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ARTICLE

Physical and Sensory Properties of Ice Cream Containing Fermented Pepper Powder

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Abstract

This study was conducted to investigate the physical and sensory properties of ice cream containing fermented pepper powder. Three ice cream formulas were manufactured: 1, control; 2, supplemented with 0.1% fermented pepper powder; and 3, supplemented with 0.2% fermented pepper powder. Formulas 2 and 3 had significantly higher viscosity and lower overrun than formula 1 ($p<0.05$). Additionally, ice creams supplemented with fermented pepper powder were harder and maintained their forms longer than the controls. 0.2% fermented pepper powder added ice cream had no pungency as much as that of control and overall sensory attribute was not significantly different from control. Therefore, ice cream containing fermented pepper powder maintained physical and sensory properties similar to the controls, and maintenance was better. It means fermented pepper powder ice cream can be utilized as the material of functional food (dessert).

Keywords fermented pepper, ice cream, unpungent pepper, sensory analysis, functional dessert

Introduction

Ice cream is a frozen dairy food made by freezing pasteurized mix composed of cream, egg yolk, sugar, milk and other materials (Arbuckle, 1986). It has high amounts of fat and sugar, and this can cause harmful effects on blood sugar or lipid metabolism (Her *et al*., 2005a). When consumed excessively, ice cream can result in lifestyle-related diseases such as diabetes or obesity because of the abrupt increase of blood sugar (Her *et al*., 2005a; Her *et al*., 2005b). Consequently, ice cream is not recommended as a dessert for children as well as for diabetic or obesity patients (Kim, 2005). However, ice cream is a favorite dessert for men and women of all ages (Her *et al*., 2005a; Ko *et al*., 2014). As a result, many studies have investigated the use of alternative sweeteners in ice cream, such as oligosaccharides and sorbitol instead of sugar (Her *et al*., 2005a; Her *et al*., 2005b). Oligosaccharide is a non-digestible saccharide composed of 3 to 10 monosaccharides (Shin *et al*., 2000). It increases bifidobacteria in the colon (Ballongue *et al*., 1997) and changes the composition and metabolism of colonic microflora (Gibson and Roberfroid, 1995). Meanwhile, research on health functional foods have increased due to increasing consumer interest in wellbeing. For example, in case of ice cream, Her *et al*. (2005a) reported on the feasibility of oligosaccharide-supple-

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mented soy ice cream for diabetic patients while Kim *et al*. (2004) investigated citron added ice cream. Tarak, Korean traditional fermented milk, has also been used to produce ice cream (Ko *et al*., 2014). In addition, Prapasuwannakul *et al*. (2014) published a study on the use of green coconut pulp for cream, milk, stabilizers, and emulsifier replacers in ice cream. In this study, ice cream contains fermented pepper powder which has degraded capsaicin.

Pepper is cultivated in Korea, Japan, and America as well as Europ, and contains a lot of nutritional materials such as vitamin, carotenoid and capsaicinoid. Capsaicin (8-methyl-*N*-vanillyl-6-nonenamide) is the active component in pepper (*Capsicum* spp.) and has anti-obesity and anti-oxidant effects (Chen *et al*., 2014; Iwai and Watanabe, 1999; Luo *et al*., 2011; Yeon *et al*., 2013). However, it is highly pungent, which prevents the food industry from using capsaicin as a food additive (Kim *et al*., 2011; Yeon *et al*., 2013).

Meanwhile, *Bacillus licheniformis* SK1230 is capsaicin degrading microorganism (Yeon *et al*., 2013), and it can be isolated from Korean traditional pickled pepper (Cho *et al*., 2014). Therefore, it suggested that *Bacillus licheniformis* SK1230 is safe to apply the food products. In our previous study, we fermented pepper using *Bacillus licheniformis* SK1230 to decrease the pungency (Kim *et al*., 2011; Yeon *et al*., 2013). The pungency could be adjusted according to the duration of fermentation. In addition, pepper fermented with *Bacillus licheniformis* showed an inhibitory effect on body fat accumulation in mice fed a high fat diet (Yeon *et al*., 2013). Furthermore, yogurt containing fermented pepper juice has decreasing effect on the body fat and cholesterol level in high fat and high cholesterol diet fed rat (Yeon *et al*., 2015).

In this study, ice cream containing fermented pepper powder was manufactured and the physical and sensory attributes were assessed to investigate the possibility of development about functional dessert.

Material and Methods

Materials

Chungyang pepper purchased from a local market (Korea) was ground in a juicer and freeze dried. Powdered pepper concentration in medium for fermentation was determined by preparatory experiments. When the powdered pepper concentration was higher than 4%, it was too thick to incubate with shaking. Accordingly, 40 g of this powder was fermented with *Bacillus licheniformis* SK1230 in 1 L of Bacillus minimum medium (NaCl 1 g/L, Na_2HPO_4 9.52 g/L, KH_2PO_4 6 g/L, NH_4Cl 2 g/L, $MgSO_4$ 0.48 g/L, $CaCl_2$ 0.02 g/L) at 37°C for 28 d to reduce the pungency, and then freeze dried. This powder was used as fermented pepper powder in this study.

To prepare the ice cream, skim milk powder (Maeil skim milk powder, Maeil, Korea), cream (Hopla, Cooperlat, Italy), milk (Maeil milk low fat & high calcium, Maeil, Korea), fracto-oligosaccharide (Beksul oligosaccharide, CJ, Korea), sugar (white sugar, Samyangsa, Korea), egg yolk, vanilla essence and gelatin (Leaf gelatin, DGF STOESS AG, Germany) were purchased from a local market (Korea).

Ice cream preparation

Three formulations of ice cream were manufactured in this study: 1, control ice cream with oligosaccharide; 2, oligosaccharide ice cream with 0.1% fermented pepper powder; and 3, oligosaccharide ice cream with 0.2% fermented pepper powder. Ice cream was prepared by modifying Kim *et al*. (2004) and Her *et al*. (2005a)'s methods. Skim milk powder, cream, milk, egg yolk, vanilla essence, and oligosaccharide were homogenized in a bowl (X-10 30D, JEIO TECH, Germany). Heat treatment was applied at 85°C for 2 min, and gelatin was added after cooling to 65°C. The mixture was then aged at 4°C for 20 h. The ice cream mix was frozen in an ice cream maker (PRO3000, NEMOX, Italy) for 17 min. Fermented pepper powder was added to the ice cream mix before heat treatment.

Physical analysis

The viscosity of the ice cream mix aged for 20 h was measured using a rotational viscometer (LVDVE230, Brookfield, USA) with spindle LV-4 (64) at 3 rpm. During measuring, all samples were in the cold water to prevent the change of temperature.

Overrun was calculated with the following equation (Ioanna *et al*., 2004).

$$overrun(\%) = \frac{W1 - W2}{W2} \times 100$$

where W1 = weight of the constant ice cream mix volume and W2 = weight of the same volume of ice cream.

The hardness of the ice cream was measured using a texture analyzer (CT3-10KG, Brookfield, USA) with a 6 mm stainless steel cylinder probe (TA-BT-kit, Brookfield, USA). The speed was 1.0 mm/s, the target value was 1.5

Table 1. Ingredients for 3 different ice cream mixes

Groups	1		2		3	
Ingredients	g	%	g	%	g	%
Fermented pepper powder	-	-	0.60	0.10	1.20	0.20
Skim milk powder	50.00	8.54	50.00	8.53	50.00	8.52
Cream	60.00	10.24	60.00	10.23	60.00	10.22
Oligosaccharide	70.50	12.04	70.50	12.02	70.50	12.01
Milk	385.00	65.73	385.00	65.67	385.00	65.60
Gelatin	2.00	0.34	2.00	0.34	2.00	0.34
Egg york	17.00	2.90	17.00	2.90	17.00	2.90
Vanilla essence	1.20	0.20	1.20	0.20	1.20	0.20
Total	585.70	100.00	586.90	100.00	586.90	100.00

mm, and the trigger load was 5 g.

Melting rate was determined by measuring the weight of the melting ice cream at 25°C. Thirty gram of ice cream was placed on a mesh attached to a cylinder, and the ice cream that dripped through the cylinder was weighed.

The color of the manufactured ice cream was measured using a colorimeter (CR-400, Konica Minolta, Japan).

Sensory properties

The sensory properties of the ice cream such as aroma, melting, hardness, smoothness, iciness, pungency, and the overall properties were analyzed by 8 panelists. All samples were presented in a plastic cup. Pungency was evaluated by the degree of intensity, and the other properties were assessed hedonically on a scale of 1, for very poor and weak, to 5, for very excellent and strong.

Statistical analysis

All experiments was conducted three times, and all data was expressed as mean standard deviation. Data was analyzed using the SPSS program, and statistical significance was determined by analysis of variance (ANOVA) with Tukey's multiple range test ($p<0.05$).

Results and Discussion

Viscosity

The viscosities of the ice cream mixes are shown in Table 1. Formulas 2 and 3 showed significantly higher viscosity than formula 1 ($p<0.05$) but there is no significant difference between two fermented pepper powder ice creams ($p>0.05$). Mucilage is produced during fermentation and the substance becomes sticky. When the pepper was fermented, mucilage also produced. The high viscosity of formulas 2 and 3 might be resulted from this mucilage.

Table 2. Viscosity of mix and overrun

Group	1[2)]	2[3)]	3[4)]
Viscosity (cP[1)])	4966.7±233.81[b]	7666.7±900.37[a]	6960±433.59[a]
Overrun (%)	20.3±1.13[a]	13.0±0.99[b]	14.8±0.18[b]

cP[1)], Centi-poise; 1[2)], Basic ice cream with oligosaccharide; 2[3)], Oligosaccharide ice cream with 0.1% fermented Chungyang pepper powder; 3[4)], Oligosaccharide ice cream with 0.2% fermented Chungyang pepper powder.

[a,b]superscripts with different letters are significantly different ($p<0.05$). * all values are mean±S.D. for three samples.

Overrun

The calculated overrun is shown in Table 2. As opposed to the results for viscosity, higher additive content ice cream resulted in more overrun ($p>0.05$), and the ice creams containing fermented pepper powder had significantly less overrun than the general ice cream ($p<0.05$). This might be related to viscosity; if the viscosity of the mix is high, less air enters the ice cream during the manufacturing process (Prapasuwannakul *et al*., 2014). Consequently, formulas 2 and 3, which have high viscosities, would have less overrun ($p<0.05$).

Hardness

The hardness measurement results for the 3 ice creams were the reverse of the overrun results (Fig. 1). Even though there is no significant difference, an additive-dose dependent decrease was observed ($p>0.05$). Muse and Hartel (2004) reported that ice cream with high overrun tends to be soft, and the inverse relationship between hardness and overrun exist (Goff *et al*., 1995; Tanaka *et al*., 1972; Wilbey *et al*., 1998). In this study, this inverse relationship between hardness and overrun could be identified, too. Moreover, numerous factors such as fat network, ice phase volume, ice crystal content and ice crystal size influence hardness (Sakurai *et al*., 1996; Wilbey *et*

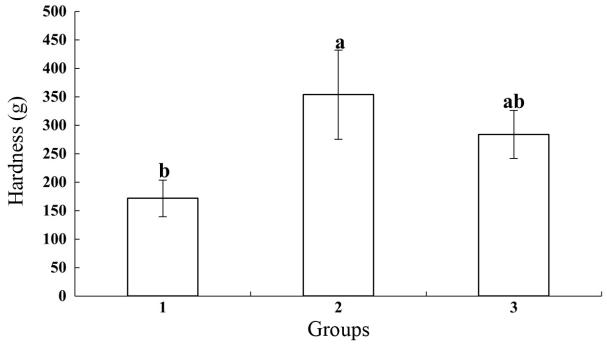

Fig. 1. Hardness for 3 manufactured ice creams (g). 1, Basic ice cream with oligosaccharide; 2, Oligosaccharide ice cream with 0.1% fermented Chungyang pepper powder; 3, Oligosaccharide ice cream with 0.2% fermanted Chungyang pepper powder. [a,b]superscripts with different letters are significantly different (p<0.05). * all values are mean±S.D. for three samples.

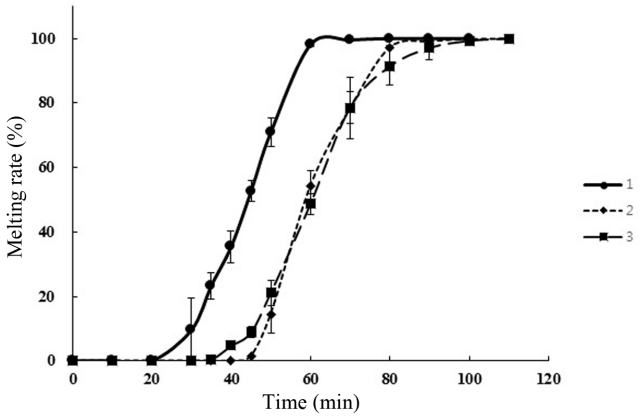

Fig. 2. Melting rate measurement for 3 different ice creams formulas (%). 1, Basic ice cream with oligosaccharide; 2, Oligosaccharide ice cream with 0.1% fermented Chungyang pepper powder; 3, Oligosaccharide ice cream with 0.2% fermented Chungyang pepper powder. * all values are mean±S.D. for three samples.

Table 3. Color measurement for 3 different ice creams

Group	1[4)]	2[5)]	3[6)]
L[1)]	87.2±0.21[a]	86.2±0.10[b]	79.8±0.33[c]
a[2)]	-3.6±0.02[b]	-3.1±0.01[a]	-3.1±0.02[a]
b[3)]	15.4±0.13[c]	16.3±0.06[b]	17.7±0.11[a]

L[1)], Brightness; a[2)], Redness; b[3)], Yellowness; 1[4)], Basic ice cream with oligosaccharide; 2[5)], Oligosaccharide ice cream with 0.1% fermented Chungyang pepper powder; 3[6)], Oligosaccharide ice cream with 0.2% fermented Chungyang pepper powder.
[a-c]superscripts with different letters are significantly different (p< 0.05). * all values are mean±S.D. for three samples.

al., 1998).

Color

The color measurement data is presented in Table 3. The brightness was decreased by increase of addition amount of fermented pepper powder (p<0.05). Fermented pepper powder appears light brown in color. Hence, formulas 2 and 3 expressed significantly higher redness and yellowness comparing to control (p<0.05).

Melting down rate

The melting rate is shown in Fig. 2. Ko *et al*. (2014) reported that the melting rate is related to air content, fat size, ice crystal size, etc. In addition, Muse and Hartel (2004) mentioned the fat network plays a key role in determining the melting rate of ice cream. According to Prapasuwannakul *et al*. (2014), melting rate may be related to viscosity, hardness, and overrun. Formulas 2 and 3 maintained their appearance much longer than formula 1 at room temperature. Sofjan and Hartel (2004) reported that lower overrun ice cream melted more rapidly. In this study, the high viscosity of formulas 2 and 3, even if it have lower overrun than control, may have been responsible for their longer form retention, as sticky mucilage from the fermented pepper powder may play a role in maintaining the ice cream form.

Sensory analysis

Fig. 3 expresses the sensory attributes for the 3 kinds of ice creams. Even though there was no significant difference, Formula 3 had the strongest pungency because of remaining capsaicin in fermented pepper powder. According to the previous study, if the fermentation time was longer, this pungency could be decreased more (Yeon *et al*., 2013). With regard to aroma and melting, formula 2 scored highest among 3 groups and showed no significant difference from control (p>0.05). Moreover, there were no significant differences among the 3 formulas (p>0.05) in smoothness, iciness and overall properties. Therefore, in sensory properties, ice cream containing fermented pepper powder demonstrated similarity to the control formula, especially 0.1% supplemented fermented pepper ice cream does with lower pungency.

Conclusion

Ice cream containing fermented pepper powder maintained physical and sensory properties similar to the controls, and maintenance was better. It means fermented pepper powder ice cream can be utilized as the material

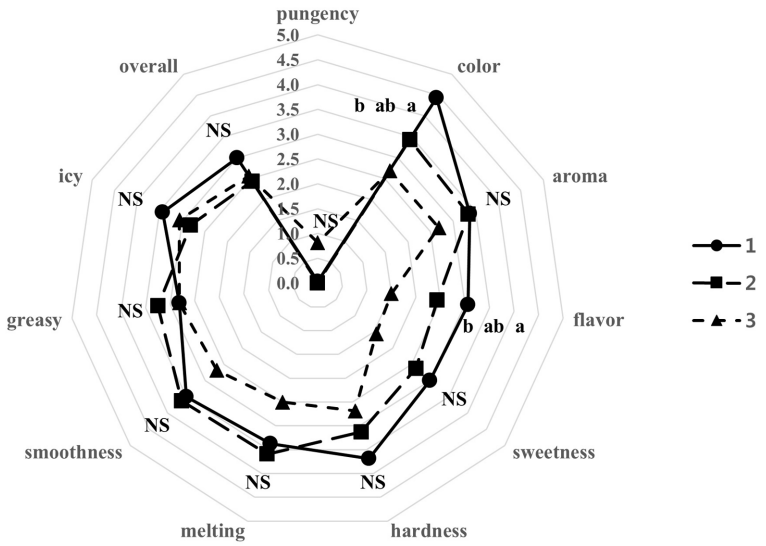

Fig. 3. Sensory attributes for 3 differently manufactured ice creams. 1, Basic ice cream with oligosaccharide; 2, Oligosaccharide ice cream with 0.1% fermented Chungyang pepper powder; 3, Oligosaccharide ice cream with 0.2% fermented Chungyang pepper powder. [a,b]superscripts with different letters are significantly different (p<0.05). [NS]not significant.

of functional food. Therefore, it suggested that fermented pepper powder may have very important roles to produce better qualities of ice cream in physical and sensory areas. Further studies are needed to determine the functional effects of ice cream containing fermented pepper powder such as its anti-obesity.

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