



Utilization Of Calcium From Eggshell For Production Of Calcium Fortified Biscuit

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ABSTRACT:

The utilization of chicken eggshells as a source of dietary calcium has been explored. This study aimed to investigate the effects of supplementing eggshell powder on the chemical composition, physical and sensorial properties, as well as the bioavailability of biscuits. The objective was to address the calcium deficiency in biscuits by incorporating eggshell powder through food fortification. The growing consumption of chicken eggs has led to a significant increase in eggshell waste, which poses environmental concerns.

The purpose of these work was to make soyabean biscuit supplemented with :

Eggshell powder

Calcium chloride.

Eggshell powder is a natural source of calcium, as well as other elements such as strontium and fluorine. These elements have been found to potentially have a positive impact on bone metabolism. Previous experimental and clinical studies have demonstrated several beneficial properties of eggshell powder, including its antiarthritic effects on humans. Notably, it has been observed that eggshell powder can have positive effects on bone density in postmenopausal women with osteoporosis. Clinical studies conducted on postmenopausal women and women with senile osteoporosis have shown that the use of eggshell powder can reduce pain and osteoresorption, while also improving mobility and bone density or preventing its loss.

Furthermore, experimental studies have indicated that eggshell powder can have positive effects on both bone and cartilage, making it a suitable option for the prevention and treatment of osteoporosis. It is worth noting that eggshell makeup constitutes approximately 9-12% of the total weight of an egg, primarily consisting of calcium carbonate and calcium phosphate deposited on the organic matrix.

The objective of this study was to investigate the impact of fortifying biscuits with calcium from chicken eggshell in order to develop functional food for the elderly that can help reduce the risk of osteoporosis. The research focused on the extraction and characterization of calcium from eggshell waste, recognizing the significance of fortifying biscuits with calcium.

AIM AND OBJECTIVE :

AIM :

Treatment for osteoporosis in the medical field aims to halt the progression of **bone loss** and decrease the likelihood of experiencing **bone fractures**.

Clinical studies have demonstrated that the utilization of eggshell powder has been associated with a reduction in pain and **osteoporosis**, as well as an **improvement in mobility** and **bone density**, effectively halting further bone loss.

OBJECTIVES :

- 1)Eggshells are not only a good source of nutrition, but they are also a rich source of minerals, particularly calcium.
- 2)Eggshell waste can be minimized by extracting and utilizing its calcium for food fortification and manufacturing calcium-rich food sources.
- 3)Eggshell powder may be more effective at reducing the risk of osteoporosis than purified calcium carbonate.
- 4)The main component of eggshell membrane is protein in the form of collagen, which benefits joints and provides nutrients that can improve joint health.

5) Eggshell powder is an excellent source of bioavailable calcium that can increase bone mineral density and potentially delay bone demineralization when consumed regularly.

LITERATURE OF REVIEW:

1. Tasnim Farzana and colleagues (2015) outlined the process flowchart for producing fortified biscuits, as well as the methods for analyzing total ash, moisture content, fat content, and total carbohydrates.
2. The processing of extracting calcium from chicken eggshell, formulating biscuits, and analyzing the chemical composition of eggshell was detailed by Md. Entaduzzaman Jony et al. in 2021.
3. In their 2019 study, Rohit J. Thakur et al. outlined various evaluation parameters including physicochemical analysis, sensory analysis, pH, and microbial studies.
4. In their recent publication, Marcellus Arnold et al. (2021) provided a detailed explanation of the graphical abstract illustrating the significance of calcium, particularly chicken eggshell calcium, in reducing the risk of osteoporosis. The authors emphasized the essential role of vitamin D in facilitating calcium absorption.
5. Tombola, Bemire, and colleagues (2021) provided an analysis of the composition and cross-sectional anatomy of chicken eggshells. Utilization of discarded chicken eggshell.
6. In their 2020 study, Faiqa Afzal and colleagues outlined the impact of fortifying eggshell powder and provided a detailed flow chart illustrating the preparation process.

INTRODUCTION :

The primary objective of this study was to address the issue of calcium deficiency through the creation of biscuits using eggshell powder. By incorporating calcium-fortified foods into our diet, we can effectively reduce the occurrence of calcium deficiency. This deficiency is responsible for conditions like osteoporosis in the elderly and rickets in children. It is crucial to acknowledge that calcium deficiency is a significant global health concern that can potentially result in osteoporosis.

Osteoporosis, derived from the Greek words "osteo" meaning bone and "porosis" meaning process, refers to the weakening and decreased durability of bones. This medical condition results in brittle bones that have a diminished ability to heal after fractures, which in turn become more frequent due to the loss of flexibility. The strength of bones is maintained by essential components such as protein, collagen, and calcium.



Fig:Osteoporosis

Osteoporosis, a prevalent condition, is characterized by decreased bone density and modified bone micro-architecture. It is most commonly observed in postmenopausal women and elderly men. Women are at a higher risk of developing osteoporosis compared to men. According to a report by the World Health Organization (WHO) in 2003, approximately 70 million individuals worldwide were affected by osteoporosis. In individuals with osteoporosis, there is a reduction in bone mineral density (BMD) due to bone demineralization, leading to weakened and fragile bones that are prone to fractures. Fractures can occur at various sites, with the hip, vertebral spine, and wrist being the most commonly affected areas. With the growing elderly population, it is essential to address public health concerns such as osteoporosis in order to improve the quality of life for the elderly.

Consequences:

1. Considerable pain
2. Low quality of life
3. Inability to work effectively due to disability.
4. Prolonged hip fracture can lead to bed rest and this in turn lead to thrombosis in leg veins.

WOMEN AND BONE DENSITY:

Estrogen, the primary female sex hormone, plays a crucial role in preserving bone density in women. Adequate levels of estrogen in the female body are essential for maintaining proper bone remodeling. However, during menopause, the decline in estrogen levels results in a decreased ability for the body to replace lost bone material, as the hormone responsible for regulating this process is insufficient.

RISK FACTORS OF OSTEOPOROSIS:**A. Major risk factors :**

1. Inadequate intake of calcium and vit.D
2. Advanced age
3. Reproductive factors
4. Gender
5. Family history of osteoporosis
6. Estrogen deficiency

B.Minor risk factors:

1. Lifestyle
2. Smoking
3. Alcohol abuse
4. Medication
5. Body size
6. Diet

CLINICAL SIGN AND SYMPTOMS:

Osteoporosis has been called “**silent disease**” because bone mass is lost over many years with no sign and symptoms.

1. Bone density loss
2. Loss of height over-time
3. Back pain
4. Vertebrae collapse
5. Weight loss
6. Decrease height rate
7. Tooth loss
8. Depression

CHICKEN EGG SHELL IS AN NATURAL SOURCE OF CALCIUM:

Calcium is a crucial micronutrient essential for the proper functioning of the human body. It plays a significant role in the formation of bones and teeth, as well as in various physiological processes. Calcium is indispensable for the normal functioning of nerve cells, muscle cells, cell division, prevention of chronic diseases, and blood clotting. For over 80 years, dietary reference intakes worldwide have emphasized the importance of vitamins D, B2, and B3 in preventing various illnesses.

Fig:Chicken eggshell is a natural source of calcium



Calcium plays a crucial role in the formation and structure of bones. Approximately 99.5% of the total calcium in the human body is found in the skeletal system. The bones undergo a continuous process of remodeling, with calcium constantly being deposited and withdrawn from them. The required amount of calcium for maintaining healthy bones and teeth varies depending on age. Additionally, the calcium stored in our bones serves as a reservoir for regulating calcium levels in the bloodstream, which is essential for the proper functioning of nerves and muscles.

The calcium requirements of individuals change throughout different life stages. During adolescence, a higher amount of calcium is necessary due to rapid bone growth. As people age, the body's ability to absorb calcium decreases, leading to a greater need for seniors. The recommended daily intake of calcium can vary. Calcium is an essential nutrient that plays a crucial role in various biological functions such as nerve cell activity, cell division, prevention of chronic diseases, and blood clotting. The recommended dietary intake of calcium ranges from 800 to 1300 mg/day depending on the age group. Typically, milk and dairy products are considered the best natural sources of calcium, with a high bioavailability rate of approximately 75% to 89%, making them a cost-effective way to meet nutritional needs.

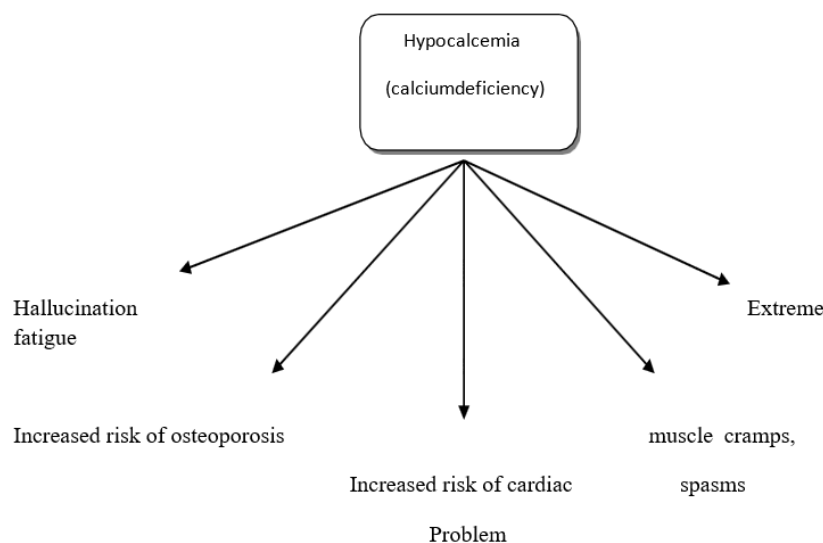


Fig : Effect of calcium deficiency in the human body

RECOMMENDED DAILY CALCIUM INTAKES :

SR. NO	AGE	CALCIUM RECOMMENDED DAILY INTAKE(mg/day)
1	0-6months	200
2	6-12 months	260
3	1-3years	700
4	4-8 years	1000
5	9-13years	1300
6	14-18 years	1000
7	19-50years	Female:1200 Male:1000
8	Over 70 years	1200

CHICKEN EGG SHELL:

Eggshell is a highly beneficial dietary source of calcium that is known to effectively increase Bone Mineral Density (BMD) and alleviate the pain experienced by elderly individuals suffering from osteoporosis.

Many nations across the globe face a significant environmental issue caused by the excessive waste of eggshells from egg product companies and food manufacturers. These eggshells, along with their membranes, are non-edible byproducts that may contain biologically active compounds.

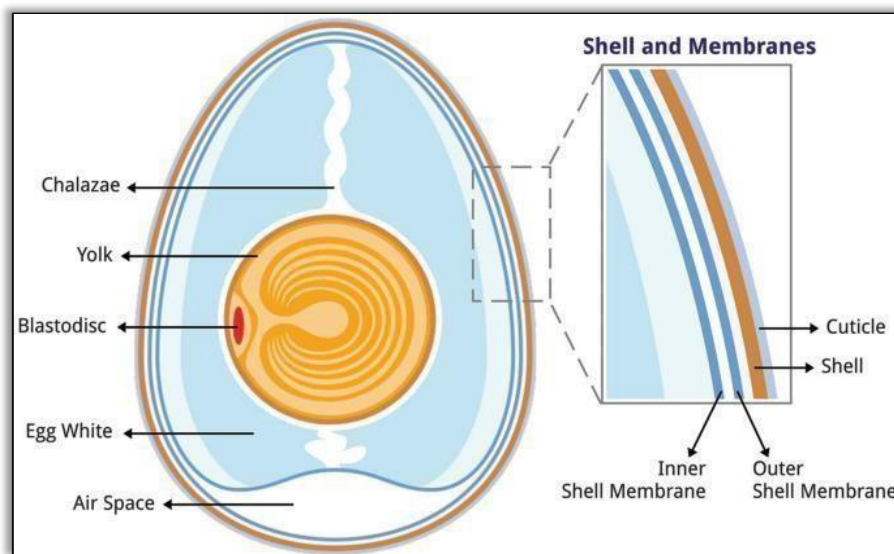


Fig : structure and cross-sectional view chicken eggshell

Chicken eggshells are known for their high calcium content, making them valuable in the prevention of osteoporosis. Eggshells have the potential to be utilized as raw materials for the production of new products.

Eggshell is rich in calcium carbonate, which has high bioavailability of calcium.

1 gm of eggshell powder contain a 360- 400 mg of calcium.



Fig : Chicken Eggshell

Eggshells contain a rich and well-balanced amount of calcium, along with trace minerals, making them an excellent natural source of this essential nutrient. In the later stages of egg production, the use of eggshell powder has been observed to enhance egg yield and enhance the shell's overall quality. Additionally, chicken eggshells can serve as a viable substitute for soil stabilizers.

The objective of this research was to evaluate the impact of incorporating eggshell powder at a 15% level on the chemical composition, sensory attributes, and calorific value of the biscuits. The addition of eggshell powder led to notable changes in the chemical composition of the biscuits.

USES OF EGGSHELL:

1. Eggshell contains calcium and trace amount of other microelements i.e magnesium, boron, copper, iron, manganese, sulphur, zinc etc.
2. Eggshell calcium is probably the best natural source of calcium and it is about 90% absorbable.

3. Chicken eggshell are waste material that can be used as an alternative soil stabilizer like lime since they have same chemical composition.
4. Discarded eggshell are often used as a plant fertilizer. This is because eggshells contain calcium.

CALCIUM FORTIFIED BISCUITS:

Research has indicated that the addition of eggshell powder to biscuits has enhanced the calcium content of these products. Furthermore, sensory evaluations have shown an overall positive reception of the products. Studies have proven that fortifying biscuits with calcium can be a cost-effective method to meet the daily calcium requirements. Eggshells can also be effectively utilized to manage industrial waste. Calcium plays a crucial role in preventing bone demineralization. The use of chicken eggshell powder may have potential benefits, such as increasing bone density and reducing pain in osteoporosis patients. Eggshell calcium is considered one of the most absorbable natural sources of calcium, with an absorption rate of about 90%. Biscuits, being flour-based bakery items, are popular among consumers due to their various flavors, long shelf life, and affordable prices. With the market competition and growing demand for health-promoting natural products, efforts are being made to enhance the nutritional value of biscuits.

The current study was undertaken to investigate the impact of biscuit fortification, with a focus on developing functional food for the elderly to mitigate the risk of osteoporosis, specifically utilizing calcium derived from chicken eggshells. Given the significance of calcium enrichment, the present research has been dedicated to extracting and characterizing calcium from eggshell byproducts.

The aim of this study was to enhance biscuits with eggshell powder and evaluate its impact on various quality parameters of the biscuits, such as physicochemical, physical, microbiological, and nutritional aspects. To our knowledge, there have been no prior studies conducted on the fortification of biscuits with eggshell powder and its potential effects on osteoporosis.

MATERIALS AND METHODS:

Materials :

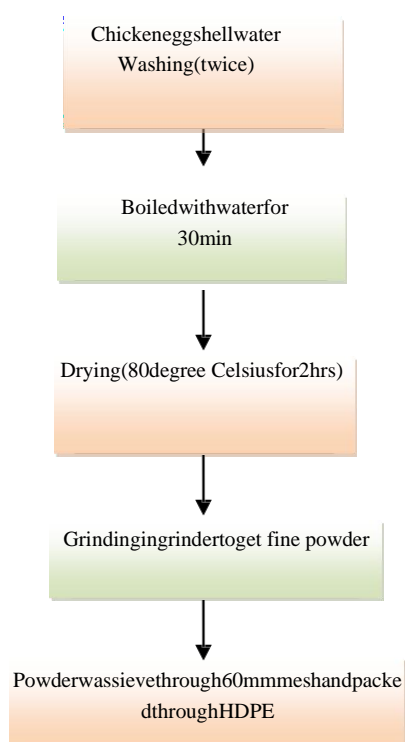
Chicken eggshell collected from a local store or a poultry farm for experiment. The commercially available ingredients such as sugar, milk powder, baking powder, soyabean flour , salt , ghee, etc. collected from the local market while reagent and chemicals also be first grade.

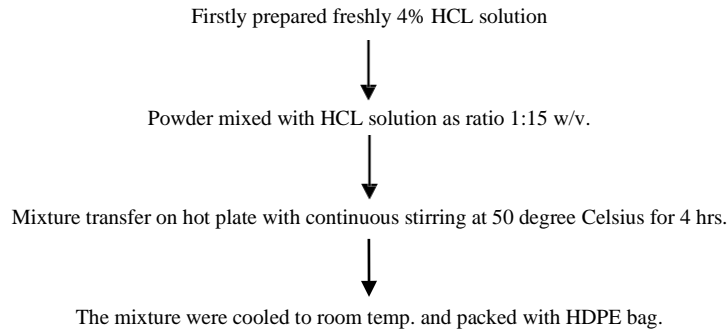
Extraction process of calcium chloride from chicken eggshell:

a) Preparation of membrane – free eggshell powder:

Chicken eggshells was washed twice and processed using four different ways:

- i. Collected chicken eggshell were rinsed thoroughly with distilled water to eliminate foreign particle.
- ii. Shell membrane were separated from eggshell manually.
- iii. Membrane free eggshell sterilized in hot water at 100 degree Celsius for 25min.
- iv. To kill pathogens that are sticks on eggshell crush the shell to small pieces then dried in hot air oven at 60degree Celsius for 6hrs.
- v. Powder was sieve through a 60 mm mesh and then packed in high density polyethylene bags and store at air tight conditions.



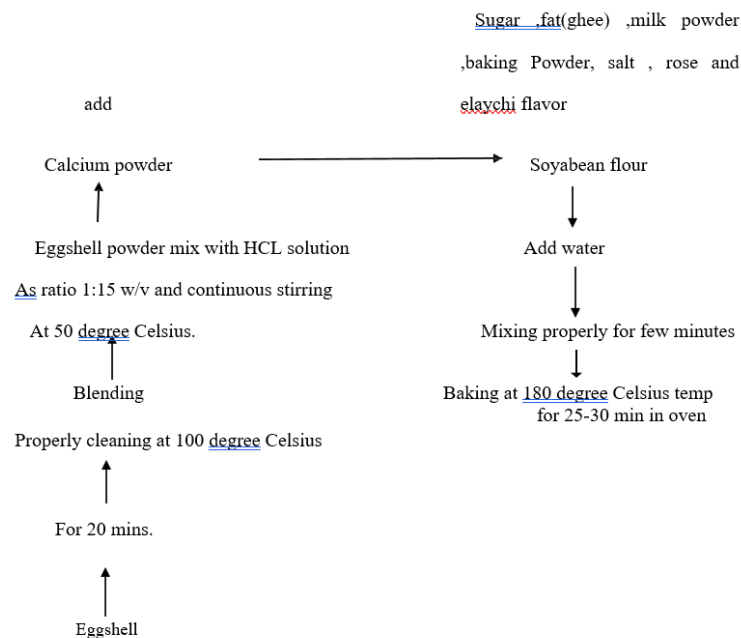
Preparation of eggshell powder**b) Calcium chloride extracted from chicken eggshell :****c) Physico-chemical analysis:**

The physico - chemical analysis of soyabean flour , eggshell powder and fortified biscuits were determine according to the procedure as described by association of official analytical chemist for moisture , protein , fat , crude fibre and ash content were determined by using gravimetric method, ash by dry using method .

FORMULATION AND PREPARATION OF BISCUITS :

The biscuits were formulated as shown in table by following method :

Sr.no	Ingredient(gm)	Quantity(gm)
1	Soyabean Flour	200
2	Fat	53.33
3	Sugar	66.6
4	Calcium Chloride	9.8
5	Salt	1.66
6	Baking Powder	5
7	Milk Powder	7.5
8	Chocolate (flavour)	5-6 drops

PROCEDURE :

EVALUATION PARAMETER:

1. Test for calcium biscuits :

Ammonium oxalate test:

Take 2ml of aqueous solution of the biscuits in a test tube and add 1-2 ml of ammonium oxalate. Then add little amount of ammonium hydroxide to it. formation of white precipitates indicate the presence of calcium ions.(test is present)



Fig : Ammonium oxalate test

1. Sensory analysis of formulated/ fortified biscuits:

Sensory properties of the formulated biscuits as follows:

- i. Color
- ii. Odor
- iii. Taste
- iv. Texture
- v. Flavor
- vi. General appearance
- vii. Mouth fill

2. Physical properties:

Weight :

Biscuit were weighted in grams after 2 hrs from baking **14.32 gm.**

3. Extraction rate of calcium chloride from eggshell :

- a) The yield of calcium chloride from eggshell according to the ratio of HCL as 1: 15.
- b) Local chicken eggshell provided the highest amount of calcium chloride than layer eggshell , when some amount of HCL was used for extraction.
- c) Extraction amount with 20.5 ml HCL was the best option in the point of cost effect.

METHOD OF ANALYSIS:

Proximate analysis : the proximate composition i.e moisture content fat, protein, total ash, carbohydrates for calcium fortified biscuits were determine according to standard analytical methods.

1. Determination of moisture content:

Moisture content was determined by drying a sample in an oven at 100 degree Celsius for 12 hrs , the weight loss incurred was calculated as :

Using formula:

$$\text{Moisture (\%)} = (\text{weight loss on drying} / \text{weight of the sample}) 100$$

2. Determination of total ash :

Crucible were first dried for about 2hrs at 100 degree Celsius in an oven and placed in a incinerator. They were cooled and about 2.0 gm of sample was weighted into the crucible. The sample were then placed in a incinerator at 600 degree Celsius for 4 hrs. percentage ash content was determined by weighing the resulting inorganic residue.

Using formula:

Weight of ash content (gm/100gm of sample)

$$= [(\text{weight of the crucible + ash}) - (\text{weight of the crucible}) / \text{weight of the sample}] \times 100$$

3. Hardness test :

The hardness test for biscuit is determined by using hardness tester instrument.



Fig : Hardness Test For Biscuit.

RESULT AND DISCUSSION:

5. Sensory properties of calcium fortified biscuits :

Evaluated calcium chloride biscuits for color, odor, flavor, texture , overall acceptability as shown in given :

SR. NO	Test	Result/ observation
1	Color	Brown red
2	Odor	Elaychi
3	Taste	Sweet
4	Texture	Solid, roughed , crunchy
5	Flavor	Rose escence
6	Mouth fill	Sweet
7	General appearance	Round, flat and dry

1. Hardness test :

The hardness test for biscuit is determined by using hardness tester instrument.

$$\text{Hardness} = 1.3 \text{ kg (} 1\text{kg} = 9.8 \text{ N)}$$

Range for hardness of biscuit : 3.76 N – 15.97 N

2. Chemical composition of soyabean flour and eggshell powder :

The proximate analysis of commercially available soyabean flour and eggshell powder is reported in following table :

1. Soyabean Flour :

SR.NO	COMPONENT	SOYABEAN (%)
1	Moisture	5.04%
2	Protein	49.4g
3	Fat	19.9g
4	Ash	4.87g
5	Ph	6.65

2. Eggshell powder :

SR.NO	COMPONENT	EGGSHELL POWDER (%)
1	Moisture	5%
2	Protein	0.2
3	Fat	90.1
5	Ash	35.4
6	Ph	7.2

3. Composition of calcium fortified biscuit product:

The composition of calcium fortified biscuit are given in table :

SR. NO	Test	Result / observation
1	Moisture content	4.5 %
2	Protein	10.20%
3	Fat	17.25%
4	Ash	1.53%
5	Total carbohydrate content	66.26%

4. Microbiological assay for eggshell powder :

The microbiological assay for eggshell powder are given in table :

SR. NO	Treat	Observation
1	Boiling	Negative
2	Autoclave	Negative

3	Hot air oven	Negative
4	Microwave	Negative

CONCLUSION AND FUTURE ASPECTS:

1. The effort to reduced the risk of osteoporosis in the elderly using calcium source .
2. The information observed in these research could be useful for scientific knowledge, especially as one of the alternative way to solve eggshell waste problem by incorporating it into biscuit to decrease calcium deficiency and risk of osteoporosis, which are global health problem.
3. The study was highlighted that both eggshell powder and calcium chloride powder extracted from eggshell increase the calcium content in the biscuit. The current research revealed that the addition of eggshell powder in a excellent source of calcium.
4. Eggshell is a food waste which may causes environmental and health problems, if it is not manage properly. In these study the innovative functional food based on biscuits enriched with calcium content .
5. It can be concluded that eggshell powder is an appropriate and cheap source of calcium for human nutrition and is easily prepared at home.

Future aspects :

1. Composed for naturally fertilized soil:

Eggshell quickly decomposed in the compost file and add valuable calcium and other minerals to the soil in the process.

2. Non toxic pest control in garden :

Scattered crushed eggshell around your plants and flower to help deter plant eating slugs, snails, and cutworms without using ecofriendly pesticides.

3. Less bitter coffiee:

Add eggshell to the coffee in the filter and your morning coffee will be less bitter.

4. Ecofriendly household abrasives :

Shake crushed eggshell and a soapy water to scour hard to clean items like thermoses and vases. Crushed eggshell can also be used as non toxic abrasive on pot and pan.

5. Natural drain cleaner :

Keep a couple of crushed eggshell in your kichen sink stainer at all time .they trapped additional solids and gradually break up and help to naturally clean kitchen pipes on their way down the drain.

• Storage conditions :

- Store at a room temperature.
- Store the biscuit in an air tight container.

• Precautions

- Avoid contamination while handling the product.
- Protect from direct sunlight.
- Store in a cool or hygienic place.

• Directions :

- Consume the product before 3 month of manufacturing.

REFERENCE :

1. Eggshells calcium extraction and the application in food fortification [internet] journal of bio-based materials and bio-energy. Vol. 15,615-620, 2021 [cited on October – 2021] available from : https://www.researchgate.net/publication/356137591_Eggshells_Calcium_Extractio_n_and_the_Application_in_Food_Fortifications
2. [and the Application in Food Fortifications](https://www.researchgate.net/publication/356137591_Eggshells_Calcium_Extractio_n_and_the_Application_in_Food_Fortifications)
3. Production of calcium chloride from eggshell [1998] [internet] Alongcot chongpuak; kasetsart univ ; Bangkok (Thioland) graduate school. [corporate author]
4. available from :<https://agris.fao.org/agris- search/search.do?recordID=TH2000002751#:~:text=Calcium%20in%20egg%20shell%20is,extraction%20period%20of%203%20hours>
5. [%20is,extraction%20period%20of%203%20hours](https://agris.fao.org/agris- search/search.do?recordID=TH2000002751#:~:text=Calcium%20in%20egg%20shell%20is,extraction%20period%20of%203%20hours)

6. Effect of calcium chloride extracted from eggshell in maintaining quality of selected fresh cut fruits [internet] research article, [2019] BY – Rohit j thakur , hamad sheikh , yogesh Gat , Roji B. waggmare from
7. [:https://link.springer.com/content/pdf/10.1007/s40093-019-0260-z.pdf](https://link.springer.com/content/pdf/10.1007/s40093-019-0260-z.pdf)
8. Indian pharmacopoeia – 2018, vol- 1 , monograph of conc.HCL and dil. HCL, Page no : 2217 and 2218.
9. IP 1996 , Appendix 13.2 , preparation of 4% HCL solution (4% HCL solution = 1.3 M) page no : A- 169.
10. Functional food for elderly high in antioxidant and chicken eggshell calcium to reduced the risk of osteoporosis- a narrative review, [cited on 19 march 2021]Department of gastronomy science and functional foods . available from : <https://www.mdpi.com/2304-8158/10/3/656>
11. A pathway for sustainable utilization of waste chicken eggshell. A narrative Review article by - Omojola awogbemi, daramy vandi von kallon and victor Sunday aigbodion . [cited on 4 nov 2021] available from
12. [:https://www.techscience.com/jrm/v10n8/47608](https://www.techscience.com/jrm/v10n8/47608)
13. Effect of egg shell powder fortification on the physiochemical and organoleptic characteristics of muffins – research article by faiqa afzal , ghulam mueen-ud- din,Muhammad nadeen[cited on 10 march 2020] available from : <https://www.thepab.org/files/2020/June-2020/PAB-MS-190120488.pdf>
14. effect of fortification with egg shell powder on injera quality by tigest fekadu,angela cassano, ignacin angos .Department of agronomy ,biotechnology and food sciences engineering, ISFOOD- 31006,panplona,spain. [cited on 1 feb 2022] published by Elsevier ltd.available from : https://www.google.com/url?sa=t&source=web&rct=j&url=https://academic.elsevier.com/bitstream/handle/2454/42641/2022020202- Fekadu_EffectFortification.pdf%3Fsequence%3D1%26isAllowed%3Dy&ved=2ahUKEwiQ0era-9X-AhXHVmwGHX6RDUIQFnoECBAQAQ&usq=AOvVaw3ZyvO935w9pG
 - a. chicken egg shell powder as dietary calcium source in biscuit by nahlaM.M Hassan,food technology research institute aggriculture research centre ,Egypt [cited on 2015] available from:[https://idosi.org/wjdfs/wjdfs10\(2\)15/14.pdf](https://idosi.org/wjdfs/wjdfs10(2)15/14.pdf)
 - b. Overview on osteoporosis –symptoms and causes [internet] available from : <https://www.mayoclinic.org/diseases-conditions/osteoporosis/symptoms-causes/syc-20351968>