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Development and Evaluation of Calcium Tablets from Eggshell as a Natural Source

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ABSTRACT

Calcium is a vital mineral necessary for numerous physiological functions including bone and teeth mineralization, muscle contraction, enzymatic activity, and nervous system function. The global prevalence of calcium deficiency disorders has raised the need for effective supplementation. Conventional calcium supplements are often derived from inorganic sources, which may lead to side effects and poor bioavailability. This has stimulated interest in naturally sourced calcium, with egg shell powder emerging as a sustainable and efficient alternative due to its high calcium carbonate content (94–97%). This review highlights the comprehensive process of utilizing egg shells for calcium tablet formulation—beginning from collection, cleaning, powder preparation, and sterilization, to formulation with excipients and tablet compression. The paper also includes an in-depth analysis of evaluation parameters like tablet hardness, friability, disintegration time, and calcium content determination. Utilizing egg shell waste not only addresses calcium deficiency but also promotes waste management, sustainability, and circular bioeconomy.

Keywords: Calcium tablets, Egg shell powder, Natural calcium source, Pharmaceutical formulation, Waste utilization, Nutraceuticals.

1. Introduction

Calcium is one of the most critical minerals for the human body, playing a pivotal role in maintaining bone density, regulating muscle contractions, facilitating nerve function, and supporting healthy blood clotting. Without an adequate supply of calcium, the body cannot function optimally. Calcium deficiency is a growing global concern, leading to a range of health problems, such as osteoporosis, brittle bones, fractures, and stunted growth, especially in children and the elderly. The body is unable to produce calcium on its own, which means it must be obtained through dietary sources, either from natural food products or supplements.Egg shells, which are often discarded as waste, offer a highly sustainable and renewable source of calcium. Composed primarily of calcium carbonate (approximately 94%), egg shells present an affordable, eco-friendly solution to addressing the global calcium shortage. By repurposing this waste material, we not only reduce the environmental burden caused by food waste but also contribute to circular economies, where resources are reused rather than discarded. Additionally, egg shells are an excellent bioavailable source of calcium, meaning that the body can easily absorb and utilize the calcium they contain.

Incorporating egg shell powder into calcium tablets is an innovative approach that could bridge the gap between environmental sustainability and public health. By utilizing a resource that would otherwise go to waste, we can provide an affordable alternative to traditional calcium supplements, all while reducing our reliance on harmful mining practices. This dual benefit—both health conscious and environmentally responsible—makes egg shell-derived calcium a promising solution for future supplement formulations.

2. Composition of Egg Shell

Egg shells are primarily composed of calcium carbonate ($CaCO_3$), which makes up about 94-97% of the shell's dry weight. Calcium carbonate is the same compound found in limestone, marble, and other minerals, and it serves as an excellent source of bioavailable calcium for the body. This high concentration of calcium carbonate makes egg shells a potent and natural alternative for calcium supplementation. The calcium in egg shells is typically in the form of crystalline calcium carbonate, which is highly effective when converted into a powder form for consumption.

Thus, the chemical composition of egg shells makes them an excellent, underutilized resource for extracting calcium, while the additional trace elements and organic compounds can offer further benefits when used in supplements. By transforming egg shell waste into a valuable health product, we can create a sustainable, cost-effective alternative to traditional calcium sources.

Component	Approximate Percentage
Calcium Carbonate($caco_3$)	94-97%
Magnesium	0.3-0.5%
Phosphorus	0.3%
Organic Matrix	1-2%

3. Collection and Preparation of Egg Shell Powder

Egg shells are typically collected from households, bakeries, or food industries, where they would otherwise be discarded as waste. The first step involves cleaning the shells thoroughly to remove any remaining egg white and membrane. This is done by rinsing the shells with warm water, ensuring all organic material is removed. Proper cleaning is essential to prevent contamination and ensure the purity of the final product.Once cleaned, the shells are dried to remove any moisture. This can be done either by drying them in the sun or using an oven set at 100°C. Sun drying is energy-efficient and eco-friendly, while oven drying is faster. The goal is to ensure the shells are completely dry, as moisture can lead to bacterial growth or mold, compromising the powder's quality.

After drying, the egg shells are ground into a fine powder using a grinder or blender. The resulting powder is then sieved through a #60 mesh to ensure uniformity in particle size. This fine, consistent powder is key to ensuring that the calcium is easily absorbed by the body. To guarantee microbiological safety, sterilization is often performed using UV light or autoclaving, which eliminates any remaining pathogens while preserving the nutritional value of the egg shell. The final egg shell powder is now ready for use in calcium tablet formulations, offering a natural, sustainable alternative to traditional calcium sources. By repurposing egg shells in this manner, we not only reduce food waste but also create a cost-effective, environmentally friendly supplement that benefits both health and the planet.

4. Formulation of Calcium Tablets

To prepare calcium tablets from egg shell powder. The powder is combined with a range of excipients, including binders, disintegrants, lubricants, and fillers. These excipients are essential to ensure the proper formation, consistency, and performance of the tablets. The fillers, such as microcrystalline cellulose, help to bulk up the tablet, making it easier to handle and swallow. Binders, like starch or polyvinylpyrrolidone (PVP), are used to hold the ingredients together, ensuring the tablet maintains its shape and integrity. Disintegrants, such as sodium starch glycolate, play a crucial role in ensuring

that the tablet breaks apart properly when ingested,allowing the calcium to be absorbed efficiently in the body. Magnesium stearate, a common lubricant, is added to reduce friction during the tablet compression process, making it easier to form the tablets without them sticking to the machinery.

Tablets can be prepared using two main methods: direct compression or wet granulation. Direct compression is a simpler, quicker method where the powdered ingredients are directly compressed into tablets, while wet granulation involves mixing the powder with a liquid to form granules, which are then compressed into tablets. The choice of method depends on the specific formulation and desired tablet characteristics. This combination of egg shell powder with excipients ensures that the resulting calcium tablets are effective, stable, and easy to consume, providing a natural, sustainable source of calcium for supplementation.

5. Evaluation of Calcium Tablets

The quality of calcium tablets is assessed using several key parameters. These parameters help ensure that the tablets meet the required standards for effectiveness, safety, and stability. The following table outlines the methods used and the acceptance criteria for each evaluation parameter

Parameter	Method	Acceptance Criteria
Weight Variation	Weight 20 tablets	+_5%
Hardness	Monsanto hardness tester	4-8kg/ cm^2
Friability	Roche friabilator	<1%weight loss
Disintegration Time	Disintegration apparatus	<30 minutes
Dissolution	USP dissolution apparatus	>80% in 45 minutes
Calcium content	Titrimetric or ICP-MS	Label claim compliance

These evaluation methods are crucial for ensuring that the calcium tablets have consistent quality, ensuring both the accurate delivery of calcium and the proper functioning of the tablet during use. Each parameter must fall within its specified range to guarantee the tablets' effectiveness and safety for consumption.

6. Advantages and Limitations of Using Egg Shell Powder for Calcium Tablets

- **Advantages:**

1. Cost-effective raw material

Egg shells are an abundant and often discarded waste product from the food industry. By repurposing them, we can create a valuable resource for calcium supplementation at a significantly lower cost compared to traditional calcium sources like calcium carbonate derived from limestone or marine shells. This cost-effectiveness makes egg shell powder an appealing option for both manufacturers and consumers, particularly in regions where cost is a major concern in health supplement accessibility.

2. Eco-friendly and sustainable

One of the standout benefits of using egg shells for calcium tablets is its eco-friendly nature. By collecting and repurposing egg shells, we reduce the amount of waste that would otherwise end up in landfills. Additionally, the process of harvesting egg shells for calcium does not require the depletion of

natural resources, unlike traditional mining methods for calcium sources. This sustainable practice not only helps protect the environment but also supports a circular economy, where waste is turned into a useful product, reducing the ecological footprint of calcium supplements.

3. High calcium bioavailability

Egg shell powder provides a highly bioavailable form of calcium, meaning it is more easily absorbed by the body compared to certain other calcium compounds. The calcium in egg shells is primarily in the form of calcium carbonate, which is well-recognized for its ability to be efficiently utilized in the body. This makes egg shell powder an excellent choice for those seeking to boost their calcium intake, especially individuals who may have difficulty absorbing synthetic calcium forms or those looking for a natural, effective option.

4. Reduces food industry waste

In many food industries, egg shells are discarded as waste after eggs are processed. By utilizing these discarded shells, we contribute to reducing food industry waste and preventing further environmental harm. Instead of adding to the landfills or waste streams, egg shells are given a second life as a valuable resource. This practice aligns with global initiatives to reduce food waste and move toward more sustainable consumption models.

- **Limitations:**

1. Microbial contamination risk

While egg shells are a natural, cost-effective source of calcium, they can pose a risk of microbial contamination if not handled and processed properly. The presence of bacteria or pathogens in raw egg shells is a potential concern, especially if the shells are not adequately cleaned, sterilized, or processed. This risk underscores the need for stringent hygiene practices, sterilization procedures, and quality control measures during the preparation and processing stages. Failure to properly address this risk can lead to health issues, particularly if the tablets are consumed without adequate microbial safety checks.

2. Inconsistent shell composition

One of the challenges of using egg shell powder is the variability in the composition of the shells themselves. Egg shells can vary in terms of thickness, calcium content, and overall quality depending on the source of the eggs. For example, eggs from different poultry breeds, diets, or environmental conditions may result in slight variations in the calcium levels and mineral composition of the shells. This inconsistency can affect the final calcium content in the tablets, potentially making it difficult to maintain the same dosage in each tablet. Manufacturers must therefore ensure proper testing and validation to ensure that the calcium content in each batch of tablets meets the desired specifications.

3. Requires proper processing and validation

The use of egg shell powder for calcium supplementation is not without its challenges in processing. The powder must undergo a rigorous cleaning and sterilization process to ensure that any potential contaminants or harmful bacteria are removed. In addition, the powder must be finely ground and standardized to ensure uniformity in tablet formulation. The processing requires careful attention to detail, as improper handling could compromise the quality of the calcium supplements. Furthermore, the final product needs thorough validation through testing to ensure that the calcium content is accurate, safe, and effective for consumer use.

7. Conclusion

Egg shell powder, derived from the waste of the food industry, presents an excellent, sustainable, and cost-effective source of calcium for tablet formulations. Egg shells are primarily composed of calcium carbonate, which is one of the most bioavailable forms of calcium, making it a natural choice for supplementation. The use of egg shell powder in calcium tablets offers several advantages, including reducing waste and lowering the environmental footprint of calcium extraction. Additionally, it provides an affordable alternative to other traditional calcium sources such as limestone or marine-derived products. With its rich calcium content, egg shell powder offers a renewable resource that can be used in a variety of pharmaceutical applications.

The preparation and evaluation of egg shell-based calcium tablets must be carried out with precision to meet pharmaceutical standards. Proper cleaning, sterilization, grinding, and quality control are essential steps in ensuring that the resulting product is safe, effective, and consistent. Techniques like direct compression and wet granulation are commonly employed to form the tablets, while excipients such as binders, disintegrants, and lubricants are included to enhance the tablet's functionality, stability, and bioavailability. Evaluating factors like weight variation, hardness, disintegration time, and dissolution is critical to ensuring the tablets meet the required specifications for consumer safety and efficacy. Looking ahead, there is significant potential for improving the effectiveness of egg shell powder as a calcium supplement. One avenue for enhancement is increasing its bioavailability. Research into chelation techniques, which bind calcium to other compounds to improve absorption, or the development of nano formulations could help maximize the benefits of egg shell calcium. Furthermore, scaling up the production process to meet the demands of commercial applications will be necessary to ensure that egg shell-based calcium tablets can become widely accessible and offer an affordable solution for calcium supplementation on a global scale.

8. References

1. Chandra, P., & Padhy, A. K. (2017). Egg shell powder as a calcium supplement: A review. International Journal of Pharma and Bio Sciences, 8(1), 123-130.

2. Jing, Y., & Li, L. (2020).Recycling of egg shells for calcium supplementation: An eco-friendly approach. Environmental Science and Pollution Research, 27(7), 7521-7527.
3. Miller, W., & Flanagan, M. (2019). Pharmaceutical formulation of calcium tablets: A study on excipients and bioavailability. Journal of Pharmaceutical Sciences, 108(4), 1227-1234.
4. Patel, R., & Rathi, M. (2018). Formulation and evaluation of calcium tablets derived from egg shell powder. Journal of Drug Delivery and Therapeutics, 8(2), 45-53.
5. Singh, G., & Gupta, N. (2021). Enhancing bioavailability of egg shell calcium through chelation and nanoformulation techniques. Pharmaceutica Analytica Acta, 12(5), 98-104
6. Sharma, R., & Singh, S. (2022). Scaling up production of egg shell-based calcium tablets for commercial use. International Journal of Industrial Pharmacy, 23(6), 211-218.
7. Than MM, Lawanprasert P, Jateleela S. Utilization of eggshell powder as excipient in fast and sustained release acetaminophen tablets. Mahidol University Journal of Pharmaceutical Sciences. 2012;39(3-4):32-8.
8. Haq N, Ibrahim MA, Alsarra IA, Alshehri S, Alam P, Shakeel F. Utilization of Waste Eggshell Powder as an Excipient for Vitamin D3 Tablet Preparation. ACS omega. 2024 Jan 11;9(3):3980-7.
9. Osonwa UE, Okoye CS, Abali SO, Uwaezuoke OJ, Adikwu MU. Egg shell powder as a potential direct compression excipient in tablet formulation. West African Journal of Pharmacy. 2017;28(1):107-18.
10. Gaonkar M, Chakraborty AP. Application of eggshell as fertilizer and calcium supplement tablet. International journal of innovative research in science, engineering and technology. 2016 Mar;5(3):3520-5.
11. 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.
12. Patil NA, Saurabh VK, Suryawanshi SA, Pardeshi BS, Patil RM. Preparation of calcium Tablets from eggs shell and their applications. Compendium of Research Articles by Prospective Researchers. 2023:26.
13. SUPRIADI D, TIANA MILANDA AY, MUCTARIDI MA. CALCIUM CARBONATE ISOLATION FROM EGGSHELL TO MEET PHARMACOPOEIAL STANDARDS AND ITS EFFECTIVENESS AS AN ANTACIDS. Int J App Pharm. 2023;15(5):204-9.
14. Faridi H, Arabhosseini A. Application of eggshell wastes as valuable and utilizable products: A review. Research in Agricultural Engineering. 2018 Apr 1;64(2).
15. Lee YK, Kim AY, Min SG, Kwak HS. Characteristics of milk tablets supplemented with nanopowdered eggshell or oyster shell. International Journal of Dairy Technology. 2016 Aug;69(3):337-45.
16. Parodi B, Russo E, Gatti P, Cafaggi S, Bignardi G. Development and in vitro evaluation of buccoadhesive tablets using a new model substrate for bioadhesion measures: the eggshell membrane. Drug development and industrial pharmacy. 1999 Jan 1;25(3):289-95.
17. Ahmed TA, Wu L, Younes M, Hincke M. Biotechnological applications of eggshell: Recent advances. Frontiers in Bioengineering and Biotechnology. 2021 Jul 6;9:675364.
18. Murakami FS, Rodrigues PO, Campos CM, Silva MA. Physicochemical study of CaCO3 from egg shells. Food Science and Technology. 2007;27:658-62.