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Functional Poultry Foods: Development of Designer Eggs and Meat through Nutrition

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Consumers today are more health conscious and want more than just the basic nutrition in their foods. By adding natural elements rich in beneficial nutrients to the diet of birds, poultry products such as eggs and meat can be converted to "designer foods." Adding omega-3 fatty acids, vitamins, minerals, antioxidants, herbs, probiotics and plant-based additions to poultry feed can result in eggs and meat with a higher nutritional value. Designer eggs fortified with omega-3 fatty acids, selenium or vitamins can assist promote heart health, immunity and overall well-being. Designer poultry meat can also provide a more healthy option for consumers, containing better fats and higher quantities of natural antioxidants. These nutritional techniques boost the quality of poultry products, but also bird health, productivity and sustainability of production systems. Designer eggs and meat are the prospective functional foods that bridge the gap between nutrition and wellness with increasing understanding of preventative healthcare. This provides a chance to poultry farmers to develop value added goods and customers are offered better food choices. Additional research and innovation will surely see designer poultry products become a major player in the future of nutrition and food security.

Keywords: designer egg; designer meat; enrichment; poultry

Introduction

Poultry products are more preferred than any other animal products all over the world for many reasons and there are no religious restraints attached to it. India is 2nd in egg production and 5th in poultry meat output in the world (BAHS, 2024). However, its per capita consumption of 106 eggs and 3.5 kg meat is much below ICMR recommendations of 180 eggs/year and 10.8 kg poultry meat/year (APEDA 2018). In 2020, India was placed at 102 out of 123 countries in the Global Hunger Index (GHI), which placed it in the group of countries where hunger is serious. One of the main reasons was that Indian diets were deficient in quality proteins, essential amino acids, vitamins, minerals and other essential nutrients. This in turn leads to malnutrition and health issues in the country. The public may easily access poultry eggs and meat, which are high in protein, low in calories, and economical. Although eggs and meat offer health benefits, many experts say they are high in cholesterol and a risk factor for cardiometabolic and cardiovascular disorders. They contain antibiotic residues that may damage humans. These beliefs reduced global egg and meat consumption. Recently, consumers have become more health conscious and want wholesome, healthful, nutritious, and residue-free food. They are willing to spend more for

healthy, health-promoting food. Consumers are increasingly seeking enriched poultry meat and eggs with health benefits (Sireesha and Prasanna, 2019).

Functional/Designer foods are foods that may provide health benefits beyond traditional nutritional value and appear similar to their conventional counterparts and intended to be consumed as part of a normal diet, but have been modified to serve physiological roles beyond nutrient requirements. Thus, functional food demand is rising in industrialized nations. This large demand for functional foods offers poor countries export prospects (Bhat et al., 2013). Poultry egg and meat are healthy foods. Consequently, there were a lot of efforts to make eggs and meat healthier by adding in things that were good for you or by removing or reducing things that were bad for you, all in an effort to lower the frequency of chronic diseases. Eggs and meat can be nutritionally altered in easy, cost-effective ways. Dietary fortification allows for the customization of eggs and meat by means of vitamin supplements, botanicals, or pharmaceuticals with functional and medicinal characteristics, thus creating 'designer egg and meat'.

Designer egg

Designer eggs refer to eggs whose contents have been altered or tailored to meet consumer preferences or current market trends, deviating from the standard egg. These eggs contain a wealth of extra nutrients and health-enhancing components such as carotenoids, chelated minerals, vitamins, n-3 PUFA acids like EPA and DHA, as well as herbal active ingredients, or they may have lower cholesterol levels. A standard designer egg may have cholesterol reduced by up to 40% and an increase in n-3 fatty acids by up to 6 times compared to normal table eggs (USDA, Nutrient Database, 2011). "Egg serves as an excellent medium for integrating various health-enhancing components," thus the potential for innovative egg design is boundless, as noted by Narahari (2005). The nutrient profile of an egg can be effectively altered through the dietary supplementation of the laying hens' feed. Designer eggs refer to eggs whose contents have been altered or tailored to meet consumer preferences or current market trends, differing from the standard egg. These eggs contain a wealth of extra nutrients and health-enhancing components, including carotenoids, chelated minerals, vitamins, n-3 PUFA acids such as EPA and DHA, as well as herbal active ingredients, or they may have lower cholesterol levels. A standard designer egg may have up to 40% less cholesterol and an increase in n-3 fatty acids by up to 6 times compared to normal table eggs (USDA, Nutrient Database, 2011). "Egg serves as an excellent medium for integrating various health-promoting components," thus the potential for innovative egg designs is boundless, as noted by Narahari (2005). The nutrient profile of an egg can be effectively altered through the dietary supplementation of the feed given to laying hens. Innovative dietary strategies have enabled the production of eggs that are lower in cholesterol and saturated fat while significantly enhancing levels of omega-3 polyunsaturated fatty acids, carotenoids, vitamins, minerals, antibodies, and even bioactive peptides (Leeson & Caston, 2003).

Table 1: Nutrient composition of standard egg vs designer egg (Quantity per 100g egg contents) (Narahari,2005)

Nutrient	Standard egg	Designer egg
Total saturated fatty acids	3.3 g	2.8 g
Total unsaturated fatty acids	6.4 g	6.9 g
PUFA	2.0 g	2.5 g
MUFA	4.4 g	4.4 g
Omega-3 fatty acid (α-linolenic acid)	0.03 g	0.7 g
Omega-3 fatty acids (EPA+DHA)	0.08 g	0.4 g
Omega-6 fatty acid (linoleic acid)	1.9 g	1.4 g
Unsaturated/saturated ratio	1.94	2.46
n6/n3 ratio	17.3	1.27

Carotenoids	1.5 mg	2.2 mg
Vitamin E	2.0 mg	15 mg
Selenium	Traces	1.8 µg
Chromium	Traces	1.0 µg
Cholesterol	400 mg	320 mg

Designer meat

There is increasing public apprehension regarding the consumption of poultry meat, which is perceived to contain higher levels of cholesterol and saturated fatty acids, potentially elevating the risk of coronary heart disease and atherosclerosis. However, chicken meat is comparatively low in fat and cholesterol, making it a healthier option than other sources of animal protein. Numerous dietary strategies have been explored to modify the fat and cholesterol compositions in meat. Supplementation with copper, garlic, and omega-3 fatty acids has been effectively utilized to lower the cholesterol levels in poultry meat (Esenbuğa et al., 2013). To improve the protein and moisture levels in the breast and thigh muscles, adjustments can be made to the amino acid concentration and the calorie to protein ratio in the diet. The primary sources of polyunsaturated fatty acids include fish oil, linseed, millets, and sea algae. The optimal ratio of omega 6 to omega 3 for human health was identified through the supplementation of linseed oil and cod liver oil (Bartos et al., 2004). When poultry meat is enhanced with ω-3 fatty acids and selenium, a 100 g serving of the enriched tissue provides 70–130% and 30–60% of the recommended daily intake for humans, respectively (Grashorn, 2007). In addition to being a rich source of high-quality proteins, meat products provide significant amounts of essential minerals, including iron, selenium, and zinc. The role of antioxidants is crucial in enhancing meat quality, as they significantly influence shelf-life. The sensory characteristics of meat, particularly texture, appearance, and flavor, significantly impact consumer preferences and purchasing decisions. Consequently, a significant focus is on enhancing the nutritional profile of meat products while ensuring that the sensory attributes remain uncompromised.

Production of designer poultry meat and egg

Meat and egg product supplementation is one way to improve the nutritional profile of animal-based diets. Because live animals can more easily integrate the nutrients into specific areas of the human tissues, dietary techniques can be tough but can deliver higher benefits than adding nutrients directly into these products. Additionally, dietary supplementation may be a safer option because it is less probable that a nutrient will be overdosed to a dangerous level. Modifying the quality of the hen's eggs and meat is possible by stimulating metabolic changes that lead to the creation of chemicals that ultimately wind up in the hen's eggs and tissues. Making enhanced eggs and meat by adding active ingredients to the finished product is another option (Moghadasian, 2008). Supplementing the diets of chickens and other fowl with the desired chemicals allows them to lay better eggs and produce higher-quality meat. This method is widely used and accepted in the industry. There are two main ways in which nutrients can be added to food: first, by fortifying the diet with certain nutrients, such as vitamin E, selenium, iron, and n-3 polyunsaturated fatty acids. Second, you can add bioactive, health-promoting herbal supplements to your feed. In addition to assisting in the reduction of cholesterol and saturated fats, these components include anticarcinogenic, antioxidant, and antibacterial characteristics.

Considerations prior to enrichment of egg and meat via poultry diet

- Availability of commercial sources of effective feed forms of the specific nutrients
- Possible toxic effects of nutrients for the laying hens (Vitamin A and D are toxic for chickens at high levels). Therefore, their dietary levels need to be monitored.
- Transfer efficiency of nutrients from feed to the egg and meat
- Possible interactions with assimilation of other nutrients from the egg and meat
- Stability of the incorporated nutrients during cooking

- Amount of nutrient delivered with egg and meat in comparison with Recommended Dietary Allowance (RDA)
- Established health benefits of nutrients and their lack in modern diets. Vitamin E is good for antioxidant defenses, diets are lacking in it, and large dosages are advantageous.
- Nutrient enrichment affects product look and taste, with vitamin E, carotenoids, and selenium preventing fishy taste in ω-3 eggs and CLA toughening meat.

Types of designer egg and meat

Many of essential nutrients in the egg and meat can be manipulated by dietary means. Among them n-3 fatty acids, vitamins, minerals, carotenoids, reduced cholesterol levels and certain active herbal components have attracted a lot of attention in nutritional sciences.

1. Omega-3 fatty acid enrichment

Commercial table eggs are high in n-6 PUFA (18:2n-6) but low in n-3s.

Normal growth and development require these fatty acids. Diets lacking these fatty acids can damage cardiovascular, neurological, immunological, and skin function. Three key n-3 fatty acids, α-linolenic acid, EPA, and DHA, are essential for efficient multi-system functioning (Fraeye et al. 2012). Scientists have incorporated ω-3 PUFA into eggs and meat to achieve the optimum dietary ω-6: ω-3 ratio. Eggs and meat are common items that can be fortified with ω-3 PUFA for optimal health benefits. DHA and EPA are present in deep sea cold water fish like salmon, mackerel, herring, tuna, bluefish, and anchovies, fish oil, and marine algae. Common sources of α-linolenic acid, a form of ω-3 PUFA, include canola oil, soybean oil, flaxseed, walnuts, spinach, and mustard green Flaxseed oil, rich in omega-3 fatty acids, is commonly used in chicken egg and meat enrichment due to its high LNA content (50-60%) (Plourde and Cunnane, 2007). However, sensory panels may identify off-flavors. Incorporating 15-20% flaxseed in hen diets caused a 'fishy' taste and decreased acceptance (Leeson et al., 1998). Lipid oxidation causes off-flavors, off-odors, and nutritional loss in unsaturated fatty acid-rich meat and eggs. Combinations of antioxidants in the hen's food may decrease these off-flavors by preventing lipid oxidation. If chickens are fed 5% flaxseed or 1.5% menhaden fish oil, fishy taints in eggs and meat are not noticeable. Regular eggs and omega-3-fortified eggs displayed similar cooking qualities (emulsification, toughness, sponge cake springiness). Kumar et al.(2020) incorporated flaxseed @ 100 g meal in combination with 10.0 g turmeric rhizome powder per kg diet of broiler chicken increased the ω-3 PUFA (ALA, EPA, DPA, and DHA) and improved overall FA profile in broiler chicken meat.

2. Conjugated linoleic acid (CLA) enrichment

CLAs are anticarcinogenic, antiadipogenic, antidiabetic, and anti-inflammatory. Dietary CLA at 5.0%, 310–1000 mg per egg (Suksombat et al., 2006). Siri et al. (2003) found that 4% dietary inclusion raised breast and thigh meat CLA by 46 and 38 times. CLA makes meat tough and black, affecting its texture and juiciness.

3. Docohexanoic acid enrichment

DHA is an omega-3 fatty acid derived from alpha linolenic acid, maternal milk, fish oil, or algal oil. It is essential to the brain, cerebral cortex, skin, and retina. Algae Schizochytrium (DHA Gold) enriched broiler meat with omega-3 without changing oxidative stability or organoleptic qualities like fish oil. By supplementing eggs with menhaden oil @1.5%, DHA levels reach 106 mg/egg. Eggs with flaxseeds provide 74-83 mg DHA (Muduli et al., 2018).

4. Vitamin enrichment

It is quite feasible to fortify the egg and meat with important vitamins.

To alter vitamin composition of eggs and meat can be done by dietary vitamin supplementation and concluded that vitamin content in final product is highly variable and dependent primarily on the vitamin concentration of the hen's diet. He stated the transfer efficiency of vitamins from feed to egg and meat varies from 5 to 80%. Birds fed diets with 3 to 10 times more supplemental vitamins in an attempt to fortify eggs with these nutrients. Vitamin E must be consumed in sufficient amounts to protect animals from radicals and oxidative stress. Poultry meats and eggs high in PUFA or deficient in antioxidants oxidize.

The addition of α-tocopherol to meals has been shown to significantly reduce lipid oxidation. Main sources are vegetable oils and plant feeds. The average egg has 1.1 mg of vitamin E, or 8.5% of RDA (Bou et al., 2004). Vitamin E deficiency causes immune system dysfunction, lipid metabolism problems, reproductive concerns, and other deficient illnesses. Stabilizing lipids against rancidity extends shelf life, reduces product off flavors and odors, and avoids myoglobin oxidation, which protects meat color and water holding ability. Dietary Vit. A incorporated @ 2600 - 22000 IU/kg , as reported to show liver storage increased 200 folds while egg yolk vitamin content doubled (Naber and Squires,1991). Vit. D3 inclusion @ 12,000 IU and Vit.K @ 7.5mg/kg of diet for 20 days when compared to control showed products with Vit. D3 enrichment as 4.6 times and Vit.K enrichment as 4.8 times (Park et al.,2005).

5. Mineral enrichment

A significant section of the population in India suffers from deficiency disorders due to inadequate dietary critical minerals. Minerals are essential for human health. Minerals that can be integrated into the diet to produce enriched eggs and meat include selenium, iodine, chromium, iron, and zinc. Mineral-fortified goods can substantially aid in meeting nutritional needs and preventing malnutrition. Incorporating zinc at 80 mg/kg into a laying hen diet elevated egg yolk zinc concentrations from 0.84 to 1.62 mg/egg (Naber & Squires, 1991). Incorporation of Sel-PlexTM (organic Se) at 0.3 mg/kg in the diet led to markedly elevated albumen values (Haugh Units) following 7 days of storage. The dietary intake of selenium in hens up to 5.1 µg/g (Na2SeO3; Se-yeast) is an effective method for producing selenium-enriched eggs. (Bennett & Cheng, 2010).

6. Reducing cholesterol levels in designer egg and meat

Negative public perception of eggs as a cholesterol supplier. Large eggs have 213 mg/yolk cholesterol and chicken meat 60mg/100g. Dietary modification lowers cholesterol. Dietary 10% menhaden fish reduced yolk cholesterol 13.6% (Oh et al.,1991). Cr picolinate @ 0.5 ppm considerably reduced carcass fat. Dietary garlic powder lowered egg and plasma cholesterol by 23% and 22%, respectively (Mottaghitalab and Taraz, 2002).

7. Herbal enrichment

In chicken feed, plant-derived secondary metabolites can boost hen performance and produce herbal-enriched super eggs and meat. They reduce TC and LDL cholesterol, enhance omega-3 fatty acids, and modulate, anti-inflammatory, and antioxidant effects. Fortify eggs and meat with phenolic chemicals, alkaloids, terpenoids, and triterpene saponins. Pulicaria gnaphalodes powder @ 0.3% in broiler diet- lowered E.coli and increased LAB spp. in ileum and caecum, lowered malonaldehyde levels in thigh meat and increased total PUFA and n-3 FA. (Shirani et al.,2019) Herbal mixture powder @ 2-6g/kg diet in broiler diet showed improved growth performance, meat quality and antioxidant property (Ashour et al.,2020).

Table 2: Herbal sources, active principles and their effects on human health (Muduli et al.,2018)

Source	Active principles	Effects
Garlic,onion and their leaves	Allicin,allylic sulphide	Lowers cholesterol,LDL,anticarcinogenic
Tomato pomace	lycopene	Lowers LDL cholesterol,antioxidant, anticarcinogenic
Sugar beet, grape pulp	betaine	Reduces plasma homocysteine
Flaxseed, canola, fish oils	Omega-3 PUFA	Reduces LDL cholesterol; hypertension;atherosclerosis
Spirulina,marigold petals,alfalfa red pepper	Carotenoid pigments	Antioxidant, anticarcinogenic
Basil leaves	Eugenol,eugenic acid	Immunomodulators

Citrus pulp	Nirangenin	Reduces LDL cholesterol
Turmeric powder	Flavonoids	Antimicrobial;antioxidant
Fenugreek,spices	Quercitin,Luteolin, diosgenin, citogenin	Antimicrobial;Stimulates insulin secretion
Seeds,weeds,legumes,fenugreek	Phytosterols	Increases HDL cholesterol, reduces blood sugar

Conclusion

Poultry eggs and meat are excellent sources of vital nutrients. The advancement of nutrient-enriched, value-added eggs and meat has significantly enhanced the realm of functional foods for human health. The egg is the optimal medium for integrating many health-enhancing components. Designer eggs and meat can provide the necessary critical nutrients and health-promoting elements to address malnutrition and enhance public health in the nation. Among all ways for developing modified eggs, food supplementation is the most straightforward, secure, and effective. The market demand for egg and meat products is increasing as customers become more health-conscious, necessitating an increase in their production.

References

1. APEDA. 2018. Poultry production in India- The current scenario
2. Ashour EA, Abd El-Hack ME, Swelum AA, Osman AO, Taha AE, Alhimaidi AR and Ismail IE.2020. Does the dietary graded levels of herbal mixture powder impact growth, carcass traits, blood indices and meat quality of the broilers?, Italian Journal of Animal Science, 19:1, 1228-1237
3. Bartos A, Pal L, Banyai A, Horvath P, Wagner L and Dublecz K (2004). Effect of different oil (fat) supplemented diets on the performance, carcass quality and fatty acid composition of tissues of broiler chicks. Allattenyesztes es Takarmanyozas, 53(1): 63-78.
4. Basic Animal Husbandry Statistics (BAHS) 2024. DAHD, Govt of India.
5. Bennett DC and Cheng KM.2010. Selenium enrichment of table eggs. Poultry Science 89 :2166–2172
6. Bhat ZF, Kumar S and Kumar P.2013.Production of designer eggs. Animal Products Techology.pp-543-568
7. Bou, R., Guardiola, F., Tres, A., Barroeta, A. C. and Codony, R. (2004). Effect of dietary fish oil, alpha-tocopheryl acetate, and zinc supplementation on the composition and consumer acceptability of chicken meat. Poult Sci 83:282–292
8. Esenbuğa N, Yörük MA and Karaoğlu M (2013). Effects of dietary inclusion of plant extract mixture and copper into layer diets on egg yield and quality, yolk cholesterol and fatty acid composition. Kafkas Üniversitesi Veteriner Fakültesi Dergisi, 19(4): 673- 679.
9. Fraeye I, Bruneel C, Lemahieu C, Buyse J, Muylaert K and Foubert I (2012). Dietary enrichment of eggs with omega-3 fatty acids: A review. Food Research International, 48(2): 961-969.
10. Grashorn MA (2007). Functionality of poultry meat. Journal of Applied Poultry Research, 16: 99-106.
11. Kumar F, Tyagi PK, Mir NA, Dev Kapil, Begum J, Biswas A, Sheikh SA, Tyagi PK, Sharma D, Sahu B, Biswas AK, Deo C and Mandal AB.2020. Dietary flaxseed and turmeric is a novel strategy to enrich chicken meat with long chain ω-3 polyunsaturated fatty acids with better oxidative stability and functional properties. Food Cemistry, 305(125458)
12. Leeson, S. and Caston, L.J. (2003). Vitamin enrichment of eggs. J. Appl. Poult. Res., 12(1): 24–26.
13. Leeson, S., Caston, L. and MacLaurin, T. (1998) ‘Organoleptic Evaluation of Eggs Produced by Laying Hens Fed Diets Containing Graded Levels of Flaxseed and Vitamin E’ in Poultry Sci. 77, 1436–1440
14. Moghadasian, M. H. (2008). Advances in dietary enrichment with n-3 fatty acids. Crit Rev Food Sci Nutr 48:402–410

15. Mottaghitalab M, Taraz Z. Effects of garlic powder (Allium sativum) on egg yolk and blood serum cholesterol in Aryan breed laying hens. British Poultry Science. 2002; 43:42-43.
16. Muduli, S., Champati, A. and Popalghat, H.K., 2018. Designer egg: A new approach in modern health care. *The Pharma Innovation*, *7*(5, Part E), p.320.
17. Naber, E.C. and Squires, M.W. (1991). Changing the cholesterol and vitamin content of eggs for improved human nutrition. ln: Qualify of Poultry Products Il. Eggs and Egg Products, Oosterwould, A. and de Vries, A.W. (Eds.). Spelderholt Centre for Poultry Research and Information Services, Beekbergen, pp. 249–256.
18. Narahari D. 2005. Nutrient manipulations for value added eggs and meat production. Conference of Indian Poultry Science Association and National Symposium
19. Oh, S.Y., Ryue, J., Hseih, C.H. and Bell, D.E. (1991). Eggs enriched in omega-3 fatty acids and alterations in lipid concentrations in plasma and lipoproteins and in blood pressure. Am. J. Clin. Nutr., 54: 689–695.
20. Park, B.S., Kang, H.K. and Jung, A. (2005). Influence of feeding beta-cyclodextrin to laying hens on the egg production and cholesterol of egg yolk. Asian Austral J. Anim. Sci., 18(6): 835–840
21. Plourde M and Cunnane SC (2007). Extremely limited synthesis of long chain polyunsaturates in adults: implications for their dietary essentiality and use as supplements. Applied Physiology, Nutrition and Metabolism, 32: 619-634.
22. Shirani V, Jazi V, Toghyani M, Ashayerizadeh A, Sharifi Fand Barekatain R.2019. Pulicaria gnaphalodes powder in broiler diets: consequences for performance, gut health, antioxidant enzyme activity, and fatty acid profile. Poultry Science 98:2577–2587
23. Sireesha P and Prasanna S.2019. Designer eggs and poultry meat as functional foods – An overview. The Pharma Innovation Journal; 8(4): 829-831
24. Suksombat W, Samitayotin S, Lounglawan P. Effects of conjugated linoleic acid supplementation in layer diet on fatty acid compositions of egg yolk and layer performances. Poultry Science, 2006; 85:16031609
25. USDA. Agricultural statistics. Government Printing Office, Washington, DC, 2011.