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# Feeding Strategies for the Production of Designer Eggs in Chickens

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## Introduction

Indian poultry industry is expanding very fast to meet the increasing demand of the domestic consumers. The poultry eggs are nutrient rich food and now regarded as an inexpensive, convenient and source of high-quality protein with several other essential nutrients. However, the health-conscious consumers demand for the wholesome, healthy and nutritious food products. Eggs are being used worldwide as food due to its protein quality (high biological value), low cost and palatability. In spite of all positives, it is being often blamed as high cholesterol food because of its lipid profile in the yolk. They are more interested and ready to pay for the products which are more beneficial, wholesome and health promoting in order to improve their well-being. The poultry eggs have already gained a healthy image, so in order to curb the prevalence of chronic diseases and several attempts were made to modify the eggs by adding ingredients which are beneficial for the health or by eliminating or reducing components that are harmful. This modification resulted in development of functional eggs. Improving consumers' health and nutritional status by designing nutritional profile of poultry egg through dietary approaches is relatively simple and economic. Eggs can be designed through dietary approaches either through supplementation of specific nutrients, or certain herbs or specific drugs that have functional and therapeutic properties.

## Normal egg composition

The normal egg consists of water (74%), protein (13%), fat (11%), carbohydrates (1%) and other nutrients with minor percentage including minerals, vitamins and carotenoids. Egg's macro-structure is approximately 9-12% of shell, 60% of albumen and 30-33% of yolk. Yolk lipid content is around 33% including 63.3% of triacylglycerols, 29.7% of phospholipids (phosphatidyl-choline: 73%; phosphatidylethanolamine: 15%) and 5.2% of total cholesterol.

## Designer egg

In the backdrop of above facts, the concept of "designer egg" has been evolved with aim to minimize the health negative nutrients (*viz*. cholesterol and triglycerides) and enriching it with health positive nutrients *viz*. Ω-3 fatty acids and antioxidants, vitamins and minerals (Ankari *et al.*, 1998). "Designer eggs" are those in which the content has been modified from the standard egg (Bhat *et al.*, 2013). "Designer eggs" are those in which the content has been modified from the standard egg. Designer eggs are produced by feeding egg-laying hens with a special diet rich in certain vitamins and other nutrients. The special diet usually includes kelp, flax seeds; canola oil and marigold extract.

## History of Designer Eggs

Cruickshank (1934) was one of the first researchers document the ability to change the nutrient profile of the egg. In the late 80s, Sim, Jiang and their associates worked together to produce nutrient enriched eggs and developed designer egg, rich in n-3 fatty acids with antioxidants and patented this egg as 'Professor Sim's Designer Egg'. Later in 1997, Van Elswyk developed eggs enriched with conjugated linoleic acid (CLA). In Australia enriched the eggs with folic acid and iron. Other available designer eggs in the market include eggs enriched with vitamins. In Canada, produced lutein and selenium enriched eggs which help in preventing eye disorders. In India, Narahari (2005) has also developed Herbal

Enriched Designer Eggs (HEDE), which is not only rich in carotenoids, n-3 PUFA, selenium, trace minerals and vitamin E, but also rich in herbal active principles like Allicin, Betaine, Euginol, Lumichrome, Lumiflavin, Lutein, Sulforaphane, Taurine and many other active principles of herbs, supplemented in the diets of hens. These eggs also contain natural sterols (phytosterols) like β-sitosterol, Brassicasterol, Campesterol, Stigmasterol etc. which are cardiac friendly in nature.

**Nutritional strategies for production of designer eggs**

**1) Low Cholesterol Eggs**

Egg is a cholesterol rich food. A large egg contains about 210 mg of cholesterol (Mahima *et al*., 2012). Although, the nutritionists and cardiologists have established that there is only an insignificant correlation between dietary and serum cholesterol levels; the consumers are still scared of consuming cholesterol rich foods, hence there is an urgent need to reduce the egg yolk cholesterol levels as well as to incorporate several other health promoting components in the egg. Lowering egg cholesterol has centered mostly on diet and pharmacological intervention. The most effective way to lower egg cholesterol content is dietary manipulation of the hen. It has been reported that supplementation with dietary micro-minerals (Copper, Chromium, Zinc and Iron), vitamins (Vit. A, Vit. E and niacin), various oils and herbal plants may change the yolk cholesterol level (Muduli *et al*., 2018). Influence of designer diets enriched with Ω-3 fatty acids and antioxidants from natural sources on egg yolk composition of 'white leghorn' hens reduced the yolk cholesterol levels and increasing omega-3 fatty acid levels in the egg (Sujatha and Narahari, 2011). Another way of reducing the cholesterol concentration in yolk by supplementation of Lactobacillus acidophilus. Addition of different amount of Lactobacillus acidophilus to ration of laying hens resulted in decrease yolk cholesterol (Alaqil *et al*., 2020). Supplementing the flaxseed meal or mixture with rapeseed meal or rice bran up to 10% of feed in the diet of poultry will help in reduction of yolk cholesterol (Panaite *et al*., 2020).

**2) Ω-3 Enriched Eggs**

Commercial table eggs contain a high proportion of Ω -6 PUFA (mainly 18:2n-6) but are a poor source of Ω-3 fatty acids (Bhat *et al*., 2013). Attempts to produce eggs high in Ω-3 PUFA can be divided into two groups. The simplest way is to produce an egg enriched in linolenic acid, which is a precursor of DHA and is also considered to have a protective effect against fatal ischemic heart disease.

**Advantages of Ω-3 fatty acid enriched eggs**

Prevention of coronary heart disease, infant development, reduction of cancer and inflammatory disease, prevention of psychiatric disorders, helpful in improvement of oxygen supply to the tissues, increase in brain function, give relief in treatment of rheumatoid arthritis, improves skin and relieves arthritis and helpful in curing inflammatory disorders and improve immune responses (Surai and Sparks, 2001). For this purpose, the hen's diet is usually relatively rich in flaxseeds, soyabean, walnut, and oils -from canola, safflower and vegetable oils and Marine algae; as a result, the egg's yolk is enriched with alphalinolenic acid (ALA) and the level of docosahexaenoic acid (DHA) is also enhanced. Among all the sources flaxseed oil is the richest source followed by fish and soybean oil. The second approach to enhance levels of n-3 in the egg, by including pre-formed DHA in the hen's diet, usually in the form of fish oil, is a more promising one. However, this may be associated with a pronounced fishy taste in the egg yolk. Supplementation of marine algae (*Schizochytrium spp.*) at different levels from 1.27%, and 1.77% (Kostik *et al*., 2015) and 5% of an oil mixture, 0.5 mg organic selenium/kg, 200 mg lutein/kg and 200 mg vitamin E/kg (Kralik *et al*., 2018) as source of omega-3 fatty acids in the diet of layer bird resulted in eggs enriched with important Ω-3 fatty acids (ALA, EPA and DHA) significantly.

**3) Vitamin Enriched Eggs**

The egg, and more precisely the egg yolk, is a vitamin-rich food that contains all vitamins except vitamin C (Ascorbic acid). The egg yolk contains high amount of vitamin A, D, E, K, B1, B2, B5, B6, B9 and B12, while egg white possesses high amounts of vitamins B2, B3 and B5 as well as significant amounts of vitamins B1, B6, B8, B9 and B12. Vitamin content of eggs can be increased over certain ranges of diet fortification and with varying efficiency of vitamin transfer. If development of designer eggs containing higher concentrations of certain vitamins is ever the objective of a commercial enterprise, vitamin transfer efficiency and vitamin cost would be two of the major considerations used in determining the economic feasibility of marketing such eggs. Supplementation with vitamin E is generally

recommended to stabilize egg lipids against rancidity and extend the shelf life of the product to layer birds. Proper vitamin nutrition has significant implications in gastrointestinal health of hens and this could have positive ramifications in marketing eggs with a higher vitamin level and better nutritive value (Zang *et al*., 2011). Saleh *et al*. (2021) reported that increased in egg-yolk vitamin E concentration and reduction in liver malondialdehyde (MDA) content by the treatment with the natural colorant could be attributed to the carotenoid content of red pepper paprika (*Capsicum annuum* L.) which has a well-known antioxidant function, such as vitamins C and E and vitamin A precursors.

**4) Mineral Enriched Eggs**

The shell contains majority of the minerals in an egg. There are approximately 2,200 mg of calcium and 20 mg of phosphorus in the shell. There has been very little success in changing the calcium and phosphorus content of the albumen and yolk. However, it is possible, to increase the content of chromium, selenium, iron, zinc, iodine and manganese. This has been done through dietary supplementation of the hen. These minerals are important in human health. Therefore, there has been some interest, in promoting these eggs as designer eggs (Bhat *et al*., 2013). Eggs can be enriched with many types of minerals by supplementation in hens feed (Satapathy *et al*., 2017). This includes minerals like selenium, iodine, chromium and copper. These minerals are very important for our health, deficiency of which can lead to the emergence of various diseases. The dietary supplementation of hens with zinc (zinc sulphate @ 75 mg/kg diet) is an effective approach to enrich egg with zinc (Megha *et al*., 2021) and iodine @ 6.50 ppm in layers diet is economically better for the production of iodine enriched eggs followed by feed iodine supplementation @ 3.25 ppm (Sumaiya *et al*., 2016). It is feasible to supply 50% of the RDA for selenium in one egg by supplementing the feed of the layer hen with 0.4 ppm selenium in the form of seleno-methionine.

**5) Antioxidants Enriched Eggs**

Poultry eggs are rich sources of natural antioxidants like vitamin-E, Se, carotenoid pigments, flavinoid compounds, lecithin and phosvitin but at the same time, are highly susceptible to oxidative rancidity during storage. These antioxidants will protect the fat-soluble vitamins and other yolk lipids from oxidative rancidity. The designer eggs and meat, not only contain high levels of the above anti-oxidants but also contain synthetic anti-oxidant like Ethoxyquin and anti-oxidants of herbal origin such as Carnosine, Curcumin, Lycopene, Quercetin and Sulforaphene, depending upon the herbs used in the poultry diet (Narahari, 2005). Hence, supplementation of these antioxidants in the diet is essential to maintain the shelf life of the product. Along with antioxidants like Vitamin E and Se, the enzymes like glutathione peroxidase, superoxide dismutase, catalaze constitute an integral part of antioxidant cellular enzyme system in omega-3 enriched products to reduce lipid peroxidation.

**6) Pigment Enriched Eggs**

The color of the yolk is a reflection of its pigment content. In addition, the type of pigment in the egg and its concentration are directly influenced by the dietary concentration of any particular pigment. Spirulina supplementation in functional feeds contributed to the rich orange yolk colour due to its high carotenoid pigment content (Sujatha and Narahari, 2011). Sujatha *et al*. (2015) showed with their studies result that the incorporation of marigold as a wholesome feed additive for desi birds under semi range system has beneficial effects on enrichment of caroteinoid pigments in egg yolk and improvement of color of desi chicken egg yolk that is most preferred by the health-conscious consumers. Saleh *et al*. (2021) concluded that egg-yolk color from hens fed the natural (paprika) colorant was more yellow than that produced from those fed the control diet. This is a significant contribution, particularly considering that egg-yolk color remains an essential criterion for consumer choice. It is well known that the color of yolk is strongly and substantially correlated to the carotenoid content.

**7) Herbal Enriched Eggs**

Phytobiotics or plant-derived products containing several plant secondary metabolites can be used in poultry feed to improve the performance of hen and to produce herbal enriched super eggs. Chicken feed may be supplemented with herbs like garlic/onion leaves, spirulina, basil leaves, turmeric powder, citrus pulp, flaxseed, red pepper, fenugreek seeds etc. These super eggs show lower LDL cholesterol, immune-modulator property, antioxidant, anti-carcinogenic properties, higher omega-3 fatty acids etc. (Muduli *et al*., 2018). All these indicated that the overall health promotion in hens popularizing herbal enriched eggs. In India, Narahari *et al*. (2005) has produced herbal enriched designer eggs (HEDE) which were not only rich in

Ω-3 FA but also had vitamin-E, Se, carotenoids, certain B-complex vitamins and trace minerals. These eggs were also rich in several herbal active principles like allicin, betaine, eugenol, lumiflavin, lutein, sulforaphane, taurine and a lot of more active principles depending on herb fed to hen. Examples of health-promoting components include garlic, fenugreek and bay leaves. Garlic (*Allium sativum*) has potential hypolipidemic, hypotensive, hypoglycemic, hypothrombotic, hypoatherogenic and galactogenic properties.

**Conclusion**

Poultry eggs are a good source of essential nutrients. The development of enriched value-added poultry eggs greatly increased the context of functional foods for human health. Hence, by manipulating the diet of chicken with the different available feed supplements in requisite amounts, value added and health promoting chicken egg can be made available to the health-conscious consumers. The designing must take into consideration the production facilities, available materials, technical know-how, economic resources of the producers and environmental impacts with welfare issues.

**Future Prospects**

Designer eggs with new functional properties are highly demanding, however, still there is lack of knowhow for their commercial production. There is need for more research for commercial production and marketing of these new generation eggs and its products. Further, more research should be done in this area to improve designer egg quality and assess long-term effects of their consumption and ultimately to convince customers of the benefits of eating these eggs.

**References**

Alaqil, A. A., Abbas, A. O. , El-Beltagi, H. S., El-Atty, H. K., Mehaisen, G. M. and Moustafa, E. S. (2020). Dietary supplementation of probiotic lactobacillus acidophilus modulates cholesterol levels, immune responseand productive performance of laying hens. *Animals*. **10**(9):1588.

Ankari, A. A, Najib, H., and Hozab, A. A. (1998). Yolk and serum cholesterol and production traits, as affected by incorporating a supra optimal amount of copper in the diet of the leghorn hen. *British Poultry Science*. **39**:93-397.

Bhat, Z. F., Kumar, S., and Kumar, P. (2013). Production of designer eggs. In: Animal Products Technology. Studium press (India) Pvt. Ltd. p. 543-568.

Cruickshank, E. M., (1934). Studies in fat metabolism in the fowl. *Biochemical Journal*. **28**:965-977.

Kostik, V., Gjorgjeska, B., Bauer, B., and Filev, K. (2015). Production of shell eggs enriched with n-3 fatty acids. *Journal of Pharmacy*. **5**(8):48-51.

Kralik, Z., Kralik, G., Grcevic, M., Kralik, I., and Gantner, M. (2018). Physical-chemical characteristics of designer and conventional eggs. *Brazilian Journal of Poultry Science*. **20** (1):119-126.

Mahima, Verma, A. K., Kumar, A., Kumar, V., and Rahal, A. (2012). Designer egg: A future prospective. *Asian Journal of Poultry Science*. **6**(3):97-100.

Megha, P. S., Ramnath, V., Raji, K., Babitha, V., and Chacko, B. (2021). Production of zinc enriched designer eggs through dietary supplementation. *Journal of Veterinary and Animal Sciences*. **52**(1):77-80.

Muduli, S., Champati, A., and Popalghat, H. K. (2018). Designer egg: A new approach in modern health care. *The Pharma Innovation Journal*. **7**(5):320-326.

Narahari, D. (2005) Nutrient manipulations for value added eggs and meat production. In: Proceedings of Conference of Indian Poultry Science Association and National Symposium, held at Hyderabad, India.

Narahari, D., Kirubakaran, A., Ahmed, M., and Michel, R. (2004). Improved designer egg production using herbal enriched functional feeds. In: Proceedings of the XXII World Poultry Congress, held at Istanbul, Turkey.

Panaite, T. D., Turcu, R. P., Soica, C., and Visinescu, C. (2020). Nutritional parameters of eggs from laying hens fed with flaxseed meal or mixture with rapeseed meal or rice bran. *Journal of Applied Animal Research*. **48**(1):566-574.

Saleh, A. A., Gawish, E., Mahmoud, S. F., Amber, K., Awad, W., and Alzawqar, M. H. (2021). Effect of natural and chemical colorant supplementation on performance, egg-quality characteristics, yolk fatty-acid profile and blood constituents in laying hens. Sustainability. **13**(8):4503.

Satapathy, D., Kumari, T, Sharma, A., and Bidanta, S. (2017). Production of designer egg through dietary manipulation and its

importance: A review. *AGRES-An International e. Journal*. **6**(4):626-636.

Sujatha, T., and Narahari, D. (2011). Effect of designer diets on egg yolk composition of 'white leghorn' hens. Journal Food Science Technology. **48**(4):494-497.

Sujatha, T., Sunder, J., Kundu, A., and Kundu, M. S. (2015). Production of Pigment Enriched Desi Chicken Eggs by Feeding of Tagetes erecta petals. *Advances in Animal and Veterinary Sciences*. **3**(3):192-199.

Sumaiya, S., Nayak, S., Baghel, R. P., Nayak, A., Malapure, C. D., and Kumar, R. (2016). Effect of dietary iodine on production of iodine enriched eggs. *Veterinary World*. **9**(6):554-558.

Surai, P. F., and Sparks, N. H. (2001). Designer eggs: from improvement of egg composition to functional food. *Trends in Food Science & Technology*. **12**:7-16.

Van Elswyk, M. E. (1997). Comparison of n-3 fatty acid sources in laying hen rations for improvement of whole egg nutritional quality: a review. *British Journal of Nutrition*, **78**: 61-69.

Zang, H., Zhang, K., Ding, X., Bai, S., Hernandez, J. M., and Yao, B. (2011). Effects of different dietary vitamin combinations on the egg quality and vitamin deposition in the whole egg of laying hens. *Brazilian Journal of Poultry Science*. **13**(3):189-196.