



Designer egg: A Consumer Oriented Approach

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Abstract

Egg has always been in debate for its identity as being a vegetarian or non-vegetarian food choice despite being one of the most nutritional food option in low cost, wider availability, excellent blending tendency with other food flavours and recipes, making it a go to choice round the globe for people of health conscious nature to those looking an option serving most nutritional qualities in it. Egg supplies most of all vital amines A, B₂, B₆, B₉, B₁₂, choline, Minerals Ca, P, K, along with a rich source of PUFA, Omega 3, 6 & 9 fatty acids. Recent advancement in field of nutrogeomics has conceptualised and marketed the designer/functional/fortified food concept which visualise the egg as one of the earliest as designer egg along with designer milk.

Keywords: Eggs, egg composition, designer egg, functional food, herbal enriched designer eggs

Introduction

In today's scenario of unequal scary food security among developed countries/states and economically weaker states has globally raised a concern among scientific world to find a better option which has all required nutrient profile and has a tendency to enhance its profile by dietary parameters. This is where egg and milk came in scenario as most affordable, largely available to wider section of population but certain nutrients low percentage and some harmful nutrient for human health emerge as setback for its adoption.

Some experiment around the globe initiated to see results of diet alteration on the nutrient profile of egg except just production. This paved the path for designer food in the scientific world. While in recent years this became the necessity as rising population and decreasing food security has put us in a spot where we rely on it as a good protein source. Egg is modified by changing the nutrient supplementation, adding herbs, organic additive that affect or increase the nutrient profile and medicinal properties in it. Egg is globally consumed largely as a good protein source as other sources are expensive. In eggs, largely chicken eggs are consumed which weighs around 58g composed of egg shell 10.5% (9-12%), egg yolk 31% (30-33%) and egg white 58.5% (57-



60%) supplying approximately, 160kcal/100g with 74% water, 13% protein, 11% fat, 1% carbohydrates and other nutrients in minor quantities. In this concept of designer egg, many researchers tried to modify the fatty acids in egg yolk by enhancing omega 3, 6 & 9 rich feeds in diet.

History

Cruickshank (1934) introduced the concept of designer eggs globally by altering the content of fatty acids. Commercially omega-3-enriched eggs were unattainable until the 1990s, when University of Alberta professor Jeong Sim produced designer egg commercially so-called Professor Sim's Designed egg. Later with advancement in technique and experimental studies functional egg with various attributes were made like egg enriched with vitamins (Michella and Slauch, 2000), enrichment with lutein and selenium (Leeson and Caston, 2004), Conjugated Linoleic acid (CLA) enriched egg (van Elswyk, 1997) and Herbal enriched designer egg (HEDE) (Naharari *et al.*, 2004).

What is Designers Egg?

Designers egg are those eggs in which the nutrient content of the egg has been modified from the standard egg and which may contain higher vitamin and minerals, lower cholesterol, higher omega fatty acids and added pharmaceutical compounds (Sim., 1998).

Why the need for designer egg?

Researcher, scientists and healthcare professionals faced big complexity and issue, because of egg high cholesterol content in normal egg (approximately 200-300mg/100g) (Alagawany *et al.*, 2018). The rapid shifting of human diet from animal based products to strict vegan based diet due to high cholesterol content and stuck/trapped per capita consumption 95 eggs/annum in 2022 much below than required 180egg /annum as per ICMR recommendation due to negative perception towards lipid/ cholesterol have been a major challenge to the egg industry forcing to investigate alternative manipulative techniques to improve the nutritional quality of egg & reduce the negatively perceived factor & to re-establish it as a healthy & nutritional health choice thus foods, that provide not only essential nutrient for health but also protection against specific disease such as cancer and coronary heart disease.

According to report of joint FAO/WHO Expert consultation protein quality evaluation, egg reported 97% true protein digestibility significantly as compared to meat, milk and cheese, thus making it test protein source needed in human body for building blocks & tissues repair & maintenance.



Ways to Produce Designer Eggs:

There have been several modifiable parameters to produce functional egg by alteration of quantity and quality of these nutrients in egg compositional profile like concentrating functional ingredients (omega 3 fatty acids, lycopene/lutein in yolk, vitamin E, selenium, and carotenoid) and reducing harmful cholesterol.

1. Concentrating conjugated linoleic acid (CLA):

CLA is a type of PUFA omega-6 fatty acids usually found in animal food products which helps the body to fight the risk of disease including diabetes (type-2), cancer and coronary heart disease along with supporting immune system response and boost the excessive fat loss journey in obese people.

2. Fortifying lycopene/carotenoid:

Lycopene is a hydrocarbon carotenoid found to have strong antioxidant properties effective in lowering the risk of prostate carcinomas (Wertz *et al.*, 2004) and enhances skin regeneration, improves fertility in humans (improve sperm motility) and prevent sun damage to skin and retinal health. Although lycopene is not found in eggs, lycopene enrichment can be achieved via feed fortification with tomato powder (Akdemir,*et al.*, 2012).

Along with lycopene, carotenoid like xanthophyll & lutein from the sources like corn gluten meal, Alfalfa (*Medicago sativa*), Marigold (*Tagetes erecta*), Red pepper (*Capsicum annum*) & Spirulina powder helps to increase their content in egg yolk & enhances the yolk colour to orange. These ingredients fortification are beneficial to humans in macular degeneration, blindness/cataract condition by protecting the retina, rods & cones.

3. Fortifying lutein content:

- ✓ Lutein has been known to have excellent antioxidant ability, has capability to quench single oxygen and scavenge peroxy radicals in cellular membrane (Lim *et al.*, 1992).
- ✓ Egg yolk normally contains the level of 0.14 to 0.16 mg of lutein (Leeson and Caston, 2004; Goodrow *et al.*, 2006).
- ✓ The deposition of lutein in the normal yolk depends on the dietary sources, depending on the type and the concentration of lutein, extent of processing etc (Leeson and Caston, 2004).
- ✓ Lutein content of enriched eggs can be increased up to 15-fold compared to the control group and enriched egg contains around 1.9 mg of lutein (Surai *et al.*, 2000).



<p>Natural sources of lutein</p> <p>Marigold (<i>Tagetes erecta</i>)</p> <p>Alfalfa (<i>Medicago sativa</i>)</p>	<p>Extract are source of lutein</p>
<p>Other sources</p> <p>Corn (<i>Zea mays</i>)</p> <p>Red pepper (<i>Capsicum annum</i>)</p>	<p>Provide zeaxanthin and capsanthin respectively (Breithaupt <i>et al.</i>, 2007)</p>

4. Fortifying with Folic acid:

Egg yolk can be enriched with highly bioavailable folate through fortification of feed with folic acid to provide up to 12.5% of the recommended daily intake of folate (House *et al.*, 2003).

5. Enrichment with Omega-3 fatty acids:

a. Flaxseed/Linseed oil

Flaxseed most widely used ingredient in the production of omega-3 enriched egg, the amount of LNA in yolk increases linearly with the dietary level of omega-3 fatty acid up to 10% PUFA are useful fatty acids to body where Ω -3 fatty acids is one of the most beneficial fatty acids to humans that keeps the bad cholesterol on lower side in adults protecting risk of heart/cardiac illness.

b. Menhaden oil/Fish oil

Most popular fish oil used as a source for enriching eggs with long-chain omega-3 fatty acids. Hargis *et al.*, (1991) found that adding 3% fish oil in the diet could slightly increase EPA to about 30mg/yolk. (Simopoulos, 2000) compared with fish oil enrichment with flaxseed enrichment, containing more bioavailable DHA and EPA than LNA for humans.

c. Marine algae

The use of marine algae carotenoids may enhance the oxidative stability of Omega-3 fatty acid enriched eggs (Herber and Van., 1998).

d. Canola seeds

Brettschneider *et al.*, (1995) found that the total omega-3 fatty acids in egg were 127mg and 159 mg when diets were supplemented with 15 and 30% canola seed.

Cherian and Sim's (1991) found that the inclusion of 10% flaxseed in diet led to a higher LNA content in yolk than did 10% canola, it is due to lower transferring efficiency in canola seed than in a flax seed.

6. Fortifying egg with antioxidants:

Antioxidant properties of any food ingredient protect the body from oxidative radicles/oxidative rancidity, degeneration of cells by scavenging the oxidative radicals produced in the cells/tissue during oxidative process in body thus preventing, the body tissue from oxidative damages. Incorporation of organic selenium & vitamin E and other herbal active compounds like



Allicin, Betaine, Lumiflavin, Lutein, Sulforaphane, Taurine, Lumichrome, Lycopene, Curcumin, Carnosine, Quercetin, Phosvitin supplies antioxidizing ability to functional eggs.

7. Enrichment of eggs with vitamin and mineral:

A. Vitamin E Enriched Egg omega -3 eggs

- On average egg contains around 1.1 mg of vitamin E which is equivalent to 8.5% of RDA (Seuss-baum, 2007).
- Egg can be enriched with vitamin E to provide up to 150% RDA without formation of off flavour (Surai *et al.*, 2001).
- Dietary supplementation of vitamin E is commonly used in commercial omega-3 eggs to mitigate the oxidation of omega -3 fatty acids to prevent undesirable off- flavours.

B. Selenium Enriched omega -3 eggs

Selenium is an essential nutrient for animal and humans. Selenium deficiency has been studied in many regions of the world (Surai, 2001). Adequate selenium can protect cells from the damage of oxidative stress and inflammatory disease (Dvorska *et al.*, 2006), selenium is an essential part of a selenoproteins (GSH-Px). Supplementation of Zn, I, Cu, Cr in birds diet shows manifold increased level of these minerals in eggs which help to deal with deficiency disease in humans.

8. Herbal enriched super eggs:

Phytobiotics or plant-derived products containing herbal active principles like, Allicin, Betaine, Eugenol, Lumiflavin, Lutein, Sulforaphane, Taurine and many more active principles in herbs can be used in poultry feed to improve the performance of hen and to produce herbal

Active principles	Source	Effect on human health
Allicin, Allylic sulphide	Garlic, onion and their leaves	Lower LDL cholesterol and anticarcinogenic
Betaine	Sugar beet, grape pulp	Reduce plasma homocysteine which damages arterial wall
Carotenoid pigments	Spirulina, marigold petals, alfalfa, red pepper	Antioxidant, anticarcinogenic
Eugenol, Eugenic acid	Basil leaves	Immunomodulators
Flavonoid compounds	Turmeric powder	Antimicrobial, antioxidants
Lutein	Bay (curry) leaves, Marigold petals	Antioxidants, Improves vision
Lycopene	Tomato pomace, grape pulp	Lower LDL (Bad) cholesterol, antioxidants



enriched super eggs which results in lower TG levels, increase good HDL cholesterol and improves immunity (Narahari, 2004).

Table: - Comparison of Natural to designer Egg

Quantity per 100g of egg contents (2 eggs)		
Nutrient content	Ordinary egg	Designer egg
Total saturated fatty acids	3.3	2.8
Total unsaturated fatty acids	6.4	6.9
MUFA	4.4	4.4
PUFA	2	2.5
ω -3 fatty acid	0.03	0.7
ω -6 fatty acid	1.9	1.4
ω -6 / ω -3 ratio	17.3	1.27
EPA+ DHA	0.08	0.4
Cholesterol	400	320mg
Carotenoids	1.5	2.5mg
Vitamin E	2	15mg
Selenium	Traces	1.8

Reference	Diet	Egg lipid composition(mg/eggs)		
		ALA	EPA	DHA
Aymond and Van Elswyk (1995)	Control	12	25	28
	1.5% Fish oil	18	15	83
	5% whole flax	90	3.3	68
	5% ground flax	110	5.3	68
	15% whole flax	163	7.6	73
	15% ground flax	212	20	90
Baucells <i>et al.</i> (2000)	% of total FA			
	4% Fish oil	0.44	0.92	3.18
	4% linseed oil	4.87	0.25	1.56
	% of total FA			



Bovet et al. (2007)	Control (incl. fish meal)	0.47	0.04	0.39
	Fish oil	1.26	0.4	5.41
Cachldora et al. (2005)	% of total FA			
	Control : marine fish oil	0.355	0.135	3.15
	0.77% HMA oil	0.371	0.110	2.75
	1.7% HMA oil	0.392	0.197	3.69
Lawlor et al. (2010)	Mg/egg			
	Control	70	1	62
	2% microencapsulated fish oil	65	12	96
	4% microencapsulated fish oil	73	24	129
	6% microencapsulated fish oil	70	40	162
Hayat et al. (2009)	% total FA			
	Control	0.1	0.00	2.07
	10% flax	1.05	0.00	3.75
	10% flax +50IU vitamin A	1.4	0.00	4.28
	10% flax seed+100IU vitamin A	1.56	0.05	4.41
	10% flax seed+150 IU Vitamin A	1.42	0.08	3.83

Quantities depend upon their levels in the feed provided (Narahari, 2005)

Conclusion:

(Fraeye et al., 2012)

Humans may be able to obtain most of the rich nutrients they require by eating designer eggs. In order to address diseases and health issues like diabetes, cancer, blood pressure, hypertension, and high cholesterol levels, efforts have been undertaken to design dietary composition with the highest nutrient composition values. Designer eggs are superior to regular eggs in ways that they offer more vital nutrients and useful qualities, such as vitamins, minerals, and necessary A.A. (amino acids). A significant source of medicines that give the body additional supplements of antibodies required for optimum health are designer eggs. From a nutritional perspective, the perceived health advantages of designer eggs, their transgenic origin, and the genetic modification of eggs through nutritional methods are all broadly accepted by human customers.