Effect of Oven drying on the nutritional properties of whole egg and its components

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Abstract: The production of vacuum dried egg powder through a simplified technique was studied. The advantage of egg powder with its production and variation in its technology which helps for a better quality and cost efficient product was tested. Eggs as a raw source were collected from the local poultry farm and processes for production were carried out. High risk factors like, reduced glucose in the dehydrated product gets eliminated through vacuum drying technology. The increase of carbohydrate in the egg powder produced through vacuum technology has a visible proof of increased shelf life which indirectly reduces the risk of caramelization. Proteins in white like ovomucoid and ovalbumin which were considered to be important for blocking digestive enzymes are also eliminated through this technology.

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Introduction

Egg is one of the most versatile and near perfect foods in nature. It is rich in protein, amino-acids, vitamins and most mineral substances, the yolk and white components are all of high biological value and are readily digested. They are known to supply the best proteins besides milk (Ihekoronye and Ngoddy, 1982; Vaclavik and Christian, 2008).

Eggs play important culinary roles and are therefore prepared into different dishes. Their functional properties of emulsification, thickening, foaming and moisturizing help contribute desirable characteristics and physical functions in the industrial production of many food products in which they are incorporated (Desrosier, 1977; Bueschelberger, 2004).

Fresh eggs are however, difficult to transport because of their bulkiness, fragility, and highly perishable nature (Frazier and Westerhoff, 1988; Jay, 2000). Egg in powder form, provides a near complete solution to these problems. The current technological procedures of egg powder production is to wash, break, filter and pasteurize the egg liquid produced, dry them whole or into their various components of egg yolk and egg white. Several processing and preservation methods like spray drying, tray drying and freeze drying techniques have been adopted with repercussions on the qualities of the products (Potter and Hotchkiss, 2006).

This study is therefore aimed at determining the effects of oven drying on the functional and nutritional properties of whole egg and its components.

MATERIALS AND METHODS

Material Preparation and sample analysis

Fresh good quality eggs were obtained from local Poultry Farms, in Thanjavur, TamilNadu. The eggs were candled to confirm their freshness and were cleaned by dusting, washing and allowed to dry. They were carefully deshelled and separated as egg white liquid, egg yolk liquid and whole egg liquid. These were later homogenized with a metal whisk during which one drop of hydrogen peroxide solution was added to free the products from viable *salmonella* microorganism and to prevent browning of the products (Desrosier, 1977). The samples were later oven dried at 44°C for 4 h and allowed to cool. The egg flakes were scooped, milled and sieved with a 60 mm mesh and then weighed. The egg powders were packed into different plastic films for further investigation.

Different types of solvents like Hexane, chloroform, ethanol, methanol, petroleum ether, and acetone are used for sample testing with 1:1 ratio that is 1ml of each white, yolk and mixed solutions with 1ml of solvent each.

Thus from the illustration it was proved that ethanol is economically and nutritionally beneficial which could be re extracted and used for a long cycle and used as a natural preservative and prevents microbial invasion in dried products causing increase in shelf life respectively. It is evident that ethanol is added to the fresh eggs and slightly heated at 20-30ºC for 4 minutes.

The obtained product of egg white, egg yolk and whole egg should be kept inside the cross-grilled trays of vacuum oven, the temperature and pressure of the vacuum system should be controlled and only at optimum conditions the experimentations can be easily

foreseen. Now temperature was set at 50ºC and the pressure pump should be adjusted to a limit of 700 atm (bar). As soon as the pressure is attained, the obtained product was dried for another 4-5 hours of complete vacuum drying with temperature of around 50ºC. The dehydrated product was achieved and it was sent for blending into powder. After powdering some comparative studies like odor, color, pH and temperature were determined eventually.

The invention relates to a dried egg product and more particularly to an improvement in dried egg powder, and process of making it. The objective of this work is to provide a dried powdered egg product which does not become rancid and which does not undergo the so-called browning reaction which, so far as we know, occurs in spray dried egg product. Another object is to provide a reconstituted egg powder.

In further, the object is to provide an improved process for dehydrating and defatting whole eggs, and stabilizing said product. Another object is to provide an improved process for desolventizing eggs dehydrated by azeotropic distillation process.

Other objects and advantages will become apparent as the following detailed description progresses, reference being had to the accompanying drawing sheets. In accordance with this invention the dried egg product is made by removing the egg shells, mixing, preferably by homogenizing raw whole liquid eggs with an organic solvent for the egg fat which forms an azeotrope with water. Removing the water by distilling off azeotrope at below the coagulation temperature of the egg, i.e., below 140°F and preferably below 100°F and, if necessary, under reduced pressure, extracting the dehydrated egg product with fat solvent, draining or filtering off excess solvent and preferably vacuum drying the remaining solid product to remove all but trace amounts of solvent, thereby obtaining a dried fat-free and cholesterol-free egg product. This product is then mixed with water and homogenized, and then dried. The resulting product has high solubility and the fat solvent is reduced to a value of below 100 ppm.

However for extra high insect resistance and freedom from Salmonella infection solvents such as ethylene dichloride and chlorinated hydrocarbon solvents from 60-100 ppm may be retained in the dried egg product. The term "fat-free" is used herein to refer to a product having less than five percent free fat by weight. There is also bound fat in the product, but the cholesterol is substantially in the free fat.

The presence of low levels of residual fat make it desirable to add small but effective and nontoxic levels of a fat antioxidant to the egg product before homogenizing and spray drying. It may be added to the boiling body of fat organic solvent as described in application or elsewhere in the process. Such antioxidants, for example, may be butylated hydroxy toluene (BHT), butylated hydroxy anisole (BHA), propyl gallate, (NDGA), or other antioxidants suitable for edible fats.

Determination of nutritional properties

The nutritional quality of egg and its components were assessed using their proximate compositions as a guide. The AOAC (2005) methods were used in determining the nutritional properties. The crude protein content was determined using Kjeldahl method.

Results and Discussions

In this study the egg powder which was produced by vaccum oven drying technology was set to different testing before getting dehydrated. The serial dilution technique was the most important to determine the desirable solvent which then to be utilized for production of dehydrated egg powder. The nature of the solvent will pave a way to get a complete multi purposed organic dehydrated egg powder.

Table 1:A Description on serial dilution with fresh egg white, egg yolk and whole egg

Sl. No.	Contents	Description	Efficiency	Quantity
1.	Hexane	Layer's separated	Inefficient	1:1
2.	Ethanol	Complete dissolution	Maximum	1:1
3.	Petroleum Ether	Layer's separated	Inefficient	1:1
4.	Chloroform	Dissolution occurred	Minimum	1:1
5.	Methanol	Partial dissolution.	Minimum	1:1
6.	Acetone	Dissolution occurred	Less efficient	1:1

The important objective of this study is to reduce the amount of proteins like ovalbumin and ovomucoid which causes digestive problems. During the addition of 20%ethanol (food graded) to the fresh egg samples, the result of these proteins getting separated was visualized. This helps to establish the major disadvantage of egg to be consumed as a nutritive supplement to cardiac patients, obese patients and infants was defeated by organic egg powder production and can be used for many pharmaceutical applications.

Table 2 :Reduced proteins in white with ethanol addition to fresh egg

Sl. No.	Contents	Function	% in Fresh Samples	% in Dried Samples
1.	Ovalbumin	Nourishment blocks digestive enzymes	54%	2.712%
2.	Ovalbumin		11%	0.24%
3.	Ovalbumin		3.5%	0.0078%

The reference containers were obtained. Contents of the container were mixed thoroughly and about 300g was drawn with a sterile long handle dipper or ladle and the liquid egg was transferred into a sterile container. After transferring the liquid egg, the container was closed to exclude atmospheric exposure. The odor was tested through nozzle smelling manually and color through carotenoid testing by calorimetric analysis.

Table 3: Comparison of fresh and dried eggs showing proximate color

Sl. No.	Contents	Color	% in Fresh Samples	% in Dried Samples
1.	Egg white	Transparent yellow	White	White
2.	Egg yolk	Sunrise yellow	Yellow	Dusty world
3.	Whole egg	Creamy yellow	Creamy yellow	Brownish yellow

The microbial preservation through ethanol addition was studied through a series of bacterial and fungal analysis. Some changes may occur in the microbiological populations of eggs during drying. For example, the total bacteria count can drop considerably, depending on the type of microorganisms present in the liquid as well as on the conditions used in drying. Some bacteria may be quite sensitive to drying, whereas others exhibit strong resistance. A combination of pasteurization or heat treatment of the liquid before drying, and heat treatment of the finished product ensures very low bacterial populations.

Microbiological analysis

Bacterial colony count

3 g of each sample was dissolved in deionized water, and serial dilution of each sample was made, to form 10^{-3}, 10^{-2} and 10^{-1} dilutions.
1 ml sample from each dilution (10-3, 10-2 and 10-1) were seeded on plate count agar using spread plate method, and the medium was then incubated at 37°C for 24 h. The colony count was reported as colony forming units per gram of food sample (cfu/g).

Isolation of bacteria

0.1 ml sample of the dilution was spread on culture plates with a sterile glass rod onto Nutrient Agar, Blood Agar and MacConkey Agar, and then incubated at 37°C for 24 h. After the incubation time, the different culture plates were examined for microbial growth. Sub-cultures were made, to get discrete colonies, and different morphological tests were performed on the colonies, which were then stored in a slant at 4°C for further biochemical investigations, in order to identify microorganisms in the isolate.

Isolation of fungi

0.1 ml of each sample was seeded on Potato Dextrose Agar and incubated at room temperature for about four days, after which the plate was examined to detect fungal growth.

Identification of isolates

The different isolates obtained from the different plates were macroscopically examined and then biochemically tested, to identify the organism to the species level, using Bergey's manual of determinative bacteriology.

The growth portion of the fungal mycelia on the Potato Dextrose Agar medium was cut and placed on grease free microscopic slide containing few drops of Lacto phenol cotton blue, and covered with a cover slip. The mycelium was then examined under the microscope at a magnification of x 10.

Total colony count

The plate count agar was examined and colonies present were counted and recorded after incubation at 37°C for 24 h, to get the total colony count in cfu/g, as shown in Table 4.

Shelf life

In the original packing, at the normal odor free condition of less than 25°C at 65% relative humidity, the product can be kept for 18 months after production. Mainly exporting was undergone for whole egg powder processing where the cost of transportation and expenditure is deeply reduced by 80% of that spray

dried product, to reduce the risk of contamination and to increase the shelf life without spray drying and making the egg product economically and nutritionally beneficial. It concerns about the marketing and commercial quality control of dehydrated egg products.

Table 4: Microbial load on the Dry Egg Yolk Powder, Dry Egg Albumin Powder and Dry Egg Mix Powder

Sl. No.	Contents	Dry Egg Yolk	Dry Egg Albumin	Dry Egg Mix
1.	Total plate count	<10000 cfu/g	<10000 cfu/g	<10000 cfu/g
2.	*Bacillus cereus*	<100 cfu/g	<100 cfu/g	<100 cfu/g
3.	Enterobacteriaceae	Absent/g	Absent/g	Absent/g
4.	*Staphylococcus aureus*	Absent/g	Absent/g	Absent/g
5.	Salmonella sp.	Absent/25g	Absent/25g	Absent/25g
6.	Fungi	<50 cfu/g	<50 cfu/g	<50 cfu/g

Discussion

The nutritional composition determined, showed high values when compared to that of fresh eggs. This is an indication that the drying temperature did not adversely affect the nutritional value of the oven dried egg components.

The moisture contents are low enough to extend the shelf life of the egg powders in an environment of low humidity (Jay, 2000).

An attempt is made here to provide a concise overview of the fundamental principles and terminology used in the drying literature. It must be noted that the models and estimation methods given here are necessarily simplistic and caution must be exercised in applying them in practice. Almost without exception design and scale-up, most dryers must be preceded with appropriate laboratory and/or pilot scale experimentation. The novel idea of reducing the high cost effective spray dried egg products thus establishing new techniques of producing vacuum dried egg powder, flakes and granules without any compensation in its nutritional value and making it cost efficient and also making instrumentation availability. This vacuum dried products makes use of ethanol, food grade as a preservative and it is also used for dissolution of egg fresh products so that drying will be done effectively.

Also the production process promises remarkable benefits in nutritional basis and also no color change, odor control, glucose regulation, carbohydrate increased egg product without any complications in production and it challenges low cost, comparatively 80% reduction in costs of the spray dried products. The limitation of instrumentations include heat which will not be continuously transferred to vacuum and long drying under continuous vacuum which needs increased energy consumption as compared to drying at atmospheric pressure. The market for high quality food products with vacuum technology is not only increasing but also diversifying.

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