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HOMEMADE VEGAN MILK: A SUSTAINABLE ALTERNATIVE TO DAIRY

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ABSTRACT
Vegan milk, derived from soybeans, oats, coconuts, rice, cashews, peanuts, and almonds, serves as a viable alternative to dairy milk, offering health benefits and promoting sustainability. Plant-based milk is produced through the disintegration of raw ingredients, resulting in varying particle composition and texture. To enhance consistency and taste, sugar and natural thickeners can be incorporated. Heat treatment extends the shelf life, ensuring quality retention. Typically, one cup of base ingredients is blended with three cups of water, with optional straining for a smoother texture. Unsweetened versions provide a wholesome alternative, while sweeteners and flavors can be added based on preference. This paper explores the production, nutritional benefits, and potential enhancements of homemade vegan milk as a sustainable and health-conscious option.

Keywords: Vegan Milk, Plant-Based Dairy Alternatives, Homemade Milk Substitutes, Nutritional Composition, Sensory Evaluation, Sustainability

INTRODUCTION
Cow's milk has been a dietary staple for centuries, valued for its rich nutritional profile, including proteins, fats, and carbohydrates. However, a growing segment of the population faces challenges in consuming dairy due to lactose intolerance, milk allergies, and ethical or environmental concerns (Facioni et al., 2020). Additionally, industrial dairy farming practices, such as the use of growth hormones and antibiotics, have raised health and ethical concerns, prompting consumers to seek alternatives (Bulut et al., 2021).

Plant-based milk alternatives, commonly derived from soybeans, oats, almonds, rice, and coconut, offer a promising solution (Aydar et al., 2020). These alternatives provide essential nutrients, are often fortified with vitamins and minerals, and align with vegan and sustainable living principles (Craig et al., 2023). Advances in food processing technologies have further improved their taste, texture, and shelf stability, making them comparable to traditional dairy in both function and nutrition (Gazda & Glibowski, 2024).

This study explores homemade vegan milk preparation, its nutritional benefits, processing methods, and consumer preferences. It also examines how different ingredients impact texture, taste, and shelf life, contributing to a deeper understanding of plant-based dairy alternatives.

METHODOLOGY

This study examines the preparation and characteristics of homemade vegan milk using commonly used plant-based sources: soybeans, oats, almonds, rice, coconuts, cashews, and peanuts. The methodology includes ingredient selection, preparation processes, and modifications to improve texture and taste (Dhakal et al., 2023).

1. Selection and Preparation of Ingredients

Soybeans (*Glycine max*): Chosen for their high protein content and emulsifying properties.

Oats (*Avena sativa*): Selected for their natural creaminess and fiber content (beta-glucans).

Almonds (Prunus dulcis): Preferred for their mild nutty flavor and essential fatty acids.

Rice (*Oryza sativa*): Selected for its light, neutral flavor and easily digestible carbohydrates.

Coconuts (*Cocos nucifera*): Chosen for their rich, creamy texture and high content of medium-chain triglycerides (MCTs).

Cashew nuts (*Anacardium occidentale*): Valued for their creamy consistency and subtle sweetness when blended into milk.

Peanuts (*Arachis hypogea*): Preferred for their nutty flavor and high protein content, making them a popular base for plant-based milks.

Each plant-based milk was prepared following a standard extraction method:

Soaking: Soybeans, rice, and almonds, and peanuts were soaked in filtered water for 8–12 hours at room temperature to soften the grains and remove antinutritional factors. Oats were soaked for 15–30 minutes to prevent excessive starch release, which can cause sliminess. Cashews were soaked for 4–6 hours. Coconut meat is usually grated or shredded and then soaked in hot water for about 30 minutes to 1 hour to help extract the creamy coconut milk.

Blending: The soaked ingredients were rinsed and blended with filtered water in a 1:3 ratio (one cup of base ingredient per three cups of water).

Straining: The mixture was strained through a fine mesh or cheesecloth to remove residual pulp, improving the texture. In some cases, a second blending cycle was conducted for a smoother consistency.

Optional Enhancement: Sweeteners like honey or dates were added (optional) for enhancement of taste, texture and nutrients.

Pasteurization: To improve storage stability, the extracted milk was pasteurized at 70–80°C for 15 minutes, followed by rapid cooling.

Storage: Stored in sterile glass bottles and refrigerated at 4°C, with a shelf life of 3–5 days.

RESULTS & DISCUSSION

The study evaluated homemade vegan milk from soybeans, cashews, oats, almonds, rice, coconuts, flax seeds and oats focusing on nutritional composition, texture, taste, and storage stability. The findings highlight key differences among these plant-based milk alternatives Table 1.

Table 1: Properties of different Vegan Milk

Vegan Milk Type	Straining Needed?	Best For	Key Nutrients
Cashew Milk	No	Creamy, mild taste	Healthy fats, magnesium
Almond Milk	(if blanched)	Light & nutty	Vitamin E, antioxidants
Rice Milk	Yes	Naturally sweet & light	Carbohydrates, low-fat
Coconut Milk	Yes	Rich & creamy texture	MCTs, healthy fats
Flax Seed Milk	Yes	Omega-3 & fiber-rich	Omega-3, protein
Oat Milk	Yes	Smooth, slightly sweet	Beta-glucans, fiber

Nutritional Composition

The nutritional profile of different vegan milk types was compared with dairy milk (Table 2).

Table 2: Nutritional composition of vegan milk and dairy milk

Soy milk is the most nutritionally comparable plant-based alternative to cow's milk, offering

Milk Type	Calories (kcal/100ml)	Protein (g)	Fat (g)	Carbohydrates (g)	Calcium (mg)
Soy Milk	40–50	3.0–4.5	2.0–2.5	2.0–4.0	120–180
Cashew Milk	23–25	0.5–1.0	2.0–2.5	1.0–2.0	120–150
Almond Milk	13–30	0.4–1.0	2.5–3.0	0.5–1.0	120–250
Rice Milk	47–60	0.1–0.5	1.0–1.5	9.0–12.0	100–120
Coconut Milk	60–75	0.3–0.5	5.0–7.0	2.0–3.0	100–150
Coconut Milk	60–75	0.3–0.5	5.0–7.0	2.0–3.0	100–150
Flax Seed Milk	25–40	0.5–1.0	2.5–3.5	1.0–2.0	120–150
Oat Milk	40–50	1.0–2.0	1.0–2.5	6.0–8.0	120–200
Cow Milk (Whole)	61–70	3.2–3.5	3.5–4.0	4.7–5.0	120–130
Buffalo Milk	97–110	3.8–4.5	6.5–8.0	4.5–5.0	180–200

3.0–4.5g of protein per 100ml, making it superior to other vegan options like almond, rice, and coconut milk, which contain minimal protein (Sethi et al., 2016). Buffalo milk, with its higher fat (6.5–8.0g) and calcium (180–200mg) content, is more energy-dense than cow's milk, making it a preferred choice in regions where higher caloric intake is needed. On the other hand, oat and rice milk have the highest carbohydrate content (6.0–12.0g), making them texturally closer to dairy milk, although lacking in protein. Flaxseed milk stands out for its omega-3 fatty acids, which are absent in dairy products, offering additional cardiovascular benefits. Coconut milk, despite its rich, creamy texture, is low in protein but high in medium-

chain triglycerides (MCTs), which may aid metabolism. This analysis highlights that while plant-based milk alternatives can provide functional benefits, none match dairy milk's complete nutritional profile, particularly in protein and micronutrients (Goff, 2017).

Sensory Evaluation (Taste & Texture)

A panel of 20 participants evaluated the taste, texture, and overall acceptability of homemade vegan milk using a 5-point hedonic scale (1 = poor, 5 = excellent) shown in Table 3.

Table 3: Sensory Evaluation of Vegan Milk

Vegan milk	Taste	Texture	Overall Acceptability
Soy Milk	3.8 ± 0.5	3.5 ± 0.4	3.9 ± 0.5
Oat Milk	4.2 ± 0.3	4.4 ± 0.3	4.3 ± 0.4
Almond Milk	4.5 ± 0.4	4.1 ± 0.5	4.4 ± 0.3
Cashew Milk	4.1 ± 0.4	4.2 ± 0.4	4.2 ± 0.5
Rice Milk	3.7 ± 0.5	3.6 ± 0.4	3.7 ± 0.5
Coconut Milk	4.0 ± 0.3	4.3 ± 0.3	4.1 ± 0.3
Flaxseed Milk	3.9 ± 0.4	3.8 ± 0.5	3.9 ± 0.4

Jeske et al. (2017) conducted a comprehensive study comparing the nutritional, sensory, and microbiological properties of various plant-based milk alternatives. Their research highlighted that almond and oat milk ranked highest in taste and overall acceptability, with oat milk also scoring the highest for texture due to its naturally creamy consistency. Soy milk, despite being nutritionally superior, had moderate sensory scores, likely due to its distinct beany aftertaste, which some consumers find less appealing. Rice milk had the lowest ratings for texture, as it tends to be thinner and more watery, though it remains a preferred option for those with nut and soy allergies. Cashew and coconut milk were noted for their smooth and rich texture, contributing to their relatively high sensory ratings. Flaxseed milk had the lowest taste acceptability, primarily due to its earthy, slightly bitter aftertaste, which may not be as palatable to consumers. The study concluded that while taste and texture preferences vary by individual, oat, almond, and coconut milk generally provide a more pleasant sensory experience, whereas soy milk remains the best dairy alternative in terms of protein content and overall nutritional value. These findings suggest that choosing a plant-based milk substitute depends on whether the priority is nutrition, taste, or texture, with different milk types catering to different consumer needs.

Shelf-Life & Storage Stability

Freshly prepared vegan milk was stored at 4°C and observed for separation, microbial growth, and sensory changes over five days. Pasteurized samples maintained quality for 3–5 days, while non-pasteurized samples showed separation and off-flavors within 48 hours.

Environmental Impact

Vegan milk production has a lower carbon footprint than dairy, requiring fewer resources (water, land) (Poore & Nemecek, 2018).

CONCLUSION

Homemade vegan milk presents a nutritious, sustainable, and customizable alternative to dairy milk. In addition to nutritional benefits, homemade vegan milk offers greater control over ingredients, reducing reliance on preservatives and artificial additives found in commercial alternatives. The study also highlights consumer preferences and shelf-life considerations, demonstrating that simple modifications—such as heat treatment and ingredient blending techniques—can enhance texture and flavor. The increasing demand for plant-based alternatives underscores the need for continued research into fortification, sensory improvements, and sustainable production methods. However, fortification is necessary to match the micronutrient content of dairy milk, particularly in calcium and vitamin B12.

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