Capolac®
Milk minerals
for bone health
Calcium is an essential nutrient needed for bone growth and health. It is the most abundant mineral element in the body, with 99% of the body calcium contained within bone and teeth. Calcium is obtained solely through dietary sources, and optimal calcium intake is especially relevant during childhood, adolescence and senior years. Milk is known to be a rich dietary source of calcium and other compounds, which benefit bone development and health e.g. proteins, minerals and vitamins.

**Capolac® a natural milk mineral concentrate**

Capolac® is a natural milk mineral concentrate containing calcium, phosphorus and zinc – in a composition similar to bone and teeth. Capolac® is suitable for calcium fortification of infant formula, child nutritional products and functional food and beverages.

Capolac® contains 24% calcium as the major mineral and additionally has a high content of phosphorus and zinc relative to milk. The mineral composition of Capolac® is compared with skimmed milk per milligram of calcium in table 1. In table 2, the content of milk minerals in Capolac® are listed in relation to the Dietary Recommended Intake if the serving size is equivalent to 200 mg of 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 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).

**Milk calcium and bone health**

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 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).
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 (1,2).

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 2

Coverage of DRI* of selected minerals with a serving of 0.8 g Capolac® corresponding to 200 mg of calcium

<table>
<thead>
<tr>
<th>Content of one serving of Capolac®</th>
<th>DRI (EAR mg/day)</th>
<th>APPROX. % COVERAGE OF DRI*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males (19-50)</td>
<td>Females (19-50)</td>
</tr>
<tr>
<td>Calcium</td>
<td>200 mg</td>
<td>800</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>104 mg</td>
<td>580</td>
</tr>
<tr>
<td>Magnesium</td>
<td>6 mg</td>
<td>330-350</td>
</tr>
</tbody>
</table>

* Dietary Reference Intakes. IOM. USDA.

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1 g of CAPOLAC provides 240 mg of calcium

A glass (200ml) of whole milk provides 243 mg of calcium

A glass (200ml) of skimmed milk provides 258 mg of calcium

A glass (200ml) of semi-skimmed milk provides 247 mg of calcium

240 mg CALCIUM covers 30% of the average requirements for adults*

* Dietary Reference Intakes. IOM 2011.

Estimated Average Requirement (EAR) for Calcium; males and females 19-50 years 800 mg/day
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
The phosphorus in Capolac® is of nutritional advantage for people who have low phosphorus intakes. See table 3 on this 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 520 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 3 |
| Phosphorus and other minerals (per mg calcium) in skimmed milk, Capolac® and calcium salts |
|---------|-----------|-----------|----------------|----------------|---------|
|         | Skimmed milk | Capolac® 0525 | Calcium Carbonate | Calcium Phosphate Dibasic (CaH₅O₆P₂) | Calcium Phosphate Monobasic (CaHO₃P) |
| Calcium | mg          | 1.0        | 1.0            | 1.0            | 1.0     |
| Potassium | mg          | 1.3        | 0.03           | –              | –       |
| Phosphorus | mg         | 0.8        | 0.52           | –              | 1.5     |
| Magnesium | mg          | 0.1        | 0.03           | –              | –       |
| Zink     | mg          | 0.003      | 0.002          | –              | –       |
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
Protein also contributes to maintain normal bones and is needed for normal growth and development of bone in children (24). 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.

Product description
Capolac® is a natural milk mineral concentrate for calcium fortification of infant formula, child nutritional products and functional foods, and beverages. The Calcium phosphate in Capolac® is similar to the composition of teeth and bone.

Properties
100% Natural milk minerals
24% calcium
12.5% Phosphorous
8% lactose
3% Milk protein
Clear in solution at pH below 4


Quality starts here

Arla Foods Ingredients is a global leader in natural whey ingredients for nutritious food products. Our trademark is the quality we provide to our customers in every aspect of our offering.