Dreamfields Pasta--
Beyond Calcium Fortification – Dietary Calcium and Enhanced Absorption with Inulin/FOS

Bryan Tungland

Summary

Long known to be part of several well know foods, such as dairy products, calcium has become a mineral of necessity, synonymous with achieving and maintaining healthy bones, teeth, skin and even weight control. Recent calcium-fortified products are a testament to this knowledge. Sadly though is the fact that even with this new understanding incidence of osteoporosis is increasing dramatically. Low calcium intake is partly at the cause, but this problem can also be as the result of ineffective utilization of the intake. Common elements known to have an effect on calcium utilization are such things as low stomach acid, the calcium source solubility, availability, and/or the lack of required dietary-derived metabolic co-factors, such as the vitamin D. Calcium has been widely known to be absorbed in the small intestine, but new evidence points to continued absorption in the large intestine if the environment is modified with performance enhancing inulin/FOS.

Driving forces

Calcium is a key mineral in the human body, making up 1.5%-2% of total body weight. It is the most abundant mineral in the body. Ninety-eight percent of this amount is in the bone, and 1% in the teeth. The remaining 1% is in blood and soft tissues and is essential for life and health. Without the 1% of circulating calcium, muscles would not contract effectively, blood would not clot and nerves would not carry messages to and from the brain. Calcium requirements vary throughout an individual's life and for different population groups. However, it is generally regarded that a significant proportion of the population in Western countries fails to achieve the recommended calcium intakes (table 1). Poor dietary habits are seen as being responsible for this situation, especially with fast food consumption dominating the daily menu.

Target group	Requirement*	Intake**
Children	800 mg	810 mg
Adolescents	1.300 mg	817 mg
Men	1.000 mg	910 mg
Women	1.000 mg	819 mg
Senior citizens	1.200 mg	857 mg

Table 1. Calcium requirements (National Academy of Science) vs. intake (*AFSSA 2000, ** INCA study 1999 and 2000).

Due to this poor calcium intake and its utilization, fighting osteoporosis and promoting calcium uptake is a hot topic. Osteoporosis a disease characterized by low bone mass and decreased bone density; i.e. increasing porosity of the bones caused by calcium impoverishment resulting in hip and related fractures. The key to preventing this debilitating disease is to build strong bones, especially by the age of 35.

In order to increase calcium uptake it is helpful to incorporate calcium into a food or beverage system, but it requires more than just that. Besides the amount of calcium in the diet, the absorption of dietary calcium is a critical factor in determining the availability of calcium for bone development and maintenance. This makes it very interesting to consider aspects that may positively influence calcium absorption in order to ensure that calcium bio-availability from foods can be optimized. Several studies strongly suggest that the addition of naturally occurring fermentable dietary fiber sources such as inulin or fructooligosaccharide (FOS) to food represents an opportunity for increasing the uptake of calcium.

> Inulin, anatural fructooligosaccharides (FOS) is a water-soluble, fermentable dietary fiber that is extracted from chicory root in pure form. Inulin is found in over 36,000 plants, and next to starch it is the most common storage carbohydrate in the plant kingdom. Inulin occurs naturally in many common foods such as in vegetables (onion, leek, garlic and chicory), in fruit (bananas) and cereal grains such as wheat, rye, and barley. Inulin has been shown to have positive effects on calcium absorption and bone density.

Mechanism behind calcium absorption

The pH of the stomach, signified by the hydrochloric acid levels, determines how well the various calcium sources will be absorbed. Research has shown that the more acidic the pH, the greater the absorption. Normally, only a small part (at the most 50% in adolescents) of dietary calcium is absorbed by the body, mainly in the small intestine, and deposited in the bones. Calcium is primarily absorbed via both an active transcellular calcitriol-dependent transport mechanism and a passive paracellular route. The active transcellular calcitriol-dependent route takes place mainly in the small intestine (duodenum and jejunum). Here vitamin D_3 actively stimulates the absorption of calcium into the blood stream. The paracellular route, which is concentrated in the early stages of the large intestine (ileum, cecum and ascending colon), contributes to a more passive absorption of calcium.

Research shows that on average only about 25-50% of dietary calcium is absorbed, much of that in the small intestine, and sometimes as little as 4%, especially if a person has an achlorhydria or hypochlorhydria condition, defined as no or low stomach acid. The other 50-75% of the calcium consumed is not available to the body and is wasted.

However, research in rats, and later in humans (1-22) has shown that the calcium uptake, regardless of source, can be further improved through an increase in the passive transcellular transport in the large intestine, facilitated by the short chain fatty acids, as produced from use of highly selective dietary fiber sources such as inulin and fructooligosaccharide (FOS). Increases in the short chain fatty acids, produced from inulin fermentation, reduce the gut pH and places calcium into its free ionic form—much like the effect stomach acid has on small intestine absorption. This ionic form of calcium helps increase the passive transcellular transport making the calcium more free to move across the gut lining into the blood stream. This interaction between calcium and inulin results in improved calcium bio-availability. And as a consequence the described mechanism contributes to effectively reducing the non-absorbed (wasted) calcium by as much as 20%, through the addition of inulin/FOS to a calcium-laden food. The overall result of the described mechanisms is visualized in figure 1 with a food product that combines calcium and inulin providing a 20% total increase in calcium uptake, as a result of the 40% utilization of the waste stream of calcium in the large intestine. As part of this on-going research, recent research published in the American Journal of Clinical Nutrition (1) also shows that inulin increases calcium absorption, but furthers shows that calcium retention or bone density in adolescents increases by 15 percent via supplementing the diet with 8 grams of inulin.

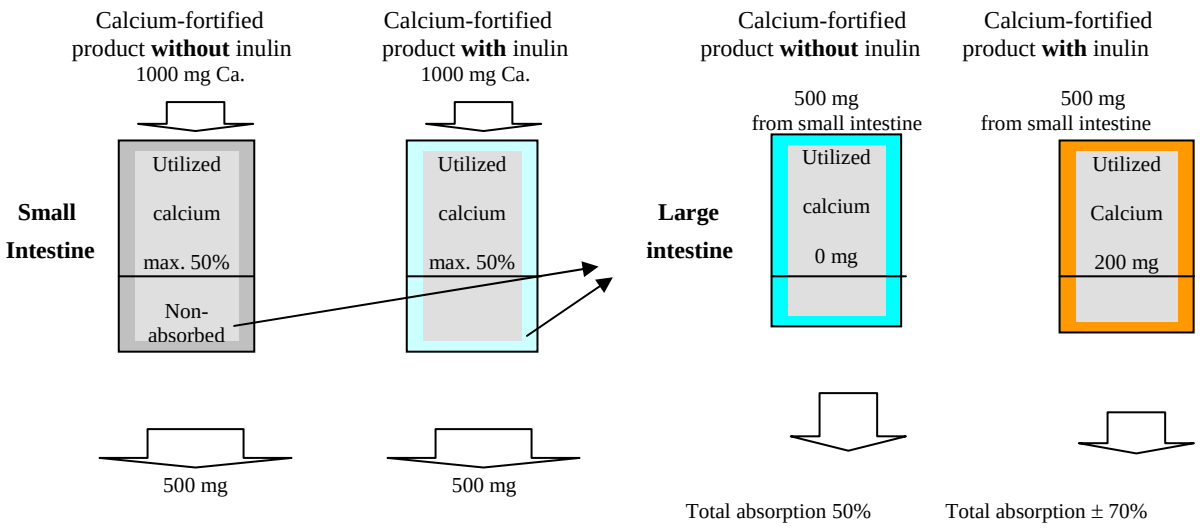

Figure 1. Calcium utilization in the intestine.

Strengthened product proposition

Few food technologists and marketers have grasped the opportunity to further strengthen their marketing proposition through the addition of the calcium-absorption stimulating ingredient inulin /fructooligosaccharide. Inulin and FOS's unique physiological properties allow for a targeted marketing positioning and communication. A food system that combines a bio-active calcium source with inulin offers a superior physiological performance in terms of the calcium effectiveness in the large intestinal transit. In product positioning and advertising this can be translated into appealing consumer-orientated claims such as 'Calcium Effective' or 'Smart Calcium' with an explanatory note on the packaging.

In the USA possible structure/function claims (S/F) and the associated amount of inulin to be used, whether incorporated in conventional foods or dietary supplements, should follow the advice of the FDA, as recommended by the National Academy of Sciences. Structure/function claims generally refer to the effect inulin has on the structure or function of the body. The claims, however, cannot suggest that the food is useful in the diagnosis, cure, treatment, prevention or mitigation of a disease or health related condition, which are health or drug claims. However, structure function claims may be used to describe non-disease states, (e.g. effects on aging, menopause, and bone care). Structure function claims are acceptable under DSHEA 21 CFR § 101.93 in the US, but are not approved, currently in Canada. They are generally allowed in varying degrees in European countries. Examples of calcium and inulin-related structure/function claims in the US for inulin are: "helps boost calcium absorption"*. *Studies have shown that 8 grams per day of inulin (a natural fiber) increases calcium absorption.

Conclusion

The ongoing success of calcium-fortified beverages speaks for itself. Consumers increasingly prefer food with added nutritional value rather than taking nutritional supplements to fill up their calcium needs. However, solely incorporating calcium into a food is not the answer to bone health. Besides the amount of calcium in the diet, the absorption of dietary calcium is a critical factor in determining the availability of calcium for bone development and maintenance. Several studies strongly suggest that the addition of inulin or fructooligosaccharides (FOS) to food represent an opportunity for increasing the uptake of calcium. Enhancing dietary calcium uptake helps create new opportunities for marketers and food technologists to develop superior product propositions with proven health benefits that go beyond food fortification. These benefits include enhancing real bone strength and ultimately contributing to fighting osteoporosis. Both the technological and physiological characteristics of inulin allow food technologists to develop good-tasting and nutritionally appealing consumer products with excellent sensoric properties.

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