African Journal of Food Science Vol. 5(4), pp. 181 – 187, April 2011
Available online http://www.academicjournals.org/ajfs
ISSN 1996-0794 ©2011 Academic Journals

Full Length Research Paper

Elaboration of blackberry (*Rubus glaucus* Benth.) jellies with native and modified banana starches (*Musa* ABB)

Shelly Alemán[1], Emperatriz Pacheco-Delahaye[1], Elevina Pérez[2]* and Mily Schroeder[3]

[1]Food Biochemistry Laboratory, Institute of Chemical Technology, Faculty of Agronomy the University of Central Venezuela, Postal Code 2105, Maracay Edo Aragua, Venezuela.
[2]Institute of Food Science and Technology, Faculty of Sciences, Central University of Venezuela, Venezuela
[3]Social Science Department, University of Phoenix, Yuma Arizona, USA.

Accepted 23 March, 2011

To diversify the use of tropical fruits such as "topocho" (*Musa* ABB) and blackberry (*Rubus glaucus* Benth), jellies were formulated, and thickened with 20% of native starch (BS), and modified granular starch (GBS) starch from unripe "topocho" with, and without the addition of carboxymethylcellulose (CMC) using corn starch as control. A sensorial evaluation of the recipes was completed (without CMC at cero time) to determine the preferred jelly. The physical and chemical properties of the stored jellies at refrigeration temperature (4ºC) during 10 days were also evaluated. The data shown that the jellies elaborated with native starch and corn starch did not show statistical significant differences ($p \leq 0.05$) in all of the parameters studied. When comparing the jellies elaborated with *topocho* starch to those elaborated with corn starch during the first five days of storage, the data did not reveal any significant variation in the ºBrix, (33.5 a 38.5), pH (3.4 a 3.9), titratable acidity (237.8 a 236 mg, as citric acid/100 ml of the sample), apparent viscosity (75 a 65 Pas) and syneresis. In addition to diversify the use of the blackberry, topocho starch could be a good substitute for the commercial corn starch to produce jellies.

Key words: Musaceas, native starch, modified starch blackberry, jellies.

INTRODUCTION

Bananas (*Musa* spp) are an important staple food at the tropics, because of their accessibility and low cost (Laborem et al., 2001; Pacheco and Testa, 2005; Vuylsteke et al., 1999). "Topocho" is a colloquial name for the banana genomic ABB variety used in Venezuela. Unripe edible pulp of bananas has important contents of starch and resistant starch (Juarez-Garcia et al., 2006). It has been suggested that the resistant starch content from bananas diminished the postprandial curve, and glycemic index in consumers of bananas (Pacheco and Testa, 2005; Daramola and Osanyinlusi, 2006; Rodríguez et al., 2008; Hernández et al., 2008; Da Mota et al., 2000; González and Pacheco, 2006).

Edible fruits of the *Rubus glaucus* plants (Andean raspberry, Andes berry) are consumed at South America (Wagner et al., 1999). These fruits with low caloric value are sources of soluble fiber, potassium, iron, calcium, and vitamin C. These berries also contain tannins with astringent properties, and various organic acids, and also

*Corresponding author. E-mail: perezee@hotmail.com. Tel: +582127534743. Fax: +212.7533871.

have pectin that confer to them a high power gelling. However, those actually characterizes these fruits is its abundance of natural pigments (anthocyans and carotenoids) of important antioxidant action (Moreno et al., 2002; García et al., 1998; Deighton et al., 2000; Sousa et al., 2007). The production of this berries is artisan (Starr et al., 2003), it have not been well commercialized, with its inherent postharvest losses. Therefore, its conversion by adding value shall represent an economic and nutritional profit. Indeed, one of the ways to add value could be to produce jellies from its edible pulp.

Fruit Jelly refers to a clear fruit spread consisting of a set of, sweetened fruit juice. Additional pectin may be added in some instances, in which the original fruit does not supply enough of it, for example with grapes. Native and modified starches have also thickener properties and can be proposed for jelly production, when pectin are not accessible or are too expensive. The goal of the study was to formulate and evaluate the quality properties of a blackberry jelly using banana starch as thickener, to diversify the potential use of these two unconventional sources as ingredients to produce jelly.

MATERIALS AND METHODS

Materials

The unripe banana fruits (*Musa* ABB or "topochos"), were acquired from a local market of Maracay, estate Aragua, Venezuela. The blackberry (*Rubus glaucus* Benth.) were obtained from a market of the Colonia Tovar, estado Aragua. The banana was selected with an unripe grade 1 (green) of optimum physiological maturation, by using the descriptor reported by Von Loesecke (1950). Sugar, commercial corn starch were bought also from the local market of Maracay estate Aragua

Sample preparation

Starch isolation, purification and modification

The native and modified (granular) starches of the banana were prepared as follows: Starch of banana (BS) was obtained from three different batches of edible portion of the unripe fruits, following the method described by Perez et al. (1993), with some modification. The cleaned tubers were peeled, weighed, sliced, and ground for two minutes at high speed in a waring blender with small volumes of distilled water. The homogenate was passed through an 80-mesh sieve. This grinding and screening operation was repeated four more times. The resulting slurry was passed consecutively through a 200-mesh muslin sieve and centrifuged at 1500 rpm for 20 min. After removing the mucilaginous layer, the sediment was washed several times by suspension in distilled water and centrifuging until it appeared to be free of non-starch material. The sediment was dried in an oven at 45°C. The dried starch was blended, passed through a 60-mesh sieve, and stored at room temperature in sealed plastic bags.

To obtain the granular starch (GBS), a portion of the native starch (BS) was submerged in a solution of ethanol (40% v/v). Then it was added with shaking (4 g.min^{-1}) solution of NaOH (3 M), and letting it rest for five minutes, to precipitate the starch. The solution was to filter using a muslin sieve and neutralized with HCl (3 M). Afterward, the sediment was washed four times by suspension in distilled water and centrifuge (3500 rpm × 10 min). The sediment was dried in an oven at 45°C, 16 h. The dried granular starch was blended, sieved through a 60-mesh colander, and stored at room temperature in sealed plastic bags.

Blackberry juice preparation

To obtain the blackberry juice (BJ), three batches of one Kilograms of berries were selected, and washed. The berries were milled in a blender (Mertvisa mod: LQ4, 30129 Caracas, Venezuela). The blend obtained was passed through a muslin filter twice (270 mesh) and cooked at 95°C for 10 min, and transferred to a sterilized glass bottles. The juice was elaborated the same day of the jelly preparation; to avoid losses of vitamins, and color.

Jelly formulation

Various assays were performed to reach the optimum recipe. Five recipes (Figure 1 and Table 1) were selected additionally, using as thickener, arboximethylcelulose (CMC) and corn starch (CS). The pH, °Brix, titratable acidity, viscosity, syneresis (AACC, 2003), and sensorial analysis (Pedrero et al., 1989) were evaluated in each before selecting the final one.

The jelly was elaborated as is highlighted in Figure 1. Each recipe was strongly mixed and cooked at 95°C for 15 min with vigorous agitation. The gel elaborated was transferred to clean plastic containers, and was stored at refrigeration temperature (4±1°C) for the further analysis.

Methods

Quality parameters

The pH, titratable acidity, °Brix (using methods N°s: 02-31, 02-52, 58-20A, and 02-31 respectively) described by AACC (2003). The gel consistency was measured [by using the Bostwick Consistometer following the method described by COVENIN-2005 (1994). Syneresis was evaluated by observing the water separation from the jellies during the storage time at refrigeration temperature (4±1°C).

Sensorial evaluation

A semi-trained affective panel (50 judges), who gave its opinion on sensory characteristics: odor, color, taste, consistency, and global acceptance were tested. The test was performed using a hedonic scale of seven points, described by Pedrero et al. (1989).

Hunter Lab color coordinates

The color was measured by the methodologies described in Hunter Laboratory Manual (2001) using a Hunter Lab., D2TADP-9000, equipped with a standard plate tile with the parameters L*= 94.64, a*= -1.24 and b*=2.27. The Hunter Lab color coordinate system L*, a* and b* values were recorded as the means of three replicates (Giese, 1995).

Table 1. Recipes selected after numerous assay.

Blackberry jelly recipe N°	Code	Blackberry juice (g)	Sugar (g)	Starch (g)	CMC (g)
1	BS:CMC	60	18	20 (BS)	2
2	BS:WCMC	60	18	20 (BS)	0
3	GBS:CMC	60	18	20 (GBS)	2
4	GBS:WCMC	60	18	20 (GBS)	0
5	CS	60	18	20 (CS)	0

CMC = Carboximetilcelulose; BS= banana starch; GBS: granular banana starch; CS= corn starch.

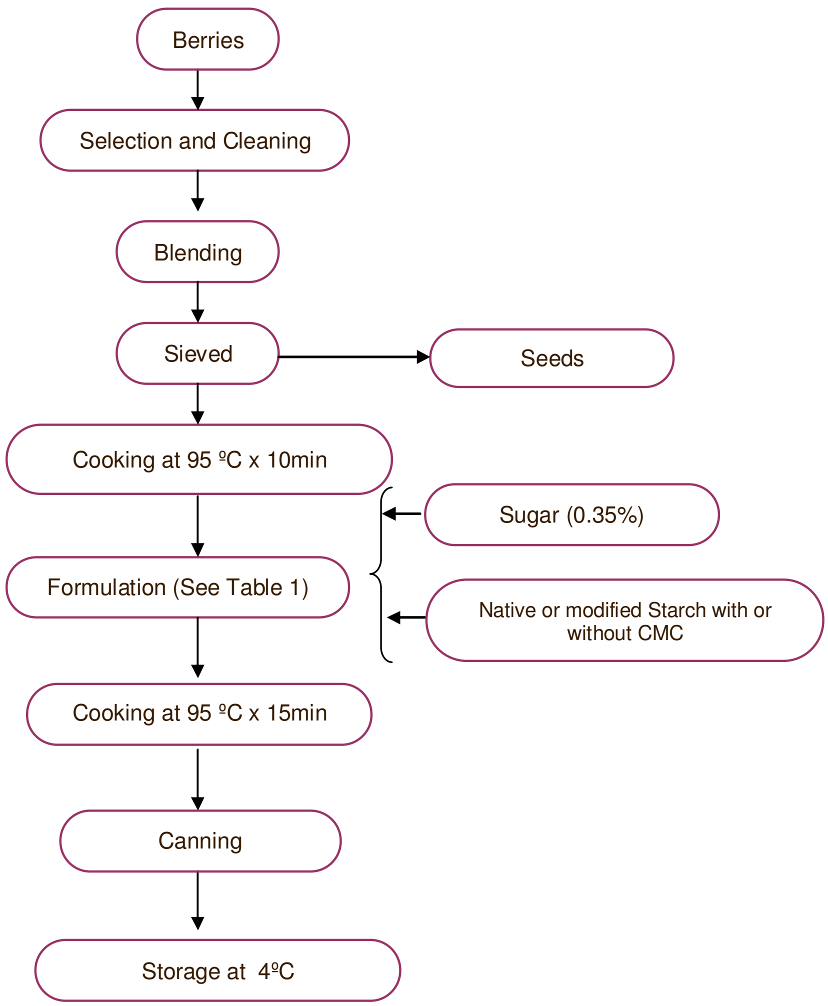

Figure 1. Scheme of elaboration of the blackberry jellies using native (BS) and modified (GS) starches.

Statistical evaluation of analytical data

Data collected of each sample (n = 3) for each batch were analyzed by one-way ANOVA followed by Tukey test, using the Stat Graphics Program (Statically Graphics Educational, Version 6.0, 1992. Manugiststics, Inc. and Statistical Graphics Corp., USA). The one way analysis of variance test was used to assess significant differences ($P \leq 0.05$) among samples. The non-parametric or

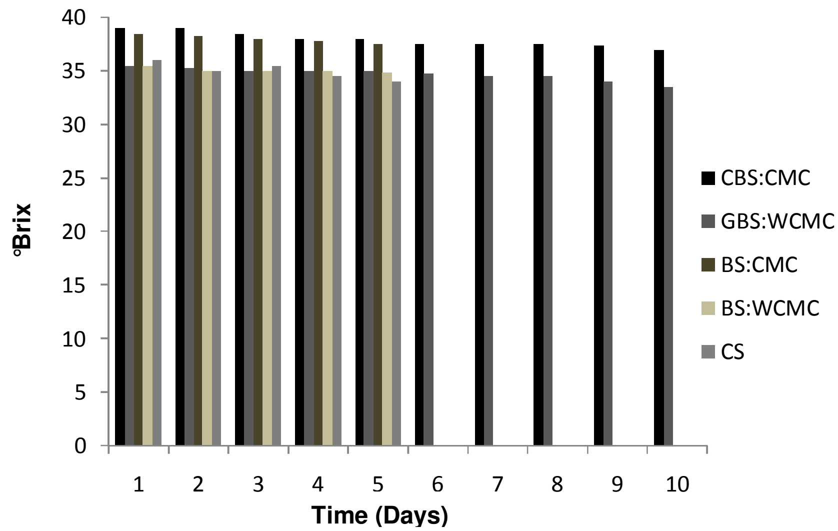

Figure 2. Effects of the thickening agent on the ºBrix during the storage of the blackberry jellies.

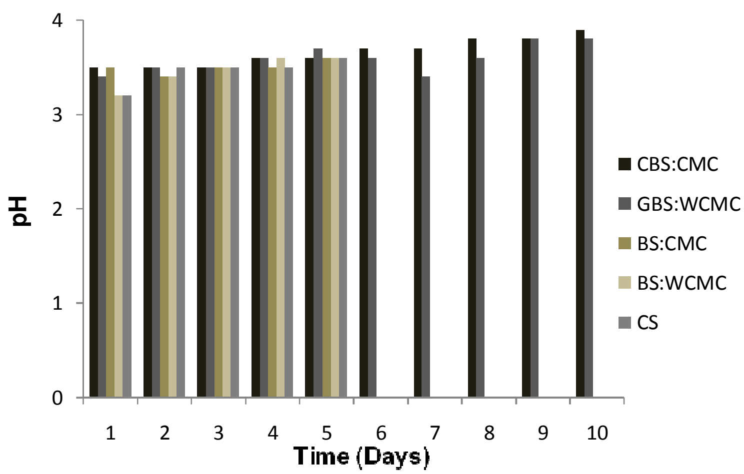

Figure 3. Effects of the thickening agent on the pH during the storage of the blackberry jellies.

Friedman's test was applied to reveal, which was the most accepted treatment, and Tukey test was employed to detect that sample(s) was (were) statistically different (s) at the same significant levels.

RESULTS AND DISCUSION

Table 1 shows the final recipes after numerous assays. The results of ºBrix, pH, titratable acidity, and apparent viscosity were evaluated on each of the recipe, using corn starch as control. As can be seen in all Figures, except for data coded as 3 and 4, which were registered until the day 10, data is represented until the fifth day. It was because, the coded recipes as; 1 (BS:CMC), 2 (BS:SCMC), and 5 (CS) had shown a high syneresis after the fifth day, while the jellies elaborated with the granular starch with and without CMC did not.

As can be seen at Figure 2, the results of the ºBrix values did not show significant differences ($p \leq 0.05$) among the type of recipes, and the storage time. This is due to the capacity of the starch to retain water inside the network of the gel because the behavior in the recipes with CMC is same.

Figures 3 and 4, are reflecting that the pH and titratable acidity neither did show significant differences ($p \leq 0.05$) among the type of recipes, and the storage time

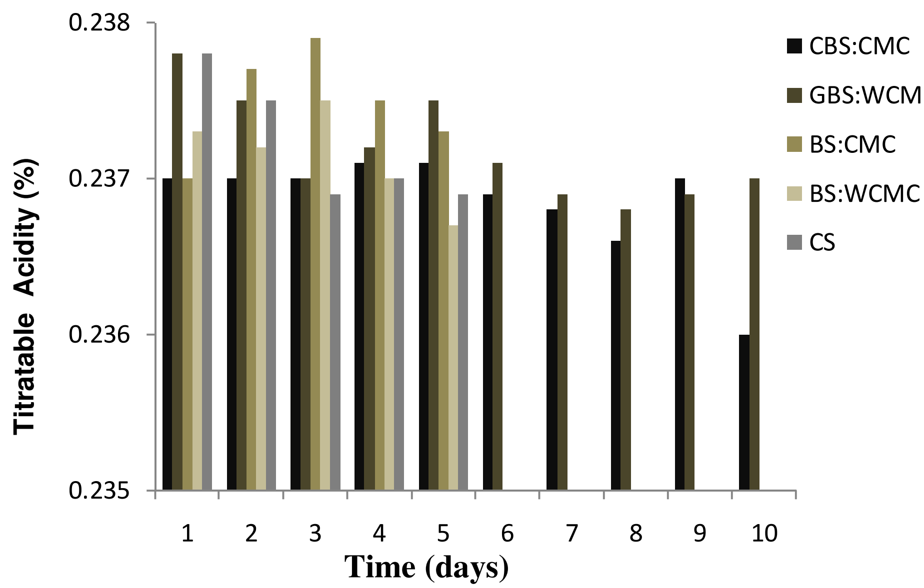

Figure 4. Effects of the thickening agent on the titratable acidity (% citric acid) during the storage of the blackberry jellies.

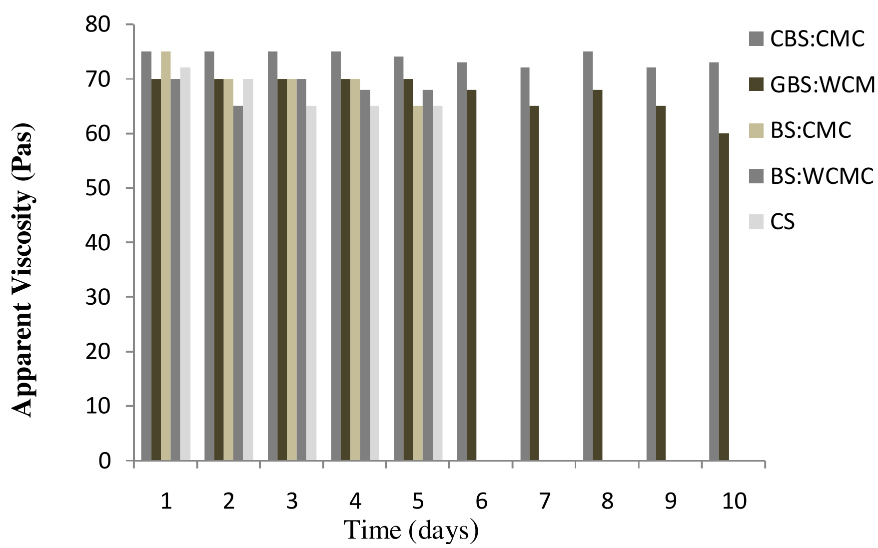

Figure 5. Effects of the thickening agent on the viscosity during the storage of the blackberry jellies.

(Figures 3 and 4). Therefore, the jellies had shown high stability at least during the first 5 days at refrigeration (4°C). Indeed, syneresis was not produced until the fifth day of storage. Consequently, the microorganisms development on the superficies of the jellies was limited (Gonzalez and Pacheco, 2006) corroborating their stability.

Figure 5 represent the apparent viscosity in (Pas) of the six jellies. It was found statistical differences ($p \leq 0.05$) among the six jellies recipes. Similar results were pointed out by Chen and Jane (1994) in their studies on granular cold water soluble corn starch, with high amylose content (70 y 60 Pas). On the other hand, Alvis et al. (2008) have reported lower apparent viscosities of tapioca, yam, and potato starches than those found in this study. Similarly, Navarro et al. (2007) have shown similar behavior when using yam starch as stabilizer of yogurt. It shall be noted that the jellies thickened with granular starch and CMC

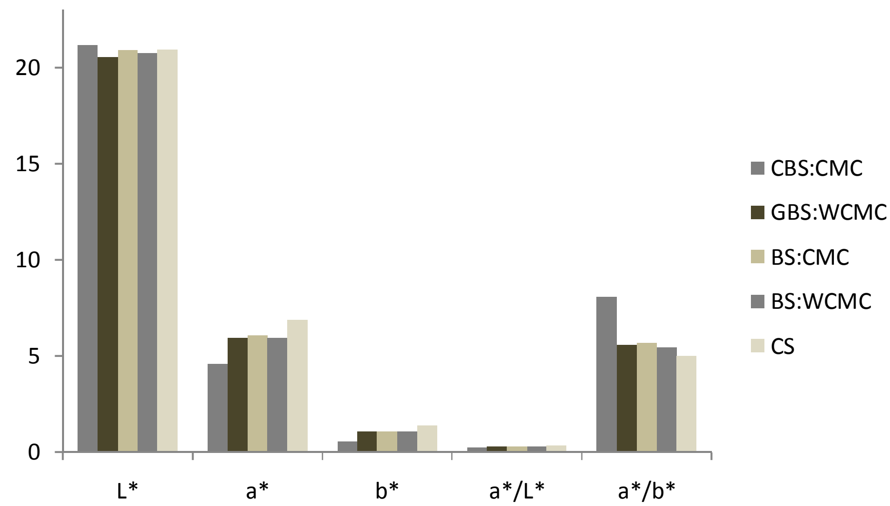

Figure 6. Effects of the thickening agent on the color parameters during the storage of the blackberry jellies.

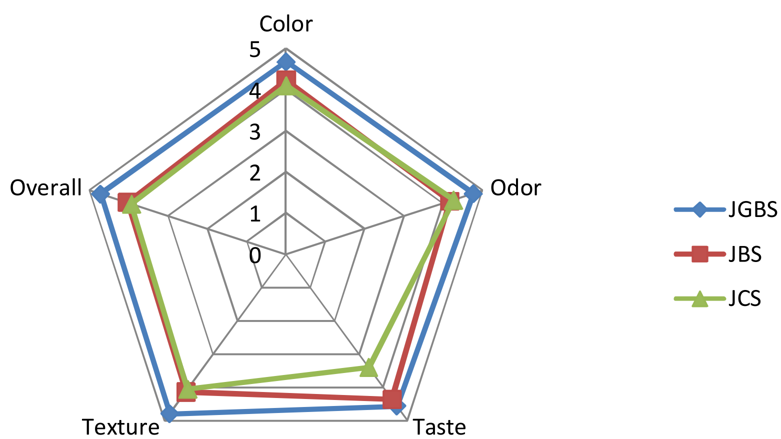

Figure 7. Sensorial evaluation of the blackberry jellies thickened with native banana starch (JBS), with modified banana starch (JGBS) and with corn starch (JCS).

have shown higher apparent viscosities than those thickened with its native counterpart and native corn starch. It can be pointed out that it is due to the higher water absorption and swelling power (23.89 and 24.89%, respectively) of the granular starches as compared to those of the native counterpart. Additionally, in Figure 5 it can be seen that the apparent viscosity developed by the corn starch was also low. With these result we can be demonstrated the feasibility to replace the CMC with the "topocho" granular starch as thickener in this kind of products. All of these results are associated with those postulated by Beleia et al. (2006), Aryee et al. (2006) and Jayakody et al. (2005).

Figure 6 shows the color parameters of the samples.

As can be seen at the Figure, there are significant statistical differences ($p \leq 0.05$) in parameters a*, b*, a*/L* and a*/b*. The data of L was similar in all of the samples, due to the influence of the strong dark fruit color. The positive a* is showing the tendency to the hue red. However, the presence of b* positive is leading to the sampled color to a yellow hue. The relation a*/L* is quite low with a lightly significant difference among them, and the relation a*/b* of the jelly coded as GBS: CMC is higher than the other three, indicative of its low yellow hue.

Data from the sensory evaluation is represented at the Figure 7. The evaluation is showing only different statistical significance at the jellies texture. It can be noted that the jellies elaborated with granular starch (JGBS), were the most favored by judges, followed by those made with native “topocho” starch (JBS), and finally those made with native corn starch (JCS). Similar results were reported by González and Pacheco (2006), Morales et al. (2000) and Navarro et al. (2007).

Conclusions

The scheme of elaboration of blakberries jellies using 5% of native and modified “topocho” starch as thickening agent is feasible. During storage it was determined that the experimental jellies elaborated with modified starch were more stables in its quality parameters (viscosity, °Brix, pH, and titratable acidity) than those elaborated with CMC and native starches. Sensory evaluation results are showing that the jellies thickened with modified “topocho” starch presented greater acceptance than those elaborated with native and starches. However, the texture was the most questioned parameter. This paper has demonstrated the possibility to diversify the potential use of the blackberry in products such as jellies, evidencing the use of starches from non-conventional sources as very competitive at the commercial level with maize starch.

ACKNOWLEDGMENT

Funding for the study was provided by the Council of Scientific and Humanistic Development (CDCH), University of central Venezuela PG Project No. 03-7607-2009.

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