

Coral Calcium: A Superior Marine-Derived Calcium Supplement manufactured by West Bengal Chemical Industries Ltd., Kolkata, India, for Bone Health and beyond

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ABSTRACT

Calcium is an essential micronutrient, crucial for bone health and human metabolism. Deficiency in calcium can lead to conditions such as osteoporosis, rickets, epilepsy, and anemia. Although dietary intake of calcium through sources like dairy products, cereals, and tofu is common, the presence of phytic and oxalic acids in these foods can hinder calcium absorption. This often necessitates the use of calcium supplements, which are derived from various sources, including calcium carbonate ores, animal skeletons, marine shells, and crustaceans. Among these, marine-derived calcium supplements, particularly coral calcium, have gained popularity due to their high safety profile, biological activity, and natural composition, which closely resembles human bone. West Bengal Chemical Industries Ltd. (WBCIL), India, specializes in producing high-quality coral calcium supplements from naturally occurring coral sand deposits. These supplements, composed primarily of calcium carbonate along with magnesium and trace minerals, offer numerous health benefits, including enhanced bone health, blood pressure regulation, and protection against dental cavities and cognitive decline. WBCIL's rigorous manufacturing process ensures the removal of pollutants and heavy metals, guaranteeing a product that meets stringent safety standards.

I. BACKGROUND

Calcium is a crucial micronutrient, significantly impacting bone health and human metabolism.¹ Calcium deficiency is associated with conditions such as osteoporosis, rickets, epilepsy, and anemia. Calcium is absorbed into the circulation through dietary intake or calcium supplements, maintaining a dynamic balance between blood and bone calcium levels.¹ The primary dietary sources of calcium are dairy products, including milk and its derivatives such as

cheese and condensed milk.¹ Other sources include cereals and tofu.² However, dietary factors alone cannot influence calcium bioavailability.¹ Phytic acid present in cereals and oxalic acid in green leafy vegetables can reduce calcium absorption by forming insoluble compounds like calcium phytate and calcium oxalate.³ Studies have shown that adults relying solely on dietary sources for mineral and vitamin intake often consume insufficient calcium levels.¹ This deficiency tends to worsen with age, contributing to the prevalence of osteoporosis.⁴ Consequently, many individuals have turned to calcium supplements to meet their nutritional needs.¹

Calcium supplements are derived from various sources, including calcium carbonate ores, calcium-rich animal skeletons, marine shells, and crustaceans.⁵ However, natural calcium carbonate ores may contain harmful elements such as heavy metals, and animal-derived calcium carries the risk of prion transmission.^{6,7} In recent years, marine-derived calcium supplements have gained attention due to their abundant availability, high safety profile, and biological activity.^{8,9} Marine mineral supplements have shown potential in enhancing bone turnover, preventing injuries, and aiding in bone repair. Utilizing marine biological calcium represents a significant opportunity to improve the utilization of biological resources and address calcium deficiency effectively.¹ Coral calcium is derived from the exoskeletons of various marine organisms and serves as a natural source of marine calcium.¹ It contains approximately 24% calcium, 12% magnesium, and over 70 trace minerals. Recently, coral calcium has gained international popularity as a calcium supplement. It is commonly used to manage bone metabolism disorders, osteoporosis, and other bone-related diseases.^{10,11,12,19} Beyond its role in enhancing calcium homeostasis and bone health, marine biological calcium exhibits additional biological functions.¹ For instance, coral calcium has been

shown to regulate blood pressure and inhibit the metastasis of colon cancer.¹ Moreover, coral calcium hydroxide demonstrates antioxidant properties, which can decelerate the aging process in murine models and prevent hepatic steatosis.¹ However, direct consumption of coral calcium presents significant challenges due to the presence of pollutants, heavy metals, and biological contaminants in the raw material. Naturally occurring coral sand often contains harmful substances such as lead, mercury, and other heavy metals, which can pose serious health risks if ingested. Additionally, the raw coral material can harbor various biological contaminants, including bacteria and other microorganisms, that must be carefully removed to ensure the safety and purity of the final product. Therefore, a thorough purification process is essential to eliminate these hazards, making the coral calcium safe and suitable for human consumption.

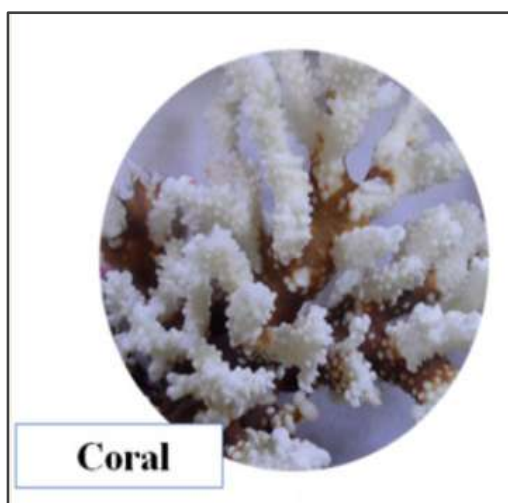


Figure: Coral Calcium¹

At West Bengal Chemical Industries Ltd., India, we specialize in producing high-quality coral calcium supplements derived from naturally occurring coral sand deposits. These deposits, once integral parts of thriving coral reefs, are responsibly collected from coastal lands or shallow waters. Our manufacturing process begins with the careful refinement of coral sand deposits to remove any pollutants or unwanted substances, ensuring purity and safety. The refined material is then meticulously ground into a fine powder. This powder forms the base of our coral calcium supplements, which are available either in powdered form or encapsulated for convenience. Our coral calcium supplements are

primarily composed of calcium carbonate, with the added benefit of small amounts of magnesium and other trace minerals. The natural composition of coral calcium closely resembles that of human bone, making it an ideal choice for various applications. For over 30 years, it has been trusted as a reliable bone graft material. Today, West Bengal Chemical Industries Ltd. focuses on using coral calcium to address and prevent low calcium levels, particularly for individuals who may not obtain sufficient calcium through their diet. Our commitment to quality and efficacy ensures that our supplements support optimal health and well-being.

Why to choose coral calcium over normal calcium carbonate supplements?

The main difference between calcium carbonate and coral calcium lies in their source and potential composition. Coral calcium is often marketed as a supplement due to its purported additional benefits, such as trace minerals and elements naturally found in coral reefs.² Proponents of coral calcium claim that it may offer health benefits beyond those of regular calcium carbonate supplements. Unlike other calcium supplements, coral calcium naturally contains magnesium. Some experts suggest that this combination is more beneficial to bone health than calcium alone.² Another study further suggests that coral calcium is easier to absorb than the type found in most calcium supplements.³ High calcium intake during pregnancy might reduce the risk of preeclampsia - one of the leading causes of maternal and infant illness and mortality. Preeclampsia is a serious complication marked by high blood pressure levels during pregnancy. Coral sand's natural magnesium and silica content might contribute to blood pressure control.¹³ Coral calcium might protect against dental cavities by remineralizing the enamel of your teeth.¹⁴ Coral calcium may help slow age-related loss of brain function.¹⁵

Comparison Between the Conversion of Coral Calcium and Rock Calcium to Calcium Phosphate

1. Composition and Origin:

- **Coral Calcium:** Derived from marine coral reefs, coral calcium is primarily composed of calcium carbonate (CaCO_3) with a natural presence of magnesium (Mg) and over 70 trace minerals. The aragonite structure of coral calcium is similar to that found in human bones. Its composition closely mirrors the

mineral matrix of bones, making it an ideal candidate for conversion to calcium phosphate ($\text{Ca}_3(\text{PO}_4)_2$), which is the primary inorganic component of bones.

- **Rock Calcium (Calcium Carbonate):** Sourced from limestone or other sedimentary rocks, rock calcium is also composed mainly of calcium carbonate (CaCO_3). However, it lacks the additional trace minerals and magnesium found in coral calcium. The structure is less porous and not as bio-similar to bone material.

2. Structural Differences:

- **Coral Calcium:** The porous nature of coral calcium, due to its original biological structure, facilitates better surface interaction when it is converted to calcium phosphate. The aragonite crystal form in coral calcium closely resembles the natural bone matrix, which allows for a more seamless conversion process, enhancing biocompatibility and integration when used in bone grafting and other medical applications.
- **Rock Calcium:** The calcite crystal form in rock calcium is denser and less porous compared to the aragonite form found in coral calcium. This structural difference results in less efficient conversion and integration into the bone matrix. The denser structure of rock calcium may require additional processing to achieve a suitable form for bone applications.

3. Conversion Efficiency to Calcium Phosphate:

- **Coral Calcium:** Due to its natural resemblance to bone composition and structure, coral calcium has a higher conversion efficiency to calcium phosphate. Studies suggest that the aragonite form of calcium carbonate found in coral is more readily converted into calcium phosphate under physiological conditions. This conversion is also facilitated by the natural presence of magnesium and other trace minerals in coral calcium, which can promote bone formation and strength.
- **Rock Calcium:** The conversion of rock calcium to calcium phosphate is generally less efficient due to its lack of structural similarity to bone and the absence of supportive trace minerals. Additional chemical processing, such as the use of high temperatures or acids, may be required to convert rock calcium into a form that can be more readily integrated into the bone as calcium phosphate. This process is less

natural and can sometimes lead to impurities or the need for additional purification steps.

4. Applications in Bone Health:

- **Coral Calcium:** Because of its high conversion efficiency and natural composition, coral calcium is widely used in bone grafts, bone cements, and as a dietary supplement for osteoporosis and bone metabolism disorders. Its similarity to the human bone matrix makes it highly effective in promoting bone regeneration and repair.
- **Rock Calcium:** Although rock calcium is commonly used as a calcium supplement, its use in bone applications is less prevalent compared to coral calcium. The need for more extensive processing to convert rock calcium into a bio-compatible form limits its use in direct bone applications. However, rock calcium is still valuable as a supplement for calcium intake when dietary sources are insufficient.

Challenges of Direct Use and Purification Process

Coral calcium cannot be taken directly due to several inherent challenges:

1. **Presence of Pollutants and Heavy Metals:** Naturally occurring coral sand may contain pollutants and heavy metals, making it unsafe for direct consumption.
2. **Biological Contaminants:** Raw coral material can harbor biological contaminants that must be removed to ensure the safety of the final product.

The purification process of coral calcium at WBCIL involves several rigorous steps to overcome these challenges and ensure the safety and quality of the product; these are proper sourcing, cleaning and drying, Grinding and Crushing, Purification, and Size Classification that are discussed later on. The purified coral calcium powder is categorized into pharmaceutical and nutraceutical grades, depending on its intended use. Pharmaceutical Grade undergoes stringent purification and quality control processes to ensure it meets the highest safety and efficacy standards. It can be used in medical applications, including bone graft materials and supplements for treating calcium deficiencies. Nutraceutical Grade is designed for dietary supplements, ensuring that it is safe for regular consumption and provides the necessary nutrients to support overall health.

Corals as a Target Taxon for Bioprospecting in WBCIL Research

At West Bengal Chemical Industries Ltd. (WBCIL), we focus on corals as a prime target for bioprospecting, given the vast potential of marine resources. With approximately 70% of the Earth's surface covered by water and containing 80% of all life, the ocean remains a rich source of therapeutic molecules. Our research specifically targets corals (Phylum: Cnidaria, Class: Anthozoa), which are categorized into hard, soft, or gorgonian types. Our primary interest lies in hard corals, known as Scleractinian corals, which are typically hermatypic and responsible for reef building. These corals and their derivatives have shown significant promise in addressing metabolic deficiencies. The naturally occurring calcium in the aragonite structure of Scleractinian hard corals has been demonstrated to protect against and reverse bone loss in mice with induced menopausal states. The growing interest in this application is driven by the limited supply of traditional treatments and the promising potential of this untapped resource.¹⁶ For over a decade, studies have explored the use of coral-derived calcium to assess its potential in enhancing bone strength and promoting bone formation. The interest stems from the porous nature of coral skeletons and their ability to convert calcium carbonate into calcium phosphate, the primary inorganic salt found in bones.¹⁷ However, the raw coral skeleton is impractical for therapeutic use due to its high dissolution rate. The true potential lies in refined coral, which has been chemically modified to enhance its durability and integrity. At WBCIL, we are at the forefront of this research, developing strengthened coral calcium products to improve their longevity and efficacy in medical applications.

Specialized manufacturing of coral calcium by West Bengal Chemical Industries Ltd., India

Coral calcium, a dietary supplement, is derived from biogenic limestone remnants of marine coral reefs, dislodged through natural processes such as hydrodynamic action. These calcareous deposits, composed primarily of calcium carbonate (CaCO_3),¹⁸ often contain magnesium (Mg) and trace elements. In adherence to legal environmental protections, WBCIL sources coral calcium by processing only non-living coral limestone deposits.

Sourcing: The initial phase involves the selective extraction of limestone from coral reefs, meticulously avoiding disruption to extant coral organisms. This ensures the harvested material originates from pristine, uncontaminated aquatic

environments, thereby minimizing exposure to heavy metals, environmental toxins, and allergens.

Cleaning and Drying: Subsequent to extraction, the coral undergoes decontamination via high-pressure water jets, followed by immersion in demineralized water (DM water) and subsequent filtration to eliminate particulate impurities.²⁰ The material is then thoroughly dried to facilitate subsequent mechanical processing.

Grinding and Crushing: The dried coral limestone is subjected to mechanical pulverization, resulting in a finely ground powder. This increases the material's surface area, optimizing it for further refinement and quality control procedures.²¹

Purification: The powdered coral undergoes pH-controlled purification processes designed to eliminate microbiological toxins.²² This step ensures the removal of any residual biological contaminants, maintaining the purity of the final product.

Size Classification: The coral powder is subjected to granulometric classification through sequential sieving, utilizing meshes with progressively finer apertures (60n US mesh size). The classified powder is then washed with mineral-enriched distilled water, facilitating the incorporation of essential minerals such as magnesium (Mg) and strontium (Sr) into the microporous structure of the calcium carbonate matrix.

Testing and Analysis

Heavy Metal Testing:

Comprehensive analytical assays are conducted to quantify the concentrations of heavy metal contaminants, specifically lead (Pb), mercury (Hg), arsenic (As), and cadmium (Cd). The results consistently fall within the stringent safety thresholds established by regulatory authorities:

- **Lead (Pb):** Quantified to ensure negligible toxicity.²³
- **Mercury (Hg):** Ensured to remain within non-toxic levels.
- **Arsenic (As):** Assessed to confirm compliance with safety standards.
- **Cadmium (Cd):** Strictly limited to safe exposure levels.

Mineral Content Analysis:

The final coral calcium product undergoes quantitative mineralogical analysis to ascertain its elemental composition. Particular emphasis is placed on the determination of calcium (Ca) and magnesium (Mg) concentrations using atomic absorption spectroscopy (AAS).

Microbiological Testing: Microbiological assays are performed to evaluate the product for bacteriological and mycological contamination. These tests ensure the minimal presence of microbial contaminants, affirming the product's safety for human consumption.

Packaging and Distribution: The processed coral calcium powder is aseptically packaged in containers that preserve its integrity and prevent contamination during storage and distribution, ensuring the product's sustained quality and efficacy.

II. CONCLUSION

In conclusion, West Bengal Chemical Industries Ltd. (WBCIL), India, stands out as a leading producer of high-quality coral calcium supplements, offering a superior alternative to conventional calcium carbonate supplements. Our meticulous extraction and manufacturing processes ensure that our products are safe, pure, and highly effective. Derived from naturally occurring coral sand deposits, our coral calcium supplements are rich in essential minerals, including calcium, magnesium, and over 70 trace minerals, closely mimicking the composition of human bone. This makes our supplements an ideal choice for enhancing bone health, preventing osteoporosis, and addressing calcium deficiencies, especially in populations at risk. WBCIL's commitment to quality and safety is demonstrated through rigorous testing for heavy metals, ensuring our products consistently meet regulatory standards. Additionally, our microbiological testing guarantees minimal contamination, making our supplements safe for human consumption. The inclusion of natural magnesium in coral calcium offers added benefits, such as improved bone health, blood pressure regulation, and potential protection against dental cavities and cognitive decline. Furthermore, our focus on utilizing marine biological calcium not only leverages an abundant and renewable resource but also aligns with sustainable practices, as we responsibly collect coral sand without disturbing living coral reefs. Our innovative approach to refining and enhancing the durability of coral calcium for medical applications underscores our dedication to advancing healthcare solutions. By choosing WBCIL's coral calcium supplements, consumers are assured of a product that supports optimal health and well-being, backed by decades of research and a steadfast commitment to excellence.

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