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Review Article

Impact of Eggs Protein on Musculoskeletal Health

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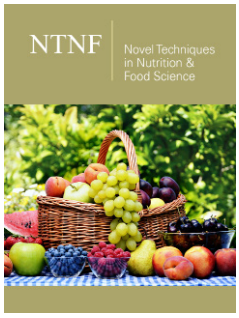

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Abstract

Once the consumer acknowledges that foods containing dietary cholesterol are not a risk factor for cardiovascular disease. The eggs contain dietary cholesterol and must be valued for their other nutritional components. Egg protein is one of the components in eggs that demands special attention. Egg protein has a high biological value and provides essential amino acids. Egg protein has been shown to be beneficial to musculoskeletal health. Egg protein may also suppress appetite, resulting in a reduction in calorie intake which leads to weight loss.

Keywords: Egg protein; Musculoskeletal; Yolk; Muscle protein synthesis; Leucine

Introduction

Eggs are a highly debated food because of their dietary cholesterol levels. The highest limit on dietary cholesterol was removed from the United States Department of Agriculture (USDA) in 2015, highlighting that whole eggs can be consumed (Dietary Guidelines for Americans 2015-2020, 2015). However, several investigations in both healthy [1,2] and unhealthy [3,4] populations suggest that egg consumption does not increase biomarkers associated with cardiovascular risk. Eggs contain various dietary components (selenium, choline, zeaxanthin, lutein, vitamins A, and D) that help prevent chronic diseases [5]. Table 1 represents the nutritional composition of eggs. Another essential nutrient found in eggs is protein. Eggs are a good source of high-quality protein and contain all the essential amino acids [6]. In fact, eggs are considered an ideal source of protein, serving as a benchmark for all other sources of protein [7]. The yolk and white part of a large egg (combined) provide 6.3 grams of protein [8]. Egg protein provides a variety of health benefits that are beneficial for people of all ages [9]. The function of egg proteins in the synthesis of skeletal muscle will be explored in the following sections (Table 1).

Table 1: Nutritional profile of Egg, whole, raw, fresh (100g) (Data is adapted from Food Data Central, https://fdc.nal.usda.gov/fdc-app.html#/food-details/171287/nutrients).

Name	Amount	Unit	Name	Amount	Unit
Water	76.2	g	SFA 20:0	0.003	g
Energy	143	kcal	SFA 22:0	0.004	g
Protein	12.6	g	Fatty acids, total monounsaturated	3.66	g
Total lipid(fat)	9.51	g	MUFA 14:1	0.007	g
Ash	1.06	g	MUFA 16:1	0.201	g
Carbohydrate, by difference	0.72	g	MUFA 16:1 c	0.198	g
Sugars, Total	0.37	g	MUFA 17:1	0.012	g
Glucose	0.37	g	MUFA 18:1	3.41	g
Calcium, Ca	56	mg	MUFA 18:1 c	3.39	g
Iron, Fe	1.75	mg	MUFA 20:1	0.027	g
Magnesium, Mg	12	mg	Fatty acids, total polyunsaturated	1.91	g
Phosphorus, P	198	mg	PUFA 18:2	1.56	g
Potassium, K	138	mg	PUFA 18:2 n-6 c,c	1.53	g
Sodium, Na	142	mg	PUFA 18:2 CLAs	0.012	g
Zinc, Zn	1.29	mg	PUFA 18:3	0.048	g
Copper, Cu	0.072	mg	PUFA 18:3 n-3 c,c,c (ALA)	0.036	g
Manganese, Mn	0.028	mg	PUFA 18:3 n-6 c,c,c	0.012	g
Selenium, Se	30.7	µg	PUFA 20:2 n-6 c,c	0.018	g
Fluoride, F	1.1	µg	PUFA 20:3	0.023	g
Thiamin	0.04	mg	PUFA 20:3 n-3	0.001	g
Riboflavin	0.457	mg	PUFA 20:4 n-6	0.022	g
Niacin	0.075	mg	PUFA 20:4	0.188	g
Pantothenic acid	1.53	mg	PUFA 22:4	0.013	g
Vitamin B-6	0.17	mg	PUFA 22:5 n-3 (DPA)	0.007	g
Folate, total	47	µg	PUFA 22:6 n-3 (DHA)	0.058	g
Choline, total	294	mg	Fatty acids, total trans	0.038	g
Betaine	0.3	mg	Fatty acids, total trans-monoenoic	0.026	g
Vitamin B-12	0.89	µg	TFA 16:1 t	0.003	g
Vitamin A, RAE	160	µg	TFA 18:1 t	0.023	g
Cryptoxanthin, beta	9	µg	TFA 18:2 t not further defined	0.012	g
Lutein+zeaxanthin	503	µg	Fatty acids, total trans-polyenoic	0.012	g
Vitamin E(alpha-tocopherol)	1.05	mg	Cholesterol	372	mg
Tocopherol, beta	0.01	mg	Tryptophan	0.167	g
Tocopherol, gamma	0.5	mg	Threonine	0.556	g
Tocopherol, delta	0.06	mg	Isoleucine	0.671	g
Tocotrienol, alpha	0.06	mg	Leucine	1.09	g
Tocotrienol, gamma	0.01	mg	Lysine	0.912	g
Vitamin D (D2+D3)	2	µg	Methionine	0.38	g
Vitamin D3(cholecalciferol)	2	µg	Cystine	0.272	g
Vitamin K (phylloquinone)	0.3	µg	Phenylalanine	0.68	g
Vitamin K (Dihydrophylloquinone)	0.1	µg	Tyrosine	0.499	g
Fatty acids, total saturated	3.13	g	Valine	0.858	g
SFA 4:0	0.004	g	Arginine	0.82	g
SFA 8:0	0.004	g	Histidine	0.309	g
SFA 10:0	0.006	g	Alanine	0.735	g

SFA 14:0	0.033	g	Aspartic acid	1.33	g
SFA 15:0	0.008	g	Glutamic acid	1.67	g
SFA 16:0	2.23	g	Glycine	0.432	g
SFA 17:0	0.022	g	Proline	0.512	g
SFA 18:0	0.811	g	Serine	0.971	g

Musculoskeletal Health and Egg Proteins

Skeletal muscle plays an important function in health [10,11]. Improving skeletal muscle health increases physical function [12], insulin sensitivity [13], and lowers the risks of cardiovascular disease and hypertension [11,14], increases the chances of osteoporosis and mortality [15]. Resistance exercise increases the demand for protein to sustain increased protein synthesis for hypertrophy and to compensate for muscle protein breakdown caused by exercise [16]. While the RDA of 0.8g protein/kg body weight/day fulfills most people's nitrogen balance demands [16] while1.4-2.0g/kg body weight/day is recommended by experts for those persons who perform extensive exercise [17]. This range should be sufficient for most people who engage in regular physical exercise. Protein requirements may be increased for athletes performing intense exercises to enhance muscle development [18]. From the research, it was found that there are no deleterious effects on renal function were seen in participants ingesting more than 3g protein/kg body weight per day or in those consuming 2.5g protein/kg body weight for 1 year [18,19]. Nearly, 73.1% of American adults are overweight or obese [20], so an emphasis on high-quality protein sources that are low in calories is essential. Eggs are low in calories and fulfill satiety, a large egg comprising 72 calories and 6.3g of high-quality protein. Therefore, eating eggs is an easy and affordable method for individuals to achieve their protein requirements. This is especially important for athletes aiming for larger protein intakes since the biological value of egg protein is high. The quality of protein consumed is important since plant proteins result in poorer muscle protein synthesis than animal proteins due to a lack of one or more necessary amino acids, low biological value, and leucine content [21].

The biological value of eggs, meat, and dairy protein is more than 90%, while plant protein's biological value ranges from 45 to 80% [22]. The World Health Organization (WHO) has revealed that eggs are the most digestible protein source, with a score of 97% (UNICEF: United Nations University), compared to 95% for dairy and 94% for meat [23]. In an investigation by Norton et al. [24] it was found that muscle protein synthesis in rats was higher in diets containing protein from eggs or whey than in soy and/or wheat [24]. In research by Moore et al. [25] the investigation group consumed whole egg protein (0, 5, 10, 20, and 40g) following resistance exercise [25]. They discovered that 20g of egg protein was adequate to maximize muscle protein synthesis, which was consistent with the results of Witard et al. [26] who discovered that intake of 20g of whey protein optimally enhanced muscle protein synthesis [26]. Hida et al. [27] compared a daily 15g egg white protein supplement to a carbohydrate supplement for female athletes over an 8-week period. There were no alterations in body composition or muscular strength recorded. However, the total protein intake for athletes taking the egg white protein supplement was unsatisfactory (1.2g/kg body weight/day), and the 15g dosage was most likely insufficient to stimulate muscle protein synthesis [27]. Iglay et al. [28] found no alteration in skeletal muscle mass or body composition among older persons who had a high-protein diet with eggs as the predominant protein source and those who do not. The high-protein diet offered 1.2g protein/kg body weight per day, which was less than the recommended amount [28]. Whereas Kato et al. [29] found that a daily snack of 15g egg white protein and 18g sugar combined with 5 weeks of resistance exercise enhanced skeletal muscle size and strength while decreasing fat mass in young men. In this research, the protein consumption was 1.3g/kg body weight/day, which, although only slightly higher than the previous research, closer to the guidelines, and probably contributes to these outcomes. A recent study analyzed the benefits of a whole egg protein intake (20g) or a diet that provides 1.4g/kg body weight or above protein, and the findings have been positive [29]. Bagheri et al. [30] provide three entire eggs or an isonitrogenous supply of egg whites for 12 weeks to resistance-trained persons, immediately after strength training (thrice a week). Throughout the investigation, the individuals consumed 1.5g of protein per kilogram of body weight. The researchers found that in both groups muscle strength and testosterone have increased, and body fat percentage decreased [30]. A separate study by the same group found that eating whole eggs or egg whites after resistance training with a protein consumption of 1.4g/kg body weight per day resulted in similar results [31]. Animal studies have suggested egg protein is superior to casein (milk protein). Matsuoka et al. [32] gave 20% egg white or casein protein to male rats for 4 weeks. The researchers discovered that rats fed with an egg white protein diet had higher average gastrocnemius leg muscle weight and carcass protein mass, as well as lower abdominal fat mass and carcass triacylglycerol [32]. This may be due to the high biological value of egg white protein than casein [33]. A previous study documented that lower lipid absorption is associated with egg white protein ingestion [34], and egg white proteins also block lipase activity [35], which might contribute to the reduction in belly fat. More study is needed to evaluate the effects of long-term egg protein. The quantity of leucine in a protein source is vital since it is the most powerful activator of muscle protein synthesis [36]. In fact, leucine alone induces muscle protein synthesis [24]. The advised dosage of leucine for maximum activation of muscle protein synthesis is 700-3000mg. One egg has 500mg of leucine in just 72 calories [15].

The yolk of an egg contains 40% of the protein [37]. Dietitians and other health experts have advised consuming just the egg white part of an egg, a significant proportion of high-quality protein is

often eliminated, thus lowering protein consumption during meals. Van Vliet et al. [37] found that whole eggs stimulated myofibrillar protein synthesis more than egg whites [37]. Bagheri revealed greater strength would be increased if the whole egg is consumed as compared to egg white [30]. This might be connected to the yolk's other constituents, such as microRNAs, phospholipids, or other micronutrients [38]. Whole egg consumption enhanced the plasma lipoproteins and reduced the risk of cardiovascular disease [39]. In the world, many people are overweight or obese, and many are seeking to reduce their weight. Researchers discovered for maintaining lean body mass while losing weight protein intakes above the RDA (2.3-3.1g/kg body weight) play an important role [15]. Pasiakos et al. [40] found that taking 1.6g/kg body weight/day protein for 1-month improved fat loss. Consumption of three times the RDA provided no additional advantage over consumption of twice the RDA [40]. The Physical Activity Guidelines for Americans prescribe 150 minutes or more of moderate-intensity activity or 75 minutes of strenuous exercise (Physical Activity Guidelines for Americans | Health.Gov). Although most individuals would not undertake this activity at the same intensity as athletes, muscular damage caused by this exercise is likely to need more protein than the RDA. Protein consumption for physically active people, not only competitive athletes, should be above the RDA, with high-quality protein from whole foods, such as eggs, distributed equally across meals at least three times per day. Strength training is also advised to be included twice a week. While it has been established that eating high-quality protein, such as that found in eggs, is important for skeletal muscle health, much of the research reviewed in this review used entire eggs or egg whites. As a result, it is probable that additional factors found in eggs are beneficial. The above studies stated that eating the yolk provided more advantages, components such as lipids, micronutrients, and other elements in the yolk may improve the beneficial effects of egg protein [38,41].

Conclusion

After the removal of the restriction of dietary cholesterol intake, eggs are considered an important food. Eggs protein is cheaper with excellent biological value. Eggs contain all the essential amino acids, especially rich sources of leucine. From the above-stated points, it is concluded that egg proteins strengthen musculoskeletal health. It's crucial to keep in mind that the egg yolk also comprises protein and other important nutrients to maintain good health. Egg protein has been linked to appetite suppression and weight loss [42-45].

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