PRODUCTION TECHNOLOGY AND CONSUMER ACCEPTABILITY OF FUNCTIONAL WHITE CHOCOLATE ICE CREAM WITH COCOA EXTRACT

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ABSTRACT – *Ice cream is the most consumed frozen dessert. Nevertheless, it is labelled as an unhealthy food. The increasing health awareness has boosted the growing demand for functional foods, including ice cream, which may improve human health and nutrition. Cocoa extract derived from cocoa beans, which contains bioactive compounds has the health benefits of vasodilating, anti-inflammatory, cardiovascular protective, neuroprotective, cognitive-enhancing, and chemo-preventive activities. Nonetheless, it has not being utilised in ice cream products. Hence, the objectives of this study were to highlight the production technology of white chocolate ice cream fortified with the wholesomeness of cocoa extract, which is stable and well accepted. Cocoa extract was extracted from freeze-dried fresh cocoa beans using solely water, incubated at 80°C for 15 minutes, filtered, frozen and freeze-dried prior to utilization in ice cream making. The functional ice cream was produced by blending of ingredients, pasteurization, incorporation of cocoa extract into white chocolate ice cream mixture, homogenization, ageing, freezing, and packing into container prior to the analyses (overrun, total solid, melting properties, color, total phenolic content). Consumer acceptability test of the ice cream was conducted by 100 panels to assess the color, white chocolate taste, sweetness, texture, meltability and overall acceptability using 5-point hedonic scale (score 1: dislike extremely; score 2: dislike; score 3: neither dislike nor like; score 4: like; score 5: like extremely). The white chocolate ice cream with added cocoa extract was well accepted by the consumers with an average sensory score of 4 for all the tested sensory attributes. The preferred ice cream has an overrun of 45%, total solids (39.88%), melting rate (0.03 g/minute), color (L*: 87.99, a*: 3.46, b*: 25.56) and total phenolic content of 222.50 ppm gallic acid equivalent per gram of wet sample ice cream.*

Keywords: Functional ice cream, white chocolate, cocoa extract, production technology, consumer acceptability

INTRODUCTION

Ice cream is the most consumed frozen dessert that indulged by people of all ages. It is estimated that the global annual consumption of ice cream is around 15.4 billion litres (Fine Dining Lovers, 2017). Nonetheless, this delightful treat is labelled as unhealthy food (Legassa, 2020). To dress up ice cream in a healthier way, numerous health-promoting ingredients such as probiotics or live microorganisms e.g. *Lactobacilli* and *Bifidobacteria* species (Cruz, *et al.*, 2009), prebiotic e.g. oligofructose or inulin (Akalin Akalin and Erişir, 2008), synbiotic (Sabet-Sarvestani *et al.*, 2021), dietary fibre e.g. soluble and insoluble fibre (Chen *et al.*, 2010), and natural antioxidants (e.g., polyphenols) from fruit and fruit-based products (Sun-Waterhouse *et al.*, 2013) have been incorporated into ice cream products to confer nutritional and health benefits to the consumers. Those ice cream products are categorised as functional ice cream: a product supplemented or fortified with bioactive substances (Soukoulis, *et al.*, 2014; Mohammed *et al.*, 2022). Ice cream as a functional food has gaining popularity and interest owing to the lifestyle changing and increasing of health awareness that significantly boost up the growth of the global functional ice cream market from USD 230 million in 2023 to USD 440 million by 2032, with a compound annual growth rate (CAGR) of 8.56% during the forecast period of 2023 to 2032 (Market Research Future, 2023).

Cocoa extract derived from cocoa beans, which contains polyphenolic compounds (bioactive compounds) has the health benefits of antioxidant (Schinella, *et al.*, 2010) and antiradical properties (Hatano, *et al.*, 2002) which increase the plasma level of antioxidants to prevent the oxidation of low-density lipoprotein (LDL)-cholesterol (Weisburger, 2001); antiplatelet effects (Steinberg, *et al.*, 2003); vasodilation and cardioprotective effects (Magrone, *et al.*, 2017); ability to modulate the immune response (Pérez-Berezo, *et al.*, 2011); anti-inflammatory (Selmi, *et al.*, 2006); anti-carcinogenic (Dryden, *et al.*, 2006; Ren, *et al.*, 2003; Martin, *et al.*, 2013); neuroprotective and cognitive-enhancing properties (Nehlig, 2013). Cocoa extract has been used in various food products for instance jam, biscuits, sausages, beverages, chocolates, cakes (Campos-Vega *et al.*, 2018); nevertheless, it has not been utilised in ice cream products. In addition, ice cream is a promising carrier for bioactive elements due to its composition, colloidal form, and low-temperature system (Mohammed, et al., 2022). Hence, the objectives of this study were to highlight the production technology of white chocolate

ice cream fortified with the wholesomeness of cocoa extract.

MATERIALS AND METHODS

Materials

The matured, fresh, and de-pulped cocoa beans used to produce cocoa extract were obtained from the Cocoa Research and Development Centre (CRDC) Bagan Datuk, Perak. White chocolate, sugar, stabiliser, and emulsifier were purchased from the local retail shops. Filter papers (Whatman no. 4) were procured from the local scientific supplier; chemicals such as ethanol absolute 99.5%, denatured was obtained from HmBG, Germany; Folin-Ciocalteu reagent from Merck, United State of America (USA); sodium carbonate anhydrous from Fisher, USA; and gallic acid was obtained from Sigma-Aldrich, USA.

Production Technology of Functional White Chocolate Ice Cream with Cocoa Extract

a) Production of Cocoa Extract from Fresh Cocoa Beans

Cocoa extract was produced according to Samuel *et al.* (2022) method by adding 1000 ml of distilled water into 10 grams of freeze-dried fresh cocoa beans. The mixture was incubated at 80ºC in an incubator shaker with 150 rpm orbital shaking mode for 15 minutes. The extract was then filtered with filter paper (Whatman no. 4) and freeze-dried at -40ºC using a freeze dryer (Brand: Labconco, USA). Figure 1 outlines the process of the production of freeze-dried cocoa extract.

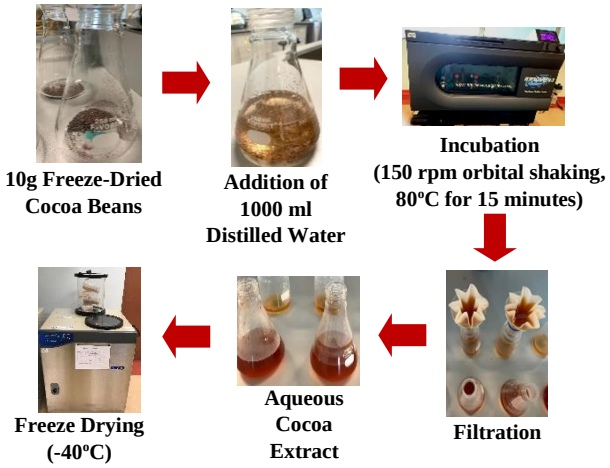

Figure 1: Production of Cocoa Extract from Fresh Cocoa Beans

b) Production of Functional White Chocolate Ice Cream with Cocoa Extract

Functional ice cream was produced by incorporating freeze-dried cocoa extract into white chocolate ice cream after the pasteurization process. The ice cream mix was homogenized, aged and frozen prior to the packing of the ice cream (Figure 2). Figure 3 shows the white chocolate ice cream with added cocoa extract (0.1%).

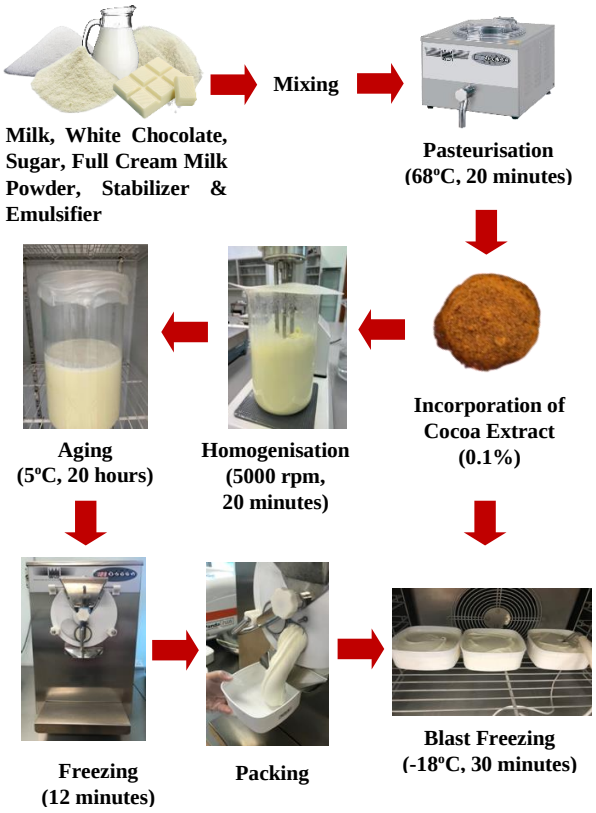

Figure 2: Production of White Chocolate Ice Cream with Cocoa Extract

Figure 3: White Chocolate Ice Cream with Cocoa Extract

Analyses of White Chocolate Ice Cream with Cocoa Extract

a) Overrun

Overrun is defined as the air added to ice cream. It can be determined by weight which computes the decrease in weight of a given volume of mix due to addition of air (Goff and Hartel, 2013). The percentage of overrun was calculated as follow:

$$\% \text{ Overrun} = \frac{\text{Wt. of mix} - \text{Wt. of same volume of ice cream}}{\text{Wt. of same vol. of ice cream}} \times 100$$

Where,
Wt. = Weight
Vol.= Volume

b) Total Solids

The total solids was measured as described by Wehr and Frank (2004). Three grams of the melted ice cream was

weighed into a dried and pre-weighed pan. The sample was dried in an oven at 100±2ºC for 3.5 hours. The pan with its dry content was cooled and weighed. The percentage of total solids was calculated as follow:

$$\text{Total Solids (\%)} = \frac{\text{Wt. of the dried pan and sample} - \text{Wt. of the dried pan}}{\text{Wt. of the sample before drying}} \text{x100}$$

Where,
Wt. = Weight

c) Melting Rate

The melting rate of ice cream was quantified according to the method described by Bolliger *et al.* (2000). The ice cream with the weight of 70 g was removed from the ice cream cup (100 ml) and placed on a wire screen (9 holes/ 1 cm^2) on top of a funnel. The test was carried out under controlled environment at temperature of 25ºC. The drip-through weight was recorded every 10 minutes for up to 60 minutes. The meltdown is defined as the mass of the drip loss divided by the total mass of the ice cream sample and plotted against time, and the highest gradient in the ascending meltdown curve indicates the maximum meltdown rate (Koxholt *et al.*, 2001).

d) Colour

The colour of the ice cream samples was measured using a calibrated colorimeter (Brand: Konica Minolta; Model: CR-5, Japan) based on illuminant D65 (intended to stimulated daylight) with 10 degrees viewing angle. Ice cream samples were filled until full into a petri dish (dimension: 60mm (D) x 15mm (H)). The results were expressed using CIELAB parameters (L*, a*, b*) whereby L* measures lightness (100 = white; 0 = black); a* measures chromaticity with positive value indicates redness and negative value indicates greenness; and b* measures chromaticity with positive value indicate yellowness and negative value indicates blueness.

e) Total Phenolic Content

Twenty-five millilitres (mL) of 95% ethanol was added into ice cream sample (50 g) and stirred with glass rod. The homogenate was left at room temperature for 4 hours and filtered through a Whatman filter paper No. 4. to obtain the phenolic extract of the ice cream.

The amount of total phenolics in the samples was determined according to the method described by Ullah *et. al.* (2015) with some modifications. One millilitre of Folin-Ciocalteu reagent was added to the phenolic extract of the ice cream sample (0.5 mL) and left at room temperature for 2-3 minutes. Two millilitres of 20% sodium carbonate was added before absorbance was measured at 730 nm using an ultraviolet-visible spectrophotometer (Cary 60, Agilent, USA) against the prepared blank. The total phenolic contents of the samples were calculated as milligrams (mg) of gallic acid equivalents (GAE) per gram (g) of sample.

f) Consumer Acceptability Test

Consumer acceptability test of the ice cream was conducted as described by Gusnadi (2020). Hundreds (100) of panels were invited to assess the colour, white chocolate taste, sweetness, texture, meltability and overall acceptability using 5-point hedonic scale (score 1: dislike extremely; score 2: dislike; score 3: neither dislike nor like; score 4: like; score 5: like extremely).

RESULTS AND DISCUSSIONS

A total of 100 consumers encompasses 59% female and 41% male with the age ranged from 19 - 64 years old (64%), 12-18 years old (29%), 65 years old and above (7%) were evaluated the organoleptic quality of the white chocolate ice cream with cocoa extract. White chocolate ice cream with cocoa extract was well accepted by the consumers with an average sensory score of 4 for all the tested sensory attributes (Figure 4).

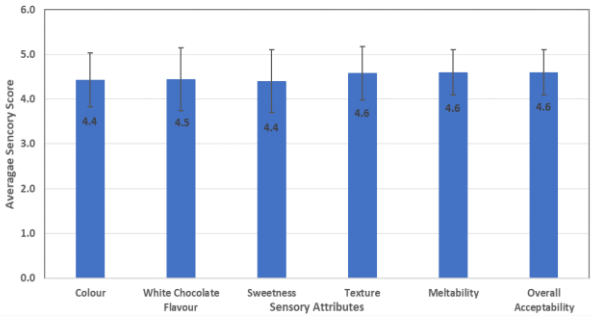

Figure 4: Sensory Scores for White Chocolate Ice Cream with Cocoa Extract

Table 1 shows the physicochemical properties of white chocolate with cocoa extract. The preferred ice cream has an overrun of 45% and 39.88% total solids; melting properties (0.03 g/minute); colour (L*: 87.99, a*: 3.46, b*: 25.56) and total phenolic content of 222.50 ppm gallic acid equivalent per gram of wet sample ice cream.

Table 1. Physicochemical Properties of White Chocolate with Cocoa Extract

Physicochemical Properties	
Overrun	45%
Total Solids	39.88%
Colour	
L*	87.99
a*	3.46
b*	25.56
Melting Properties	0.03 /minute

Total Phenolic Content	222.50 ppm gallic acid equivalent/ gram of wet sample

CONCLUSIONS

The white chocolate ice cream enriched with cocoa extract was well accepted by the consumers with an average sensory score of 4 for all the tested sensory attributes.

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REFERENCES

Akalin, A. S. and Erişir, D. (2008). Effects of inulin and oligofructose on the rheological characteristics and probiotic culture survival in low-fat probiotic ice cream. *Journal of Food Science* **73**: M184-188.

Bolliger, S., Goff, H. D. and Tharp, B. W. (2000). Correlation between colloidal properties of ice cream mix and ice cream. *International Dairy Journal* **10**: 303-309.

Campos-Vega, R., Nieto-Figueroa, K. H. and Oomah, B. D. (2018). Cocoa (*Theobroma cacao* L.) pod husk: Renewable source of bioactive compounds. *Trends In Food Science and Technology* **81**: 172-184.

Chen, W., Duizer, L., Corredig, M. and Goff, H. D. (2010). Addition of soluble soybean polysaccharides to dairy products as a source of dietary fiber. *Journal of Food Science* **75**: C478–C84.

Cruz, A. G., Antunes, A. E. C., Sousa, A. L. O. P., and Faria, J. A. F. (2009). Ice-cream as a probiotic food carrier. *Food Research International* **42(9)**: 1233-1239.

Dryden, G. W., Song, M. and McClain, C. (2006). Polyphenols and gastrointestinal diseases. *Current Opinion in Gastroenterology* **22(2)**: 165-170.

Fine Dining Lovers (2017). 10 numbers behind ice cream. https://www.finediningloversm.com/article/10-numbers-behind-ice-cream

Goff, H. D. and Hartel, R. W. (2013). Calculation of ice cream mixes. In: Ice Cream, 7th edition, Springer New York, New York, pp. 184-188.

Gusnadi, D (2020). The consumer acceptability of purple sweet potato-based ice cream. Test Engineering and Management **83**: 6268-6270

Hatano, T., Miyatake, H., Natsume, M., Osakabe, N., Takizawa, T., Ito, H., and Yoshida, T. (2002). Proanthocyanidin glycosides and related polyphenols from cacao liquor and their antioxidant effects. *Phytochemistry* **59 (7)**: 749-758.

Koxholt, M. M. R., Eisenmann, B., and Hinrichs, J. (2001). Effect of the fat globule sizes on the meltdown of ice cream. *Journal of Dairy Science* **84**: 31-37.

Legassa, O. (2020). Ice cream nutrition and its health impacts. *Journal of Food Nutrition Science* **7(1)**: 19-27.

Market Research Future (2023). Global functional ice cream market overview. https://www.marketresearchfuture.com/reports/functional-ice-cream-market-10759.

Magrone, T., Russo, M. A. and Jirillo, E. (2017). Cocoa and dark chocolate polyphenols: from biology to clinical applications. *Frontiers in Immunology* **8**: 1-13.

Martin, M. A., Goya, L. and Ramos, S. (2013). Potential for preventive effects of cocoa and cocoa polyphenols in cancer. *Food and Chemical Toxicology* **56**: 336-351.

Mohammed, N. K.; Khair, M. F. B.; Ahmad, N. H.; Hussin, A. S. M. (2022). Ice cream as functional food: a review of health-promoting ingredients in the frozen dairy products. *Journal of Food Process Engineering* **45 (12)**: e14171.

Nehlig, A. (2013). The neuroprotective effects of cocoa flavanol and its influence on cognitive performance. *British Journal of Clinical Pharmacology* **75(3)**: 716-727.

Pérez-Berezo, T., Franch, A., Ramos-Romero, S., Castellote, C., Pérez-Cano, F. J. and Castell, M. (2011). Cocoa-enriched diets modulate intestinal and systemic humoral immune response in young adult rats. *Molecular Nutrition and Food Research* **55 (supplement 1)**: S56-S66.

Ren, W., Qiao, Z., Wang, H., Zhu, L., and Zhang, L. (2003). Flavonoids: promising anticancer agents. *Medicinal Research Reviews* **23(4)**: 519-534.

Sabet-Sarvestani, N., Eskandari, M. H., Hosseini, S. M. H., Niakousari, M., Gahruie, H. H. and Khalesi, M. (2021). Production of synbiotic ice cream using *Lactobacillus casei*/ *Lactobacillus plantarum* and fructooligosaccharides. *Journal of Food Processing and Preservation* **45**: 1-11.

Samuel Yap, K.C., Arief Huzaimi, M. Y. and Chin, H. H. (2022). Cocoa fresh beans aqueous extract as free radical quencher. Pelita Perkebunan **38(2)**: 137-143.

Schinella, G., Mosca, S., Cienfuegos-Jovellanos, E., Pasamar, M. A., Muguerza, B., Ramón, D. and Ríos, J. L. (2010). Antioxidant properties of polyphenol-rich cocoa products industrially processed. *Food Research International* **43(6)**: 1614-1623.

Selmi, C., Mao, T. K., Keen, C. L., Schmitz, H. H. and Gershwin, M. E. (2006). The anti-inflammatory properties of cocoa flavanols. *Journal of Cardiovascular Pharmacology* **47(2)**: S163-S171.

Soukoulis, C., Fisk, I. D. and Bohn, T. (2014). Ice cream as a vehicle for incorporating health-promoting ingredients: conceptualization and overview of quality and storage stability. *Comprehensive Reviews in Food Science and Food Safety* **13**: 627-655.

Steinberg, F. M., Bearden, M. M., and Keen C. L. (2003). Cocoa and chocolate flavonoids: Implications for cardiovascular health, *Journal of the American Dietetic Association* **103(2)**: 215-223.

Sun-Waterhouse, D., Edmonds, L., Wadhwa, S. S., and Wibisono, R. (2013). Producing ice cream using a substantial amount of juice from kiwifruit with green, gold or red flesh. *Food Research International* **50**: 647-656.

Ullah, R., Nadeem, M., Ayaz, M., Tayyab, M., Imran, M. and Sajid, R. (2015). Antioxidant characteristics of ice cream supplemented with sugarcane (*Saccharum officinarum* L.) juice. *Food Science and Biotechnology* **24(4)**: 1227-1232.

Wehr, H. M. and Frank, J. F. (2004). Standard methods for the examination of dairy products, 17th edition, American Public Health Association, Washington, D. C.

Weisburger, J. H. (2001). Chemopreventive effects of cocoa polyphenols on chronic diseases. *Experimental Biology and Medicine* **226(10)**: 891-897.