



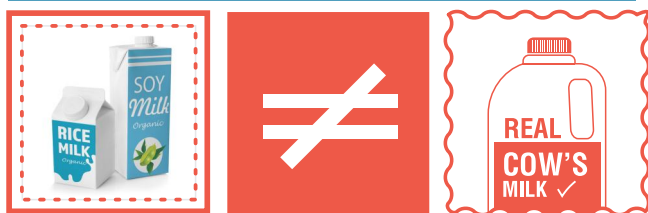
# DBN Review N° 12

A resource about dairy-based nutrition  
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This review describes the nutritional differences between cow's milk and plant-based milk alternatives and summarises arguments for and against the use of these non-dairy milk alternatives, given current scientific evidence.

A publication for health professionals

## Are plant-based beverages as good as cow's milk?



**W**orldwide, sales of non-dairy milk alternatives more than doubled between 2009 and 2015 – a reflection of both consumer demand and the burgeoning array of products to meet that demand. Meanwhile, consumption of cow's milk has dropped by 13% in the US over the last five years.<sup>1</sup>

Many plant-based milk substitutes are used as alternatives to cow's milk. Plant-based milk substitutes are essentially suspensions of dissolved and disintegrated plant material and extracts in water, with homogenisation and thermal treatments used to improve the suspension and stability of the product. These beverages are made to visually resemble cow's milk and often include the word 'milk' in the beverage name.<sup>1</sup> Many of these are fortified in an attempt to match dairy's unique nutrient package and it is often assumed that these so-called dairy alternatives are just as healthy as dairy foods.

In contrast, milk and dairy are naturally nutrient dense and provide high-quality protein and a variety of important micronutrients, such as calcium, potassium, iodine and vitamins A, B<sub>12</sub> and B<sub>2</sub>, in an easily absorbed form.

The food-based dietary guidelines of South Africa recommend that consumers should have 'milk, *maas* or yoghurt every day'. Health authorities also recommend three servings of dairy per day to meet daily calcium requirements.

### Why do people exclude milk or dairy from their diet?

Consumers usually choose non-dairy beverages in the case of milk allergies or lactose intolerance, when following an exclusion diet to identify foods with adverse effects, or for personal lifestyle choices such as being vegetarian or following a trend. A recent study also found that consumers who chose exclusively plant-based dairy alternatives did so based on the belief that animal mistreatment is reduced by lower consumption of animal products or because of the perceived lesser environmental effect,<sup>2</sup> while others are concerned with the saturated fat levels and hormone content of milk and the use of antibiotics in dairy cattle.<sup>1,3</sup>

### What are typical dairy alternatives when milk is excluded from the diet?

Beverages derived from seeds, fruits, nuts, legumes or cereals are commonly used as alternatives to cow's milk.

Popular choices include oat and rice milk (cereal based), soy and pea milk (legume based), potato milk (vegetable based), flax and hemp milk (seed based) and almond, cashew and coconut milk (nut based).<sup>1,3</sup>

There seems to be an assumption that if a product is called 'milk' or looks like milk, it has the same nutritional properties as cow's milk. However, as the nutritional composition of these plant-based 'milk' products depend on the source, processing methods and fortification, they have different nutritional properties and varying levels of macro- and micronutrients.

### Are milk substitutes suitable for use as a complete milk replacement?

Generally, plant-based milk alternatives do not have the same nutritional composition as cow's milk. Cow's milk is a natural source of well-absorbable and highly bioavailable protein, calcium and micronutrients such as riboflavin, vitamin B<sub>12</sub>, iodine, potassium and phosphorus.<sup>4,5</sup> In contrast, plant-based dairy alternatives are not naturally high in nutrients and therefore have to be fortified, specifically with calcium and vitamin B<sub>12</sub>.

A comparison of the nutritional composition of cow's milk and plant-based substitutes is given in Table 1. For a representative quantity, values for milk alternatives are given as an average across four products consumed in the South African market.<sup>6</sup>

### How does the protein quality of cow's milk and plant-based dairy alternatives compare?

Cow's milk and plant-based dairy alternatives differ considerably with regard to the amount and quality of protein present per 100 mL.<sup>7</sup>

Cow's milk contains both whey and casein, which both have high biological value. Cow's milk typically contains approximately 3.5% protein, whereas plant-based milk substitutes generally contain around 0.5% protein (this excludes soy milk, which has a protein content of approximately 3%).<sup>4,6,8-10</sup> The high protein quality and content of cow's milk are due to the presence of enzymes, immunoglobulins, bactericides, mediators and growth factors – all related to the physiological role of milk. These components are not present in plant-based beverages.

Cow's milk is also naturally high in 'complete' protein, whereas plant-based milk substitutes contain mostly 'incomplete' protein. Owing to the ratio of essential amino acids in animal-derived protein, the protein in cow's milk has a higher bioavailability than that of plant-based milk substitutes. For example, the nutritive value of soy protein is limited by its lower content of methionine and cysteine.<sup>9</sup> Therefore, when plant-based protein is used, more total protein must be consumed for the body to get enough of the amino acids it needs.

A major drawback of nut milk is that the protein content from almonds is strained out of the milk along with the pulp; hence, it contains very little protein – usually only 1 g per cup, compared to 8 g in cow's milk.<sup>1</sup>

## Do plant-based milk alternatives contain sugar?

Some alternatives contain added sugar for taste, while milk naturally contains a sugar called lactose.<sup>9</sup> Scientific evidence confirms that lactose and its metabolites (e.g. galactose) are unlikely to be detrimental to health. Differences in the effect of various sugars on health outcomes indicate that lactose as present in milk and dairy products should not be targeted when the sugar content of the diet has to be reduced.

## Are non-dairy beverages fortified with calcium nutritionally equivalent to cow's milk?

Owing to the difference in the bioavailability of nutrients in fortified products, fortified non-dairy beverages cannot be considered nutritionally equivalent to cow's milk. One of the factors influencing the absorbability of the fortified substances is the physical state of the substance in the fortified beverage and its interaction with the food matrix. Adding calcium to a product does not guarantee nutritional equivalence to other products that naturally contain similar amounts of calcium. The calcium content of fortified non-dairy beverages therefore has to be considered in context.<sup>3,11,12</sup>

Manufacturers fortify soy milk with calcium owing to the low calcium content in the beverage, but the bioavailability of the fortified calcium does not compare with that of cow's milk. One of the possible contributing factors of poor bioavailability of calcium in plant-based beverages is the presence of isoflavones and phytates.<sup>11</sup> A study to compare the bioavailability of calcium fortificants in soy milk found that the use of tricalcium phosphate and a combination of sequestering and stabilising agents resulted in a Ca:P ratio of 1.3:1 compared to an ideal ratio of 1:1. Soy milk fortified with calcium carbonate showed less calcium stability and a poorer Ca:P ratio of 2.6:1, but exhibited a higher calcium availability than tricalcium phosphate. As calcium bioavailability is the

**Table 1**

Comparison of the nutritional composition of cow's milk and plant-based beverages.<sup>6</sup>

Source (per 100 ml)	Energy (kJ)	Protein (g)	Carbohydrate (g)	Total fat (g)	Vitamin D (IU)	Calcium (mg)	Sodium (mg)
Cow's milk (Full cream)	258.0	3.3	4.7	3.3	1.2	119.0	49.0
Soy milk (unsweetened, unfortified)	163.3	3.3	2.8	1.9	Not available*	79.0	36.8
Almond milk (unsweetened)	103.0	0.6	3.5	1.1	0.8	125.0	51.3
Rice milk (unsweetened)	235.5	0.2	11.4	1.0	Not available*	110.7	29.5
Coconut milk	469.3	0.2	2.2	11.5	Not available*	Not available*	30.2

\*No nutrition analysis performed

critical factor in choosing calcium salts for use as a fortifying agent, calcium carbonate should be considered as the preferred option in soy milk.<sup>12</sup>

Calcium in cow's milk is highly bioavailable and provides more than half of the recommended dietary allowance in a typical diet of toddlers and young children. The presence of milk constituents such as lactose and casein phosphopeptides also increases the intestinal permeability for calcium salts, which increases intestinal absorption.<sup>5</sup> The lack of these substances in plant-based milk alternatives may explain, in part, the difference in bioavailability of calcium.

## What are the consequences of replacing cow's milk with milk substitutes?

Although calcium-fortified milk alternatives have been considered as a replacement for dairy in the case of low-dairy diets, concerns related to the lack of bioactive nutrients, the risk of excess energy intake and the relative bioavailability of calcium have been raised.

Nut milks in general tend to be highly diluted. Although this allows for a relatively lower energy content, it also means that they supply minimal amounts of the nutrients typically found in nuts, including protein, manganese, magnesium and copper. In addition, some common nut milks, for example almond milk, contain carrageenan, a thickener and emulsifier derived from seaweed, which has recently been implicated in preliminary (but not conclusive) studies on ulcers, inflammation and other gastrointestinal complications.<sup>1</sup>

Another risk associated with the exclusion of dairy is that individuals do not necessarily compensate for low calcium intake by consuming more calcium-rich non-dairy foods.<sup>13</sup>

A recent study has shown that the increased consumption of plant-based milk alternatives led to an increase in the number of adolescent girls not meeting the estimated average requirement for nutrients that have been identified as being of public health concern, namely protein, calcium, zinc and vitamin D.<sup>13</sup>

Several studies have shown that milk and other dairy products should be part of every individual's daily dietary intake to meet



calcium recommendations for good health, especially with regard to optimal skeletal development and maintenance of bone health.<sup>2,13</sup> Adequate dairy intake is essential for the accretion of peak bone mass during growth (which has been shown to protect against osteoporosis) and to reap the benefit of a cardioprotective role, among other advantages.<sup>5,14,15</sup>

In addition, a recent study has shown that milk alternatives do not contain adequate levels of vitamin D.<sup>16</sup> Of the nearly 3000 pre-schoolers included in the study, 5% of those who drank only cow's milk presented with low vitamin D levels compared with 11% of those who drank only milk substitutes. A longitudinal study by Rockell et al.<sup>17</sup> has also shown that prolonged milk avoidance in young, growing children had lasting detrimental effects on height and weight and was associated with persistent osteopenia, despite modest increases in milk consumption during the follow-up period two years later. These findings are supported by those of the large-scale National Health and Nutrition Examination Survey,<sup>18</sup> which showed that children who excluded cow's milk because of allergy were more likely to have a lower weight, height and

body mass index than children who consumed milk. To properly evaluate the value of using milk or milk alternatives, arguments for and against the use of the respective products are summarised in Table 2.

### What is the position of international authorities on plant-based milk alternatives?

Although the Food and Drug Administration (FDA) has not released a formal definition for the terms 'natural' and 'clean' or any of their derivatives, several members of Congress have signed a letter urging the FDA to ban the use of the word 'milk' for anything but liquid coaxed from a cow's udder. The group claims that nut and grain milks are an imitation and therefore should be labelled similarly to imitation cheese or non-dairy creamer.<sup>23,24</sup>

In June 2017, the European Union (EU) Court of Justice stated in a press release that the terms 'milk', 'cream', 'butter', 'cheese' and 'yoghurt' are reserved for animal products under EU laws and cannot be used for purely plant-based products.<sup>25</sup>

**Table 2**

Arguments for and against the use of milk and various milk alternatives

Product	Arguments for use	Arguments against use
<b>Cow's milk</b>	<ul style="list-style-type: none"> <li>Provides calcium, potassium, vitamins A, B<sub>12</sub> and B<sub>2</sub>, and high-quality protein.</li> <li>Owing to its unique nutrient matrix, milk provides a variety of health benefits, including immune and inflammatory system support, improved bone mass, improved blood sugar regulation, reduced body fat, reduced risk of heart attack and maintenance of lean body mass.<sup>3,5,23</sup></li> <li>Lactose-free milk is available for lactose-intolerant individuals</li> </ul>	<ul style="list-style-type: none"> <li>The protein in cow's milk is a common allergen.</li> <li>Some people have concerns about the lactose content of milk.<sup>5,10</sup></li> </ul>
<b>Soy milk</b>	<ul style="list-style-type: none"> <li>This can be considered a good source of protein, vitamin A, vitamin B<sub>12</sub>, potassium and isoflavones.</li> <li>If fortified, it is a good source of calcium and vitamin D.</li> <li>Contains little saturated fat.<sup>3,24,25</sup></li> </ul>	<ul style="list-style-type: none"> <li>Contains high levels of phytic acid, which inhibits the body's absorption of essential minerals such as calcium, magnesium, iron and zinc.</li> <li>Intake may be problematic in individuals with thyroid disorders.</li> <li>Very little calcium and no vitamin D are present in unfortified soy milk.<sup>3,16</sup></li> <li>High intake of soy-based foods may cause fertility problems and lower sperm counts.<sup>24</sup></li> <li>Soy protein is a common allergen. People who are allergic to cow's milk protein often cross-react to soy protein.<sup>12,25</sup></li> <li>Higher fat content than other plant-based milks.<sup>1</sup></li> <li>Sweetened varieties can contain up to 19 g sugar.<sup>1</sup></li> </ul>
<b>Almond milk</b>	<ul style="list-style-type: none"> <li>It is low in energy (kilojoules) and saturated fat.</li> <li>It is rich in vitamins A and E, manganese, selenium, magnesium, potassium and zinc.</li> <li>It is lactose free and hence associated with easier digestion.</li> <li>If fortified, it is a good source of calcium and vitamin D.<sup>3,12</sup></li> </ul>	<ul style="list-style-type: none"> <li>It is not protein rich.<sup>3,24</sup></li> <li>Unfortified forms are very low in calcium and vitamin D.<sup>12</sup></li> <li>It may contain carrageenan (a food additive extracted from red seaweed), which may cause gastrointestinal issues.<sup>1</sup></li> </ul>
<b>Rice milk</b>	<ul style="list-style-type: none"> <li>It is a lactose-free product.</li> <li>It is considered the least allergenic of the milk alternatives.</li> </ul>	<ul style="list-style-type: none"> <li>It ranks lowest among the various milk alternatives with regard to nutritional composition.</li> <li>It is not protein rich.</li> <li>It is high in carbohydrates and has a high glycaemic index, making it a poor choice for people with diabetes.<sup>3</sup></li> <li>Inorganic arsenic levels may pose a health risk for infants and children at high levels of consumption.<sup>24</sup></li> <li>Contains no fibre.<sup>1,3</sup></li> </ul>
<b>Coconut milk</b>	<ul style="list-style-type: none"> <li>Contains medium-chain triglycerides and potassium.</li> <li>Consumption is not associated with an increase in cholesterol levels.<sup>3,7</sup></li> <li>It rarely causes allergies.</li> </ul>	<ul style="list-style-type: none"> <li>It contains very little protein.<sup>3,7</sup></li> <li>It may contain carrageenan, which may cause gastrointestinal problems.<sup>1</sup></li> </ul>

## Conclusion

*Commercially there are several plant-based milk alternatives available that look like cow's milk, but which differ significantly from cow's milk with regard to nutritional composition and bioavailability of nutrients.*

*Replacing cow's milk with plant-based milk alternatives may result in unintended nutritional consequences owing to the lack of nutritional balance compared with cow's milk. It is important that plant-based dairy alternatives should not be considered a nutritional substitute for cow's milk until nutritional quality and bioavailability have been established.*

*Current evidence indicates that the sum of the dairy nutrients in the dairy food structure (referred to as the dairy matrix) has specific effects on health as seen in the metabolic effects of whole dairy on body weight, cardiometabolic risk, and bone health compared with that of single nutrients. This important feature further distinguishes dairy from plant-based beverages.<sup>26</sup>*

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