CAPOLAC®

— A milk mineral concentrate high in milk calcium
Bioavailability of calcium – comparing milk calcium with inorganic milk
Numerous studies have compared the bioavailability of calcium from milk and dairy products with that of inorganic calcium sources, and the evidence shows that the bioavailability of milk calcium is at least as good as that from other calcium sources.

In a rat model study comparing bioavailability of calcium from skim milk fortified with calcium carbonate or milk calcium measured as bone mineral density, bone calcium content, bone breaking strength showed no significant difference between groups in any of the measured parameters (1).

When healthy fasting subjects in a human study ingested a 500 mg dose of calcium from either of five calcium salts, calcium lactate, calcium acetate, calcium gluconate, calcium citrate, calcium carbonate, or from whole milk, no significant difference was found in absorption. The mean calcium absorption from the various sources was 32% (2). When comparing the calcium absorption from whole milk, chocolate milk, yoghurt, imitation milk, cheese and calcium carbonate, the mean absorption values were between 21 and 26% with none of the sources being significantly different from the others (3).

Comparison of the fractional calcium absorption from a calcium- and sulphate-rich mineral water, containing 467 mg Ca/L, with that from milk showed no significant difference (4). In a study using urinary calcium excretion as a qualitative measure for the bioavailability of calcium, only supplementation with calcium carbonate plus vitamin D compared with supplementation with milk showed a significantly higher urinary calcium excretion (5).

**CAPOLAC® mineral composition compared to milk**
CAPOLAC® contains calcium as the major mineral and additionally has a high content of phosphorus and zinc relative to skimmed milk. The mineral composition of CAPOLAC® is compared with skimmed milk per milligram of calcium in table 1. In table 2 and 3, the content of milk minerals in CAPOLAC® (Table 2) and skimmed milk (Table 3) are listed in relation to the Dietary Recommended Intake if the serving size is equivalent to 200 mg of calcium.

**Effect of milk calcium on bone health compared to other calcium sources**
The beneficial effect of milk calcium, which makes it superior to other calcium sources, becomes apparent when comparing the effects on bone mass accretion. The bioavailability of calcium from a food source is best evaluated by measuring its effect on changes in bone mass over time.

Studies have shown that the gain in bone mass density obtained by supplementation with milk calcium is still
When comparing the effect of calcium supplementation on bone mineralization in growing pigs fed a diet providing calcium either as milk, calcium sulphate or calcium carbonate, the diet containing milk led to greater bone mineral content, bone mineral density and breaking strength (12).

In conclusion, the studies of bioavailability of calcium from milk and dairy products compared to that of inorganic calcium have shown that the absorption of milk calcium is as good as that of other calcium sources. It is in relation to the effects on increasing bone mass that milk calcium proves itself to be superior to inorganic calcium sources. This becomes evident in studies showing that an acquired gain in bone mass obtained by supplementing with milk calcium is still present years after the supplementation has ceased. In opposition to this, bone mass increments obtained by supplementing with inorganic calcium have been shown to reverse to baseline when supplementation with calcium was withdrawn.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Coverage of DRI of selected minerals with a serving of CAPOLAC® corresponding to 200 mg of calcium.</th>
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</thead>
<tbody>
<tr>
<td><strong>DRI</strong></td>
<td><strong>Content of one serving of CAPOLAC®</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Males</strong></td>
</tr>
<tr>
<td>Calcium</td>
<td>200 mg</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>92 mg</td>
</tr>
<tr>
<td>Magnesium</td>
<td>5 mg</td>
</tr>
<tr>
<td>Zink</td>
<td>0.46 mg</td>
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</table>

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Coverage of DRI of selected minerals with a serving of skimmed milk corresponding to 200 mg of calcium.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DRI</strong></td>
<td><strong>Content of one serving of skimmed milk</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Males</strong></td>
</tr>
<tr>
<td>Calcium</td>
<td>200 mg</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>155 mg</td>
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<tr>
<td>Magnesium</td>
<td>19 mg</td>
</tr>
<tr>
<td>Zink</td>
<td>0.7 mg</td>
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</tbody>
</table>

present years after the supplementation has ended (6). This is opposed to supplementing with inorganic calcium, where the gain in bone mass density is reversed after withdrawal of the supplementation (7-9). A study in which prepubertal girls consumed milk-derived calcium fortified foods for 12 months showed significant increases in bone mass density compared to the non-supplemented controls (10). A follow-up study of the same girls showed that the increase in bone mass density in the calcium supplemented girls obtained during the intervention was still present more than 3 years after the cessation of the calcium supplementation (6). These findings are supported by a 2-year intervention study of dairy food supplementation in teenage girls. One year after the supplementation had ended, the bone mineral density of the girls was re-examined, and results showed that the significant difference between the supplemented girls and controls was still maintained (11).
Studies with CAPOLAC® as test material

Studies, in which CAPOLAC® has been applied as the source of milk calcium to study calcium bioavailability or effects on bone metabolism, are limited. One such published study is the aforementioned by Bonjour et al, in which bone mineral density was measured in girls supplemented with CAPOLAC® or placebo (10). In a research project performed at the KVL Department of Human Nutrition, Denmark, CAPOLAC® was compared to calcium carbonate with respect to bioavailability and influence on iron absorption. No significant difference in bioavailability was shown in the animal model. In the human model, the bioavailability of calcium from CAPOLAC® was significantly lower compared to that of calcium carbonate enriched bread. Intake of CAPOLAC® showed no influence on iron absorption. The study was supported by the Danish Dairy Board’s Research Foundation and was completed in 2004 (13).

In an animal study also conducted at the Department of Human Nutrition, CAPOLAC® and calcium carbonate were supplemented in a rat diet to compare the bioavailability of the calcium. Although not significantly different, supplementation with CAPOLAC® showed a slight tendency to a better bioavailability of calcium than from calcium carbonate supplementation, which was shown in an increased bone mass (14).

Phosphorus and bone health

Phosphorus in CAPOLAC®

The phosphorus in CAPOLAC® is of nutritional advantage for people who have low phosphorus intakes. See table 4 on next page for comparison of phosphorus content in different calcium sources.

Today, the most widely used calcium supplement is calcium carbonate, which does not contain any phosphorus. CAPOLAC® contains 460 mg phosphorus per 1000 mg calcium. This makes CAPOLAC® an excellent source of both calcium and phosphorus. In comparison, skimmed milk contains 1300 mg phosphorus per 1000 mg of calcium.

<table>
<thead>
<tr>
<th>TABEL 4</th>
<th>Skimmed milk</th>
<th>CAPOLAC® 0525</th>
<th>Calcium Carbonate</th>
<th>Calcium PhosphateDibasic (CaH₄O₈P₂)</th>
<th>Calcium PhosphateMonobasic (CaHO₄P)</th>
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</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
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<tr>
<td>Potassium</td>
<td>1.3</td>
<td>0.03</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Phosphorus</td>
<td>0.8</td>
<td>0.46</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Magnesium</td>
<td>0.1</td>
<td>0.03</td>
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<tr>
<td>Zink</td>
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<td>–</td>
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</table>
Studies regarding phosphorus and bone health

Bone minerals consist of calcium phosphate, and phosphorus is as important as calcium in supporting bone augmentation and maintenance. Although typical adult diets contain abundant phosphorus, some groups of the population may have phosphorus intakes lower than recommended (e.g. vegetarians, people on weight loss diets and the elderly), and for those people high calcium intakes from supplements without any phosphorus may have negative effects on bone health (15). Among elderly women in US, 10-15% have phosphorus intakes of less than 70% of the recommended daily allowance (15). Regarding growth, a recent animal study has documented the codependence of calcium and phosphorus for growth and development. Shapiro and Heaney (16) conclude the following: “If the diet is low in phosphorus, calcium supplementation alone will be inadequate and may even aggravate the deficiency. In these circumstances, optimal total nutrition, but at the very least a phosphorus calcium source, would be preferable to a supplement providing calcium alone.

It has often been suggested that diets with relatively high phosphorus intakes may increase the risk of osteoporosis, but these ideas have never been documented. Many new studies show a protective effect of diets with relatively high contents of animal protein and phosphorus (17-20).

Protein and bone health

New evidence shows that sufficient intakes of both animal protein and calcium are important to maintain bone mass, especially in elderly (17). The former hypothesis, which suggested that high protein diets lead to increased bone loss, only seems relevant when calcium intakes are low. With sufficient calcium intakes protein helps to maintain bone mass (21).

Several recent epidemiological studies show increased bone loss in individuals habitually consuming low-protein diets (22). Also data from calcium supplementation studies show that calcium supplemented individuals with the highest protein intakes gain bone, whereas those with the lowest intakes bone (23). Promislow et al. (18) found a significant positive association between intake of animal protein and bone mass density in women. Intake of vegetable protein was negatively associated with bone mass density in both sexes.

Effect of calcium on iron absorption and iron status

Several studies have shown that a diet with a high calcium intake has no effect on the level of iron status, when the study is continued for more than a few days (24-29). In iron replete, men and women, and in premenopausal women it has been found that supplementation of 1200 mg calcium has no effect on iron status (24, 29).

It has only been demonstrated in short term studies that calcium inhibits iron absorption. Some of the studies have tested the absorption of iron with a test meal, and some as a supplement of iron and calcium without a meal, and nearly all concluded that calcium intake simultaneously with iron intake inhibits the absorption of iron (30-34).
Both dietary and supplemental calcium seem to have the same effect. Calcium seems to interfere with iron transport through the mucosal cell because the inhibitory effect is equal in both heme and nonheme-iron (32).

The inhibitory effect is dose dependent up to a calcium intake of 300 mg calcium. The maximum inhibition of iron absorption is about 60% (32).

Nevertheless, a low absorption of iron caused by calcium is only a problem, if it increases the risk of iron deficiency. But in most of the studies, no association is found when the amount of calcium in the diet is compared with the size of the iron stores. Although calcium supplementation interferes with iron absorption, when the two minerals are taken together in a meal, it does not appear to adversely affect iron absorption or iron status in the long run in healthy people. Some investigators advise people who are in risk of iron deficiency to eat calcium-rich diets and iron-rich diets at different times of the day (35, 36).

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REFERENCES


14 Andersen SB. Bioavailability of calcium from diets fortified with milk mineral – studied in rats. Bachelor project, Royal Veterinary and Agricultural University, Frederiksberg, Denmark (2000).


