

## A REVIEW STUDY ON EGG & EGG-DERIVED FOODS

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### ABSTRACT

*Eggs are sources of protein, lipids and micronutrients that play an essential role in basic nutrition. However, eggs are historically linked with unfavorable aspects in human health, primarily owing to their cholesterol content. Nowadays, however, it is recognized that the reaction of cholesterol in human blood levels to dietary cholesterol intake relies on many variables, such as ethnicity, genetic composition, hormonal factors and the nutritional condition of the consumer. Eggs being a traditional food having nutrients that perform essential functions beyond basic nutrition, their promotion as functional foods should be addressed. Additionally, in recent decades, there has been a growing demand for functional foods, which is anticipated to continue to rise in the future, due to their ability to reduce the risks of certain illnesses and socio-demographic variables such as the growth in life expectancy. This article provides a short review of the benefits and drawbacks of egg consumption and the potential market of functional eggs, and it examines the possibilities of the creation of functional eggs via technological techniques.*

**KEYWORDS:** Cholesterol, Egg, Egg-Derived, Foods, Technological Elaboration.

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### 1. INTRODUCTION

Human nutrition in industrialized nations is characterized by an excessive intake of protein, cholesterol, saturated fatty acids (SFA), n-6 polyunsaturated fatty acids (PUFA), calories or salt, while consumption is inadequate in n-3 PUFA, fiber and antioxidants. These imbalances are partially responsible for the high prevalence of both obesity and the development of chronic or degenerative non transmissible illnesses, from which cardiovascular diseases (CVD) are the main cause of death and morbidity worldwide. The consumption of a lower fat diet is generally accepted in all clinical guidelines on CVD prevention, and is based on total fat consumption of 25 percent –35 percent of total calories, of SFA should be no more than 7 percent –10 percent, trans fatty acids less than 1 percent, unsaturated fats, mainly monounsaturated fats (MUFA) and n-3 PUFA) should represent the rest of the calories from fat and cholesterol, for a total of less than 300 mg/day[1]–[4].

In order to improve public health, nutritional experts and related organizations, such as the U.S. Department of Agriculture and U.S. Department of Health and Human Services of the Spanish Society of Community Nutrition (SENC), has persistently recommended a reduction in the

intake of foods that are related to the occurrence of chronic diseases, and an increased consumption of fruits and vegetables, grains, legumes, low-fat dairy products, lean meats and fish, especially fatty fish species that are high in n-3 PUFA. Owing to the persistence of these recommendations, there is a significant degree of awareness of this issue in the populations of industrialized nations, and, luckily, nutritional content is already a key consideration in the choice of meals by the customer. However, while there is a huge demand for healthy food, people are hesitant to alter their eating patterns. This indicates that there is tremendous potential for meals that are eaten frequently when they are transformed to functional foods by altering the composition to incorporate specific components that are good to health. Another method to produce functional meals is to alter the amount of specific components in the food to make it more suited to the recommendations of nutrition experts.

In this respect, since eggs are a traditional food having elements that perform essential functions beyond basic nutrition, their promotion as functional foods should be addressed. Eggs are of special importance from a functionality point of view, since they provide a moderate calorie supply (approximately 150 kcal/100 g), a protein of high quality, significant culinary diversity and low economic cost, which put eggs within reach to most of the population. Eggs are also relatively high in fat-soluble compounds and may, therefore, be a healthy addition in the diet for individuals of all ages and at various phases of life. In particular, eggs may play a particularly beneficial function in the diets of individuals at risk of low-nutrient intakes such as the elderly, pregnant women and children. Additionally, it must be noted that eggs may be eaten across the globe, having no usage limitations on religious grounds[5]–[10].

However, eggs are a problematic item for nutritional experts and health authorities, because of the saturated fat level (approximately 3 g/100 g) and cholesterol content (around 200–300 mg/100 g). Owing to these two features, over the last 40 years, the public has been cautioned against frequent egg intake owing to the high cholesterol level in eggs and the possible connection with CVD. This was predicated on the premise that excessive dietary cholesterol intake is linked with high blood cholesterol levels and CVD. Afterwards, further research indicates that, in contrast to SFA and TFA, dietary cholesterol in general and cholesterol in eggs in particular have minimal impacts on the blood cholesterol level and on CVD.

However, the amount of eggs and egg yolk utilized by food businesses in their formulations is continuously rising. Nowadays, egg-yolk products are widely utilized by the food industry as a consequence of three extremely essential properties: manufacturing and stabilization of emulsions, foaming stability and thermal relation, as it is a key component for the elaboration of many food items. Unfortunately, eggs and egg-derived items are responsible for a significant number of food-borne diseases each year, primarily caused by Salmonella. For this reason, as well as for their reduced price and convenience of handling and storage compared to shelled eggs, the food service sector and commercial food producers have demonstrated a growing interest in the use of liquid pasteurized egg products instead of fresh whole eggs.

Thus, it would be of significant importance to create egg-derived goods, suitable for food businesses, with a changed nutritional content that helps preserve the health of customers. Nowadays, retail markets for functional eggs are accessible, primarily enhanced with n-3 PUFAs or with reduced cholesterol content. However, in most instances, these eggs are produced via alteration of layer-hen's diet and administration, while considerably less attention has been given

to the creation of functional eggs by means of technological techniques In this article, the potential creation of functional pasteurized liquid eggs by technical techniques and their benefits in the food business and from the point of view of nutritionists are also addressed..

### *1.1. Advantages of Egg Consumption for Human Health:*

Important nutritional component from eggs is phosphovitin, a phosphoglycoprotein found in egg yolk that comprises approximately 7 percent of yolk proteins. It has a particular amino-acid makeup, consisting of 50 percent serine, and 90 percent of which are phosphorylated. This particular structure makes phosphovitin a powerful metal chelator and, through this method, it serves as an essential melanogenesis inhibitor to limit excessive melanin production in the melanocytes of animal and human skin. It was claimed that egg-yolk phosphovitin has the potential to be utilized as a natural bioactive molecule as a hyper-pigmentation inhibitor for human skin.

Other noteworthy egg components from the nutritional point of view are the carotenoids. Carotenoids are natural pigments in hen egg yolks that give its yellow hue, which may vary from extremely light yellow to dark bright orange. Egg carotenoids comprise less than 1 percent of yolk lipids, and are primarily composed of carotene and xanthophylls. The total concentration of lutein and zeaxanthin is 10 times higher than of cryptoxanthin and carotene, combined, and are not endogenously produced by the human body and tissue levels thus rely on dietary intake. These natural chemicals present in the bodies of animals, and in dietary animal products, are ultimately obtained from plant sources in the diet, primarily from dark green leafy vegetables. Lutein and zeaxanthin concentration in eggs relies on various variables, such as the diet provided to laying hens, or the husbandry method. Thus, varied levels of these carotenoids in non-enriched eggs were recently observed, ranging approximately 167–216 µg/yolk for lutein and about 85–185 µg/yolk for zeaxanthin.

Additionally, a higher serum response to lutein was observed after the intake of eggs compared with the consumption of dietary lutein supplements or vegetables. This may be linked with the fact that carotenoids rely on a lipophilic environment for effective gastrointestinal absorption. Consequently, eggs are a highly significant dietary source of these carotenoids, particularly in the case of individuals who eat modest quantities of plants with a high concentration of these compounds (as happens in western industrialized nations) (as occurs in western developed countries). Taking into consideration the existence of all these components, eggs may be regarded a healthy inclusion in the diet for individuals of all ages and at various phases of life, but they may play a particularly beneficial function in the diets of those at risk of low-nutrient intakes.

Owing to their great nutritional content, eggs are also an essential item that should be included in the design of menus for patients, and are particularly useful in feeding individuals with gout, since it is a source of protein that does not contribute purines. Additionally, for individuals in sports training, egg proteins may have a significant impact on the training outcomes, since, by its inclusion in the diet, it may be able to increase skeletal muscles synthesis. It is widely known that necessary amino acids promote skeletal muscle protein synthesis in animal and human models, and the protein in egg has the greatest biological value. Fifteen grams of egg white protein contain approximately 1300 mg of leucine (the third most prevalent amino acid in egg, after glutamic and aspartic acids), and is also an abundant source of branched amino acids and aromatic amino acids. Recent studies revealed that leucine produces a maximum skeletal muscle

protein anabolic response in young individuals, which indicates that egg white protein consumption may have a major impact on body mass accretion. Specifically, leucine promotes skeletal muscle synthesis independently of all other amino acids in animal models and is a strong activator of the cell hypertrophy mammalian target of rapamycin complex pathway. Additionally, leucine reduces muscle protein breakdown and breakdown-associated cellular signaling and mRNA expression.

## *1.2. Undesirable Effects of Egg Consumption:*

Despite its abovementioned nutritional advantages, egg intake was historically linked with unfavorable effects for human health and nutrition. In this regard, egg whites include anti-nutritional agents, among which are proteins such as ovomucoid that may block trypsin or avidin, which can bind biotin. However, these components are thermo-labile and, thus, these compounds are typically eliminated while boiling eggs, after which they do not produce additional negative effects. Additionally, eggs have been the topic of many suggestions from nutrition experts in order to limit egg intake, due to its high cholesterol and saturated-fat content. Decreasing saturated-fat intake is the main dietary approach advised for reducing blood cholesterol levels, and this strategy has frequently led to a decrease in the consumption of eggs. Nevertheless, replacing eggs for other animal-protein items in the diet may result in modest modifications to low-density lipoprotein cholesterol (LDL) and, therefore, egg intake should be evaluated in a similar manner to other protein-rich meals.

Although metabolic studies have indicated that dietary cholesterol is a significant predictor of serum cholesterol concentrations, other investigations failed to find changes in the serum total-cholesterol concentration when eggs were added to diets that already included modest levels of cholesterol. In this respect, extensive research efforts, and even meta-analyses, have been performed to examine the effects of eggs on blood cholesterol levels and cardiovascular health, with widely diverse results. Several experts suggest that dietary cholesterol from eggs may be a significant risk factor for cardiometabolic illnesses like CVD and diabetes. Furthermore, lecithin (about 250 mg in a big egg yolk) is transformed by intestinal bacteria to trimethylamine, which is in turn oxidized by the liver to trimethylamine oxide, which is pro-atherosclerotic. In this respect, a meta-analysis showed that a consumption augmentation of four eggs per week may potentially raise the risk of CVD by 6 percent and diabetes by 29 percent. Nevertheless, a recent systematic analysis revealed no apparent connection between egg intakes with CVD among diabetes people.

However, for a significant number of studies, conventional beliefs that dietary cholesterol intake translates directly into increased plasma cholesterol levels and the development of CVD in all people were considered to be incorrect. First, a conservative assessment indicates that about 30 percent of the population would hyper-respond to dietary cholesterol, while around 70 percent of people are hypo-responsive to high dietary cholesterol intake. Therefore, clinical investigations have clearly demonstrated that plasma compartment changes, resulting from dietary cholesterol intake, are affected by many variables such as ethnicity, genetic composition, hormonal factors and body mass index. All of these factors decide who will hyper-respond to dietary cholesterol and those who are hypo-responsive to consumption. In addition, those people who hyper-respond to dietary cholesterol consumption typically exhibit elevated LDL and high-density lipoprotein cholesterol (HDL), allowing for the preservation of the LDL/HDL ratio, an essential marker for

CVD risk. This indicates that, for healthy people, the nutritional advantages substantially exceed the worry around the dietary cholesterol supplied by one big egg.

### *1.3. Recommendations and Worldwide Consumption of Eggs:*

Guidelines from such like the U.S. Department of Agriculture and U.S. Department of Health and Human Services or the SENC encourage healthy people to restrict dietary cholesterol consumption to fewer than 300 mg per day. However, due to the increasing amount of scientific research demonstrating a lack of connection between egg consumption and CVD, current dietary recommendations advise healthy individuals may eat one egg a day as part of a balanced diet. Other recommendations have produced various results, ranging from no limit to advising frequent consumption of eggs. Despite the advice to reduce egg consumption, the global production of eggs grew in recent decades and surpassed 64 million tons in 2009, with China as the biggest world producer, with 36 percent of the world's output. For consumers, Mexico is the biggest consumer per capita, achieving an average consumption of 355 eggs per person each year, followed by China (344) and Japan (325). (325). The rise in global egg production and consumption is logical, since egg protein is of high quality and cheap economic cost, while a large demand for protein sources are required in emerging nations, in which a third of the population are poorly fed.

Additionally, the fact that eggs are a healthy dietary option for the elderly plays a significant part in their consumption growth, since it is anticipated that, by the year 2020, the number of persons worldwide over the age of 60 may reach one billion. Although higher total seric cholesterol levels have been found to predict CVD in middle-aged people, this measure does not appear to be significant for the older population. Unfortunately, in the elderly, the limitation of fat and cholesterol from the diet frequently leads in the following addition of foods that are rich in simple carbohydrates. This shift in food composition may be harmful, producing increases in seric triglycerides (TG), which are usually accompanied with low HDL levels, which has been recognized as the best lipoprotein predictor of CVD risk in older people. Furthermore, it has been hypothesized that the intake of a low-fat diet by older people may induce insulin resistance as a result of increasing levels of LDL and TG and reduced HDL levels in blood.

Furthermore, another important factor that could raise egg consumption in the near future is the fact that typical factors of modern life, such as frequent travel, busy schedules, little time to cook and eat at home and the inability to eat together as a family, play an important role in the increased consumption of pre-cooked and processed foods. As eggs are frequent components used by the food business for their thickening, gelling, emulsifying, foaming, coloring, and flavoring characteristics, it is also anticipated that the global consumption of eggs contained in food industry formulations would rise in future years.

However, in the case of pre-cooked and processed meals, the usage of pasteurized liquid eggs and egg powders are more frequently utilized than fresh eggs. Food industries primarily make use of the liquid egg products produced from the shelling and pasteurization of shelled eggs, while whole egg products are used as components for the production of egg pasta, mayonnaise, pastry or baked meals. The pasteurization procedure may increase interactions between lipids and molecular oxygen, resulting in losses of nutritional and sensory characteristics of the egg products. Besides the potential effect of processing on lipid oxidation, the initial composition of raw materials may affect the behavior throughout processing.

Thus, there is a huge potential market for functional egg products enriched with bioactive substances by means of technical techniques. Fortification is typically the most cost efficient and feasible method to deliver micronutrients to populations in need, particularly if the technology already exists and if an adequate and fair food-distribution system is in place. It is generally feasible to add numerous micronutrients without significantly raising the overall cost of the food product at the time of production, particularly when they produce big quantities of foods.

#### *1.4. Potential Markets for Egg-Derived Functional Foods:*

The growing demand for functional foods over recent decades may be explained by the increasing expense of healthcare, the constant rise in life expectancy and the desire for a better quality of life in later years. Functional meals may enhance the overall health of the body, reduce the risk of certain diseases and may even be used to treat specific ailments. Taking into consideration the increasing aging of the population of industrialized nations, functional meals are a viable option for reducing health expenses, since medical services for the elderly population are quite costly.

Although the phrase “functional food” has previously been defined many times, there is no unitarily recognized definition for this category of meals. In most countries, there is no legal definition for the word and establishing a boundary between conventional and functional meals is difficult, even for nutritionist or food specialists. The European Commission’s Concerted Action on Functional-Food Science in Europe (FuFoSE), coordinated by International Life Science Institute (ILSI) Europe stated that “a food product can only be considered functional if, together with the basic nutritional impact, it has beneficial effects on one or more functions of the human organism, thus either improving the general and physical conditions or/and decreasing the risk of the evolution of diseases.

## **2. DISCUSSION**

Eggs are a cheap and extremely nutritious meal, containing 18 vitamins and minerals, the composition of which may be influenced by many variables such as hen diet, age, strain as well as environmental conditions. Nevertheless, while various compositions have been recorded by many authors, on average, the macronutrient content of eggs contain minimal carbohydrates and approximately 12 g per 100 g of protein and lipids, most of which are monounsaturated and provide the diet with several important elements. Some of these minerals, such as zinc, selenium, retinol and tocopherols, are low in individuals eating a western diet, and given its antioxidant activity, may protect humans from various degenerative processes, including CVD. Eggs constitute a highly essential dietary item, particularly for certain groups such as the elderly, pregnant women, children, convalescents and individuals who are sports training. The amount of both fresh eggs and eggs utilized by food businesses in their formulations rises continuously.

## **3. CONCLUSIONS**

Owing to its greater security, cheaper price and simpler handling and storage characteristics, food producers choose to utilize pasteurized egg products rather than raw eggs. Additionally, the number of functional-food markets has also grown in recent decades and, due to certain reasons such as the increasing aging of the population of developing nations, are anticipated to continue to increase in the future years. Nevertheless, the availability of functional eggs in the market and awareness of such goods by the customers are lower than other categories of foods.

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Consequently, the creation of functional egg-derived foods via technological techniques may be an attractive approach to increase revenue for egg farmers and the food business, in addition to improving the general conditions of public health. This may be particularly intriguing for the inclusion of bioactive chemicals that need to be kept at refrigeration temperatures, since egg-derived products such as pasteurized liquid eggs must be stored under refrigeration throughout the commercialization process. Additionally, these goods are safer from the microbiological point of view, cheaper, simpler to carry and store, and because of the heat treatment performed, in certain instances are less allergic than fresh eggs. Thus, functional egg-derived goods produced via technological techniques are a highly intriguing alternative for food producers.

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