Full Length Article

Quality Evaluation of Orange Peel (Flavedo) incorporated Ice Cream

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ABSTRACT

By-products of fruits possess antioxidant polyphenols, anti-mutagenic, cardio preventive and antiviral activities. The consumers are aware of the health benefits of nutraceutical foods and the demand for such foods is increasing in recent years. Orange peels are rich in flavanones, powerful antioxidants that help to reduce oxidative damage and fight free radicals. Hence, an attempt was made to develop a value added ice cream with orange peel. Orange peel powder was incorporated in ice cream at varying levels viz. 1.5, 2.5, 3.5 and 5 per cent. Based on texture, sensory attributes and physio-chemical properties, sensory evaluation of the product revealed that incorporation of orange peel powder at 2.5% level found to be acceptable.

Key Words: Ice cream - Orange peel – Flavour - Sensory attributes.

INTRODUCTION

Ice cream is a delicious, wholesome, nutritious, frozen dairy food consumed around the world and relished by all age groups. A typical composition range for the components used in ice cream mix is milk fat 10-16%, milk solids not fat 9-12%, corn syrup solids 4-6%, stabilizers/emulsifiers 0.5%, total solids 36-45% and water 55-64% (Goff, 1997). Flavour and stabilizer usually used are of synthetic origin and this can be partly replaced by orange peel which is a waste by product in juice industry as orange peel has a higher level of vitamin C than the pulp and also contribute cellulosic material , essential oils, paraffin waxes, steroids and triterpenoids, fatty acids, pectin pigments besides flavour.

Orange constitutes about 60 per cent of the total citrus production (Lucia and Calogera, 2008). Peel represents between 50 and 65 per cent of total weight of the fruits and was the primary by-product (Ashbell and Donahaye, 1984).

According to Soukoulis *et al.* (2009), the quality of ice cream was influenced by several sensory attributes viz. flavour, texture, melting quality, package, and appearance. These attributes also affect the consumer preference for different variants of ice cream.

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Ice cream was a well-known dessert among all ages in many countries. Warke *et al.* (2000) stated that ice cream was one of the major products in the dairy industry and continues to dominate attention of a large segment of the population. Its mixture was made of dairy products (e.g. whole milk, condensed milk, milk powder, cream), sweeteners (sugar, glucose), stabilizers, emulsifiers and colourings. Ice cream could also serve as a topping, add-on or mix-in for other desserts.

Considering the above facts, an attempt has been made to develop an innovative ice cream utilizing the orange peel which contains good flavour and health benefits.

MATERIALS AND METHODS

Preparation of ice cream

The quantity of milk, cream, skim milk powder, sucrose, sodium alginate and GMS required for a batch (i.e. 6 kg of ice cream mix) was calculated by serum point method (Marshall *et al*., 2003). The composition of the experimental mixes were 6.0 % fat, 11.5 % MSNF, 14.0 % sucrose, 0.1 % sodium alginate and 0.2 % GMS. The composition of control was 10% fat, 11% MSNF, 15% sucrose, 0.25% sodium alginate and 0.15% GMS. The calculated quantities of liquid ingredients viz. whole milk and cream for each treatment were weighed, mixed and blended thoroughly in a stainless steel vessel for ice cream preparation.

The prepared ice cream mix was homogenized at 2500psi (I stage) & 500psi (II stage), then pasteurised at 72º C for 30 min and cooled to room temperature and kept for ageing at 4º C. Just before freezing, dried orange peel powder at 2.5% was added to the mix. The frozen ice cream was dispensed to cups and stored at -25º C for further studies.

Orange peel was dried in a fluidized bed dryer with below 60ºC temperature for 50-55 min, powdered in a mixer sieved in 40 size mesh sieve was used for incorporation in ice cream. Organoleptical evaluation of the peels revealed that orange peel dried by the fluidized bed dryer was preferred over hot air oven for incorporation in ice cream.

Physico-chemical and sensory evaluation of ice cream and ice cream mixes

Ice cream samples viz. control, T_1, T_2, T_3 and T_4 were evaluated for physiochemical and sensory characteristics. Protein, total solids, pH and acidity were calculated according to AOAC (1990). Gerber's method (Davide, 1977) was used for fat estimation. The total solids of the ice cream were determined by the standard procedure as described for milk using 2 g of sample (ISI Standards).

The titratable acidity of the ice cream was determined by the standard method suggested in ISI Handbook of Food Analysis (1989). The pH of the ice cream mixes was determined at 25°C using a Systronic digital pH meter, Model 335, Systronic Ltd., Ahmedabad, India. The protein content of the ice cream mixes was determined by Kjeldahl method (Menefee and Overman, 1940).

Ice cream samples were organoleptically evaluated for appearance,

taste, flavour, body & texture, and overall acceptability, following the 9-point hedonic scale (Larmond, 1977).

The results obtained were statistically analysed by applying one way ANOVA in IBM SPSS (US) software (version 20) as per the Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The sensory analysis revealed that the flavour differ between the ice cream samples (Table 1). The ice cream flavour and aftertaste scores were negatively affected by addition of orange peel powder, which was also evidenced by the low scores of these attributes by Karaca *et al*. 2009. The acceptance mean values of the colour of the orange peel incorporated ice creams were higher when compared to that of the control ice cream. The decrease in taste might be due to the increase in addition of orange peel powder contributed by the higher fibre content in the orange peel as per Gorinstein *et al.* (2001). The contents of total, soluble and insoluble dietary fibre in peels were significantly higher than in peeled fruits ($P< 0.05$ in all cases).

Table – 1. Sensory evaluation of Ice cream using 9-point hedonic scale@

Sensory attributes	Control (C)	T_1	T_2	T_3	T_4	F- value
Colour & Appearance	7.04^{e}± 0.05	7.2^{d}± 0.06	7.35^{c}± 0.16	7.38^{b}± 0.17	7.4^{a}± 0.12	45.213**
Taste	6.5^{e}± 0.04	7.29^{d}± 0.14	7.92^{a}± 0.12	7.54^{b}± 0.05	7.31^{c}± 0.14	68.102**
Flavour	6.8^{e}± 0.07	7.32^{c}± 0.10	8.24^{a}± 0.18	7.45^{b}± 0.14	7.24^{d}± 0.17	54.923**
Body & Texture	7.10± 0.03	7.12± 0.21	7.16± 0.14	7.18± 0.15	7.25± 0.45	62.357^{NS}
Overall acceptability	6.88^{e}± 0.02	7.23^{d}± 0.14	7.66^{a}± 0.19	7.38^{b}± 0.14	7.30^{c}± 0.12	69.314**

@Average of six trials

Mean with different superscripts within a same row differ significantly from each other (P<0.01)

NS – Non significant (P > 0.05)

** Highly significant (P < 0.01)

T_1- Ice cream incorporated with 1.5% orange peel

T_2- Ice cream incorporated with 2.5% orange peel

T_3- Ice cream incorporated with 3.5% orange peel

T_4- Ice cream incorporated with 5% orange peel

Regarding the scores for overall acceptability, (T_2) 2.5% incorporation was found to be best as compared to other treatments because as the percentage of incorporation increase the flavour and taste scores decreased due to the increase in addition of orange peel contributed by the higher fibre content in the orange peel as per Gorinstein *et al.* (2001) and hence, T_2 was considered to be the optimum level of addition of orange peel in preparation of orange ice cream. The flavour, taste and overall acceptability were found to score higher for T_2 among others in consumer panel on evaluation using 9 point hedonic scale.

Table – 2. Physico-chemical properties of ice cream@

Attributes	Control (C)	T_1	T_2	T_3	T_4	F - value
Fat (%)	10.23^{e}± 0.12	11.54^{d}± 0.14	11.63^{c}± 0.23	12.02^{b}± 0.20	12.41^{a}± 0.16	7.123^{NS}
Protein (%)	4.73^{b}± 0.32	4.52^{e}± 0.21	4.61^{d}± 0.20	4.72^{c}± 0.12	4.89^{a}± 0.11	2.872^{NS}
Total solids (%)	38.77^{e}± 0.13	40.21^{d}± 0.20	42.65^{c}± 0.22	43.87^{b}± 0.21	44.36^{a}± 0.30	17.932**
Acidity (% LA)	0.12^{e}± 0.01	0.15^{d}± 0.02	0.18^{c}± 0.03	0.21^{b}± 0.03	0.24^{a}± 0.04	12.865^{NS}
pH	6.2^{a}± 0.13	6.1^{b}± 0.11	6.0^{c}± 0.12	5.9^{d}± 0.14	5.7^{e}± 0.15	32.321^{NS}

@Average of six trials
Mean with different superscripts within a same row differ significantly from each other (P<0.01)
NS – Non significant (P > 0.05)
** Highly significant (P < 0.01)

The average compositional values, acidity and pH of control as well as experimental samples (T_1, T_2, T_3 and T_4) are presented in Table 2. There was an increase in the total solids content of the mix with an increase in level of orange peel addition which is from 40.21 in T_1 to 44.36 in T_4. Citrus peel is rich in nutritional ingredients such as soluble sugars (46.241±0.015 g/100g d.b), proteins (8.120±0.120 g/100g d.b) and minerals (3.170±0.035 g/100g d.b) that tends to increase the total solids (M'hiri *et al*., 2015).

Incorporation of orange flavedo at different levels also tend to increase the fat content. These findings also correlate the findings of Hanan *et al.* (2012). All the experimental samples had no significant difference in protein content compared to the control. Incorporation of orange flavedo at higher levels tend to increase the acidity and decrease pH of mixes significantly (P<0.05). Similar observations were also reported by Desai *et al.* (2010), while studying the effect of malted ragi flour in cake preparation. There was a decrease in pH and increase in titratable acidity as the quantity of orange peel increased due to its ascorbic acid content. Savita *et al.* (2010) revealed that the ascorbic acid content in fresh peel was 82.45mg/ 100 g. Ice cream productions can be made at acidity 0.7% lactic acid with no loss of ice cream quality. Higher levels than 0.7% lactic acid contribute to progressive loss of sensory quality and hence lower stability with increase in acidity as the higher inclusion levels.

The results obtained in this study were similar to the findings of Nasser *et al.* (2008) and Magda *et al.* (2008) revealed that crude fibre and carbohydrate increased as the inclusion level of orange peel increased. Our findings also correlated with the

findings of Hanan *et al.* (2012) who found that incorporation of 10 per cent citrus peel powder in wheat biscuits increased crude protein, crude fat content as well as crude fibre, moisture and calorie value. The total citrus solid extract was characterized by a low fat content (0.48 to 4.00 g/100 g d.b) (Kammoun *et al.,* 2011; Ghanem *et al.*, 2012; Marin *et al.*, 2007).

Table – 3. summarizes the results of textural analysis of ice cream viz. hardness, adhesiveness, springiness, cohesiveness, and gumminess. @

Textural Attributes	Control (C)	T_1	T_2	T_3	T_4	F - value
Hardness (g)	$1528.33^{a}\pm 0.81$	$1625.21^{e}\pm 0.42$	$1726.84^{d}\pm 0.52$	$1842.14^{c}\pm 0.61$	$1934.78^{b}\pm 0.72$	675.986**
Adhesiveness (g)	$-258.96^{e} \pm 0.14$	$-286.58^{d}\pm 0.23$	$-309.66^{c}\pm 0.35$	$-324.12^{b}\pm 0.30$	$-352.54^{a}\pm 0.39$	78.931^{NS}
Springiness (g)	$0.1277^{e}\pm 0.02$	$0.1364^{d}\pm 0.01$	$0.2789^{c}\pm 0.01$	$0.3256^{b}\pm 0.02$	$0.4256^{a}\pm 0.01$	3.452**
Cohesiveness (g)	$0.1078^{e}\pm 0.01$	$0.1123^{d}\pm 0.01$	$0.1168^{c}\pm 0.02$	$0.1134^{b}\pm 0.02$	$0.1756^{a}\pm 0.03$	4.879^{NS}
Gumminess (g)	$563.00^{e}\pm 0.22$	$613.12^{d}\pm 0.36$	$647.84^{c}\pm 0.22$	$715.21^{b}\pm 0.31$	$729.53^{a}\pm 0.42$	58.730**

@Average of six trials
Mean with different superscripts within a same row differ significantly from each other (P<0.01)
NS – Non significant (P > 0.05)
** Highly significant (P < 0.01)

The lowest hardness values were observed in the control ice cream. In the ice cream samples with ($p \leq 1.0$) of fibre significantly differ from ($p \leq 0.05$) the control ice cream. The addition of greater amount of orange peel powder as a fat replacer significantly increased the hardness of ice cream ($p \leq 0.05$). The effect of fat content on hardness of ice cream was evaluated by Roland *et al.* (1999) and Rossa *et al.* (2012), who opined that the hardness was inversely proportional to the fat content.

The adhesiveness values of control ice cream (Table 3) were not significantly different ($p \leq 0.05$) from those of most fat reduction in ice cream with added orange fibre. These results were not in agreement with those findings of Aime *et al.* (2001) and Prindiville *et al.* (1999), who found that low fat ice cream had the lowest adhesiveness.

The ice cream with 5% orange peel powder showed higher springiness values than those of the other samples. However, the ice cream with 1.5 % orange peel powder did not differ significantly from the control. The cohesive values did not differ between different ice creams, indicating that fibre addition did not affect this parameter, which agreed with the results obtained by Hwang *et al.* (2009).

The gumminess of control ice cream were significantly lower ($p \leq 0.05$) than those of the reduced-fat ice creams, but different values were obtained by Prindiville *et al.* (1999).

It was concluded that the ice cream with 2.5 per cent T_2 was found to be the best among all treatments by sensory and textural qualities. By utilizing the orange peel a waste of juice industry could be incorporated in ice cream to enhance the flavour, texture and to enrich the product acceptability by the consumers. T_2 was judged as the best by the overall acceptability scores though there was no significant difference between the scores of body and texture.

The scores diminished gradually which might be due to hard texture of ice cream as the inclusion levels of orange peel increased due to the pectin present in orange peel.

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