SUMMARY

Key words: **xanthophylls, antioxidants, eggs, functional food, health, consumers**

The key for maintaining the health state is represented by rational nourishment, and egg is one of the foods which fulfil all the criteria for a functional food, this one improving the sanguine flow, strengthening the immune system, protecting the eyesight and assuring a good functioning of brain.

So, the PhD thesis entitled ***"Innovative nutritional solutions to obtain with functional eggs"***, is structured in two parts: the part of literature study and part of own research summing 11 chapters, at which were added general conclusions and recommendations, together with thesis' originality and innovative contributions as well as the studied literature.

In first part of thesis were included three chapters which illustrate the specific of digestion and nourishment at laying hens, quality and nutritive value of hen eggs as well as general aspects regarding obtaining of eggs with functional character by utilisation of foddering additives.

Second part of the PhD thesis, structured in eight chapters, illustrate research aim and design, materials and working methods, the obtained results regarding enrichment of hen eggs in xanthophylls, saturated fatty acids and antioxidants, evaluation of influence of those experimental factors on productive performances of laying hens and also on the quality of obtained eggs.

Also in the second part of thesis was debated the impact of consumption of such eggs as functional food on consumers' health, as well as economical aspects regarding production costs of such products.

Nowadays, foods are not only for fulfilling the satiation and a provider of necessary nutrients, but also to prevent the affections related with nutrition and for improving the mental and health state of consumers. In developed countries, man nourishment is characterised by an excessive consumption of protein, cholesterol, saturated fatty acids and omega-6 polyunsaturated fatty acids and a scanty consumption of omega-3 fatty acids, fibres and antioxidants; those nutritional imbalances are responsible for the high rate of obesity and chronically or non-transferable degenerative diseases, from which cardiovascular diseases represent a major cause of morbidity and mortality at world level.

From the above mentioned reasons, the current thesis approaches a complex study of nourishment of laying hens, aiming to improve the eggs and their transformation from a complete food into a functional one. So were identified and nutritionally characterized a great variety of raw materials much of them indigenous

and with a high availability which could be used in foddering as specific sources for xanthophylls pigments (luteine and zeaxanthin) and respectively omega-3 polyunsaturated fatty acids and antioxidants.

Sources with the highest concentration of xanthophylls pigments were spirulina powder (5684 ppm), white seabuckthorn (236 ppm) and marigold (174 ppm), the lowest concentration being founded in pulp of dried pumpkin (2.8 ppm); xanthophylls sources with the greatest availability to be industrially utilised were corn gluten (with a xanthophylls content between 167-200 ppm) and granulated alfalfa (with a content of 72.54 ppm) – those ones being selected and utilised in different rates into the structure of some experimental recipes for mixed fodders which allow to obtain some advantageous results in the light of husbandry performances and especially regarding content in luteine and zeaxanthin of the eggs obtained in this way.

Regarding the sources of omega-3 polyunsaturated fatty acids and antioxidants, have emerged through content and availability grape seeds oil and meal, marc, linen meal (as Extrulin product) and camelina meal; all of those being subject of some experimental variants, being introduced in different combinations and rates in structures of experimental mixed fodders which were given to laying hens.

- **Were formulated and experimented two specific fodder additives as source for xanthophylls pigments (AX1 and AX2,** with a xanthophylls content of 512 ppm and respectively 964 ppm); their introduction (in rates of 2 and 4%) in feed of laying hens had a strong influence on quality of obtained eggs, determining the increasing with 50 up to 250% of egg's luteine and zeaxanthin content, but in the conditions of increasing of food cost with 80 up to 260%.
- **Experimental series A** which aimed on **possibilities of obtained of eggs enriched in xanthophylls pigments** using synthetic luteine and respectively natural sources (alfalfa and corn gluten, in different rates) reached at the end to a nutritional solutions certified in conditions of a macro-test at farm level (experimental variant E2 from experiment A3 - with 5% alfalfa and 10% corn gluten in the structure of mixed fodder) which allow obtaining of eggs with a content in xanthophylls (luteine and zeaxanthin) higher with around 400% face to the one from conventional eggs (from control batch), in conditions of a light increased productivity (laying intensity with 1.4% higher), with a cost for food with only 4.7% higher, which will allow an increase of economical efficiency even in the conditions in which the selling price of eggs with character of functional food will be only with 5% higher face to the one of conventional eggs – even if obviously could be applied a higher profit rate, perfect justified by eggs quality.
- At the end of **experimental series B** were evaluated some **possibilities for obtaining of eggs enriched in omega-3 polyunsaturated fatty acids and antioxidants** by using in food of laying hens of some specific sources for those

nutrients; so, based in first two experiments (B1 and B2), in **experiment B3** was tested a nutritional solution of utilisation of some natural sources (1% grape seeds meal, 2% camelina meal and 3% linen meal - Extrulin in structure of mixed fodder) which will allow obtaining of some eggs with a higher content in omega-3 fatty acids with around 73% face to the one from conventional eggs, and implicit a rate of fatty acids Ω6/Ω3 in egg much more nutritional advantageous, in conditions of a productivity (laying intensity) almost equal, with a cost of food higher with around 6% higher, which will allow an increase of economical efficiency in the conditions in which the selling price of eggs with character of functional food will be only with 10% higher face to the one of conventional eggs - obviously, also in this case could be applied a higher profit rate, perfect justified by eggs quality.

- **Clinical studies** effectuated on volunteers highlighted the fact that a **controlled consumption, relatively high, of eggs with character of functional food – enriched in luteine and zeaxanthin – could have beneficial effects on consumers' health state**, without being noticed modifications of sanguine biochemical indicators which indicate a possible metabolic disorder of organism, no matter of age group, sex and corporal mass of the subjects involved in study.

In case of consumption of eggs enriched in luteine and zeaxanthin, values of cholesterol both LDL-cholesterol, as well as HDL-cholesterol was light increased at the end of experimental period (after 6 weeks), but without over-came the admissible limits, at all the subjects who participate at the study. For triglycerides, the obtained values were lower at the end of study, face to the ones determined at the beginning of it, but weren't under the admissible limits.

Consumption of eggs enriched in omega-3 polyunsaturated fatty acids leas to a significant protein intake and determinate a significant decreasing of fibrinogen - marker of inflammation in human organism; after consumption of such type of eggs the values for transaminases, HDL-cholesterol and LDL-cholesterol, protein C reactive and triglycerides remained into normal limits, without significant modifications of parameters, while concentration of total proteins had a significant increase which was correlated with the significant decrease of fibrinogen values.

It weren't reported adverse reactions or intoxications symptoms after consumption of eggs. Consumed eggs were well appreciated and well tolerated by all the volunteers whom participated at study.

At the end of effectuated research and conclusions formulated regarding nutritional solutions for obtaining of some eggs with character of a functional food, enriched in xanthophylls and respectively, in essential fatty acids, we make the following **recommendations**:

- utilization of experimental raw material as specific source for xanthophylls and respectively for essential fatty acids and antioxidants, in food of laying hens;

• periodic regularly consumption, controlled (up to 6-10 eggs/week) of such eggs with character of functional food, with positive effects on consumers' health state.

So, by the approached thematic – identification and evaluation of efficiency of some solutions for obtaining of eggs with character of functional food, enriched in luteine and zeaxanthin and respectively, in omega-3 polyunsaturated fatty acids and antioxidants – being one of the first research at national level which utilised in experiments raw materials rich in xanthophylls, which could replace the commercial synthesised luteine, as well as winemaking by-products and other specific sources with high availability for obtaining of eggs with an increased content in omega-3 fatty acids and antioxidants. Also, the research regarding formulation and testing of those two fodder additives (originals) with a high content in xanthophylls have a major contribution to the originality feature of thesis. At last but not least, we consider that being very useful and original the evaluation of influence of a regularly and controlled consumption of those two type of eggs with character of a functional food on human consumers' health state, through effectuation of specific clinical studies at Parhon Institute.

Multidisciplinary of research which was the aim of the current thesis is assured by the diversity of scientific domains approached in the realised studies, such as: analytical chemistry and biochemistry, physiology, animal nutrition and nourishment, husbandry, zoo-economy, human nutrition and medicine and not only.

So, egg is recommended for consumption no matter of age and health state, due to its complexity and its transformation and assimilation capacity of the nutrients which are so necessary to humans and not only.