Powerful Nutrient Delivery Systems Turned by Everyday Eggs

Eggs are nutrient-dense and nutrition-packed foods. A recent review paper published examines approaches to egg fortification, which could guide poultry keepers and poultry feed manufacturers to produce functional eggs.

Study

Omega-3 fatty acids, such as α-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), are cardioprotective and neuroprotective and support cardiometabolic health, based on established biological mechanisms and epidemiological evidence.

Fish oil, flaxseed, and algae are excellent sources of these fatty acids, with varying enrichment efficiencies, sensory qualities, and oxidation resistance.

Fish oil may alter the taste, unlike algal oil, and enhance oxidation, though it is the most efficient DHA source. Flaxseed is rich in ALA, which is, however, inefficiently converted to omega-3 fatty acids.

These can increase omega-3 fatty acid levels in the yolk by two- to ten-fold when added to poultry feed, improving the ratio of pro-inflammatory omega-6 to anti-inflammatory omega-3 fatty acids. However, excessive levels of omega-3 fatty acids can worsen lipid oxidation, prompting yolk enrichment with antioxidants.

Lipase-mediated hydrolysis of triglycerides in the intestine generates monoacyl glycerols (MAGs) and free fatty acids. Omega-3 fatty acids are much better absorbed as MAGs than as free fatty acids.

After absorption, omega-3 fatty acids reach the liver and are preferentially inserted into specific lipoproteins during assembly. Selective transport to the ovarian follicles is followed by receptor-dependent uptake and yolk deposition. The fatty acid composition of the yolk reflects the liver lipoprotein profile, explaining the rapid response of the yolk to feed enrichment.

DHA deposition is favored among dietary fatty acids because of its resistance to oxidation and its higher esterification into phospholipids, particularly phosphatidylcholine. This persists longer in the liver, promoting its packaging into ovary-targeted lipoproteins. Ovarian receptors take up DHA, mostly into yolk phospholipids, until saturation.

Findings

Feed supplementation with vitamin E, folate, carotenoids, and plant-derived polyphenols increases oxidation resistance and nutritional value, potentially improving cardiovascular and cognitive health by enhancing antioxidant capacity rather than through direct therapeutic effects.

Carotenoids, including lutein, zeaxanthin, β-cryptoxanthin, and β-carotene, occur in highly bioavailable form in eggs, compared to plant sources. They comprise <1 % of yolk lipids but account for the yolk color and antioxidant properties of the egg.

Carotenoid enrichment of eggs can provide up to 15-fold higher carotenoids to the body. The egg matrix also enhances the bioavailability of accompanying plant-based carotenoid-containing foods.

Enrichment sources include microalgae such as Spirulina, yeast, bacteria, plants such as marigold and basil, and byproducts of carrots and tomatoes. Crab meal is another rich source, as are biofortified maize and other crops.

Eggs also provide about 1.1 mg of vitamin E, at 8.5 % of the recommended daily allowance. Enrichment can yield up to 150 % of the RDA.

Antioxidant minerals like iodine and selenium also accumulate in yolk proteins and lipids. Selenium is a component of glutathione peroxidase, a key antioxidant buffer molecule, while iodine regulates thyroid hormone synthesis. Enrichment with iron, chromium, zinc, and manganese is also being explored.

Unlike lipids, mineral deposition into the yolk is a one-time event, though other individual-level factors affect its efficiency. Micronutrient deposition is also affected by the form of the mineral, the feed composition and formulation, production system, and hen type. More evidence is required to support the use of micronutrient-fortified eggs for consistent population-level clinical benefit, particularly from long-term human studies.

Future work is essential to ensure the standardization of egg enrichment across bioactive deposition, feed formulation, chicken biology, and production facilities. This would facilitate regulatory and research efforts and aid in commercialization.

Artificial intelligence, digital manipulation of feed, and careful monitoring of chicken health could support data-driven adjustments to nutrient inputs for precision nutrition and efficient enrichment. Microbiome-related strategies, such as probiotics, prebiotics, and dietary fiber, could help enhance nutrient deposition into the egg via the gut–egg axis.

Conclusion

The authors of this review offered a mechanistic view of nutrient enrichment of eggs. This underlines "*the potential of next-generation functional eggs as effective vehicles for improving nutrient intake and advancing preventive and precision nutrition*," while emphasizing that translation to clinical outcomes requires further validation.

Source:

https://www.news-medical.net/news/20260130/Turning-everyday-eggs-into-powerful-nutrient-delivery-systems.aspx