Evaluation the Potential of Using Plant-Based Milk Substitutes in Ice Cream Production

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Introduction

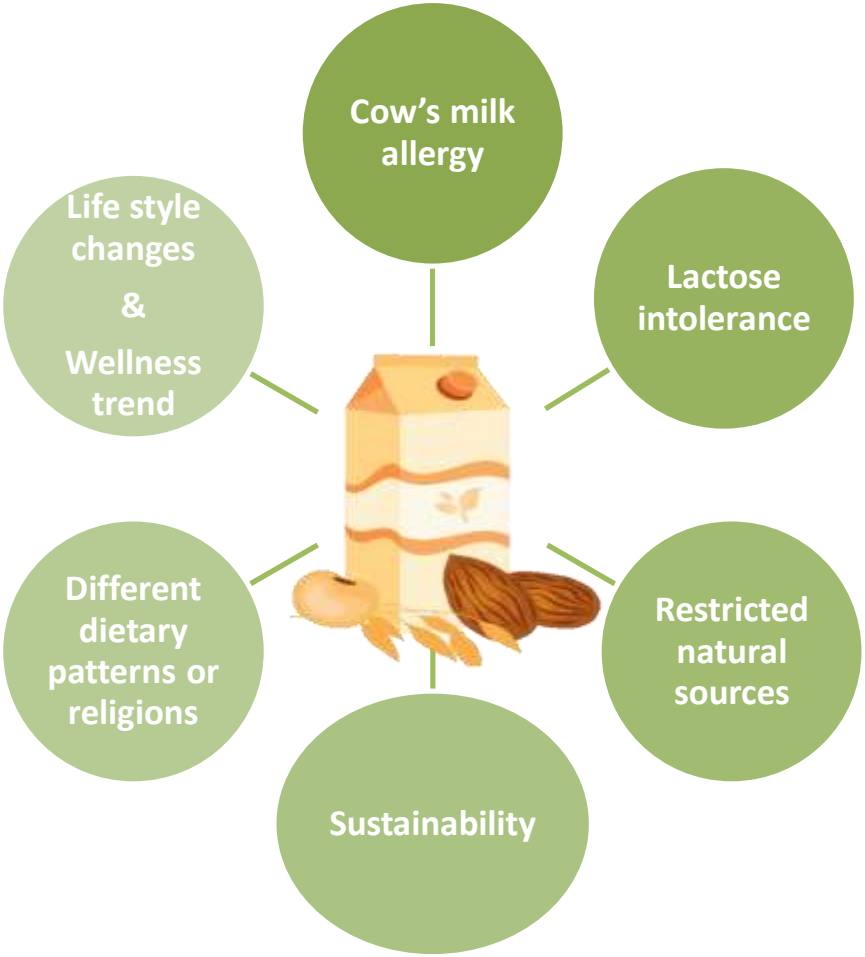

Fig 1.The reasons behind the consumption of plant-based milk substitutes

Introduction

65%

lactose-intolerence

https://medlineplus.gov/genetics/condition/lactose-intolerance/#frequency

0.25-5%

Cow's milk allergy

https://www.worldallergy.org/education-and-programs/education/allergic-disease-resource-center/professionals/cows-milk-allergy-in-children#:~:text=The%20estimated%20prevalence%20of%20cow's,higher%20in%20children%20than%20adults.

984 million $ by 2031

Vegan ice-cream

https://straitsresearch.com/report/vegan-ice-cream-market#:~:text=Market%20Overview,almond%2C%20coconut%2C%20and%20others.

Introduction

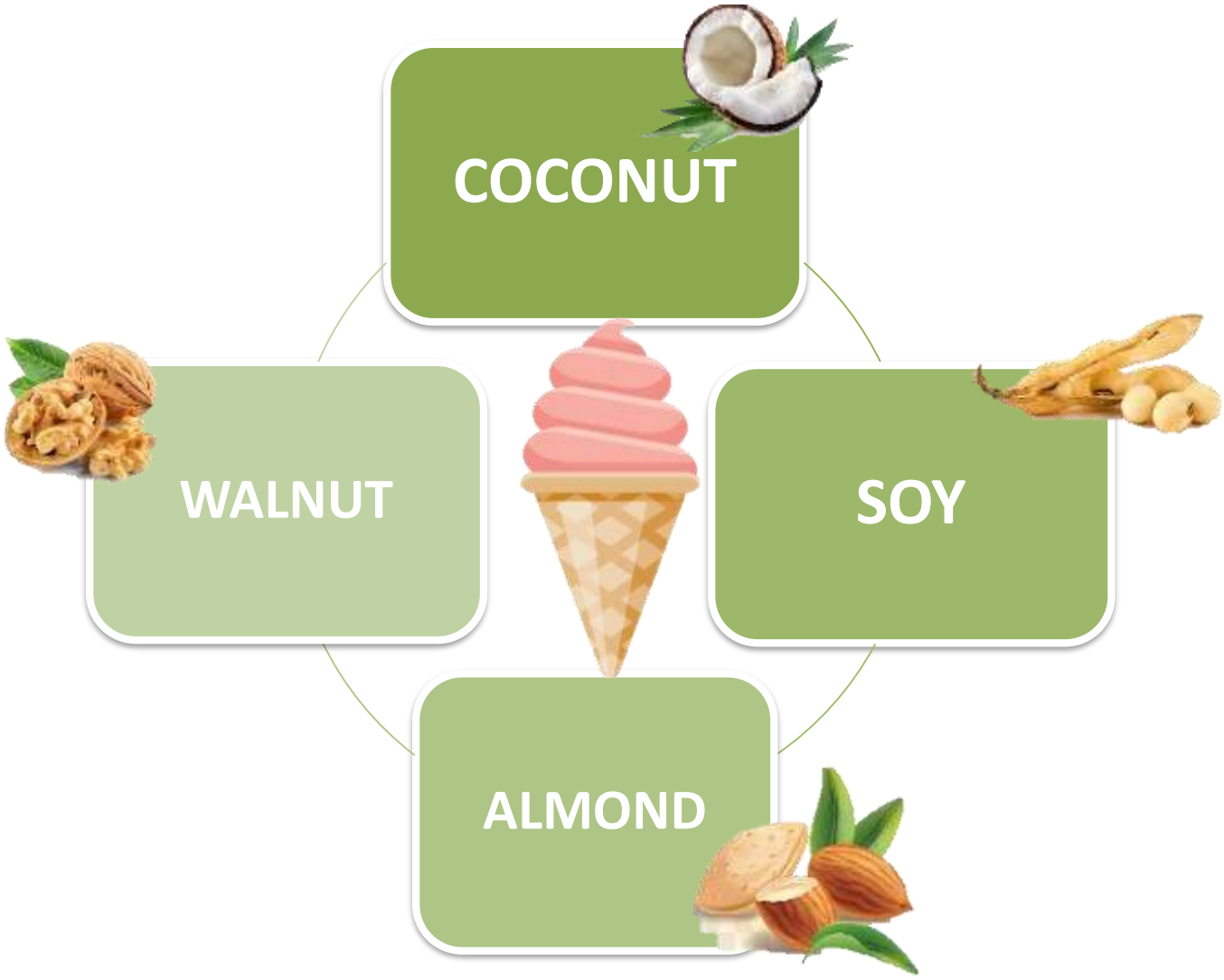

Fig 2. The major plant-based milk alternatives in ice-cream production

Table 1. The major effects of using plant-based milk substitues on technological and nutritional properties of ice cream

	Plant-based milk substitute	Major Findings	References
Tree Nut 	Coconut	Melting resistance↑, Viscosity↑, Hardness↑, Overrun↑, Protein↑, Total solids↑, Total soluble solids↑, Fat↓, pH↑, Sensory acceptability↑	Anwar et al., 2022
	Coconut	Fat↑, Time of the first drop↓ (with increased inulin content) Melting resistance↑ (after 45 min., with increased inulin content) Overrun↓, Hardness↑ (with increased locust bean gum content) Dark color↑ (with increased inulin content) Taste↑, Creamy consistency↑	Góral et al., 2018
	Coconut	Energy↑, Total solid↑, Fat↑, Iron↑, Ascorbic acid↑, Calcium↑, Protein↑, Moisture↑, pH↑ (coconut-based milk substitute and guava pulp)	Patel et al., 2015
	Coconut	pH (6.33±0.01), Titratable acidity (0.33±0.05%), Total solids (38.02±0.14%), Moisture (61.86±0.33%), Fat (11.66±0.60%), Protein (4.18±0.16%), Ash (0.41±0.25%), Overrun (66.76±1.44%), Total phenolic content (0.093±0.002 GAE mg/g), DPPH radical scavenging activity (60.39±0.02 mg/g), Total antioxidant capacity (0.36±0.04 mmol (AAE)/g)	Perera et al., 2021
	Coconut	Solids-non-fat↑, Overrun↓, Total solids↓, Total phenolics↑, Minerals↑, Flavour↑, Taste↑	Beegum et al., 2021
	Coconut	Overrun↓- Melting rate↓- Hardness↑ (increasing levels of sodium caseinate repla-cement) Body and Texture↑- Flavor and Taste↑ (with increasing SC concentration)	Supavititpatana et al., 2011
	Coconut	Water content↓- Total solids↑-Foam capacity↓-Foam stability↑ (with increasing proportion of coconut-based milk substitute) Viscosity↑ (with increasing proportion of mung bean extract)	Widjajaseputra et al., 2017

Table 1. The major effects of using plant-based milk substitues on technological and nutritional properties of ice cream *(continued)*

	Plant-based milk substitute	Major Findings	References
Legumes 	Soy	Viscosity↔, Fat globule size↔, Hardness↔, Melting rate↔, Overrun↓- Fat destabilization↑ (commercial vegetable oil) Mouth coating↑ (heavy cream) Off-flavor↑ (commercial vegetable oil and commercial high oleic soybean oil) Flavor, Texture, and Overall liking↑ (commercial high oleic soybean oil and heavy cream)	Wang, 2023
	Soy Kefir	Acidity↑- Phenolic compounds↑-Sensory scores↑ (addition of kefir) Viability of probiotics↑ (higher than 10 log CFU/g)	Mendonça, 2022
Legumes and Tree Nuts	Soy and Coconut combination	pH↑, Melting rate↓, Viscosity↑, Freezable water↑	Aboulfazli, 2014
	Soy and Coconut combination	Acid and bile tolerance↑, Probiotic survival↑ (soy milk), Probiotic survival↓ (coconut milk), Total acceptability↓	Aboulfazli, 2015
	Soy and Coconut combination	Apparent viscosity↔, Hysteresis↓, Particle size↓, Freezable water↓	Aboulfazli, 2015a
	Soy and Coconut combination	Consistency index↑, Viscosity↑ (soy-based milk substitute), Melting resistance↑ (soy-based milk substitute), Total sensory scores↓ (soy-based milk substitute), L. acidophilus La-05 probiotic survival percentage↑ (coconut-based milk substitute), B. bifidum Bb-12 probiotic survival percentage↑ (soy and coconut-based milk substitute)	Aboulfazli, 2015b
	Soy and Coconut combination	Melting rate↓, Apparent viscosity↑, Particle size↑, Total acceptability↓	Aboulfazli, 2015
	Soy and Coconut combination	pH↓, Probiotic growth↑	Aboulfazli, 2016
Legumes and Seeds	Soy and Sesame	Overrun↔- Hardness and Consistency↑- Cohesiveness↓- Air bubbles↑ (optimized ice cream) Tg↓- Ice content↓- Unfreezable water↑- Frozen water↓ (soy-based ice cream), Mean particle diameter↔ (optimized ice cream), Sensory attributes↑	Ghaderi, 2021
Legumes	Sweet Lupin and Soy	Protein content↑ (soy), Fat ↑ (soy), Ash↑, Fiber↑, Total carbohydrate↑, Overrun↑, Melting resistance↑, Taste, and Texture ↔ (up to 25% replacement)	Asresa, 2022

Table 1. The major effects of using plant-based milk substitues on technological and nutritional properties of ice cream *(continued)*

	Plant-based milk substitute	Major Findings	References
 Nuts	Almond Drink	Consistency↑-Apparent viscosity↑-Particle size↓ (addition of stabilizers), Density↔	Kotet al., 2021
	Almond and Hemp	Viscosity↑- Consistency↑- Appearance↑ (hemp-based milk substitute and pectin), Sensory↑ (almond-based milk substitute)	Leahu et al., 2022
	Fresh and Dried Walnut	Fat↑, Protein↑, Unsaturated fatty acid↑, Overrun↑, Rheological properties↑, Brightness value↓, Different volatile compounds↑, Sensory evaluation↔	Bekirogluet al., 2022
	Bambara Groundnut	Fat↓, Ash↓, Protein↑, Carbohydrate↑, Calcium↑, Iron↑, Potassium↑, Magnesium↑, Sensory characteristics↔, Tannin and Phytate contents↑	Ezeet al., 2023
 Seeds	Hemp Drink	Melting rate↑- Unfreezable water content↑ (almond and hemp protein-containing products) Shear stress↑- Consistency coefficient↑- Pseudoplastic character↑ (addition of mic-robial transglutaminase and guar gum) Color, Smell, Final taste, and Texture↑ (addition of almond protein) Sensory attributes↑ (addition of guar gum)	Hidaset al., 2023
	Riceberry and Sesame-Riceberry	Probiotic activity↑, Probiotic viability↑ (prebiotic-supplemented samples) Antioxidants and Phenolic compounds↑	Kemsawasdet al., 2020
Cereals and Legumes	Rice, Lentil, and Chickpea	Overrun↑, High cell density↑ (>107 cfu/mL), Ash↑, Protein↓, TTA↑, Dry matter↑, Apparent viscosity↑, Hardness↑, Gumminess↑, Adhesiveness↑, Springiness↑, Cohe-siveness↓, Ice particulate↑, Artificial taste↑	Pontonioet al., 2022

Vegan Ice Cream/Frozen Dessert Market

Conclusion

- Consequently, the sustainable food industry may ultimately benefit from creative methods for making ice cream with various milk substitutes, and these methods should be developed further to satisfy present and increasing needs and interests.
- It is important to optimize and adjust both plant-based milk substitutes and ice cream production process parameters. In this regard, plant-based ice cream should be reasonably priced, have desirable or-ganoleptic properties, be wholesome, and be environmentally friendly.
- To improve plant-based ice cream's quality and acceptability, it is crucial to increase product stability, reduce or eliminate undesirable flavors, boost nutritional value, and enhance sensory attributes.
- To summarise, more research is needed within the scope of the subject to compare the benefits and drawbacks of various plant-based products including ice cream based on their nutritional qualities and environmental impacts.

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