Influence of Dietary Factors on Calcium Bioavailability

A Brief Review

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ABSTRACT

There are several factors that affect calcium bioavailability, such as physiological and dietary factors. These dietary factors help to achieve an appropriate status of calcium for a correct bone mineralization. In this pathway, recently some compounds present in milk that seem improve calcium absorption such as lactose and certain caseinophosphopeptides formed during digestion of caseins have been studied. On the other hand, the possible inhibitory effect of fiber has been also studied, without conclusive results between in vitro and in vivo studies and the role of phytic acid on impairs calcium bioavailability could be prevented by using fructo-oligosaccharides, which cannot be digested in the small intestine and arrive practically intact to the colon, where are fermented. Finally, calcium fortification must be executed by suitable compounds with high bioavailability, better technological properties, and a correct calcium : phosphorus ratio. For that reason, the objective of the present article is to review the influence of all these conditional factors on calcium bioavailability.

Index Entries: Calcium bioavailability; casein; caseinophosphopeptides; fructo-oligosaccharides; phytic acid/fiber; fortification.

INTRODUCTION

Because of its structural function as a provider of resistance and rigidity to bone mass and teeth, calcium is essential for optimal growth and development (1,2). Effective absorption occurs principally in the intestine,
at the level of the ileum, and involves two mechanisms: passive diffusion and active transport. In passive diffusion, calcium crosses the intestinal mucus by diffusion depending on the concentration gradient of the cation and is a nonsaturable process (3). Active transport is a saturable process that requires the presence of vitamin D, as well as transport proteins and the subsequent use of energy (4). However, calcium retention in the organism can also be conditioned by other factors in addition to mechanisms of absorption. These can be of two kinds: individual and physiological factors or extrinsic and dietary factors (5). The aim of this article is to analyze the main dietary factors that currently affect calcium bioavailability.

**Milk Proteins and Calcium Bioavailability**

Variations in calcium bioavailability of milk because of its protein composition have been demonstrated in several studies about the influence of casein and serum proteins and the effect of certain phosphopeptides formed during the digestion of casein.

**Distribution of Calcium in Relation to Casein and Serum Proteins**

In breast milk, calcium is fundamentally related to serum proteins and calcium complexes of low molecular weight, whereas in cow’s milk, this cation is principally associated with casein (6). The serum proteins : casein ratio also varies according to the type of milk: 60 : 40 for human milk and 20 : 80 for cow’s milk. In cow’s milk, casein forms large micelles and contains calcium phosphate in a colloidal state, whereas in breast milk, the casein forms small micelles (7). It is thought that the type of micelle formed affects the digestibility and precipitation of calcium in the gastrointestinal tract and, subsequently, its bioavailability (8).

It has been indicated that higher calcium bioavailability in cow’s milk versus human milk and fortified infant formulas probably is the result of higher calcium content in cow’s milk, and to this calcium is associated caseins as well. In this case, the size of cow’s milk micelle and phosphate in a colloidal state presented in these micelles barely influence on calcium bioavailability and it is more important than the effect of protein composition and, particularly, the cation–caseins relation. In this respect, when calcium dialyzed from several infant formulas was compared according to the principal protein composition (serum, casein, 50% serum–50% casein, hydrolyzed protein, and soy), a greater percentage was found in formulas where casein and hydrolyzed protein were the principal proteins (9), demonstrating the positive effect of caseins in the absorption of calcium. However, these formulas also contained the highest content of calcium, which may be another of the factors that most influences its bioavailability (10).