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A review: Chemical composition and utilization of egg

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Abstract

Egg (*Gallus Gallus*) is one of the food items, which fulfils the daily dietary requirement of the human body in balance. Egg is a very good source of protein, Vitamin A, B₆, B₁₂, Folate, Amino acid, Iron, Phosphorus & Selenium. Egg contains 12 per cent of protein, 11 per cent of fat and other important components of minerals and vitamins. Egg provides a well-balanced and unique source of nutrients for persons of all ages. Egg significantly contributes to the body's nutrient necessary during rapid growth so that it is an excellent food for growing children and teenagers. Egg consists of mainly three main parts, the egg white, the yolk and the egg shell. It is incredibly nutritious and healthy foods for our body.

Keywords: utilization of egg, source of protein, Vitamin A, B₆, B₁₂

Introduction

The biological value of an egg is very high because egg is a rich source of protein. The quality of the protein in egg is often the standard for measuring the quality of all other food proteins. Egg is also contains essential unsaturated fatty acids (Linoleic, oleic acid), iron, phosphate, trace minerals and the fat-soluble vitamins. (Stadelman and Newby 2017) ^[1].

India is among the top egg producer countries in the world with production of egg about 78.48 billion. Availability of eggs in India is 63 per person per year, while as per National Nutrition Institute this should be about 180 eggs per person per year. (Anonymous 2016) ^[2].

Egg contains 12 per cent of protein, 11 per cent of fat and other important components of minerals and vitamins (Panda, 1995) ^[3]. Egg provides a well-balanced and unique source of nutrients for persons of all ages. Egg significantly contributes to the body's nutrient needs during rapid growth and hence an excellent food for growing children and teenagers. (Stadelman and Cotterill, 1995) ^[4].

During transportation of fresh eggs to different regions considerable loss of 2.5 per cent due to breakage occurs (Jayaraman *et al.*, 1976) ^[5]. Therefore it is essential to reduce the wastages and also to protect price structure. Because of the disadvantages in the storage of whole egg and the increased production, it's necessary to preserve the egg for domestic consumption and also to promote export (Rao *et al.*, 1995) ^[6].

Egg consists of three main parts, the egg white, the egg yolk and the shell. The shell consists of calcite crystals embedded in a matrix of proteins and polysaccharide complex. Inside the shell the viscous colourless liquid called the egg white accounts for about 58 per cent of the total egg weight. (Anonymous 2015) ^[7] The composition of egg white (albumin) and yolk is given in the following table.

Percentage composition of egg white and yolk

Nutrients	Egg White	Egg yolk
Water	88.0	48.0
Protein	11.0	17.5
Fat	0.2	32.5
Minerals	0.8	2.0

(Yadunandan and Joseph, 2014) ^[8]

Percentage distribution of weight

Part	Weight (%)
White	57-61
Yolk	27-32
Shell	8-11

(Anonymous, 2016)^[9]

Egg White

Egg white is composed of thick and thin portions. 20-25% of the total egg white of fresh eggs (1-5 days old) is thin white. The chief or main constituents of egg white besides water are proteins. Many different-different types of proteins are present in egg white^[10, 11].

Ovalbumin

Ovalbumin constitutes 55% of the proteins of egg white (albumin). It is a phospho glycoprotein. It is composed of three components A1, A2, and A3, which differ only in phosphorus content.

Conalbumin

Conalbumin constitutes 13% protein of the egg white (albumin). It consists of two forms neither of which contains phosphorus nor sulphur.

Ovomuroid

Ovomuroid is a glycoprotein. This constitutes about 10% of the egg white proteins.

Ovomucin

Ovomucin protein is responsible for the thickness of the thick albumen and the jelly like character of egg white. It contains 2% of the egg albumin. Ovomuroid content in the thick layers of albumin is about 4 times more than in thin layers. It is soluble in dilute salt solution but insoluble in water.

Lysozyme

This content of 3.5% of egg white. Lysozyme is an enzyme capable of lysing or dissolving the cell wall of bacteria. It is composed of 3 components A, B and C. It makes the vitamin unavailable and binds biotin.

Avidin

Avidin is 0.05% of the egg white protein. It is denatured by cooked eggs and heat and do not affect the availability of biotin.

Ovoglobulin

Ovoglobulin is a protein consisting of two components G1 and G2 and both are excellent foaming agents.

Ovoinhibitor

Ovoinhibitor is another protein capable of inhibiting chymotrypsin and trypsin. (Anonymous, 2017)^[12].

Egg Yolk

In the egg, the shade of yolk usually is yellow in color. It is spherical in shape and is suspended in the egg white (known alternatively as albumen or glair/glaire) by one or two spiral bands of tissue called the chalazae.

The yolk mass, together with the eggcell or ovum properly (after fertilization, the embryo) is enclosed by the vitelline membrane, whose structure is different from a cell membrane

^[13, 14]. The yolk is mostly extracellular to the oolemma, being not accumulated inside the cytoplasm of the egg cell (as occurs in frogs)^[15] contrary to the claim that the avian egg cell (in strict sense) and its yolk are a single giant cell^[16]. After the fertilization, the cleavage of the embryo leads to the formation of the germinal disc.

The Solid content of egg yolk is about 50%.

Percentage composition of egg yolk on dry weight basis is given below

Nutrient	Granules	Plasma
Lipid	34	77-81
Protein	60	18
Ash	66	2

(Anonymous, 2008)^[17]

Chemical composition of egg contents

1. The composition and weight of a table egg is dependent on heredity, season, diet, age and other factors. An average weight of typical White Leghorn egg usually 55 gm.
2. In addition to water (74%), the main chemical compositions of hen egg are 12.8% proteins, 11.8% lipids and small amounts of minerals and carbohydrates.
3. Most of the proteins are present in the egg white and the egg yolk, amounting to 50% and 44%, respectively; the eggshell contains the rest of the proteins. The yolk accounts for slightly over one-third of the edible portion, but it yields three-fourths of the calories and provides all or most of the fat in whole eggs.
4. Mainly the yolk comprises 48% of water, 16% of protein, 32.6% of fat, and vitamins and some minerals. The egg white consists of 88% of water, 10% of protein, and some minerals. The amount of lipid in the egg white is negligible (0.01%) compared with the amount present in the yolk.
5. Carbohydrates are a minor component of hen eggs. Their average content is about 0.5 g per egg, 40% of which is present in the yolk. The shell makes up 11% of the weight of an egg, and approximately 98% of the shell consists of calcium.
6. Carbohydrates are present as free and conjugated forms which are attached to proteins and lipids. Glucose accounts for about 98% of the total free carbohydrate in the egg white.
7. The content of carbohydrate in egg yolk is about 0.7-1.0 % and it consists of oligosaccharides bound to protein, composed of mannose and glucosamine; the remaining 0.3% is free carbohydrate in the form of glucose.
8. About 94% of the minerals are in the egg shell fraction; the rest are distributed in egg white and egg yolk. Most of the minerals are in conjugated form, and only a small portion is present as inorganic compounds or ions.
9. Calcium represents over 98% of total mineral in the shell; other inorganic components include phosphorus, magnesium, and trace contents of iron and sulphur. Egg yolk contains 2% minerals, phosphorus being the most abundant.
10. More than 61% of the total phosphorus of egg yolk is contained in phospholipids. The major inorganic components of egg white are sulphur, potassium, sodium, and chlorine. (Anonymous, 2012)^[18]

Egg Quality

Fresh Eggs

- Stand high when broken onto a plate
- Yolk stands high and round
- Two “layers” of egg white evident
- Small air cells
- Yolks are slightly acidic

Older Egg

- Spreads out when broken onto a plate
- Yolk does not stand high and round
- One “layer” of white that spreads out
- Large air cells
- Egg becomes more alkaline

(Anonymous, 2010) ^[19]

Consumption of Eggs

The eggs contain high nutritional value, the digestible protein coefficient of yolk is about 100% while the digestible protein coefficient of albumin is 97% and usually per cent of albumin to yolk is 2 : 1. The gross thermal energy generated from whole egg are very high value because it is contain fat and protein on 155- 180 calories/gm, and the ratio of crude protein in egg is about 12% also contain all kinds of vitamins except ascorbic acid and it is rich in mineral elements such as calcium, copper and zinc.

Chemical Analysis of an Egg

Portion	Percentage (%)	Moisture (%)	Protein (%)	Fat (%)	Ash (%)
Whole egg	100	75.2	12.6	10.5	1.0
Albumin	66	87.6	10.9	0.2	0.7
Yolk	34	51.1	16.0	30.6	1.7

* The proportion including shell: albumin=58%, yolk=30% and shell=12%.

Composition of an Eggshell

Chemical	Percent (%)
Calcium carbonate	94.0
Magnesium carbonate	1.0
Calcium phosphate	1.0
Organic matter	4.0

(Anonymous, 2007)^[20]

Foam

The foam can be created by physical stress of beating egg whites. By beating them with a whisk two types of physical stress are caused, the first stress of which occurs as the whisk drags the liquid through itself, creating a force that unfolds the protein molecules. This process is called denaturation. The second stress comes from the mixing of air into the whites, which causes the proteins to come out of their natural state. These denatured proteins gather together where the water and air meet and create multiple bonds with the other unravelled proteins, and thus become a foam, holding the incorporated air in place, because the proteins consist of amino acids; some are hydrophilic (attracted to water) and some are hydrophobic (repelled by water). This process is called coagulation.^{[21][22]} When beating egg whites, they are classified in three stages according to the peaks they form when the beater is lifted: soft, firm, and stiff peaks. Overbeaten eggs take on a dry appearance, and eventually collapse. Egg whites do not beat up correctly if they are exposed to any form of fat, such as cooking oils or the fats contained in egg yolk.

Uses

Eggs are incredibly healthy and nutritious foods. They not only serves a delicious breakfast, but also been used in natural beauty treatments. Eggs shell, egg white and egg yolk all have valuable qualities of their own^[23].

Egg white (albumin) is used in the clarification and stabilization of wine as a fining agent. Some protein powders also use egg whites as a primary source of protein. Egg white can also be added to shaken cocktails to create a delicate froth.

In the 1750s, egg whites were believed to prevent swelling, and were used for that purpose. Egg whites were also used in the bookbinding process, to attach the gold to a bound spine, known as glairing, and also to give a book cover shine^[24]. To help soothe areas of skin that were afflicted, egg white mixed with Armenic bole could help restore the fibers.

Egg yolk contains an antibody called antiglobulin (IgY). The antibody transfers from the laying hen to the egg yolk by passive immunity to protect both embryo and hatchling from microorganism invasion.

Egg yolk is used to make liqueurs such as Advocaat or eggnog.

Egg yolk can be used to extract egg oil which has various cosmetic, nutritional, and medicinal uses.^[25]

Benefits

There are several health benefits that can be derived from eggs, including:

Strong Muscles

The protein present within eggs helps to keep muscles working well while slowing the rate at which they are lost.

- **Brain health:** Eggs contain minerals and vitamins. That are needed for the regular functioning of cells, including the nervous system, brain, memory and metabolism.
- **Good energy production:** Eggs contain all the daily essential vitamins and minerals that are needed to produce energy in all the cells of the body.
- **A healthy immune system:** Vitamin A, vitamin B₁₂, and selenium are key to keeping the immune system healthy.
- **Lower risk of heart disease:** Choline (which is associated with the development of heart disease) plays an important part in breaking down the amino acid homocysteine.
- **Healthful pregnancy:** Some nutrients within eggs help to prevent congenital disabilities, such as spina bifida.
- **Eyesight:** Zeaxanthin and Lutein help to prevent macular degeneration, the leading cause of age-related blindness. Other vitamins also promote good vision.
- **Weight loss and maintenance:** The high quality of protein within eggs might help keep people energized and feeling fuller for longer. Feeling full prevents snacking, which reduces overall calorie intake.
- **Skin benefits:** Some vitamins and minerals within eggs help to prevent the breakdown of body tissues and promote healthy skin. A strong immune system also contributes to a healthy look overall. The health benefits of eggs can only be experienced when the diet of egg is balanced.^[26]

Preservation of Eggs

Freezing

Egg breaking, separation and pasteurization and freezing are

the steps involved. Whole egg or yolk, in contrast, can be pasteurized at 60 – 61.5 °C for 3.5 -4.0 minutes. Without significant changes in physical and functional properties. The pasteurized whole or separated eggs are placed in cans or suitable container and frozen in sharp freezer room with circulating air at -29 °C. Freezing may take from about 48 to 72 hours. Eggs are pasteurized to kill all Salmonella organisms.

Cold Storage

Eggs are usually stored at -1.5 °C to 0 °C which is just above their freezing point. Only eggs of high quality should be stored. They remain in desirable condition only if the storage room is well controlled as to humidity, 85-90% circulation of air and free from objectionable odours. Eggs may retain quality as long as 6 months in cold storage. Before being placed in cold storage, eggs may be dipped in light mineral oil.

Drying

It is a satisfactory method for preserving eggs, either whole or as separated yolks or whites. Spray dried egg white and egg yolk has long shelf life. (Anonymous 2008)^[27]

Conclusions

The egg is composed of structures that serve to protect and nourish the developing embryo. It is a source of all of the essential nutrients except vitamin C. Eggs are incredibly nutritious and healthy foods so that it is used in many types.

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