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Importance and Application of Egg Shell in Human Life to Improve Dietary Calcium Uptake

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ABSTRACT

Egg shell (ES) deposition, its nutritional makeup, theories of calcium absorption, and the importance of calcium in daily life were all covered in the current review paper. There are two phases to the creation of ES. About 95% of the dry ES is composed of calcium carbonate, which weighs 5.5 grams. One ES has around 0.3% phosphorus, 0.3% magnesium, and traces of sodium, potassium, zinc, manganese, iron, and copper. The amount of calcium that is accessible relies on both vitamin D status and dietary intake since calcium absorption is dependent on vitamin D. Calcium reabsorption may occur at several points along the nephron. Intestinal acidity (particularly for CaCO3 absorption), oestrogen, vitamin D, soluble fiber/prebiotics, probiotics, and synbiotics have all been shown to favourably boost calcium absorption.

Keywords; Egg shell (ES), Calcium, Calcium Carbonate, Nutrition.

Introduction

Egg shell provides protection from mechanical damage to growing embryo. It also provides nutrition and metabolic activity.

As we know that calcium is one of the most essential minerals for the human body for the development of bone and also human skeleton is made up of 98% calcium. Researchers state that over the past century calcium intake in human decline rapidly. Decrease level of calcium leads to many severe diseases like survey, rickets (softens the areas of growing tissue at the ends of a child's bones (growth plates), it can cause skeletal deformities such as:

- Bowed legs or knock knees.
- Thickened wrists and ankles.
- Breastbone projection [1].

Beri-Beri and causes Low Bone Density symptom arise that is-Osteoporosis (Osteoporosis is a bone disease that develops when bone mineral density and bone mass decreases), Hypocalcemia, osteoarthritis and bone deterioration.

Given the critical importance of calcium and the widespread occurrence of dietary calcium insufficiency, calcium supplement preparations have emerged as a significant nutritional intervention. These supplements can effectively bridge the gap between actual dietary intake and recommended levels, thereby promoting healthy growth and mitigating the risk of calcium-related disorders. Calcium supplement preparations, particularly those derived from calcium carbonate ($CaCO_3$) as their primary raw material, serve as key alternative sources of dietary calcium and constitute an essential component of osteoporosis treatment regimens. Consequently, calcium supplementation is frequently prescribed in clinical practice [2].

In several intervention studies, the benefit of calcium supplementation was usually greater in the appendicular than in the axial skeleton and more substantial in children with a relatively low calcium intake. Despite a positive effect on mean aBMD gain, there is still wide interindividual variability in the response to calcium supplementation. As discussed above, it is possible that part of the variability in the bone gain response to calcium supplementation could be related to genetic background [3]. Calcium requirements by age and reproductive status and contribution of 1 g of chicken eggshell as a percentage of the recommended intake (RI) [4].

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Table: 1. Eggshell Membrane [4].

Human Life Stage		Calcium RI (mg) Infants and Children	Percentage of RI (%)
0–6 Months		300	126
7–12 Months		450	84
1–3 Years		500	76
4–6 Years		550	69
7–9 Years		700	54
10–18 Years		1,000	38
Adult-Females			
19 Years-Menopause		750	50
Post Menopause		800	47
Pregnant (Last Trimester)		800	47

Eggshell constitutes around 10% of a hen's egg by weight (Laca et al., 2017). Vast amounts of chicken eggs are produced annually, with a significant proportion (30%) processed in food industries, lead to a massive accretion of eggshell waste (Ahmed et al., 2019). Almost all of it is treated as waste and is directly disposed of in landfills with minimal or no pre-treatment [5].

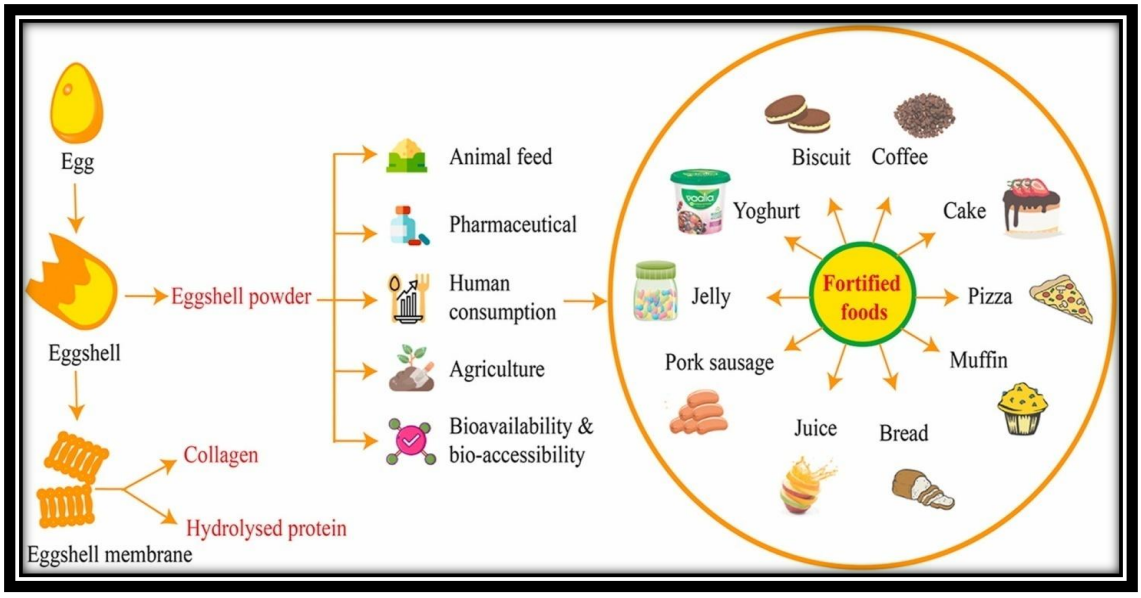

Figure: 1. Percentage of the Recommended Calcium Intake [5].

As many method or techniques used in calcium extraction from egg shell. Like:

1-Electric discharge-assisted mechanical milling

2-pulsed electric field

3-thermal analysis; egg shells; calcium carbonate, X-ray powder diffraction

2. Application / Use of Egg Shell

So, we saw that calcium carbonate is found in egg shell and it is widely used in most sectors for example- Pharmaceutical sector, dental preparation, source of mineral salts, calcium supplements, making lime water, plaster, agriculture, medical device and preparation and textile, as a cosmetic, absorbing radiation.

The shell is the outermost hard layer of the chicken egg that can be found in a white or brown color [6]. **Figure 2** shows eggshell biomass waste color as white (**Figure** 2a) and brown (**Figure** 2b). According to the reviewed literature, the amount of calcium

carbonate in the white and brown eggshells are considered equivalent [6,7]. Eggshells are used in different industries, which are divided into two main groups. The first one is feed manufacturers who use eggshells to prepare feed for chickens, pigs, pets, etc., since they have a rich source of calcium carbonate. The second industry is manufacturers who apply eggshells in non-food applications, such as the production of fertilizers, cement production, etc. [8,9].

Figure: 2. Eggshell biomass waste with variable shell color: (a) White and (b) Brown.

Market for Egg Shell Waste

The egg shell of chicken consists of CaCO3 in the form of calcite i.e. 95% and organic material i.e. 3.5% [10]. Egg shell has brought new revolution for the replacement of previous product in the market like limestone, pure CaCO3, soil conditioners, biomaterials, additives, excipient supplements, catalyst and waste water purifiers [11]. In past decade more than approx 60% calcium carbonate or lime stone was used in manufacturing of the steel, and the other else was used in building and construction, water purifier, domestic use, paper, plastic and paint ((Cree and Rutter, 2015; Limestone, 2019; Lewicka et al., 2020) [12]. Alginate wound dressing can appear in the form of a hydrogel, fiber, nonwoven fabric, freeze-dried scaffold and foam, all of which are prepared by Ca–Na ionic cross-linking interaction. Calcium alginate fiber or the corresponding nonwoven fabric employed as a kind of typical wound dressing, can absorb the wound exudates and then formed gel to keep the wound wet. That provided a safe, sealed and physiological microenvironment, and minimized the bacterial infection possibility around the wound. Furthermore, the hypoxia microenvironment stimulates angiogenesis and facilitates cells to secret the growth factor, which promotes the new granulation tissue formation and accelerated wound healing [13]. Calcium oxide (CaO) which is known as lime and originated from calcinations of egg shell waste. It is used as neutralizing agent in agriculture, petrochemical, pesticide, cosmetics, tanning industries and as a plastics glass and paper (EuLA (2020)] [14].

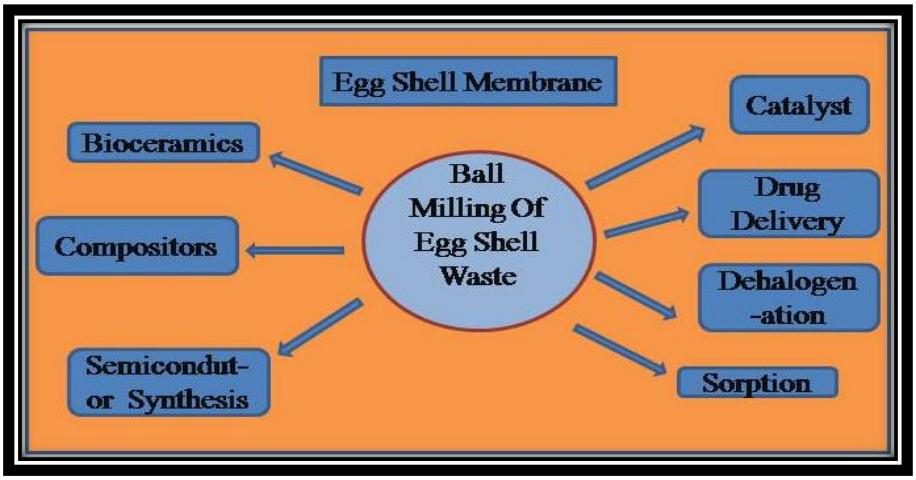

Figure: 3. Ball Milling of Eggshell Waste.

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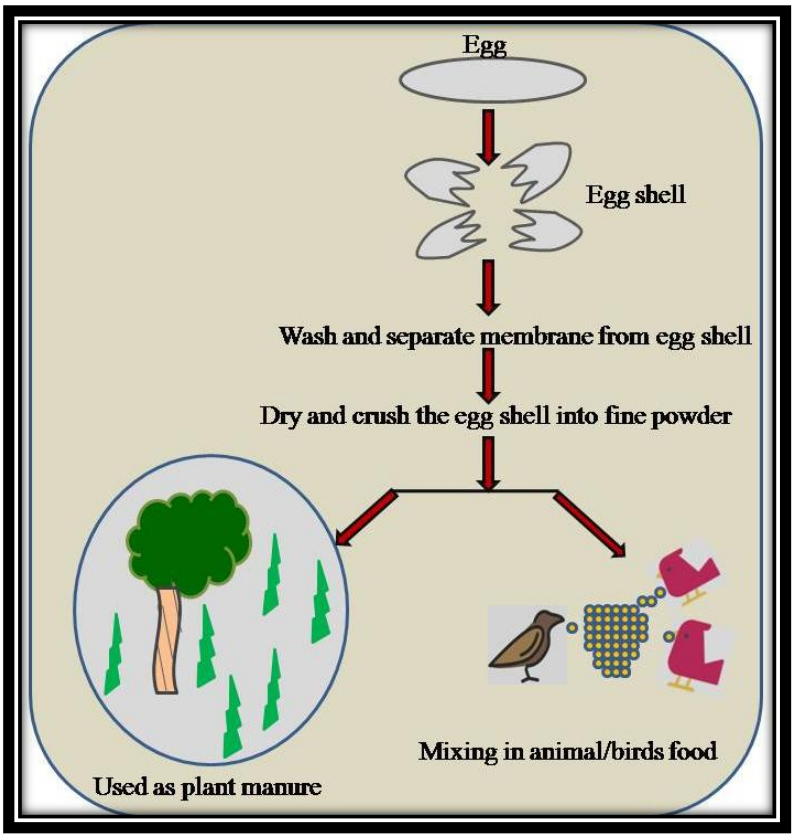

Figure: 4. Uses of Egg Shell as Plant Growth Hormone.

Figure: 5. Egg shell used as manure and pesticide.

Egg shell used as plant growth hormone and manure and also as a pesticide. As we know that egg shell is used as agriculture waste and largely measured as worthless and discarded because of pollution. The waste yields to hydroxyapatite a very useful compound which is found in bone and teeth. Hydroxyapatite is a superb material used in repairment of bone and cell regeneration.

Human Beings

Egg shell on making powdered is very good source of calcium for orally taken supplement it boosts bone density and treat age related bone problem. Egg shell also used as skin ulcers, the shell on combination with litchi, peanuts is treated with enzyme (5% amylase, 1% Protease and 2% pectase) egg shell shows excellent spreadibility and used as incremental filler.

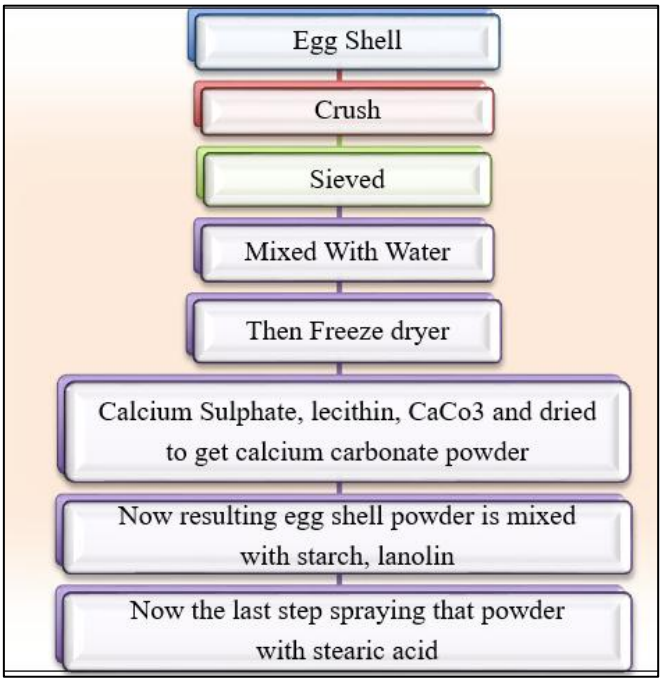

Figure: 6. Egg Shell Used as Antiulcer (Skin).

Animals

As we know that egg shell has very good source of calcium so this can also be used for animal feeding for full filling the calcium supplement in animal. Now, we will see the procedure. After washing and cleaning egg shell it will be dried at 72-76 degree Celsius. With the help of calcium on maintaining diet of hen to produce egg in large quantity and also it can maintain egg shell quality very high.

Production of Nanoparticle

CaCO3 contain about 95% of egg shell weight and used to produce calcium hydroxide Crushed egg Shell dissolve in HCL (10-14%) and then filtration and mixing with NaOH (10-15M). The ppt of calcium hydroxide is washed with distill water and dry at (100-149°C) to produce calcium hydroxide. Nanoparticles will have range of (0.01 to 0.1 µm) which has Calcium oxide. It will have a very good binding agent as Binder. On adding with copper sulfide using egg shell as templet. egg shell is pulverized and loaded with Cu and sulfide ion to generate copper sulfide nanoparticle that it will exhibit antimicrobial properties against Staphylococcus aureus and also with incorporation with copper and making complex copper nanoparticle it will result in strong antibacterial properties against (E. Coli and S. aureus).

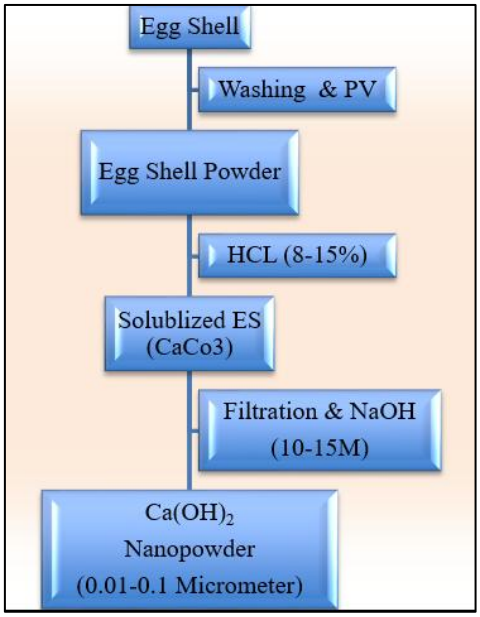

Figure: 7. Extraction of Nanoparticles from Egg shell.

CONCLUSION

Nutraceuticals, medicine, bioremediation, supporting chemical processes, and cosmetics are all potential applications for the ES membrane, a promising natural biomaterial. Although ES membranes have several advantages, their size, shape, and thickness cannot be changed, and their insoluble nature due to disulphide limitations in their molecular structure severely restricts the range of uses for ES membranes. However, a number of studies have proposed soluble ES membrane protein (SEP) as a substitute biomaterial. The dissolution of the ES membrane through reductive cleavage of disulphide bonds, which modifies the ES membrane's structure, thickness, and solubility, provides the basis for the production of SEP. SEP has been used extensively in tissue engineering in the biomedical sector. There is also a chance that ES membranes will be utilised in the pharmaceutical sector in the future due to the discovery of Ovocalyxin36 (OCX-36), a novel potential antibacterial protein linked to the membrane.

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