – in food.

Presence of Salmonella spp.

The microbiological determinations carried out on eggs samples collected from both systems have demonstrated the absence of *Salmonella* bacteria at each of the three periods of analysis.

Weight of the eggs and of their components

Differences very statistically significant (*p<0.001)* between the two systems (conventional vs. organic) were recorded for:

- albumen - 26.78 ÷ 43.52 vs. 30.41 ÷ 46.58 g (in all three periods of analysis);
- yolk - 16.92 ÷ 18.57 vs. 11.34 ÷ 13.04 g (in all three periods of analysis);
- shell- 7.88 vs. 6.43 at the beginning of the laying and 7.62 vs. 6.03 in peak lay.

Differences distinct statistically significant ($p<0.01$) between the two systems (conventional vs. organic) were recorded for:

- whole egg – 51.58 ÷ 70.07 vs. 48.18 ÷ 66.64 g (in all three periods of analysis);
- shell - 8.19 vs. 7.05 at finally lay.

Weight of eggs from organic system was lower than that of eggs from the conventional system, with higher proportions of white and lower of yolk and shell.

Haugh index of eggs

Differences very statistically significant ($p<0.001$) between the two systems (conventional vs. organic) were recorded to the three periods analyzed average values between 63.9 ÷ 73.4 vs. 73.4 ÷ 82.9 U.H.

Lower values of Haugh index results on egg samples decreased from one lay period to another, which due to aging of birds and thus albumen pH increases, due to loss of carbon dioxide through the pores of the shell; at the same time whites gradually liquefies, while electrostatic links between lysozyme ovomucină and loosening.

Intensity of yolk coloration

Differences very statistically significant ($p<0.001$) between the two systems (conventional vs. organic) were recorded at the beginning of the laying 12.8 vs. 7.9 no. color on scale La Roche and in peak lay 12.3 vs. 8.2 no. color on scale La Roche.

Differences distinct statistically significant ($p<0.01$) between the two systems (conventional vs. organic) were recorded at finally lay 8.4 vs. 7.1 no. color on scale La Roche.

Lower organic yolk pigmentation was attributed to the low intake of feed containing the pigments that give yolk color.

Conclusions. Research results allow the following conclusions:

- Between the two rearing systems are differences in the quality of fodder used and products obtained outlined in chapter about comparative assessment of feeding hens in organic systems to the conventional.
- If in the content of organic and mineral components are variable and sometimes contradictory data, the results of research have shown the following:

- organic *mixed fodder* contain a higher proportion of dry matter, crude ash, crude protein, crude fat and low in organic matter, crude fiber (for samples from beginning and end of the laying period), nitrogen free extract and for minerals analyzed than conventional mixed fodder.
- organic *eggs* have better levels in yolk proteins and lipids, albumen proteins and minerals both albumen and yolk compared to conventional egg.

➢ On the other side, fodder used and products obtained organic are lower in undesirable components: heavy metals, pesticides, nitrates, mycotoxins, bacteria compared to conventional ones.

Recommendations. We consider that in any zootechnical farm is absolutely necessary and we recommend strict selection of fodder ingredients and their detailed analysis, measures absolutely necessary for assessing fodder quality to obtain quality products.