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Sensory profile and consumer perception of plant-based non-dairy milk jellies

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Abstract

This study focused on the organoleptic characteristics and consumers' purchasing decision of milk jellies made with lactose-free cow milk and various plant-based non-dairy milk, including almond milk, coconut milk, oat milk and soymilk. All milk alternatives were measured for the CIE color system. The hedonic scale was used to evaluate product liking on appearance, color, taste, flavor, texture, and overall acceptability–still, the scaling test assigned for the purchasing intention. The results showed that milk alternatives' lightness, taste, and flavor preference affected consumers' liking and purchasing decisions for non-dairy milk jellies. Preference mapping showed the relevance of the high lightness of milk alternatives and product acceptability. Coconut milk jelly was the most preferred, as did lactose-free milk jelly, while soymilk jelly was the least.

1. Introduction

People with lactose intolerance have a lowered ability to digest milk sugar (lactose), causing abdominal pain, bloating, cramping, flatulence, and diarrhea when they drink or eat milk and lactose-containing foods. Lactose intolerance affects most adults globally, primarily found in people living in Asia, Africa and South America regions. The lactose-free product market (milk, cheese, yogurt and ice cream) is estimated to grow at 5.4% CAGR; the global market will reach USD 17.4 billion by 2026 (Market Data Forecast, 2022). The lactose-free milk and milk alternatives segment accounted for the market's highest share. Lactose-free milk is most preferred because of its nutritional benefits and taste of standard milk; however, it contains saturated fat and cholesterol, contributing to heart disease. Still, milk alternatives from almond, coconut, oat, and soy are good options for milk allergies with less fat and calorie content but low protein.

Soymilk is the cheapest of the plant-based options liked by lactose-intolerant consumers who are health conscious. It is naturally lactose-free and rich in protein and essential amino acids, calcium, iron, vitamin B12, anthocyanins, and dietary fiber. It can help lower LDL (bad cholesterol) levels and prevent hormone-related cancers by its high phytochemicals called isoflavones. However, the oxidation of unsaturated lipids by lipoxygenases in soybeans causes undesirable taste and flavor in soymilk, retarding its market growth (Chambers *et al.*, 2006). Today, other milk alternatives from cereals and nuts, such as coconut milk, almond milk, and oat milk, are accepted as functional foods with health-promoting ingredients such as dietary fibers, minerals, vitamins, and antioxidants (Das *et al.* 2012). Coconut milk has a thick and creamy texture with high vitamins and minerals such as iron, calcium, magnesium, and zinc. It is a good source of fiber and antioxidants and has healthy fats called medium-chain triglycerides (MCTs). These substances have been found to promote anti-inflammatory, antibacterial and antifungal properties, weight loss, and boosting the immune system (Belewu and Belewu, 2007). At the same time, almond milk and oat milk, which have different flavors, have been increasingly consumed due to their potential health benefits and driven by the development of lactose-free products (Settaluri *et al*., 2012).

Regarding the high competition of plant-based milk alternatives, the flavor remains a constant interest in consumers; nonetheless, the relatively high price of these products and health nutrients may also limit the scope of

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sales. For example, applying plant-based milk substitutes, which generally have less than 1% saturated fat, is not intended for the low-fat product as cow's milk chooses. Suitability and consumer preference are the main criteria responsible for selecting the suitable milk alternative for the right lactose-free product. This supports a growing awareness of specific inputs in these products and subsequently increases purchasing decisions. As far as the authors know, the information on consumer favorability and familiarity of milk alternatives to create renewable plant-based products is scarce. Therefore, it is interesting to study the effects of various milk alternatives on the sensory profile and consumer acceptability of lactose-free dairy jellies.

2. Materials and methods

2.1 Materials

All unsweetened lactose-free cow milk (CP-Meiji Thailand, Co., Ltd., Bangkok, Thailand), and plant-based milk alternatives, including almond milk (Almond breeze®, Heritage Snack and Food Co., Ltd., Samut Sakhon, Thailand), soymilk (Tofusan™, Tofusan Co., Ltd., Samut Sakhon, Thailand), oat milk and coconut milk (UFC Velvet™, Universal Food Public Company Limited, Bangkok, Thailand), Agar powder (Platapiantong Seng Huad Co., Ltd., Thailand), and refined sugar were used.

2.2 Preparation of milk jelly

A regular milk jelly recipe (% by total weight) included 7.14% agar powder, 35.71% milk, and 57.14% sugar. Added an agar powder into the milk alternative, stirred, and allowed swelling for 15 mins before heating at 75±2℃ for 5 mins.The sugar was added, further mixed for 1 min, and let the mixture cool down to 60±2℃. Poured the warmed mixture into cups (2×4 cm^2) and refrigerated at 4℃ before analysis.

2.3 Color measurement

CIE Lab system L^*, a^*, and b^* values, where L^* indicates lightness on a 0-100 scale from black to white, a^* red (+) and green (–), and b^* yellow (+) and blue (–). A colorimeter (MiniScan EZ, Hunter Associates Laboratory, Reston, VA) was used to measure the color of milk alternatives. Hue angle ($h°$) = $\arctan^{-1}$ b*/a* and chroma (C) = $[(a^*)^2 + (b^*)^2]^{1/2}$ was calculated. Five samples were analyzed per treatment.

2.4 Sensory evaluation

A sensory test was performed in an individual booth by sixty untrained panelists (18 - 50 years old) who commonly consume agar jellies. Organoleptic attributes on appearance, color, taste, flavor, texture and overall acceptability were assessed by a 9-point hedonic scale (1 – extremely dislike and 9 - extremely like). The quality index (Q1) was calculated by the equation: Q1 = (Score × 100)/9 according to Fernandes and Salas-Mellado (2017). Each panelist was invited to rinse the palate before tasting the samples coded with random three-digit numbers. Panelists also evaluated the purchasing intention using a 5-point scale test (1 – certainly would not buy and 9 - certainly would buy) (Lawless and Heymann, 1998).

2.5 Statistical analysis

Data were statistically analyzed using the analysis of variance (ANOVA) and compared mean treatment by Duncan's new multiple range test (Cochran and Cox, 1992). The SPSS software version 17.0 was used. Data observed for color and sensory analysis were performed on the external preference mapping through the principal component analysis (PCA) using the R-program (R Foundation for Statistical Computing, Vienna, Austria).

3. Results and discussion

3.1 Product characteristics

The ANOVA results reveal significant liking differences in all attributes among jellies with various milk alternatives (Table 1). The jelly made with lactose-free milk received higher scores for all characteristics than milk alternatives, except for that with coconut milk, which was comparable ($p > 0.05$). Most panelists preferred the white color, delicious taste, pleasant flavor, and creamy texture of lactose-free milk jellies. It is possible due to the lactose-free production process under the lactase addition. This enzyme helps break down lactose into glucose and galactose, enhancing the flavor and sweetness of the milk. At the same time, the creamy lactose-free milk, influenced by its higher fat content (8% fat), was more desirable than coconut milk (4.5% fat), soymilk (4.5%), and almond milk (2.5% fat), respectively (Sethi *et al*., 2016). Concerning the instrumental color analysis in Table 1, lactose-free milk had L^* (99.61), a^*(-2.38), and b^*(4.53), classifying into the white color family, a mixture of yellow and green color. Among milk alternatives, coconut milk with L^* (93.78), a* (-0.37), and b^* (4.21) could identify to the grey color family, a mixture of orange and yellow color. It presented a higher L^* value than oat milk, soymilk, and almond milk, contributing to a white color close to the lactose-free milk. The CIE L^*, a^*, and b^* determined that these oat, soy, and almond milk showed brown-composing color, lowering the white milk jelly color and consumer preference. As seen in Table 2, it was also observed that almond milk showed a lower ($p < 0.05$) hue angle than other milk alternatives, indicating an off-

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Table 1. Color measurement of dairy jellies with various milk alternatives.

Milk alternatives	Lightness (*L*100-white/0-black*)	Red/green (*+a*/–a**)	Yellow/blue (*+b*/–b**)	Hue (*h°*)	Chroma (C)
Lactose-free milk	99.61±1.09^{a}	–2.38±0.24^{d}	4.53±0.41^{c}	89.68±0.08^{a}	5.12±0.75^{b}
Almond milk	83.09±1.12^{d}	0.71±0.30^{a}	6.94±0.24^{a}	84.16±0.15^{b}	6.98±0.52^{a}
Coconut milk	93.78±0.82^{b}	–0.37±0.09^{b}	4.21±0.20^{c}	89.68±0.04^{a}	4.23±0.37^{c}
Oat milk	87.04±0.44^{c}	–0.88±0.16^{c}	6.87±0.11^{a}	89.70±0.10^{a}	6.93±0.22^{a}
Soymilk	84.15±0.60^{d}	–0.89±0.07^{c}	5.80±0.18^{b}	89.69±0.16^{a}	5.86±0.14^{b}

Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p<0.05$).

Table 2. Sensory evaluation of dairy jellies with various milk alternatives.

Milk alternatives	Appearance	Color	Taste	Flavor	Texture	Overall acceptability
Lactose-free milk	6.92±0.88^{a}	7.29±1.00^{a}	6.96±1.19^{a}	6.92±1.10^{a}	6.42±1.05^{ab}	7.13±1.20^{a}
Almond milk	5.88±1.02^{b}	5.67±0.98^{b}	5.17±1.63^{b}	5.38±1.54^{b}	5.63±1.24^{b}	5.67±1.42^{b}
Coconut milk	7.46±0.85^{a}	7.42±1.12^{a}	6.83±1.17^{a}	6.92±1.14^{a}	7.00±1.02^{a}	7.29±1.08^{a}
Oat milk	4.71±1.07^{c}	4.42±1.20^{c}	3.92±1.74^{c}	3.88±1.40^{c}	4.71±1.40^{c}	4.46±1.12^{c}
Soymilk	4.71±0.82^{c}	4.71±1.16^{c}	4.00±1.41^{c}	3.88±1.14^{c}	4.04±0.87^{c}	4.21±1.14^{c}

Values are presented as mean±SD. Values with different superscripts are statistically significantly different ($p<0.05$).

white or a light tan milky drink. The highest chroma was found in almond milk, showing a more excellent saturation or intensive color. When considering the texture attribute, coconut milk has a creamy texture with a sweet and coconut taste; by comparison, it is not thin or watery against other milk alternatives. Thus, the jelly with coconut milk was somewhat tender, breaking down in a way to met desirable panelists' eating sensations. All explanations might be why the jellies with coconut milk were preferred with higher scores for appearance, color, and texture.

The different tastes and flavors of milk alternatives affect consumer perception, as seen in Table 2 with the lowered scored jellies from soy and oat milk against almond and coconut milk ($p < 0.05$). Based on the scientific reports, soymilk has a high protein with essential amino acids similar to lactose-free milk; however, it does not meet the palatability of the beverage worldwide (Ju *et al.*, 2021). Some consumers do not appreciate soymilk due to its raw-beany flavor and unique taste. Although the slightly nutty, oaty flavor complements the roasted coffee tremendously well, it is noted that most consumers gave lowered taste and flavor scores for oat milk jellies. With its production that requires water to make a milk-like beverage, almond milk has only 2% almond-the rest is water, presenting a less creamy texture. Therefore, it is not surprising that almond milk jelly was less acceptable than coconut milk jelly. This finding implies that the difference in composition of store-brand milk alternatives affected the consumer acceptability of milk jelly.

According to Table 2, high scores of other attributes perception might influence overall acceptability, which supported the high liking of milk jellies with lactose-free milk and coconut milk. In this regard, the quality index analysis (QI) was calculated and found differently depending on each milk alternative used. The result confirmed that coconut milk was the best, with the highest QI of 81%, followed by lactose-free milk (QI = 79%), almond milk (QI = 63%), oat milk (QI = 50%), and soymilk (QI = 47%), respectively. Fernandes and Salas-Mellado (2017) reported that the product with a QI score of more than 70% showed good sensory acceptance. Thus, dairy jellies made with coconut and lactose-free milk were preferred, while the others were under the quality line. Coconut milk is a better choice for non-dairy jelly as the milk contains one-third of cow's milk calories, and half the fat but is high in medium-chain triglycerides (MCTs), which may reduce cardiovascular risk and provide anti-viral and anti-bacterial properties in the body (Levy, 2018).

3.2 Purchasing intention

The purchasing intention in Figure 1 reveals that consumers who were willing to pay milk jellies with coconut milk, lactose-free milk, almond milk, oat milk, and soymilk were 4.37, 4.33, 3.17, 1.79, and 1.67. The result suggested that customers commonly perceived the quality of three jellies made with coconut milk, lactose-free milk, and almond milk. However, a successful product with high customer satisfaction is a huge factor. Thus, this study emphasized the consumers who would both certainly buy (score 5) and possibly buy (score 4) which were about 91.7%, 83.3%, and 32% for milk jellies with lactose-free milk, coconut milk, and almond milk, respectively. This reflects that the almond milk jelly with 45% of "the consumers may/ may not buy (score 3)" (Figure 1), showing consumers were hesitant to buy. The results corresponded with the

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overall acceptability and quality index, guiding customer to focus on product taste and flavor quality, making the non-dairy jelly with coconut milk more appealing, and receiving a high willingness to pay.

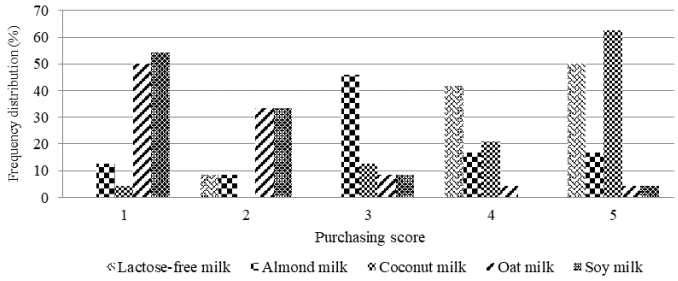

Figure 1. Frequency distribution (%) of dairy jellies with various milk alternatives.

In general, non-dairy milk has been dominated by soymilk in the Thai market, while other plant-based non-dairy alternatives have entered the early stage. It is interesting to know that the popularity of soymilk, the cheapest milk substitute with high nutrients close to dairy milk but with no adverse health effects, is overlooked. The willingness to pay for the soymilk jelly was 1.67, indicating "would probably not buy." The soybean's strong and sharp flavor is attributed to remarkably decreasing milk jelly preference. At the same time, some groups of consumers can detect the aftertaste (undesirable sour, bitter and astringent characteristics) in soymilk caused by the oxidation of isoflavones, saponins, fatty acids, and phenolic acids (Ma and Huang, 2014). Thus, a relationship between sensory perception and the likelihood of purchasing the jelly is mainly toward the good product's palatability–an effective purchase trigger. This observation suggests innovating to create tasty, creative menus for soymilk jelly-like chocolate or strawberry flavored versions to increase consumer acceptance.

3.3 Principal component analysis and preference mapping

PCA was used to explain the relevance between instrument color scales of milk alternatives and consumer acceptability of the samples in Figure 2. The biplot represented 93.54% of the total variability with 73.95% (Dim 1) and 19.59% (Dim 2), indicating the panelists could discriminate satisfactorily among the samples. The Dim 1 axis positively correlated with L^* and all sensory attributes, appearance, color, taste, flavor, texture, and overall acceptability. At the same time, Dim 2 was correlated positively with a^* but negatively with hue. The result showed that consumers preferred the high lightness of milk alternatives (white color) associated with non-dairy jelly acceptability (Figure 2b). It can be seen that coconut milk jelly was located on the right side of Dim 1, closely related to all preferable attributes. At the same time, a group with oat milk and soymilk jellies was positioned on the negative side, revealing that consumers did not prefer these non-dairy jellies attributes. It might be due to these milk alternatives' lower L^* or less white color, causing the products' color and appearance to differ from those with the standard cow milk.

In conclusion, the lightness or white color, good taste and flavor, and creamy texture of milk alternatives closely resemble cow's milk are considered significant factors. Among non-dairy milk alternatives, coconut milk is the best choice for lactose-free milk jelly, while soymilk is the least. A guideline for the subsequent research suggests blending two or more types of plant-based milk to create a product with a novel taste and creamy texture with more health benefits.

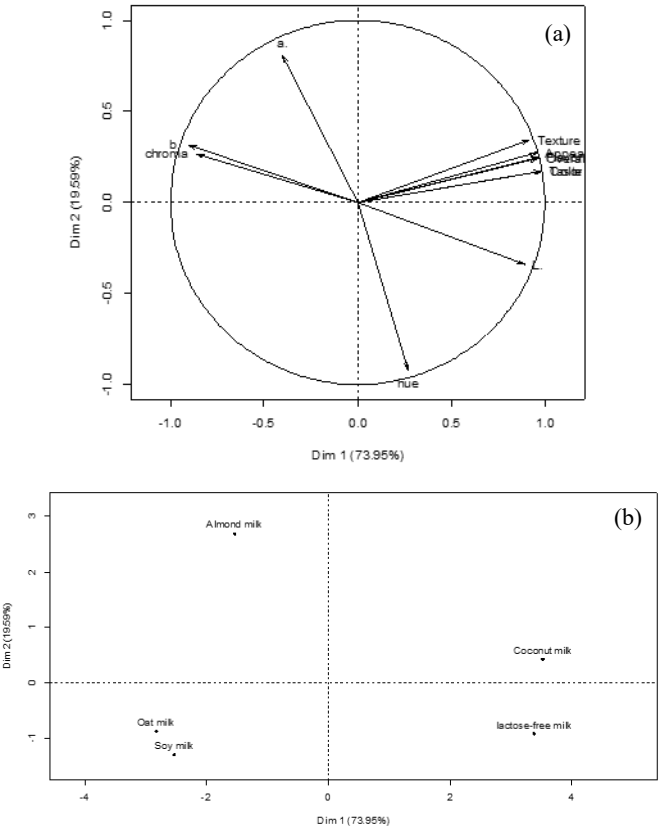

Figure 2. Preference mapping of various non-dairy jellies: (a) projection of variables and (b) projection of samples.

Conflict of interest

The authors declare no conflict of interest.

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References

Belewu, M.A. and Belewu, K.Y. (2007). Comparative physicochemical evaluation of tiger nut, soybean and coconut milk sources. *International Journal of*

Agricultural Biology, 9(5), 785–787.

Chambers, E., Jenkins, A. and Mcguire, B.H. (2006). Flavor properties of plain soymilk. *Journal of Sensory Studies,* 21(2), 165–179. https://doi.org/10.1111/j.1745-459X.2006.00059.x

Cochran, W.G. and Cox, G.M. (1992). Experimental Designs, 2nd ed. New York, USA: Wiley.

Das, A., Chaudhuri, U.R. and Chakraborty, R. (2012). Cereal based functional food of Indian subcontinent: A review. *Journal of Food Science and Technology,* 49(6), 665–672. https://doi.org/10.1007/s13197-011-0474-1

Fernandes, S.S. and Salas-Mellado, M.D.L.M. (2017). Addition of chia seed mucilage for reduction of fat content in bread and cakes. *Food Chem*istry, 227, 237–244. https://doi.org/10.1016/j.foodchem.2017.01.075

Ju, S., Song, S., Lee, J., Hwang, S., Lee, Y., Kwon, Y. and Lee, Y. (2021). Development of nano soymilk through sensory attributes and consumer acceptability. *Foods*, 10(12), 3014. https://doi.org/10.3390/foods10123014

Lawless, H.T. and Heymann, H. (1998). Sensory Evaluation of Food: Principle and Practices. New York, USA: Chapman and Hall. https://doi.org/10.1007/978-1-4615-7843-7

Levy, J. (2018). Coconut milk nutrition: Beneficial vegan milk or high-fat trap? Retrieved on January 22, 2022 from Website: https://draxe.com/nutrition/coconut-milk-nutrition

Ma, Y. and Huang, H. (2014). Characterisation and comparison of phenols, flavonoids and isoflavones of soymilk and their correlations with antioxidant activity. *International Journal of Food Science and Technology,* 49(10), 2290–2298. https://doi.org/10.1111/ijfs.12545

Market Data Forecast. (2022). Lactose-free market growth and forecast 2021-2026. Retrieved on February 14, 2022 from Website: https://www.marketdataforecast.com/market-reports/lactose-free-market

Sethi, S., Tyagi, S.K. and Anurag, R.K. (2016). Plant-based milk alternatives an emerging segment of functional beverages: A review. *Journal of Food Science and Technology,* 53(9), 3408–3423. https://doi.org/10.1007/s13197-016-2328-3

Settaluri, V.S., Kandala, C.V.K., Puppala, N. and Sundaram, J. (2012). Peanuts and their nutritional aspects-A review. *Food and Nutrition Sciences,* 3 (12), 1644–1650. https://doi.org/10.4236/fns.2012.312215

https://doi.org/10.26656/fr.2017.8(3).259