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Comparative Study of Functional Properties of Fermented Vegetable Milks in Health

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Abbreviations: RAE: Royal Spanish Academy; LAB: Lactic Acid Bacteria; FVM: Fermented Vegetable Milks; FOSHU: Food for Specified Health Use; FAO: Food and Agriculture Organization of the United Nations; LDL: Low-Density Lipoprotein; HFFD: High Fat and Fructose Diet

ABSTRACT

One of the areas of research and innovation of greatest interest in the food industry has been the development of new functional beverage products, specifically those that are used as an alternative to milk of animal origin, since nowadays protein allergy, lactose intolerance and other problems generated by the consumption of cow's milk, has influenced consumers to choose this type of product. Among them are Fermented Vegetable Milks (FVM) with microorganisms whose consumption has been important due to the beneficial effects on health seen in the increase in quality of life. Non-FVM lack nutritional balance compared to cow's milk, however, by fermenting them, functionally active components with beneficial health properties, also improving sensory acceptability, which is an important factor that limits their consumption and hearing. A review of five vegetable milks is carried out: soy milk, almond milk, rice milk, oat milk and coconut milk. Where studies have found that fermented soy milk offers significant benefits compared to coconut milk which provides fewer benefits. In addition to the nutritional, physicochemical and sensorial properties of FVM, mostly dependent on the raw material, the fermentation process and the microorganisms used. Research on FVM will require efforts in the coming years to prepare new and nutritionally adequate functional products.

Keywords: Fermentation; Probiotics; Prebiotics; Antioxidants; Vegetable Milks

Introduction

Formerly it was considered that the diet was only consuming food that provided nutrients to meet the metabolic requirements and vital functions of the individual. But now it aims to improve health, which is why within the food industry the use of titles such as "Functional Foods", "Super Foods" and "Enriched Foods" has been extended to include them in the diet, increasing the interest of consumers for these types of food [1], which represents a benefit for the consumer and an opportunity for the food industry, providing greater added value to their products [2]. Since there is an increase in the use of seeds, grains or fruits as a substitute for many foods of animal origin [3] as well as an increase in diseases that have originated from lifestyle, various environmental situations and the economy, vegetable milks arise, becoming a demand by consumers seeking to improve their eating habits [4] The use of vegetable milks is due to the fact that there are people who avoid consuming milk of animal origin, either because they have a diet free of this type of milk, free of cholesterol and low calorie content [5] or because consuming it causes problems in the body, as it is in the case of people who are lactose intolerant and allergic to cow's milk proteins [6].

Vegetable Milks

Milk is one of the most basic and fundamental foods in the human diet, which is why the study of milks obtained from plants, seeds and nuts that are similar to conventional milk has increased in recent years and den as a result an alternative. According to studies, vegetable milks date from 200 years old, although historically it was until the 19th century that the term "vegetable milk" was known with the origin of soy milk [7]. Although defining it as vegetable milk, has caused many questions and many opinions say that it should not be called "milk" [8] because the definition for the term "milk" is only given to the type of animal origin , as the CODEX Alimentarius says that "it is the normal mammary secretion of dairy animals obtained through one or more milkings without any addition or extraction, intended for consumption in the form of liquid milk or for further processing" [9,10]. But the RAE (Royal Spanish Academy) defines white juice obtained from some plants, fruits or seeds as "milk" [11]. Then, vegetable milk can be defined as a kind of diluted emulsion of the fractions of some plant, seed or fruit, [12,13] with homogeneous distribution of soluble solids in suspension having a appearance and use similar to that of cow's milk [14], because as Ma. José Plana mentions, the label of a food product or its advertising must guarantee adequate information to consumers, respecting the Citizens' expectations regarding the quality of the product [15] making it possible to find these products of plant origin with the name of "milk" on the market.

It is difficult to compare vegetable milks with cow's milk due to its complete table of nutrients compared to vegetable milks [16] as shown in Table 1 based on USDA data [17-22]. But in favor of vegetable milks, the ones that most they are close to the nutrients that cow's milk has: soy milk, almond milk, oat milk, rice milk, coconut milk, among others [16]. Currently we can find in the market vegetable milks of different origin such as soy, almond, oats, rice, among others (Table 2), these companies are based on various processes for their production, summing up in the hydration or without prior hydration of the raw material, carried or not at high temperatures, then the raw material is dry or wet grinded [7,23] to finish with filtration, eliminating grinding waste by adding other ingredients such as sugar, flavorings and stabilizers, homogenizing it to improve the suspension as well as pasteurize the final product to avoid harmful microorganisms and prolong the shelf life of the product [14,24]. The general process for the production of vegetable milk is shown in Figure 1.

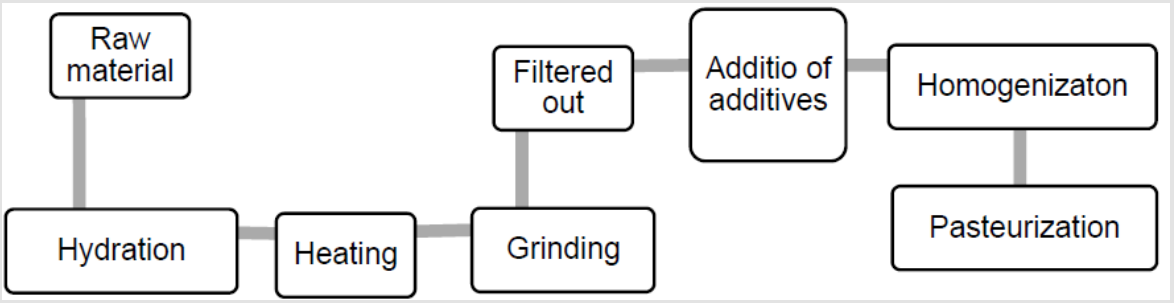

Figure 1: General process for the production of vegetable milks.

Table 1: Comparative view of the nutritional profile of bovine milk versus plant-based milk substitutes (USDA, 2020).

Composition						
Source	**WATER(G)**	**CALORIES (KCAL)**	**FAT (G)**	**CARBOHYDRATES (G)**	**FIBER (G)**	**PROTEIN (G)**
Cow	88.13	61	3.25	4.8	0	3.15
Soja	90.36	43	1.47	4.92	0.2	2.6
Almond	93	41	3.73	1.24	0.8	1.66
Oats	88	43	0.12	10.64	0.2	0.25
Rice	89.28	47	0.97	9.17	0.3	0.28
Coconut	67.62	19	24	3.8	2.2	2.3

Table 2: Comparative view of the nutritional profile of bovine milk versus plant-based milk substitutes (USDA, 2020).

Vegetable Milk	Fruit or Seed	Product	Vegetable Milks
Soy milk	*Glycine max* 		Soy salud Alpro soya Silk soymilk
Almond milk	*Prunus dulcis* 		Vita Alpro almond Silk almond
Oats milk	*Avena sativa* 		Alpro oat Silk avena
Rice milk	*Oryza sativa* 		Vita arroz Alpro rice Silk arroz
Coconut milk	*Cocos nucifera* 		Vita coco Alpro oconut Silk coconut

Soy Milk (*Glycine max*)

Soy milk is the most popular on the vegetable milks market as it contains the same amount of protein as cow's milk and is neutral in flavor [25]. It is especially indicated for those people who have lactose intolerances or allergies since it does not have it, which causes better digestibility by not needing enzymes to digest them, helps to improve the level of cholesterol in the blood and decrease the risk of cardiovascular diseases. It has a considerable calcium content, giving it beneficial properties for bones and circulation in general, improving healing processes, and its potassium content helps to eliminate liquids, maintaining the proper functioning of the heart, kidneys and nerves [26,27]. Although studies estimate that around 14% of people who consume cow's milk are also allergic to soy milk [25] these, along with milk from cattle, are among the eight main food allergens. It is not recommended during pregnancy, or for consumption in children or babies, but it is recommended for women with menopause due to its content of isoflavones or phytoestrogens [28].

Almond Milk (*Prunus dulcis*)

In particular, almond milk is the favorite among consumers of vegetable milks, it contains vitamins, minerals, iron, quality proteins and fibers [29]. It is rich in potassium for what is considered an astringent drink [30], it also contains magnesium and a good amount of calcium (compared to other vegetable milks) but it usually contains a large amount of sugar as well as being low in protein whence methionine is the limiting amino acid [31]. It is indicated to reduce blood cholesterol levels used in postoperative processes for its high nutritional value, its easy digestion helps diarrhea and vomiting as it is a good regulator of intestinal mobility, indicated for pregnant women, nursing mothers to combat nervous diseases and for anemia, improves the nervous system problem [32]. One of the problems for consuming almond milk is that the almond allergen: amandin, is highly resistant to heat treatments but sensitive to the enzyme pepsin, but using mechanical treatments and fermentation treatments can be easily eliminated [33].

Oat Milk (*Avena sativa*)

Oat milk, a difference from the others, contains a high fiber content, which strengthens the digestive system, helps to decrease the risk of diabetes, cholesterol and body fat [34]. Oatmeal is one of the cereals whose macronutrient distribution is optimal because it is an excellent source of carbohydrates that allows the body to feed energy. It has amounts of unsaturated fats and essential fatty acids like linoleum and antioxidant vitamins like vitamin E, it provides more or less half of the protein than cow's milk. One of the disadvantages of consuming oat milk is that it is low in calcium, so to be a substitute for milk it must also be fortified, which contains a large amount of starch, around 60%, and when mixed with water and when heated, the starch present begins to gelatinize and form a gel with high viscosity, leading to low acceptability. It can also contain gluten because it can be processed in facilities that handle gluten-containing foods (wheat, rye) like most cereals and some legumes (Table 3), but it is very good to be tolerated and suitable for people with food allergies and intolerances [35]. unless the consumer is allergic to avenin, which is the protein in oats [36].

Table 3: Compounds and factors causing allergy to vegetable milks.

Vegetable Milk	Allergic Reaction	Symptoms
Soy milk	• Soy protein. • Gluten (Does not contain gluten, but can be processed in facilities that handle foods that contain gluten)	• Spotted, irritated, itchy or rash. • Irritation in the mouth and • Throat.
Oat milk	• Oat protein: Avenin. • Gluten (Does not contain gluten, but can be processed in facilities that handle foods that contain gluten)	• Runny nose or stuffy nose • Itchy eyes • Nausea
Almond milk	• Nuts • Amandin the main protein of almonds. • Gluten (Does not contain gluten, but can be processed in facilities that handle foods that contain gluten)	• Vomiting • Diarrhea • Stomach ache
Rice milk	• Rice • Gluten (Does not contain gluten, but can be processed in facilities that handle foods that contain gluten)	• Difficult breathing • Anaphylaxis
Coconut milk	• Coconut	

Rice Milk (*Oryza sativa*)

Rice milk has almost twice as many carbohydrates as cow's milk, but it is almost protein-free, with the advantage of being gluten-free with great digestibility that has been present in the human diet for thousands of years. It is recommended for weight loss because it contains half the calories of soy milk, oatmeal and almonds, it contains silica, a compound that favors the fixation of calcium and magnesium in bones and cartilage [37]. One of the problems when consuming rice milk is that it contains arsenic (Table 3), arsenic is a metalloid that has intermediate properties between metals and nonmetals [38]. It is a toxic substance, which in humans will depend on the dose, however, consuming small prolonged doses can cause problems in the future, so it is advisable to vary the consumption of products derived from rice to avoid exposure to arsenic [39] especially when consumed by babies and pregnant women. It is also very low in calcium and its total protein content in the rice drink is lower than that of milk proteins, therefore, it is necessary to supplement it with calcium and the essential amino acids that it lacks [32].

Coconut Milk (*Cocus nucifera*)

Coconut milk is produced from green coconuts with tender meat, it is the grated meat mixed with water [40], is rich in saturated fat without being harmful, which makes it suitable to replace cow's milk. It is easily digestible because more than 50% of the fat is a medium chain of fatty acid triglycerides [41]. This food strengthens the immune system and the body's defenses, it contains vitamin B, fiber and minerals such as calcium, phosphorus or magnesium. It is good for muscles and nerves, for anemia, for the prostate gland, strengthens bones, helps control weight thanks to its fiber content, joint inflammation for selenium concentration and skin care and hair [42]. That is why many people consider coconut milk to be of utmost importance, since it helps the body to improve both externally and internally [43].

Vegetable Milk Fermentation Products

Fermentation

Lactic acid fermentation of plant foods has been known for approximately 1.5 million years [44] since then and until today this

type of fermentation has been studied, specifically the fermentation of plant milk, this type milk is rich in fiber completely suitable for microbial growth, improving and providing the different organoleptic properties to the properties before fermentation [45]. Fermented milks are obtained from the fermentation of Lactic Acid Bacteria (LAB), among which probiotics can be found. LAB can grow in simple media from sugars (hexoses and pentoses) that produce lactic acid. During lactic fermentation, metabolites such as acetaldehyde and diacetyl are produced that give the final product a characteristic flavor and aroma. Lactic acid is also produced until pH values of 3.8 - 4 are reached. This increase in acidity improves its preservation. Also during heterolactic fermentation by the action of bacteria and yeasts, they are slightly alcoholic beverages (up to 2% ethanol), foamy, due to the CO_2 produced and acid as a consequence of the lactic acid generated (Figure 2).

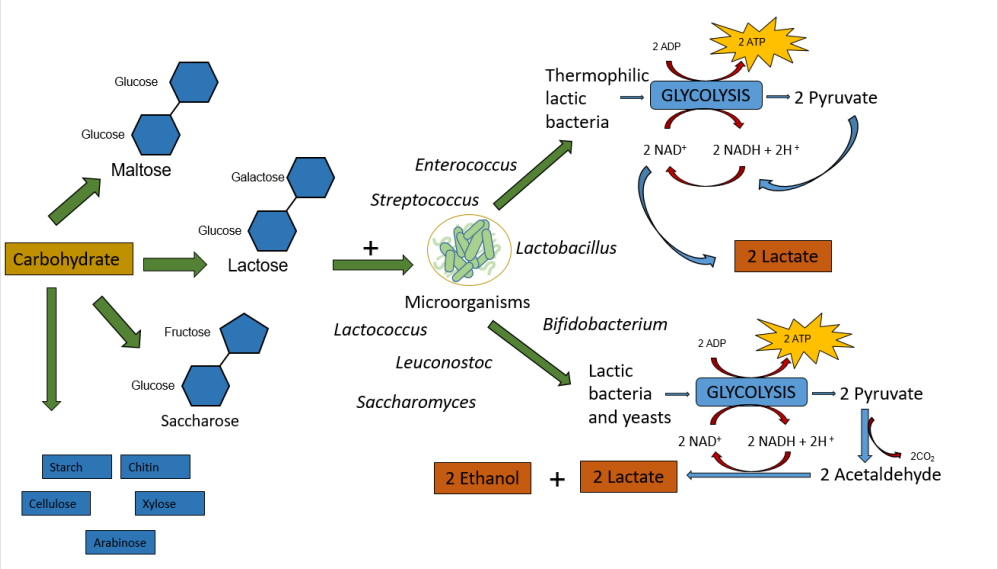

Figure 2: Metabolic pathway of lactic acid fermentation

Yogurt

It is the main product that has been marketed from FVM, its process is similar to that of cow's milk yogurt: preparation of vegetable milk, formulation, pasteurization, homogenization, incubation and refrigeration (FAO, 2020). Its definition according to NOM-181-SCFI-2010 is the "product obtained from the fermentation of milk, standardized or not, through the action of microorganisms Streptococcus thermophilus and Lactobacillus delbrueckii sp bulgaricus, and resulting in a reduction in pH" Other alternative crops of the genus Lactobacillus and Bifidobacterium can also be added. The vegetable milks that when fermented obtain a similar appearance to that of cow's milk yogurt are those of coconut, almond and soy, they offer a much creamier and thicker texture although the textures of the vegetable milk yogurts will be mostly liquid consistency similar to its main appearance (Figure 3). When fermentation is finished and placed at low temperatures, they gain a little creaminess. Other beverages, such as oatmeal and rice, ferment, but produce an excessively liquid texture, even after staying at low temperatures.

Figure 3: Vegetable milks (soy milk, almond milk, oat milk, rice milk, coconut milk)

Nowadays, there is an endless number of yogurts of vegetable origin in the market of functional foods made by hand, the best known is soy milk yogurt, its use has some limitations due to its taste and smell, it is not as pleasant as Harlé mentioned, its consumption is decreased by this factor (taste and odor) that can occur due to the release of compounds such as hexanal and 2-pentifuran, but fermentation reduces the concentration of these compounds making the smell pleasant [46]. Another limitation is the relatively high contents of raffinose and stachyose that cause digestion problems in the human body. This is why studies have reported that raffinose and stachyose in soy milk can be broken down by fermenting LAB [47] in addition to improving their taste and smell when fermented. Another of the most important problems in making soy yogurt is the amount of soluble solids, mainly composed of proteins and starches. As they are vegetable drinks and do not contain lactose, the bacteria will need an additive. For example soy milk, coconut milk, and almond milk are always fermented if they have any added sugar, syrup, or tapioca starch [41]. Oat milk, being a cereal, also preserves some starch. Despite the liquid texture, the taste is quite good and rice milk should not be added more, as it always contains natural sugar. To obtain a thick and creamy yogurt, a thickener (gelatin, agar or starches) must be added before fermentation, that is, before adding probiotics [48].

Kefir

Kefir is a fermented dairy product originating from the Caucasus region. Kefir fermentation is done at room temperature, which makes the process easier. These grains are mixtures of bacteria and yeasts in a matrix of proteins, lipids, and carbohydrates. These yeasts produce alcohol and carbon dioxide, and it contains many functional substances [49]. Traditional kefir has unique health benefits, such as immunomodulation, improvement of the digestive system, antimutagenic, anticancer and antimicrobial properties [50]. Making it is very simple when we ferment soy milk [51] and almond milk. In coconut milk it is difficult when the environment is because the fat of the coconut milk becomes solid and complicates the process.

Innovative Products Based on Fermented Vegetable Milk

These products are those that are not considered yogurt because yogurt contains two specific microorganisms: Lactobacillus delbrueckii ssp. and Streptoccocus termophilus, if one is missing it is not considered yogurt and it is where the fermented dairy products enter. According to the NMX-F-703COFOCALEC-2012 Norm, the fermented dairy product contains viable, active microorganisms and in quantities of a minimum of 106 CFU / g, they can be made from dairy solids or from fermented milk [52]. FVM are criticized for the microbes present in these products since they are made in a conventional and homemade way through experience that is shared from their production on a small scale, but this makes it a source of opportunity for industry, when compared to vegetable milks that are not fermented or that do not have any functional ingredient. Juárez demonstrates the acceptance of a 4.36 probiotic-fermented almond milk product (7-point hedonic scale), which compares it with data obtained before the fermentation of almond milk and considers it acceptable to consumers [53]. Salous analyzes the acceptance of fermented oat, rice and quinoa milks, resulting in greater acceptance in the fermentation of oat milk, which contained 10% of the vegetable milk and 2% of the concentration of the fermenter [54].

Functional Activity of Fermented Vegetable Milks

Functional Foods: The concept of functional foods arose around the 1980s when the development of foods from which a health benefit could be obtained was proposed in the eastern culture, since the decrease in life years and the high costs of medical care increased the concern of consumers, leading them to take preference over these foods and medicine, as they are considered equally important in the prevention and cure of diseases by designing foods FOSHU (Food for Specified Health Use) [55]. A functional food is that food that is made not only for its nutritional characteristics but also for one or more specific functions to improve health or reduce the risk of disease, for which biologically active components such as vitamins, fatty acids, antioxidants are added [56]. As defined by the Washington Institute of Medicine, functional foods are "those foods that encompass potentially healthy products including any modified food or ingredient that can provide a health benefit beyond the traditional nutrients it contains" [7]. Recently the use of fermented foods has emerged as an important strategy in the diet to improve human well-being due to the functional characteristics that they can impart to the food product [57].

Today there are countless products with functional characteristics, among which foods that contain probiotics and prebiotics, such as yogurt, cheese and fermented milk of animal and plant origin, stand outs [56]. The most used probiotic bacteria with strains of the species: Bifidobacterium lactis, *L. casei*, *L rhamnosus*, *L. acidophilous*, *L. delbruekii* subsp. Bulgaricus, *L. johnsonii*, *L. fermentum* and *L. reuteri*, among others. Each of these strains have different metabolic characteristics, so conditions, such as temperature and the nature of added sugars, must be adjusted so that they are suitable for consumption and that probiotics survive and are in high numbers, since the minimum intake of a probiotic must be greater than> 106-108 CFU / g or> 108-1010 CFU / viable cell dose per dose [58].

Probiotic Activity: The FAO (Food and Agriculture Organization of the United Nations) defines probiotics as live microorganisms that when administered in sufficient quantities confer a beneficial effect on the health of the host [44]. The most used probiotics in the food area are bacteria of the genus Lactobacillus and Bifidobacterium

[59]. As for prebiotics, the FAO defines them as "Non-digestible, fermentable compounds that result in the selective stimulation of growth and activity of a number of bacterial species / genera of the microbiota that confer benefits for the host's health" [44] and those products that contain prebiotics and prebiotics, using the prebiotic to the prebiotic to improve its survival during its trip Through the gastrointestinal tract they are known as symbiotics [60]. These microorganisms need to be administered through food. Supplements or capsules orally or topically being the most important thing is that it must be consumed alive [61] so that after its consumption in sufficient quantity and in the appropriate matrix it fulfills the benefit to the health of the consumer.

Probiotics have to be of human origin, non-pathogenic, resist gastric acidity and bile acids, adhere to the epithelial tissue of the intestine, be able to live in the gastrointestinal tract, produce antimicrobial substances (organic acids, and bacteriocins), modulate the immune response and influencing metabolic activity Furthermore, fermentation has been shown to improve protein digestibility, mineral bioavailability and micronutrients [56]. In fermentation, microorganisms can release vitamins in situ, bioactive compounds, antioxidants and unsaturated fatty acids or contribute to inactivate anti-nutritional factors such as phytates [62]. By selecting suitable cultures for fermentation according to the raw material, you speed up the fermentation time thus improving the quality and functionality of the food. Traditionally, dairy products of animal origin are the main vehicle of probiotics to be ingested by humans. Making people who cannot or do not want to consume this type of milk have to choose not to consume them or that the demand for the study of the use of alternative milk based on plants, fruits or seeds is at its peak.

There are reports that fermentation has been used to increase the bioavailability of vitamins, minerals, and isoflavones in soybeans, as well as to modify its flavor, improve its stability, and even create new food products [57]. One of the most used ingredients for fermentation in vegetable milks are the kefir grains, which are mostly LAB, acetic acid bacteria, yeasts and fungi that are united by a polysaccharide called kefiran [45]. It contains between 2 and 7 thermophilic strains, that is, they need a certain temperature (around 43 º C) to ferment. This is capable of synthesizing natural flavors such as acetaldehyde or diacetyl which improve the quality of food Strengthens the immune system, favors digestion, improves allergic symptoms, improves the state of the skin in cases of acne or eczema, has anticancer properties Castillo-Escandón, et al. [58].

Juárez and Gallardo demonstrate that L. brevis Lb9H-PTA-120751 probiotics manage to survive in an almond milk product at a pH of 6.6 at a temperature of 4 °C in a concentration of 2 $X10^8$ CFU / mL over a period of 28 days, making it satisfactory because it is considered that a concentration of 1 x 10^6 CFU / mL of viable microorganisms is needed for them to reach the intestine and to exert their beneficial effect (Juárez & Gallardo, 2018). In a sesame rice milk product that had glucose added as a substrate for fermentation with L. acidophilus and *L. casei*, this was brought to a temperature of 42 °C for 2.5 hours, where the stability of the microorganisms was excellent. And it was stored for up to 10 days where it was found that at this time lactobacilli were still viable (Hernández et al., 2014). On the other hand, a sample of coconut yogurt analyzed by Jimena does not represent a good option for transporting probiotics. It was observed that the number of viable cells obtained is not optimal and does not guarantee that this fermented food can maintain an appropriate concentration of microorganisms capable of exerting its protective effects on consumer health [53]. Furthermore, soaking is effective in increasing minerals and vitamins (B6 and B12), insoluble fiber and bioactive components. This is maintained for natural fermentation, where LAB will break down anti-nutritional factors and improve the content of calcium, magnesium, iron, increasing beneficial bacteria that aid in digestion and immunity of other internal organs [63].

Prebiotic Activity: There is extensive information on studies conducted in the last five years that support that there are numerous physiological benefits associated with the consumption of prebiotics. The most outstanding function is the improvement of intestinal transit, as mentioned in his study, which thanks to the carbohydrate that is not digested, reaches the large intestine, decreasing the consistency of the stool, increasing the weight and frequency of defecation to prebiotics defines as "Non-digestible, fermentable compounds that result in the selective stimulation of the growth and activity of a number of bacterial species / genera of the microbiota that confer benefits for the health of the host" [44] and those products that They contain prebiotics and prebiotics, using the prebiotic to the prebiotic to improve its survival during its journey through the gastrointestinal tract, they are known as symbiotics [60]. On the other hand, for a carbohydrate to be considered a prebiotic, it must reach the colon without being degraded or altered, and it must be a food substrate that stimulates the existing intestinal microbiota, particularly lactobacilli and bifidobacteria.

Pacifici mentions that the moderate intake of the oligosaccharides in soy milk that is raffinose and stachyose is associated with prebiotic activity, hypertensive action and liver protection, as well as inhibition of colon cancer, moreover it is known to be oligosaccharides are not digestible by the enzymes that occur naturally in the human small intestine, causing excessive consumption to cause bloating, diarrhea, among other alterations in the body [64]. That is why fermentation with microorganisms is a method to eliminate these oligosaccharides from soy milk due to the production of α-galactosidase. The addition of mead, sugarcane juice, and coconut water to vegetable milks are reported to contain probiotic compounds that make foods rich in probiotics beneficial

for those who consume it to prevent gastrointestinal diseases, some types of cancers, diabetes, lactose intolerance, among others [65].

Antioxidant Activity: There are various types of antioxidants, but their main function is to break down peroxides or alter the formation of complexes with the free radical residues available in the body. Xiudong studied on the fermentation of soy milk with kombucha gave an increase in the antioxidant and inhibition activities of α-glucosidase and α-amylase during fermentation at 28 °C and 37 °C causing the high total phenolic content, Ferulic, chlorogenic and ascorbic acid improves the antioxidant activity of soy milk [66], Chevan also previously studied the antioxidant activity and the content of polyphenols in fermented soy milk supplemented by probiotic lactobacilli, recently very good results [67], these and other studies affirm that soy milk yogurt can affect as a useful functional food for various diseases related to oxidation [68] since fermentation produces high content of phenolic acids, isoflavones, aglycones and antioxidant activity [69].

Oats and their products in which fermented milks are found are good antioxidants because their nutritional components include the presence of phenolic compounds, avenanthramides (2–289mg/Kg), saponins (avenacoside A290mg/Kg and avenacoside B-110mg/Kg) Phytic acid, sterols and many others make it have positive results [63], as demonstrated by research where it is fermented with Monascus anka, helping to increase phenolic compounds along with increased glucosamine content, which resulting in the improvement of the free radical scavenging property of oats [35]. For its part, the content of soluble and insoluble fiber in coconut milk increases its nutritional value by being fermented, giving it various antioxidant properties [63].

Protein Boost: A study on vegetable milk-based yogurts found the increase in protein when fermented, comparing it to a dairy yogurt. Protein content ranged from 0.6 to 4.6 g / 100 g for yogurt of plant origin, where the increase was more significant for soy and almond milk but not for coconut milk [48] as well as the results of another study considering that lactic fermentation altered the digestibility of soy protein [64] having a lower bioavailable protein content compared to unfermented soy milk. Another research report highlights the protein increase in almond milk with increased protein from rice bran, since as reported almond milk is the third vegetable milk with the amount of protein closer to the amount of protein that has cow's milk. This product was heated to 42 °C and L. bulgaricus and S. thermophilus were inoculated for 6 hours, stored at 4 °C, obtaining a protein percentage of 9.5. In this way it will be obtained that when adding a protein extract it will have beneficial results in the nutritional properties of those who consume it [70].

Health Benefits: Nuts, cereals, and oilseeds have countless health benefits due to their rich content of bioactive compounds, macronutrients, micronutrients, and photochemicals. The products and foods made from them are key elements in a daily diet for a healthy life. In them are the vegetable milks that, when fermented, improve these bioactive and nutrients, making consumption provide many more benefits in human health.

Immunological: Since the possible physiological benefits are studied and confirmed, such as antimutagenic, immunopotentiating and antitumor activities, as well as in the prevention of pathogenic bacteria, there is a wide variety of milk fermented with LAB with properties that promote the improvement of the body's those who consume it [71]. Soy milk contains plant substances (isoflavones) with many virtues, since it is fermented with the possibility of preventing breast cáncer [72], attenuates the symptoms of menopause and osteoporosis and improves the state of the skin. Soy milk includes phytoestrogens like genistein, daidzein, and glycythein, which are similar to estrogen molecules in terms of their structure. they have many positive health effects against diseases, dermatological diseases, cancer, osteoporosis, cardiovascular diseases and neurodegenerative disorders [24]. However, to detect isoflavones, the body must absorb them. A Japanese team showed that a single intake of soy milk fermented by lactobacilli and enriched with isoflavones increased the effect of the active ingredient on isoflavones [68].

Cholesterol: There are many studies that prove that FVM can lower blood cholesterol. One of them is especially almond milk, due to the large amount of unsaturated and monounsaturated fatty acids that its composition has, as well as the beneficial cholesterol that it contributes to our body. The patient studies showed a clear improvement in the cholesterol level of the patients who consumed almonds [73]. also reduce serum cholesterol and Low-Density Lipoprotein (LDL) in men with moderate hypercholesterolemia [74]. Another study demonstrates the beneficial effects of soy milk on lipid metabolism in rats on a diet high in cholesterol and sucrose, and is further enhanced by the fermentation of soy milk. The fermentation of *L. plantarum* from soy milk resulted in the modification of isoflavones in soy milk, increasing the forms of deconjugated and aglyconic isoflavones [75]. Recent studies affected that oat beta-glucan has a reducing effect on LDL cholesterol and apolipoprotein B [34]. Betaglucan is a soluble and viscous fiber recognized for its importance at the cardiovascular level, since it produces a decrease in cardiovascular risk.

Diabetes: Sugar is known to be a causative agent of diabetes due to its rapid absorption into the body and obesity can be induced when consumed in excess. Sugar is primarily used to produce sweetness in yogurt production, however, sugar remains a cause of various lifestyle-related illnesses, causing the demand for alternative sweeteners to replace it to be increasing [76]. In 2019, the number of deaths worldwide from diabetes was approximately 4.2 million people [77]. This is where experts point out that all nuts, especially almonds, are very good for the diet of people with diabetes. Since

these fruits are the center of dietary fiber, they contain unsaturated fatty acids, that is, beneficial fats for the body, they also contain vitamins and minerals, among many other properties. In addition, the consumption of beta-glucan from fermented oats is related to the decreased risk of diabetes and obesity, by decreasing the glycemic response and the serum level LDL [32]. Products derived from these foods help prevent and control diabetes. In a study on kefir-fermented soy milk, it shows the beneficial effects on obesity and hyperglycemia induced by HFFD (high fat and fructose diet) in rats. This study demonstrated that during the kefir fermentation process, the ability to inhibit α-amylase and lipase from the affected pancreas; and the strong inhibitory action changed after a 16 h fermentation of soy milk [74].

Conclusion

There is no definitive answer on whether FVM is healthier than animal-based milk, but it is clear that it is suitable as an option for people who are lactose intolerant. This review shows that vegetable milks differ in their properties and in their benefits as functional foods depending on the raw material and the fermentation process (temperature, microorganism, environment, time). However, of the reported milks, the one that continues to have a better response as a functional food is soy milk, making coconut milk the least reported as beneficial. Although many of the results are promising in the future, there is still much to do in the study of the functional health benefits of FVM and it is unlikely but of utmost importance to know that a single active compound or A single functional benefit is universally effective for all consumers. Therefore, functional fermented foods must be formulated and processed in such a way that they cover the needs of the organism and health of specific groups of consumers. The acceptability of the final product of the fermentation of functional vegetable milks by consumers has been positive, having an acceptable taste and an odor that attracts the attention of people who choose to consume this type of milk, which, when fermented, releases Functional properties that the consumer benefits in the medium or long term, but concerted research efforts are needed in the coming years in the functional drinks segment to prepare newer products made as they are tasty and nutritionally adequate.

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