

Designer Eggs: Pioneering Innovations and Future Prospects

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ABSTRACT

Designer eggs are those whose composition has been deliberately modified to enhance their nutritional value beyond that of regular eggs. This is achieved by altering the diet or managing the immune systems of laying hens, resulting in eggs free from harmful components and enriched with beneficial nutrients. Designer eggs offer various health advantages, such as lower cholesterol, higher levels of unsaturated fatty acids, and an optimal omega-6 to omega-3 ratio, which contribute to cardiovascular health. These eggs are particularly valued for their enhanced nutritional profile, including increased antioxidants like vitamin E and carotenoids, as well as higher levels of n-3 fatty acids like Docosahexaenoic acid (DHA). These improvements not only enhance the eggs' stability during storage and cooking but also ensure the availability of essential nutrients without compromising taste. Consuming designer eggs can significantly boost up the antioxidant and n-3 fatty acid status of individuals, making them a valuable addition to a healthy diet. According to relevant scientific research and reviews, "designer eggs" represent a promising development in the functional food industry, paving the way for set up a new era of health-focused food products that cater to the evolving needs of consumers.

INTRODUCTION

Animal-derived designer foods are made also by the utilization of feed special nourishments or by using advanced technologies such as genetic engineering and cross-breeding (Alagawany *et al.*, 2018). In the food sector, designer eggs are a popular category of Nutri-functional food. Advanced progressing of the poultry sector, there is a growing interest in poultry biotechnology for modifying egg composition for human health through genetic and nutritional alterations. As per Narhari (2005), the egg is an increasingly popular option for incorporating a variety of health-promoting ingredients. For this purpose, nutritional modification of the laying hens' feed, it could be effectively producing an alteration of numerous nutrients in an egg (Hu *et al.*, 2001). That could be achieved by adjusting sterol (Cholesterol) levels, lipid profiles, minerals and amino acids (AA) or by introducing beneficial pharmacological compounds (Alagawany *et al.*, 2018). Designer eggs are vegetarian, immune-boosting, speciality or organic breakfast and lunch with better vitamins, minerals, a balanced omega-6:3 FA ratio, decreased total cholesterol, an increase in IgG and vital pigment like Flavonoids. Now a day for humans, eggs remain a healthy, highly nutritious with a high nutritional content and quality. Eggs being most consumable common foods in worldwide because of its nutritious profile, variety, and low cost as a foodstuff. In human diet phospholipids and fatty acids (saturated) are all major contributed through only by animal products. (Eaton, 1992).

PUFAs (polyunsaturated fatty acids) were found possess unique governing functions, throughout a creation of various physiologically potent chemicals comprising like eicosanoids. The n-6/omega-6 (FA) are two of the most significant PUFA in modern

diet. These PUFAs must be obtained through the diet (Parra Cabrera *et al.*, 2011).

In the human body, PUFA (polyunsaturated fatty acids) (n-3 and n-6) being incompatible and have an impact on eicosanoid biosynthesis and inter-cellular communications (Surai, 2001). Arachidonic acid (20:4n-6) and (EPA; 20:5n-3) Eicosapentaenoic acid and (DHA; 22:6n-3) docosahexaenoic acid can be formed by elongating and desaturating LA and ALA (Gregory *et al.*, 2011). Due to the fact that these 2 classes of PUFAs are physiologically as well as functionally diverse, with often opposing physiological effects (Simopoulos, 1991). Many physiological responses in the human body are hypothesized to be influenced by the absolute level and equilibrium of n-6 and n-3 PUFAs in the diet.

Why need of designer eggs?

- ✓ The most commonly consumed eggs are chicken eggs, including minerals as well as vitamins like (vit-A), (vit-B2) Riboflavin, (Vit-B9), Vit-B6, Vit-B12, Choline, Fe, Ca, Potassium and Phosphorus.
- ✓ Researcher, scientists and healthcare professionals faced big complexity and issue, because of egg high cholesterol (approximately 200-300mg/100g) contents (Alagawany *et al.*, 2018).
- ✓ Medical doctors advised for excessive egg eating, because of high cholesterol value and fat which having probable link to coronary heart disease (Hu *et al.*, 2001).
- ✓ Nutritionally modified yolk/value added eggs are another technique to minimize the cholesterol effects of eggs. The total fat content of egg yolks cannot be changed; however, the fat chemical configuration might be changed by changed or revised

type of nutrient feed formulation to chickens.

- ✓ Optimized formulated nutritional feeding to layer can easily alter saturated (FA) configuration of (Bird) yolk fat.
- ✓ Consumers are always looking for novel food items, and they're interested in industry for a new type of food which includes health and wellness benefits. The composition of "Designer eggs" has been altered from that of the conventional egg because of standard, organic, nutritional rich quality, low fat content, highly healthy & delicious taste etc.

Health benefits

Omega-3 PUFA in more than 600 mg and tocopherol in more than 6 mg can be found in designer eggs. Eggs have additional health benefits due to their stable ratio omega-6/omega-3 (1:1) and SAFA ratios (1:1). As a result, designer eggs may provide, egg consumers around the world with a new food product alternative and functional choice (Choudhary and Tandon, 2009; Alagawany *et al.*, 2018). Docosahexaenoic acid (DHA) boosted Eggs Plus, columbus eggs, omega 3 eggs, Bio-omega 3 eggs, England's best, Greek eggs, Baby eggs, Achyrona mega eggs, and omega-3 herbal eggs are available in global markets under various names depending on geographical area (Surai and Sparks, 2001). Egg industry has done a good job of looking for innovative ways to alter consumer perceptions of issues with egg and its foodstuffs, especially the high cholesterol values.

Designer egg proteins easily digestible and because of its high biological contents and present all essential amino acids equivalent to the optimal amino acid balance required by consumers, as well as numerous vit-minerals. Availability of nutrients existing in egg is not optimized associated through a suggested

consumption in humans for improved health prominence (Table No.1). In comparison to the ordinary egg, various nutritional measures increased sterol, n-3 (F.A) as well as lutein+zeaxanthin by 368, 150 and 13.97 percent, simultaneously. Designer eggs saturated fat as well as n-6 fatty acids are dropped as 17.15 and 10.25 percent (Otten *et al.*, 2006).

Eggs providing near-about 20-30% of the RDI for vit-E, A, and B-12, as well as 10-20% of the RDI for total fatty acids, saturated and polyunsaturated fatty acids, and folate. A single egg could provide 10% protein, 6% vit-A, 6% vit-D, 3% vit-E, 15% vit-B2, 4% vit-B6, 8% vit-B12, 6% folic acid, 2% thiamine, 4% zinc, and 4% iron of the RDI for human beings. A substantial number of these elements in eggs, such as vit-E, omega 3 fatty acids, selenium, and carotenoids, can be improved by changing dietary components (Surai and Sparks, 2006).

Table 1: Nutrient composition (per 100 g) and dietary reference intake (DRI) of key nutrients between standard and designer eggs.

Components	D.R.I (31 to 50 year of age)		Standard egg	Designer egg
	♀ Female	♂ Male		
Protein Value, gm	46	56	12.3	
(CHO) Carbohydrate, gm	130	130	1.01	
Total fat, % of kcal	20-35	20-35	9.95 g	
Saturated fat, % kcal	<10	<10	3.38 g	2.8 g
n-6 (F.A) fatty acid, gm	12	17	1.56	1.4 g
n-3 fatty acid, gm	1.1	1.6	0.28	0.7 g
Cholesterol, mg ^b	<300	<300	372	320 mg
Trans-fatty acid, gm	Low level	Low level	0.054	
EPA and DHA, mg ^b	250	250	49	400 mg
Vit-A, µg	700	900	171	
Vit-D, µg	5	5	2.62	
Vit-E, µg	15	15	0.48	15 mg
Vit-K, µg	90	120	-	
Vit-C, mg	75	90	-	

Thiamin, mg	1.1	1.2	0.067	
Riboflavin, mg	1.1	1.3	0.523	
Niacin, mg	14	16	0.103	
Pantothenic acid, mg	5	5	1.57	
Vit B6, mg	1.3	1.3	0.188	
Vit B12, µg	2.4	2.4	1	
Folic acid, µg	400	400	87	
(Ca) Calcium, mg	1200	1200	62	
(Mg) Magnesium, mcg	320	420	9	
(P) Phosphorus, mg	700	700	193	
(Na) Sodium, g	1.5	1.5	0.128	
(K) Potassium, g	4.7	4.7	0.135	
Copper, µg	900	900	53	
Chromium, µg	20	35	-	1.0
(I) Iodine, µg	150	150	-	
(Fe) Iron, mg	8	8	1.74	
(Mn)Manganese, mg	1.8	2.3	0.032	
Molybdenum, µg	45	45	-	
(Se) Selenium, µg	55	55	37.2	
(Zn)Zinc, mg	8	8	1.32	
Lutein + zeaxanthine, mg	-	-	0.47	2.2 mg

Adapted from Otten et al., (2006), Mc-Guire, US Department of Health and Human Services (2015), Jena and Sahoo (2014)

Table 2: Nutritional content of normal egg and designer egg

Sr. No.	Nutrient content	Quantity per 100 g of egg contents eggs	
		Ordinary Egg	Designer Egg
1.	saturated fatty acids (Total)	3.3 gm	2.8 gm
2.	unsaturated fatty acids (Total)	6.4 gm	6.9 gm
3.	(MUFA) Mono-unsaturated fatty acids	4.4 gm	4.4 gm
4.	(PUFA) Poly-unsaturated fatty acids	2.0 gm	2.5g
5.	(ω-6 F.A) Linoleic acid	1.9 gm	1.4g
6.	(ω-3 F.A) Linoleic acid	0.03g	0.7g
7.	(DHA+EPA) ω-3 fatty acids	0.08g	0.4g
8.	N6/N3 ratio	17.3g	1.27
9.	Unsaturated/Saturated fatty acids	1.94g	2.46
10.	Cholesterol	400mg	320mg
11.	Carotenoids	1.5mg	2.2mg
12.	Vitamin E	2mg	15mg
13.	Se (Selenium)	Trace	1.8µg
14.	(Cr) Chromium	Trace	1µg

(Narhari, 2005)

Omega-3-enriched designer eggs

Commercial table eggs are abundant in n-6 PUFA (primarily 18:2n-6), but little in n-3 fatty acids. Generally, 2 kinds of endeavors to generate eggs higher in n-3 PUFA. The easiest method is to make an egg rich in linolenic acid (Van Elswyk, 1997), which is a precursor to DHA and is also thought to safeguard against deadly ischemic heart disease (Van Elswyk, 1997). (Hu et al., 1999).

However, because DHA is associated with the majority of human health endorsing qualities of n-3 fatty acids, a health benefit of ALA-enriched eggs may be limited (because the conversion of linolenic acid to DHA into the human body may not always be effective). When the elderly and children's diets are high in n-6 PUFAs. The second group or route to increasing n-3 levels in eggs is to include pre-formed DHA in the hen's diet, which is commonly oil in the fish like (menhaden, tuna) (Leskanich and Noble, 1997).

Health benefits of omega-3-enriched designer eggs

Main benefits of omega-3 eggs for the consumers are the fatty acids that enhance in phospholipids, which results in improved health (Ferrier et al., 1995). Other beneficial effects have been reported, including lower plasma triglyceride concentrations (Jiang and Sim, 1993), systolic and diastolic blood pressures (Farrell, 1994), and platelet aggregation (Farrell, 1994). Consumption of modified eggs reduced overall plasma cholesterol levels in several trials (Lewis et al., 2000).

As a result, eating 1-2 omega-3 eggs per day might ensure health benefits by boosting saturated (F.A) level in lipids as well as, other kind of situations, lowering triglycerides, sterols levels in the body. Most of researcher's studies found no substantial increased in cholesterols or triglyceride values in human

body as outcomes even by eating even huge quantities of omega-3 eggs. 2 of the 25 participants in recent research by Lewis *et al.*, (2000) responded to increase in dietary cholesterol through egg consumption by having a substantial proliferation in total serum value as well as LDL-cholesterol value (Meester *et al.*, 1998).

These findings could explain the discrepancy in the results of studies on the outcome of egg feeding on plasma triglycerides levels reported over previous 20 years. However, the researchers report that eggs enriched with n-3 PUFAs provide good nutritional value. Scientists also suggest us to increase our intake of n-3 fatty acids by increasing omega-3 fatty acid consumption (Surai and Sparks, 2001).

Commercial production, global market and current research on omega-3 enriched designer egg

- ✓ In different nations, different sorts of eggs can be found, United Kingdom, the only designer egg sold in stores is the Belovo 'Columbus' egg, which is made in Belgium.
- ✓ Omega-3 fatty acids and vitamin E are abundant in these eggs (De-meester *et al.*, 1998).
- ✓ In Europe, Columbus egg is currently produced in excess of 50 million each year. The nutritional lipid composition of these eggs is balanced (C18, omega-6: omega-3=1:1), as well as a good ratio of structural lipids exists (PUFAs, omega-6:3 ratio=1:3).
- ✓ Largest manufacturer of chicken goods in Mexico and North-USA, Pilgrim's Pride Company, produced the so-called Eggs Plus, which includes more vitamin E and omega-3 fatty acids (Marshall *et al.*, 1994)
- ✓ Gold Circle Farms (containing 150mg D.H.A, 6mg vit-E, CO, U.S.A.) also

Omega Tech. (America) both produces qualitative similar eggs.

CONCLUSIONS

Designer eggs could be a good way for humans to get more of the nutrients they need. As a result, attempts have been made to develop dietary composition with highest nutrient composition values that can modify body immunological activities, treat diseases and health complications such as diabetes, cancer, blood, hypertension, lower cholesterol levels. The designer eggs used to provide extra critical nutrients with beneficial quality including vitamins, minerals, essential A.A than standard egg. Designer eggs are major source of therapeutics that provide extra supplements to the body with antibodies that are necessary for optimal health. As nutritional point of view, auspicious health benefits of designer eggs, human consumers widely accepted (Designer egg) transgenic nature modifications, egg genetical manipulation through nutritional approaches.

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