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ICE CREAM AND SHERBETS MADE WITH PURPLE AND ORANGE CACTUS PEAR PULP: CHEMICAL AND SENSORY ANALYSIS

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Abstract: Different levels of cactus pear (purple and orange) pulp were tested in ice creams and dairy-free ice cream (sherbets). The selected formulation was choice according to sensory characteristics and preferences. The ice cream chosen were 25 % and 20 % pulp and the sherbet 40 % and 35 % pulp for orange and purple cactus pears, respectively. The total betalain ranged from 2.97 to 8.21 mg L^{-1} for ice creams and from 6.29 to 18.99 mg L^{-1} for sherbet and the ORAC was 60.2 and 39.5 (μmol Eq Trolox 100 mL^{-1}) for ice cream and 65.3 and 56.6 for sherbet with orange and purple pulp, respectively. The acceptability of the sherbets did not show significant differences between ecotypes, unlike ice cream, where the ice cream with a 25 % addition of orange cactus pear was more acceptable.
Keywords: *Opuntia ficus-indica,* ice cream, sherbet, colored cactus pear fruit.

INTRODUCTION

The consumer tendency for the consumption of ice cream and dairy-free ice cream as sherbets is towards health concerns, i.e. no additives or preservatives, among other factors. New flavored and artisanal products are other purchase drivers in this market (Domblaser, 2015; Barry-Callebaut, 2023). Among the fruits that have increased in attractiveness lately is the cactus pear (*Opuntia ficus-indica*), not only for being a new flavor for a lot of consumers, but because it is a low-water-use plant (Inglese et al., 2017) being therefore, one of the few plants that can face climate change. The attractive color of the cactus pear fruits is due to the presence of betalains: red-purple betacyanins and yellow-orange betaxanthins, both pigments with a good potential as natural food coloring (Sáenz, 2017, Carmona et al., 2020, Vergara et al., 2014), in addition to its antioxidant activity, betalains are considered as bioactive pigments. The fruit has also other bioactive compounds as vitamin C and polyphenols (Robert et al., 2015). Then the colored cactus pear fruit pulp, as other vegetables, as carrots or red-beet, can be considered as "coloring foods" according to the concept introduced by the EU some years ago (EU 2013) where they classify food with colorant properties or coloring foods that may not be declared as a food additives. In this context, colored cactus pear can be used to formulate foods avoiding the use of synthetic colorants. Cactus pear fruit has been tested for some processed products, including sweets, jams, toppings, and juices, also due to its contribution of natural pigments (Carmona et al., 2019; Chahuan et al., 2018; Sáenz, 2017; Azeredo, 2009). Ice cream and sherbet have been studied much less. El-Samahy et al. (2009) in a preliminary study about red cactus pear ice cream shows that the sensory characteristics are adequate when 5-10 % of cactus pear pulp is added to the mixture for the ice cream; orange cactus pear was not included in this study. As far as we know, there isn't any research about cactus pear sherbet. The increase in the consumption of these types of products according to Hosch (2018) is related to climate change, the temperature rise around the globe and the innovation in flavors consumers are looking for, which is in the line with this research. Thus, the aim of this study was to prepare and characterize ice creams and sherbets using colored cactus pear pulp (fruits with orange and purple pulp) and evaluate their acceptability and preference.

MATERIALS AND METHODS

Purple and orange cactus pear fruits (*Opuntia ficus-indica*) were harvested at the Antumapu Experimental Station of the University of Chile, Santiago, Chile.

Whole milk (3 % fat), whole milk cream (25 % fat), sugar and agar-agar were purchased at the local market to prepare the ice cream and

sherbet. The fruit (orange: OCP and purple: PCP) were harvested at commercial maturity state, thorns were removed by sweeping with a soft broom, then the fruits were washed and hand peeled. The cactus pear pulp was obtained in a screw press with a 1 mm screen, packed in polypropylene bags and kept frozen at -20 °C until it was used. Cactus pear pulp ice cream was prepared according to Marshall et al. (2003). Four percentages of cactus pear pulp were selected to formulate the ice cream: 15 %, 20 %, 25 %, and 30 %. To prepare the base mix, the milk and cream were stirred and heated to 90 °C, and then the agar-agar (0.5%) and sugar were added (14%). The base mix was cooled down to 40 °C with constant stirring and when it reached room temperature it was put in an ice-maker (Gelataio Magnum Plus GC4000, SIMAC, Italia) for 40 min, until it formed a semi-solid mix. The ice cream was packed in plastic containers (25 mL) and stored at -18 ºC. Cactus pear pulp sherbet preparation was done according to Di Bartolo (2005) by selecting four cactus pear pulp percentages: 25 %, 30 %, 35 %, and 40 %. The pulp was added to a mix prepared with water, sugar (10%) and agar-agar. First, the water was heated to 90 ºC while adding the agar-agar, until it was totally dissolved and then the sugar and cactus pear pulp were added. The final steps of the process were like those described above for the ice cream.

ANALYSIS OF CACTUS PEAR PULP

Total soluble solids (°Brix), pH and acidity were determined according to AOAC (1996) methods. Color parameters (L*, a*, b*, C* and Hab) were determined with a HunterLab colorimeter (UltrascanPro, USA). Betacyanins and betaxanthins identification were performed by HPLC according to Fernandez-Lopez and Almela (2001) using a modular HPLC Agilent (Agilents Technologies, USA) equipped with a Merk-Hitachi L-6200 pump with Waters 996 photodiode array, coupled to Software Millennium 32. A YMC C18 column (5 µm particle size, 25 cm x 4.6 mm i.d.) was used. Antioxidant capacity was determined by ORAC according to Huang et al. (2002) in a Biotek Fluorimeter FLx800 (BioTek Instruments, Inc., Winooski, VT).

CACTUS PEAR PULP ICE CREAM AND SHERBET

The final mix used for the different formulations of ice cream and sherbet studied, was 76.9 % milk, 8.6 % cream, 14 % sugar and 0.5 % agar-agar for the ice cream and 89.5 % water, 10 % sugar and 0.5 % agar-agar for sherbet.

ANALYSIS OF CACTUS PEAR PULP ICE CREAM AND SHERBET

Analysis like that done on pulp was performed on the ice cream and sherbet. Furthermore, the overrun was calculated according to Goff and Artel (2013).

SENSORY ANALYSIS

A Focus Group composed of five trained judges, defined the quality descriptors according to the Quality Description Analysis (QDA) (Lawless, 2017) for ice cream: color intensity, aroma intensity, crystallinity degree, creaminess, milk taste, cactus pear pulp taste, taste persistence and sweetness. The quality parameters determined for the sherbet were: Color intensity, appearance, aroma intensity, crystallinity degree, cactus pear pulp aroma, smoothness, cactus pear pulp taste, sweetness and sweetness persistence.

ACCEPTABILITY AND PREFERENCE

Acceptability and preference were determined in one session; the samples were delivered in a monadic order, by first delivering the sherbet and then the ice cream, first the yellow-orange pulp products and

then the purple. Sixty consumers, between eighteen and sixty years of age carried out the evaluations.

All assessors were selected and trained respecting all protocols to avoid harm and risks to the participants. All participants received information about the study, and they agreed informed consent to participate.

STATISTICAL ANALYSES

The sessions to evaluate the ice cream and sherbet were done independently by twelve trained judges with a completely randomized design and four samples were evaluated in each session corresponding to the different cactus pear pulp percentages added.

The consumer's acceptability and preference analyses were done by 60 untrained people. The experimental unit corresponded to a portion of 25 mL.

All the chemical and physical analyses were done in triplicate with a randomized design. The ANOVA and Tukey test were performed. ANOVA was also applied to quality while the acceptability sensory analysis and Friedman test was used to analyze the consumer's preference.

RESULTS AND DISCUSSION

As shown in Table 1, total soluble solids, pH, acidity, betacyanins and betaxanthins of the pulp (CP) were like those reported in other studies of the same cactus species (Castellar et al., 2005, Stintzing et al., 2005, Morales el al., 2009, Carmona et al., 2019). The ORAC value was higher for the purple ecotype pulp, but both values were higher than melon, watermelon, like kiwi and to other common consumed fruits. However, they were lower compared to blueberry and raspberry, fruits that are generally recognized as rich in antioxidants.

Parameters	OCP	PCP
Total soluble solids (°Brix)	13.53±0.21	13.50±0.36
Acidity (% citric acid)	0.034 ±0.001	0.035 ±0.000
pH	6.24 ± 0.06	6.59 ± 0.01
Color parameters		
L*	37.95 ± 0.96	11.49 ± 0.27
a*	35.55 ± 0.78	41.03 ± 0.39
b*	64.12 ± 1.61	19.26 ± 0.49
C*	73.32 ± 1.75	45.32 ± 0.56
h°	60.98 ± 0.33	25.14 ± 0.36
Betacyanins (mg BE L^{-1})	3.43 ±0.24	180.97 ±8.63
Betaxanthins (mg IE L^{-1})	71.56±1.71	21.37 ±0.71
ORAC (μmol Trolox 100 mL^{-1})	860.70±33.2	1213.00 ± 87.0

Table 1. Orange (OCP) and purple (PCP) cactus pear pulp characteristics

BE: Betanin equivalent; IE: Indicaxanthin equivalent

SENSORY ANALYSIS

SELECTION OF THE BEST ICE CREAM AND SHERBET

Two criteria were used to select the best ice cream and sherbet**.** The best results from the quality sensory evaluation, considering mainly color intensity as well as taste, came from the higher proportion of pulp added in the product. The four treatments of each ice cream and sherbet of both color fruit pulp was evaluated to select one from each ecotype of fruit, namely purple and orange.

Table 2a) show the ice cream quality parameters from orange (OIC) and purple cactus pear pulp (PIC) (Table 2 b) with different proportions of cactus pear pulp added.

Color intensity for orange cactus pear pulp ice cream (OIC) showed higher values in the ice cream with higher proportions of pulp added (Table 2). The parameters of creaminess and the degree of crystallization were influenced by the percentage of milk and cream in the formulation, these ingredients

give texture characteristics and smoothness to the palate of the ice cream (Marshall et al. 2010). The ice cream with a higher proportion of pulp (OIC30) presented lower creaminess and higher degree of crystallization, probably due to the higher water content to which the pulp contributes. With respect to the cactus pear pulp taste, the panel only found significant differences in the treatment when less pulp was added (OIC15). Considering the criteria of the greater pulp percentage combined with good sensory quality, the characteristics of OIC25 and OIC20 were analyzed, determining that OIC25 with high creaminess, high intensity of color and low crystallinity degree was the ice cream selected for the following evaluations.

The increased preference of OIC was for OIC15 and the least preferred was OIC30 (Table 3) according to the high or low amount of milk and cream added, respectively.

Orange cactus pear ice cream (OIC)		Purple cactus pear ice cream (PIC)	
Treatment	Preference	Treatment	Preference
OIC30	3,08 a	PIC30	2,50 ab
OIC25	2,25 a	PIC25	3,08 b
OIC20	2,17 a	PIC20	2,00 a
OIC15	2,50 a	PIC15	2,42 ab
Orange cactus pear sherbets (OS)		Purple cactus pear sherbets (PS)	
Treatment	Preference	Treatment	Preference
OS40	2,15 ab	PS40	3,25 c
OS35	3,15 c	PS35	1,75 a
OS30	2,08 a	PS30	2,83 bc
OS25	2,62 abc	PS25	2,17 ab

Table 3. Preferences of ice-creams and sherbets with different proportions of orange and purple cactus pear pulp

Letters in columns means significant differences among treatments (P≤0.05)

The ice cream with the lowest pulp percentage (PIC15), showed less color intensity, aroma intensity and degree of crystallization. The PIC20 was selected due to its high color, creaminess, and low crystallinity degree.

The preferred purple cactus pear pulp ice cream (PIC) was PIC15 and PIC20 (Table 3). In order to combine good sensory qualities (color intensity, aroma intensity, creaminess), increased preference and a percentage of cactus pear pulp that is accepted by consumers, the ice cream selected from purple cactus pear was PIC20.

The parameters for the sherbet are shown in Table 4a and b). For the selection of the best sherbet, the treatment that combines good sensory quality (higher color intensity), increased percentage of pulp and preference was selected. The OS40 sherbet was preferred the most (Table 3). The choice, as in the previous trials, was given by including the highest percentage of pulp, since the sensory quality only indicated differences in color intensity.

For purple cactus pear pulp sherbet, the preference was marked towards PS35 treatments, as the most preferred, and PS25 second (Table 3). The sensory characteristics did not indicate a difference for the selection, therefore the sherbet with the greatest proportion of pulp was chosen, in this case PS35.

CONSUMER ACCEPTABILITY AND PREFERENCES

There were no significant differences between ecotypes for the consumer's acceptability of selected sherbet. However, the ice cream from pulps of different colors showed significant differences, the orange cactus pear ice cream being more accepted than those of the purple cactus pear. It is worth highlighting that considering these are new products for consumers, all values of acceptability were high (9.01-12.07) (de Lima et al., 2016), which in the development of a future commercial product could be a

Product	Color intensity	Aroma intensity	Sweetness	Creaminess	Crystallinity degree	Milk taste	Cactus pear taste	Taste persistence
OIC30	11.84± 1.93 a	5.37± 3.80 a	7.86 ± 2.69 a	9.51± 1.80 b	8.65± 2.28 a	8.54± 2.33 a	9.45± 2.00 a	8.88 ± 1.41 a
OIC25	10.33± 1.98 a	6.79± 3.51 a	8.53 ± 2.18 a	9.85± 2.13 ab	6.33± 3.28 b	8.48± 2.87 a	8.40± 2.90 a	8.52 ± 1.60 a
OIC20	9.15± 1.92 b	6.57± 2.52 a	9.50 ± 2.86 a	10.03± 1.77 ab	5.32± 3.26 b	9.35± 2.79 a	8.25± 2.99 a	8.41 ± 1.93 a
OIC15	8.03± 2.71 b	4.43± 3.21 a	8.69 ± 3.25 a	11.13± 2.04 a	5.69± 2.63 b	10.27± 2.58 a	5.62± 2.64 b	8.44 ± 1.16 a

Table 2a. Sensory quality evaluation of orange cactus pear ice-creams (OIC) with different pulp proportions

Different letters mean statistical differences according Tukey Test (p≤0.05). OIC30: 30 % OCP; OIC25: 25 % OCP; OIC20: 20 % OCP; OIC15: 15 % OCP.

Product	Color intensity	Aroma intensity	Sweetness	Creaminess	Crystallinity degree	Milk taste	Cactus pear taste	Taste persistence
PIC30	13.17 ± 1.79 a	7.06 ± 3.68 ab	7.60 ± 2.95 a	8.59 ± 1.36 ab	9.05 ± 3.20 ab	6.45 ± 2.70 b	10.85± 1.50 a	10.17 ± 2.12 a
PIC25	10.13 ± 2.06 b	7.97 ± 3.50 a	7.41 ± 4.01 a	6.27 ± 2.09 b	10.56 ± 1.78 a	6.52 ± 3.75 b	9.88± 2.12 a	9.06 ± 2.52 a
PIC20	12.04 ± 1.65 a	6.83 ± 3.49 ab	8.13 ± 3.19 a	9.73 ± 1.69 a	8.78 ± 2.81 b	8.39 ± 2.88 b	9.79 ± 2.02 a	7.81 ± 2.33 a
PIC15	8.14 ± 2.75 c	4.41 ± 2.98 b	9.66 ± 2.53 a	10.37 ± 2.06 a	6.31 ± 3.43 c	10.81 ± 2.27 a	8.05 ± 3.06 a	8.20 ± 2.01 a

Table 2b. Sensory quality evaluation of purple cactus pear ice creams (PIC) with different pulp proportion

Different letters mean statistical differences according Tukey Test (p≤0.05).PIC30: 30 % PCP; PIC25: 25 % PCP; PIC20: 20 % PCP; PIC15: 15 % PCP.

Product	Color intensity	Appearance	Aroma intensity	Cactus pear aroma	Sweetness	Sweetness persistence	Unctuosity	Crystallinity degree	Cactus pear taste
OS40	10.95 ± 2.19 a	10.48 ± 2.13 a	6.36 ± 2.77 a	7.40 ± 3.47 a	8.63 ± 2.34 a	8.09 ± 3.05 a	7.50 ± 2.78 a	7.65 ± 3.92 a	8.75 ± 3.34 a
OS35	10.28 ± 1.81 ab	9.98 ± 2.51 a	6.63 ± 2.83 a	5.52 ± 2.93 a	8.48 ± 2.03 a	8.07 ± 2.59 a	8.08 ± 3.50 a	7.12 ± 3.57 a	7.97 ± 3.67 a
OS30	8.50 ± 2.52 bc	10.58 ± 2.76 a	5.91 ± 2.90 a	5.63 ± 3.14 a	8.00 ± 2.34 a	7.98 ± 3.14 a	9.33 ± 2.18 a	6.90 ± 2.94 a	7.01 ± 4.05 a
OS25	7.86 ± 1.75 c	10.26 ± 2.77 a	5.90 ± 2.49 a	6.29 ± 3.55 a	7.37 ± 1.74 a	7.37 ± 3.56 a	8.18 ± 3.91 a	7.59 ± 3.48 a	7.99 ± 2.18 a

Table 4a. Sensory quality evaluation of orange cactus pear sherbets (OS) with different pulp proportion

Different letters mean statistical differences according Tukey Test (p≤0.05). OS40: 40 % OCP; OS35: 35 % OCP; OS30: 30 % OCP; OS25: 15 % OCP.

Product	Color intensity	Appea-rance	**Aroma intensity**	**Cactus pear aroma**	**Sweetness**	**Sweetness persistence**	**Unctuosity**	**Crystallin-ity degree**	**Cactus pear taste**
PS40	12.04 ± 1.57 a	10.36 ± 3.23 a	6.84 ± 3.33 a	7.07 ± 3.08 a	9.62 ± 2.36 a	8.71 ± 2.14 a	8.75 ± 2.60 a	8.80 ± 3.67 a	7.95 ± 3.50 a
PS35	11.64 ± 1.56 a	10.02 ± 3.47 a	7.29 ± 2.51 a	7.47 ± 2.58 a	9.14 ± 2.29 a	8.36 ± 2.45 a	8.95 ± 2.53 a	8.00 ± 3.53 a	9.00 ± 3.78 a
PS30	12.44 ± 1.68 a	10.79 ± 3.44 a	8.37 ± 2.30 a	8.48 ± 2.64 a	8.46 ± 2.55 b	7.28 ± 3.06 b	8.61 ± 3.10 a	7.77 ± 3.85 a	9.10 ± 2.98 a
PS25	12.40 ± 1.68 a	9.85 ± 3.09 a	5.70 ± 3.19 a	6.48 ± 3.10 a	7.55 ± 2.41 ab	7.84 ± 1.69 ab	8.84 ± 2.20 a	8.20 ± 2.58 a	9.30 ± 2.93 a

Table 4b. Sensory quality evaluation of purple cactus pear sherbets (PS) with different pulp proportions

Different letters mean statistical differences according Tukey Test (p≤0.05). PS40: 40 % PCP; PS35: 35 % PCP; PS30: 30 % PCP; PS25: 15 % PCP.

Kind of product/ Parameters	**Sherbets**		**Ice creams**	
	OS40	**PS35**	**OIC25**	**PIC20**
pH	6.51 ± 0.03a	6.66 ± 0.07a	6.65 ± 0.08a	6.63 ± 0.01a
Acidity (g/100 g citric acid)	0.0117 ±0.0004a	0.0090 ±0.0010b	0.0488 ± 0.0028a	0.0480 ±0.0002a
Soluble solids (°Brix)	15.83 ± 0.32a	15.93 ± 0.81a	23.60 ± 1.04 a	23.70 ± 0.26 a
SS/acidity	1354 ± 5.06b	1775 ± 86.43a	484 ± 36.77a	494 ± 3.97a
Betacyanins (mg/L)	0.35 ±0.02	16.64 ±2.51	0.14 ±0.02	7.06 ±1.36
Betaxanthins (mg/L)	5.94 ±0.23	2.35 ±0.37	2.83 ±0.19	1.15 ±0.04
ORAC (µmol Trolox/L)	65.3 ± 11.1	56.6 ± 11.9	60.2 ± 7.4	39.5 ± 8.0
Color parameters				
L*	55.99 ± 2.64	19.71 ±1.42	6.71 ± 0.34	0.63 ± 0.26
a*	24.24 ± 0.93	52.20 ± 2.20	19.84 ± 0.49	3.45 ± 1.47
b*	85.14 ± 3.32	30.69 ± 1.96	11.33 ± 0.56	0.90 ± 0.47
C*	88.53 ± 3.43	60.55 ± 2.89	22.86 ± 0.28	3.57 ± 1.54
h°	74.10 ± 0.19	30.42 ± 0.57	29.71 ± 1.74	14.16 ± 2.15
Overrun	18.1±1.8	7.5±0.4	25.4±1.2	16.9±2.4

Table 5. Technological characteristics of the ice creams and sherbets selected

OS40: Sherbet with 40 % OCP; PS35: Sherbet with 35 % PCP; OIC25: 25 % OCP; PIC20: 20 % PCP

favorable point. In addition, given that there were few alternatives in which to transform Opuntia fruit colors; this would be a highly attractive possibility.

The consumer's preference showed that there were significant differences between consumer choices. OIC25 was preferred the most, followed by PIC20, OS40 and PS35, respectively. This selection could be due to the Chileans palate that is accustomed to dairy and creamy products. The fat content is an attribute highly appreciated by the consumers (Rolon et al., 2017). Moreover, the Chilean consumers have less familiarity with sherbet. There were no significant differences between sherbet preferences of different ecotypes (Table 3). The ice cream OIC25 was the product with high scores (12.07) for the preferred product among different formulations and type of color ecotype.

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE SELECTED PRODUCTS

The acidity value in the sherbet of both pulp ecotypes is proportional to the acidity of the pulp (Table 5). In the case of ice cream, this value is greater since it is influenced by the acidity that milk and cream add to the formulation.

The betalain content is in accordance with other products using cactus pear color pulps in their formulation, such as toppings (Morales et al. 2009). In terms of the color parameters the orange cactus pear pulp sherbet (OS40) and ice cream (OIC25) products showed high L* values, 55.99±2.64 and 6.71±0.34, respectively, compared with purple cactus pear products, in accordance with the type of raw material used, the purple cactus pear products being darker (PS35=19.71 ±1.42 and PIC20= 0.63 ± 0.26). Moreover, sherbet has greater luminosity, probably influenced by the composition, where water is added instead of milk.

As was expected, a* values were higher in purple products and b* values in orange products, in accordance with the higher content of betacyanins in purple cactus pear and betaxanthins in orange cactus pear, respectively. The hue (h°) values were between 0 and 90, with values close to 0 being more red-purple and those close to 90 more orange-yellow, being 30.42 ± 0.57 for PS35, 14.16 ± 2.15 for PIC20, 74.10 ± 0.19 for OS40 and 29.71 ± 1.74for OIC25. Sherbet and ice cream color is directly related not only to the betalains content but to the profile of betalains.

The overrun of the selected products was OS40=18.1 and PS35=7.5 for the sherbet. For the ice-cream it was OS40=25.4 and PS35=16.9 (Table 5). The ice cream and sherbet have a low rate of aeration compared to commercial products, because they were made in a domestic type of ice cream machine, which adds less air than industrial machinery. The incorporation of air depends on the composition of the mixture (fat content) as well as the kind and amount of stabilizer and emulsifier used. The range of overrun is usually higher in creamy ice cream than in fruit ice cream or sherbets (Ramirez-Navas et al. 2005), which explains the values that were reported in this study where the ice cream overrun is significantly higher that of the sherbet. Ideally the overrun for a standard ice cream should have a value between 100-120 %, to reduce costs and make production more profitable (Goff and Hartel, 2013). According to the classification of the previous authors, these kinds of ice cream and sherbet are in the super premium category since the air addition value is below 50 %. The amount of air also has a great effect on the density of ice cream. A gallon (3.8 L) of ice cream must weigh at least 4.5 Lb, making the minimum density 0.54 g mL^{-1}. Better quality ice cream has a higher density – of up to 0.9 g mL^{-1} (Rohrig, 2014). El-Samahy et al. (2009) reported in a preliminary study on production of red cactus pear ice cream, that as the percentage of pulp added increases, the rate of aeration decreases. Something similar occurred with the values presented in this research, however, this is not significant, since the indicated values correspond to the final ice cream and sherbet and are not comparable to each other due to their different form of preparation and formulation.

In conclusion, ice creams and sherbets made with colored cactus pears have the advantage of using the natural pigments of the fruit, avoiding the use of artificial colorants. The pH of the ice creams and sherbets prevents the degradation of the pigments because the betalains are more stable at pH close to 4.5 (Azeredo, 2009). The orange cactus pear shows better characteristics for preparing these kinds of products. This study opens a

new opportunity for the use of colorants from fruits from a low-water-use plant and the behavior of the pigments during the shelf-life is the following step to be studied.

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