There are many plant-based beverages used as alternatives to cow's milk. Many of these are fortified in an attempt to match dairy's unique nutrient package and it is often assumed that these dairy alternatives are just as healthy as dairy foods.

ARE PLANT-BASED BEVERAGES AS GOOD AS COW'S MILK?

Milk and other dairy products are nutrient dense and provide high-quality protein and a variety of important micronutrients, such as calcium, potassium, iodine and vitamins A, B_{12} and B_2, in an easily absorbed form.

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 beverages 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.[1]

What are typical plant-based beverages when milk is excluded from the diet?

Beverages made from seeds or fruits, nuts, legumes or cereals are commonly used as alternatives to cow's milk. Popular choices include coconut milk, almond milk, soy milk and rice or oat milk.

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 depends on the source, methods of processing and fortification, they have different nutritional properties and varying levels of macro- and micronutrients.

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.

Are plant-based beverages suitable for use as a complete milk replacement?

Generally, plant-based beverages 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_{12}, iodine, potassium and phosphorus.[2,3]

In contrast, plant-based beverages are not naturally high in nutrients and therefore have to be fortified, specifically with calcium and vitamin B_{12}.

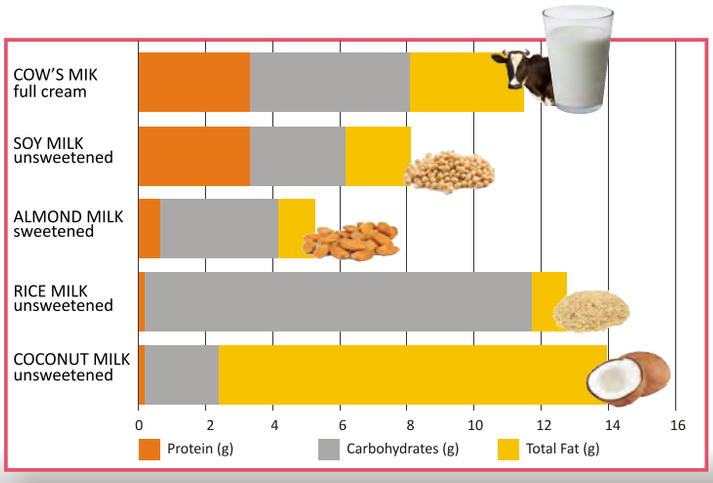
A comparison of the nutritional composition of cow's milk and plant-based beverages is given in Table 1 and Graphs 1 and 2.
To get a representative quantity, values for milk alternatives are given as an average across four products consumed in the South African market.

	Cow's milk full cream	Soy milk unsweetened	Almond milk sweetened	Rice milk unsweetened	Coconut milk unsweetened
Protein	3,3 g	3,3 g	0,6 g	0,2 g	0,2 g
Carbohydrates	4,7 g	2,8 g	3,5 g	11,4 g	2,2 g
Total Fat	3,3 g	1,9 g	1,1 g	1 g	11, 5g
Vitamin D	1,2 IU	*	0,8 IU	*	*
Calcium	119 mg	79 mg**	125 mg**	110,7 mg**	*
Sodium	49 mg	36,8 mg	51,3 mg	29,5 mg	30,2 mg

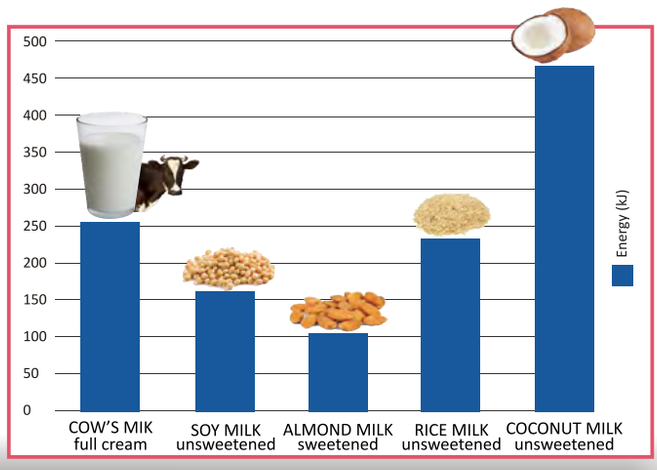
*Nutritional analysis not performed
** Fortified with calcium

Table 1.
Comparison of the nutritional composition of cow's milk and plant-based beverages.[4]

Graph 1.
Comparison of macronutrients per 100 g.



Graph 2:
Comparison of energy content (kJ) per 100 ml.



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

Cow's milk and plant-based beverages differ considerably with regard to the amount and quality of protein present per 100 ml. Cow's milk typically contains approximately 3.3% protein, whereas plant-based milk alternatives generally contain around 0.5% protein (this excludes soy milk, which has a protein content of approximately 3.3%).[2,4,5,8] The high protein content of cow's milk is 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.

Are plant-based beverages fortified with calcium nutritionally equivalent to cow's milk?

Owing to the difference in the bioavailability of nutrients in fortified products, fortified plant-based 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 plant-based beverages therefore has to be considered in context.

Calcium in cow's milk is highly bioavailable and provides more than half of the recommended dietary allowance (RDA) 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.[3]

The lack of these substances in plant-based beverages may explain, in part, the difference in bioavailability of calcium.

Cow's milk is also naturally high in 'complete' protein, whereas plant-based beverages 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.[7] 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.

Do plant-based beverages contain sugar?

Some plant-based beverages contain added sugar for taste, while milk naturally contains a sugar called lactose.[7] 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.

What are the consequences of replacing cow's milk with plant-based beverages?

Although calcium-fortified plant-based beverages 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. Another risk associated with the exclusion of dairy is that individuals do not necessarily compensate for the low calcium intake by consuming more calcium-rich non-dairy foods.[8]

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 (EAR) for nutrients that have been identified as being of public health concern, namely protein, calcium, zinc and vitamin D.[9]

Several studies have shown that milk and other dairy products should be part of every individual's daily dietary intake in order to meet calcium recommendations for good health, especially with regard to optimal skeletal development and maintenance of bone health.[1,9]

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 cardio-protective role, amongst other advantages.[3,10,11]

In addition, a recent study has shown that plant-based beverages do not contain adequate levels of vitamin D.*[12] 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[13] 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,[14] which showed that children who excluded cow's milk because of allergies were more likely to have a lower weight, height and body mass index than children who consumed milk.

* In South Africa milk is not fortied with vitamin D.

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

The Food and Drug Administration (FDA) has not yet released a formal definition for the terms 'natural' and 'clean' or any of their derivatives, but 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 product and therefore should be labelled similarly to imitation cheese or non-dairy creamer.[15,16] 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.[17]

CONCLUSION

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

Replacing cow's milk with plant-based beverages may result in unintended nutritional consequences owing to the lack of nutritional balance compared with cow's milk. It is important that plant-based beverages should not be considered a nutritional substitute for cow's milk.

Current evidence indicates that the sum of the 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 once again distinguishes dairy from plant-based beverages.[18]

Addendum
In order to properly evaluate the value of using milk or plant-based beverages, arguments for and against the use of the respective products are summarised in **Table 2.**

Table 2.
Arguments for and against the use of milk and various plant-based beverages

PRODUCT	ARGUMENTS FOR USE	ARGUMENTS AGAINST USE
Cow's milk 	• Provides calcium, potassium, vitamins A, B_{12} and B_2, and high-quality protein. • 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.[19,3] • Lactose-free milk is available for lactose-intolerant individuals.	• The protein in cow's milk is a common allergen. • Some people have concerns about the lactose content of milk.[3,8]
Soy milk 	• This can be considered a good source of protein, vitamin A, vitamin B_{12}, potassium and isoflavones. • If fortified, it is a good source of calcium and vitamin D. • Contains little saturated fat.[20,21]	• Contains high levels of phytic acid, which inhibits the body's absorption of essential minerals such as calcium, magnesium, iron and zinc. • May be problematic in individuals with thyroid disorders. • Very little calcium and no vitamin D are present in unfortified soy milk.[12] • High intake of soy-based foods may cause fertility problems and lower sperm counts.[21] • Soy protein is a common allergen. People who are allergic to cow's milk protein often cross-react to soy protein.[22]
Almond milk 	• It is low in energy (kilojoules) and saturated fat. • It is rich in vitamins A and E, manganese, selenium, magnesium, potassium and zinc. • It is lactose free and hence associated with easier digestion. • If fortified, it is a good source of calcium and vitamin D.[21]	• It is not protein rich.[20] • Unfortified forms are very low in calcium and vitamin D.[21] • It may contain carrageenan (a food additive extracted from red seaweed), which may cause gastrointestinal issues.
Rice milk 	• It is a lactose-free product. • It is considered the least allergenic of the plant-based milk alternatives.	• It ranks lowest amongst the various plant-based beverages with regard to nutritional composition. • It is not protein rich. • It is high in carbohydrates and has a high glycaemic index, making it a poor choice for people with diabetes. • Inorganic arsenic levels may pose a health risk for infants and children at high levels of consumption.[20]
Coconut milk 	• Contains medium-chain triglycerides and potassium. • Consumption is not associated with an increase in cholesterol levels.[23] • It rarely causes allergies.	• It contains very little protein.[6] • It may contain carrageenan, which may cause gastrointestinal problems.

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