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# Value Added Food Products for Calcium and Vitamin D Deficit Population

**K. N. Sai Sreenivas[1] and Dr. D. B. Puranik[2]**

[1]Ph.D. Scholar, Dept. of Dairy Technology, Dairy Science College, Bangalore-560024.

[2]Professor and Head, Dept. of Dairy Technology, Dairy Science College, Bangalore-560024.

**Abstract:** In general, value addition refers to adding economic value to a product. Value-added food items are being developed to address calcium and vitamin D deficiencies. Blood coagulation, neuromuscular transmission, and muscle contraction all require calcium. Tetany, rickets, osteomalacia, and osteoporosis are some of the consequences associated with calcium deficiency. Vitamin D, on the other hand, is essential for cell growth, immunological function, and bone mineral density maintenance. Processed egg shell and sun dried mushroom have recently been added to the list of calcium and vitamin D sources, respectively. Eggshell is made composed of 94% calcium carbonate and has been shown in studies to help people with osteoporosis boost bone density and reduce discomfort. On other side since ergosterol is found in milligram amounts in mushrooms, converting a modest amount of ergosterol to vitamin D results in a nutritionally significant rise in vitamin D.

**Key words:** Value addition, calcium, vitamin D, egg shell, mushroom

## INTRODUCTION

Nutrition is the science that studies how nutrients and other elements in diet interact with an organism's maintenance, development, reproduction, health, and disease. Food intake, absorption, assimilation, biosynthesis, catabolism, and excretion are all included. Nutrition The World Health Organization (WHO) defines nutrition as "the intake of food in proportion to the body's nutritional demands." An appropriate, well-balanced diet, combined with frequent physical activity, is the cornerstone of good health. Reduced immunity, as well as poorer physical and mental development, are all consequences of poor diet. Undernutrition and micronutrient deficiencies are thought to be the cause of 3.1 million child deaths per year, according to the WHO. According to the FSSAI, around 70% of Indians are deficient in micronutrients. This necessitates value addition, which is defined as adding economic worth to a product. By the year 2025, value addition to food items is predicted to reach 35% [6].

### Calcium (Ca)

The most abundant element in the human body is calcium. As electrolytes, calcium ions play a critical function in the physiology and biochemistry of humans and cells. They are involved in signal transduction pathways, where they operate as a second messenger, neurotransmitter release from neurons, all muscle cell contractions, and fertilisation. Calcium ions are required as a cofactor by several enzymes. Calcium ions from outside the cell are also necessary for maintaining the potential difference across excitable cell membranes and for appropriate bone production [Norman and Alan, 1997]. Approximately 98 percent of the 1200 g of calcium in an adult's skeleton is in the form of hydroxyapatite. Hydroxyapatite is a calcium, phosphorus, and hydroxide crystal with a lattice-like structure. The extracellular fluid (50%) and various tissues, particularly skeletal muscle, contain the remaining calcium. Calcium concentrations are kept between 8.5 and 10.5 mg/dl (4.3 to 5.3 mEq/L or 2.2 to 2.7 mmol/L) [4].

### Recommended Dietary Allowance (RDA) for calcium – India

Calcium requirement proposed as RDA for adult man and adult woman is 1000 mg/d and is 1.5 times the value proposed by earlier expert group i.e., 600 mg/d for adult man and woman. For pregnant women, the calcium values proposed is similar to the value proposed for adult woman i.e., 1000 mg/d. For lactating woman, an additional allowance of 200 mg is added to EAR of 800 mg and a total of 1000 mg has been set as EAR and adding 10% CV, the RDA is set at 1200 mg. For post-menopausal women the recommendation is 1200 mg/d [10].

### Complications associated with calcium deficiency

- Metabolic bone disease
- Rickets in childhood
- Inadequate bone mass accrual in childhood and adolescence
- Inadequate foetal bone mass accrual/other metabolic effects and programming
- Osteoporosis - postmenopausal and senile

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The parathyroid reaction to vitamin D deficiency is amplified even more by a low dietary calcium intake. Secondary hyperparathyroidism (SHPT) occurs as a result of the mobilisation of mineral and matrix from the skeleton, resulting in increased bone loss, a high risk of fracture, and low peak bone mass in children [Harinarayan *et al.*, 2008]. The action of calcitriol and the intestinal vitamin D receptor (VDR) is required for active calcium transport [Ross *et al.*, 2011]. Because of the high demand for calcium, normal serum vitamin D levels govern absorption of 30 percent of dietary calcium and more than 60-80 percent during growth periods. This is why vitamin D deficiency in childhood can lead to delayed growth and bone deformities, raising the risk of fractures later in life [Bueno and Czepielewski, 2008]. There have been reports of osteomalacia, low dietary calcium, and 25(OH)D status in postmenopausal women, children, and pregnant women and their offspring in the Indian subcontinent (<300 mg/day) [7].

**Osteoporosis and its prevalence**

WHO's definition of osteoporosis is, "A systematic skeletal illness defined by reduced bone mass and micro architectural degeneration of bone tissue - leading to bone fragility and fracture susceptibility". One in every three women and one in every five men over the age of 50 is predicted to suffer from osteoporotic fractures, and in India, 100 million people over the age of 50 are either osteoporotic or have poor bone mass.

**Eggshell – a dietary calcium source**

Egg products that employ egg generate tons of eggshells as a waste product in various nations across the world. Because of its insufficient utilization and disposal, eggshell waste is a severe environmental issue. The eggshell makes about 9-12 percent of the overall weight of the egg. It's mostly calcium carbonate, with a little magnesium carbonate and calcium phosphate. Eggshell has a chemical makeup of 2% water and 98 percent dry substance. 5 percent crude protein and 93 percent ash make up the dry matter. Mineral content averages in different sections of the egg and egg shell. Eggshells have calcium and trace amounts of other micro elements, i.e. magnesium, boron, copper, iron, manganese, molybdenum, sulphur, silicon and zinc [8]. Previous research suggests that using chicken eggshell powder to enhance bone density and relieve pain in osteoporosis patients may be beneficial. Eggshell calcium is the best natural source of calcium, with a bioavailability of roughly 39% [16].

**Egg shell powder (ESP) - Method of preparation**

Eggshells are gently washed with water, first with tap water and then with potable water, and thoroughly cleaned with a soft brush. The eggshells are then cooked for 5-10 minutes in 100°C water and dried in the open air overnight. Dried eggshells are roasted for 10 minutes at 180°F in the oven. They are brought to room temperature before being ground into powder [19].

**Case studies with egg shell powder**

| Author and Year | Results |
|---|---|
| [18] | Ca from ESP was absorbed (~39%) as good as that from purified $CaCO_3$ (~40%) in piglets |
| [8] | Rats fed with Nano-Powdered Egg Shell (NPES) and powdered eggshell exhibited 6.6 and 2.2% greater bone mineral densities |
| [12] | Percentage and rate of Ca absorption was greater in eggshell (~37%) than in milk (~30%) |
| [19] | ▪ Eggshells boiled for a total of 30 min pose no risk to human consumption<br>▪ *Bacillus cereus* would be a risk but suggested less chance of it contaminating eggshell |

**Supplemental sources of calcium in comparison to egg shell powder**

| Calcium Salts | Elemental Ca (mg/g) | Bio-Availability (≈%) | Pros & Cons |
|---|---|---|---|
| Calcium Citrate | 211 | 37 | Most expensive; doesn't contain much elemental calcium; taken with or without food; easily absorbable |
| Calcium Chloride | 273 | 32 | |
| Calcium Acetate | 253 | 29 | |

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| | | | |
|---|---|---|---|
| Calcium Carbonate | 400 | 39 | Taken with meals or glass of acidic (orange) juice; may cause gas |
| Calcium Phosphate | 390 | 40 | Expensive than calcium carbonate; taken with food |
| Egg shell powder | 380 | 39 | Low price; easy absorption |

**Intestinal calcium absorption and vitamin D**

Vitamin D's main role in calcium homeostasis is to improve calcium absorption from the gut. Calcium is absorbed through tight junctions by both an active transcellular mechanism that requires energy and a passive paracellular pathway that does not. The hormonally active form of vitamin D, 1,25Dihydroxyvitamin D3 (1,25(OH)2D3), is the major stimulator of active intestinal calcium absorption, which involves calcium influx, translocation of calcium through the interior of the enterocyte, and basolateral extrusion of calcium by the intestinal plasma membrane pump, through its genomic actions. There's also mounting evidence that 1,25(OH)2D3 can improve calcium transport in the paracellular space [3].

**Vitamin D (Calciferol)**

Calcitriol, or bioactive vitamin D, is a steroid hormone that has long been recognised for its involvement in regulating calcium and phosphorus levels in the body, as well as bone mineralization. Vitamin D receptors have recently been discovered in a wide range of cells, indicating that this hormone has biologic effects that go far beyond mineral metabolism control. Unfortunately, the word vitamin D refers to one or more members of a group of steroid compounds and is therefore imprecise. When light energy is absorbed by a precursor molecule called 7-dehydrocholesterol, vitamin D3, also known as cholecalciferol, is produced in the skin of mammals. As a result, vitamin D is not a genuine vitamin because people who get enough sunlight do not need to take supplements. Vitamin D can also be found in foods such as egg yolk, fish oil, and a variety of plants. Vitamin D2 (ergosterol) is the plant version of vitamin D. Natural diets, on the other hand, rarely contain sufficient amounts of vitamin D, thus exposure to sunlight or the ingestion of vitamin D-fortified foods is required to avoid deficiency.

**Complications with vitamin D deficiency**

- Rickets in children
- Osteomalacia in adults
- Muscle cramps and joint pains
- Fatigue
- Renal osteodystrophy
- Disorders of cell metabolism

**Recommended Dietary Allowance (RDA) for vitamin D**

The Committee after considering the available evidence of vitamin D status decided to increase recommended intakes for vitamin D compared to earlier revision of 2010. Accordingly, an EAR of 400 IU and an RDA of 600 IU is recommended while emphasizing the importance of outdoor physical activity as a means of achieving adequatę vitamin D status in a tropical country like India. The increased requirement is attributed to progressive decrease in sunlight exposure necessitating dietary sources to meet the requirement [10]

**Vitamin D metabolism**

Most vertebrates can manufacture sufficient levels of vitamin D if their skin is exposed to enough sunlight (UVB rays). Most vertebrates require a sufficient amount of vitamin D, which can be either from their diet or via adequate skin exposure to sunlight. When the skin is exposed to sunshine, vitamin D3 is created. By exposing the skin to ultraviolet light, vitamin D3 is produced from 7-dehydrocholesterol. Vitamin D3 can also be found in animal foods such as fatty fish (such as salmon, mackerel, and tuna), cod liver oil, milk, and other dairy products. Veggie sources of vitamin D2 include sun-exposed yeast and mushrooms. Notably, the majority of food sources are deficient in vitamin D content.

Vitamin D (in both D3 and D2) is a prohormone that undergoes two hydroxylations before reaching its physiologically active form, 1,25(OH)2D. The initial hydroxylation occurs at position C25 in the liver, resulting in 25-hydroxyvitamin D, also known as 25(OH)D or calcidiol. The most common form of vitamin D in circulation is 25(OH)D. The second hydroxylation takes place at position C1 and results in the formation of 1,25(OH)2D, also known as calcitriol. The kidneys generate 1,25(OH)2D predominantly, but not solely. 1,25(OH)2D is released into the bloodstream, where it binds to vitamin D binding protein (DBP) and travels to its target tissues via the vitamin D receptor to perform its endocrine functions (VDR). For paracrine and autocrine activities, 1,25(OH)2D is generated in various extrarenal tissues. VDR is

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found in nearly every cell in the body. Many different cell types can generate 1,25(OH)2D. 1,25(OH)2D has the ability to regulate a large number of genes that are involved in cell growth and differentiation [14].

**Sun dried mushroom – rich source of vitamin D**

Mushrooms are a high-nutrition food that are high in protein, have a high content of amino acids (e.g. leucine), fibre, and are low in fat but high in essential fatty acids (e.g. linoleic acid, palmitic acid, oleic ,stearic acid, arachidonic acid). Furthermore, edible mushrooms are high in vitamins (B1, B2, B12, C, D, and E). Agaricus bisporus spp. are the most widely farmed mushrooms in the planet. Antioxidant, anticancer, anti-diabetic, anti-allergic, immune-modulating, cardiovascular protector, anti-cholestrolemic, antiviral, antibacterial, anti-parasitic, anti-fungal, detoxification, and hepato-protective effects are some of the most important medicinal properties of mushrooms; they also protect against tumour development and inflammation [1].

In mushrooms, ergosterol is found in milligramme amounts, but microgram amounts of vitamin D2 (1 g=40 IU) have biological activity, therefore converting a little amount of ergosterol to vitamin D2 results in a nutritionally significant rise in vitamin D [13]. Vitamin D2 levels increased similarly in sliced white button mushrooms exposed to commercial scale UV therapy or 2.5 hours of sunlight, rising from 1.6 IU (0.4 g) per 100 g in untreated mushrooms to 1200 IU (30 g) per 100 g for both ways of exposure, according to a study [20]. Under UV light, the B ring of ergosterol is photochemically cleaved, and the intermediate (pre-vitamin D2) is generated, which is subsequently thermally rearranged to become vitamin D2 (ergo-calciferol) [9].

**Value added food products incorporating egg shell powder/sun dried mushroom powder**

| Author and Year | Product | Rate of addition | Results from the study |
|---|---|---|---|
| [17] | Dibis Probiotic Yoghurt | 0.5, 0.6, 0.9 and 1.1% | Egg shell powder up to 0.9% could be used as calcium fortifier |
| [8] | Biscuits | 3, 6 and 9% | ▪ Increased calcium contents 407.33, 778.11 and 1175.23mg/100g<br>▪ Ca bioavailability of 26.0, 35.4 and 41.43%<br>▪ ESP at 6% did not alter sensorial properties |
| [21] | Cake | 3, 6 and 9% | ESP up to 6% is suitable for calcium enrichment |
| [22] | Bread | 2.5, 5.0, 7.5, 10.0, 12.5% | ▪ Bread with 5.0% egg shell powder was marked best quality<br>▪ Increasing amount of eggshells increases bread porosity |
| [5] | Yoghurt | 0.1, 0.3 and 0.5% | Nano-ESP up to 0.3% has acceptable composition and quality |

**Benefits of egg shell and sun dried mushroom**

- Economical
- More effective in increasing bone mass
- Mushrooms also provide other health benefits
- Most suitable and reliable
- Waste utilization – avoid environmental problem

## CONCLUSION

Micronutrient deficiencies are known as "hidden hunger" because their effects go unrecognised for a long time. Calcium and vitamin D play an important role in bone metabolism and other bodily functions. Calcium in large doses should be given to the human body, particularly at a young age, in order to produce adequate peak bone density and avoid the danger of bone deformities later in life. It is necessary to use an interdisciplinary approach that involves nutritional intervention and adopting a healthy lifestyle. To preserve bone health, a dose of 800 mg calcium and 400 IU vitamin D should be considered. In this context, egg shell and sun dried mushroom are ideal and cost-effective calcium and vitamin D sources, with the requirement for adequate communication mechanisms to encourage their absorption. As previously said, food processing and value addition have enormous potential, particularly in specialist sectors such as organic and fortified foods.

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## REFERENCES

1. BODH, P., SHARMA, M. AND KAUR, L. 2016. Development of vitamin D rich product prepared from mushroom powder. *World J. Pharm. Life Sci.* 2: 253-260.
2. BUENO, A.L. AND CZEPIELEWSKI, M.A. 2008. The importance for growth of dietary intake of calcium and vitamin D. *J Pediatr* 84: 386-394.
3. CHRISTAKOS, S., DHAWAN, P., PORTA, A., MADY, L.J. AND SETH, T. 2011. Vitamin D and Intestinal Calcium Absorption. *Mol. Cell Endocrinol.* 347(1-2): 25–29.
4. GOLDSTEIN, D.A. 1990. Serum Calcium, Chapter 143, Clinical Methods: The History, Physical, and Laboratory Examinations, 3rd edition, Boston: Butterworths.
5. EL-SHIBINY, S., EL-KADER, A. AND MOHAMED, ABD. 2018. Use of nano-sized eggshell powder for calcium fortification of cow's and buffalo's milk yogurts. *Acta Sci. Pol. Technol. Aliment.* 17(1): 37–49
6. GONMEI, Z. and TOTEJA, G.S., 2018. Micronutrient status of Indian population. *The Indian J. Med. Res.* 148(5): 511.
7. HARINARAYAN, C.V., RAMALAKSHMI, T., PRASAD, U.V. AND SUDHAKAR, D. 2008. Vitamin D status in Andhra Pradesh: A population based study. *Indian J. Med. Res.* 127: 211-218.
8. HASSAN, N.M.M. 2015. Chicken Eggshell Powder as Dietary Calcium Source in Biscuits. *World J. Dairy and Food Sci.* 10: 199-206.
9. JANAKAKUMARA, J.V. 2005. Conversion of ergosterol in edible mushrooms to vitamin D2 by UV irradiation. National University of Singapore.
10. NIN. 2020. https://www.nin.res.in/RDA_short_Report_2020.html. Accessed on 21-07-2021.
11. NORMAN, G.N. AND ALAN, E. 1997. Chemistry of the Elements, 2nd ed. Butterworth-Heinemann.
12. OGUIDO, A.K., R.C. DE ANGELIS AND I.F.U. YADA. 1995. Kinetics of intestinal calcium absorption from milk and eggshell in the rats. *Semina: Ci. Agr., Londrina*. 16(1): 7-13.
13. PHILLIPS, K.M. AND RASOR, A.S. 2013. A Nutritionally Meaningful Increase in Vitamin D in Retail Mushrooms is Attainable by Exposure to Sunlight Prior to Consumption. *J. Nutr. Food Sci*.
14. RITU, G. AND AJAY, G. 2014. Vitamin D Deficiency in India: Prevalence, Causalities and Interventions. *J. nutri.* 6: 729-775.
15. ROSS, A.C., TAYLOR, C.L. AND YAKTINE, A.L. 2011. Overview of Calcium, Dietary Reference Intakes for Calcium and Vitamin D, Institute of Medicine (US) Committee to Review Dietary Reference Intakes for Vitamin D and Calcium: National Academies Press.
16. SAKAI, S., HIEN, V.T.T., TUYEN, L.D., DUC, H.A. AND MASUDA, Y. 2017. Effects of Eggshell Calcium Supplementation on Bone Mass in Postmenopausal Vietnamese Women. *J. Nutr. Sci. Vitaminol.* 63: 120-124.
17. SALMAN, H., ALI, A. AND MANSOUR, A. 2012. Utilization of egg-shell powder as a calcium fortifier in stirred dibis probiotic yoghurt. *J. of Agric. Sci*. 43: 11-18.
18. SCHAAFSMA, A. AND PAKAN, I. 1999. Effect of a chicken egg shell powder enriched dairy product on bone mineral density in persons with osteoporosis or osteopenia. *Nutr*. 15: 157.
19. SHARMA, L. AND SINGH, P. 2018. Development of value added products based on eggshell and sun-dried mushrooms for the vitamin D and calcium deficit population. *J. Nutr. Disorders Ther.* 8(2): 1-4
20. SIMON, R.R., PHILLIPS, K.M., HORST, R.L. AND MUNRO, I.C. 2011. Vitamin D mushrooms: comparison of the composition of button mushrooms (*Agaricus bisporus*) treated postharvest with UVB light or sunlight. *J Agric. Food Chem.* 59: 8724- 8732.
21. SUBHAJIT, R., BARMAN, A.K., ROY, P.K. and SINGH, B.K., 2017. Chicken eggshell powder as dietary calcium source in chocolate cakes. *The Pharma Innovat.* 6(9, Part A): 1.
22. VIJOLE, B., MONTRIMAITE, K. and MOSCENKOVA, E., 2017, April. Facilities of bread enrichment with calcium by using eggshell powder. In *11th Baltic Conference on Food Science and Technology" Food science and technology in a changing world*" *FOODBALT* 2017. Latvia: University of Agriculture, 91-95.

 