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Functionality of a Mixture of Three Gums from Species Located in Venezuela in the Ice Cream Preparation

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Abstract: *Acacia glomerosa, Enterolobium cyclocarpum* and *Hymenaea courbaril,* species located in Venezuela, South America, produce gum in good yield. The mixture of theses gums were tested as stabilisers in the ice cream preparation. Quality characteristics (viscosity, whippability, foam expansion, color measurement, meltdown, shape factor and sensory properties) were investigated. These characteristics were compared with some commercial food gums, Kappa carrageenan, sodium alginate and carboxymethyl cellulose. The mixture tested provided the suitable viscosity for the ice cream mix with the corresponding whippability, body and texture. It gave better foaming properties and air incorporation and good sensory attributes to the confection, as indicate by the highest score flavor (7.12), creaminess (5.96), overall acceptability (7.17) and lowest score of iciness (2.96). The mixture of the gums investigated, enhanced viscosity in the product mix and hence could produce a ice cream preparation with improve quality characteristics and better sensory attributes.

Key words: *Acacia glomerosa, Enterolobium cyclocarpum, Hymenaea courbaril,* mixture of gums and ice cream preparation

Introduction

Stabilizers have important role in the ice cream industry (Flack, 1981). They retard ice crystal growth and improve overall characteristics, i.e. air incorporation, body, texture and melting properties (Flack, 1981, Arbuckle, 1981 and 1986). They have water-binding capacity by forming a three dimensional network of hydrated molecules through the system (Voulasiki and Zerfiridis, 1990). The ice preparation uses commonly sodium alginate, carboxymethyl cellulose, carrageenan, locust been and guar gums as stabilisers. These additives are frequently used as a mixture.

Acacia glomerosa, Enterolobium cyclocarpum and *Hymenaea courbaril,* species located in Venezuela, South America, produce gum in good yield. These gums have interesting properties and chemical features. *A. glomerosa* and *E. cyclocarpum* contain galactose, arabinose, rhamnose, glucuronic acid and its 4-O-methyl derivative. The backbones of theses gum correspond to a β- D-(1->3)-galactan (León de Pinto *et al.,* 1994 and 2001), as have been reported for *Acacia senegal* gum (Street and Anderson, 1983).

The seed gum from *H. courbaril* contains galactose, glucose, xylose, arabinose and very low uronic acid residues and its polysaccharide backbone corresponds to a xyloglucogalactan (Añez, 2002). These gums have non-newtonian behavior, their apparent viscosity decreased with the increasing of temperature, although the pseudoplasticity is not affected (Ávila *et al.,* 1994 and Rincón, 2001). This behavior has been reported for others gums (Elfak *et al.,* 1979; Casas and García, 1999).

This work deals with the application of a mixture of gums, from species located in Venezuela, in the preparation of ice cream.

Materials and Methods

Origin and Purification of the Gum Samples: Gums from *Acacia glomerosa* Benth., *Enterolobium cyclocarpum* (Jacq.) Griseb. and *Hymenaea courbaril* L, were collected from trees located in different counties of Zulia State, Venezuela, South America.

The gums from the two first species were collected after injuries were made at the trunk level. The *H. courbaril* gum was obtained from the seeds by basic treatment (30% NaOH) at the endosperm level.

The gum samples were dissolved in distilled water (3%) and the solutions were filtered through Whatman N° 1 and 42 filter papers. They were dialyzed against running tap water for two days and the gums were recovered by freeze-drying. The powdered pure gums from *A. glomerosa, E. cyclocarpum* and *H. courbaril* were mixed (2:1:2). The optimum concentration of the mixture (0.3%) was established previously (Rincón, 2001).

The others ingredients, used in the preparation of ice cream, were kindly donated by "Productos EFE" S. A., Caracas, Venezuela. The commercial stabilizers (K-carrageenan, sodium alginate, carboxymethylcelulose) were supplied by Grindsted Products A/S.

Preparation of Ice Cream: Ice cream was prepared (30

Kg batches) using the formulation shown in Table 1. The ingredients were added gradually to water (60 °C). The mix was stirred constantly and held in a water bath (70°C); pasteurized (82°C for 20 min), passed through a double stage homogenizer (2000 psig first stage and 500 psig second stage, respectively) and cooled (5°C). Vanilla flavor was added to the mix, after ageing (4 h); and then the mix was frozen in a Cherry Burrell continuous freezer to a draw temperature (-4.6 °C) and a suitable overrun (100%). The ice cream confection was packaged in plastic cups, covered with plastic lids and stored in the hardening room (-30°C) for one week.

Table 1: Formulation of the ice cream preparation

Ingredients	%, w/w
Sugar	14.46
Fat	10
MSNF	11.46
Stabiliser[a]	0.2, 0.3
Emulsifiers[b]	0.2
Vanilla	0.073
Color	0.16
Maltodextrin	0.16
Water	63.18
Total	100

[a]Five treatments: Control (with no stabilizers). A= K-carragenan (0.2%), B=Carboxymethyl cellulose (0.2%), C= Alginate (0.2%), D=mixture of gums investigated (0.3 %), [b]Mono-diglycerides were used as emulsifiers (0.2%).

iscosity, foam expansion and whippability assessments were carried out on the ice confection mix, after overnight ageing (4°C), whereas melt-down/shape factor and sensory evaluation were carried out with ice confection samples which has been stored (-30°C) for one week.

Viscosity: All measurements were made with a Brookfield viscometer, model DVII+, version 3.0, with spindle number 2 at 0.6 rpm. Viscosity of the samples were measured at 22°C.

Total Solids: They were determined by Gravimetric method (AOAC, 1990). The sample (2 g) was weighed into a flat-bottom dish. Then heated on a steam bath for 30 min and then in an air-oven (105°C) for 3.5 h. The residue was reported as total solids (%).

Foam Expansion: It was determined by modification of Poole method (1984). Samples (125 mL) were diluted with distilled water (125 mL) and whipped at maximum speed for 5 min in a Philips mixer Model HR1190/BS. Foams plus remaining unfoamed liquid were transferred immediately to a glass measuring cylinder (2 L)

$$\% \text{ Foam expansion (FE)} = \frac{\text{Foam volume (mL)}}{\text{initial liquid volume (250 mL)}} \times 10$$

Whippability: It was measured using a modified Haggett method (1976). Mix samples (125 mL) were diluted with distilled water (125 mL), then whipped in a Philips mixer model HR1190/BS at full speed for 5 min. Foams and remaining unfoamed liquid were transferred immediately to a glass measuring cylinder (2 L). The final whipped volume was recorded and the results expressed as:

$$\text{Percentage overrun (\% OR)} = \frac{100 \times (Vf - Vi)}{Vi}$$

Color Measurements: Color was measured using the Nippon Denshoku Color Meter Model ND-20DP. Both the CIE (X, Y, Z) and Hunter (L, a, b) methods were used.

Meltdown and Shape Factor: Meltdown and shape factor (SF) were determined by Cottrell method (1980). Ice confection was made in the shape rectangular block, held at low temperature (-30°C) for one week. A stainless steel sieve (mesh size of 2.5 mm) was used as a screen and placed over a beaker (2 L). Frozen samples were then placed over the screen and allowed to melt at room temperature (20°C).

The SF was determined by measuring the ice cream block dimensions at zero time and 2.5 h after melting, the results are expressed as:

$$SF = \frac{\text{original length}}{\text{original depth}} \times \frac{\text{final depth}}{\text{final length}} \times 100$$

Sensory Evaluation: Sensory evaluation was conducted using a structured scale method with 25 panelists. Four different characteristics were scored, based on appearance, flavor, texture (creaminess and iciness) and overall acceptability. One hour prior to evaluation, samples were removed from the hardening cabinet (-30 °C).

The samples (100 mL cups), tempered in a refrigerator (8°C), were presented in random order on individual trays served with a response form. Evaluations were conducted in individually lighted booths. Water was provided for rinsing between samples.

The data were analysed by one way analysis of variance (ANOVA), followed by Duncan least significant difference technique, using Costat as a statistical package software.

Results

Quality characteristics of the ice cream preparation are given in Tables 2 and 3. Sensory evaluation appears in Table 4.

Disccussion

Compared with the control, as expected, all stabilizers showed the ability, in varying degrees, to provide the mix with high viscosity as desired in the ice cream manufacturing; the mixture of the gums studied provided the highest viscosity Table 2.

The whippability, a measured of the amount of air (OR %) varies from 78-125%, Table 2. The treatments C and D exhibited the strongest level of whippability, although they have the highest values of viscosity, Table 2. These results may be related to better aeration and protein orientation in the whipped system, even at high levels of viscosity. In this respect, these results are according with those reported previously (Cottrell *et al.*, 1980 and Abu-Lehia *et al.*, 1989); the high viscosity is a desirable property, attributed to its ability to impart a desirable whippability, body and texture.

A high positive correlation (r = 0.92) between the viscosity and color intensity of the ice cream confection, (Table 2), is probably due to the effect of the stabilisers; the increasing of viscosity, helps the stabilization of the system and increases its uniformity, therefore, may be related to the color intensity of the product.

The five treatments exhibited variable foam expansion values (FE), (Table 2). The alginate (158%) and carrageenan (155 %) gave comparable values to that provided by the mixture of gums from species located in Venezuela (154%). It was reported that high viscosity is associated with an optimum foaming capacity (Townsend and Nakai, 1993).

The same trend as in the FE results was observed in whippability which showed a strong positive correlation with FE (r=1.00). Whippability of an ice confection mix is impaired by increased mix viscosity (Cottrell *et al.*, 1979 and Arbuckle, 1986).

The mixture gums studied provided the resulting products with the highest total solids, but without significant differences relative to the others treatments, which indicates that the use of stabilizers did not influence total solids in a significant way, (Table 2).

Table 2: Quality characteristic of the ice cream preparation[a] with different treatments of stabilisiers

Treatments	Viscosity (x 10^{-3} PaS)	Total solids (%)	FE (%)	WP (%OR)	C I (%)
Control	15±0.08	35±0.02	21.3±0.08	78.0±0.06	5.4
A	32±0.01	35.6±0.01	155.0±0.00	105±0.05	8.5
B	30±0.03	35.6±0.00	145.7±0.01	98±0.05	8.5
C	40±0.02	35.8±0.01	158.0±0.00	125±0.04	10.1
D	43±0.05	36.4±0.01	154.0±0.04	114±0.06	11.2

[a]Means of triplicate assessment (Mean ± SE)

FE: Foam expansion, WP (OR %): Whippability (%overrun)

C I: Color intensity

A = K-carragenan , B = Carboxymethyl cellulose, C = Alginate, D = mixture of gums investigated

Table 3: Meltdown, shape factor properties for ice cream preparation[a] with different treatments of stabilisiers

Treatments	SF (%)	Meltdown (%)
Control	63.2±0.07	65 ±0.06
A	71.4±0.05	30 ±0.01
B	75.0±0.04	35.6±0.00
C	80.0±0.02	21.3±0.01
D	78.6±0.05	22.5±0.01

[a]Means of triplicate assessment (Mean ± SE)

SF: Shape factor

A = K-carragenan, B = Carboxymethyl cellulose, C = Alginate, D = mixture of gums investigated

The use of stabilizers (single or as a mixture) demonstrated the tendency to reduce the rate of meltdown, (Table 3). The meltdown gave high positive correlation with shape factor (SF) of the ice cream confection (r=0.91). It is worthy to note that the mixture of gums tested provided desirable melting characteristics in ice cream preparation, (Table 3).

The appearance attributes exhibited positive

Table 4: Sensory scores[a] for ice cream preparationa

		Sensory attributes[b]			
Treatments	Appearence[c]	Creaminess[d]	Iciness[e]	Flavor[f]	OA[g]
Control	4.99[c]	4.48[b]	3.40[b]	6.12[ab]	5.92[ab]
A	5.24[bc]	5.44[a]	3.10[b]	6.28[ab]	5.88[ab]
B	5.00[c]	4.60[b]	5.96[a]	5.58[b]	5.60[b]
C	6.28[a]	5.80[a]	3.00[b]	6.52[ab]	6.72[ab]
D	6.20[ab]	5.96[a]	2.96[b]	7.12[a]	7.17[a]

[a]Means of 25 sensory scores
[b]Means followed by the same letter the same column are not significantly different ($p < 0.05$) by Duncan Multiple Range Test
[c]Based on 9 point scale, 9: excellent; 1: poor
[d]Based on 9-point scale, 9:extremely creamy; 1: not creamy
[e]Based on 9-point scale, 9:extremely icy; 1: not icy
[f]Based on 9-point scale, 9:like extremely; 1: dislike extremely
[g]Overall acceptability, based on 9-point scale, 9: like extremely; 1: dislike extremely

correlations with creaminess ($r=0.87$), flavour ($r=0.92$) and overall acceptability ($r=0.97$).

Texture was evaluated by scoring creaminess and iciness attributes, which are important to perceived quality of final product. Sensory analysis, in general, except for CMS, (Table 4), showed that the use of stabilizers impart a better texture for ice cream preparation; although, the best texture was observed with the mixture of gums. The increasing iciness was perceived by the judges as an increase in ice crystal size of the product; the iciness may be related to the mix viscosity but it has been reported that increasing viscosity restricts molecule migration to the crystal nuclei which limits the size of ice crystal (Moore and Shoemaker, 1981; Voulasiki and Zerfiridis, 1990 and Goff *et al.,* 1993).

Creaminess, had positive correlations with total solids and flavor, ($r=0.87$ and 0.84 respectively). The effect of total solids on creaminess is due to its ability to reduce the amount of free water to be frozen, obstructing the ice crystal growth; enhancing the creamy mouth feel of the product (Arbuckle, 1986 and Fox, 1992). The creaminess will lead to better overall acceptability, as indicated by their high positive correlation ($r=0.94$). Flavor also had positive correlation with overall acceptability, ($r=0.97$), (Table 4).

The mixture of gums studied from *A. glomerosa*, *E. cyclocarpum* and *H. courbaril* led to obtained a product with the better sensory attributes, as was indicated by the highest score flavor (7.12), creaminess (5.96), overall acceptability (7.17) and the lowest score of iciness (2.96), (Table 4). Although, the results also indicated that a single stabiliser (except in treatment B) could improve the sensory properties of the ice cream confection.

The results of this work indicated the good functionality of the mixture of these three gums in the food industry. Further work may be needed to explore these possibilities.

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