

DEVELOPMENT OF EGGHELL POWDER AND ASSESSMENT OF IT'S CALCIUM CONTENT AS NATURAL SOURCE

Rida Fatima

Student of BS Human Nutrition and Dietetics, Department of Human Nutrition and Food Technology, Superior University Lahore

Tabeen Irfan (Corresponding Author)

Lecturer, Department of Human Nutrition and Food Technology, Faculty of Allied Health Sciences, Superior University, Lahore

Email: tabeen.irfan@superior.edu.pk

Ambreen Javed

Student of BS Human Nutrition and Dietetics, Department of Human Nutrition and Food Technology, Superior University Lahore

Wania Farooq

Student of BS Human Nutrition and Dietetics, Department of Human Nutrition and Food Technology, Superior University Lahore

Hafiza Eisha Arshad

Student of BS Human Nutrition and Dietetics, Department of Human Nutrition and Food Technology, Superior University Lahore

Rimsha Rafique

Lecturer, Department of Human Nutrition and Food Technology, Faculty of Allied Health Sciences, Superior University, Lahore

Ayeza Imtiaz khan

Research & Data Analyst, Research Pub, Lahore, Pakistan

ABSTRACT

Background: Calcium is an essential mineral found in many foods, supplements. Calcium deficiency is a worldwide problem. Eggshells are considered as waste and cause environmental problem. They contain about 94-97% of calcium carbonate which is highly bioavailable if they sterilized properly. It is a cheap alternative source as compared to synthetic calcium supplement. **Methodology:** To make eggshell powder chicken eggshell were collected from different restaurants and bakeries and then taken to the laboratory. The eggshell sample was washed with tap water at 30-35 °C and then prepared for experimental use within 24 hours and the membrane was removed from shell. Then the sterilization process has started at 121 °C for 15 min followed by heating in water at 95 °C for 60 min and then dried in hot air dryer at 70

°C for 3 hours. This method helps remove moisture. The dried material was ground by using grinder and then transformed into fine powder. Oven drying method is used to measure the moisture content of eggshell powder. Due to high level of calcium in eggshell, it is used in many industries like food and pharmaceutical. **Aim:** Our aim was to develop the calcium content from eggshell and assess their potential as a natural calcium source. **Result:** Physicochemical analysis showed that the total ash content was $2.45 \pm 0.53\%$ Low ash indicate low minimal inorganic impurities with sand soil and Extraneous materials moisture content was $3.33 \pm 0.41\%$. Low moisture reduces the risk of microbial growth. loss on drying was $2.76 \pm 0.59\%$ it confirms that calcium has low volatile content. **Conclusion:** Mineral analysis revealed a calcium concentration of 25 mg/g in the sample. Eggshell particle is a harmless, organic, medical-grade calcium cause. It is optimal for strengthening edibles such as flour / juice or as an independent augmentation to avoid rickets / osteoporosis. At 25 mg/g, you would require 40-48g particle to strike the mature RDA of 1000-1200 mg. Excellent utilized as a nutritional increase, not the exclusive calcium origin.

Keywords: Calcium, Eggshell powder, Calcium carbonate, Mineral analysis, Source, Sterilization, Food, Pharmaceutical Application

INTRODUCTION

One of the important minerals for living being is calcium which play important role in blood clotting, muscular contraction, nerve transmission, skeleton maintenance along with bone production. Despite its significance calcium shortage is nevertheless a common public health issue, especially in developing nations where access to reasonably priced calcium rich foods and supplements is restricted and dietary intake is inadequate. Malnutrition, osteoporosis, rickets, osteomalacia, and other bone related illnesses are greatly significantly worsened by the deficiency. The phosphate salt of calcium, which make up 99% calcium of the body to the bone and teeth for their mechanically rigidity. Calcium is necessary nutrient that is involved in most metabolic activities. Calcium is a necessary nutrient that is involved in most metabolic activities (1,2,3).

Calcium is important mineral and it has very main functions and role in human body. A significant section of the world's population suffers from calcium deficiency, which is still a major global public health concern, especially in low- and middle-income

nations. In addition to preserving bone health, a sufficient calcium intake lowers the chances of a number of unfavorable health outcomes, such as pregnancy problems, cardiovascular illnesses, and many types of cancer. The connection between calcium consumption and osteoporotic fractures is still complicated and needs more research, even if calcium intake is lower in many developing nations. The need for population-specific recommendations is shown by the differences in calcium consumption recommendations made by various organizations. Accurately estimating the prevalence of calcium shortage worldwide is still hampered by the lack of standardized techniques for determining calcium status. Therefore, to address insufficient calcium intake, better evaluation instruments, raised awareness, and evidence-based nutritional policy are required (4,5,6).

Children in underdeveloped countries frequently have low vitamin D, and, low dietary calcium intake (3). Because calcium must be lost through the skin, kidneys, and intestines, calcium storage is easily caused. Growing older can hinder growth, delay the consolidation of the skeleton, and occasionally cause rickets, through the latter is more frequently caused by vitamin deficiencies. Osteoporosis is a frequent aspect of ageing in humans. Fracture rates rise in both genders as a result of bone loss, which begin in women after menopause and in males at the age 55. The density attained at maturity, and the rate of future bone loss, dictate bone density, which is inversely correlated with an individual's risk of fracture (7,8).

Nutrition deficiencies mainly trigger individual all-around the pregnant women of reproduction age. A steady calcium concentration is necessary to keep the body's system in the state of homeostasis. When the calcium concentration is less than 3MG/DL, hypoglycemia occurs. Disorder ranging from minor perioral paresthesia to serve heat arrhythmia a disease triggered by calcium deficiency (9,10).

Studies have shown that, when compared to traditional calcium supplements like calcium carbonate, calcium extracted from eggshell powder can be absorbed easily and may provide even better digestibility. Under various dietary circumstances, eggshell powder's efficacy as a calcium source has been shown, suggesting that it may promote calcium intake. Additionally, there doesn't seem to be any adverse effects on the absorption and digestion of other nutrients when eggshell powder is consumed. Eggshell powder, a widely accessible by-product of the poultry industry, provides an economical and environmentally friendly method of calcium supplementation. In addition to reducing eggshell waste, its use offers a different dietary calcium source for food fortification and nutraceutical uses. Eggshell powder is being investigated more and more as a useful component for preventing calcium deficiency and promoting bone health because of its high calcium availability and nutritional value (11,12,13).

The rationale of the present study is based on the increasing demand for safe economical, and bio-available source of calcium to prevent and manage calcium

deficiency related disorders such as osteoporosis and impaired bone health and malnutrition. Worldwide egg production reached around 70 - 90 million metric tons per year in recent years reflecting increasing demand for eggs as a food source. This massive production implies a correspondingly large generation of eggshell as a byproduct. In 2018, around 2.3 million egg ton are discarded as waste. Using eggshell as a calcium supplement is not only organic, sustainable but also reduce environmental this study aims, to evaluate eggshell powder as an effective source of calcium highlighting its nutritional value potential health benefits and suitability food use in food or pharmaceutical application (14,15).

Methodology:

The study was conducted as an experimental investigation in the Department of Pharmacy, Superior University, over a period of four months. Capsules containing eggshell powder (150 mg), moringa powder (300 mg), and vitamin D₃ powder (1 mg) were successfully formulated, with each capsule weighing 451 mg. The prepared formulation was evaluated for calcium content, loss on drying, moisture percentage, and ash percentage using ASTM and AOAC standard methods under the guidance of PCSIR. Ethical principles, including product safety, regulatory compliance, transparency, environmental responsibility, and professional conduct, were maintained throughout the study. The collected data were analyzed using SPSS version 25, and the results were expressed as mean $\pm$ standard deviation to assess the quality characteristics of the formulated capsule

RESULT

TEST	PRODUCT
ASH	2.45 $\pm$ 0.53
MOISTUER	3.33 $\pm$ 0.41
LOD	2.76 $\pm$ 0.59
CALCIUM CONTENT	25 mg SD + ₋ 0.46

--	--

The WHO standard recommendations were followed for conducting the physicochemical examination of the prepared product (T0). The mean $\pm$ standard deviation (SD) was used to express the obtained data. The product's total ash value of $2.45 \pm 0.53\%$ indicated that the sample included inorganic mineral content. The product's moisture content was $3.33 \pm 0.41\%$, indicating reduced moisture levels and improved storage stability. In a similar vein, the loss on drying (LOD) value, which indicates the quantity of moisture and volatile materials eliminated during the drying process, was found to be $2.76 \pm 0.59\%$. Additionally, calcium analysis showed that the prepared product contained 2.5 ± 0.46 mg of calcium, indicating a significant amount of calcium. So, the conclusion is parameters of the formulated product were found to be within acceptable limits, demonstrating good quality and stability.

DISCUSSION

Our research:

We discover the value of Ash, moisture content, and Lod which is present in eggshell powder sample. ***Moister content was 3.33 ± 0.41 , ash content was 2.45 ± 0.53 , Lod was 2.76 ± 0.59 , Calcium value $2.5 \text{mgSD} \pm 0.46$.*** According to our result Calcium is the most abundant mineral found in the sample. 25mg Ca is present in 1g of chicken eggshell powder. Which is a good amount of calcium when use as a supplement. Values maybe vary from different previous studies of different testing methods and they mostly had fortification of chicken eggshell calcium powder in food and we have prepared an organic supplement. In developing countries people are not be able to intake adequate amount of calcium because of low income so it's a cheap and organic source of calcium instead of expensive calcium fortified products and foods (16,17).

About 94–97% of the eggshell structure is made up of calcium carbonate, with trace amounts of magnesium, phosphorus, potassium, and other minerals. Therefore, the high mineral concentration in the generated product can be inferred from the enhanced ash content (18).

Because minerals are essential for skeletal development, bone mineralization, and bone density maintenance, a high ash content is advantageous from a functional standpoint. The findings imply that the eggshell powder made in this study may be a useful natural source of dietary minerals, especially calcium, for improving bone health (19,20).

The present study analyzes the Physicochemical characteristics of calcium powder made from eggshell by quantifying the total moisture level, ash or loss on drying (Lod). Through these tests we know the purity, stability and storage quality of the

eggshell powder. According to these tests we can decide whether the powder is suitable for nutritional and pharmaceutical items.

Total ash present in eggshell powder was found to be $2.45 \pm 0.53\%$. After completing the burning of organic material, the remaining ash will show the inorganic material present in it. It is an important step used to analyze the purity and mineral content of the powder. Ash values indicate the presence of these minerals. The lower ash percentage may indicate that during processing the impurities and organic material were effectively removed and eggshell powder had a low amount of contamination from inorganic material. calcination and heating method difference also a cause of low ash value. According to published studies eggshell powder has a higher ash value because it contains 94-97% of inorganic material. Difference in studies may be due to eggs obtained from different species, washing and drying method, grinding technique, difference in temperature and particle size of power. Ash value indicates that the powder contains important minerals and inorganic material. This proves that eggshell powder can be used in food products and calcium supplements. In pharmaceutical and nutraceutical, ash determination is important because high levels of ash will indicate contamination and adulteration. The balanced ash content indicates that the product is pure well-refined and high quality (21,22).

The eggshell powder's moisture content was found to be $3.33 \pm 0.41\%$. Because it affects microbiological growth, product stability, texture, flow ability, and shelf life, moisture content is a crucial quality characteristic. This study's low moisture content predicts better storage stability and effective drying of the eggshell powder. Low moisture content powders are typically less vulnerable to chemical deterioration, clumping, enzymatic breakdown, microbiological spoilage. This study's moisture analyzer approach used infrared heating at regulated temperatures to quickly and accurately determine the water content. Because it directly influences product stability, shelf life, microbiological growth, and nutrient preservation, moisture content is a crucial quality characteristic for eggshell powder. The moisture level of eggshell powder in the current investigation was found to be comparatively low, suggesting efficient drying during processing. Low moisture levels improve storage stability by lowering the possibility of microbiological infection and enzymatic degradation (23).

Eggshell powder was found to have a drying value loss of $2.76 \pm 0.59\%$. LOD calculates the quantity of volatile materials such as moisture and other volatile compounds—lost during heating. This study's low LOD value confirms that the powder was sufficiently dried before examination and shows little volatile materials. This result implies: less moisture residue, enhanced stability of Physicochemical and reduced chance of microbial infection when being stored. In pharmaceutical quality control, LOD is especially crucial because high volatile content might have

detrimental effects on formulation stability and Compressible during tablet production, powder flow characteristics, and overall product quality. The resemblance among the moisture content and LOD values shows that most of the easily vaporized matter existing right now in the test was likely water, with smallest existence of other volatile pollutants (24).

In investigations on eggshell derived calcium grain usually record low LOD values due to the extremely calcified environment of eggshell. The current discoveries therefore uphold the appropriateness of the prepped eggshell particle for usage needing reliable and low moisture calcium cause Eggshell Powder's Connection to Bone Health. The results of this study show that eggshell powder has qualities that make it ideal for enhancing calcium availability and promoting bone health. The high ash content verifies the availability of minerals, while the low moisture content and LOD values show outstanding stability and storage quality. Above all, the significant calcium content emphasizes eggshell powder's nutritional worth as a natural calcium supplement (25).

Osteoblasts and osteoclasts work together to continuously remodel bone tissue. To preserve this equilibrium and avoid excessive bone resorption, one must consume enough calcium. Eating eggshell powder, which is high in calcium, may help improve skeletal strength, bone mineralization, and calcium availability.

Previous research:

According to comparable research, the moisture content of eggshell powder varies from 1% to 6%, depending on the drying temperature and processing parameters. The manufactured eggshell powder exhibited sufficient drying efficiency, as evidenced by the value found in this investigation falling within this acceptable range. It is especially beneficial to have less moisture when developing calcium supplements, dietary items that have been fortified, pharmaceutical tablets, nutraceutical compositions, as it promotes powder operating properties and prolongs storage shelf life. As written in previous studies chicken eggshell powder is low in carbs (0.26%) as compared to other poultry eggshell (1.5%). Domestic chicken eggshell powder contains (7%) of protein whereas other poultry and duck contain (6.5%). Chicken eggshell is low in fat and carbs but high in protein. Calcium is the most abundant mineral found in eggshell powder sample. As written in previous studies other minerals like Mg, Fe, Zn, Na, K are also present in eggshell (7).

As mentioned in previous studies after two hours at 100-degree Celsius moisture content was recorded as 0.39% and after 6 hours it rises to 0.68%. Calcium content was 34.52mg per 100g. There ash content was 5.60% at 100 degrees Celsius for 2 hours (24).

CONCLUSION

This research concludes that eggshell powder can help as a productive, commercial and Eco-friendly cause of calcium for nutritional supplementation. The developed supplement, including eggshell derived calcium, moringa, and vitamin D3 (cholecalciferol), has the capability to help bone health, better calcium digestion, and support to entire nutritional wellness. The observation spotlight that applying the eggshell garbage for calcium concentration not only give health benefits but also support ecological sustainable development by decreasing trash. Therefore, this composition may be pondering a viable strategy for building cost effective and nutrition dense calcium supplement. It is also a cheap source of calcium. It is great source of calcium for Pakistani people and its sustainability is also high.

FUTURE ASPECTS

Further studies are recommended to evaluate the long-term stability and shelf life of the developed eggshell-derived calcium capsules. Human clinical trials should be conducted to assess their bioavailability, safety, and effectiveness in improving calcium status and bone health. Future research may also investigate different concentrations of eggshell calcium, moringa, and vitamin D3 to optimize the formulation. In addition, the commercial feasibility and consumer acceptance of the developed capsules should be explored on a larger scale.

REFERENCE

1. McLean FC, Hastings AB. A biological method for the estimation of calcium ion concentration 1934, Vol. 107, 337-350
2. Shlisky J, Mandlik R, Askari S, Abrams S, Belizan JM, Bourassa MW, Cormick G, Driller-Colangelo A, Gomes F, Khadilkar A, Owino V. Calcium deficiency worldwide: prevalence of inadequate intakes and associated health outcomes. 2022 Jun.
3. Pettifor JM. Calcium and vitamin D metabolism in children in developing countries. *Annals of Nutrition and Metabolism*. 2014 Oct 1;64(Suppl. 2):15-22.
4. Bronner F. Intestinal calcium absorption: mechanisms and applications. *The Journal of nutrition*. 1987 Aug 1;117(8):1347-52.
5. da Silveira EA, Moura LD, Castro MC, Kac G, Hadler MC, Noll PR, Noll M, Rezende AT, Delpino FM, Oliveira CD. Prevalence of vitamin D and calcium

deficiency and insufficiency in women of childbearing age and associated risk factors: a systematic review and meta-analysis. *Nutrients*. 2022 Oct 17;14(20):4351.

6. Bartter J, Diffey H, Yeung YH, O'Leary F, Häsler B, Maulaga W, Alders R. Use of chicken eggshell to improve dietary calcium intake in rural sub-Saharan Africa. *Maternal & child nutrition*. 2018 Oct;14:e12649.

7. Tamanna ST, Amin MR, Rahman MT, Al Mamun MA, Alauddin M. Development of eggshell powder as an alternative source of Ca and Fe for human health: A compositional and comparative study. *Food Chemistry Advances* 9 (2025): 101187.

8. Omelka R, Martiniakova M, Babikova M, Svik K, Slovak L, Kovacova V, Vozar J, Soltesova-Prnova M. Chicken eggshell powder more effectively alleviates bone loss compared to inorganic calcium carbonate: An animal study performed on ovariectomized rats. *J Physiol Pharmacol*. 2021 Dec 1;72(6).

9. Islam MK, Tusty TA, Akhand AA, Ahsan N. Human Uptake of Eggshell Powder as an Alternate Source of Calcium. *Dhaka Univ. J. Pharm. Sci [Internet]*. 2019 Vol. 18 No. 2 (2019).

10. Schaafsma A, Beelen GM. Eggshell powder, a comparable or better source of calcium than purified calcium carbonate: piglet studies. *Journal of the Science of Food and Agriculture*. 1999 Sep;79(12):1596- 600.

11. Singh A, Kelkar N, Natarajan K, Selvaraj S. Review on the extraction of calcium supplements from eggshells to combat waste generation and chronic calcium deficiency. *Environmental Science and Pollution Research*. 2021 Sep;28(34):46985-98.

12. Urooj A, Suma PF, Kalra R. IN VITRO BIO-ACCESSIBILITY OF CALCIUM FROM EGG SHELL POWDER AND CALCIUM SALTS. *Journal of Advances in Food Science & Technology*. 2018 Sep 28;5(3):72-80.

13. Schaafsma A, van Doormaal JJ, Muskiet FA, Hofstede GJ, Pakan I, van der Veer E. Positive effects of a chicken eggshell powder-enriched vitamin–mineral supplement on femoral neck bone mineral density in healthy late post-menopausal

Dutch women. British Journal of Nutrition. 2002 Mar;87(3):267-75.

14. Pebrianti SA, Insanullah ZN, Raihan N, Trinita RR. FOOD SAFETY CONSIDERATIONS OF EGG SHELL POWDER FOR FOOD APPLICATIONS: A REVIEW. Journal of Innovation Food and Animal Science (JIFAS). 2025 Jun 30;1(2):43-51.

15. Aditya S, Stephen J, Radhakrishnan M. Utilization of eggshell waste in calcium-fortified foods and other industrial applications: A review. Trends in Food Science & Technology. 2021 Sep 1; 115:422-32.

16. Ray S, Barman AK, Roy PK, Singh BK. Chicken eggshell powder as dietary calcium source in chocolate cakes. The Pharma Innovation 6, no 9 2017 Sep 1;6(9, Part A):1.

17. Schaafsma A. Short-term effects of a chicken egg shell powder enriched dairy-based products on bone mineral density in persons with osteoporosis or osteopenia. Bratislavske lekarske listy. 1999 Jan 1.

18. Waheed M, Butt MS, Shehzad A, Adzahan NM, Shabbir MA, Suleria HA, Aadil RM. Eggshell calcium: A cheap alternative to expensive supplements. Trends in Food Science & Technology. 2019 Sep 1;91:219-30.

19. World Health Organization. Vitamin and mineral requirements in human nutrition. World Health Organization; 2004.

20. Therdtai N, Soontrunnarudrungsri A, Khotchai W. Modified eggshell powder using thermal treatment and its application in Ca-fortified dog biscuits. Heliyon. 2023 Feb 1;9(2).

21. Weaver CM, Gordon CM, Janz KF, Kalkwarf HJ, Lappe JM, Lewis R, O'Karma M, Wallace TC, Zemel B. The National Osteoporosis Foundation's position statement on peak bone mass development and lifestyle factors: a systematic review and implementation recommendations. Osteoporosis international. 2016 Apr;27(4):1281-386.

22. Sakai, Seigo et al. "Effects of Eggshell Calcium Supplementation on Bone Mass

in Postmenopausal Vietnamese Women.” *Journal of nutritional science and vitaminology* vol. 63,2 (2017): 120-124.

23. Hossain MF, Numan SM, Khan SS, Mahbub S, Akhtar S. Human consumption, nutritional value and health benefits of Moringa (*Moringa oleifera* Lam.): a review. *International Journal of Community Medicine and Public Health*. 2022 Sep;9(9):3599-604.

24. Ningrum EM, Suharto RH, Al Kautsar AM, Hakim MA. Calcium Carbonate Content and Proximate Composition of Chicken Eggshell Flour at Different Oven Temperatures. *Hasanuddin Journal of Animal Science (HAJAS)*. 2025;7(2):142-51.

25. Jung S, Shin S-H, Kim Y-S, Joo N-S, Yeum K-J. Effects of Eggshell Calcium- and Vitamin D-Fortified HMR Combined with Aerobic Exercise on Bone Mineral Density in Postmenopausal Women: A Pilot Randomized Controlled Trial. *Nutrients*. 2026; 18(4):605.