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Original article

The effect of trehalose, sucrose and maltodextrin addition on physicochemical and sensory aspects of freeze - dried strawberry puree

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Summary Use of trehalose as a novel drying aid to produce freeze-dried strawberry puree was studied and compared with conventional drying aids for fruit purees, namely sucrose and maltodextrin (MD). Glass transition temperature (T_g), colour, sensory profile and consumer preference were determined. Purees dried with MD and/or trehalose presented higher T_g values as compared to sucrose. Sensory evaluation indicated that samples dried with trehalose retained fresh strawberry aroma and flavour, keeping a good sweetness/sourness balance, while puree dried with sucrose was mostly sweet. Addition of MD caused an increase in products visual viscosity and sourness, attributes which were negatively correlated to preference. Trehalose presented several advantages for increasing the quality of freeze dried fruit purees. It raised T_g, gave an adequate sweetness/sourness balance, and allowed a better perception of fresh strawberry flavour.

Keywords Freeze drying, glass transition, maltodextrin, sensory analysis, strawberry, sucrose, trehalose.

Introduction

Consumer acceptability of food products is determined by many factors, including aroma, flavour, colour and texture. In dehydrated fruit products the kind of dehydration process (i.e. air drying, freeze drying, etc.) as well as the use of drying aids - such as sugars - can have a great influence on those attributes.

Drying methods involving high temperatures can lead to loss of flavour compounds and promote reactions such as caramelization and Maillard reaction which may modify aroma, colour and flavour. Freeze drying has proved to be the most suitable method for drying thermo sensitive substances, minimising thermal degradation reactions while relatively high aroma retention is attained in an amorphous micro structure matrix (Chirife & Karel, 1973) having excellent rehydration properties (Sabarez *et al*., 2000; Beaudry *et al*., 2004). One approach to improve the quality of dried products such as fruits, consists in the use of drying aids, as mentioned above, mainly carbohydrates (sucrose, maltodextrin, etc) in order both to increase aroma retention and also rise the glass transition temperature (T_g) of the dried product. A high T_g value contributes to minimise physical changes such as shrinkage, collapse and/or crystallisation of freeze dried products (Roos, 1995).

The use of drying aids, other than positively affecting product's physicochemical properties, can alter aroma, texture and colour, improving or diminishing overall quality (Kopjar *et al*., 2008). Sucrose has been widely reported in literature as a drying aid of fruit purees (Bhandari *et al*., 1997); however, the use of sucrose has some drawbacks such as a relatively low T_g, ease of hydrolysis in acidic media and participation in Maillard reactions.

Trehalose is a naturally occurring, non-reducing, bland, non-toxic, dietary disaccharide, with almost half the sweetness of sucrose and similar sweetness dynamic profiles (Galmarini *et al*., 2008). It is commonly found in nature including honey, mushrooms and bakers yeasts, some of which are known to contain almost 20% of trehalose on a dry solid basis (Colaco & Roser, 1994). The use of trehalose as a functional food ingredient has been approved by FDA as a GRAS additive and since then it has been used in many countries.

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It is well known that the glass transition temperature (T_g) of trehalose is much higher than that of sucrose (Roos, 1995; Rossi *et al*., 1997; Patist & Zoerb, 2004); in the anhydrous state the T_g of trehalose and sucrose may be considered to be about 105–115 °C and 60–62 °C respectively. Trehalose is a non reducing sugar that has a high chemical stability under low pH conditions, therefore, it does not react with amino acids or proteins by Maillard browning reaction (Schebor *et al*., 1999; Komes *et al*., 2003, 2005). Trehalose has also a low cariogenic potential when compared to sucrose and moderate glycaemic index with low insulinemic response (Cargill Foods, 2004).

Komes *et al*. (2003) compared the influence of the addition of different sugars on volatile retention during both freeze drying and foam-mat drying of strawberry puree. They added 8% of trehalose or sucrose before drying and observed that the addition of trehalose resulted in the lowest loss of total aroma as well as of individual fruit volatiles when compared with sucrose by headspace solid-phase micro extraction in combination with gas chromatography (GC-FID and GC-MS). Most of the literature on the use of trehalose as a drying aid in food for freeze drying has focused on the instrumental study of aroma retention (Komes *et al*., 2003, 2005) but little work is found on its sensory characteristics.

It is the purpose of present study to determine glass transition temperature, colour, sensory profile and consumer acceptance of freeze dried strawberry puree. The effect of trehalose was compared with that of other traditional drying aids namely sucrose and maltodextrin (MD).

Materials and methods

Sample preparation

Fresh strawberries were washed with water, sliced and submerged in a 0.5% solution of 1:1 ascorbic and citric acid. They were blanched, drained and blended to a fine puree. The puree was then added with one or the other of the following carbohydrates: trehalose, sucrose and/or maltodextrin DE 12 (MD 12). Table 1 shows the composition of the different systems studied.

Commercial food grade crystalline trehalose (dihydrate) was provided by Cargill Inc., Wayzata MN, U.S.A; maltodextrin DE 12 was from Productos de Maíz S.A., Buenos Aires, Argentina and commercial refined sucrose was from Ledesma, Buenos Aires.

The strawberry purees were freeze dried at room temperature in a FIC Ll-I-E300-CRT freeze drier (Buenos Aires, Argentina) operated with a freezing plate at −35 °C and a vacuum below 100 μm. The freeze dried samples were vacuum packaged in cryovac film and kept at −18 °C until use.

Table 1 Effect of drying aids (sucrose, trehalose and/or MD) on the glass transition temperature and collapse of freeze dried strawberry purees equilibrated at 32% relative humidity (RH)

Sample Nº	Composition (g carbohydrate added/100 g puree)	T_g (onset) (°C)	Collapse* (%)
1	Strawberry puree + 30% sucrose	4.78	11.4
2	Strawberry puree + 40% sucrose	5.71	-
3	Strawberry puree + 30% trehalose	14.83	7.3
4	Strawberry puree + 40% trehalose	22.55	5.2
5	Strawberry puree + 40% Maltodextrin (MD)	46.12	0
6	Strawberry puree + 10% MD and 30% trehalose	22.29	3.25
7	Strawberry puree + 10% MD and 30% sucrose	8.94	9.75
8	Strawberry puree (plain)	−13.34	20

*As determined from measured radial shrinkage.

Determination of thermal transitions

Glass transitions were determined by differential scanning calorimetry (DSC; onset values) using a DSC 822e 104 Mettler Toledo calorimeter (Schwerzenbach, Switzerland). The instrument was calibrated with indium (156.6 °C), lead (327.5 °C) and zinc (419.6 °C). All measurements were performed at a heating rate of 10 °C/min. Hermetically sealed 40 μL medium pressure pans were used, (an empty pan served as a reference). Thermograms were evaluated using Mettler Star^e program. All samples were stored at 32% relative humidity (RH) (at room temperature) for a period of 15 days before determination of glass transition temperature.

Determination of collapse

For determination of collapse samples of strawberry puree (with or without drying aids) were placed in transparent plastic cups (40 mm diameter, 10 mm height).

Collapse of freeze dried samples after 2 weeks humidification at 32% RH at room temperature (about 23 °C) was arbitrarily defined as the ratio between measured sample diameter after freeze drying and after storage of the freeze dried samples. Results were expressed as relative percentage reduction.

Instrumental colour determination

Colour was determined by reflectance measurements of the colour attributes luminosity (L^*), a^* and b^* with a white background of reflectance (Lo). A handheld tristimulus reflectance spectrocolourimeter with integrating sphere (Minolta CM-508-d, Minolta Corp., Ramsey, NJ, USA) was employed. Two replicates were analyzed. Colour functions were calculated for illuminant D65 at 2° standard observer and in the CIELab uniform colour space. The strawberry purees were reconstituted with mineral water to their original volume before measurements.

Sensory evaluation

A panel of ten assessors (female students of Facultad de Ciencias Agrarias, Pontificia Universidad Católica, Argentina; ages 20–24) analyzed the reconstituted strawberry purees by quantitative descriptive analysis (QDA) method (Stone & Sidel, 1993). They received three training sessions (30 min long each) where they learnt how to measure the following attributes (with the aid of standards): red colour intensity, visual viscosity, fresh strawberry aroma, strawberry flavour, sweetness and sourness. The standards for sweetness and sourness were fresh strawberry puree added with 35% sucrose and 0.6% tartaric acid respectively. Aroma was determined by sniffing of the headspace, plain fresh strawberry puree was considered the maximum for strawberry aroma and flavour. The determination of visual viscosity was based on previous work done by Zamora (1994); she found that, even though visual and oral viscosities yielded similar results, visual measurements showed less variation. The QDA was done in duplicate in two other sessions of 30 min each.

Freeze dried strawberry purees were reconstituted with cold mineral water before testing. During each session assessors evaluated 6 g of every sample presented in random order served in three digit coded cups at 12 ± 2 °C in individual booths under day light (6500 K), rinsing between samples with distilled water.

Consumer testing

A total of one hundred strawberry consumers participated in the test. There were 40 men and 60 women, being half of the total population 18–25 years old and the other half ranged between 25–60 years old. In order to determine the number of consumers necessary for the sensory acceptability test, we took into account the recommendations recently described by Hough *et al.* (2006).

Freeze dried strawberry purees were reconstituted with cold mineral water to their original volume before testing. Samples were presented in random order in a sequential monadic way in three digit coded cups at 12 ± 2 °C. Consumers had to try each sample and indicate their level of overall likeness on a nine-point hedonic scale from 1 = dislike extremely to 9 = like extremely, with 5 = neither like nor dislike. The test took place in the panel discussion area within the sensory laboratory.

Data analysis

Analysis of variance (ANOVA) was carried out to assess attributes significantly different among samples using the General Linear Model command in SPSS v. 13.0 (SPSS Inc. Chicago, IL, USA). The variability of each descriptor was studied using a model where assessor was considered a random factor and sample and replication fixed factors. Multiple means comparisons were carried out by Student Neuman-Keuls (SNK) test at $P < 0.05$.

The correlation among sensory attributes, acceptance and instrumental colour determination was found by Pearson's correlation using SPSS v.13.0.

Partial least-squares regression (PLS, Infostat v. 2007, Universidad Nacional de Córdoba, Argentina) was used to explore relationships between sensory and instrumental (X-variables, regressors: predicting) and consumer data (Y-variables, regressands: predicted).

Results and discussion

Determination of thermal transitions

Figure 1 shows the DSC thermogram for freeze dried strawberry purees, either plain or added with 40% trehalose, 40% sucrose or 40% MD, previously equilibrated at 32% RH. A glass transition is clearly apparent in all systems displayed (Busso Casati *et al.*, 2007).

Table 1 shows the T_g (onset values) of different samples previously equilibrated at 32% RH. It can be seen that the lowest T_g value corresponded to plain strawberry puree. Strawberry has a high monosaccharides content (43% fructose and 38% glucose on total sugar basis) and it is well known that these sugars have very low glass transition temperatures (Roos, 1995). As

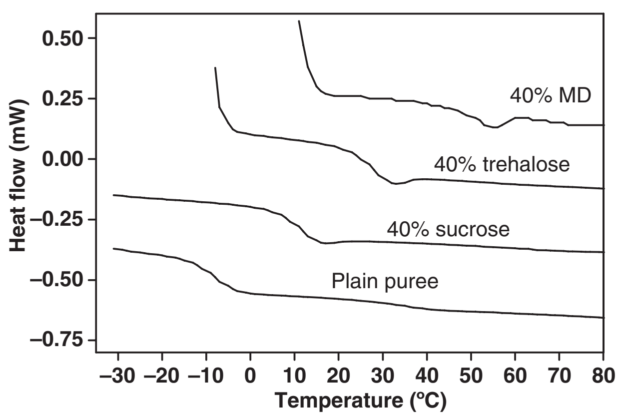

Figure 1 Thermograms showing the glass transition temperature at 32% relative humidity for plain strawberry puree and with addition of sucrose, trehalose, or MD (DE 12).

shown in Table 1, the addition of trehalose, sucrose, MD or their mixtures led to an increase of the glass transition temperature of freeze dried strawberry puree. It is to be noted that addition of trehalose instead of sucrose produced a significant increase in T_g; addition of MD led to the highest observed glass transition temperature. This behaviour is in agreement with knowledge of the T_g of added high molecular weight anhydrous carbohydrates, such as MD (Roos & Karel, 1991).

It is well known that collapse may occur in amorphous food structures during storage; this physical change is time dependent and is a function of $(T - T_g)$, where T is the storage temperature (Roos & Karel, 1991). In present study collapse was arbitrarily defined as the relative percentage reduction in sample diameter after 2 weeks storage at 32% RH at room temperature (Table 1). As expected from measured T_g's, radial shrinkage was lower in samples containing trehalose and/or MD as compared to samples containing only sucrose. For example, plain strawberry puree experimented 20% radial shrinkage, while samples with 30% trehalose and 30% sucrose showed a radial shrinkage of 7.3 and 11.4% respectively. Addition of MD, either alone or in combination with sugars, was more effective in preventing shrinkage.

Sensory evaluation

Only samples 1, 3, 4, 5 and 6 were subjected to sensory evaluation.

ANOVA of mixed model for attribute scores are summarised in Table 2. The source of variation was mainly samples, except for red colour intensity were the interactions sample*assessor and sample*replication were also a source of variation. Assessors, replications, assessor*replication, sample*replication and sample*assessor interactions were non significant for every other attribute, supporting the interpretations that panel performance was consistent.

For the attribute red colour intensity the interactions sample*assessor (S*A) and sample*replica (S*R) were found significant ($P < 0.05$), this would be indicating that not all the judges evaluated colour in the same fashion for every sample. Other authors observed that this can happen when samples are very similar in their sensory properties so assessors can not differentiate easily among them (Tang *et al.*, 1999; Zamora & Guirao, 2002). In order to verify this observation ANOVAS were conducted for the samples whose means had the biggest difference and which were found significantly different by SNK test (Table 3) for the mentioned attribute. No significant interactions were found when comparing samples 4 and 5 ($F_{1,1} = 1.45$ for S*R and $F_{1,9} = 3.24$ for S*A); samples 4 and 6 ($F_{1,1} = 2.21$ for S*R and $F_{1,9} = 2.49$ for S*A); and samples 1 and 5 ($F_{1,1} = 2.52$ for S*R and $F_{1,9} = 1.48$ for S*A). This data shows that there was an agreement among assessors. This being so, interactions (Table 2) could be attributed to the similarity among samples rather than to different criteria used by judges. These results are in accordance with the instrumental colour determination (Table 3). As it can be observed, for parameter a^* (red colour) samples 5 and 6 were different from 1, 3 and 4 ($P < 0.05$) which partially explains the differences found by sensory analysis. In terms of luminosity (L^*), sample 5 was different from the rest ($P < 0.05$) with the highest value. It can be deduced that sensory evaluation integrated the instrumental parameters a^* and L^*, given that, even though the instruction given was to measure red colour intensity, sample 5 was considered different from the others by sensory evaluation because it was the lighter one.

The means for every evaluated attribute are presented in Table 3. As it can be observed, strawberry puree with 40% MD (sample 5) was different from the rest in every attribute. It presented the lowest sweetness, which could be expected since it had no addition of disaccharides; and it was perceived as the sourest. Given that all samples had similar pH values (range 3.5–3.6) the differences in perceived sourness can be related to a sour–sweet interaction. It is known that, although sweet and sour tastes are perceived by their own unique pathways, their perceived intensities are different when both are present in a mixture. In general, sourness is suppressed by sweeteners with a very stable pattern and the amount of sourness suppressed depends on both components' levels. Mixture suppression is a phenomenon whereby the perceived intensity of two tastes in a mixture is less than if they were unmixed, at the same concentration level (Schifferstein & Frijters, 1991; Lawless & Heymann, 1998). This interaction can also be observed in Table 4 which shows a negative correlation ($P < 0.01$) between the two attributes.

Table 2 *F*-values of samples for evaluated attributes

	***F*-values**					
Attribute	**Replicate (R)**	**Sample (S)**	**Assessor (A)**	**R × S**	**R × A**	**S × A**
Strawberry flavour	2.23	28.45***	0.74	1.24	1.92	1.72
Sweetness	2.48	77.21***	5.56	1.88	0.76	0.88
Sourness	1.81	10.87***	0.29	0.28	0.78	1.51
Strawberry aroma	2.53	28.17***	0.82	1.18	1.93	1.74
Visual viscosity	2.40	54.11***	1.32	0.73	0.97	1.10
Red colour intensity	0.20	15.45***	0.85	3.10*	0.99	2.12*

*$P < 0.05$; ***$P < 0.001$.

Table 3 Mean scores and standard error deviation of sensory attributes, instrumental colour determination and consumer preference for each sample

	Sample 1	Sample 3	Sample 4	Sample 5	Sample 6
Strawberry flavour	46.2 ± 3.9 b	68.1 ± 3.6 a	48.6 ± 5.3 b	10.8 ± 1.9 c	50.4 ± 3.0 b
Sweetness	85.5 ± 2.0 a	45.0 ± 3.9 bc	52.5 ± 5.1 b	8.6 ± 1.4 d	40.9 ± 4.0 c
Sourness	21.2 ± 4.4 b	49.60 ± 4.5 a	49.0 ± 4.2 a	64.7 ± 5.5 c	49.9 ± 4.1 a
Strawberry aroma	63.4 ± 2.2 b	75.5 ± 2.0 a	78.6 ± 2.2 a	12.4 ± 1.6 d	42.1 ± 3.6 c
Visual viscosity	49.5 ± 3.9 c	18.8 ± 2.3 b	37.6 ± 2.9 a	83.10 ± 2.1e	63.2 ± 2.5 d
Red colour intensity	54.5 ± 4.6 ab	70.1 ± 3.5 a	75.0 ± 3.3 a	23.5 ± 4.3 c	42.4 ± 5.1 b
Instrumental colour determination					
Red (a^*)	17.8 ± 0.7a	18.0 ± 0.7a	16.6 ± 0.1a	11.6 ± 0.7 b	13.4 ± 0.5 b
Yellow (b^*)	8.3 ± 0.9 a	7.7 ± 0.2 a	7.3 ± 0.6 a	4.8 ± 0.02 b	4.7 ± 0.3 b
Luminosity (L^*)	20.9 ± 0.2 a	21.6 ± 0.8 a	20.8 ± 0.4a	25.6 ± 0.4 b	19.5 ± 0.3 a
Consumer test					
Preference	7.0 a	5.9 b	6.7 a	2.2 c	5.4 b

Different lower case letters represent significant differences ($P < 0.05$) among samples according to Student Neuman-Keuls.

Table 4 Correlation of sensory attributes, consumer preference and instrumental measurement of red colour (a^*).

	Red colour intensity	Strawberry flavour	Sweetness	Sourness	Strawberry aroma	Visual viscosity	Preference
Strawberry flavour	0.802						
Sweetness	0.569	0.565					
Sourness	−0.360	−0.415	−0.968**				
Strawberry aroma	0.983**	0.849	0.700	−0.514			
Visual viscosity	−0.936*	−0.892*	−0.511	0.336	−0.935*		
Preference	0.815	0.786	0.907*	−0.778	0.898*	−0.729	
Red (a^*)	0.868	0.782	0.801	−0.688	0.925*	−0.898*	0.856

*$P < 0.05$; **$P < 0.01$.

Sample 5 also presented the lowest mean values for red colour intensity (23.5), strawberry aroma (12.4) and strawberry flavour (10.8). On the other hand, it showed the highest mean score for visual viscosity which could be the cause of the diminished flavour, aroma and colour. This effect of viscosity has been mentioned by Delwiche (2004) were the increase of viscosity in a solution has shown to decrease both taste and flavour intensity. Pangborn *et al*. (1978) found that also in natural stimuli (tomato juice, orange drink, and a coffee beverage) increased viscosity depressed flavour and aroma. This relationship was also evidenced by the fact that viscosity was negatively correlated ($P < 0.05$) with red colour intensity, strawberry aroma, strawberry flavour and a^* (Table 4).

The three samples added with trehalose (samples 3, 4 and 6) were not perceived as different in terms of sourness, but the three of them were different from that added with sucrose which was perceived as the least sour and sweetest sample.

In terms of sweetness, no difference was found between the two samples added exclusively with trehalose. However, the addition of 10% MD to a sample with 30% trehalose caused a small sweetness reduction being this sample perceived as less sweet ($P < 0.05$) than that added with 40% trehalose. The addition of MD also caused an increase in perceived viscosity ($P < 0.05$) from a mean value of 18.8 to 63.2. It is to be noted that viscosity in the five samples was perceived as significantly different (see Table 3).

Samples 3 and 4 (added only with trehalose) were the ones that presented the higher mean values for strawberry aroma and for sensory red colour intensity. The high score for strawberry aroma could be indicating that the presence of trehalose during freeze drying facilitates retention of volatiles related to fresh strawberry puree aroma. It should be pointed out that the standard used was plain fresh strawberry puree, so the attribute strawberry aroma refers only to those volatiles which account for this characteristic. Previous results have shown that some sugars, particularly sucrose are useful in helping to retain flavour in freeze dried foods (Lovric & Pilizota, 1980; Lovric & Pozdevic, 1984). Komes *et al*. (2005) studied the influence of the addition of trehalose and sucrose on the retention of volatiles responsible for the characteristic aroma on dehydrated apricot puree. They used foam-mat drying and freeze drying for puree dehydration, and volatiles analysis was done by manual head-space solid phase microextraction coupled with gas chromatography. They found that the best retention of aroma compounds in dehydrated apricot puree was obtained when trehalose was added. However, they did not examine the effect of drying aids on structural parameters of the dehydrated apricots (i.e. determination of T_g value).

Kopjar *et al*. (2008) also found that the addition of trehalose had positive effect on colour and aroma retention of a freeze-dried strawberry cream filling. They reported that, in addition to improvements in colour and aroma levels, compared to the control cream filling, trehalose also had a positive effect on the levels of fruity esters and on retention of anthocyanin, and the extent of retention was proportional to the amount of trehalose added.

It can be seen (Table 3) that the addition of MD reduced the mean scores for strawberry aroma and red colour indicating that the proportion of volatiles which explain fresh strawberry aroma retained during freeze drying or released during reconstitution is lessened by the addition of MD. It is important to mention that odour identification is reduced when odours are presented without colour cues or when they are paired with inappropriate colours (Davis, 1981; Zellner & Kautz, 1990; Blackwell, 1995). This indicates that individuals associate certain odours with specific colours and when the colours are altered, the odour identification is decreased: the stronger the colour-odour association, the greater the impact of colour (Delwiche, 2004). Table 4 shows a positive correlation ($P < 0.01$) between red colour intensity determined by assessors and strawberry aroma, therefore the decrease in colour resultant from the addition of MD can also influence the decrease in aroma perception.

Finally, for strawberry flavour, sample 3 (30% trehalose) was the one with the highest mean value. The difference with sample 4 (40% trehalose) in terms of flavour can be attributed to the fact that sample 3, together with sample 1 (30% sucrose), are the ones with the biggest proportion of puree. However, in sample 1 the strawberry flavour is masked by sweetness, this is why this showed the same strawberry flavour as samples 4 and 6 (10%MD + 30% trehalose), which have a smaller proportion of puree but are less sweet. The greatest mean for strawberry flavour for sample 3 can also be related to the fact that it is the least viscous sample.

Integration of texture, taste, and smell would explain the above findings. Sensory pathways are known to overlap widely in the periphery, with so-called 'gustatory nerves' responding to taste, tactile and thermal

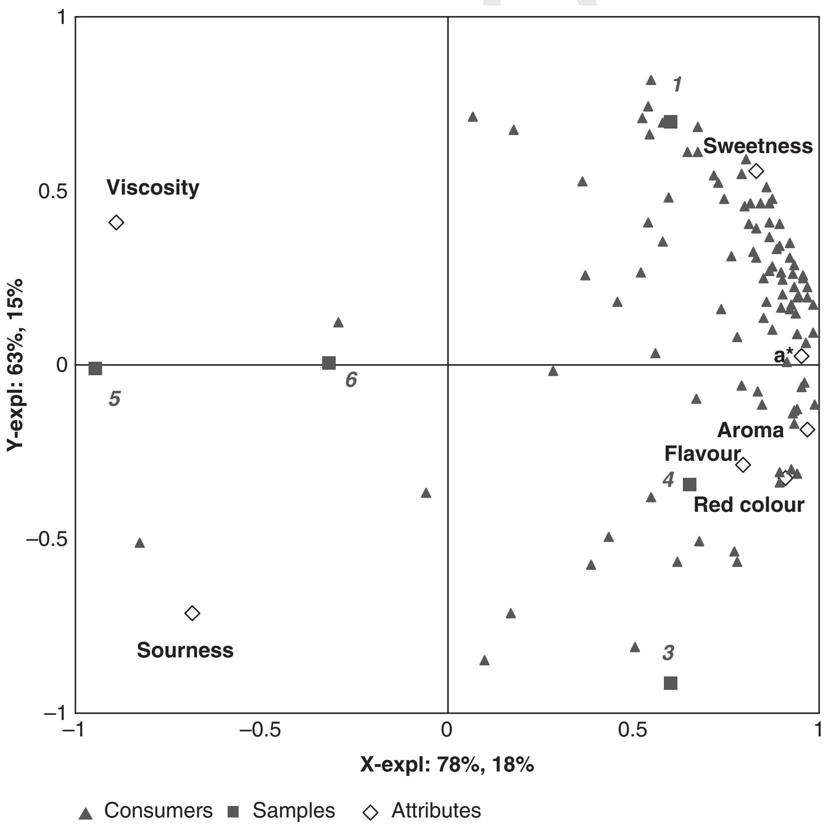

Figure 2 Partial least squares regression (PLS2) factors for sensory attributes, instrumental determination of red colour (a^*) and consumer preference.

stimulation, all of which occur simultaneously during ingestion. The interaction of texture with taste, smell, and flavour has only begun to be revealed by the recent advent of techniques that allow the simultaneous measurement of human (Delwiche, 2004).

Consumer test

Hough *et al.* (2006) compared the difference in α (type I error) values when using different number of consumers; for ninety one consumers the α value was 10% while for 112 consumers it decreased to 5%. Since in present study the number of consumers involved were 100 we can safely assume an α somewhere in the abovementioned range (5–10%).

Results from one-way ANOVA for consumer preference scores showed that sex and age factors were non significant (data not shown), indicating that preference along the population was homogeneous not presenting specific consumer segments. Therefore mean scores obtained from the one hundred subjects are reported in Table 3.

As it can be observed, the sample containing sucrose and the one with 40% trehalose obtained the highest scores, followed by the two samples added with 30% trehalose. Finally, the addition of 40% MD presented very low scores which can be associated to rejection. The influence of the samples' profile on consumer preference was further confirmed by PLS.

PLS2 explained 78%, 18% of X - (sensory and instrumental data) and 63%, 15% of Y- (consumer data) variance in two first factors (Fig. 2). The sensory attributes strawberry aroma, strawberry flavour and red colour intensity were clustered and related to instrumental attribute red colour (a^*) and were opposite to viscosity; sweetness was independent from strawberry flavour and opposite to sourness. Samples 3 and 4 were clustered and associated to strawberry aroma, strawberry flavour and red colour attributes. Sample 1 was mostly described by sweetness while sample 6 was very close to the centre of coordinates, thus showing medium values for all attributes and could not be related to any product's characteristics in particular. Sample 5 was related with viscosity and sourness. Practically all the consumers were grouped around samples 1, 3 and 4 and the attributes strawberry flavour, strawberry aroma, red colour and sweetness.

Even though samples 1 and 4 presented different sensory profiles, they were not differentiated in terms of preference. On the other hand, samples 3 and 4 with similar sensory characteristics presented differences according to preference. This could be explained by the small difference in sweetness (sample 4 is slightly sweeter than sample 3). It is evident that sweetness and aroma are important parameters when developing a fruit puree.

Conclusion

As compared to sucrose, trehalose addition was more effective for increasing T_g of freeze dried strawberry puree and also maintained a good sweetness/sourness balance. The sample added with sucrose was mostly sweet.

Samples added with MD presented the highest T_g values but it also caused an increase in products visual viscosity and sourness, attributes which were negatively correlated to preference. It also showed that the strawberry flavour was decreased, as well as sweet taste.

Preference seemed to be characterised by sweetness, aroma and flavour and was opposed to sourness and visual viscosity.

It may be concluded that the use of trehalose as a novel drying aid presented several advantages for increasing the quality of freeze dried fruit purees. Among them, it raised T_g, gave an adequate sweetness/sourness balance, and allowed a better perception of the natural strawberry flavour.

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