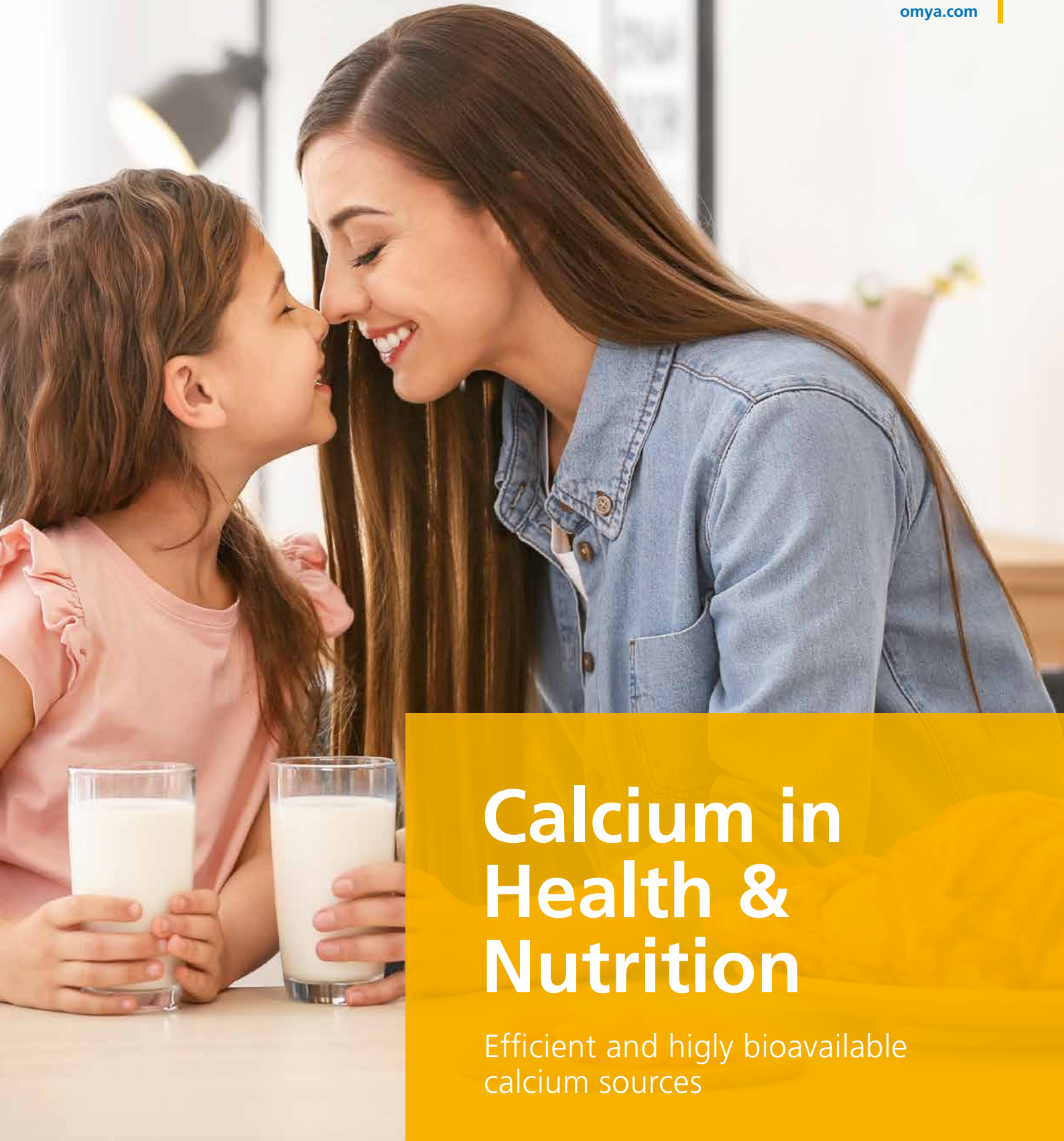




Calcium in Health & Nutrition

Efficient and highly bioavailable
calcium sources



THINKING OF TOMORROW

Natural Calcium Carbonate (NCC)

When life appeared on earth, some living organisms such as corals and bivalves developed the ability to synthesize Calcium Carbonate, which was primarily utilized in the organism to create the shell and skeleton.

When the sea creatures died, their skeletons and shells settled down onto the ocean floors. Following a geographical phenomenon called diagenesis and

lithification, carbonated sedimentary rocks were produced from this Calcium Carbonate rich deposit.

Chalk and limestone are such sedimentary rocks. Marble has to undergo an additional process called metamorphosis, one that causes recrystallization through high pressure and high temperature.



Omya is familiar with the needs of various applications and tailors the NCCs to meet requirements. This is why our portfolio comprises chalk, limestone and marble-based products of different particle sizes for the consumer goods industry.

Omya offers white Natural Calcium Carbonate (NCC) of the highest purity for your food, pharmaceutical, nutraceutical, home and personal care applications.

Benefits of NCC

- *Carbon footprint is a third than that of a Precipitated Calcium Carbonate (PCC)*
- *Products meet international standards such as E170, FCC, USP, EP, JP*
- *Halal and Kosher certified*



Calcium in a Health Journey

Calcium is the most abundant mineral in the body. It is not only essential for healthy bones and teeth but also required for vascular contraction and vasodilation, muscle function, nerve transmission, intracellular signaling and hormonal secretion, although less than 1% of total body calcium is needed to support these critical metabolic functions.

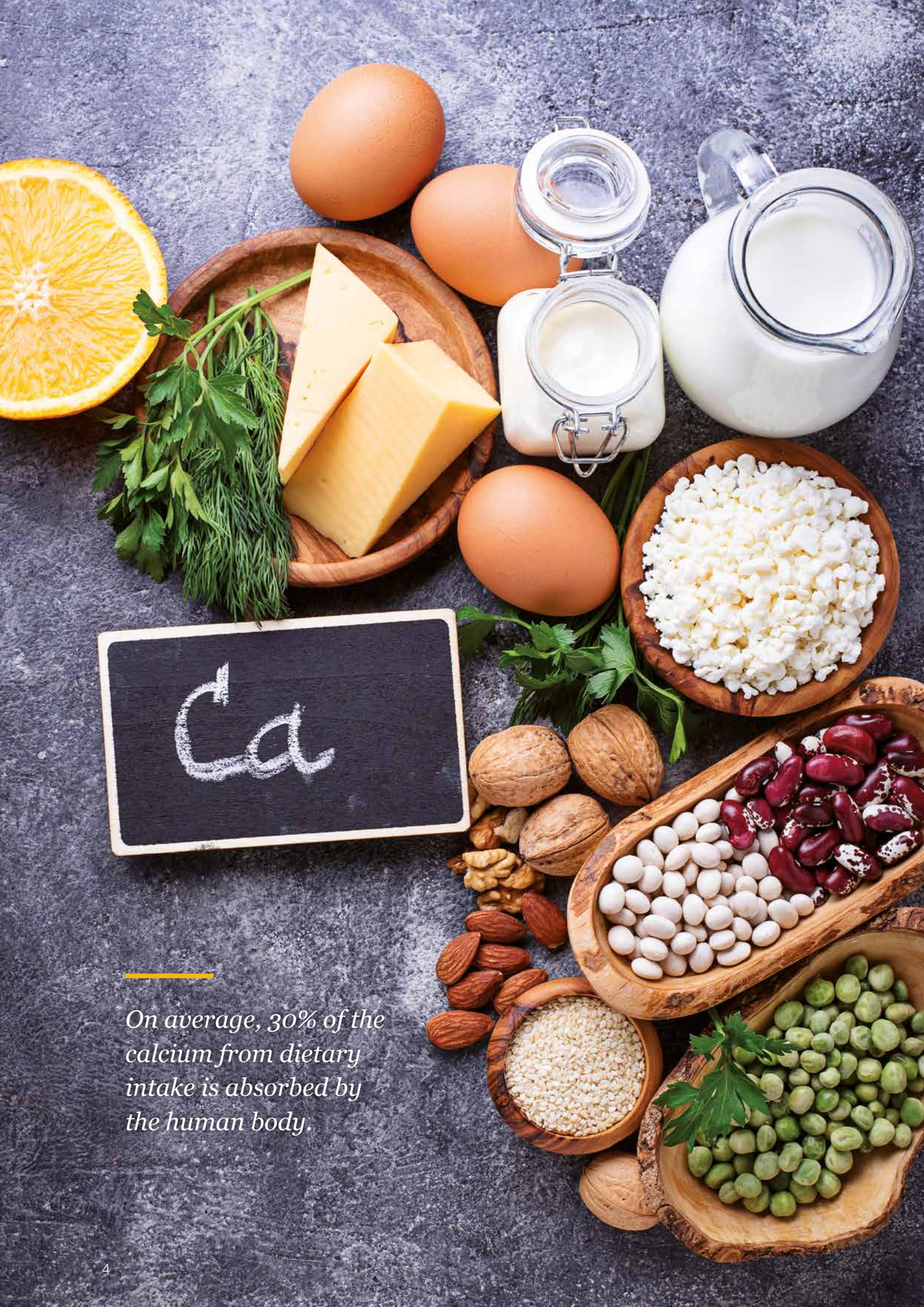
While 99% of calcium is concentrated in the bones and teeth, small amounts circulate in the blood stream. Adequate, lifelong dietary calcium intake is essential. Insufficient calcium supply can lead to lower bone density, causing osteoporosis, a disease whereby the bones become brittle and porous and more prone to breakage.

As a consequence, calcium fortified foods and supplements became mainstream because they allow consumers to achieve recommended daily intake levels of essential calcium easily without impacting individual eating and drinking habits.

Recommendations

The RDA (Recommended Daily Allowance) in the European Union is 800mg calcium per day, independent of gender or age.

The RDI (Dietary Reference Intake) in the US varies by gender and age: 1000mg/day for adults between the ages of 19-50 and even higher for adolescents and postmenopausal women.



On average, 30% of the calcium from dietary intake is absorbed by the human body.

Absorption & Bioavailability

Omya Natural Calcium Carbonate is among the best bio-available elemental calcium sources. With 40% of available elemental calcium, it only takes one-quarter gram of Omya Natural Calcium Carbonate to provide 100mg of elemental calcium: that equates to 10% of an adult's daily requirement.

A variety of foods, including dairy products, contain naturally occurring calcium. However, the absorption of calcium is influenced by some factors, such as other nutrients contained in the food. The calcium absorption can be either enhanced or inhibited by certain ingredients. Well known enhancers are, for example, non-digestible oligosaccharides and Vitamin D3.

Examples of calcium absorption inhibitors may be phytic acid and, to a greater degree, oxalic acid, which forms the very insoluble salt calcium oxalate.

In addition, the overall calcium level of an individual influences the calcium absorption, meaning that calcium is absorbed until a certain threshold is reached, after which no further calcium absorption occurs and the additional calcium is excreted. On average, 30% of the calcium from dietary intake is absorbed by the human body.

Water Solubility and Bioavailability

No significant relationship between water solubility and calcium absorption from various salts has been found in studies.*

Calcium Carbonate is insoluble in water, but soluble in the acidic environment of the stomach.

Calcium Carbonate reacts with the hydrochloric acid in the stomach, releasing Ca^{2+} ions which are absorbed in the small intestine.

With 40% of available elemental calcium, it only takes 1/4 gram of Omya Natural Calcium Carbonate to provide 100 mg of elemental calcium.

*Please refer to studies on next pages.

Summaries of different bioavailability studies

Bioavailability and Solubility of different Calcium-Salts as a Basis for Calcium Enrichment of Beverages (2010)

Kressel G., Wolters M., Hahn A.; Institute of Food Science and Human Nutrition, Leibniz University of Hannover, Hannover, Germany. Food and Nutrition Sciences, 2010, 1, 53–58.

'The tested new salts (calcium lactate citrate & calcium citrate malate) were easily water soluble, significantly better than calcium gluconate. Calcium Carbonate is almost insoluble. The bioavailability of the four different salts (Calcium Carbonate, calcium gluconate, calcium citrate malate, calcium lactate citrate) was founded to be almost identical.' •

Calcium Bioavailability of Calcium Carbonate Fortified Soymilk is Equivalent to Cow's Milk in Young Women (2005)

Zhao, Y., Martin, BR., and Weaver, CM.; Purdue University, West Lafayette, IN. The Journal of Nutrition, 20 July 2005, 2379–2382.

'Ca bioavailability from Calcium Carbonate-fortified soymilk and TriCalcium Phosphate-fortified soymilk was compared with cow's milk in young healthy women (...).The results of the present study clearly showed that Calcium Carbonate-fortified soymilk has calcium bioavailability similar to that of cow's milk. Our results also confirmed findings of other studies that calcium in TriCalcium Phosphate-fortified soymilk is less absorbable than in cow's milk.' •

Absorbability and Cost Effectiveness in Calcium Supplementation (2001)

Heaney, RP., et al. Journal of the American College of Nutrition, Vol. 20, No. 3, (2001) 239–246.

'All three calcium sources (marketed Calcium Carbonate, encapsulated Calcium Carbonate and marketed calcium citrate) produced identical 24-hour time courses for the increment in total serum calcium. Thus, these were equally absorbed and had equivalent bioavailability.' •

Solubility and Absorbability of Calcium Salts

Weaver, Connie M., International Dairy Journal, 8 (1998), 443–449.

'When a variety of calcium salts (Calcium Carbonate, tricalcium phosphate, calcium citrate) with a range of 0.1-10mM in solubility in water at neutral pH were compared, no detectable difference in calcium absorption could be detected.' •

Bioavailability of Calcium in Breads Fortified with Different Calcium Sources

Ranhotra, G.S., et al., Cereal Chemistry, 1997; 74(4): 361–363.

'In breads fortified with five different calcium sources, calcium was equally well available from all sources, as judged based on calcium status of the femur in experimental animals and calcium absorption data. Calcium Carbonate, a commonly used calcium source in fortified

foods and in supplements, was one of the sources tested. This calcium salt can be viewed as a good source of bio-available calcium compared to more expensive sources.' •

Institute of Medicine of the U. S. National Academy of Science

Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride, Institute of Medicine, National Academy Press, Washington, D.C., 1997, p. 71.

'Bioavailability of calcium when measured from nonfood sources, or supplements, depends on the presence or absence of a meal and the size of the dose. Supplement solubility is not very important, but tablet disintegration (for example, breaking apart) is essential.'

'In studies that measured calcium absorption under similar test conditions, a 250mg elemental calcium load given with a standardized breakfast meal resulted in average fractional absorption rates of calcium from calcium citrate malate, Calcium Carbonate, and tricalcium phosphate of 35, 27 and 25%, respectively. ...Under the same conditions, absorption of calcium from milk was similar at 29%.' •

Calcium Carbonate Compared to Calcium Lactates and Oyster Shells

Tsugawa, N., et al., Biol Pharm Bull, 18 No. 5 (May, 1995), 677–682.

'We conclude that calcium is utilized to the same extent from Calcium Carbonate, DL-calcium lactate, L-calcium lactate and powdered oyster shell-calcium.' •

A Comparison of Several Calcium Supplements

Kohls, K.J. and C. Kies, Journal of Applied Nutrition, 44 No. ¾ (1992), 50–61.

'The additional calcium sources used were milk, oyster shell, dolomite, Calcium Carbonate, ... calcium gluconate and calcium lactate ... Pronounced differences in apparent absorption of calcium supplements for the intestinal tract were not demonstrated.' •

Overview of Calcium Content and Solubility of Different Calcium Salts

Calcium Source	Calcium Content [%]	Solubility [mM/l]*	Fractional Absorption	Bio-availability
Calcium Carbonate	40	0.14	0.296 ± 0.054	good
Tricalcium Phosphate	39	0.97	0.252 ± 0.130	average
Calcium Citrate	21	7.3	0.242 ± 0.049	average
Calcium Citrate Malate	30	80	0.363 ± 0.076	very good

*Solubility in water at neutral pH, expressed as millimoles/liter; Weaver, Connie M., International dairy Journal, 8 (1998), 443-449

There is little or no significant difference in the bioavailability of most of the calcium sources available.

Applications in Health and Nutrition

Besides providing calcium as nutrient, NCC can take over various technological functionalities in fortified foods.

Benefits

- *White pigment E170*
- *pH buffer*
- *Carrier*
- *Extrusion aid*
- *Reduction of acrylamids*
- *Anti-caking agent*
- *Gelling agent*
- *Dusting agent*
- *Bulking agent*

Regulatory

Various regulations are relevant if calcium is added as a nutrient to fortified food or in supplements. Regulations can differ depending on the region, target group (e.g. infants, adults) and final application.

Calcium Carbonate is an allowed source of calcium in fortified food items within the European Union. In the US, Calcium Carbonates are affirmed as GRAS (Generally Recognized as Safe).

Omya manufactures according to common product specifications across the world to maintain the high purity of the raw material:

- ✓ **FCC (Food Chemicals Codex)**
- ✓ **E170 within the European Union**
- ✓ **Pharmacopoeia (European, Japanese and U.S)**



Nutritional Claims

In the European Union, the following nutritional claims on calcium are possible: "high in calcium" and "source of calcium".

Making a claim of "high in calcium" for a fortified food item requires the product to contain 30% of the RDA (recommended daily allowance) per serving size, 100g or 100ml. The 30% RDA equivalent would therefore be 240mg of calcium, corresponding to 600mg of Calcium Carbonate.

The claim "source of calcium" requires the foodstuff to contain only 15% of the RDA. This is equivalent to 120mg of calcium or 300mg of Calcium Carbonate.

In the USA the RDI (recommended daily intake) is set at 1000mg for adults. The claim 'source of calcium' can be made when the food item contains 10% of the RDI per reference amount. A minimum of 20% of the RDI allows the claim 'excellent source of calcium' to be made.

Up to five times less Omya Calcium Carbonate is required to meet the same calcium content and nutritional claim than other available solutions on the market.



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