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„Nutritional Evaluation and Comparison of Plant-Based Milk Alternatives in Austria"

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BMD	bone mineral density
CI	confidence interval
CMA	cow’s milk allergy
EFSA	European food safety authority
EQ	equivalents
G	grams
GHG	greenhouse gas
GI	gastrointestinal
HF	hip fracture
HR	hazard ratio
KCAL	kilocalorie
KG	kilogram
LCA	life cycle analysis
LI	lactose intolerance
M	mean
MAX	maximum
MIN	minimum
ML	millilitres
MUFAS	mono-unsaturated fatty acids
OF	osteoporotic fracture
PEF	pulsed electric field processing
PUFAS	poly-unsaturated fatty acids
QA	quinolizidine alkaloid
RCT	randomized controlled trail
RR	risk ratio
SD	standard deviation
SFAs	saturated fatty acids
TFAs	trans fatty acids
UHT	ultra-high-temperature

1. Introduction

Dairy milk has been systematically consumed by humans since the Neolithic Revolution around 10 000 BC, with cow's milk being the most produced milk worldwide by far. 85% of milk produced comes from cows, followed by buffalo milk (11%), goat (2.3%), sheep (1.4%) and camel milk (0.2%) (Cavero-Redondo et al., 2019). Since cow's milk has become a staple food in many cultures worldwide in the last century, it will be the topic I discuss in particular; however, it is important to recognize that demand for plant-based alternatives has been sharply increasing across the globe in the last few years.

While commercial plant-based milk alternatives seem to be a very recent invention, mixtures similar to plant-based drinks have been around for centuries. Native Americans such as the Wabanakis have been using milk made from nuts for centuries (Kamila, 2020). Horachata, a beverage made from tiger nuts, was consumed in North America and today's Spain since before 1000 AD (Zaslovsky, 2015). Almond milk is described in recipes from the 13th century Levant (Muhammad bin Hasan al-Baghdadi, 1226). Soy milk, which was first used in China around 2000 years ago, was traditionally consumed in populations with lactose intolerance and as a source of nutrients when milk supply was low (Sethi et al., 2016).

Historically, the word milk has been used to refer to "milk-like plant juices" since 1200 AD, however nowadays plant-based milk alternatives are not allowed to be called "milk" anymore (Online Etymology Dictionary). In EU regulation 1308/2013 (Attachment VII) the term "milk" is regulated: *""Milk" means exclusively the normal mammary secretion obtained from one or more milkings without either addition thereto or extraction therefrom."* In case the milk is not derived from cows, the animal species it originates from has to be stated.

In the last decade, as ethical and environmental concerns about dairy production have been rising, more and more consumers have been looking for alternatives to milk, with many more plant-based milk alternatives becoming commercially available. When consumers are looking to buy something to drink, they are looking for functional foods, not just something to quench their thirst. Plant-based milk alternatives are produced from many different types of foods such as legumes, grains or seeds, with more than a dozen different foods serving as bases for plant-based milk alternatives, often being mixed together. To create a nutritionally adequate milk substitute, those drinks are often fortified, and technological improvements continue to make dairy alternatives both more functional as well as more similar to dairy – flavor, color, texture and nutrition wise. Barista versions of plant-based milk alternatives allow the creation of foam in coffee, and flavors such as chocolate or vanilla allow for a broader taste spectrum. The market value of plant-based milk alternatives is rising immensely, and the market is getting more and more competitive each year (more: chapter 3.2.1.).

The question of dairy milk alternatives being healthy and a nutritionally adequate substitute for dairy is discussed controversially, however. There is also a wide range in the nutritional value of different kind of plant-based dairy alternatives.

Therefore, I would like to present an overview of the current Austrian market (2021) of plant-based dairy alternatives. It should be noted that this market is still fairly new and will continue to develop in the coming years. I will compare plant-based dairy alternatives within specific categories and between them, as well as to milk. Furthermore, I will give a critical discussion of the health aspects of milk as well as plant-based milk alternatives, as well as with regard to their respective appropriateness for different consumer groups.

2. Milk

2.1. Nutritional Values

Whole milk, reduced fat milk and skimmed milk are the most common types of milk. Table 1 shows the nutritional values of 100 grams (g) of these different types. Salt content was calculated on the basis of sodium content.

Type of Milk	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)
Whole milk (≥ 3.5% fat)	66	3.6	2.2	0.9	0.1	4.7	4.7	
Reduced fat milk (1.5%-1.8%)	48	1.6	1.0	0.4	0.0	4.8	4.8	
Skimmed milk	35	0.1	0.0	0.0	0.0	4.8	4.8	
Type of Milk	**Protein (g)**	**Salt (g)**	**Vitamin D (µg)**	**B2 (mg)**	**B12 (µg)**	**Calcium (mg)**	**Cholesterol (mg)**	**TFA (mg)**
Whole milk (≥ 3.5% fat)	3.3	0.1	0.09	0.18	0.41	120.0	9.5	149.0
Reduced fat milk (1.5%-1.8%)	3.3	0.1	0.03	0.18	0.42	118.0	4.2	66.5
Skimmed milk	3.5	0.1	traces	0.17	0.30	123.0	0.2	3.7

Table 1: Nutritional values of whole milk, reduced fat milk and skimmed milk per 100 ml (Souci et al., 2015).

2.2. Nutrients of Importance

2.2.1. Fatty Acids

Whole milk contains 3.6 g of fat per 100 g with about half of the total 66 kcal coming from fat (32 kcal). More than half (61%) of the total fat in whole milk comes from saturated fatty acids (SFAs) which the German Nutrition Society advises to only consume at an amount of 7% to 10% of our daily kcal. A middle-aged woman needing on average 1800 kcal (standard weight from the German Nutrition Society) should get between 126 and 180 kcal from SFAs, while a middle-aged man with an average energy requirement of 2300 kcal is recommended to get between 161-230 of his daily kcal from SFAs. It is recommended to consume three portions of dairy a day, and if one was to consume those three portions in whole milk (200 ml per portion), this would add up to 13.2 g of SFAs and 118.8 kcal. This is a substantial portion of the recommended intake of saturated fatty acids, especially for women. Whole milk is, therefore, high in saturated fatty acids, while being rather low in monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs).

Due to the high amount of saturated fatty acids present in whole milk, it makes sense that the consumption of reduced fat milk products is recommended by the Austrian Nutrition Pyramid (Salz, 2020).

Reduced fat milk contains 1.6 g of fat and 1.0 g of saturated fatty acids; less than half of what we find in whole milk.

Skimmed milk only contains only 0.1 g of fat per 100 g and close to 0 g of saturated fatty acids, MUFAs and PUFAs.

Whole milk contains a significant amount of trans fatty acids (TFAs); however, the TFAs in milk is highly variable, depending on how animals are fed and kept (DGE, 2016).

2.2.2. Vitamin B2

Milk is high in vitamin B2 with around 0.2 mg in 100 ml with no significant variations in different types of milk. The vitamin B2 recommendations include 1.4 mg/day for men and 1.1 mg/day for women (Deutsche Gesellschaft für Ernährung e.V., 2015). Three portions of cow’s milk (1.2 mg of vitamin B2) would be sufficient to meet women’s vitamin B2 recommended intake.

2.2.3. Vitamin B12

The daily vitamin B12 recommendation for adults is 4.0 µg (Deutsche Gesellschaft für Ernährung e.V., 2018). If the dairy recommendations of three portions a day were covered by milk, whole milk and reduced fat milk would contribute more than half of the B12 recommendations with around 2.5 µg of vitamin B12. Milk is a valuable source of B12 and while skimmed milk contains less B12, it would still deliver 1.8 µg of vitamin B12 in a day.

2.2.4. Calcium

Cow's milk, containing an average of 120 mg of calcium per 100 ml, is a valuable source of calcium. Three 200 ml glasses of milk add up to 720 mg of calcium, which is 72% of the recommended daily amount for adults (Deutsche Gesellschaft für Ernährung e.V., 2013).

Plant-based milk alternatives are often fortified with calcium, since they are naturally low in calcium. These products are then usually fortified with either tricalciumphosphat, calciumcarbonate or lithothamnium calcareum (more: chapter 3.2.3.).

In Austria, calcium intake is below the recommended intake for most of the population, although this does not necessarily indicate an insufficient intake for individuals due to different individual calcium requirement. The only population reaching recommendations for calcium consumption (1000 mg) are 19- to 25-year-old men. 75% of women and 58% of men in Austria have a calcium consumption below the recommended intake, with women consuming on average 832 mg of calcium per day, men 970 mg (Rust et al., 2017).

2.3. Impact on Health

2.3.1. Inflammation

Systemic inflammation is associated with the risk and progression of chronic diseases and obesity (Nieman et al.,2020). Dairy milk does not have proinflammatory effects; in fact, multiple systematic reviews have shown milk to have weak to modest anti-inflammatory effects (Nieman et al.,2020; Ulven et al., 2019; Bordoni et al. 2017). Inflammatory markers in studies included CRP, IL-6 TNF-α,EndoCAb IgM, and TNF-α to sTNFR-RII and LBP to sCD14 ratios (Ulven et al., 2019).

However, the anti-inflammatory effects vary in their magnitude depending on the type of dairy product, fat content of milk and the health status of the subjects. While low-fat milk has generally shown to have anti-inflammatory activity, studies on high-fat products have had mixed results. This might be due to the higher content of saturated fatty acids, which have been linked to inflammation. Meta-analyses on high-fat dairy, however, have generally also indicated an anti-inflammatory response (Bordoni et al. 2017; Ulven et al., 2019).

Nieman et al. (2020) also discuss the potential beneficial effects of dairy and dairy proteins in their review, agreeing that dairy is not associated with inflammation but rather with anti-inflammatory responses, especially in obese subjects (Nieman et al., 2020).

The anti-inflammatory effect in dairy milk is shown to be stronger in individuals with metabolic disorders. Subjects with metabolic disorders such as obesity experience low grade inflammation, and therefore may experience higher anti-inflammatory effects when consuming dairy, while subjects with allergies to cow's milk experience pro-inflammatory responses (Bordoni et al. 2017; Ulven et al., 2019).

Fermented milk products have the strongest anti-inflammatory activity. This might be a result of the anti-inflammatory activity of strains of lactic acid bacteria and bifidobacteria, as well as that of the products that derive from the fermentation with bacteria, including bioactive peptides and glycans, which interact with gut microbes or immune cells (Bordoni et al., 2017). Certain studies, such as the ones showing that specific dairy products such as kefir and yogurt have long-term positive effects on inflammation, have to be interpreted with caution, since there are only a limited number of studies, which often have a high risk of bias. (Ulven et al., 2019).

The anti-inflammatory effects of milk might be linked to a broad range of nutrients, such as polyunsaturated fatty acids, proteins and glycans, with vitamin D and calcium also possibly contributing to these effects (Nieman et al.,2020).

2.3.2. All-Cause Mortality

There is a lack of association between dairy intake and risk of all-cause mortality. There is also no dose-response in regards to mortality, and this also applies when it comes to the type of dairy product (milk, cheese, yogurt or butter), as well as the fat content (low-fat or high-fat) (Cavero-Redondo et al.,2019).

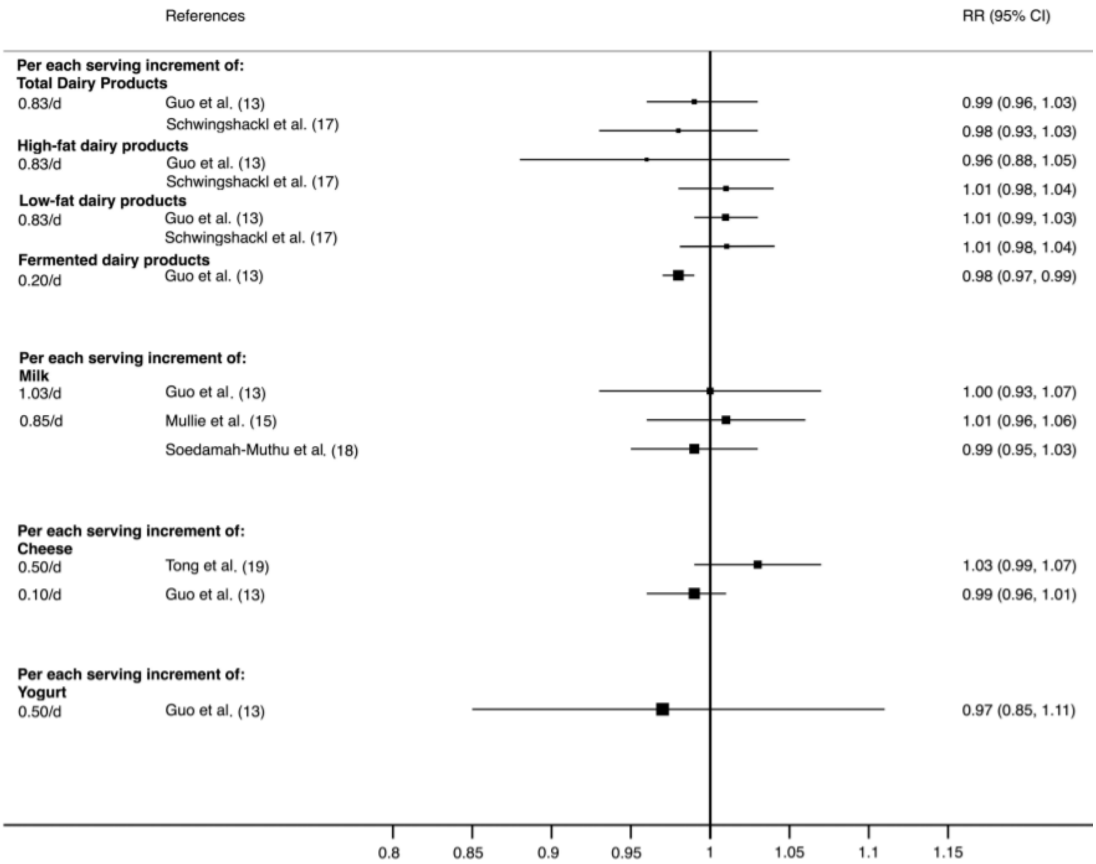

Figure 1: Forest plot for dose-response analyses of dairy product consumption in adults, risk ratio (RR) (Cavero-Redondo et al.,2019).

The effect of dairy on the risk of all-cause mortality is complex and may be influenced by the nature of food matrix components. Dairy milk contains components beneficial for health such as calcium, vitamin A, potassium and protein. Diets rich in some of these nutrients have been shown to lower stroke risk. On the other hand, bovine milk is high in saturated fatty acids, which are associated with adverse health effects (Cavero-Redondo et al.,2019).

The exact mechanisms responsible for this lack of association with risk of all-cause mortality still need further study; however, publication bias could lead to the dismissal of possible negative health effects. (Cavero-Redondo et al., 2019; Mullie et al., 2016).

2.3.3. Coronary Heart Disease and Stroke

No association has been found between dairy milk consumption and risk of heart disease or stroke (Mullie et al., 2016).

2.3.4. Bone Health

2.3.4.1. Bone Mineral Density (BMD)

Some studies show a dose-response association between dairy milk consumption and bone mineral density. These studies, however, have shown heterogenous results and are difficult to compare, due to differences in age and gender of the subjects involved, as well as in the type of dairy product being studied. Nutrients contained in milk such as calcium, vitamin D, inorganic phosphate and proteins play a role in BMD (De Lamas et al., 2019). Also, dairy has an effect on the endogenous insulin-like growth factor system. As discussed earlier, different types of dairy have different impacts on health parameters. Cheese and fermented dairy have a higher vitamin K content than milk, which is known to be a cofactor for posttranslational conversion of glutamyl to γ-carboxyglutamyl residues in osteocalcin - this helps calcium to bind to bone proteins and therefore mineralize the bone (Matía-Martín et al., 2019).

De Lamas et al. (2019) have emphasized the importance of dairy consumption in children in their review. BMD increased when dairy was added to the children's diets, and effects on children's height were inconclusive, but products such as cheese and fermented dairy like yogurt were also considered, not just dairy milk (De Lamas et al., 2019). Certain studies that were compared in meta-analyses were actually not comparable due to different age ranges, outcome assessments, and ways of estimating the main effect. A generally positive relationship between milk intake during infancy and adolescence and hip BMD in adulthood was shown, which also applied to milk intake after 65 (Malmir et al., 2020).

2.3.4.2. Osteoporotic Fractures (OF)

There is no significant association between milk intake and osteoporotic fracture risk (Figure 2). Some studies showed that a low milk intake leads to a higher risk of hip fracture (HF) in all age groups. This effect however was not significant (Matía-Martín et al., 2019), and the studies showing a positive association had for the most part methodologically inferior study designs. Studies that were methodologically superior showed neither a dose-response relation between milk consumption and HF risk, nor any relationship therein (Malmir et al., 2020).

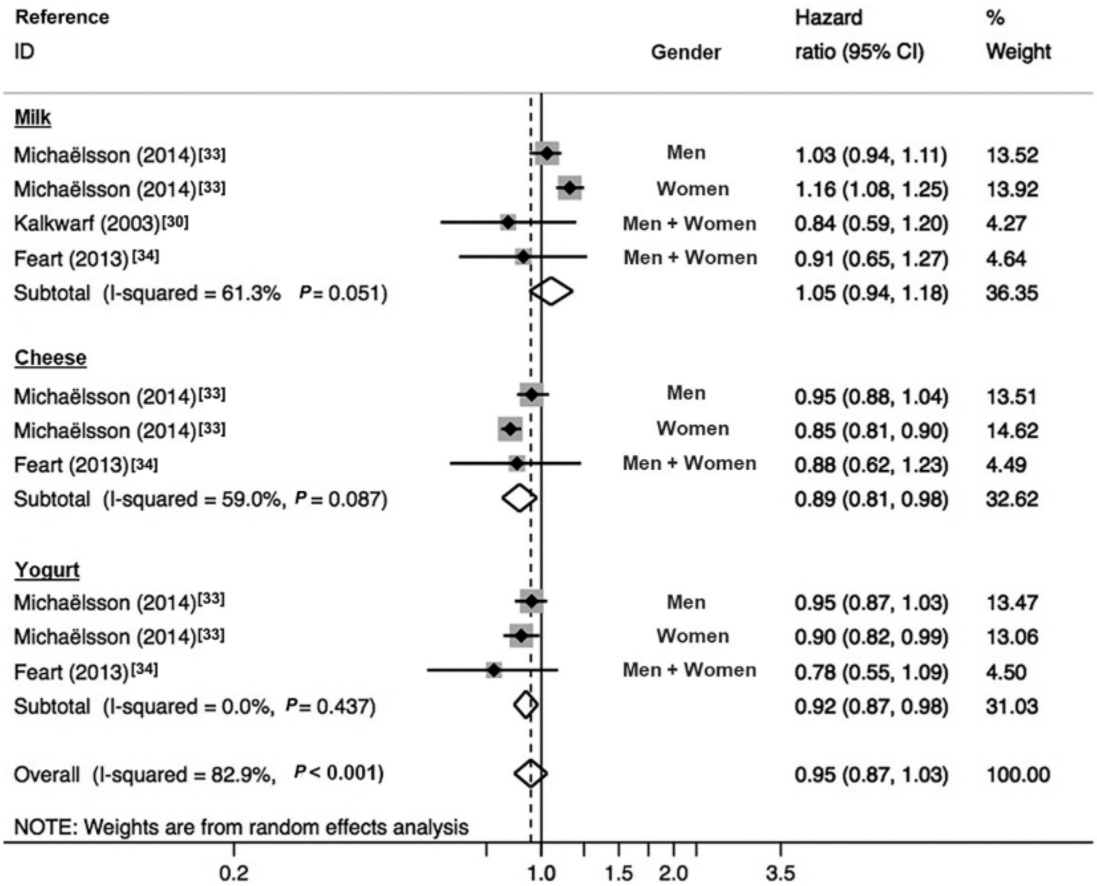

Figure 2: Pooled hazard ratio (HR) (95% confidence interval (CI)) of OF at any site related to the highest compared with the lowest dairy intake, considering the type of dairy (Matía-Martín et al., 2019).

In their meta-analysis Matia-Martin et al., (2019) also could not find an association between dairy consumption and osteoporotic fracture at any site except for vertebral fracture, while only showing that yogurt and cheese may affect OF risk (Matía-Martín et al., 2019).

2.3.4.3. Osteoporosis

The study design in which the relationship between milk consumption and osteoporosis was examined, as well as the type of dairy examined, both play a role in the outcome. While total dairy intake was associated with reduction of osteoporosis risk, dairy milk consumption showed no association (overall RR ¼ 0.79; 95% CI: 0.57–1.08) (Malmir et al., 2020). Cross-sectional studies revealed a positive association between milk consumption and bone microarchitecture (Matía-Martín et al., 2019), while an inverse correlation between the intake of dairy milk and the risk of osteoporosis was shown in both case-control studies and cross-sectional studies (0.63; 95% CI: 0.55–0.73). Non-linear dose-response meta-analysis also showed this inverse association (Pnonlinearty ¼ 0.005), and meta-regression showed an association of 22% and 37% reduced risk of osteoporosis with every additional 20 grams intake of milk. Cohort studies, however, did not show any association between milk intake and risk of osteoporosis (Malmir et al., 2020) (Figure 3).

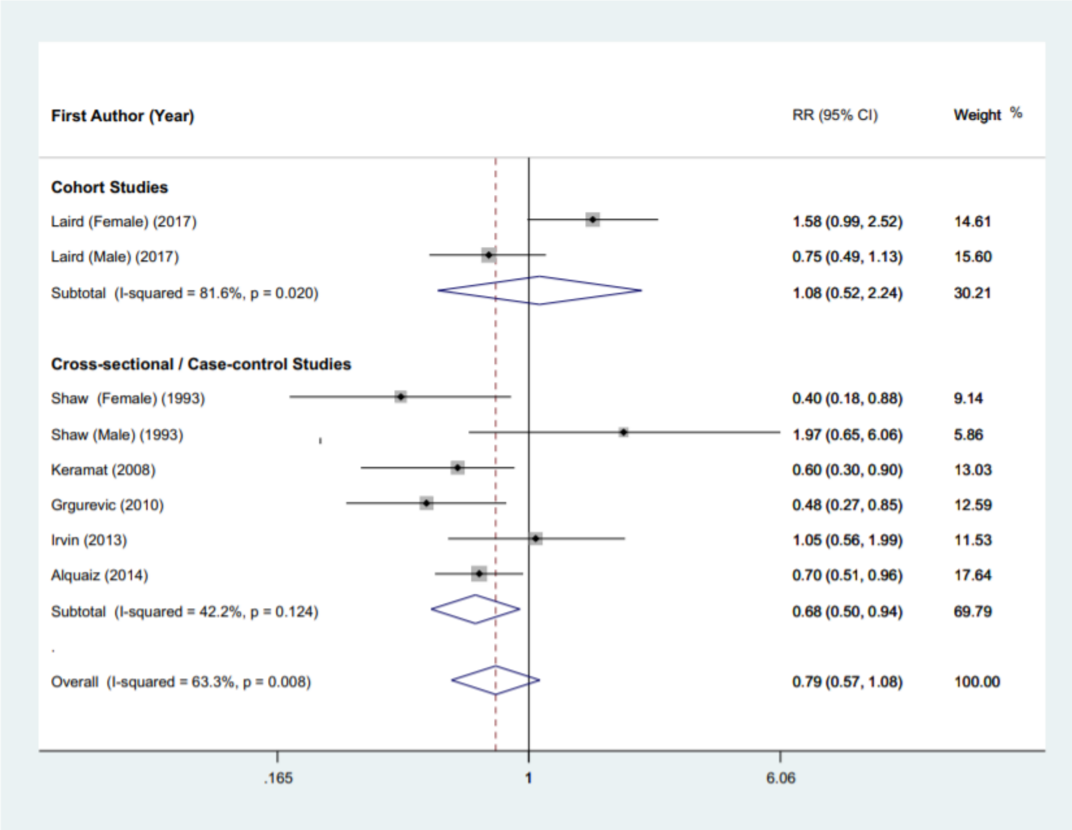

Figure 3: Forest plots showing the association between consumption of milk and risk of osteoporosis (Malmir et al., 2020).

2.3.4.4. Research on Milk and Bone Health

A lot of research concerning dairy milk intake and bone health has been done in both Caucasian and Chinese women and girls alike, with more research being needed on the potential bone health effects in other ethnicities, as well as those in men (Van Den Heuvel et al., 2018). It is important to study the relation between milk consumption and bone health in various ethnic populations. Milk consumption is higher in European and North American populations than those in Asia-Pacific regions, North Africa, the Far East and South America, and in populations where milk intake is very low, an augmentation might have more positive effects than in populations with higher dairy consumption (Matía-Martín et al., 2019).

Most studies use food frequency questionnaires (FFQs) as an easy and affordable method to assess dairy intake, however, these pose many problems as FFQs are inherently inaccurate. Furthermore, yogurt and fermented milk help to increase calcium absorption in the small intestine and attenuate bone loss that is induced by sex hormone deficiency. Certain foods, such as fermented dairy, have also been related to a healthier, nutrient-dense dietary pattern as well as healthier behaviors. Studies looking at combined effects of dairy products on bone health and health in general, therefore, might not be meaningful in examining effects of a specific type of dairy product (e.g., milk) (Matía-Martín et al., 2019).

2.3.5. Summary

Dairy milk has weak anti-inflammatory properties in humans without allergies to dairy, with those effects being stronger in subjects with metabolic disorders (Bordoni et al. 2017; Ulven et al., 2019). There is no association between milk consumption and heart-disease, stroke or all-cause mortality (Mullie et al., 2016; Cavero-Redondo et al.,2019). Studies on the relationship between bone health and dairy milk are often methodologically flawed and inconsistent. There seems to be no relationship between milk consumption and osteoporosis and fractures (except for vertebral fractures), however, there might be positive association between milk consumption and bone mineral density (Matía-Martín et al., 2019; De Lamas et al., 2019). Heterogeneity and health of subjects, types of dairy product, and study designs are all issues, with a lack of randomized-controlled trials (RCTs) only adding to this problem. Certain nutrients in dairy should in theory contribute to bone health, but testing this in RCTs is difficult, especially in the long term. Therefore, causal interpretations cannot be made.

2.4. Allergies and Intolerances

2.4.1. Cow's Milk Allergy (CMA)

CMA is one of the most common food allergies in early childhood. It is an IgE-associated allergy. Data on its prevalence vary, but the European EuroPrevall birth cohort has shown an incidence of CMA of 0.54 % (Linhart et al., 2019), while other studies show that cow's milk protein causes allergic symptoms in 2-3% of infants. Strategies for primary preventions include exclusive breastfeeding for 4-6 months, while infants that cannot be exclusively breastfed should receive allergen-reduced formulas (Lifschitz & Szajewska, 2014). Management of CMA used to consist of fully eliminating dairy products, however, in the last few years, emphasis was put on a more proactive approach that actively modulates the immune system with prebiotics and probiotics (D'Auria et al., 2019).

CMA can manifest in gastrointestinal (GI) symptoms anywhere from mouth to rectum, while reactions in the skin and respiratory tract could potentially be life-threating and may even lead to anaphylactic shock (Linhart et al., 2019). The Hill and Hosking classification indicates the three different ways in which CMA affects individuals: IgE-sensitized individuals react with immediate cutaneous reactions and anaphylaxis, while non-IgE-sensitized individuals show gastrointestinal symptoms within an hour of consumption of moderate amounts of cow's milk. The last group are individuals with late reactions. After several hours or days, they react with GI disturbances, with or without respiratory symptoms and/or eczema/urticaria (D'Auria et al., 2019).

Diagnosis of CMA can be difficult due to delayed reactions, as well as the fact that there are no specific tests for diagnosis. Serum specific IgE or skin prick tests are usually negative and atropy patch tests show conflicting data, therefore an elimination diet followed by a standardized challenge is recommended to test for

CMA (D'Auria et al., 2019); however, molecular allergy diagnosis performed with recombinant allergen molecules may be a faster alternative (Linhart et al., 2019).

For infants affected with CMA, hydrolysate milk formulas are recommended, with GI symptoms usually disappearing within 2 to 4 weeks after the elimination of antigens. (D'Auria et al., 2019).

2.4.2. Lactose Intolerance (LI)

Lactose intolerance is one of the most common food intolerances. Lactose, a disaccharide made up of glucose and galactose linked with a β-1→4 glucosidic bond, is contained in many dairy products. In the brush border of the small bowel mucosa, lactose is hydrolyzed by β-galactosidase (lactase) and then absorbed through the mucosa. In individuals with lactose intolerance, the activity of the lactase enzyme is reduced to a varying degree. (Di Costanzo & Berni Canani, 2019). Lactose is then fermented by gut microbiota which can cause the typical symptoms of abdominal pain, bloating, flatulence, distension, borborygmi and diarrhea (Deng et al., 2015). Corresponding to the degree of lactase activity reduction, there is substantial variability in intra- and interindividual symptoms (Di Costanzo & Berni Canani, 2019).

There are three different types of LI: Congenital lactase deficiency (CLD) is an extremely rare autosomal recessive disease with reduced or absent enzymatic activity from birth. Primary lactose intolerance or adult-type lactase deficiency is a common autosome recessive condition in which a change of lactase gene expression (developmentally regulated) occurs. Primary lactose intolerance is the most common type of lactose intolerance, with around 70% of the population affected worldwide. Secondary lactase deficiency is a transient condition induced by intestinal damage due to diseases such as infections, celiac disease, food allergy, small bowel bacterial overgrowth, Crohn's disease, or radiation/chemotherapy-induced enteritis (Di Costanzo & Berni Canani, 2019).

LI can be treated with a lactose-reduced diet and enzyme (lactase) replacement (Deng et al., 2019). Usually, 12g of lactose (1 cup of milk, 240 ml) can be tolerated (Di Costanzo & Berni Canani, 2019). Studies have shown that probiotics might be helpful in the treatment of lactose intolerance, with probiotics containing various health benefits such as improving intestinal health and enhancing the immune responses, although none of these alleged beneficial effects on health have been approved by the authorities so far. Symptoms of lactose intolerance may be reduced by the consumption of probiotic bacteria in fermented and unfermented milk products (Oak & Jha, 2019).

The prevalence of adult-type lactase deficiency differs in different ethnicities and geographic locations. In Northern Central Europe and North America 5-15% of the population are lactase non-persistent, while around 40% of the population of Mediterranean countries are affected, and in African, Asian and South American countries the number is 65%-90% (Leis et al., 2020).

2.4.3. Differences between Cow's Milk Allergy and Lactose Intolerance

Patients and parents often confuse lactose intolerance with cow's milk allergy and vice versa. CMA can cause a secondary lactase deficiency (Di Costanzo & Berni Canani, 2019), however, there are several differences between CMA and LI (Table 2).

	Lactose Intolerance	**Cow's Milk Allergy**
Mechanism	Enzyme deficiency	Immune-mediated reaction
Onset of symptoms	Childhood	First year of life
Resolution	Irreversible	Usually remits in childhood
Food component involved	Lactose	Cow's milk proteins
Eliciting doses	Grams	Nanograms to milligrams
Gastrointestinal symptoms	Abdominal pain, bloating, flatulence, distension, borborygmi and diarrhea	IgE-mediated: urticaria, angioedema of the lips, tongue and palate, oral puritus, nausea; colicky abdominal pain; vomiting; diarrhea Non-IgE-mmediated: vomiting, diarrhea, blood and/or mucus in the stools, abdominal pain, malabsorption often

		associated with failure to thrive or poor weight gain
Extrainstestinal symptoms	Headache, vertigo, memory impairment and lethargy	IgE-mediated: skin (acute urticaria and/or angioedema); respiratory system (nasal itching, sneezing, rhinorrhea, or congestion, and/or conjunctivitis, cough, chest tightness, wheezing, or shortness of breath); other (signs or symptoms of anaphylaxis) Non-IgE/IgE-mediated: atopic eczema
Test to confirm the diagnosis	Lactose breath test	Oral food challenge
Dietary treatment	Low lactose diet	Cow's milk proteins-free diet

Table 2: Differences between lactose intolerance and cow's milk allergy (adjusted from: Di Costanzo & Berni Canani, 2019).

2.5. Milk and Dairy Consumption in Austria (Rust et al., 2017)

According to the Austrian food pyramid, daily consumption of dairy products should include three portions, with one portion of milk equaling to 200 ml, yogurt 180 to 250 g and cheese 50 to 60 g.

Austrian women consume 255 to 268 g of dairy products a day (Table 3), with only half of Austrian women managing to consume the recommended three portions a day.

19-<25 years		**25-<51 years**		**51-<65 years**	
M	SD	M	SD	M	SD
268.1	181.2	254.6	186.3	256.5	160.0

Table 3: Dairy consumption in Austrian women in g (including mean (M) and standard deviation (SD)) (Rust et al., 2017).

Men in Austria consume 260 to 318 g of dairy and therefore also on average do not reach the recommendations (Table 4).

19–<25 years		**25-<51 years**		**51-<65 years**	
M	SD	M	SD	M	SD
309.9	222.2	269.7	210.9	259.9	207.9

Table 4: Dairy consumption in Austrian men in g (including mean (M) and standard deviation (SD)) (Rust et al., 2017).

Milk and dairy products are an important source of calcium. The daily calcium recommendations are not reached by many Austrians; however, if Austrians consumed the daily recommended three portions of dairy products, their daily calcium consumption would improve by around 200 to 300 mg.

3. Plant-Based Milk Alternatives

3.1. Reasons for Consumption of Plant-Based Milk Alternatives

With consumers looking for functionality in beverages, plant-based milk alternatives are a fast-growing segment of functional and specialty beverages on the world market. The functionality of these plant-based milk alternatives needs to address certain needs and lifestyles of consumers, such as boosting energy, suiting a vegan lifestyle, or certain allergies and intolerances (Sethi et al., 2016).

As discussed in 2. 4., lactose intolerance and cow's milk allergy are among the reasons to switch to plant-based milk alternatives. Further reasons might be ethical and environmental concerns. Also, the number of people, both vegan and non-vegan, who abstain from consuming dairy, is increasing rapidly (BMEL, 2021; Franceagrimer, 2021; FMCG Gurus Dairy Trends in 2021 Global Report, 2021).

3.1.1. Ethical Concerns

Ethical concerns are a very common reason for consumers to reach for plant-based milk alternatives. In Germany, animal welfare is important to 2/3 of consumers, while 41 % are under the impression that animal welfare has decreased in the last few decades (Zühlsdorf et al., 2019). Demands for huge quantities of milk and milk products, as well as economic pressure, has led the dairy industry to exploiting cows in order to provide low prices to consumers, with factory farming enabling huge yields at low prices with albeit low ethical standards (Rayamajhi, 2014).

The EU dairy sector is the second-largest agricultural sector in the EU. In 2016, 168 million tons of milk were produced, 97% of which was cow's milk. In 2020, Austria produced around 3.8 million tons of raw dairy milk (Statistik Austria, 2021a). While the number of cows producing milk has decreased over the last few decades, the amount of milk produced has increased (Pulina et al., 2020). In 2015 there were 23.4 million dairy cows in the EU, with more than half of dairy farms being large or very large farms. The number of dairy cows decreased by 81% from 1983 to 2013 in the EU, while average herd sizes and yield have increased. This has been made possible with increases in feeding efficiency as well as breeding. Yield per dairy cow differs highly from EU-15 (countries that joined the EU before 2004) and EU-13 (countries that joined the EU after 2004), with yields in the EU-15 being 43% higher. 3 % of the milk produced in the EU in 2016 was organic milk, while in Austria, the number was more than 10%. Yields on organic farms are on average 30 % lower than those on non-organic farms (Augère-Granier, 2018).

Being bred to yield more milk can compromise the health of the cows, however, with a correlation between milk yield during previous lactations and health issues such as mastitis, milk fever and retained placenta. There is also a relationship between milk yield in the current lactation and ovarian cysts, milk fever and claw disease, with a possible connection between lactation frequency and various other diseases (Fleischer et al., 2001). More efficient feeding with higher amounts of concentrates, combined with often very high amounts of protein, might also be an issue for the metabolic health of the cows (Kirchgeßner et al., 2008).

In Austria, according to BGBl. II Nr. 492/2004 idgF, 2% of livestock farms have to be checked if the animal welfare regulations are followed. In 2017 2.399 out of 60.588 businesses keeping cows were checked, and out of those 148 (which is 16%) of the businesses showed issues with following animal welfare regulations. Often these issues concerned feed and freedom of movement. In 2018 the number was similar, with 131 out of the 2.594 businesses (20%) being checked having issues with animal welfare (Tierschutzbericht, 2019).

It is questionable, and arguably impossible, that the recommended three portions of dairy a day would be able to be sourced ethically for our growing world population.

3.1.2. Environmental Concerns

Concerning environmental balance, production of dairy products is among the worst of all types of food production. The processing of dairy accounts for 5-25% of food production emissions, depending on the type of product being produced. The majority of the greenhouse gas emissions come from the cow's digestion, as well as the storage and spreading of the manure. The production of feed accounts for the majority of the energy requirements of dairy products (Müller-Lindenlauf, 2014).

Soy is an important feed for livestock, including dairy cows. Not enough soy is produced in Europa to feed all of our livestock, therefore a large portion of it is imported from South America and the USA, with Germany importing around 3.5 million tons of soy in 2019 alone. Ecologically, the huge demand of feed is of great concern for the environment. Brazil is the main producer of soy for feed, with Amazonas regions as well as the Cerrado region being turned into soy fields, causing a tremendous impact on the biodiversity and climate with tons of CO_2 being emitted. The use of pesticides also poses environmental concerns (Bundesinformationszentrum Landwirschaft, 2020).

The CO_2 footprint of raw milk in industrial countries is between 0.7 and 1.5 kilogram (kg)/CO_2-equivalents (eq) per liter. Raw milk then has to be processed, creating an even higher CO_2 footprint. The CO_2 footprint of milk after processing per liter in total is between 1 and 1.7 kg/CO_2-eq. This is quite low among dairy products, however, with the average CO_2 footprint of 1 kg of cheese being between 5.7 and 9.5 kg/CO_2-eq (Müller-Lindenlauf 2014). Organic dairy causes 17.7% less greenhouse gases than dairy from conventional production, due to the abandonment or reduction of soy from South America in organic feed (Lindenthal et al., 2010).

In Austria, non-organic full fat dairy milk causes CO2 emissions of about 1200 g CO2-eq per liter, while organic full fat dairy milk causes just slightly more than 1000 g CO2-eq per liter. More than 80% are emissions from farming and less than 20% are emission from transport, packaging and storage. Compared to that, plant products have a significantly lower CO2 footprint. One kilogram of vegetables such as zucchini, tomato, cucumber and potatoes, both organic and non-organic, causes around 200 g CO2-eq, which is around 16% of the CO2 footprint of non-organic, full-fat dairy milk (Lindenthal et al., 2010).

Eutrophication, acidification, space requirement and direct impacts on biodiversity are further negative environmental impacts of dairy production (Müller-Lindenlauf, 2014).

In Austria, the consumption of three portions of dairy and dairy products a day is recommended, with one portion being 200 ml of dairy, or two thin slices of cheese the size of the palm of one's hand. From an ecological point of view, this would be difficult for our planet to handle. The Planetary Health Diet is a diet from the EAT-Lancet-commission that is supposed to protect the health of humans as well as of the planet equally, and as for dairy products, including milk or products produced from this amount of dairy, the daily recommended amount would be 250 g (0 g – 500 g) (The Eat-Lancet Commission, 2019).

Looking at the ethical and environmental concerns of dairy production, the prospect of having to feed a growing world population and typical consumer habits, it makes sense to look for alternative milk and dairy products.

3.1.3. Vegan Diets

In Austria, there are around 840.000 vegetarians and 106.000 vegans (Statistik Austria, 2022). Austria nevertheless has the highest per capita meat consumption out of the whole of the EU. In 2021, around 2% of the population was vegan, with factory farming being the main reason why most people choose to go vegan (Statistik Austria, 2017; Statistik Austria, 2021c).

3.2. Austrian Market Analysis

3.2.1. Overview

Surveys in Europe have shown that consumers are planning to consume more plant-based alternatives due to Covid-19, including more plant-based dairy alternatives. Between 35% and 60% of those surveyed said that they would increase their intake of plant-based milk alternatives due to Covid-19 (FMCG Gurus Dairy Trends in 2021 Global Report, 2021).

The worldwide plant-based milk alternative sector is thought to be growing rapidly between 2018 and 2024 at a compound rate of more than 14%, with plant-based milk alternatives being the most prominent (European Consumer Survey on Plant-Based Foods, 2020).

From 2018 to 2020, the sales value of plant-based food in Austria grew by 57% (83 million €), with sales volume increasing by 52% (26 million Kg/L) in that same period of time. Discounters such as Hofer and Lidl showed the strongest increases (83% or 15 million € and 82% (6 million Kg/L respectively), but those numbers account for all the plant-based food alternatives, including products such as plant-based meat alternatives. Plant-based milk alternatives (plain milks – not including flavored milk alternatives), have the biggest sales value in Austria of 37 million €, with oat milk being the most popular plant milk in Austria with sales values of 10 million €, followed by almond milk (9.5 million €). In discounters, oat and rice milk were the most popular. (Smart Protein Plant-based Food Sector Report, 2021)

3.2.2. Methods

An analysis of the Austrian market of plant-based milk alternatives was done on products that were available in stores on the Austrian market between July and October of 2021. Also, only products with no added flavors such as vanilla or chocolate were analyzed. Plant-based milk alternatives from the leading grocery retailers in Austria have been taken into consideration, including Spar, with a market share of 34.6%, REWE Group (Billa, Billa Plus, Penny, ADEG, Bipa) (33.3%) as well as Lidl and Hofer with a shared market share of 25.4%. These retailers make up 93.3% of the market share in Austria (Statistik Austria, 2021b). Products from DM and Denns were also included, as these stores provide an important market, especially for consumer groups such as vegans and vegetarians. Both nutritional value and ingredients were evaluated and compared.

The number of plant-based milk alternatives added up to n=166 with 29 included brands, 37 of which were oat drinks, 13 rice drinks, 6 spelt drinks, 2 buckwheat drinks, 1 millet drink, 26 soy drinks, 6 pea drinks, 1 lupin drink, 21 almond drinks, 13 coconut drinks, 5 cashew drinks, 1 hazelnut drink, and 34 mixed drinks. 98 of those are organic.

3.2.3. Fortification

Out of the 166 milk alternatives analyzed, 61 (37%) were fortified with calcium, vitamin B2, vitamin B12 and/or vitamin D. Out of the 61 fortified drinks, 29 were fortified with all of those four micronutrients.

Calcium: When plant-based milk alternatives are fortified with calcium, it is usually with 120 mg/100 ml of calcium, to mimic the amount contained in cow’s milk.

Vitamin B2: Plant-based drinks are typically fortified with 0.21 mg/100 ml of vitamin B2, analogous to the amount that naturally occurs in cow's milk (0.17 mg/100 ml in skimmed milk and 0.18 mg/100 ml in reduced fat and whole milk).

Vitamin B12: Cow's milk (whole as well as reduced fat) contains 0.4 µg/100 ml of B12. Skimmed milk has a lower amount with 0.3 µg/100 ml. Plant-based dairy is often fortified with 0.38 µg 100 ml of B12.

Vitamin D: Vitamin D fortification is frequently 0.75 µg/100 ml, but can go up to 1.5 µg/100 ml in some cases. When plant-based milk is fortified it contains significantly more vitamin D than cow's milk, with whole milk containing 0.09 µg/100 ml of vitamin D, reduced fat milk 0.03 µg/100 ml, and skimmed milk only containing traces.

Very few drinks are fortified with vitamin E or iodine. Potassium iodide is occasionally used as a source of iodine fortification. The exact amounts are not provided in most products. Very few specialty drinks, such as plant-based milk alternatives marketed towards young children, are fortified with further nutrients such as zinc, iron, folic acid or vitamin C (more: chapter: 3.2.4.6.2.).

3.2.4. Types

3.2.4.1. Cereal-Based Milk Alternatives

Cereal-based milk alternatives include oat, rice, spelt, buckwheat and millet drinks. There are also corn drinks on the world market, but not on the Austrian market. Therefore, corn drinks were not included in the analyses.

3.2.4.1.1. Oat Drinks

3.2.4.1.1.1. Production

Oats are made up of 55-60% starch, which is known to gelatinize and form a gel like consistency when heated to 44.7-73.7 °C. To prevent this, enzymatic hydrolysis is used after adding water to the oats in order to obtain a better consistency, and therefore a product with higher acceptability (Figure 4). The product is then filtrated and 2.85 kg of oat milk is produced out of 1 kg of rolled oats. Oats milks are ultra-high-temperature (UHT) treated (Sethi et al., 2016).

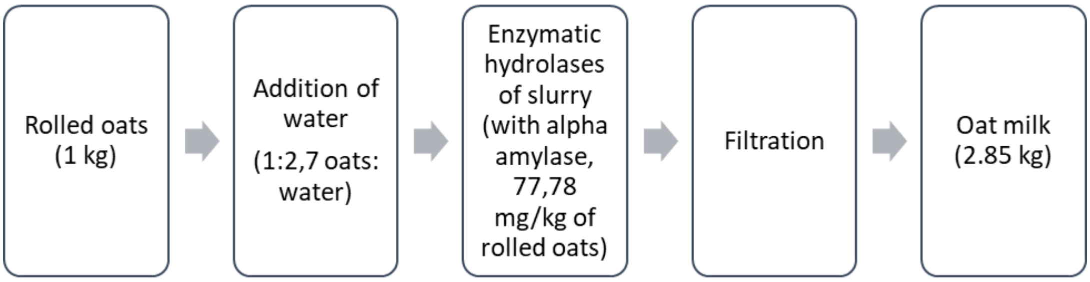

Figure 4: Process of producing oat milk (Sethi et al., 2016).

3.2.4.1.1.2. Nutrients and Functional Aspects

Oats have hypocholesterolaemic (reducing LDL cholesterol), antioxidative and anticancerous properties, and contain phytochemicals and proteins with good amino acid balance (Thies et al., 2016). They are especially appreciated for their functionally active component b-glucan, a soluble fiber with neutraceutical properties, which is known to reduce blood glucose levels (Ho et al., 2016; Sethi et al., 2016). Oats help Type-2 diabetics with blood glucose control as well as their blood lipid profile (Hou et al., 2015). B-glucan can increase viscosity in a solution and therefore delay gastric emptying time, resulting in longer satiety. It also increases GI transit time (Sethi et al., 2016). Oats also contain phenolic compounds, avenanthramides and saponins (Paul et al., 2021.). Avenanthramides are primarily exclusively found in oats, and according to some authors these phytochemicals show chemopreventive and anticancerous properties in various models, while their effect on humans remains to be proven (Turrini et al., 2019). *"Oat contains 60 % starch, 11–15 % total protein, 5–9 % lipids, 2.3–8.5 % dietary fibre and 0.54 % calcium"* (Sethi et al., 2016). However, oats contain relevant amounts of phytic acid, an antinutrient that can inhibit the absorption of certain minerals such as iron and zinc (Sethi et al., 2016).

While oats have beneficial properties for one's health, it should be noted that oat drinks contain only around 10% oats. In Austrian oat drinks, that percentage spans from 5.5% to 16%, with one 200 ml portion of oat drink containing on average 20 g of oats. Nevertheless, studies on oat milk have also indicated that oat drinks may have cholesterol reducing effects (Önning et al., 1999). This might be due to either the effects of the b-glucans, or to the replacement of saturated fat from dairy milk with unsaturated fat, in the case that oat drinks are consumed instead of dairy milk (Önning et al., 1998). However, the number of current studies on the health effects of oats drinks is scarce.

3.2.4.1.1.3. Market Overview of Oat Drinks in Austria

Oat milks are the most consumed dairy-alternatives in Austria (Smart Protein Plant-based Food Sector Report, 2021). Table 5 shows an overview of the oat drinks available on the Austrian market, including nutrition values per 100 ml. The mean (m), standard deviation (SD) minimum (min) and maximum (max) of all values that were specified in all products (energy, fat, SFAs, carbohydrates, sugar, protein and salt) were calculated. As not all products had specifications for MUFAs, PUFAs, fiber and the micronutrients vitamin D, vitamin B2, vitamin B12 and calcium, no m, SD, min and max were calculated for those values. 37 oat drinks from 18 brands are included. Of those 37 products, 24 are organic.

Oat Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D (µg)	B2 (mg)	B12 (µg)	Calcium (mg)
Aito Oat Drink Barista	58	3.0	0.3			6.7	3.5	1.0	0.6	0.1	1.00	0.20	0.40	120
Allos Hafer + Calcium	51	1.0	0.2			9.0	4.2	1.0	0.1	0.1				
Allos Hafer 0% Zucker Drink	29	0.9	0.2			4.5	0.0	0.4	0.6	0.1				
Allos Hafer Barista Drink	57	1.2	0.2			10.0	4.0	1.3	0.9	0.1				
Allos Haferdrink ungesüßt	51	1.4	0.2			9.0	4.2	1.0	1.0	0.1				
Alnatura Haferdrink Calcium	39	1.4	0.2			6.0	5.2	0.5	0.6	0.1				120
Alpro Barista Hafer	59	3.0	0.3	1.1	1.6	6.7	3.3	1.0	0.8	0.1	0.75	0.21	0.38	
Alpro Haferdrink Ohne Zucker	40	1.5	0.2	0.5	0.8	5.6	0.0	1.2	0.2	0.1	0.75	0.21	0.38	120
Alpro Haferdrink Original	44	1.5	0.1	0.7	0.7	6.8	3.3	1.4	0.3	0.1	0.75	0.21	0.38	120
Dennree Hafer	42	0.8	0.1	0.2	0.4	7.8	4.5		0.7	0.1				
Dennree Hafer Calcium	42	0.8	0.1			7.8	4.5		0.7	0.1				
DM Bio Haferdrink Natural	40	1.4	0.2			6.0	5.2	0.5	0.6	0.1				
Hofgut Storzeln Hafer	50	1.1	0.3			9.0	4.5	0.5	0.7	0.1				
Ja! Natürlich Haferdrink	41	0.8	0.1			7.7	4.5		0.7	0.1				
Joya Bio Hafer	42	0.8	0.1	0.2	0.4	7.7	4.5	0.7	0.7	0.1				
Joya Bio Hafer Glutenfrei	42	0.8	0.1	0.2	0.4	7.7	4.5	0.7	0.7	0.1				
Joya Hafer 0% Sugar	25	0.8	0.1	0.0	0.0	4.0	0.0	0.2	0.4	0.1	0.75		0.38	
Joya Hafer Barista Bio	57	2.1	0.4	0.0	0.0	8.9	4.1	0.3	0.4	0.0				
Joya Hafer Chia	47	1.3	0.2	0.3	0.7	7.8	4.6	0.6	0.7	0.1	0.75		0.38	
Joya Hafer Frisch	28	0.7	0.1	0.2	0.4	4.8	2.8	0.3	0.4	0.1	0.75		0.38	
Natumi Hafer Barista	55	1.8	0.4	0.6	0.8	8.4	4.1	0.3	1.2	0.1				
Natumi Hafer Glutenfrei	42	0.8	0.1			7.7	4.5		0.7	0.1				

Natumi Hafer Natural	48	1.3	0.3	0.4	0.6	8.4	5.6	0.5	0.5	0.1				
Natumi Hafer Zero	25	0.8	0.1	0.2	0.4	3.9	0	0.2	0.4	0.1				
Oatly Hafer Barista	59	3.0	0.3			6.6	4.0	0.8	1.0	0.1	1.10	0.21	0.38	120
Oatly Hafer Bio	36	0.5	0.1			6.7	4.1	0.8	1.0	0.1				
Oatly Hafer Calcium	46	1.5	0.2			6.7	4.1	0.8	1.0	0.1	1.10	0.21	0.38	120
Oatly Hafer Classic	46	1.5	0.2			6.6	4.1	0.8	1.0	0.1	1.10	0.21	0.38	120
Oatly Hafer Deluxe	57	2.8	0.3			6.6	4.1	0.8	1.0	0.1	1.10	0.21	0.38	120
Provamel Hafer	47	1.3	0.5	0.2	0.6	8.1	3.9	0.8	0.3	0.1				
Provamel Hafer Calcium	47	1.3	0.5			8	3.8	0.8	0.3	0.1				
Rude Health Oat Drink	43	1.6	0.4			6.1	4.1	0.3	0.8	0.1				
Schärdinger Hafer	42	0.8	0.2			7.7	4.5		0.8	0.1				
Share Hafermilch	42	1.6	0.2			6.4	2.7		0.0	0.1				
SPAR NATUR*PUR Bio-Haferdrink	42	0.8	0.2			7.7	4.5	0.3	0.8	0.1				
Voelkel Hafer	35	0.8	0.3			5.5	5.2	1.6	0.8	0.1				
Zurück zum Ursprung BIO-Haferdrink Natur	42	0.8	0.2			7.7	4.5		0.8	0.1				
Mean	44	1.3	0.2			7.1	3.8		0.7	0.1				
SD	9	0.7	0.1			1.4	1.5		0.3	0.0				
Max	59	3.0	0.5			10.0	5.6		1.2	0.1				
Min	25	0.8	0.1			3.9	0.0		0.1	0.1				

Table 5: Nutritional values of oat drinks in Austria per 100 ml.

3.2.4.1.1.4. Nutritional Values

On average, the analyzed oat drinks have 44 kcal per 100 ml, ranging from 25 to 59. It is interesting to note, however, that barista versions of oat drinks raise the average energy content, as they are generally higher in energy due to a higher fat (and protein) content. In the category of oat drinks, for example, six barista versions were included with an average energy content of 57.5 kcal per 100 ml, while non-barista oat drinks have an average energy content of 41.7 kcal per 100 ml.

The average fat content ranges from 0.8 g of fat to 3.0 g per 100 ml, with an average of 1.3 g. Of those, on average 0.2 g are saturated fatty acids, 0.3 g MUFAs and 0.6 g per 100 ml PUFAs. Not all oat milks display their amount of MUFAs and PUFAs, though: 21 out of the 37 have those specifications. The carbohydrate content ranges from 3.9 g to 10.0 g/100 ml, with an average of 7.1. Of those, on average 3.8 g/100 ml are sugar (0 g-5.6 g). The protein content varies substantially, with a minimum of 0.1 g/100 ml of protein, to 1.2 g/100 ml of protein (m = 0.7g /100 ml). The salt content in every product is 0.1 g/100 ml.

3.2.4.1.1.5. Composition

The most common ingredient in oat drinks is water, followed by oats. The oat content ranges from 5.5% to 16%, with one product containing fermented oats. The next highest ingredient after oats is, in the vast majority of products, oil. Four products contain more chicory root fiber, soy or inulin than oil. 32 oat drinks contain sunflower seed oil, while 5 contain rapeseed oil. One contains more chia oil and flaxseed oil than sunflower seed oil. Most contain salt. None have added sugar.

Some products were fortified and some contain additives (more: chapters 3.2.3. and 3.3.). Furthermore, the emulsifier E472e was used in one product. One oat milk contains pea protein. “Hafer Chia” (oat-chia) drink containing chia oil and flaxseed oil contains extracts with tocopherols as an antioxidant. Additionally, the thickener carob bean flour is also used in one product. Agave fiber is contained in one product.

3.2.4.1.1.6. Comparison to Milk

Oat drinks have on average a similar number of kcal as reduced fat milk. However, energy wise, different oat milks are not comparable, as they range from 25 kcal to 59 kcal per 100 ml. But even the most energy dense oat drink contains fewer kcal than full-fat milk.

Oat drinks also contain on average just slightly less fat than reduced fat milk (1.3 g/100 ml vs 1.6 g/100 ml). However, the fatty acid profile of cow's milk is quite different compared to that of oat drinks. Saturated fat in oat drinks accounts for only 15% of their fat content, while it is around 60% in whole and reduced fat milk. About 8% of the fat in whole milk and 25% of the fat in reduced fat milk comes from MUFAS, while in oat drinks it is 23%. The amount of PUFAs in oat drinks (46% of fat) is significantly higher than in milk (3% of fat in whole milk). As with all plant-based milk alternatives, oat drinks do not contain trans fatty acids or cholesterol, unlike milk. All in all, it can be said that oat drinks have a more favorable fatty acid profile than milk.

Oat drinks contain more carbohydrates than milk (7.1 g/100 ml vs 4.7/4.8 g/100 ml) but less sugar (3.8 g/100 ml vs. 4.7/4.8 g/100 ml).

With an average of 0.7 g/100 ml of protein (0.1 g/100 ml-1.2 g/100 ml), oat drinks are much lower in protein than milk, with an average of about 3.3-3.5 g per 100 ml.

As with other plant-based milk alternatives, oat drinks that are fortified have similar amounts of calcium, vitamin B2 and vitamin B12, as well as much higher amounts of vitamin D, as milk. Oat drinks that are not fortified are very low in those nutrients (more: chapter 3.2.3.).

3.2.4.1.2. Rice Drinks

3.2.4.1.2.1. Production

To produce rice drinks, rice is milled. When it is fully milled, only the white rice remains, while when it is partially milled, brown rice remains. Afterwards, the milled rice is ground and combined with water, resulting in a slurry. It is then filtered to remove coarse parts. The starch is then partially broken down with enzyme treatment and a suspension mixture is created. Other ingredients such as oil and vitamins are added last (Lamothe, 2020).

3.2.4.1.2.2. Nutrients and Functional Aspects

Rice is high in starch (nearly 90%) with a noticeably low protein content, lacking threonine and lysine (Paul et al., 2020). Rice bran contains valuable phytonutrients such as high quantities of ferulic acid and p-coumaric acid, both of which are reported to be potent antioxidants (Chaudhary et al., 2019; Shen et al., 2019). When rice drinks are made, this rice bran is usually removed, leading to rice milk lacking vital nutrients such as iron, 85% of which is contained in the bran (Paul et al., 2020). The arsenic content of rice in general is often a concern, and although rice drinks only contain 5.1%-17% rice, the arsenic content might be an issue (Meharg et al., 2008).

3.2.4.1.2.3. Market Overview of Rice Drinks in Austria

13 rice drinks from 11 different brands were analyzed, 10 of which were organic. Table 6 shows the nutritional values per 100 ml of the analyzed rice drinks.

Rice Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D (µg)	B2 (mg)	B12 (µg)	Calcium (mg)
Allos Reis 0% Zucker	44	0.7	0.1			8.8	0	0.5	0.5	0.0				
Allos Reis ungesüßt	60	0.8	0.6			13	6.4	0.5	0.5	0.1				
Alnatura Reisdrink Calcium	50	1.1	0.1			9.9	7.1	0.5	0.5	0.1				120
Alpro Reisdrink Original	47	1.0	0.1	0.3	0.6	9.5	3.3	0	0.1	0.1	0.75		0.38	120
Dennree Reis Natur	50	0.6	0.1			11	4.2		0.1	0.1				
DM Bio Reis Drink Natur	48	1.1	0.1			9.4	6.7	0.1	0.1	0.1				
Joya Bio Reis	55	0.8	0.1	0.2	0.5	12	6.5	0.3	0.2	0.1				
Joya Reis 0% Zucker	22	0.5	0.1	0	0	3.9	0	0.4	0.2	0.1	0.75		0.38	120
Natumi Reis Natural	50	1.1	0.1	0.3	0.6	9.9	7.1	0.1	0.1	0.1				
Natur aktiv Bio Reis Drink	60	1.4	0.4			11	4.8	0.2	0.1	0.1				
Rude Health Brown Rice Drink	50	0.9	0			10	5.8	0.3	0.2	0.1	0.8		0.40	120
SPAR Veggie Reisdrink Natur	54	0.8	0.1			11	6.4	0.5	0.5	0.1				
Vegavita Reisdrink	54	1.0	0.1			11	6.0		0.5	0.1				
Mean	50	0.9	0.2			10.0	4.9		0.3	0.1	0.77			
SD	10	0.2	0.2			2.2	2.5		0.2	0.0	0.03			
Max	60	1.4	0.6			13.0	7.1		0.5	0.1	0.80			
Min	22	0.5	0.0			3.9	0.0		0.1	0.0	0.75			

Table 6: Nutritional values of rice drinks in Austria per 100 ml.

3.2.4.1.2.4. Nutritional Values

The energy content in the analyzed rice drinks range from 22 kcal to 60 kcal with an average of 50 kcal. On average, the rice drinks contain 0.9 g of fat per 100 ml (SD 0.2), with a range of saturated fatty acids from 0 to 0.6 g/100 ml (m=0.2), of which 0.2 g are MUFAS and 0.4 g PUFAS. However, only 4 of the 13 drinks had specifications on MUFAS and PUFAS. The rice drinks also contain an average of 10 g per 100 ml (3.9 - 13) of carbohydrates, 4.9 g per 100 ml of which are sugar. Rice drinks contain 0.1 g per 100 ml of salt.

3.2.4.1.2.5. Composition

Rice drinks are mostly made up of water, followed by 5.1 %-17 % rice. Only one product contains brown rice, which is also reflected in the name ("Brown Rice Drink"). The third most common ingredient in all drinks is sunflower oil. A third of rice drinks are fortified (more: chapter 3.2.3.). All drinks contain salt and none have added sugar. Three rice drinks have additives (more: chapter 3.3.).

3.2.4.1.2.6. Comparison to Milk

Rice drinks contain on average 50 kcal per 100 ml, ranging from 22 to 60, which is similar to reduced fat milk with an energy content of 48 kcal/100 ml. Rice drinks on average only contain about one fourth the fat of whole milk (0.9 g/100 ml vs 3.6 g/100 ml), and almost half that of reduced fat milk, which contains 1.6 g per 100 ml. It does contain more fat than skimmed milk, however, with only 0.1 g/100 ml. Rice drinks have a better fatty acid profile than milk since the percentage of MUFAs and PUFAs is higher, and their saturated fatty acid content is lower. It is, however, important to add that the absolute amount of MUFAs in rice drinks is still quite low compared to cow's milk, since the absolute amount of fat is very low. Rice drinks do contain a significant amount of PUFAs, with an average of 0.4 mg per 100 ml, which is four times as much as that in whole milk.

Rice drinks are high in carbohydrates and contain a similar amount of sugar as milk. With an average of 10 g/100 ml, they contain about twice as much of carbohydrate as milk. Milk is way higher in protein than rice drinks. With 0.3 g of protein per 100 ml, rice drinks contain close to no protein, while milk contains more than 10 times the amount.

3.2.4.1.3. Spelt Drinks, Buckwheat Drinks and Millet Drinks

As spelt drinks, buckwheat drinks and millet drinks only have a small representation in the market, and their nutritional values are quite similar, as seen in tables 7, 8 and 9, they are summarized in one section.

3.2.4.1.3.1. Nutrients and Functional Aspects

Buckwheat is a gluten-free grain with a balanced amino acid profile, as well as a high concentration of bioactive flavonoids (Huda et al., 2021). An increased intake of buckwheat might be beneficial for cardiovascular health as it improves glucose levels, triglycerides, and total cholesterol (Li et al., 2018). Buckwheat contains high levels of rutin, a phenolic metabolite which may be beneficial in preserving insulin signaling (Kreft, 2016).

Millet is also rich in polyphenols, especially benzoic acid and cinnamic acid derivates, with proposed antidiabetic, antioxidant, hypocholesterolaemic and antimicrobial effects (Devi et al., 2014).

3.2.4.1.3.2. Market Overview of Spelt Drinks, Buckwheat Drinks and Millet Drinks in Austria

Tables 7 to 9 give an overview of the nutritional values from spelt drinks, buckwheat drinks and millet drinks available on the Austrian market. 6 spelt drinks, 2 buckwheat drink and 1 millet drink are included. All of these are organic.

Spelt Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)
Allos Dinkeldrink ungesüßt	59	1.1	0.1			11	5.5	0.9	0.8	0.1
Dennree Dinkel	43	1.0	0.1	0.2	0.6	7.7	7.0		0.7	0.1
DM Bio Dinkeldrink Natur	42	1.5	0.2			6.2	5.7	0.4	0.8	0.1
Ja! Natürlich Dinkeldrink	45	0.6	0.1			9.6	7.8		0.5	0.1
Natumi Dinkel Natural	45	1.0	0.1	0.3	0.5	8.7	6.7	0.5	0.5	0.1
Zurück zum Ursprung BIO-Dinkeldrink Natur	44	0.5	0.1			9.0	7.0		0.8	0.1
Mean	46	1.0	0.1			8.7	6.6		0.7	0.1
SD	6	0.4	0.0			1.6	0.9		0.1	0.0
Max	59	1.5	0.2			11.0	7.8		0.8	0.1
Min	42	0.5	0.1			6.2	5.5		0.5	0.1

Table 7: Nutritional values of spelt drinks in Austria per 100 ml.

Buckwheat Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)
Hofgut Storzeln Buchweizen pur	51	1.1	0.2	0.6	0.3	8.4	5.6	0.7	1.6	0.1
Natumi Buchweizen Natural	51	1.1	0.2	0.3	0.6	8.4	5.6	0.7	1.6	0.1
Mean	51	1.1	0.2	0.5	0.5	8.4	5.6	0.7	1.6	0.1
SD	0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0
Max	51	1.1	0.2	0.6	0.6	8.4	5.6	0.7	1.6	0.1
Min	51	1.1	0.2	0.3	0.3	8.4	5.6	0.7	1.6	0.1

Table 8: Nutritional values of buckwheat drinks in Austria per 100 ml.

Millet Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)
Natumi Hirse Natural	54	1.1	0.1	0.3	0.7	10	5.5	0.5	0.7	0.1

Table 9: Nutritional values of millet drinks in Austria per 100 ml.

3.2.4.1.3.3. Nutritional Values

None of the described drinks are fortified, and are therefore low in calcium, vitamin B2, vitamin D and contain no vitamin B12. With around 50 kcal per 100 ml, spelt drinks, buckwheat drinks and millet drinks resemble reduced fat milk, containing 48 kcal per 100 ml. With around 1 g of fat per 100 ml, they are quite low in fat, even lower than reduced fat milk with 1.6 g/100 ml. Their fatty acid profile is very good, with only 0.1 g-0.2 g/100 ml of saturated fat and high amounts of MUFAs and PUFAs. In spelt drinks and in the analyzed millet drink, PUFAs make up more than 60% of the total fat content. All the drinks are quite high in naturally occurring sugars, with more than 50% of the carbohydrates being sugar (5.5 g/100 ml for millet drinks, 5.6 g/100 ml for buckwheat drinks and 6.6 g/100 ml for spelt drinks). Spelt drinks and millet drinks are similarly low in protein, with only 0.7 g of protein per 100 ml. Buckwheat drinks, however, are significantly higher in protein, with 1.6 g per 100 ml.

3.2.4.1.3.4. Composition

The main ingredient in all drinks is water, followed by spelt, buckwheat or millet. Spelt drinks contain between 11% and 17% spelt. For buckwheat drinks, it is 12.5% buckwheat, and the millet drink contains 15% of millet. The next most contained ingredient in each drink is sunflower oil, followed by salt. None of the drinks are fortified, contain additives or added sugar.

3.2.4.1.3.5. Comparison to Milk

The described drinks have a similar energy content as reduced fat milk. With around 1 g of fat per 100 ml, they have a fat content between that of reduced fat milk and skimmed milk, and their fatty acid profile is more favorable than that of milk. Only around 10% of the contained fat comes from saturated fatty acids, while in dairy milk, more than half of the fat is saturated. Spelt drinks, buckwheat drinks and millet drinks contain a significant amount of MUFAs and PUFAs. In dairy milk, the fatty acids are mainly saturated fatty acids, with a small amount of MUFAs and an insignificant amount of PUFAs. In the described cereal-based drinks, around 90% of the contained fatty acids are MUFAs or PUFAs, with the millet drink being particularly high in PUFAs, and buckwheat drinks in MUFAs. Cereal-based drinks contain on average double the amount of carbohydrates as dairy milk and slightly more sugar as well. While spelt drinks and millet drinks only contain 20% of the protein content of dairy milk, buckwheat drinks contain about half of the protein content of dairy milk. Due to these drinks not being fortified, they are not comparable to dairy milk in terms of micronutrients.

3.2.4.2. Legume-Based Milk Alternatives

Legume-based milk alternatives include soy drinks, lupin drinks, peanut drinks and cowpea drinks. On the Austrian market, there are no peanut drinks or cowpea drinks, therefore, those will not be discussed in further detail.

3.2.4.2.1. Soy Drinks

3.2.4.2.1.1. Production and Improvement of Flavor

To produce soy drinks, soybeans are soaked in water and then ground to produce a slurry. Flour or full fat flakes can alternatively also be used. Trypsin inhibitors are inactivated by heating the slurry, and the heat also helps improve the flavor and increase shelf-life. The slurry is then filtered to remove the fiber residue. Lastly, the soy drinks can be fortified, flavored, pasteurized, homogenized or sterilized (Snyder and Wilson, 2003).

Soy milk has been traditionally consumed in China and to a lesser extent in other East Asian countries for hundreds of years. The traditionally produced soy milk, however, expired quickly and had a beany flavor coming from compounds that are produced when the beans are ground with water. Commercially available soy milk is processed in order to increase shelf life, nutritional value and reduce the beany flavor that is often not appreciated by the western palate (Berk, 1992; Sethi et al., 2016).

There are different methods to achieve this reduction of the beany flavor. One of these methods is a vacuum treatment at high temperatures. This helps to remove sulfur components, short chain fatty acids and sterols. Another method is the Cornell hot grinding method, where soybeans are soaked in water and ground with steam or boiling water. Lipoxygenase is then inactivated as the slurry is kept at 80°C. Starting with isolates and concentrates, defatted flour and alkaline soaking are also ways to reduce the beany flavor. Evaporation can also be used to remove the unwanted flavor compounds. Genetically engineered varieties of soybeans that do not have lipoxidase activity can also be a way of avoiding off-flavors. When soy milk is produced, soy protein runs the risk of being dissociated, denatured and aggregated. This can reduce the solubility of proteins, so pulsed electric field processing (PEF) is often used to avoid this. (Sethi et al., 2016; Berk, 1992)

3.2.4.2.1.2. Nutrients and Functional Aspects

Soy is a source of monounsaturated and polyunsaturated fatty acids. Soy contains high amounts of isoflavones, which are functionally active components that are claimed to have anticarcinogenic effects, protect against cardiovascular disease and osteoporosis. The most prominent isoflavone in soy is genistein. A dry soybean contains, on average, 40% protein, 20% fat, 35% carbohydrates and 5% ash (Sethi et al., 2016). Soy is high in minerals such as iron, calcium and zinc (Rizzo and Baroni, 2018).

Soy protein is a main allergen, however, making soy drinks unsuitable for people with allergies to soy proteins. (Sethi et al., 2016) Prevalence of soy allergies are 0 to 0.5% (0.27) for the general population and 0 to 12.9% (2.7) for allergic children (Katz et al., 2014).

3.2.4.2.1.3. Health Aspects of Soy

Soy products are the main source of isoflavones in the human diet. Isoflavones are phytoestrogens which resemble vertebrae steroid estrogens (17β-estradiol) due to a similar molecular structure. Endogenous estrogens and isoflavones both have a phenol group in common, which allows them to attach to and activate estrogen receptors. Soy products mainly contain the isoflavones genistein and daidzein. When these phytonutrients are consumed, they have estrogenic or, in high concentrations, antiestrogenic effects. When there is a deficit of estrogen, isoflavones have the effect of a weak estrogen. Isoflavones have beneficial chemoprotective effects and may also have a positive influence on hormone disorders. However, they may also have endocrine disrupting properties in certain populations (Krížová et al., 2019).

Genistein can be used as a supplement to reduce menopausal symptoms. Results have been controversial, but genistein seems to reduce hot flashes. Moreover, soy consumption may lower LDL cholesterol. It has also been shown to lower blood pressure in hypertensive patients. Genistein may also positively affect bone health, since it reduces osteoclastic factors and increases osteoblastic factors. However, studies on the relationship between soy consumption and bone health have shown ambiguous results (Krížová et al., 2019).

Consuming soy may help prevent the occurrence, reoccurrence and lower the mortality rate of breast cancer (Fritz et al., 2013). A higher intake of soy during childhood and/or adolescence may potentially lower the risk of breast cancer later in life. Women who already suffer from breast cancer may also benefit from soy isoflavone consumption, as they may lower risk of death and cancer recurrence. Breast tissue differentiation during childhood and adolescence is influenced positively by isoflavone intake, showing that breast cancer cell formation can be reduced. Meta-analyses show that there is a relationship between isoflavone consumption and reduction of prostate cancer risk. Cell culture studies and animal studies indicate that soy isoflavones inhibit thyroid peroxidase activity and therefore thyroid hormone synthesis. When adequate amounts of iodine are taken, high intakes of isoflavones do not increase the risk of hypothyroidism. Furthermore, isoflavones are highly antioxidative (Krížová et al., 2019).

An umbrella review by Li et al. (2020) found no association between consumption of soy and risk of mortality from cancer, CDV and all-causes. A negative relationship between fermented soy consumption (miso and natto) and CDV mortality was found however (0.84; 95% CI: 0.73, 0.979), and a reduced cancer risk (ovarian, prostate, gastric, colorectal, lung and breast) was found in association with high soy consumption. However, there is a positive correlation between gastric cancer and high intake of miso soup in males, which might be due to the high salt content. While isoflavone consumption is not correlated with risk of coronary heart disease, CVD or stroke, soy consumption is negatively correlated with risk of those diseases. The FDA approved a health claim for food-labeling in 1999 for soy protein (25 g day) and the prevention of coronary heart disease (Li et al., 2020). Soy protein lowers LDL cholesterol as well as triglycerides (Messina, 2016). Positive effects on the serum lipid profile are mainly due to soy proteins. These effects are strongest in hypercholesterolemic subjects. Li et al. (2020) states that: *"Recently, a systematic review of 43 human studies and 62 animal studies by the European Food Safety Authority concluded that no harmful effect of isoflavones from food supplements has been observed on mammary gland, uterus, and thyroid in peri- and postmenopausal women. Generally, soy and isoflavone consumption is more beneficial than harmful. The results herein support promoting soy intake as part of a healthy diet."* (Li et al., 2020).

Potential negative effects of soy on male hormones are often discussed. However, studies show that testosterone levels, as well as sperm count, are not lowered by soy or isoflavone consumption (Messina, 2016).

Soy isoflavones have been shown to inhibit thyroid peroxidase in vitro, thyroid peroxidase having an important function in the synthesis of T3 and T4. It seems that in vivo, however, soy might have a more significant effect on subjects with a compromised thyroid function. Soy might moderately rise TSH levels with no changes in levels of fT3 and fT4. It is not clear yet, however, if the rise in TSH has clinical significance (Otun et al., 2019).

3.2.4.2.1.4. Market Overview of Soy Drinks in Austria

Table 10 shows the nutritional values of soy drinks on the Austrian market. 26 soy drinks, 12 of which are organic, are included.

Soy Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D (µg)	B2 (mg)	B12 (µg)	Calcium (mg)
Allos Soja Barista Drink	28	1.6	0.4			0.8	0.0	0.0	2.6	0.1				
Allos Sojadrink ungesüßt	41	2.3	0.6			1.1	0.5	0.5	3.6	0.1				
Alnatura Sojadrink Ungesüßt	41	2.1	0.6			2.0	0.8	0.5	3.6	0.0				
Alpro Barista Sojadrink	42	1.9	0.3	0.4	1.2	2.7	2.5	0.6	3.3	0.1	0.75	0.21	0.38	120.0
Alpro Proteindrink Natur	57	2.8	0.5	0.6	1.7	2.5	2.5	0.9	5.0	0.1	0.75	0.21	0.38	120.0
Alpro Sojadrink Bio	38	1.8	0.3	0.4	1.1	2.3	2.3	0.5	3.0	0.1				12.3
Alpro Sojadrink Light	28	1.2	0.2	0.3	0.7	1.7	1.5	0.9	2.1	0.1	0.75	0.21	0.38	120.0
Alpro Sojadrink Ohne Zucker	33	1.8	0.3	0.4	1.1	0.0	0.0	0.6	3.3	0.1	0.75	0.21	0.38	120.0
Alpro Sojadrink Original Gekühlt mit Calcium	39	1.8	0.3	0.4	1.1	2.5	2.5	0.5	3.0	0.1	0.75	0.21	0.38	120.0
Alpro Sojadrink Original mit Calcium	39	1.8	0.3	0.4	1.1	2.5	2.5	0.5	3.0	0.1	0.75	0.21	0.38	120.0
Dennree Soja	31	1.5	0.4	0.5	0.6	0.6	0.9	0.9	3.0	0.0				
Dennree Soja mit Calcium	45	1.5	0.4			4.5	4.5		2.9	0.2				
DM Bio Soja Drink Natur	38	1.9	0.5			1.8	0.7	0.2	3.2	0.0				
Happy Soya Soja Drink Natur	39	1.7	0.2			2.6	2.5	0.5	3.0	0.1	0.75	0.21	0.38	120.0
Hofgut Storzeln Soja natur + Calcium	43	2.4	0.4	0.5	1.5	0.9	0.8	0.7	4.1	0.0				120.0
Hofgut Storzeln Soja natur pur	43	2.4	0.3	0.5	1.4	0.9	0.8	0.7	4.1	0.0				
Ja! Natürlich Bio Soja Drink	47	2.7	0.4			1.0	0.9	0.9	4.6	0.0				
Joya Bio Soja	33	1.6	0.2	0.0	0.0	1.2	0.0	0.8	3.0	0.0				
Joya Soja Barista	35	1.9	0.3	0.0	0.0	0.8	0.7	0.5	3.3	0.1	0.75		0.38	120.0
Joya Soja Frisch	51	2.1	0.3	0.4	1.3	3.9	3.4	0.6	3.7	0.1				120.0
Joya Soja Natur (+Calcium)	38	1.7	0.2	0.4	1.0	2.4	2.4	0.5	3.0	0.1	0.75		0.38	120.0
Natumi Soja Natural	41	2.1	0.6	0.6	0.9	2.0	0.8	0.2	3.5	0.1				
Provamel Soja ohne Zucker	35	2.1	0.4	0.4	1.3	0.0	0.0	0.6	3.7	0.0				
SPAR Veggie Soja Drink Natur	42	1.9	0.3	0.4	1.1	2.8	2.7	0.5	3.2	0.1			0.38	120.0
SPAR Veggie Soja Drink ungesüßt	39	2.2	0.3	0.5	1.3	0.8	0.7	0.6	3.8	0.0	0.77	0.21	0.38	120.0
Zurück zum Ursprung Soja Drink Natur	49	2.0	0.3			3.5	2.5		3.7	0.1				
Mean	40	2.0	0.4			1.8	1.5		3.4	0.1				

SD	6.7	0.4	0.1	1.2	1.2	0.6	0.0
Max	57.0	2.8	0.6	4.5	4.5	5.0	0.2
Min	28.0	0.4	0.2	0.0	0.0	0.6	0.0

Table 10: Nutritional values of soy drinks in Austria per 100 ml.

3.2.4.2.1.5. Nutritional Values

The energy content of soy drinks on the Austrian market varies widely, from 28 to 57 kcal/100 ml. On average, soy drinks contain 40 kcal per 100 ml. The fat content also has a wide range from 0.4 g to 2.8 g per 100 ml with an average of 2.0 g, with 20% of the fatty acids being SFAs and 20% MUFAs. With an average of half of the total fat coming from PUFAs, soy drinks are very high in those fatty acids. As PUFAs are often lacking in the western diets, soy-based products could be a valuable addition to those diets. With 1.8 g/100 ml of carbohydrates and 1.5 g of those being sugar, soy drinks are very low in carbohydrates. On average, soy drinks that have specifications on fiber content, contain 0.6 g of fiber, similar to cereal-based drinks. Among plant-based milk alternatives, soy drinks stand out for their relatively high protein content, with an average of 3.6 g/100 ml. There are however on one hand soy drinks with only 0.6 g of protein, on the other hand those with 5 g of protein. Half of the analyzed soy drinks are fortified (more: chapter 3.2.3.).

3.2.4.2.1.6. Composition

As in all plant-based dairy alternatives, the main ingredient is water, followed by soy, ranging from 5.3% to 9.8% total content. 8 of the 26 soy drinks analyzed contain only those two ingredients. 12 contain some kind of sweetener (apple juice concentrate, apple extract, sugar, glucose syrup and/or fructose). The majority of soy drinks have added salt. 13 products are fortified with calcium, vitamin B2, vitamin B12 and/or vitamin D (chapter 3.2.3.). One soy drink was also fortified with vitamin E. 11 of the 26 drinks contain additives such as the ones described in chapter 3.3. Additionally, one soy drink contained soluble corn fiber.

3.2.4.2.1.7. Comparison to Milk

The mean energy content of soy milk is just slightly lower than that of reduced fat dairy milk (40 kcal/100 ml vs 48 kcal/100 ml), while the mean fat content is just slightly higher than that of milk (2 g/100 ml vs 1.6 g/100 ml). However, as mentioned before, the fat content in soy milk is highly variable. Soy drinks contain much less saturated fat than whole milk and reduced fat milk. With an average of 0.4 g of MUFAs per 100 ml, soy drinks contain just as much of these fatty acids as milk. When it comes to PUFAs, however, those two types of drinks are not at all comparable, as soy drinks contain ten times the amount of full fat milk. Dairy milk contains more than double the amount of carbohydrates as soy drinks and more than three times the amount of sugar. The average amount of protein in soy drinks is 3.4 g per 100 ml, just as much as that of milk. 11 of the analyzed soy drinks contain more protein than dairy milk (up to 1.7 g per 100 ml more), while 3 contain only between 2 and 3 g of protein per 100 ml. All in all, average fortified soy drinks are nutritionally very similar to reduced fat dairy milk, with a more favorable fatty acid profile.

3.2.4.2.2. Pea and Lupin Drinks

3.2.4.2.2.1. Nutrients and Functional Aspects

Pea drinks are usually based on pea protein. Unlike soy protein, pea protein is considered to be hypoallergenic. According to Ge et al., 2020 pea protein is antioxidative, anti-inflammatory and can lower cholesterol as well as modulate intestinal bacteria activity. Further, it has antihypertensive properties that can be explained by antihypertensive peptides inhibiting the angiotensin 1-converting enzyme or renin (Ge et al., 2020). Pea protein has a comparable amino acid profile to soy or lupin protein. Protein in these pulses is high in lysine, but low in methionine (Dahl et al., 2012). It therefore makes sense to combine pea protein with grain protein to increase digestibility. In some pea drinks, pea protein is combined with rice. Rice protein is high in methionine and is, therefore, a great addition to pea protein.

The in vitro digestibility of raw pea protein is reduced by the presence of protease inhibitors, although the digestibility of pea protein has been reported to be higher than that of soybean and several other pulses (Dahl et al., 2012).

Bitter lupin variants have to be de-bittered before consumption. Intoxication is not associated with consuming industrially consumed lupin-based food, but instead with insufficient de-bittering of the seeds by consumers. Despite the process of de-bittering, lupin seed-based products might still be too high in quinolizidine alkaloids (QAs). Meat alternatives based on lupin seeds have been shown to be high in QAs. Only between 89 % and 97% of QAs are removed by boiling and water treatment (Schrenk et al., 2019). Those on a vegan diet might consider such products, as well as plant-based milk alternatives such as lupin drinks. It therefore is noteworthy that lupin drinks are based on sweet lupin seeds, as opposed to the bitter variants.

Lupin drinks are usually based on sweet lupin seeds, a type of lupin with very low quinolizidine alkaloid (QA) and higher protein content. Lupin has various nutraceutical properties, such as suppressing appetite and positively affecting glycaemia, blood lipids and hypertension. The high soluble fiber content improves digestion. While other legumes contain anti-nutritional factors such as saponins and protease inhibitors, lupin does not (Arnoldi et al., 2015; Kouris-Blazos and Belski, 2016).

Lupin has beneficial health effects in terms of prevention of diabetes, hypertension and hypercholesterolemia. The beneficial properties for hypercholesterolemia might be due to the fiber, as it binds cholesterol and cholic acid, as well as it forms short-chain fatty acids in the large intestine, which is why evidence points towards beneficial alterations of the gut microbiome (Arnoldi et al., 2015; Kouris-Blazos and Belski, 2016). The protein γ-conglutin might be related to the hypoglycemic effects of lupin. Lupin contains beneficial polyphenols that have not been studied extensively yet. Studies have also reported antioxidative and anti-inflammatory activities of lupin, most likely due to phenolic acids and flavonoids. Lupin might therefore play a role in the prevention of cardiovascular disease (Arnoldi et al., 2015).

3.2.4.2.2.2. Market Overview of Pea and Lupin Drinks in Austria

Lupin drinks are not very common in the Austrian market, whereas pea drinks are only more recently on the rise. Six pea drinks and only one lupin drink were analyzed. The lupin drink is also organic. As most pea drinks are blended with grains such as rice and oats, those have been added to the list, although they are mixed drinks. Since there was only one lupin drink taken into consideration, the values must be interpreted and generalized with caution. Tables 11 and 12 show the nutritional values of pea drinks and the one lupin drink on the Austrian market.

Pea Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D(µg)	B2 (mg)	B12 (µg)	Calcium (mg)
Princess and the Pea Original mit Ballaststoffen	53	2.5	0.2			3.7	1.9	1.6	3.2	0.3				120
Princess and the Pea Original Ungesüßt	43	2.5	0.2			2	0.1	0.1	3.2	0.3				120
SPAR High Protein Hafer-Erbsen Drink	41	0.5	0.1			5.5	3.2	0.5	3.3	0.1				120
Vly Barista	45	3.2	0.3	1.9	1.1	2.1	1.4		2.1	0.1				120
Vly Original	54	3.1	0.3	1.9	1	2.8	1.8		3.5	0.2				120
Vly Ungesüßt	31	1.7	1.1	0.5	0.1	0.2	0		3.6	0.2				120
Mean	45	2.3	0.4			2.7	1.4		3.2	0.2				120.0
SD	8	1.0	0.4			1.8	1.2		0.5	0.1				0.0
Max	54	3.2	1.1			5.5	3.2		3.6	0.3				120.0
Min	31	0.5	0.1			0.2	0.0		2.1	0.1				120.0

Table 11: Nutritional values of pea drinks in Austria per 100 ml.

Lupin Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D	B2 (mg)	B12 (µg)	Calcium (mg)
Soyatoo Lupine	52	0.3	0.1			10	6.6		2.1	0.3				

Table 12: Nutritional values of lupin drinks in Austria per 100 ml.

3.2.4.2.2.3. Nutritional Values

With 53 kcal per 100 ml, the lupin drink is slightly higher in energy than the average pea drink with 45 kcal per 100 ml, while both are slightly higher in energy than average soy drinks. Pea drinks range from 31 kcal to 54 kcal per 100 ml. The lupin drink is extremely low in fat with only 0.3 grams per 100 ml and therefore does not contain traceable amounts of MUFAs or PUFAs. The pea drinks have a higher fat content, with 2.3 g/100 ml. Pea drinks are very high in MUFAS with more than half of the fat coming from MUFAs, and also contain more PUFAs than SFAs. While lupin drinks are high in carbohydrates with 10 g/100 ml, pea drinks only contain 2.7 g/100 ml on average. The protein content of legume-based drinks stands out among plant-based milk alternatives. The protein content of pea milks ranges from 2.1 g/100 ml to 3.6 g/100 ml with an average of 3.2 g/100 ml and can be considered very high. The lupin drink also has a significant amount of protein, with 2.1 g/100 ml. The only nutrient that the pea drinks are fortified with is calcium. The lupin drink is not fortified.

3.2.4.2.2.4. Composition

Apart from water, in four of the six pea drinks the main ingredient is pea protein (2.1 %-4.3 %). One drink contains more rapeseed oil than pea protein, while another one contains more oats than pea protein, which is however reflected in the name ("Hafer-Erbsen Drink" (oat-pea drink)). Unlike many other plant-based milk alternatives, all pea drinks contain rapeseed oil instead of sunflower oil. Two drinks contain fermented rice, which makes the drinks nutritionally more valuable, as the rice protein increases the digestibility of the pea protein. Two drinks contain a source of sweetener (maltodextrin and/or sugar). Except for one, all the pea drinks contain additives (more: chapter 3.3.). The pea drink that is advertised as "with fiber" contains inulin. Two have salt added.

The lupin drink contains 10% sweet lupin seed as well as rice syrup as a sweetener, and vanilla extract, despite not being advertised as containing vanilla.

3.2.4.2.2.5. Comparison to Milk

Pea, as well as lupin drinks, have a similar calorie content as milk. While the lupin drink has just slightly more fat than skimmed milk, pea drinks have slightly more than reduced fat milk. However, the fatty acid profile of pea drinks is very different. Unlike milk, pea drinks are low in saturated fatty acids, very high in MUFAs and high in PUFAs. The pea drinks are lower in carbohydrates than milk, but the lupin drink is significantly higher in carbohydrates. As for micronutrients, only pea drinks compare with dairy milk in terms of calcium, due to being fortified. Pea drinks and the lupin drink both lack B12 and B2 when compared to milk.

3.2.4.3. Nut-Based Drinks

Nut-based milk alternatives include almond drinks, coconut drinks, hazelnut drinks and the less common tiger nut drink. Due to containing more rice than tiger nut (despite not specifying this fact), one tiger nut drink was analyzed and added to 3.2.4.6., to be included in the chapter on mixed drinks.

3.2.4.3.1. Almond Drinks

3.2.4.3.1.1. Production

Similar to the processing of other plant-based milk alternatives, almonds are roasted and blanched before being crushed, and the oil extracted (Paul et al., 2020).

3.2.4.3.1.2. Nutrients and Functional Properties

Almonds are nutrient dense and rich in minerals such as magnesium, potassium, zinc, calcium and copper. Almonds, and therefore also almond milk, are a good source of vitamin E. Almonds contain arabinose and might have prebiotic, antioxidant, laxative, immunostimulant, as well as cholesterol lowering properties. Nuts, however, are potential allergens. Also, higher costs are associated with almonds and therefore almond drinks (Sethi et al., 2016).

3.2.4.3.1.3. Market Overview of Almond Drinks in Austria

Although almond drinks are quite similar to other nut-based drinks nutritionally, they will be discussed separately, as they are so prominent on the Austrian as well as the worldwide market. Table 13 depicts the nutritional values of almond drinks available in Austria. 21 drinks are included, 12 of which are organic.

Almond Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D (µg)	B2 (mg)	B12 (µg)	Calcium (mg)
Allos Mandel Calcium Drink	41	1.9	0.3			5.4	4.0	0.3	0.5	0.1				120
Allos Mandel Drink 0% Zucker	27	2.5	0.2			0	0	0.6	0.8	0.1				
Alpro Barista Mandel	25	1.2	0.1	0.9	0.2	2.6	2.5	0.2	0.5	0.1	0.75			120
Alpro Mandeldrink Ohne Zucker	13	1.1	0.1	0.7	0.3	0	0	0.3	0.14	0.1	0.75	0.21	0.38	120
Alpro Mandeldrink Original	22	1.1	0.1	0.7	0.3	2.4	2.4	0.4	0.4	0.1	0.75	0.21	0.38	120
Alpro Mandeldrink Ungeröstet & Ohne Zucker	13	1.1	0.1	0.8	0.2	0	0	0.2	0.5	0.1	0.75	0.21	0.38	120
Dennree Mandel	21	1.4	0.2			1.2	0.5		0.7	0.1				
DM Bio Mandeldrink Natur	22	1.9	0.2			0.5	0.5	0.2	0.9	0.1				
Ja! Natürlich Mandeldrink	32	2.7	0.2			0.7	0.5	0.5	1.0	0.1				
Joya Mandel 0% Zucker	14	1.2	0.1	0.7	0.3	0.1	0	0.4	0.4	0.1				120
Joya Mandel Barista	20	1.4	0.2	0	0	1.0	0	0.1	0.7	0.1				
Joya Mandel Barista fresh	20	1.4	0.2	0	0	1.0	0	0.1	0.7	0.1				
Joya Mandel Frisch	14	1.2	0.1	0	0	0.2	0	0.4	0.5	0.1	0.75		0.38	120
Natumi Mandel ungesüßt	29	2.2	0.2	0.4	1.5	1.1	0.2	0.6	0.8	0.1				
Natur aktiv Bio Mandel Drink	21	1.4	0.2			1.2	0.2	0.2	0.7	0.1				
Natur aktiv Bio Mandel Drink (gekühlt)	32	2.7	0.3			0.7	0.5		1.0	0.1				
Provamel Mandel	38	2.5	0.2	1.8	0.5	2.4	2.2	0.6	1.0	0				
Provamel Mandel Ohne Zucker	29	2.5	0.2	1.8	0.5	0	0	0.6	1.0	0.1				
Share Bio Mandeldrink	18	1.4	0			0.6	0		0.6	0.1				
SPAR Veggie Mandeldrink	24	1.1	0.1			0.4	0.12		0.3	0.1	0.75	0.21	0.38	120
Vegavita Mandeldrink	21	1.4	0.2			1.2	0.5	0.5	0.7	0.1				
Mean	24	1.7	0.2			1.1	0.7		0.7	0.1				
SD	8	0.6	0.1			1.3	1.1		0.2	0.0				
Max	41	2.7	0.3			5.4	4.0		1.0	0.1				
Min	13.0	1.1	0.0			0.0	0.0		0.1	0.0				

Table 13: Nutritional values of almond drinks in Austria per 100 ml.

3.2.4.3.1.4. Nutritional Values

With an average of 24 kcal per 100 ml, almond drinks are particularly low in energy. As with many plant-based milk alternatives, the kcal span is wide, from only 13 kcal to 41 kcal per 100 ml. Almond drinks are low in saturated fat, with only about 10% of the total fat content coming from saturated fatty acids. About half of the fat comes from MUFAs, and with 0.6 g PUFAs per 100 ml, almond drinks are high in these as well. The fatty acid profile is very balanced. With 1.1 g of carbohydrates per 100 ml and only 0.7 g of protein per 100 ml, almond drinks are low in these macronutrients. Some almond drinks contain virtually no protein. Four almond drinks have specifications for their vitamin E content, which was 1.8 mg per 100 ml for all of them. The daily recommended amount of vitamin E is 12–15 mg for men depending on age, and 11–12 mg for women (DGE, 2000). One 200 ml portion of almond drink contributes about 30% of vitamin E to the daily recommended amount. Eight drinks are fortified (more: chapter 3.2.3.).

3.2.4.3.1.5. Composition

After water, three of the almond drinks list sugar as their main ingredient, while the others list almonds. The almond content of these almond drinks is quite low, with each containing only 2% to 5% almonds. As opposed to other plant-based milk alternatives, almond drinks often contain added sugar. About half of the almond drinks, 10 out of 21, have added sugar in the form of sugar, maltodextrin, agave nectar and/or fructose. The vast majority (17 out of 21) of the almond drinks contain one or multiple additives (more: chapter 3.3.), especially the stabilizer gellan and the emulgator lecithin, which are used in most of the products. One drink contains rice starch. Except for 5 drinks, all have added salt.

3.2.4.3.1.6. Comparison to Milk

On average, almond drinks contain only half of the energy of that of reduced fat milk, while their fat content is slightly higher. The fatty acid profile of almond drinks is more balanced, as the saturated fat content is lower, and the MUFA and PUFA content is higher. Almond drinks contain only a fraction of the carbohydrate and protein content of milk. Almond drinks are nutritionally not comparable to milk, especially when not fortified. While they stand out for their high vitamin E content, low calorie content and balanced fatty acid profile in comparison to milk, they lack protein, as well as calcium, vitamin B2 and vitamin B12, when not fortified with those nutrients.

3.2.4.3.2. Coconut Drinks, Cashew Drinks and Hazelnut Drinks

3.2.4.3.2.1. Market Overview of Coconut Drinks, Cashew Drinks and Hazelnut Drinks in Austria

13 coconut drinks, 6 of which are organic, 5 cashew drinks, with 4 being organic, and 1 hazelnut drink were analyzed. Tables 14, 15 and 16 show the nutritional values of these drinks per 100 ml. Several coconut drinks contain another plant ingredient besides coconut, such as rice or soy, despite not specifying this in their names. The ones that only contain coconut are underlined in the table.

Coconut Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D (µg)	B2 (mg)	B12 (µg)	Calcium (mg)
Allos Kokos Drink 0% Zucker	22	1.5	1.2			1.7	0	0.2	0.2	0.1				
Alnatura Kokosdrink Ungesüßt	12	0.5	0.1			1.3	1.3	0.5	1.7	0.1				
Alpro Barista Kokosnuss	33	1.4	0.7	0.2	0.5	3.3	3.3	0.2	1.5	0.1				120
Alpro Kokosnussdrink ohne Zucker	14	1.2	1.1	0.1	0	0	0	0	0.1	0.1	0.75		0.38	120
Alpro Kokosnussdrink Original	10	0.9	0.9	0	0	2.7	1.9	0.1	0.1	0.1	0.75		0.38	120
DM Bio Kokosdrink Natur	15	0.4	0.1			1.3	1.3	0.5	1.7	0.1				
Joya Kokos	19	0.9	0.8	0	0	2.6	1.9	0.2	0.1	0.1	0.75		0.38	120
Joya Kokos Barista	24	2.0	1.3	0	0	0.3	0	0.3	1.1	0.1				120
Joya Kokos Frisch	23	0.9	0.8	0	0	3.4	2	0.2	0.2	0.1	0.75		0.38	120
Natur aktiv Kokosdrink	53	5.1	4.7			0.7	0.5		0.5	0.1				
Rude Health Coconut Drink	53	1.2	1.0			10.4	4.2	0.7	0.1	0.1				
SPAR NATUR*PUR Bio-Kokos-Drink	55	4.4	4.1			2.4	1.3	0.5	1.3	0.1				
SPAR Veggie Kokos Drink ungesüßt	32	1.1	1.0			5.3	3	0.5	0.5	0.1				
Mean	26	1.7	1.4			2.6	1.6		0.6	0.1				
SD	16	1.3	1.4			2.8	1.2		0.6	0				
Max	55	5.1	4.7			10.4	4.2		1.7	0.1				
Min	2.9	0.4	0.1			0	0		0.1	0.1				

Table 14: Nutritional values of coconut drinks in Austria per 100 ml.

Cashew Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D (µg)	B2 (mg)	B12 (µg)	Calcium (mg)
Alnatura Cashew Drink Ungesüßt	34	2.8	0.5			0.9	0.5	0.5	1	0.1				
Alpro Cashewdrink Original	23	0.2	0.2	0.7	0.2	2.6	2	0.2	0.5	0.1	0.75	0.21	0.38	120
Natur aktiv Bio Cashew Drink	26	1.3	0.2			2.9	2.9		0.5	0.1				
Provamel Cashew	33	2.4	0.5	1.5	0.4	1.6	0	0.2	0.8	0.1				
Rude Health Cashew Drink	28	2.1	0.4			1.4	0.3	0.2	0.9	0.1				
Mean	29	1.8	0.4			1.9	1.1		0.7	0.1				
SD	5	1.0	0.2			0.8	1.3		0.2	0.0				
Max	34	2.8	0.5			2.9	2.9		1.0	0.1				
Min	23.0	0.2	0.2			0.9	0.0		0.5	0.1				

Table 15: Nutritional values of cashew drinks in Austria per 100 ml.

Hazelnut Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D (µg)	B2 (mg)	B12 (µg)	Calcium (mg)
Alpro Haselnussdrink Original	29	1.6	0.2	1.3	0.1	3.2	3.2	0.3	0.4	0.14	0.75	0.21	0.38	125

Table 16: Nutritional values of hazelnut drinks in Austria per 100 ml.

3.2.4.3.2.2. Nutritional Values

In regard to the nutritional value of these coconut drinks, it is important to note that out of the 14 coconut drinks analyzed, 7 contain not only coconut: 5 also contain rice and 2 of them contain soy, which is not made obvious in the name. As added rice and soy have an impact on the nutritional values in question, one must take this into consideration when comparing these drinks.

The individual coconut drinks vary widely nutrition wise. With an average of 26 kcal per 100 ml, coconut drinks are generally low in energy. However, the calorie content ranges from 10 kcal/100 ml to 55 kcal/100 ml, with only three drinks with more than 50 kcal, that are very much skewing the average calorie content. The same large variations apply to the fat content as well, with ranges from 0.4 g/100 ml to 5.1 g/100 ml, with an average of 1.7 g of fat per 100 ml. Cashew drinks have a similar calorie content of an average of 29 kcal/100 ml, however these drinks have a SD of only 5, compared to coconut drinks with SD of 16. The one hazelnut drink that was analyzed has a calorie content of 29 kcal/100 ml. Cashew and hazelnut drinks have a similar average fat content to coconut drinks, with 1.8 g/100 ml and 1.6 g/100 ml. Cashew drinks also vary widely in their fat content, from 0.2 g/100 ml to 2.8g/100 ml.

While most plant-based milk alternatives are low in saturated fatty acids but contain a significant amount of MUFAs and PUFAs, coconut drinks are high in SFAs and very low in unsaturated fatty acids. Out of the average 1.7 g of fat per 100 ml, the average SFA content is 1.4 g/100 ml. For those drinks that MUFA and PUFA specifications are available, their content is 0 g or close to 0 g. With only 22% of fat coming from SFAs, cashew drinks are much lower in SFAs than coconut drinks with 80% of fat coming from SFAs. The hazelnut drink has a low SFA content comparable to the cashew drinks.

The carbohydrate content of coconut drinks also has a broad range from 0 g to 10.4 g/100 ml, with an average of 2.6 g/100ml. The coconut drink with 10.4 g of carbohydrates per 100 ml is one containing more rice than coconut, which explains the high carbohydrate content. Half of the analyzed drinks contain less than 2 g of carbohydrates per 100 ml. Cashew drinks contain on average 1.9 g of carbohydrates per 100 ml, with a SD of 0.8. On average, sugar makes up more than half of the carbohydrate content in all three types of drinks.

The fiber content in all three types of drinks is insignificant, averaging at 0.3 g/100 ml for those drinks that have fiber specifications, as is the protein content, with 0.4 g/100 ml in the hazelnut drink, an average of 0.7 g/100 ml in cashew drinks and an average of 0.6 g/100 ml in coconut drinks. 6 of the 13 coconut drinks are fortified, but none of the coconut drinks are fortified with vitamin B2. Only one of the cashew drinks is fortified, as well as the one hazelnut drink (more: chapter: 3.2.3.).

3.2.4.3.2.3. Composition

As mentioned in 3.2.4.3.2.2., out of the 14 coconut drinks, 5 also contain rice and 2 soy. The main ingredient in most coconut drinks is water, followed by either coconut (partially de-fatted or not), coconut milk, or coconut pulp. The coconut content ranges from 3.5% to 12%, with one drink containing more rice than coconut. Besides that, some coconut drinks only contain salt. Three coconut drinks also contain added sugar in the form of agave nectar, sugar and/or fructose. The vast majority of coconut drinks (10 out of 13) contain additives such as thickeners, stabilizers, emulsifiers, acid regulators and aromas (more: chapter 3.3.).

After water, the main ingredient in cashew drinks is cashews (3.1%-6.5%). For three of these drinks, those, as well as salt, are the only ingredients. One drink contains added sugar, as well as stabilizers, emulsifiers (more: chapter 3.3.) and is fortified with calcium, vitamin B2, B12 and D, as well as with vitamin E, with is very uncommon among plant-based dairy alternatives (more: chapter 3.2.3.). Another drink contains stabilizers as well as acid regulators.

The one hazelnut drink analyzed contains more added sugar than hazelnuts. It contains 2.8% hazelnuts, as well as salt, stabilizers and emulsifiers, and is also fortified (more: chapters 3.3. and 3.2.3.).

3.2.4.3.2.4. Comparison to Milk

Coconut, cashew and hazelnut drinks all have under half the calorie content of reduced fat milk while containing around the same amount of fat. While cashew and hazelnut drinks contain significantly less SFAs than milk (similarly to other plant-based drinks), coconut drinks have a higher SFA content when compared to milk. SFAs account for 82% of fatty acids in coconut drinks, while the number is only around 60 % in full-fat and reduced fat milk. Compared to that, cashew drinks only have an average of 22% and the hazelnut drink 13%. Coconut and cashew drinks have a lower carbohydrate content (especially sugar) when compared to milk. Although the hazelnut drink contains added sugar, it is slightly lower in sugar than milk (3.2 g/100 ml vs. 4.7/4.8 g/100 ml). Milk contains several times more protein than coconut, cashew or hazelnut drinks.

3.2.4.4. Seed-Based Drinks

Seed-based drinks include hemp drinks and the less common sesame drinks, flax drinks and sunflower drinks (Sethi et al., 2016). Of those plant-based milk alternatives, only hemp drinks are available on the Austrian market. Those were not included in the analyses, however, because they are only available in a select few organic and specialty stores with a low market share.

3.2.4.5. Pseudo-Cereal-Based Drinks

Pseudo-cereal-based drinks include quinoa drinks, amaranth drinks and teff drinks. These drinks, however, are only available in specialty stores in Austria, and therefore not included in the analyses.

3.2.4.6. Mixed Plant-Based Drinks

Out of the 166 analyzed plant-based milk alternatives, 34 (20%) are drinks that are based on more than one plant ingredient.

3.2.4.6.1. Market Overview of Mixed Plant-Based Drinks in Austria

34 drinks were included 20 of which are organic. Table 17 shows the nutritional values of mixed plant-based drinks in Austria per 100 ml.

Mixed Drinks	Energy (kcal)	Fat (g)	SFAs (g)	MUFAs (g)	PUFAs (g)	Carbo-hydrates (g)	Sugar (g)	Fiber (g)	Protein (g)	Salt (g)	Vitamin D (µg)	B2 (mg)	B12 (µg)	Calcium (mg)
Allos Hafer Mandeldrink ungesüßt	52	2.8	0.3			5.6	3.3	0	1.1	0.1				
Allos Reis Haselnussdrink ungesüßt	74	1.9	0.2			13	5.5	0.9	0.8	0.1				
Allos Reis Kokosdrink ungesüßt	60	0.8	0.6			13	6.5	0.5	0.5	0.1				
Allos Reis Mandeldrink ungesüßt	81	2.6	0.4			13	5.5	0.8	1.0	0.1				
Alnatura Hafer-Hanf-Drink mit Leinöl	33	2.2	0.3			2.7	1.6	0.5	0.7	0.1				
Alpro Growing Up Haferdrink	60	3.3	0.3			5.9	3.0	0.2	1.8	0	1.5	0.21	0	120
Alpro Growing Up Sojadrink	65	2.2	0.4	0.5	1.3	8.6	2.5	0.4	2.5	0	1.5	0.21	0.38	120
Alpro Hafer-Mandeldrink	23	1.0	0.1	1.0	0.3	2.4	2.0	1.5	0.4	0	0.75	0.21	0	120
Alpro Not M*LK Drink Pflanzlich & Fettarm, 1,8%	44	1.8	0.2	0.6	1	5.7	0	1.0	0.7	0.1	0.75		0.38	120
Alpro Not M*LK Drink Pflanzlich & Voll, 3,5%	59	3.5	0.4	1.0	2.0	5.7	0	1.0	0.7	0	0.75		0	120
Dennree Hafer Barista mit Soja	58	1.9	0.4	0.6	0.8	8.7	5.6		1.3	0.1				
Dennree Reis Kokos	52	1.1	1.0			10	6.0		1.0	0.1				
DM Bio Barista Haferdrink mit Soja	55	1.8	0.4			8.4	5.5	0.3	1.2	0.1				
Harvest Moon Bio Milk Alternative Drink	45	2.1	1.5			5.3	1.1		0.8	0.1				
Innocent Haselnuss & Reis Pflanzendrink	67	3.2	0.28			8.6	3.5	0.5	0.8	0.1				114
Innocent Kokosnuss & Reis Pflanzendrink	46	1.3	1.1			8.3	3.1	0	0	0.1				
Joya Hafer Protein	47	1.7	0.3	0	0	4	2.1	1.0	3.3	0.1				

Joya Kokos Reis	64	1.8	1.6	0	0.1	11.4	5.9	0.4	0.3	0.1				
Joya Mandel Hafer	36	1.1	0.1	0	0	5.4	2.9	0.5	0.9	0.1	0.75		0.38	120
Joya Mandel Haselnuss	60	1.2	0.1	0	0	11.6	6.6	0.5	0.5	0.1	0.75		0.38	120
Joya Mandel Kokos	23	1.2	0.6	0.4	0.2	2.5	2.5	0.3	0.3	0.1				
Joya Mandel Protein	44	3.4	0.4	0	0	0.7	0	0.7	3.2	0.1	0.75		0.38	120
Joya Mandel Reis	29	1.4	0.1	0	0	3.4	1.9	0.4	0.6	0	0.75		0.38	120
Natumi Dinkel Mandel	62	2.4	0.2	1.3	0.8	9.1	7.0	0.6	0.7	0.1				
Natumi Hafer Kokos	49	1.5	1.2	0.1	0.2	8.3	5.4	0.3	0.5	0.1				
Natumi Hafer Mandel	58	2.1	0.3	0.6	1.2	8	5.7	0.6	1.8	0.1				
Natumi Reis Kokos	50	1.1	0.1	0.3	0.6	9.9	7.1	0.1	0.1	0.1				
Natumi Soja Barista Kokos	25	1.6	0.9			1	0.4	0.2	1.6	0.1				
Provamel Hafer Mandel	47	2.5	0.4	1.2	0.9	5	2.5	1.0	0.7	0.1				
Provamel Kokosnuss Mandel	35	2.4	1.0	1.1	0.3	2.4	2.3	0.2	0.7	0.1				
Rude Health Almond Drink	56	1.5	0.3			10.5	4.7	0.2	0.2	0.1				
Rude Health Hazelnut Drink	69	1.3	0.1			13.9	4.1	0.1	0.4	0.1				
Rude Health Tiger Nut Drink	56	2.0	0.3			9.8	5.0	0	0.6	0.1				
Vegavita Bio-Kokos-Reisdrink	34	0.9	0.8	0	0	6.2	3.5	0.5	0.1	0.1				
Mean	48	1.8	0.6			6.9	3.7		0.9	0.1				
SD	14	0.7	0.5			3.7	2.1		0.9	0.0				
Max	69	3.4	1.6			13.9	7.1		3.3	0.1				
Min	23.0	0.9	0.1			0.7	0.0		0.0	0.0				

Table 17: Nutritional values of mixed drinks in Austria per 100 ml.

3.2.4.6.2. Nutritional Analysis

Plant-based milk alternatives that are based on more than one plant ingredient are heterogenous in their nutritional values and composition. Therefore, the nutritional values and compositions that stand out will be discussed below.

Alpro Growing Up Haferdrink, Alpro Growing Up Sojadrink: These two drinks are marketed towards children as a dairy milk replacement starting at one year old. One of the drinks is mainly based on soy, the other one on oats. Both are, compared to other plant-based dairy alternatives, quite high in energy and fat, similar to whole milk. The fatty acid profile is different, however, as both plant drinks are lower in SFAs and higher in MUFAs, and especially PUFAs, when compared to milk. Their carbohydrate content is higher than that of milk, but their sugar content is slightly lower, despite sugar being added in the form of maltodextrin in both drinks and additional sugar and fructose being added to the soy drink. With 2.5 g of protein per 100 ml, the soy drink is lower in protein than average soy drinks (3.4 g/100 ml) as well as milk (3.3/3.5 g/100 ml), but higher in protein than most plant-based milk alternatives. Oat drinks are usually quite low in protein. As protein is especially important for growing children to whom the drinks are marketed towards, pea protein is added to increase the protein content to 1.8 g/100 ml. Like many other fortified drinks, both contain added vitamin D, but 1.5 µg/100 ml instead of the usual 0.75 µg/100 ml, and vitamin B2, B12 and calcium. Both drinks also contain added micronutrients that none of the other plant-based milk alternatives contain, such as iron, iodine and vitamin C. The oat-based drink also contains added zinc and folic acid.

Alnatura Hafer-Hanf-Drink mit Leinöl: This oat drink contains 2% hemp paste as well as 0.9% flaxseed oil, both of which are high in PUFAs.

Harvest Moon Bio Milk Alternative Drink: This is the only plant-based milk alternative analyzed that contains yeast flakes.

Joya Hafer Protein, Joya Mandel Protein: While it is not specified in the name, these drinks contain more soy than oat or almond and therefore have a similar amount of protein as milk.

Rude Health Almond Drink, Rude Health Hazelnut Drink: Despite being called “almond” and “hazelnut” drink, these drinks contain mostly rice and only 1% of almond for the almond drink and 2% of hazelnut for the hazelnut drink.

Rude Health Tiger Nut Drink: This is the only drink on the Austrian market containing tiger nuts. This drink, however, although not specified in the name, contains more rice than tiger nut.

3.3. Additives

Gellan gum (E418) is often used as a stabilizer and thickener; it is a polysaccharide produced through fermentation and often used as a substitute for gelatin or agar. The European Food Safety Authority (EFSA) concluded that there are no concerns of safety with gellan as a food additive (Younes, 2018).

Some plant-based milk alternatives contain potassium phosphate or dicalcium phosphate as an acidity regulator, the ADI for phosphates (phosphoric acid–phosphates – di-, tri- and polyphosphates) being 40 mg/kg body weight per day. Some infants and children may exceed this ADI (Younes, 2019). Another acidity regulator used in very few plant-based milk alternatives is calcium citrate.

Locust bean gum and guar gum are used as thickeners in several of the drinks. The EFSA has stated that both are safe as a food additive for the general population (Mortensen et al., 2017a; Mortensen et al., 2017b).

Mono- and di-glycerides of fatty acids, also known as E472e, are used as an emulsifier in one oat drink. According to the EFSA, this emulsifier is of no safety concern (Younes et al., 2017). Another emulsifier added to plant-based milk alternatives, especially almond drinks, is lecithin, which also has been concluded to be safe as an additive by the EFSA. (Mortensen et al., 2017c).

Some products contain aroma.

3.4. Nutritional Comparison of Different Categories of Plant-Based Milk Alternatives and Milk

3.4.1. Energy

Table 18 gives an overview of the energy content of different types of plant-based milk alternatives per 100 ml. Across the categories of plant-based dairy alternatives, the mean energy content is 41 kcal/100 ml, slightly lower than the energy content of reduced fat milk with 48 kcal/100 ml. On average, millet drinks are the most energy dense plant-based milk alternatives. Only one millet drink was analyzed, however, therefore this might not be representative. Buckwheat drinks with 51 kcal/100 ml and rice drinks with 50 kcal/100 ml are also rather energy dense. Even the most energy dense drinks are lower in energy than whole milk, with 66 kcal per 100 ml. Almond drinks are the lowest in kcal, with an average of 24 kcal per 100 ml. With 3.5 kcal per 100 ml, skimmed milk has an extremely low energy content that is not comparable to any plant-based milk alternative. However, there is a wide range in regard to the energy content within categories with coconut drinks having a SD of 16 for example, while a representative picture of other drinks such as hazelnut, millet or lupin could not be drawn, due to their scarcity in the market.

Type	Energy in kcal (SD)
Almond	24 (8)
Buckwheat	51 (0)
Cashew	30 (5)
Coconut	28 (16)
Hazelnut	29 (0)
Lupin	53 (0)
Millet	54 (0)
Oat	44 (9)
Pea	43 (9)
Rice	50 (10)
Soy	40 (7)
Spelt	46 (6)
Mean	41
SD	11
Max	54
Min	24

Table 18: Mean energy content of different plant-based milk alternatives (including SD).

3.4.2. Fatty Acids

As shown in table 19, The average fat content of plant-based drinks is 1.4 g per 100 ml. With 2.1 g of fat per 100 ml, pea drinks are the highest in fat, followed by soy milk with 2.0 g/100 ml. Lupin drinks are the lowest in fat with only 0.3 g/100 ml, however, there was only one lupin drink in the analysis. Rice milk is also very low in fat, averaging at around 0.9 g/100 ml. Plant-based milk alternatives generally have a very good fatty acid profile, especially compared to milk. They are very low in saturated fat, with an average of 0.3 g/100 ml. This means only 21% of the fat content comes from saturated fat. Coconut drinks are an exception, containing on average 1.4 g/100 ml, a significantly higher amount than drinks based on other foods. Plant-based drinks are on average high in PUFAs and MUFAs, however, not all of these products have those specifications. In almond, cashew, hazelnut and pea drinks that have MUFA specifications, these fatty acids make up for half of total fatty acids. 0.5 g of PUFAs are on average contained in plant drinks with these specifications, with soy and hazelnut drinks being low in PUFAs. In spelt drinks and millet drinks, PUFAs make up more than half of the fatty acid content.

Type	Fat (g)	SFAs (g)
Almond	1.7	0.2
Buckwheat	1.1	0.2
Cashew	1.8	0.4
Coconut	1.7	1.4
Hazelnut	1.6	0.2
Lupin	0.3	0.1
Millet	1.1	0.1
Oat	1.3	0.2
Pea	2.1	0.5
Rice	0.9	0.2
Soy	2.0	0.4
Spelt	1.0	0.1
Mean	1.4	0.3
SD	0.5	0.4
Max	2.1	1.4
Min	0.3	0.1

Table 19: Average content of fats and SFAs in plant-based dairy alternatives.

3.4.3. Carbohydrates and Sugar

Table 20 shows the average carbohydrate and sugar content of different plant-based milk alternatives. On average, plant-based milk alternatives contain 5.7 g of carbohydrates per 100 ml. Lupin drinks, millet drinks and rice drinks all stand out for their high carbohydrate content (10 g/100 ml). This might not be representative for all lupin and millet drinks, as only one of each was analyzed. Almond drinks, with an average of 1.6 g of carbohydrates per 100 ml, and soy drinks, with an average of 1.8 g of carbohydrates per 100 ml, have the lowest carbohydrate content among plant-based milk alternatives. The mean sugar content in plant-based drinks is with 3.6 g per 100 ml lower than in milk (4.7/4.8 g/100 ml). With 6.6 g of sugar per 100 ml, lupin drinks and spelt drinks have the highest sugar content. Again, the lupin drink might not be representative, as only one was analyzed, which had added sugar in the form of rice syrup. Almond drinks have the lowest average sugar content, with only 0.9 g/100 ml.

Type	Carbo-hydrates (g)	Sugar (g)
Almond	1.6	0.9
Buckwheat	8.4	5.6
Cashew	2.0	1.1
Coconut	2.6	1.6
Hazelnut	3.2	3.2
Lupin	10.0	6.6
Millet	10.0	5.5
Oat	7.1	3.8
Pea	2.7	1.6
Rice	10.0	4.9
Soy	1.8	1.5
Spelt	8.7	6.6
Mean	5.7	3.6
SD	3.6	2.2
Max	10.0	6.6
Min	1.6	0.9

Table 20: Average carbohydrate and sugar content in plant-based milk alternatives per 100 ml.

3.4.1. Protein

With an average protein content of 1.3 g per 100 ml, plant-based drinks are generally low in protein compared to milk (3.3/3.5 g/100 ml), but the variance is high, with an SD of 1 (Table 21). Cereal- and nut-based drinks typically have a low protein content, with 0.4 g in hazelnut drinks, 0.6 in coconut and rice drinks and 0.7 g per 100 ml in almond, millet, oat and spelt drinks. Buckwheat drinks have a much higher protein content than most cereal-based drinks, with an average of 1.6 g/100 ml. Legume-based drink are very similar to milk in their protein content, with soy drinks containing 3.4 g of protein per 100 ml, pea drinks 3.1 g of protein per 100 ml and the one lupin drink containing 2.1 g of protein per 100 ml.

3.4.2. Salt

The salt content in all plant-based drinks is 0.1 g/100 ml, just as in milk, except for the lupin drink, which contains 0.3 g of salt per 100 ml (Table 22).

Type	Protein (g)
Almond	0.7
Buckwheat	1.6
Cashew	0.8
Coconut	0.6
Hazelnut	0.4
Lupin	2.1
Millet	0.7
Oat	0.7
Pea	3.1
Rice	0.6
Soy	3.4
Spelt	0.7
Mean	1.3
SD	1.0
Max	3.4
Min	0.4

Table 21: Average protein content in plant-based milk alternatives per 100 ml.

Type	Salt (g)
Almond	0.1
Buckwheat	0.1
Cashew	0.1
Coconut	0.1
Hazelnut	0.1
Lupin	0.3
Millet	0.1
Oat	0.1
Pea	0.1
Rice	0.1
Soy	0.1
Spelt	0.1
Mean	0.1
SD	0.1
Max	0.3
Min	0.1

Table 22: Average salt content in plant-based milk alternatives per 100 ml.

4. Discussion and Conclusions

4.1. Plant-based Milk Alternatives – An Adequate Dairy Substitute?

In milk, the micronutrient that stands out the most is calcium. With 120 g per 100 ml, milk very much contributes to achieving the recommended calcium intake, as described in chapter 2.5. Out of the 166 plant-based milk alternatives, 56 are fortified with usually 120 g of calcium per 100 ml. When these drinks are fortified, they have a calcium content comparable to milk, whereas non-fortified drinks cannot compare to milk in terms of calcium content.

Milk is also rich in vitamin B2 and vitamin B12 (more: chapters 2.2.2. and 2.2.3.). Concerning these micronutrients, plant-based milk alternatives are only similar to milk when fortified.

As for fatty acids, it can be said that plant-based milk alternatives generally have a more favorable fatty acid profile than milk. More than half of the fatty acids in milk come from SFAs, while on average it is less than a third in plant-based milk alternatives (with the exception of coconut milk). In Austria, SFA consumption is too high, while PUFA consumption is too low (Rust et al., 2017). With an average of 1.4 g of fat per 100 ml, the fat content of plant-based milk alternatives is similar to the fat content of reduced fat milk (1.6 g/100 ml). Reduced fat milk does not contain a significant amount of PUFAs, while plant-based milk alternatives with these specifications on average contain 0.5 g per 100 ml. Plant-based milk alternatives, unlike milk, do not contain any trans fatty acids, which is beneficial for health.

Apart from their total fat content, plant-based milk alternatives are on average most similar to reduced fat milk, as opposed to whole or skimmed milk. This also goes for energy content, with 41 kcal/100 ml on average for plant-based milk alternatives vs. 48 kcal/100 ml in reduced fat milk.

Generally, plant-based milk alternatives cannot compare to milk when it comes to protein content. The average protein content of plant-based milk alternatives is 1.3 g/100 ml, and 3.3-3.5 g/100 ml for milk. The only types of plant-based milk alternatives that compare to milk protein content are legume-based drinks.

There are plant-based milk alternatives for specific groups, such as young children, as discussed in chapter 3.2.4.6.2. These drinks are an adequate milk substitute for young children in terms of energy, macro, and micronutrients.

All in all, it can be said that legume-based drinks such as soy, lupin and pea drinks that are fortified with calcium, vitamin B2 and vitamin B12 are nutritionally very similar to reduced fat milk and, therefore, an adequate substitute.

4.2. Physicochemical Properties and Functional Performance

Plant-based milk alternatives are expected to have similar physicochemical properties and functional performance to milk.

4.2.1. Appearance and Texture (McClements et al., 2019)

Milk has a light and creamy appearance. Plant-based milk alternatives, while having a similar appearance, might differ color-wise due to the properties of the plant ingredients on which the drinks are based on. Plant-based milk alternatives generally have a lower whiteness index than milk, a result of natural pigments and a difference in size and concentration of particles. To make plant-based milk alternatives more similar to milk, the natural pigments can be either reduced or bleached and the particle size can be changed.

When it comes to texture of a drink, the rheological properties are important to consider. To make the rheological properties of plant-based milk alternatives more similar to milk, some contain additives such as guar gum, which increases viscosity. Thickeners create a mouthfeel and texture more similar to milk. Soy drinks are rheologically similar to milk, even without these additives.

4.2.2. Stability and Shelf Life (Sethi et al., 2016)

Stability-wise, plant-based milk alternatives often encounter the issue of gravitational separation, which is due to larger particle size and can be avoided by ensuring that the initial particle size is not too large. Ultra-high-pressure homogenization is one of the methods used to make particles smaller and more uniform. Furthermore, oil droplets in plant-based drinks tend to aggregate, which is why many plant-based milk alternatives have added emulsifiers.

To increase shelf life, different kinds of thermal treatments are used. During pasteurization, drinks are heated at temperatures below 100°C, while the drinks are heated at 121°C for 15-20 minutes when using in-container sterilization. Ultra-high-temperature (UHT) treatment involves direct heat methods such as steam injection. Pasteurized products need to be refrigerated, while sterilized and UHT treated products can be stored at room temperature. High starch content in certain drinks, such as oat or rice, limits applicability of thermal treatments, and non-thermal treatments such as ultra-high-pressure homogenization are preferred in order to increase shelf-life.

4.2.3. Nutrient Value, Anti-Nutrients and Bioactive Compounds

In certain plant-based milk alternatives, such as soy milk, inactivation of trypsin inhibitors can play an important role. Trypsin inhibitors reduce protein absorption in the small intestine. They can be inactivated by heat, but overheating may lead to degradation of amino acids and therefore lower the nutritional value. It is therefore essential to treat these drinks with a specific combination of both time and temperature, and pH level might also play a role. The sprouting of legumes such as soy beans when producing soy milk is a promising way to increase nutritional value. Sprouting leads to a reduction in trypsin inhibitors as well as phytates, which can reduce bioavailability of minerals. Furthermore, sprouting leads to an increase in protein content, a reduction in fat content, as well as reducing the beany flavor. Sprouting of soy beans is therefore not only increasing the nutritional value of soy milk, but also sensory acceptability (Sethi et al., 2016).

Fermentation is another promising way to increase nutritional value by increasing protein and vitamin content while reducing anti-nutrient content of plant-based milk alternatives. Flavor profile and texture are also improved during fermentation. Using mixed-culture fermentation with more than one microbial species instead of traditional monocultures of microbes can increase the quality of plant-based drinks even more. Anti-nutrients such as phytates and saponins are reduced even further when these plants are fermented with mixed cultures and, therefore, mineral bioavailability can be increased. Bioavailability or concentration of bioactive compounds can also be increased through fermentation. Certain bacteria enable, for example, the conversion of glucoside isoflavones into aglycone isoflavones with higher bioactivity and bioaccessibility (Tangyu et al., 2019).

4.3. Ecological Aspects

As discussed in chapter 3.1.2., a possible motivation for consumers to switch to plant-based dairy alternatives are environmental reasons, as plant-based milk alternatives generally have a lower environmental impact than milk (McClements et al., 2019).

Figure 5 compares the environmental impact (land use, greenhouse gas (GHG) emissions, eutrophication, and water use) of different plant-based milk alternatives (soy, almond, oat, rice) as well as cow's milk in a life cycle analysis (LCA). *"An LCA examines how much of an environmental impact a product has by examining factors such as energy consumption, water use, land use, green-house gas emissions, pollution, and fossil fuel utilization associated with agricultural production, storage, transportation, retail, and utilization."* (McClements et al., 2019). Milk has a significantly higher environmental impact than all plant-based milk alternatives in all four categories. The impact that plant-based milk alternatives have, however, very much depends on the type of drink. Almond and rice drinks, for example, have a significantly higher water use than soy and oat drinks. However, their water use is still just about half as high as that of milk (McClements et al., 2019).

There are clear environmental benefits when replacing milk with plant-based milk alternatives. The extent and nature of these benefits depend on the type of alternative.

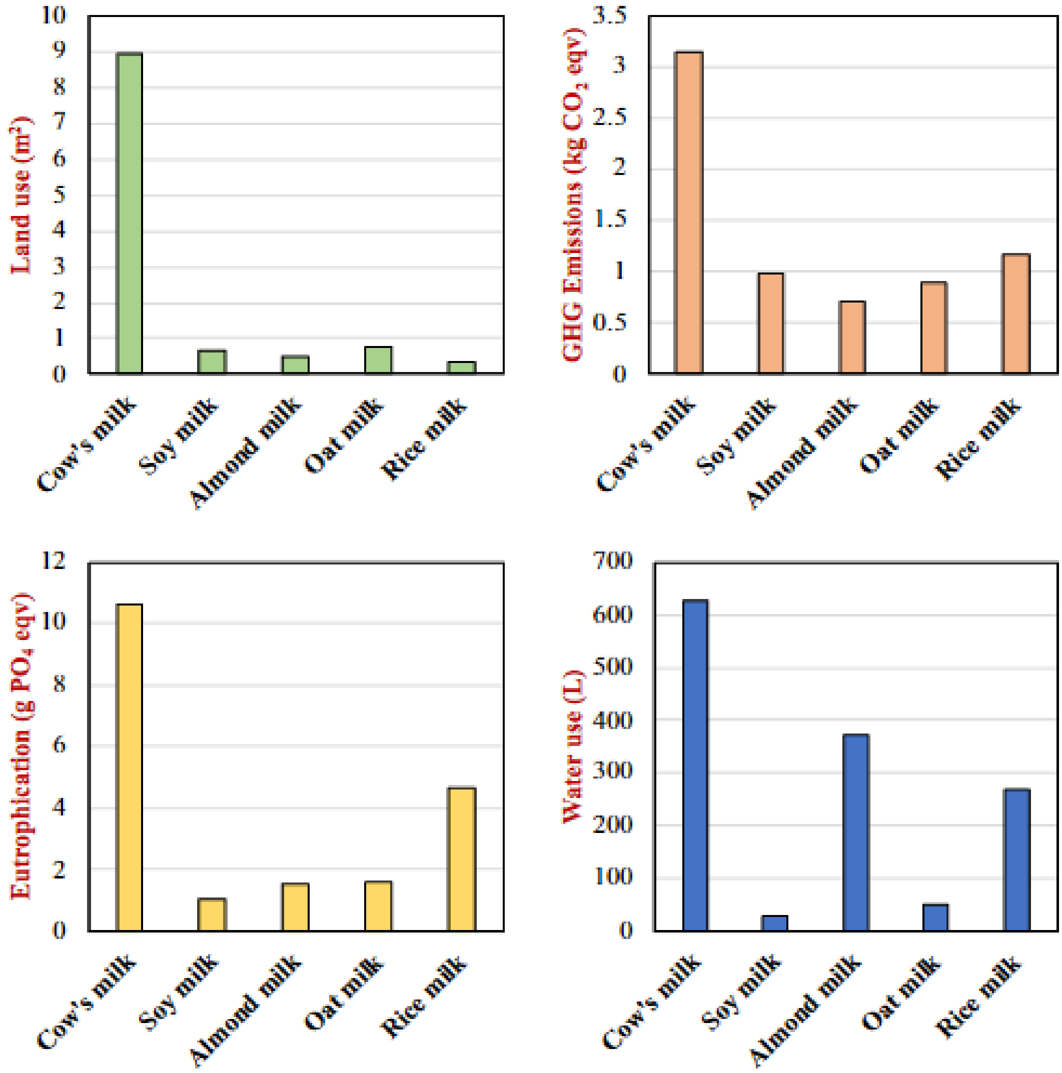

Figure 5: Environmental impact in terms of land use, GHG emissions, eutrophication and water use of cow's milk, soy drinks, almond drinks, oat drinks and rice drinks per liter (McClements et al., 2019).

5. Summary

The aim of this master’s thesis is to evaluate the nutritional aspects of plant-based milk alternatives and give an overview of plant-based milk alternatives on the Austrian market.

Plant-based milk alternatives considered were available on the Austrian market between July and October 2021, which totaled 166 products. All products were organized by category such as oat drinks, soy drink and mixed drinks (drinks based on more than one food) and the nutritional values of every product in each category were listed. This allowed for nutritional comparison of the products within and across categories, as well as to milk. The ingredients were also looked at and discussed in detail.

Plant-based milk alternatives within their categories often vary widely nutritionally in terms of values and composition. Drinks based on legumes such as soy, pea and lupin tend to be very high in protein, compared to other plant-based milk alternatives. 37% of analyzed drinks are fortified, mostly with calcium, B2, B12 and/or vitamin D. Plant-based milk alternatives only resemble milk in terms of micronutrients when fortified, especially concerning calcium, a nutrient critical for Austrians. The fatty acid profile of plant-based milk alternatives is more favorable than that of milk, as they are generally much lower in saturated fatty acids, and higher in MUFAs and PUFAs. Milk is only matched in protein content by legume-based drinks.

Plant-based milk alternatives widely differ in their appropriateness as a milk substitute. When fortified with calcium, B2 and B12, soy, pea or lupins drinks are nutritionally an appropriate match for reduced-fat milk.

Production and processing techniques such as fermentation and sprouting of foods that are used as a base for plant-based milk alternatives are promising to further increase nutritional values of these products. Fortification should be extended to

more drinks to help Austrians meet their calcium requirements and make plant-based milk alternatives a nutritionally adequate substitute for milk.

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7. Appendix

7.1. Summary (German)

Ziel der Masterarbeit ist es, die ernährungsphysiologischen Aspekte pflanzlicher Milchalternativen zu bewerten und einen Überblick über diese Produkte auf dem österreichischen Markt zu geben.

Insgesamt wurden 166 pflanzliche Milchalternativen, die zwischen Juli und Oktober 2021 auf dem österreichischen Markt erhältlich waren, untersucht. Alle Produkte wurden Kategorien wie Haferdrinks, Sojadrinks und gemischte Milchalternativen, Getränke auf Basis von mehr als einem Lebensmittel, zugeordnet und deren jeweilige Nährwerte entsprechend aufgelistet. Dies ermöglichte sowohl einen Vergleich der Nährwerte zwischen den Produkten derselben Kategorie als auch zwischen denen unterschiedlicher Kategorien, sowie mit Milch. Die jeweiligen Inhaltsstoffe wurden ebenfalls detailliert besprochen.

Innerhalb ihrer Kategorien variieren pflanzliche Milchalternativen ernährungsphysiologisch oft stark in Wertigkeit und Zusammensetzung. Getränke auf Basis von Hülsenfrüchten wie Soja, Erbsen und Lupinen sind im Vergleich zu anderen pflanzlichen Milchalternativen tendenziell sehr proteinreich. 37 % der analysierten Getränke sind meist mit Calcium, B2, B12 und/oder Vitamin D angereichert. Hinsichtlich der Mikronährstoffe ähneln sie Milch nur in angereicherter Form. Vor allem betrifft dies Calcium, dessen Deckung sich für ÖsterreicherInnen besonders kritisch erweist. Darüber hinaus ist das Fettsäureprofil pflanzlicher Milchalternativen ernährungsphysiologisch günstiger als das von Milch, da erstere im Allgemeinen viel weniger gesättigte Fettsäuren und mehr MUFAs und PUFAs enthalten. Dem Proteingehalt von Milch ähneln jedoch nur Alternativen auf Hülsenfruchtbasis.

Pflanzliche Milchalternativen unterscheiden sich sehr stark darin, ob sie als Milchersatz geeignet sind oder nicht. Milchalternativen auf Soja,- Erbsen- oder

Lupinenbasis, die mit Calcium, B2 und B12 angereichert sind, ähneln ernährungsphysiologisch fettreduzierter Milch und sind somit als Ersatz geeignet.

Produktions- und Verarbeitungstechniken wie Fermentation und Keimung von Lebensmitteln, die als Basis für pflanzliche Milchalternativen dienen, versprechen eine weitere Steigerung der Nährwerte dieser Produkte. Die Nährstoffanreicherung der Milchalternativen sollte ausgeweitet werden, um den Kalziumbedarf der ÖsterreicherInnen zu decken und pflanzliche Milchalternativen zu einem ernährungsphysiologisch adäquaten Milchersatz zu machen.

Eine weitere Steigerung der Nährwerte von pflanzlichen Milchalternativen versprechen Produktions- und Verarbeitungstechniken wie Fermentation und Keimung von Lebensmitteln, die als Basis für die Herstellung solcher Produkte dienen. Abschließend ist festzustellen, dass die Nährstoffanreicherung von Milchalternativen ausgeweitet werden sollte, um sie zu einem ernährungsphysiologisch adäquaten Ersatz für Milch zu machen und somit auch den Calciumbedarf der ÖsterreicherInnen zu decken.

7.2. Composition of Analyzed Plant-Based Milk Alternatives (German)

Oat Drinks:

Aito Oat Drink Barista: Haferbasis (Wasser, Vollkornhafer 10 %), Rapsöl, Kalziumkarbonat, Emulgator (E472e), Salz, Stabilisator (Gellan), Riboflavin (Vitamin B_2), Folsäure, Jod, Vitamin D_2, Vitamin B_{12}.

Allos Hafer + Calcium: Wasser, europäischer HAFER* (16%), kaltgepresstes Sonnenblumenöl*, Rotkalkalge Lithothamnium Calcareum (0,35%), Meersalz. enthält folgende allergene Zutaten: Gluten
*kontrolliert biologischer Anbau

Hafer 0% Zucker Drink: Wasser, italienischer HAFER* (11 %), Sonnenblumenöl*, Meersalz.
enthält folgende allergene Zutaten: Gluten
*aus kontrolliert ökologischem Anbau.

Allos Hafer Barista Drink: Wasser, italienischer Vollkorn-HAFER* (16%), Inulin* (1%), kaltgepresstes Sonnenblumenöl*, Meersalz.
enthält folgende allergene Zutaten: Gluten

Allos Haferdrink ungesüßt: Wasser, italienischer HAFER* (16%), kaltgepresstes Sonnenblumenöl*, Meersalz.
enthält folgende allergene Zutaten: Gluten
*aus ökologischem Landbau.

Alnatura Haferdrink Calcium: Zutaten: Wasser, HAFERVOLLKORN* 11 %, Sonnenblumenöl*, Meeresrotalge 0,4 %, Meersalz *aus biologischer Landwirtschaft

Alpro Barista Hafer: Haferbasis (Wasser, Hafer (10%)), Sonnenblumenöl, Zichorienwurzelfasern, Erbsenprotein, Säureregulator (Kaliumphosphate), Meersalz, Vitamine (B2, B12, D2).

Alpro ohne Zucker: Haferbasis (Wasser, Hafer (8,7%)), Zichorienwurzelfasern, Sonnenblumenöl, Calciumcarbonat, Meersalz, Stabilisator (Gellan), Vitamine (B2, B12, D2).

Alpro Haferdrink Original: Haferbasis (Wasser, Hafer (9,8%)), Zichorienwurzelfasern, Sonnenblumenöl, Tricalciumphosphat, Meersalz, Stabilisator (Gellan), Vitamine (B2, B12, D2).

Dennree Hafer: Wasser, VOLLKORNHAFER* (12%), Sonnenblumenöl*, Meersalz
*aus kontrolliert biologischer Landwirtschaft

Dennree Hafer Calcium: Zutaten: Wasser, VOLLKORNHAFER[1] (12%), Sonnenblumenöl[1], Meeresalge Lithothamnium calcareum (0,4%), Meersalz
[1]aus kontrolliert ökologischer Erzeugung

DM Bio Haferdrink Natural: Wasser, 11% VOLLKORNHAFER*, Sonnenblumenöl*, Meersalz
*aus biologischer Landwirtschaft

Hofgut Storzeln Hafer: HAFERBASIS fermentiert 99% (Wasser, HAFER* 10%); Sonnenblumenöl*; Salz
(*biologische Landwirtschaft-EG Kontrollsystem) * = Zutaten aus ökol. Landbau, ** = Zutaten aus biol.dynamischem Anbau

Ja! Natürlich Haferdrink: Wasser 87.91% • Bio-HAFERFLOCKEN 11.5% • Bio-Sonnenblumenöl .5% • Speisesalz .09%

Joya Bio Hafer: Haferbasis 99,5% (Wasser, Vollkornhafer* 11,5%); Sonnenblumenöl*, Salz.
*aus biologischer Landwirtschaft

Joya Bio Hafer Glutenfrei: Haferbasis 99,5% (Wasser, glutenfreier Vollkornhafer* 11,5%); Sonnenblumenöl*, Salz.
*aus biologischer Landwirtschaft

Joya Hafer 0% Sugar: Wasser, Hafer 5,5%, Sonnenblumenöl, Calciumcarbonat, Verdickungsmittel: Gellan; Salz, Vitamin D, Vitamin B12.

Joya Hafer Barista: Wasser, Hafer 10%, Sojabohnen, Sonnenblumenöl, Salz.

Joya Hafer Chia: Haferbase 98,6 % (Wasser, Vollkornhafer 11,9%), Chiaöl 0,1%, Leinöl, Sonnenblumenöl, Calciumcarbonat, Antioxidationsmittel: Stark tocopherolhaltige Extrakte; Salz, Vitamin D2, Vitamin B12.

Joya Hafer Frisch: Haferbasis 99,1% (Wasser, Hafer 7,2%); Sonnenblumenöl, Tricalciumphosphat, Stabilisator: Gellan; Säureregulator: Dikaliumphosphat; Vitamin D2, Vitamin B12, Salz.

Natumi Hafer Barista: Wasser, VOLLKORNHAFER*(10%), SOJABOHNEN (2%), Sonnenblumenöl*, Meersalz
*aus kontrolliert ökologischer Erzeugung

Natumi Hafer Glutenfrei: Wasser, glutenfreier HAFER* (11,5%), Sonnenblumenöl*, Meersalz
*kontrolliert biologischer Anbau

Natumi Hafer Natural: Wasser, Vollkornhafer* (15%), Sonnenblumenöl*, Meersalz
* Aus kontrolliert biologischem Anbau

Natumi Hafer Zero: Wasser, glutenfreier Hafer* (5,5%), Sonnenblumenöl*, Verdickungsmittel: Johannisbrotkernmehl*, Meersalz
* Aus kontrolliert biologischem Anbau.

Oatly Hafer Barista: Wasser, Hafer 10%, Rapsöl, Säureregulator (Dikaliumphosphat), Calciumcarbonat, Salz, Vitamine (D2, Riboflavin, B12), Kaliumiodid.

Oatly Hafer Bio: Wasser, Hafer* 10%, Meersalz.
* aus kontrolliert biologischem Anbau

Oatly Hafer Calcium: Wasser, Hafer 10%, Rapsöl, Calciumcarbonat, Calciumphosphate, Salz, Vitamine (D2, Riboflavin, B12), Kaliumiodid.

Oatly Hafer Classic: Wasser, Hafer 10%, Rapsöl, Säureregulator (Dikaliumphosphat), Calciumcarbonat, Calciumphosphate, Salz, Vitaminen (D2, Riboflavin, B12), Kaliumiodid.

Oatly Hafer Deluxe: Wasser, Hafer 10%, Rapsöl, Säureregulator (Dikaliumphosphat), Calciumcarbonat, Calciumphosphate, Salz, Vitaminen (D2, Riboflavin, B12), Kaliumiodid.

Provamel Hafer: haferbasis* (wasser, hafer* (11,9%)) sonnenblumenöl*agavenfaser*meersalz
* aus kontrolliert biologischem Anbau

Provamel Hafer Calcium: Wasser Hafer* (12%) Sonnenblumenöl* Ballaststoff (Inulin)* Meeresalge lithothamnium calcareum (0.4%) Meersalz Stabilisator (gellan)
* aus kontrolliert biologischem Anbau

Rude Health Oat Drink: Spring water, oats* (11%), cold-pressed sunflower oil*, sea salt
* From certified organic farming.

Schärdinger Hafer: Zutaten: 12% Vollkornhaferflocken, Sonnenblumenöl, Gellan, Salz.

Share Hafer Drink: Zutaten: Wasser, HAFER*(11,5%), Sonnenblumenöl*, Meersalz
* aus ökologischem Landbau

SPAR NATUR*PUR Bio-Haferdrink: Zutaten: Wasser, 12% HAFERFLOCKEN, Sonnenblumenöl*, Salz unjodiert, Stabilisator: Gellan.
*aus biologischer Landwirtschaft

Voelkel Hafer: Zutaten: Natürliches Mineralwasser, Vollkorn-HAFER* 12%, Sonnenblumenöl*, Ur-Steinsalz.
*aus kontrolliert ökologischer Erzeugung

Zurück zum Ursprung BIO-Haferdrink Natur: Wasser, 12% Vollkornhaferflocken*, Sonnenblumenöl*, Salz
*aus biologischer Landwirtschaft

Rice Drinks:

Allos Reis 0% Zucker: Wasser, italienischer Reis* (13,7%), kaltgepresstes Sonnenblumenöl*, Meersalz
*aus kontrolliert ökologischem Anbau

Allos Reis ungesüßt: Wasser, europäischer Reis* (17%), kaltgepresstes Sonnenblumenöl*, Meersalz.
*aus kontrolliert ökologischem Anbau

Alnatura Reisdrink Calcium: Wasser, Reis* 14 %, Sonnenblumenöl*, Meeresrotalge Lithothamnium calcareum)0,4 %, Meersalz

*aus biologischer Landwirtschaft

Alpro Reisdrink Original: Reisbasis (Wasser, Reis (12,5%)), Sonnenblumenöl, Tricalciumphosphat, Meersalz, Stabilisator (Gellan), Säureregulator (Kaliumphosphate), Vitamine (B12, D2).

Dennree Reis Natur: Trinkwasser, Reis* (14%), Sonnenblumenöl*, Salz
*aus kontrolliert biologischer Landwirtschaft

DM Bio Reis Drink Natur: Wasser | 13 % Reis* | Sonnenblumenöl* | Meersalz
* aus biologischer Landwirtschaft

Joya Bio Reis: Reisbasis 99% (Wasser, Reis* 13,5%); Sonnenblumenöl*; Salz
*aus biologischer Landwirtschaft

Joya Reis 0% Zucker: Wasser, Reis 5,1%, Sonnenblumenöl, Calciumcarbonat, Verdickungsmittel: Gellan; natürliches Aroma, Salz, Vitamin D, Vitamin B12.

Natumi Reis Natural: Wasser, Reis*(13%), Sonnenblumenöl*, Meersalz
* = Zutaten aus ökol. Landbau

Natur aktiv Bio Reis Drink: 99% Reisbasis (Wasser, 12,4% Reis*), Sonnenblumenöl*, Salz.
*aus biologischer Landwirtschaft

Rude Health Brown Rice Drink: Spring water, brown rice* (17%), cold-pressed sunflower oil*, sea salt
* From certified organic farming

SPAR Veggie Reisdrink Natur: Wasser, Reis 14%, Sonnenblumenöl, Meersalz unjodiert, Tricalciumphosphat, Stabilisator: Gellan, Vitamin D2 und B12

Vegavita Reisdrink: Wasser, 13% Reis*, Sonnenblumenöl*, Meersalz.
*Aus kontrolliert biologischer Landwirtschaft

Spelt Drinks:

Allos Dinkeldrink ungesüßt: Wasser, italienischer DINKEL* (eine WEIZENart) (16%), kaltgepresstes Sonnenblumenöl*, Meersalz.

Dennree Dinkel: Wasser, VOLLKORNDINKEL* (eine WEIZENART) (13,4%), Sonnenblumenöl*, Meersalz
*aus kontrolliert biologischer Landwirtschaft

DM Bio Dinkeldrink Natur: Zutaten: Wasser, 11% DINKELVOLLKORN*, Sonnenblumenöl*, Meersalz.
*aus biologischer Landwirtschaft

Ja! Natürlich Dinkeldrink: Wasser • Bio-DINKELFLOCKEN 11.5% • Bio-Sonnenblumenöl • Speisesalz

Natumi Dinkel Natural: Wasser, Vollkorndinkel* (Weizen) (17%), Sonnenblumenöl*, Meersalz
* Aus kontrolliert biologischem Anbau

Zurück zum Ursprung BIO-Dinkeldrink Natur: Wasser, 12% Vollkorndinkelweizenflocken*, Sonnenblumenöl*, Salz
*aus biologischer Landwirtschaft

Buckwheat Drinks:

Hofgut Storzeln Buchweizen Drink Pur: Wasser, Buchweizen* 12,5%, Sonnenblumenöl*, Salz.
*aus kontrolliert biologischem Anbau

Natumi Buchweizen Natural: Buchweizen* (12,5%), Sonnenblumenöl*, Meersalz.
*aus kontrolliert ökologischer Erzeugung

Millet Drinks:

Natumi Hirse Natural: Wasser, Hirse* (15%), Sonnenblumenöl*, Meersalz*
*aus kontrolliert ökologischer Erzeugung

Soy Drinks:

Allos Soja Barista Drink: Wasser, italienischer SOJA* (5,3%), Meersalz.
* aus kontrolliert ökologischem Landbau.

Allos Sojadrink ungesüßt: Wasser, italienischer SOJA* (7,5%), Meersalz

Alnatura Sojadrink Ungesüßt: Wasser, SOJABOHNEN* 9%
*aus biologischer Landwirtschaft

Alpro Barista Sojadrink: Sojabasis (Wasser, geschälte Sojabohnen (8,7%)), Apfelextrakt, Säureregulatoren (Kaliumphosphate), Calciumcarbonat, Meersalz, Stabilisator (Gellan), Vitamine (B2, B12, D2).

Alpro Proteindrink Natur: Sojabasis (Wasser, geschälte Sojabohnen (13,1%)), Zucker, Säureregulator (Kaliumphosphate), Calciumcarbonat, Aroma, Meersalz, Stabilisator (Gellan), Vitamine (B2, B12, D2).

Alpro Sojadrink Bio: Sojabasis* (Wasser, geschälte Sojabohnen* (8%)), roher Rohrzucker*, Meersalz
*= aus kontrolliert biologischem Anbau.

Alpro Sojadrink Light: Sojabasis (Wasser, geschälte Sojabohnen (5,6%)), löslicher Mais-Ballaststoff, Fruktose, Zucker, Calciumcarbonat, Säureregulator (Kaliumphosphate), Meersalz, Aroma, Stabilisator (Gellan), natürliches Aroma, Vitamine (B2, B12, D2).

Alpro Sojadrink Ohne Zucker: Sojabasis (Wasser, geschälte Sojabohnen (8,7%)), Säureregulatoren (Kaliumphosphate), Calciumcarbonat, Aromen, Meersalz, Stabilisator (Gellan), Vitamine (B2, B12, D2).

Alpro Sojadrink Original Gekühlt mit Calcium: Sojabasis (Wasser, geschälte Sojabohnen (8%)), Zucker, Säureregulatoren (Kaliumphosphate), Calciumcarbonat, Aroma, Meersalz, Stabilisator (Gellan), Vitamine (B2, B12, D2).

Alpro Sojadrink Original mit Calcium: Sojabasis (Wasser, geschälte Sojabohnen (8%)), Zucker, Säureregulatoren (Kaliumphosphate), Calciumcarbonat, Aroma, Meersalz, Stabilisator (Gellan), Vitamine (B2, B12, D2).
Dennree Soja: Trinkwasser, Sojabohnen* (8%)

Dennree Soja mit Calcium: Trinkwasser, Sojabohnen* (7,8%), Agavendicksaft* (3,5%), Meeresalge Lithothamnium Calcareum (0,35%), Meersalz, Verdickungsmittel: Johannisbrotkernmehl*
* Aus kontrolliert biologischem Anbau.

DM Bio Soja Drink Natur: Zutaten: Wasser, 8% SOJABOHNEN*
* aus biologischer Landwirtschaft

Happy Soya Soja Drink Natur: Zutaten: Wasser, SOJABOHNEN 6,9%, Zucker, Calciumcarbonat, Stabilisator: Gellan, Salz, Säureregulator: Dikaliumphosphat; Aroma, Vitamine: B2, D2, B12.

Hofgut Storzeln Soja natur + Calcium: Wasser, Sojabohnen* 9,5%, Meeresalge: Lithothamnium Calcareum
*aus kontrolliert biologischem Anbau

Hofgut Storzeln Soja natur pur: Wasser, Sojabohnen* 9,4%.
*aus kontrolliert biologischem Anbau

Ja! Natürlich Bio Soja Drink: Bio-Sojabasis 100% (Bio-SOJABOHNEN • Wasser)

Joya Bio Soja: Sojabasis 100% (Wasser, Sojabohnen* 6,8 %)
*aus biologischer Landwirtschaft

Joya Soja Barista: Sojabasis 99% (Wasser, Sojabohnen 7,5 %); Calciumcarbonat, Stabilisator: Gellan; Säureregulator: Kaliumcarbonate; Vitamin D, Vitamin B12, natürliches Aroma, Salz.

Joya Soja Frisch: Sojabasis 96% (Wasser, Sojabohnen 8,8%); Rübenzucker; Glukosesirup; Calciumcarbonat; Salz.

Joya Soja Natur (+Calcium): Sojabasis 98% (Wasser, Sojabohnen 7,1%), Zucker, Calciumcarbonat, Salz, natürliche Aromen, Vitamin D, Vitamin B12.

Natumi Soja Natural: Wasser, Sojabohnen* 9%
* Aus kontrolliert biologischem Anbau

Provamel Soja ohne Zucker: Sojabasis* (wasser, geschälte sojabohnen* (9,8%))
(* = aus kontrolliert biologischem Anbau)

SPAR Veggie Soja Drink Natur: Sojabasis 96,3% (Wasser, SOJABOHNEN* 7,2%), Zucker, Calciumcarbonat, Stabilisator: Gellan, Meersalz, Säureregulator: Dikaliumphosphat, Vitamin E, Riboflavin, Vitamin B12, Aroma.

SPAR Veggie Soja Drink ungesüßt: 99,7% Sojabasis (Wasser, 8,6% SOJABOHNEN), Calciumcarbonat, Riboflavin (Vitamin B2), Vitamin D, Vitamin B12.

Zurück zum Ursprung Soja Drink Natur: Wasser, 8,5% Sojabohnen*, konzentrierter Apfelsaft*
*aus biologischer Landwirtschaft

Pea Drinks:

Princess and the Pea Original mit Ballaststoffen: Wasser, 3,9 % Erbsenprotein, 2,1 % Rapsöl, Maltodextrin, Inulin, Zucker, Calciumphosphat, natürliches Aroma, Emulgator Lecithine, Meersalz, Stabilisator Gellan.

Princess and the Pea Original ungesüßt: Wasser, 3,9 % Erbsenprotein, 2,1 % Rapsöl, Maltodextrin, Calciumphosphat, natürliches Aroma, Emulgator Lecithine, Meersalz, Stabilisator Gellan.

SPAR HIGH PROTEIN Hafer-Erbsendrink: Wasser, Hafer 8,3%, Erbsenprotein 3,5%, Calciumphosphate

Vly BARISTA: Wasser, Rapsöl, Erbsenprotein (2.5%), Fermentierter Reis, Säureregulator: Kaliumphosphat, Calciumcarbonat, Zitrusfasern, Meersalz, Natürliche Aromen

Vly ORIGINAL: Wasser, Erbsenprotein (4.1%), Rapsöl, Fermentierter Reis, Säureregulator: Dikaliumphosphat, Calciumcarbonat, Natürliche Aromen

Vly UNGESÜSST: Wasser, Erbsenprotein (4.3%), Rapsöl, Säureregulator: Dikaliumphosphat, Calciumcarbonat, Natürliche Aromen

Soyatoo Lupine: Trinkwasser, SÜSSLUPINENSAMEN 10%*, Reissirup*, natürlicher Vanilleextrakt, Vanilleextrakt*, Meersalz
* aus kontrolliert biologischem Anbau

Almond Drinks:

Allos Mandel Calcium Drink: Wasser, Rohrzucker*, europäische Mandeln* (2,8%), Reisstärke*, Rotkalkalge Lithothamnium Calcareum (0,4%), Meersalz
* Aus kontrolliert biologischem Anbau

Allos Mandel Drink 0% Zucker: Wasser, italienische MANDELN* (5%), Meersalz.
*aus ökologischem Landbau.

Alpro Barista Mandel: Wasser, Mandeln (2,5%), Zucker, Fruktose, Säureregulatoren (Kaliumphosphate), Calciumcarbonat, natürliche Aromen, Stabilisatoren (Gellan, Guarkernmehl), Meersalz

Alpro Mandeldrink Ohne Zucker: Wasser, Mandeln (2,3%), Tricalciumphosphat, Meersalz, Stabilisatoren (Johannisbrotkernmehl, Gellan), Emulgator (Lecithine (Sonnenblumen)), Vitamine (B2, B12, E, D2).

Alpro Mandeldrink Original: Wasser, Mandeln (2,3%), Zucker, Tricalciumphosphat, Meersalz, Stabilisatoren (Johannisbrotkernmehl, Gellan), Emulgator (Lecithine (Sonnenblumen)), natürliches Aroma, Vitamine (B2, B12, E, D2).

Alpro Mandeldrink Ungeröstet & Ohne Zucker: Wasser, Mandeln (2,3%), Tricalciumphosphat, Meersalz, Stabilisatoren (Johannisbrotkernmehl, Gellan), Emulgator (Lecithine (Sonnenblumen)), natürliches Aroma, Vitamine (B2, B12, E, D2).

Dennree Mandel: Wasser, MANDELN* (2,5%), Maltodextrin*, Emulgator: Lecithine*; Meersalz
*aus kontrolliert biologischer Landwirtschaft

DM Bio Mandeldrink Natur: Trinkwasser, MANDELPASTE*, Meersalz
*aus biologischer Landwirtschaft

Ja! Natürlich Mandeldrink: Wasser • Bio-MANDELN 5% • Meersalz • Stabilisator (Bio-Guarkernmehl)

Joya Mandel 0% Zucker: Wasser; Mandeln 2%; Calciumcarbonat; Verdickungsmittel: Gellan, Guarkernmehl; Emulgator: Lecithine; Salz.

Joya Mandel Barista: Wasser, Mandeln 2,5%, Maltodextrin, Stabilisatoren: Gellan, Lecithine; Säureregulator: Dikaliumphosphat; Salz.

Joya Mandel Barista fresh: Wasser, Mandeln 2,5%, Maltodextrin, Stabilisatoren: Gellan, Lecithine; Säureregulator: Dikaliumphosphat; Salz

Joya Mandel Frisch: Zutaten: Wasser, Mandeln 2%, Tricalciumphosphat, Stabilisatoren: Gellan, Guarkernmehl; Emulgator: Lecithine; Salz, Vitamin D, Vitamin B12.

Natumi Mandel ungesüßt: Wasser, Mandeln* (4%), Emulgator: Lecithine* (aus Sonnenblumen), Meersalz
*aus kontrolliert biologischem Anbau

Natur aktiv Bio Mandel Drink: Wasser, Rohrzucker*, 2,3% Mandeln*, Meersalz, Säureregulator: Calciumcitrate; Stabilisator: Gellan.
* *aus kontrolliert biologischem Anbau

Provamel Mandel: Wasser, Mandeln (5%)*, Agavendicksaft*, Stabilisator (Gellan)
* aus kontrolliert biologischem Anbau.

Provamel Mandel Ohne Zucker: Wasser, Mandeln (5%)*, Meersalz, Stabilisator (Gellan)
* aus kontrolliert biologischem Anbau

Share Bio Mandeldrink: Wasser, MANDELMARK* (3%), Meersalz, Stabilisator: Gellan, Emulgator: Sonnenblumenlecithine*
* aus ökologischem Landbau

SPAR Veggie Mandeldrink: Wasser, Zucker, MANDELN 2%, Calciumcarbonat, Stabilisatoren: Gellan, Guarkernmehl, Salz unjodiert, Emulgator: Lecithine, Vitamin E, Riboflavin, Vitamin D2, Vitamin B12.

Vegavita Mandeldrink: Wasser, 2,5% MANDELN*, Maltodextrin*, Emulgator: Lecithine*, Salz.
*Aus kontrolliert biologischer Landwirtschaft

Coconut Drinks:

Allos Kokos Drink 0% Zucker: Wasser, Kokosnuss* (4,8 %), Reisstärke*, natürliches Kokosnussaroma*, Meersalz, Verdickungsmittel: Guarkernmehl*, Xanthan.
*aus ökologischem Landbau

Alnatura Kokosdrink Ungesüßt: Wasser, Kokosfruchtfleisch* teilentfettet 8 %, Meersalz

*aus biologischer Landwirtschaft

Alpro Kokosnussdrink ohne Zucker: Wasser, Kokosmilch (7%) (Kokoscreme, Wasser), Kokosnusswasser (2,6%), Tricalciumphosphat, natürliches Kokosaroma, Stabilisatoren (Guarkernmehl, Xanthan, Gellan), Meersalz, Vitamine (B12, D2).

DM Bio Kokosdrink Natur: Wasser, 8% Kokosfruchtfleisch* teilentölt , Meersalz
*aus biologischer Landwirtschaft

Natur aktiv Kokosdrink: Wasser, 12% Kokosmark*, 2,5% Agavendicksaft,* Stabilisator: Guarkernmehl*; Speisesalz.
*aus kontrolliert biologischer Landwirtschaft

SPAR NATUR*PUR Bio-Kokos-Drink: Wasser, 12% Kokosmark*, 2,5% Agavendicksaft*, Stabilisator: Guarkernmehl*, Salz unjodiert.
*aus biologischer Landwirtschaft.

Coconut Drinks (mixed):

Alpro Barista Kokosnuss: Sojabasis (Wasser, geschälte Sojabohnen (2,9%)), Kokosmilch (3,5%) (Kokoscreme, Wasser), Zucker, Fruktose, Säureregulatoren (Kaliumphosphate), Calciumcarbonat, Meersalz, Aroma, Stabilisator (Gellan).

Alpro Kokosnussdrink Original: Wasser, Kokosmilch (5,3%) (Kokoscreme, Wasser), Reis (3,3%), Tricalciumphosphat, Stabilisatoren (Guarkernmehl, Gellan, Xanthan), Meersalz, Aromen, Vitamine (B12, D2).

Joya Kokos: Wasser, Kokosmilch 5,3% (Kokoscreme, Wasser), Reis 3,8%, Verdickungsmittel: Gellan, Guarkernmehl; Säureregulatoren: Tricalciumphosphat, Dikaliumphosphat; Emulgator: Lecithine; Vitamin B12, Vitamin D2, Salz, natürliches Aroma.

Joya Kokos Barista: Wasser, Kokosnussmilch 9% (Kokosnusscreme, Wasser), Sojabohnen 2,3%, Kalziumkarbonat, Säureregulatoren: Dikaliumphosphat, Kaliumkarbonat; Verdickungsmittel: Gellan-Gummi; Salz, natürliches Aroma.

Joya Kokos Frisch: Wasser, Kokosmilch 8,7% (Kokoscreme, Wasser), Reis 3,8%, Verdickungsmittel: Gellan, Guarkernmehl, Xanthan; Säureregulatoren: Tricalciumphosphat, Dikaliumphosphat; Emulgator: Lecithine; Vitamin B12, Vitamin D, Salz, natürliche Aromen.

Rude Health Coconut Drink: Spring water, Organic rice, Organic coconut milk (7.5%), Sea salt.

SPAR Veggie Kokos Drink ungesüßt: Wasser, 14% Reis, 4% Kokosmilch (Kokosnussfruchtfleisch, Wasser), Tricalciumphosphat, Stabilisator: Gellan, Emulgator: Lecithine, Meersalz unjodiert, natürliches Aroma, Vitamin D, Vitamin B12.

Cashew Drinks:

Alnatura Cashew Drink Ungesüßt: Wasser, CASHEWKERNE* 6,5 %, Meersalz
*aus biologischer Landwirtschaft

Alpro Cashewdrink Original: Wasser, Cashewkerne (3,1%), Zucker, Tricalciumphosphat, Meersalz, Stabilisatoren (Johannisbrotkernmehl, Gellan), Emulgator (Lecithine (Sonnenblumen)), Vitamine (B2, B12, E, D2).

Natur aktiv Bio Cashew Drink: Wasser, 3,1%, Cashewkerne*, Rohrzucker*, Meersalz, Säureregulator: Calciumcitrate; Stabilisator: Gellan.
*aus kontrolliert biologischer Landwirtschaft.

Provamel Cashew: Wasser, Cashewkerne (6%), Meersalz.

Rude Health Cashew Drink: Natural Spring water, Organic Cashews* (5%), Sea Salt.
* = produced to organic standards

Hazelnut Drinks:

Alpro Haselnussdrink Original: Wasser, Zucker, Haselnüsse (2,8%), Tricalciumphosphat, Meersalz, Stabilisatoren (Johannisbrotkernmehl, Gellan), Emulgator (Lecithine (Sonnenblumen)), Vitamine (B2, B12, E, D2).

Mixed Drinks:

Allos Hafer Mandeldrink ungesüßt: Wasser, französischer HAFER aus der landwirtschaftlichen Genossenschaft Cocebi*(9%), italienische MANDELN* (3%), kaltgepresstes Sonnenblumenöl*, Meersalz.

Allos Reis Haselnussdrink ungesüßt: Wasser, Reis* (17%), HASELNÜSSE* (3%), Meersalz.

Allos Reis Kokosdrink ungesüßt: Wasser, europäischer Reis* (17%), Kokosnussmilch* (4%) ((60%) Kokosnuss* entsprechen (2,4%) des Fertigproduktes, Wasser, Verdickungsmittel: Guarkernmehl*), natürliches Kokosnussaroma*, Meersalz.

Allos Reis Mandeldrink ungesüßt: Wasser, Reis* (17%), europäische MANDELN* (3%), kaltgepresstes Sonnenblumenöl*, Meersalz.

Alnatura Hafer-Hanf-Drink mit Leinöl: Wasser, HAFERVOLLKORN* 4%, Hanfpaste* 2% (geschälte Hanfsamen* 83%, Hanföl* 17%), Leinöl* 0,9%, Meersalz
*aus biologischer Landwirtschaft

Alpro Growing Up Haferdrink: Zutaten: HAFERBASIS (Wasser, HAFER (7,8%)), pflanzliche Öle (Rapsöl, Sonnenblumenöl), Erbsenprotein, Maltodextrin, Calciumcarbonat, natürliches Aroma, Säureregulator (Kaliumphosphate), Stabilisator (Gellan), Eisen, Kaliumiodid, Zink, Vitamine (A, B2, B9, B12, C, D2).

Alpro Growing Up Sojadrink: Sojabasis (Wasser, geschälte Sojabohnen (6,6%)), Maltodextrin, roher Rohrzucker, Fruktose, Sonnenblumenöl, Calciumcarbonat, Säureregulator (Kaliumphosphate), Aromen, Emulgator (Lecithine (Sonnenblumen)), Stabilisator (Gellan), Eisenpyrophosphat, Kaliumiodid, Vitamine (B2, B12,C, D2).

Alpro Hafer-Mandeldrink: Haferbasis (Wasser, Hafer (3,2%)), Mandeln (1,7%), Zichorienwurzelfasern, Tricalciumphosphat, Stabilisatoren (Johannisbrotkernmehl, Gellan), Meersalz, natürliche Aromen, Vitamine (B2, B12, E, D2).

Alpro Not M*LK Drink Pflanzlich & Fettarm, 1,8%: Haferbasis (Wasser, Hafer (8,7%)), Sonnenblumenöl, Zichorienwurzelfasern, Erbsenprotein, Calciumcarbonat, Säureregulator (Kaliumphosphate), natürliche Aromen, Meersalz, Stabilisator (Gellan), Vitamine (B12, D2).

Alpro Not M*LK Drink Pflanzlich & Voll, 3,5%: Haferbasis (Wasser, Hafer (8,7%)), Sonnenblumenöl, Zichorienwurzelfasern, Erbsenprotein, Calciumcarbonat, Säureregulator (Kaliumphosphate), natürliche Aromen, Meersalz, Stabilisator (Gellan), Vitamine (B12, D2).

Dennree Hafer Barista mit Soja: Wasser, VOLLKORNHAFER* (10%), SOJABOHNEN* (2,2%), Sonnenblumenöl*, Meersalz
*aus kontrolliert biologischer Landwirtschaft

Dennree Reis Kokos: Wasser, Reis* (14%), Kokosmilch* (6%) (Kokosnussextrakt*, Wasser), Meersalz, natürliches Kokosnussaroma*
*aus kontrolliert biologischer Landwirtschaft

DM Bio Barista Haferdrink mit Soja: Wasser | 10 % VOLLKORNHAFER* | 2 % SOJABOHNEN* | Sonnenblumenöl* | Meersalz
* aus biologischer Landwirtschaft

Harvest Moon Bio Milk Alternative Drink: Wasser, Kokos*, Reis*, CASHEWNUSS*, Sonnenblumenöl*, Hefeflocken*, Meersalz.
*aus kontrolliert biologischem Anbau

Innocent Haselnuss & Reis Pflanzendrink: Quellwasser, Reis 11%, geröstete Haselnüsse 5,8%, Meersalz

Innocent Kokosnuss & Reis Pflanzendrink: Quellwasser, Reis (11%), Kokosnussmilch (9,1%), Zitrusfasern (0,30%), Meersalz.

Joya Hafer Protein: Wasser, Sojabohnen 6,9%, Hafer 4,1%, Salz, Aromen

Joya Kokos Reis: Wasser, Reis 11,5%, Kokosmilch 10% (Kokoscreme, Wasser), Maltodextrin, Emulgator: Lecithine; Verdickungsmittel: Gellan; Salz.

Joya Mandel Hafer: Haferbase 97,3% (Wasser, Hafer 7,4%), Mandeln 2%, Maltodextrin, Calciumcarbonat, Salz, Stabilisator: Gellan; Vitamin D2, Vitamin B12.

Joya Mandel Haselnuss: Wasser, Reis 13,2%, Haselnüsse 1,2%, Mandeln 0,6%, Kalziumcarbonat, Stabilisator: Gellan; Emulgator: Lecithine; Salz, natürliches Aroma, Vitamine D & B12.

Joya Mandel Kokos: Wasser, Kokosnussmilch 3,3% (Kokoscreme, Wasser); Zucker; Mandeln 1,3%, Salz, Calciumcarbonat, Verdickungsmittel: Gellan, Guarkernmehl; Emulgator: Sonnenblumenlecithin.

Joya Mandel Protein: Wasser, Sojabohnen 5,8%, Mandeln 2,5%, Calciumcarbonat, Salz, Emulgator: Lecithine, Vitamin B12, Vitamin D, natürliches Aroma, Aroma.

Joya Mandel Reis: Wasser; Mandeln 3%; Reis 2%; Rübenzucker; Stabilisator: Gellan; natürliches Aroma; Salz.

Natumi Dinkel Mandel: Wasser*, VOLLKORNDINKEL* (15%), MANDELN* (2,5%), Sonnenblumenöl*, Meersalz
*aus kontrolliert ökologischer Erzeugung

Natumi Hafer Kokos: Wasser, VollkornHAFER* (10%), Kokosmilch* (6%), natürliches Aroma*, Stabilisator: Gellan, Meersalz
*aus kontrolliert ökologischer Erzeugung

Natumi Hafer Mandel: Wasser, HAFER*(14%), MANDELN* (3%), Emulgator: Lecithine (aus Sonnenblumen), Meersalz

Natumi Reis Kokos: Wasser, Reis* (14%), Kokosmilch* (6%), Meersalz, natürliches Aroma*
*aus kontrolliert ökologischem Anbau

Natumi Soja Barista Kokos: Wasser, Kokosmilch* (Kokoscreme*, Wasser)(7%), SOJABOHNEN*(4%), natürliches Kokos-Aroma*, Meersalz, Stabilisator: Gellan
*aus kontrolliert ökologischer Erzeugung

Provamel Hafer Mandel: haferbasis* (wasser, hafer* (7,2%)), mandeln (2.3%)*, sonnenblumenöl*, agavenfaser*, meersalz, stabilisator (gellan)
*= aus kontrolliert biologischem Anbau.

Provamel Kokosnuss Mandel: Wasser, Kokosmilch* (Kokoscreme, Wasser) (5,2%), Agavendicksaft*, Mandeln* (2,6%), natürliches Kokosaroma*, Meersalz, Stabilisatoren (Gellan, Johannisbrotkernmehl).
(* = aus kontrolliert biologischem Anbau)

Rude Health Almond Drink: Wasser, Reis, Mandeln (1%), Sonnenblumenöl, Meersalz.
* Aus kontrolliert biologischem Anbau

Rude Health Hazelnut Drink: Natural Spring Water, Organic Rice, Organic Italian Hazelnuts (2%), Organic Cold-Pressed Sunflower Oil, Sea Salt

Rude Health Tiger Nut Drink: Quellwasser, Bio-Reis, Bio-Erdmandeln (6%), Meersalz
*aus kontrolliert biologischem Anbau.

Vegavita Bio-Kokos-Reisdrink: Wasser, 9% Kokosmilch* (Wasser, Kokoscreme*), 7% Reis*, Meersalz.
*Aus kontrolliert biologischer Landwirtschaft