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**Subhajit Ray**  
 Department of Food Engineering  
 & Technology Central Institute  
 of Technology, Assam, India

**Amit Kumar Barman**  
 Department of Dairy  
 Microbiology Faculty of Dairy  
 Technology W.B.U.A.F.S.,  
 Mohanpur Campus, Nadia,  
 West Bengal, India

**Pradip Kumar Roy**  
 Department of Dairy  
 Engineering Faculty of Dairy  
 Technology W.B.U.A.F.S.,  
 Mohanpur Campus, Nadia,  
 West Bengal, India

**Bipin Kumar Singh**  
 Sanjoy Gandhi Institute of Dairy  
 Technology Patna, Bihar, India

#### Correspondence

**Subhajit Ray**  
 Department of Food Engineering  
 & Technology Central Institute  
 of Technology, Assam, India

## Chicken eggshell powder as dietary calcium source in chocolate cakes

**Subhajit Ray, Amit Kumar Barman, Pradip Kumar Roy and Bipin Kumar Singh**

#### Abstract

Chicken eggshell powder (CESP) might be an attractive source of Ca for human nutrition. It can be utilized as a dietary calcium source. In this study the effect of eggshell powder supplementation on each of chemical composition, physical and sensorial properties of ESP fortified chocolate cake were studied. To carry out the project necessary ingredients were purchased from Sodepur Market, Kolkata adjacent to the institution. The cake was prepared from wheat flour supplemented with eggshell powder at three levels of supplementation as follows 3, 6 and 9%. The boiling process for 30 min of eggshell kills any microbial growth on the surface. The obtained results indicated that the addition of eggshell powder led to a pronounced increase calcium contents in the supplemented of cakes 504.5, 816.8 and 1364.5 mg/100g at 3%, 6% and 9%, respectively. Eggshell powder formulation results some characteristic change in physicochemical properties and sensorial properties of cakes. With respect to the calcium content, texture and sensory properties, we can suggest that the best way to use chicken eggshell as dietary calcium supplement is powdered to cake upto 6% eggshell supplementation.

**Keywords:** Eggshell powder, calcium, nutritional value, physicochemical properties, sensory characteristics

#### 1. Introduction

In many countries around the world, egg products companies and some food manufacturers that use egg in their products generate tons of waste eggshell; this possess a serious environmental problem. Therefore, to increase daily calcium intake, commercially available calcium fortified foods has been placed on the market. These foods are fortified with many calcium sources such as calcium carbonate, calcium phosphate, cattle bone powder and milk calcium [1]. Eggshell makes up from 9- 12% of the total egg weight; it consists largely of calcium carbonate (94%) with some magnesium carbonate and calcium phosphate deposited on the organic matrix [2]. Eggshell calcium is a good source of dietary calcium and an excellent replacement material for important crustacean shells [3]. Moreover, calcium from crushed eggshell powder was absorbed easier than commercial CaCO<sub>3</sub> in the rat small intestine [4]. Chicken eggshell is a waste material from domestic sources such as hatcheries, poultry farms, egg product factories, homes and restaurants [5, 6]. Many researchers have been looking for ways to utilize the eggshell waste as a source of Calcium in human nutrition [7]. Eggshell and shell membranes are non-edible by-products with little saleable value but they may contain biologically active compounds [8]. From the chemical point of view, the egg shell consists of water (2%) and dry matter (98%). The dry matter is composed of 5% crude protein and 93% ash. Average values of mineral contents in different parts of the egg and egg shell [9]. Eggshells contain calcium and trace amounts of other micro elements, i.e. magnesium, boron, copper, Iron, manganese, molybdenum, sulphur, silicon and zinc. A risk factor for human health is the infection with *Salmonella enteritidis* at consumption of undercooked eggs [10], as eggs can become contaminated internally and on the outer shell surface. Despite the fact that pasteurization was predicted to be effective for reducing *S. enteritidis*. Therefore, the way to avoid Salmonella contamination is to eliminate the infectious agent from eggs through several cooking methods. Another way to avoid Salmonella is to thoroughly wash eggshells under running tap water, scrub with a domestic sponge and then immerse eggshells in a solution of 10 drops of sodium hypochlorite (domestic bleaching agent) per liter of tap water. Rinse, dry with paper towels and use the eggshells [11]. Therefore, it is important to emphasize the necessity to avoid the contamination with *Salmonella*. By-products from processed foods are promising as good natural calcium sources such as egg-shell [12].

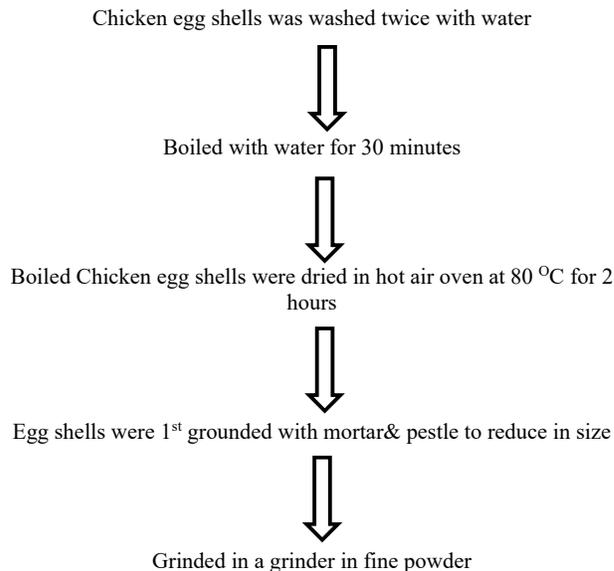
Deficiency of calcium (Ca) in the diet is a common problem. Ca intake from dairy products is an appropriate way to fulfil Ca requirements. However, people do not usually consume them in the amounts established by clinical guidelines. Supplementation with tablets is costly and sometimes involves difficulties of adherence to treatment. Chicken eggshell is a source of Ca, which is available at home that can be used as Ca supplementation [13]. Calcium is a mineral required to human body health for a variety of physiological functions and the maintenance of bone tissues throughout life [14]. As a structural component, calcium combines with phosphorus to comprise the mineral portion of bone and also it has function as a metabolic component, biochemical and physiological processes [15, 16]. Calcium plays a key role in the treatment and prevention of bone demineralization. A widely used calcium enrichment source is purified CaCO<sub>3</sub> with a high calcium content (about 40%). Chicken eggshell powder, with a calcium content of about 38%, is a promising but little known source of calcium for human nutrition. The use of chicken eggshell powder might be beneficial, it could increase bone density and reduce pain in patients with osteoporosis. Eggshell calcium is probably the best natural source of calcium and it is about 90% absorbable. Cakes are flour-based bakery products which attract consumers owing to their various tastes, long shelf life and relatively low cost [17]. Due to competition in the market and increased demand for health-promoted natural products, attempts are being made to improve cakes nutritional value as well as functionality by modifying their nutritive composition [18]. Therefore, the expanded application of eggshell in food industry was worthy to study further. The present work was conducted to study the effects of eggshell powder fortification e.g. 3%, 6% and 9% on cake in terms of chemical composition, mineral content, physical characteristics and organoleptic properties [19]. The nutritional composition of eggshell is represented by table 1 [20].

**Table 1:** Nutritional status of eggshell powder

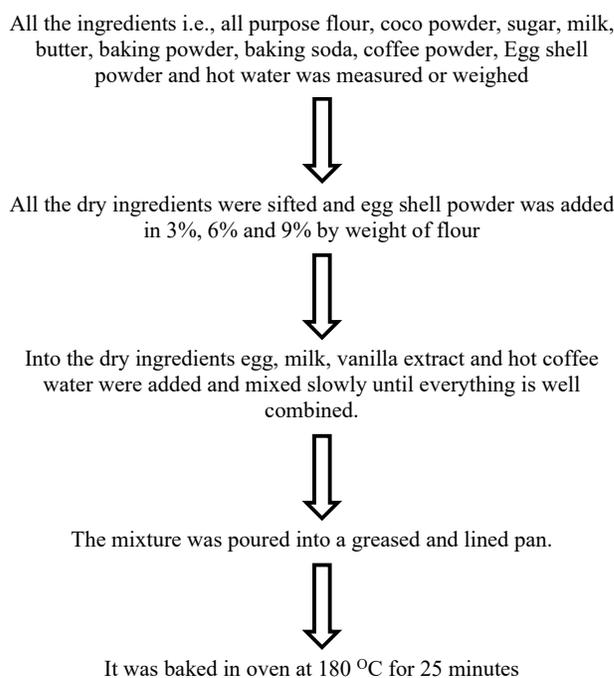
	White eggshell powder	Brown eggshell powder
Moisture (%)	0.46	0.20
Protein (%)	3.92	5.04
Ash (%)	94.61	94.28
Fat	0.35	0.08
Calcium (%)	34.12	33.13
Magnesium (%)	0.29	0.36
Phosphorous (%)	0.04	0.07
Potassium (%)	0.03	0.04
Sodium (%)	0.05	0.04
Copper (ppm)	< 1 ppm	< 1 ppm
Iron (ppm)	22 ppm	< 1 ppm
Manganese (ppm)	< 1 ppm	< 1 ppm
Zinc (ppm)	< 1 ppm	< 1 ppm

**2. Materials and Methods**

Wheat flour, sugar, eggs, coco powder, butter, milk, baking powder and vanilla were purchased from the local market of Sodepur, Kolkata, West Bengal. Chicken egg shell were collected from household waste for this purpose and the processing operation was carried out through a series of steps as described in figure 1 and 2 respectively [21, 22].



**Fig 1:** Preparation of Eggshell Powder



**Fig 2:** Preparation of Chocolate cake

**2.1 Chemical Analysis of Raw Materials:**

In this study the major raw materials considered were wheat flour and different levels of egg shell powder along with the other usual ingredients viz. sugar, vanaspati, emulsifier and stabilizer, permitted colour, flavour, antioxidants etc. All the chemical analysis viz. ash, fat, calcium and zinc content of raw materials e.g. wheat flour and egg shell powder (ESP) were analyzed and the result was shown in table 2. The determination procedure of all these chemical quality parameters were followed by [23].

**2.2 Physicochemical analysis of ordinary cake and different formulated eggshell powder (ESP) fortified cake:**

In this context different levels of eggshell powder (ESP) formulation e.g. 3%, 6% and 9% were considered. The physical parameters e.g. bulk density of ordinary cake/control and different formulated cake varieties were measured and represented by table3. The chemical quality parameters viz. moisture, ash, fat and calcium content were measured and the result was shown in table 4. Here also the determination procedure of all these chemical quality parameters were followed by [23].

**2.3 Evaluation of sensory characteristics of ordinary cake and different formulated eggshell powder (ESP) fortified cake**

A 9 point hedonic scale (1= lowest desirability, 9= highest desirability) is designed to evaluate the sensory characteristics by using ten trained panellists [24].

**3. Result and Discussions**

**3.1 Chemical qualities of raw materials**

The result was shown in table 2.

**Table 2:** Chemical composition of wheat flour and egg shell powder (% on dry weight basis)

Parameter	Wheat flour	Egg shell powder
Ash (%)	0.54	93.62
Fat (%)	0.8	0.02
Calcium (mg/100g)	19.4	35095.65
Zinc (mg/100g)	0.93	44.5

The result of the major chemical quality parameters of wheat flour and egg shell powder(ESP) as shown in table 2 revealed that the egg shell powder as a mineral enriching component e.g. calcium and zinc plays an important role for providing health benefits.

**3.2 Physicochemical characteristics of ordinary cake/control and different formulated eggshell powder (ESP) fortified cake**

**3.3 Determination of physical characteristics**

The experimental measurement for bulk density as physical characteristic measurement was shown in table 3.

**Table 3:** Determination of bulk density

Sl No.	Sample	Bulk density (g/ml)
1.	Control	1.15
2.	3% ESP	2.675
3.	6% ESP	3.5
4.	9% ESP	4.96

The result showed that as the increase of amount of egg shell powder increases the bulk density also increased and certainly the value was less in control due to unavailability of egg shell powder. Therefore 9% egg shell powder is optimized.

**3.4 Determination of chemical characteristics**

The experimental measurement for chemical quality parameters determination was represented in table4.

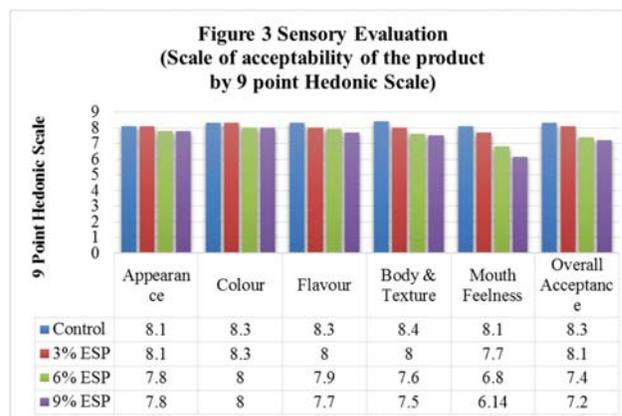
**Table 4:** Evaluation of Chemical quality of Egg Shell Powder (ESP) fortified biscuits

Type of Cake	Moisture (%)	Ash (%)	Fat (%)	Calcium (mg/100g)
Control	23.5	0.3	1.6	16.24
3%	27.39	2	1.56	504.5
6%	28.57	3	1.5	816.8
9%	26.32	5.5	1.3	1364.5

Now from table 4, it was being observed that the moisture content of control, 3%, 6% and 9% ESP fortified cake is 23.5, 27.39, 28.57 and 26.32 respectively. Ash content was estimated to be 0.3%, 2%, 3% and 5.5% for control, 3%, 6% and 9% ESP fortified cakes. Fat content of ordinary chocolate cake was estimated as 1.6% and ESP fortified cakes have nearly same fat content. The calcium content of chocolate cake, 3%, 6% and 9% ESP fortified cakes were estimated to be 16.24, 504.5, 816.8 and 1364.5 mg /gm respectively. Therefore, ESP fortified cakes are nutritionally more acceptable than ordinary chocolate cakes.

**3.5 Evaluation of sensory characteristics of control and egg shell powder (ESP) fortified biscuits**

Colour, flavour, taste, texture and overall acceptability characteristics of different formulated Egg shell fortified chocolate cakes and ordinary chocolate cake were performed in this study. The result was shown in figure-3.



**Fig 3.** Indicates that though 9% egg shell powder fortified cake formulation was nutritionally good but sensory analysis in terms of overall acceptability revealed that 3% egg shell powder formulated cake variety was satisfactory in comparison to other formulations. Therefore it was considered for further study.

**4. Conclusion**

It can be concluded that eggshell powder is an appropriate and cheap source of Ca for human nutrition. Eggshell powder supplementation with wheat flour in different levels viz. 3%, 6% and 9% respectively was considered in this study. Though calcium content was high in 9% ESP and 3% ESP formulation shows better overall acceptability but by considering all quality aspects cake formulation by 6% ESP was considered in further study.

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