Development of reduced fat purple sweet potato ice cream mix powder

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Abstract

Purple sweet potato (PSP) (*Ipomoea batatas*) is processed as flour and use in the production of food such as bread. Moreover, PSP flour can also be added in ice cream product to improve the functional properties. Ice cream is a popular product in Thailand. However, ice cream needs to keep at a low temperature so the cost of transport is higher. Therefore, ice cream mix powder has been created. Moreover, the high consumption of ice cream causes of non-communicable disease (NCDs). The aim of this study was to determine physical and chemical properties of purple sweet potato flour (PSPF) and use as an ingredient to developing a reduced fat PSP ice cream mix powder. In addition, the physicochemical properties and sensory evaluation of reduced fat PSP ice cream mix powder by varying four levels of PSPF at 0, 50, 75 and 100% (w/w) were determined. The results showed that PSPF contains a considerable amount of protein (3.82%), carbohydrate (88.94%), fat (0.03%), and dietary fiber (9.69%). The solubility was at 36.37% and color values were 40.32, 11.36 and -5.21 for L*, a* and b*, respectively. As the results of reduced fat PSP ice mix powder, the increase of PSPF resulted in the increasing of viscosity and hardness while decreasing of overrun and melting rate of the product. For sensory evaluation, reduced fat PSP ice mix powder from 100% PSPF replacement obtained the highest overall liking score of 7.6 (like moderately to like very much). Besides, this developed product could be reduced by 32.38% fat and increased total phenolic content and antioxidant activity.

Keywords: Ice cream mix powder, purple sweet potato, reduce, fat, bioactive compounds

Introduction

Recently, health-conscious consumers have focused on low-fat products as the intake of such products decrease the risk of obesity and cardiovascular diseases (Akalin et al. 2008). Moreover, the market for foods that provide nutritional function and new eating experiences for consumers has grown rapidly in recent years (Graaf, 2007; Tuorila, 2007; Van Kleef, Luning & Jongen, 2002; Williams, Stewart-Knox & Rowland, 2004). Ice cream is one of the most consumed dairy products in the world (Gorski, 1997; Hoyer, 1997) but the ice cream available commercially is generally poor in natural antioxidants like vitamin C, colors and polyphenols. Thus, it is of interest to explore the possibility of improving the nutritional attributes of ice cream using ingredients with health benefits, focusing on natural antioxidants, natural colorants, vitamins, low fat and freedom from synthetic additives in light of consumer expectations (El-Nagar et al. 2002; Gidley, 2004; Starling, 2005; Kleef et al. 2002).

Purple sweet potato (PSP) (*Ipomoea batatas*) are starchy tubers which have good nutritional value and positive health benefits as excellent sources of carbohydrate, fiber, vitamins, minerals and phytochemical compounds (Hal, 2000; Teow et al. 2007). PSP contain high amount of anthocyanin (0.4 to 0.6 mg anthocyanin/g fresh weight), which mainly consists of mono- or di- acylated forms of cyanidin and peonidin (Hagiwara et al. 2002; Suda et al. 2003). Anthocyanin provides various biological functions such as free radical scavenging, anticarcinogenic activity and antihypertensive effects (Oki et al. 2002; Yang & Gadi, 2008). Moreover, PSP anthocyanins can be used as natural food-safe edible colorants (Suda et al. 2003; Terahare et al. 2004). Sweet potatoes have great potential to contribute to the human diet and food production as starch, bakery and snacks. Sweet potato flour could be produced with many advantages including longer shelf life, ready usage and easy delivery, thus increasing the economic value of sweet potatoes. Therefore, the aim of this study was to determine physical and chemical properties of purple sweet potato flour (PSPF) and use as an ingredient to developing a reduced fat PSP ice cream mix powder. In addition, the physicochemical properties and sensory evaluation of reduced fat PSP ice cream mix powder also were determined.

Materials and methods

Raw materials

PSP was purchased from a local market, Nakornpathom, Thailand. Other ingredients used for ice cream mix powder production included salt (Thai Refined salt co., Ltd., Thailand), sugar (Dynasty pacific co., Ltd., Thailand), full cream milk powder (Dairyfarm Co., Ltd., Thailand), and whipping cream (UFM Food Centre Co., Ltd., Thailand), non-dairy cream (NDC) (Thai Food and Chemical Co., Ltd.), fat powder (Inthaco Co., Ltd., Thailand).

PSPF preparation

PSPF was prepared following the method of Aina, Falade, Akingbala, & Titus (2009) with some modifications. Briefly, all the roots were cleaned, hand-peeled and cut into 3 mm thick slices using a food processor. The thin slices were steamed for 30 min and dried in a hot air oven 60±5˚C for 5-8 h to moisture content 7±2% (w/w). The dried purple sweet potatoes were ground and sieved through a 120 mesh screen. The PSPF was stored in aluminum foil bag at -20ºC until required for use.

Preparation of ice cream mix powder

The formulas of ice cream mix powder were modified from the commercial ice cream mix powder recipe as shown in **Table 1**. The preparation of ice cream mix powder was done by mixing all the ingredients together then kept in aluminum bag until required for use. The process of making ice cream from ice cream mix powder was done by mixing 100g of ice cream mix powder with 150g of warm water (45ºC). Then the mixture was blended together by homogenizer at the lowest speed for 5 min. Finally the ice cream was kept at -18ºC for 4 h. These two formulas were used for sensory evaluation. The formula which obtained the highest overall liking score was selected to be a control formula.

Table 1 The formulas of ice cream mix powder.

Ingredient (%)	Formula A	Formula B
Salt	0.1	0.1
Sugar	30	29.5
Full cream milk	19	19
NDC	13.5	15
Whipping cream	10	15
Fat powder	3	5
Food additive	24.4	16.4

Preparation of reduced fat purple sweet potato ice cream mix powder

The control formula which was selected from previous experiment was used to prepare reduced fat purple sweet potato ice cream mix powder by partially replacing NDC with 0, 50, 75 and 100% PSPF. Other ingredients were the same. Then, the preparation of reduced fat purple sweet potato ice cream mix powder was the same as the above process. The accepted reduced fat purple sweet potato ice cream mix powder was selected by sensory evaluation.

Physico-chemical analysis

The physico-chemical properties of purple sweet potato flour, reduced fat purple sweet potato ice cream mix powder and its ice cream were analyzed at the Laboratory of Food Science and Food Chemical unit, Institute of Nutrition, Mahidol University.

Proximate analysis: the moisture content, ash, protein, fat, carbohydrate, dietary fiber and sugar were determined using standard method of Latimer (2016). The calorie content was calculated based on the contents of protein, fat and carbohydrate.

Color measurement: the color values of sample were determined using Hunter Lab Digital Colorimeter (COLORFLEX 4510 model, USA). The CIE color values were recorded as L^* (lightness), a^* (redness) and b^* (yellowness).

Solubility analysis: PSP flours were measured solubility (%) according to the method of Eastman and Moore (1984) with some modifications. 50 mL of distilled water was transferred into blender jar. The powder sample (0.5g, dry basis) was carefully added into the blender operating at high velocity for 5 min. The solution was placed in tube and centrifuged at 3000×g during 5 min. An aliquot of 25 ml of the supernatant was transferred to pre weighed Petri dishes and immediately oven-dried at 105º for 5 h. Then the solubility (%) was calculated by weight difference.

Water activity: Water activity of the samples was determined using a portable water activity meter set A_w (model ms 1, Novasina, Switzerland).

Viscosity: A concentric cylinder viscometer (model LVT, Brookfield, Stoughton, MA) was used to measure the viscosity of 600 ml of ice cream mix at 4 to 5°C after 4 h. Spindle #2 H was used to take the torque measurements at 2.5 rpm for 30 sec. the results were expressed as CPS.

Overrun: The volumes of mix and ice cream were weighed. The overrun was measure of how much it was reduced and expressed in percent.

$$\text{Overrun\%} = \{(\text{weight of ice cream mix}) - (\text{weight of ice cream})\}*100*(\text{weight of ice cream})^{-1}$$

Melting rate: The ice cream samples were stored at –18 °C overnight. The samples were then placed on a stainless steel sieve (No.25) at ambient temperature until 50% of the ice cream was melted and weight of the melted ice cream was recorded every 5 min. The plot of the percentage of the melted ice cream versus time was developed, the slope of the linear part of the plot indicating the melting rate (g/min) (Criscio et al. 2010).

Texture analysis: A texture analysis was evaluated on frozen ice cream samples stored at −18°C for one month. Measurements were performed at ambient temperature (approximately 25±2°C) using texture analyzer (TA.XT plus, Stable Micro Systems Ltd, YL, UK) equipped with a P/36R cylindrical probe. The ice cream samples were transferred to room temperature, 3 min before the analysis. The texture analysis circumstances were as follows: penetration depth, 20 mm; force, 5 g; probe speed during penetration, 2 mm s^{-1}. Hardness was considered as the peak pressure force (g) during penetration (Akalin et al. 2008).

Total phenolic contents and antioxidant activities: Approximately 0.5 g of sample was mixed with (10 mL) 70% (v/v) aqueous ethanol was used to extract samples. After thoroughly mixing (1 min) with Vortex mixer, the mixture was heat in the water bath for 2 h at 50°C. The residue was extracted after it was re-mixed and centrifuge at 4600 rpm for 15 min at 4°C. The clear supernatant was separated for the analysis of total phenolic compounds using the Folin-Ciocalteu colorimetric method (Ainsworth & Gillespie, 2007) and the results were expressed in gallic acid equivalents per gram dry weight (mg GAE/g DW) of sample. Antioxidant activity were determined using the DPPH-radical scavenging assay (Fukumoto & Mazza, 2000) , ORAC (oxygen radical absorbance capacity) assay (Ou et al. 2001) and FRAP assays (Benzie & Strain, 1996) and the results were expressed as Trolox equivalents per gram dry weight (TE/g DW).

Total anthocyanin: Total anthocyanins were determined by pH differential method (Lee, Durst, & Wrolstad, 2005) using a spectrophotometer. The pigments were extracted by combined 1 g of each sample with 12 ml HCl (1%). After incubation for 48 h at 3 to 5°C, the tubes were centrifuged at 4600 rpm for 5 min at 25°C. Samples were filtered and stored at –20 ° C until analysis. Absorbance was measured at 520 nm and 700 nm in buffers at pH 1.01 and 4.5 using $A = [(A_{520} - A_{700})$ pH 1.0 - $(A_{520} - A_{700})$ pH 4.5] with a molar extinction coefficient of 26900. Results were expressed as mg of cyanidin-3-glucoside equivalents (CGE) in g dry weight (mg cy-3-glue/ L).

Sensory evaluation

Sensory evaluation was conducted with 30 untrained panelists comprised of faculty members, staffs and graduate students of the Institute of Nutrition, Mahidol University (INMU), Thailand. The test was performed in an individual testing booth under the daylight-fluorescent lights of the sensory science laboratory at INMU. All ice cream samples were prepared from ice cream mix powder. Samples were coded using random three-digit numbers. Panelists were provided with a glass of water and, instructed to rinse and swallow water between samples. They were given written instructions and asked to evaluate the products for acceptability based on its appearance, color, flavor, taste, texture and overall acceptability using nine-point hedonic scale (1 = dislike extremely to 9 = like extremely) (Meilgaard et al. 1999). The protocol was approved by Mahidol University Ethical Board (MU-CIRB) (No. MU-CIRB 2018/135.1907).

Statistical analysis

All measurement except sensory evaluation was performed in triplicates. Experimental data was analyzed using computer software (IBM SPSS Statistics 19.0 IBM, Chicago, Illinois, USA). Independent sample t-test or one-way Analysis of Variance (ANOVA) and Duncan's multiple range tests was performed to compare mean value. Average values are considered significantly different when $p < 0.05$.

Results and discussion

PSPF characteristics

The physicochemical characterization of PSPF is presented in **Table 2**. PSPF contains 371 Kcal of energy, 4.53% of moisture content, and 2.67% of ash. Protein, fat, carbohydrate and dietary fiber were at 3.82, 0.03, 88.94 and 9.69%, respective. The moisture content and fat of PSPF seemed to be lower than the study of Phomkaivon (2018). Phomkaivon (2018) reported that moisture content and fat of Thai sweet potato flour ranged at 6.35 to 7.54% and 0.45 to 0.56%, respectively. However, the protein content and ash showed the similar results. This might be due to the different sweet potato varieties, seasoning, growing area and drying process. PSPF also was evaluated for solubility. The result showed that solubility of PSPF was 33.13%, which similar with solubility reported (32.96%) by Phomkaivon (2018). Hydration properties of flours depended on their characteristic of starch granules (Neelam et al. 2012). Moreover, the variation in solubility and swelling power could be caused by differing degrees of engagement of the hydroxyl groups, forming hydrogen and covalent bonds between the starch chains (Gunarate & Hoover, 2002). Moreover, the water activity of PSPF was 0.33 which was lower than the guideline for quality control in Thai regulations. The color values were expressed as Hunter values (L^*, a^*, b^*). PSPF had brightness (L^*) of 40.32, redness (a^*) of 10.35 and yellowness (b^*) of -5.21. A purple color was observed from PSPF, probably due to the presence of anthocyanins and phenolic compounds, which can vary according to the cultivars.

Table 2 Characterization of purple sweet potato flour (PSPF)[1].

Parameters	PSPF
Energy (kcal/100g)	371.32±3.00
Moisture (%)	4.53±0.60
Protein (g/100g)	3.82±0.31
Total fat (g/100g)	0.03±0.05
Total carbohydrate (g/100g)	88.94±0.70
Ash (g/100g)	2.67±0.22
Dietary fiber (g/100g)	9.69±1.47
Solubility (%)	33.13±4.06
A_w	0.33±0.03
Color	
*L**	40.32±0.95
*a**	10.35±0.73
*b**	-5.21±0.57

[1] the data are displayed as having a mean±SD.

Total phenolic contents, antioxidant activities and total anthocyanins of purple sweet potato Flour (PSPF)

Table 3 shows total phenolic contents, antioxidant activities and total anthocyanin of purple sweet potato Flour (PSPF). PSPF exhibited the antioxidant activities by 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging, ferric reducing antioxidant power (FRAP) and oxygen radical absorbance capacity (ORAC) assay of 1.09 µmol trolox equivalent (TE)/100g dry weight (DW), 35.91 µmol TE/g DW and 129.83 µmol TE/g DW, respectively. The result of total phenolic contents (TPCs) using Folin-Ciocalteu method was 3.92 mg GAE/g DW and total anthocyanin was 56.63 mg cy-3-glue/L. However, Phomkaivon (2018) found the lower level of total phenolic contents, antioxidant activities and total anthocyanins in Thai purple sweet potato (Phichit 65-3). Phenolic compounds and anthocyanins in purple sweet potatoes show powerful antioxidant activity. The main anthocyanins in purple sweet potatoes are 3,5-diglucoside derivatives from cyanidin and peonidin, acylated with p-hydroxybenzoic acid, ferulic acid, or caffeic acid, respectively (Kim et al. 2012). Therefore, it might be said that PSP is a good sources of natural colorants, and dietary phytochemicals and antioxidants.

Table 3 Total phenolic contents, antioxidant activities and total anthocyanins of purple sweet potato flour (PSPF)[1].

Sample	Total phenolic contents (mg GAE/g DW)	Antioxidant activities			Total anthocyanins (mg cy-3-glue/ L)
		DPPH radical scavenging assay (umol TE/100g DW)	FRAP assay (umol TE/g DW)	ORAC assay (umol TE/g DW)	
PSPF	3.92 ± 0.16	1.09 ± 0.10	35.91 ± 3.53	129.83±11.13	56.63±3.08

[1]the data are displayed as having a mean±SD.

Selection of the control formula for fat reduced purple sweet potato ice cream mix powder

There were two different ice cream mix powder formulas which had been used to prepare ice cream. The sensory characteristics of two different ice cream formulas are shown in **Table 4**. The sensory evaluation indicated that formula B obtained the higher scores on appearance, flavor, taste, texture and overall liking than formula A. However, there was no significant difference on the color. Therefore, formula B was more preferable than formula A. This might be due to the appropriate quality of ingredients.

Table 4 Sensory characteristics of two different ice cream formulas.

	Sensory characteristics	Formula A	Formula B
Before test	Appearance	7.00±1.08	7.80 ±1.10*
	Color[ns]	7.67±0.84	8.07±0.91
After test	Flavor	7.10±1.16	7.67±0.92*
	Taste	7.07±1.17	7.73±1.17*
	Texture	6.87±1.50	7.97±1.03*
	Overall liking	7.33±0.99	8.03±0.77*

[1]Results of 30 panelists
*Significantly different (p<0.05) at p<0.05 using t-test

Feasibility study of using purple sweet potato flour in fat reduced ice cream mix powder

In case of sensory evaluation, **Table 5** showed that there were no statistically significant differences in color, flavor, taste, texture and overall liking of ice cream with 50, 75 and 100% PSPF replacement while appearance score of ice cream with 75 and 50% PSPF had significant higher score than ice cream with 50% PSPF. However, the overall liking score presented that ice cream with 100% PSPF replacement gained the highest score (7.60) as compared to other mount of PSPF replacing. This might be due to the higher amount of PSPF provides better color, flavor, taste and texture. Moreover, ice cream with 100% PSPF replacement should contains higher level of phenolic compounds and anthocyanins and results in powerful antioxidant activity. Therefore, 100% PSPF could be used to replace NDC for fat reduced purple ice cream mic powder production.

Table 5 Sensory characteristics of fat reduced ice cream prepared at different levels of purple sweet potato flour (PSPF)[1,2,3].

	Sensory characteristics	PSPF (%)		
		50	75	100
Before test	Appearance	6.77±1.17[b]	7.30±0.92[a]	7.60±0.93[a]
	Color	7.33±3.37[a]	7.10±1.27[a]	7.80±1.00[a]
After test	Flavor	7.03±1.38[a]	7.23±1.22[a]	7.40±1.16[a]
	Taste	7.33±3.18[a]	7.07±1.53[a]	7.30±1.34[a]
	Texture	7.83±2.41[a]	7.27±1.28[a]	7.27±1.20[a]
	Overall liking	7.40±2.90[a]	7.30±1.32[a]	7.60±1.22[a]

[1]All data were represented as mean±SD. [2]Different letters in same row indicate significant difference at p<0.05 using one way ANOVA followed by Duncan multiple range test. [3]9-points hedonic scale (1=Dislike extremely, 5=Neither Like nor Dislike, 9=Like Extremely.

Physical properties of fat reduced PSPF ice cream mix powder and its ice cream

Three different levels (50, 75 and 100%) of PSPF were used to replace NDC in fat reduced PSP ice cream mix powder. The physical properties of fat reduced PSP ice cream mix powders and theirs ice cream are shown in **Table 6**. There were no significant differences on solubility and water activity between the ice cream mix powder samples with three different levels of PSPF. However, the solubility of fat reduced PSP ice cream mix powder seemed to be decreased with the increase of PSPF level, possibly due to the higher protein content. The water activity of fat reduced PSP ice cream mix powders were in line with the standard of Thai regulation. The color of fat reduced PSP ice cream mix powders was purple which comes from the natural PSP pigment such as anthocyanins. Color of fat reduced PSP ice cream mix powder showed significant difference in brightness (L^*), redness (a^*) and yellowness (b^*) values (p<0.05). Increasing the content of PSPF increased a^* values of fat reduced PSP ice cream mix powder. The highest redness value was observed in fat reduced PSP ice cream mix powders with 100% PSPF replacement. Moreover, ice cream samples were made from fat reduced PSP ice cream mix powders to analyses on viscosity, overrun, melting rate and hardness. The results presented that the viscosity increased with the increase of PSPF level. This might be due to the increase of protein content of the ice cream. The overrun of ice cream decreased with the increase of PSPF replacement. The overrun depends upon the fat, milk-solids-non-fat and solid content of the ice cream mix. An elevated fat content can enable a higher overrun, as more coalesced fat droplets are available to trap a greater amount of air bubbles in the ice cream (Abd El-Rahman et al. 1997). A change in the emulsification capability of milk proteins such as the amphiphilic property can alter their interactions with other components at the air cell interfaces of ice cream, resulting in different overrun values (Barfod et al. 1991; Schmidt, 2004). The differences in the soluble non-starch polysaccharide, protein and/or sugar contents of PSPF would be responsible for the detected overrun values. An extremely low overrun indicates little air has been included, causing an excessively cold sensation in the mouth and lack of creaminess and smoothness. If overrun was too high, the ice cream would be frothy. Many factors such as mix ingredients, the consistency coefficient of mix, the amount of air incorporated, volume and nature of the ice crystals and the network of fat globules were reported to affect the melting characteristics (Akalin et al. 2008; Guinard et al. 1996; Muse & Hartel, 2004; Roland et al. 1999). As depicted in **Table 6**, the increasing of PSPF replacement resulted in slower melting rate. Meltdown of ice cream includes heat and mass transfer phenomena in which water has higher thermal conductivity than fat (Soukoulis et al. 2008). Also, solid fat particles enhance the matrix viscosity, and hence reduce the rate of meltdown (Clarke, 2004). For the texture of ice cream, fat reduced ice cream with 75 and 100% PSP was significantly harder than 50% PSP. This was consistent with the results acquired by Guinard et al. (1997) who reported that the hardness of the ice cream texture is inversely correlated with the fat content and since the rise in the fat content reduces the ice crystals volume, the increase of the ice crystals could probably lead to a harder texture.

Table 6 Physical properties of fat reduced purple sweet potato flour ice cream mix powder and its ice cream at different levels of PSPF[1,2].

Physical properties	PSPF (%)		
	50	75	100
Solubility (%)#	94.98±5.77[a]	90.85±0.18[a]	86.61±5.72[a]
Water activity#	0.33±0.00[a]	0.32±0.00[a]	0.33±0.01[a]
Color#			
L*	55.41±0.01[a]	52.94±0.12[b]	51.56±0.01[c]
a*	4.54±0.07[c]	4.78±0.01[b]	5.42±0.07[a]
b*	0.32±0.02[a]	0.02±0.11[b]	-1.06±0.02[c]
Viscosity (CPS)$	6.96×10^3±227.16 [c]	12.76×10^3±52.92[b]	13.76×10^3±208.17[a]
Overrun (%)$	28.89±00[a]	24.44±00[b]	20.74±3.39[c]
Melting rate (g/min)$	74.22±4.99[a]	52.09±8.04[b]	7.35±0.85[c]
Hardness (g)$	27019±37423[b]	38089±5272[a]	40956±4884[a]

[1]All data were represented as mean±SD. [2]Different letters in same row indicate significant difference at $p<0.05$ using one way ANOVA followed by Duncan multiple range test. # the analysis was done using ice cream mix powder. $the analysis was done using ice cream prepared from their ice cream mix powder.

Nutritional values, total phenolic contents, antioxidant activities and total anthocyanins in fat reduced purple sweet potato ice cream mix powder.

Table 7 presented that calorie and fat content in the ice cream prepared from fat reduced PSP ice cream mix with 100% PSPF was decreased by 7 and 32.38%, respective, while the carbohydrate content was increased by 9% when compared with the control formula. This could be due to the replacement of NDC with PSPF. However, protein, dietary fiber, moisture content and ash were not significant different between these two formulas. According to the Thai FDA regulation on nutrition labelling, it was reported that the food contains at least 25% less fat than in the same amount of reference food could be claimed as fat reduced. Therefore, the developed ice cream mix powder could be claimed as fat reduced PSP ice cream mix powder.

Table 7 Nutritional values of fat reduced purple sweet potato ice cream mix powder and the control formula[1].

Nutritional values	Ice cream mix powder formula	
	Control	PSPF
Energy (kcal/100g)	456.16±1.60*	421.90±2.34
Moisture (%)	2.92±0.20	3.64±0.22*
Protein (g/100g)[ns]	14.96±0.84	16.02±0.77
Total fat (g/100g)	15.57±0.40*	10.46±0.24
Total carbohydrate (g/100g)	62.13±0.23	67.81±0.32*
Ash (g/100g)[ns]	2.39±0.16	2.21±0.18
Dietary fiber (g/100g)[ns]	3.68±0.16	3.70±0.24

[1]Results of 30 panelists
*Significantly different ($p<0.05$) at $p<0.05$ using t-test

PSPF contained high amount of total phenolic contents, antioxidant activities and total anthocyanins (**Table 3**). Therefore, fat reduced PSP ice cream mix powder had significantly higher amount of total phenolic contents, antioxidant activities and total anthocyanins than the control formula (**Table 8**).These data suggested that total phenolic contents and total anthocyanins were positively correlated with antioxidant activities which were found in many plants (Ghasemzadeh et al. 2010). Moreover, the processing appears to increase antioxidant activity. Therefore, the development of fat reduced sugar PSP ice cream mix powder, which contains bioactive compound from PSP, might be a starting point of healthy food choice for general people.

Table 8 Total phenolic contents, antioxidant activities and total anthocyanins of fat reduced purple sweet potato ice cream mix powder and the control formula.

Ice cream mix powder formula	Total phenolic contents (mg GAE/g DW)	Antioxidant activities			Total anthocyanins (mg cy-3-glue/ L)
		DPPH radical scavenging assay (umol TE/100g DW)	FRAP assay (umol TE/g DW)	ORAC assay (umol TE/g DW)	
Control	2.19 ± 0.12	0.08 ± 0.01	0.41 ± 0.04	31.63±1.65	ND
PSPF	2.37 ± 0.13*	0.68 ± 0.07*	5.09 ± 0.51*	87.06±7.77*	18.60±1.50

[1]All data were represented as mean±SD.
*Significantly different ($p<0.05$) at $p<0.05$ using t-test

Conclusions

PSPF was a good source of carbohydrate and dietary fiber. Moreover, PSPF showed a deep intense purple color with high total anthocyanins, total phenolic contents, and antioxidant activities. Application of PSPF in ice cream mix powder, it is possible to replace NDC with 100% PSPF for fat reduced PSP ice cream mix powder production. The developed ice cream has retained much of the natural color as well as total phenolic contents, antioxidant activities and total anthocyanins. Therefore, this knowledge could be used for improving the nutritional attributes of ice cream and also for other health food products.

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