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Enhanced Egg Production in Practice: The Case of Bio-Omega-3 Egg

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Abstract: Objective of this research was to determine the effect of enriched feed "Bio-omega" on the hens performance under practical conditions in the farm Totally of 16,000 Hisex Layers were divided into two treatment groups (8,000 hens in each group), housed in cages (4 hens in each cage) and were to age of 30 to 50 weeks. Hens received food and water *ad libitum* from 30th to 50th week of age. The diet was supplement with standard type diet, and enriched type diet plus herbal mix, extra some minerals and vitamins. Egg production, egg weight, feed intake, mortality, as well as, yolk fatty acid composition and internal egg quality characteristics were recorded. Based on obtained results of the investigation it can be conducted that the enriched diet had positive effect on hens performance. Thus, egg production for hens fed enriched type diet was over 90 % for more to 8 wks, feed intake was in average 107.8 g per hen and day, egg weight increase and was in average 65.1 g per egg and mortality was 1.5 %. Concerning the internal egg quality characteristics, hens receiving the enriched diet produced less intensively colored egg yolks than those received the control diet. The fatty acid composition of the egg yolk was significantly affected by the diet. Eggs from hens fed the enriched diet had more omega-3 fatty acids ,more vitamin E, less cholesterol (170 mg Vs 200 per regular egg), more folic acid, Iodine and selenium in comparison to regular eggs.

Key words: Bio-omega 3 eggs, herbal mix, enhanced eggs

Introduction

The hen's egg is a complex biological and chemical entity. Also, the hen egg, consists of a minute centre of life (for the fertilized egg) and its yolk is a rich source of lipid as it contains about 30% of lipids. In recent years, the lipid composition of chicken egg has been an area of primary consumer concern, due to the connection between specific dietary lipids and the development of coronary heart disease and some forms of cancer (Simopoulos and Salem, 1992). Due to the health benefits associated with the consumption of polyunsaturated fatty acids (PUFA) ,much research has been carried out to enrich eggs with those fatty acids (Van Elswyk *et al*.,1992). PUFA are separated into two groups:n-3 or n-6 PUFAs, depending on the position of the first double bond from methyl end of the chain, with both types are required for normal human health. The linoleic (18:2n=6) and arachidonic acids (20:4n-6) are the major n-6 fatty acids, and linolenic acid (LNA), eicosapentenoic acid (EPA),as well as, and docosahexaenoic acid (DHA) are the main n-3 fatty acids. Arachidonic acid can be synthesized from linoleic acid, while EPA and DHA from linolenic acid *in vivo*. Linoleic and linolenic acid are essential fatty acids for poultry. Because animals cannot synthesize these important precursors for biosynthesis of other components, must be supplied in the diet. Dietary supplementation of farm animals provides a unique method of manipulating the content of some micronutrients and other non-nutrient bioactive compounds in foods of animal origin, with a view to improving the nutrient intake of consumers or improving their overall health. Feeding flaxseed to laying hens increases the omega-3 fatty acid in the egg by 6 to 8 times, making one egg equal to 114 g of cold water fish as source of the omega-3 fatty acids.

The beneficial effects of omega-3 (n-3) fatty acids include reducing heart disease, reducing circulating cholesterol levels and suppressing inflammation in humans and animals (Klatt, 1986).The current recommended ratio of omega-6 to omega-3 intake is 1 to 4 ,while the western diet provides a ratio approximately 20 to 1.This imbalance is being linked to such problems as heart attacks, diabetes, cancer, etc.

However, a higher polyunsaturated fatty acids content leads in yolk to increase in lipid unsaturation and thus, to greater susceptibility to oxidation and free radicals production. In order to prevent lipid peroxidation, antioxidants synthetic origin or natural, have been widely used by the food industry.

Nowadays, the designer egg production technology has been further improved, and several bioactive compounds with health promoting properties like folic acid, iodine and selenium are dietary incorporated into eggs (Yalcin *et al*., 2001; Surai, 2003 ; Botsoglou *et al*., 1997; Yannakopoulos *et al*., 1999; Yannakopoulos *et al*., 2001; Tservenil-Gousi, 2001). Various designer eggs such as the "Columbus eggs", "Eggs Plus", "England's best", and "DHA enriched eggs", are already commercialized in many countries all over the world

Table 1: Effect of enriched diet plus herbal mix on some productive performance of laying hens

Age of hens (weeks)	Egg production/ 100 hen day	Mean eggs weight (g)	Food intake (g/hen/d)	Body weight (kg)
32-35	91.8[a]	62.3[a]	108[a]	1.92[a]
36-39	91.2[a]	64.4[b]	108[a]	1.95[a]
40-43	88.1[b]	66.1[c]	108[a]	1.98[b]
44-47	86.6[bc]	66.2[c]	107.5[b]	1.98[b]
48-51	86.0[c]	66.4[c]	107.5[b]	2.02[c]
Average	88.7	65.1	107.8	1.97[a-c]

Means within a column with different superscript indicate significant differences with p<0.05 (LSD test)

Table 2: Effect of dietary treatments on some egg characteristics

Egg traits	Control diet	Bio-omega-3 diet
Yolk weight/Egg weight, %	25.23	26.50
Albumen (white) weight/Egg weight, %	63.49[a]	58.62[b]
Yolk/albumen, ratio	0.397[a]	0.452[b]
Yolk color (Roche fan)	12	10
Egg shape	0.79	0.80

a-bMean values in the same row with the same parameter with different letters were significantly different (LSD test, P<0.05)

(Surai and Sparks, 2001). In Greece there are in supermarket :"Every day" "Omegga 3 eggs", "Egg Plus","Baby eggs","Achyrona omega eggs" and "Bio-omega 3 eggs".

The aim of the present study was to evaluate some production characteristics of "Bio-omega-3" eggs, a new type of designer eggs produced in Athens, Greece, by Megafarm according to Patent No Gr1004395, with a view to improving the nutrient intake of consumers with vitamin E, folic acid, polyunsaturated fatty acids, herbal antioxidants, iodine, and Se in a palatable and acceptable commodity.

Materials and Methods

The study was carried out with 16,000 *Hisex* brown laying hens of 30 weeks of age. The birds were kept in a 3-floor battery, were randomly distributed into 2 equal groups. The birds were allocated to two dietary treatments that included a typical corn and soybean meal diet (control diet), and served as control group and a diet that had been further supplemented with flaxseed and an mixture herbal additive, as well as, vitamin E, Se, I, and Folic acid (enriched diet) and served as "bio-omega-3" feed, for a period of 140 days. Feed and water were provided to layers *ad libitum*. Feed consumption and mortality, was determined each week, whereas the number of eggs laid was recorded daily. The herbal mix has the follow chemical analysis: protein 11.4%,Starch 1.7 %,Sugar 6.9 %,fat 5.6 %,Cellulose 14.9 %,Minerals 9.07 %,Density 0.28 %,Sodium Chloride 0.64 %,Calcium 1.60%, Phosphorus 0.24% ,Magnesium 0.97% ,Potassium 1.30%, Sodium 0.11%, Iron 850 mg/kg, Copper 10 mg/kg, Manganese 90 mg/kg and Zinc 26 mg/kg. In addition contain menthol, aldehydes, phenols as thymol and carvacrol, phenolic esters, alkaloids, p-cymene-2,3-diol, etc.

Eggs weight was measured every day and egg production was calculated as the number of eggs per hen per day. After a 4-week feeding period, a sample of 15 eggs per dietary treatment was used for the determination of fatty acid composition, cholesterol, vitamin E, folic acid, iodine and selenium content. Lipids were extracted from the six eggs collected also after 4-wks, and fatty acids wee quantified using gas chromatography as described by Hargis *et al.* (1991). Odor and taste of eggs, yolk color and general acceptance were sensory evaluated by 20 panelists. Prior to sensory evaluation, the eggs were boiled for 10 min and then cooled to room temperature. In addition samples of six eggs per type, of some nutrient enhanced eggs, omega eggs, from a supermarket in Thessaloniki were taken at random ,for fatty acid analysis under practical conditions.

All data were subjected to statistical analysis according to the STATISTIX program.

Results and Discussion

Zootechnical results: The effect of enriched diet plus herbal mix on productive performance are given in Table 1.

Feed consumption was at 107.8 g/hen/day for hens fed the enriched diet and 106.5 g for those fed control diet. The difference is not significant (P>0.05). Novak and Scheineder (2001) reported that feed consumption was significantly (P<0.05) for hens fed 10 % flaxseed diets (107.7 g) when compared to the soy-diet controls (106.6 g). However, Basmacioglou *et al.* (2003), who used fish oil (1.5%) and flaxseed (4.32%) reported that feed intake not affected by any of the treatments. Egg production during the feeding period in the present study, was estimated over 90% for more to 8 wks for hens receiving the diet supplemented with flaxseed and the herbal mix (enriched diet). Our results are better than that reported previously by Yannakopoulos *et al.* (2001) for layers receiving another flaxseed enriched diet. Average egg weight during the whole feeding period was estimated at 64.84 g and 65.92 g, for the control and the enriched diets, respectively. Leeson *et al.* (1998) and

Table 3: Effect of dietary treatments on the levels of some nutrients in eggs "Bio-omega-3" of net weight of 60.57g

Egg weight	60.57*	
Fat %	6.78	
Fatty acid	%	mg/egg
C18:2n-6	16.67	632
C18:3n-3	7.99	306
C20:5n-3	0.84	32
C22:6n-3	0.79	30
Saturated (S)	27.51[a] (34.88)[b]	1054
Monounsaturated (MUFA)	46.21[a] (51.98)[b]	1771
Polyunsaturated (PUFA-P)	26.28[a] (13.14)[b]	1007
Total n-3	9.61	368
Total n-6	16.67	639
Fatty acids ratio	P/S	1/1
Omega-6/Omega-3	1.7/1	

•edible portion (yolk+white). ** Number in parenthesis is fatty acids for regular egg

Table 4: Effect of special diet enriched with herbal mix on some egg parameters

Egg parameters	Bio-omeaga-3	Regular
Cholesterol per egg, mg	175	220
Folic acid, per egg, µg	11	9
Iodine, per egg, µg	34	9
Se, per egg, µg	22	5
Vitamin E, per egg, mg	3.7	0.8

Yannakopoulos *et al.* (1999) reported that diet with 10 or 20% flaxseed had no effect on egg production or egg weight. The mortality was 1.5% for bio-omega hens group and 2.0 % for control. This may be due because both thymol and carbachol from herbal mix have antibacterial effects. Krause and Ternes (1999) reported that antimicrobial activities of thyme oil and its components have may been used in medicine. Hence, on the bases of our results, improvement in egg production might be due to healthier birds whose feed efficiency and nutrient absorption have been improved by herbal supplementation.

Feeding the "special diet" enriched with herbal mix affects ($P<0.05$) the percentages of albumen and yolk weight to egg weight (Table 2). Also, the yolk: white ratio was 0.397 (39.7%) for regular and 0.452 (45.2%) for bio-omega 3 eggs. Our results indicated that the yolk: albumen ratio in bio-omega-3 eggs was the highest ($P<0.05$) . However, the greater yolk: white ratio in Bio-mega-3 eggs indicate less solids (e.g. fatty acids) in yolk. Ahn *et al.* (1997) reported that yolk: albumen ratio is an important index for solids content.

Egg yolk colour, which is an important factor for egg marketing, was 10 (Roche Fan) in Bio-omega 3 eggs and higher 12 in regular eggs. The lower value of yolk colour for Bio-omega 3 eggs due only to natural such as lutein and zeaxanthin which are pressed in feedstuffs (e.g. corn) or herbal mix. In contrast, the higher value in regular egg due not only to natural pigments but to added synthetic pigment supplementation.

Fatty acid profile results: The effect of "special" diet on fatty acid profile of the yolk, after 4 weeks feeding is presented in Table 3. The fatty acid composition was affected by flaxseed supplementation.

The Bio-omega-3 eggs were found to contain less saturated and more polyunsaturated lipids compared to the regular eggs. The Bio-omega-3 eggs were also found to contain higher levels of n-3 fatty acids, particularly of the DHA type, compared to regular eggs (120 mg vs 0 mg).Despite the fact that flaxseed do not contain DHA, the eggs contain this acid, this confirms the processes of synthesis of DHA from the precursor linolenic acid under the enzymatic influence of desaturase and elongase (Cherian and Sim, 1991). The increase in yolk polyunsaturated fatty acid (PUFA) is accompanied by substantial decrease in saturated fatty acid, resulting in a healthy fat profile and more nutrional egg. This might be possibly due to diet supplementation with the herbal additive that might helped in a more efficient conversion of a-linolenic acid to DHA. In addition, Bean and Leeson (2003) reported that birds consumed flaxseed deposied higher ($P<0.0001$) amounts of linolenic acid ,and docosahexaenoic acid and total n-3 fatty acids into their eggs. According to Cherian and Sim PUFA (n-6 and n-3 series) in the diet are more effective in reducing Monounsaturated than Saturated acids in eggs through the inhibition of desaturase enzyme activity on the production mainly the oleic acid. In the present study ,it was shown that a rich source of PUFA as flaxseed resulted in significantly lower concentrations of saturated, mainly oleic acid in eggs.

Due to increase in omega-3 fatty acids in eggs and decease in omega 6 ratio omega-6/omega-3 for Bio-omega-3 eggs is 1:1.7 (Table 3). Also, due to decrease the saturated fatty acids in Bio-omega 3 eggs, the ratio P/S is 1/1. Jiang *et al.*, 1991, reported there were not significant changes in the total omega-6 fatty acid content of yolk at a dietary inclusion of 15% flaxseed meal, compared to their control.

Total n-3 PUFA content of Bio-omega 3 egg exceed 400 mg which constitutes about 45-50% of the daily human requirements for these fatty acids (estimated 800-1000 mg).

The Bio-omega-3 eggs contained also cholesterol at markedly lower levels than the control eggs, possibly due to the combined action of the herbal additive constituents (Table 4). These results lend support to pertinent finding of Basmacioglu and Ergul (2001) and demonstrated lower cholesterol in Bio-omega-3 eggs when compared with regular eggs. So, it might be important to develop the herbal mix as cholesterol lowered supplements. This, result may due in composition of herbal as thymol, carvacrol, p-cymene

Table 5: Fatty acid composition of some enhanced omega 3 eggs in Greek market

	Village eggs	Omegga-3	Baby plus**	Bio-omega-3
Egg weight* (g)	53.05	52.03	53.70	54.62
Fat %	12.17	7.95	7.8	8.0
Fatty acid (%)				
C18:2n-6	11.24	14.44	21.92	17.57
C18:3n-3	0.44	4.61	1.39	5.89
C20:5n-3	0.23	0.75	1.04	1.15
C22:6n-3	0.32	0.80	0.20	0.91
Saturated (S)	34.88	30.02	29.56	27.50
Monounsaturated (MUFA)	51.98	49.38	45.2	46.97
Polyunsaturated (PUFA-P)	13.14	20.60	25.24	25.53
Total n-3	1.90	6.15	2.63	7.96
Total n-6	11.24	14.45	21.92	17.57
Fatty acids ratio				
P/S	0.38	0.69	0.85	0.92
Omega-6/Omega-3	5.9:1	2.2:1	8.33:1	2.2:1

*white+yolk. **Vitamin enriched egg is the information appears on egg carton

and other constituents of essential oils may which inhibit biosynthesis of FPP, a precursor of cholesterol synthesis. Crowell, (1999) reported that the components of essential oils inhibit hepatic 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase activity which is a key regulatory enzyme in cholesterol synthesis. In addition, Milink *et al.* (2003) reported that addition of omega-3 containing oils to chicken feed does not change the cholesterol content on egg yolk.

The higher levels of vitamin E and selenium into the Bio-omega-3 eggs (Table 4) compared to the control eggs, as well as the possible transfer of natural antioxidant compounds from the herbal additive, could justify the higher oxidative stability exhibited by the Bio-omega-3 eggs (Yannakopoulos *et al.*, 2004). Botsoglou *et al.* (1997) reported that feed a thyme extract to hens, found some protective effect on yolk lipid oxidation, and attributed this effect to the transfer of some phenolic antioxidants of thyme from feed to egg.

The Bio-omega-3 eggs also contained higher levels of folic acid and iodine in comparison to control eggs (Table 4). Iodine can play important role as both an antioxidant and hormone stimulant. This trace element can bind to arachidonic acid and DHA acid to form specific iodolipids.

Nutrional comparison in fatty acids, of Village-traditional eggs to some nutrient enhanced eggs from Greek market are given in Table 5.

Total n-3 fatty acids are lower in village eggs compare to all other types enriched eggs and was affected by type of diet. In addition, the linoleic to linolenic acid ratio was affected by diet. Based on present results, eggs from village hens (villager eggs) had better ratio than those Baby eggs. However, the ratio omega-6 to omega-3, was 2.2 for omegga and Bio-omega 3 eggs. Simopoulos and Salem (1989) reported that the eggs of chickens found on the Peloponnese in Greece that graze on wild plants and purslane were shown to contain twenty times more omega-3 fatty acids than standard supermarket eggs. They had a ratio of omega-6 to omega-3 fatty acids of 1 to 1, whilst the supermarket eggs had a lopsided ratio of 20 to 1. Therefore, not only is the presence of omega 6 and omega 3 in the human diet necessary for health, but the ratio of omega-6 to omega-3 is critical to achieving an appropriate balance of these fatty acids (National Institutes of Health. EFA Edution.http://efaeducation.nih.gov/ Accessed 22 Nov 04).

It is notice that the effects of age on Bio-omega-3 egg characteristics of hens were not investigate in this study. The differences between fatty acid composition of Bio-omega-3 eggs between Table 1 and 3 could be attributed to the egging period.

Results from the sensory panel (data not presented),showed that the organoleptic acceptability or flavour quality was superior in the Bio-omega-3 eggs compared to the control eggs. This should be due to the combined action of the herbs, vitamins and minerals occurring in the herbal additive, since it is known that the ingredients used in layer diets to enrich eggs with polyunsaturated fatty acids often influence the sensory characteristics of the eggs (Van Elswyk, 1997). Moreover, the panelists have graded the Bio-omega-3 eggs as more acceptable than the regular eggs. This finding is in agreement with Narahari (2003).

The Bio-omega-3 eggs are value - added and consumer must have a market willing to pay a premium, a way to get the product to market, be able to differentials/certify your product, label it according to government claim/content regulations and also ensure the market where servicing is provided with a reliable and consistent supply of product.

Conclusions: The results obtained from this study

indicated that the inclusion of both flaxseed and the herbal mix plus vitamins and minerals into hen diets could enhance yolk n-3 polyunsaturated fatty acids, selenium, iodine, vitamin E, natural carotenoids without decreasing the organoleptic characteristics, making, thus, the Bio omega-3 egg attractive for consumers.

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