

Research Report

Jam processing: Effect of pectin replacement by locust bean gum on its characteristics

Aida Mekhoukhe^{a,*}, Nacer Mohellebi^a, Tayeb Mohellebi^a, Leila Deflaoui-Abdelfettah^b, Sonia Medouni-Adrar^a, Lila Boulekbache-Makhlouf^a and Khodir Madani^{a,c}

^a*3BS Laboratory, Faculty of Natural Sciences and Life, University of Bejaia, Bejaia, Algeria*

^b*Applied Biochemistry Laboratory, Faculty of Natural Sciences and Life, University of Bejaia, Bejaia, Algeria*

^c*Agri-Food Technologies Research Center, Rouad of Targa Ouzemour, Bejaia, Algeria*

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Abstract.

OBJECTIVE: the present work proposed to extract Locust Bean Gum (LBG) from Algerian carob fruits, evaluate physicochemical and rheological properties (solubility). It aimed also to develop different formulations of strawberry jams with a mixture of LBG and pectin in order to obtain a product with a high sensory acceptance.

METHODS: the physicochemical characteristics of LBG were assessed. The impact of temperature on solubility was also studied. The physical and the sensory profile and acceptance of five Jams were evaluated.

RESULTS: composition results revealed that LBG presented a high level of carbohydrate but low concentrations of fat and ash. The LBG was partially cold-water-soluble (~62% at 25°C) and needed heating to reach a higher solubility value (~89% at 80 °C). Overall, the sensorial acceptances decreased in jams J3 which was formulated with 100% pectin and commercial one (J5). The external preference map explained that most consumers were located to the right side of the map providing evidence that most samples appreciated were J4 and J2 (rate of 80– 100%).

CONCLUSION: In this investigation, the LBG was used successfully in the strawberry jam's formulation.

Keywords: Locust bean gum, boiling water treatment, solubility, strawberry jam, sensory proprieties

1. Introduction

Carob gum namely Locust Bean Gum (LBG), caroubin or algaroba, is obtained from *Ceratonia siliqua* fruit (Leguminosae family) [1, 2]. The carob tree grows amply in Mediterranean areas. It is an agro-sylvo - pastoral species with diverse socio-economic and ecological interests [3]. It can be exploited for the valorization of marginal lands, as a barrier against desertification, for the fight against erosion, as a firebreak, and as a windbreak. It may be also used as forage, ornamental, aromatic, and medicinal plant [3–5].

*Corresponding author: Aida Mekhoukhe, Tel.: +213 557234266; Fax: +213 34813710; E-mails: aida.mekhoukhe@univ-bejaia.dz; aidamkhe@yahoo.fr

In Algeria carob is known for its virtues and its very distinctive color (a brown that turns to the dark). It is very abundant and distributed along the Tellian Atlas [6]. In recent years, awareness-raising work and significant logistics have been implemented to harvest this product and export or transform it locally. It has acquired very significant market shares at the international level, thus deploring the lack of interest and investment in this sector in Algeria [7].

The fleshy pulp of each carob fruit contains more than 40% sugars, and presents a large number of polyphenols, fibers, proteins, and minerals [8–10]. The seeds are dark, chocolate-covered pods that are 10–20 cm long. The kernel is formed of the husk (30–33%), the germ (23–25%), and the endosperm (42–46%) [1, 3, 11].

The pulp can be used for human consumption and as animal feed mainly for their nutritional value [9, 12, 13]. It is often roasted to obtain a brown powder with a chocolate flavor that is exploited as a cocoa substitute [12, 14]. In Egypt, syrups made from the pulp are a popular drink [3, 15]. The Arabs are using an alcoholic drink from the pulp and the Kabyles make from the fruit a dish called tomina [12].

LBG is a white to creamy powder [16, 17]. It is obtained from the endosperm of seeds after removing of the seed hull; which can be removed by thermo- mechanical or chemical treatment [17]. The seeds are split lengthwise and the separation of the germ and endosperm is achieved. The endosperms are recovered, grounded, and sifted to producing the LBG [18, 19]. Chemically, LBG is a galactomannan which corresponds essentially to high molecular weight hydro colloidal polysaccharides composed of galactose and mannose monomers [1, 20, 21].

This molecule is considered as the first galactomannan employed as an additive (E410) in many industrial applications (food and non-food industries) as a thickening and stabilizing agent, due to its capacity to increase viscosity at rather low concentrations (1%) [17]. The properties of this biopolymer are roughly unchanged by pH, salts, or heat treatment because it is non-ionic and the nonappearance of toxicity, this is the main reasons for its application in the food industry as a substitute for agar and other mucilaginous substances [1, 2]. Being the most sought-after derivative of carob, the gum has very interesting characteristics as a multi-additive [16, 22].

Among the characteristics of LBG that favor it in food applications is the synergy with certain gums, in particular κ -carrageenan and xanthan [1, 22]. Effectively, LBG is less expensive than other hydrocolloid agents and may often be linked to accomplish elevated viscosity or other characteristics of food gels, such as elasticity [22–24]. Casas and Garcia-Ochoa [25] showed that the xanthan alone is unable to form a gel. In contrast, when it is mixed with LBG a dramatic heightened in viscosity is discerned, much greater than the viscosity of the separated hydrocolloid solutions. In another investigation, Imeson [26] showed that κ -carrageenan and LBG mixtures can also be exploited for cake frosting or to allow an elastic cohesive gel texture like gelatin.

To our knowledge, some studies [19, 25], have shown a synergistic interaction of LBG at low concentration (1%) with xanthan and guar gums. However, the use of LBG alone or in combination with other hydrocolloids, such as pectin in the production of jam, hasn't been yet reported. The purpose of this work was firstly to extract LBG from Algerian carob, evaluate the yield, chemical composition, and its solubility. Secondary, to formulate jam, and to show the effect of pectin substitution by LBG on its physicochemical and sensory properties.

2. Materials and methods

2.1. Plant material

The fruit of *Ceratonia siliqua* was collected during the summer of 2017 from the Imazayen area situated in the south-east of Bejaia (Algeria). After air-drying, seeds are removed from their pods, ground with an electric grinder (IKA-WorkS, Type A11), and freeze-dried. Fresh strawberries were obtained from a local market, crystal sugar was purchased, pectin was supplied from SARL SPC EL Kseur Toudja group (Algeria), and commercial strawberry jam was purchased.

2.2. Extraction of locust bean gum (LGB)

The LBG was obtained by the water extraction, as described by Dakia et al. [11] with some modifications. An aliquot of whole carob seeds (100 g) was mixed with 800 mL of boiling water at 100 °C with agitation for 1 h. The seeds were recovered, washed and the tegument removed manually from the endosperm. The endosperm was dried at 100°C for 2 h, milled by crusher (IKA-WorkS, Type A11), and sifted to acquire LBG powder with grain size $\leq 125 \mu\text{m}$.

2.3. Chemical analysis

The moisture content of LBG was determined using the method of AOAC [27]. The sample was dried at $105 \pm 1^\circ\text{C}$ until obtaining a constant weight, it was expressed as a percentage. The total of sugars content was determined as described by Dubois et al. [28]. Briefly, after extraction sample with ethanol (80%), the phenol and concentrated sulfuric acid were added to give a yellow-orange color. The absorbance of the solutions was assessed at 485 nm and the concentration of total sugars was calculated using a standard curve prepared with D- glucose. Determination of lipids and fibers was carried out according to De Pádua et al. [29]. Lipids from LBG were extracted with ethyl ether in the Soxhlet apparatus for 5 h. After evaporation of solvent, the residual mass was considered as lipids. For the fibers content, LBG was treated with HCl (5%) at boiling temperature, the residue was digested with NaOH (5%), the mixture was washed with ethyl alcohol and ethyl ether, and dried for 2 h at 100°C, the residual mass was considered as fibers. The ash content was determined after dry mineralisation in a furnace fixed at 600°C for 6 h according to the AOAC procedure [30] and proteins content was measured by Kjeldahl method according to the method of AOAC [31], so the sample was mineralised in H_2SO_4 . Organic nitrogen was distilled in boric acid and the recovered solution was neutralised by NaOH 0.1 N. Proteins content was calculated using nitrogen to provide conversion factor of 6.25 per gram of sample.

2.3.1. Gum solution analysis

Gum solution (1%, w/v) was prepared at room temperature in distilled water. The pH value of the gum solution (1%) was determined using pH meter (Bante 210 pH meter, China). The total soluble solid of the gum solution was determined by direct reading in the refractometer (Schmidt Haensch, AR 12 Abbe Refractometer, Germany).

2.3.2. Solubility measurements

The solubility of LBG was measured according to Dakia et al. [32]: 16 samples were prepared (0.1%, w/v) at different temperatures under agitation, 8 solutions at room temperature (25°C) for 10; 25; 30; 60; 80; 120; 160 and 180 min, other 8 samples at 5; 10;15; 25; 30; 45; 50 and 60 min. Subsequently, each sample was centrifuged (6000 g, 30 min, at 20°C). The supernatant of the corresponding sample was recovered and dried at 105°C for 24 h, the dry weight was considered as soluble substances.

$$\text{Solubility (\%)} = \frac{C_s}{C_p} \times 100 \quad (1)$$

where, C_s : concentration of supernatant (mg/mL); C_p : concentration of the initial solution (mg/mL).

2.4. Strawberry jams preparation

Different formulations of strawberry jams were formulated (strawberry jam without gum, strawberry jam with LBG, strawberry jam with pectin, and jam with strawberry and pectin mixture (50% of each). The fruits (about 6 kg) were selected to choose healthy and still firm, washed thoroughly with water, and crushed for collecting pulp. Sugar was added to the pulp fruit, mixed, and let macerate for 24 h at 6°C. The mixture was heated at 80°C, thus different ingredients (Table 1) were added (pectin and LBG), while boiling and stirring were continued, a

Table 1
Formulations of strawberry jams using different proportions of hydrocolloids

Samples	LBG%	Pectin	Sugar
J1	0	0	P
J2	100	0	P
J3	0	100	P
J4	50	50	P
J5(control)	0	100	P

J1: Jam1; J2: Jam 2; J3: Jam 3; J4: Jam 4; J5: Jam 5. J1: Gum 0%; J2: LBG 100%; J3: Pectin 100%; J4: LBG and Pectin 50%; J5: 5 Control (commercial); P: Presence.

thermometer was used for controlling temperature. The filling was carried out at a high temperature in sterile glass jars. The control jam bought in the market served as a comparison between the jam formulations.

2.4.1. Strawberry jams analysis

The pH of each jam sample was determined using a pH meter. The titrable acidity of samples was carried out by titration with NaOH solution (0.1 N) according to the procedure of Rajeev and Kok [33] and total soluble solids content was determined using refractometer according to the method of Witherspoon and Jackson [34].

2.4.2. Sensory and consumer evaluation

The sensory and consumer evaluation of the five jam samples was performed in the sensory analysis laboratory of the Food Sciences Department at the University of Bejaia (Algeria).

The samples were evaluated by a panel consisted ten expert assessors (ten women between the ages of 30–60). The experts evaluated odor, color, smell, mouth feel (sweet taste, strawberry aroma, acidity, and aftertaste) and texture (consistency) using a numerical interval scale from 1 to 5 where 5 means “in accordance with the sensory specification” (corresponds to the highest intensity and 1 means the lowest intensity).

In the consumer acceptance test, participants were selected according to the following criteria: age (from 20 to 40 years), various socioeconomic backgrounds, regular jam consumers (minimum intake of one a week). 122 participants were selected. The untrained panelists were submitted to taste samples in individual tables under white light, each sample (10 mL) was transferred into a plastic cup presented with a digit number code and displayed in balanced order, provided water and bread for cleaning the palate between each sample. The consumers evaluated the overall acceptability of the five samples using a 9-point hedonic scale ranging from 1 (“dislike extremely”) to 9 (“like extremely”). In this study, only this overall liking parameter is assessed and presented.

3. Statistical analysis

Analysis of variance (ANOVA) was used to determine the statistical difference and the statistical significance at $p < 0.05$ using Statistica software (STATISTICA 5.5 StatSoft, USA). Results are expressed as the means $\pm$ SD of three replicates.

The data collected from sensory evaluation and hedonic were processed using the Software XLSTAT (version 16.5.03 2014, Addinosoft), which is a complete tool for analyzing data and statistics. The main features of this software, used to interpret the results as follows: Principal Component Analysis (PCA), Hierarchical Cluster Analysis (HCA), and Preference MAPPING (PREFMAP).

4. Results

The results of the separation of carob seeds after water extraction (Table 2) indicated that the endosperm was the greatest fraction in the seeds, it yielded $51.62 \pm 1.22\%$, while the germ yield from this treatment represents $18.91 \pm 1.76\%$ of the total weight of the seeds.

The compositional data of LBG are represented in Table 2. The analysis showed that LBG had a low level of lipids (0.84 ± 0.05 g/100 g), crude fiber content ($0.65 \pm 0.06\%$) and ash ($0.65 \pm 0.05\%$), an appreciable quantity

Table 2
Yield extraction and physicochemical analysis of LBG

Yield extraction Mean $\pm$ SD	
Husk*	22.63 ± 1.27
Endosperm*	51.62 ± 1.22
Germ*	18.91 ± 1.76
Contents	Mean $\pm$ SD
Chemical analysis	
Moisture	8.66 ± 0.59
Carbohydrates**	16.67 ± 0.46
Fiber*	0.65 ± 0.06
Lipids**	0.84 ± 0.05
Ash*	0.65 ± 0.05
Protein**	4.46 ± 0.82
Physical properties	
pH	6.29 ± 0.01
Degree Brix***	0.71 ± 0.01

Results are mean values of 3 determinations $\pm$ standard deviation; * : %;

** g /100 g; *** : °bx.

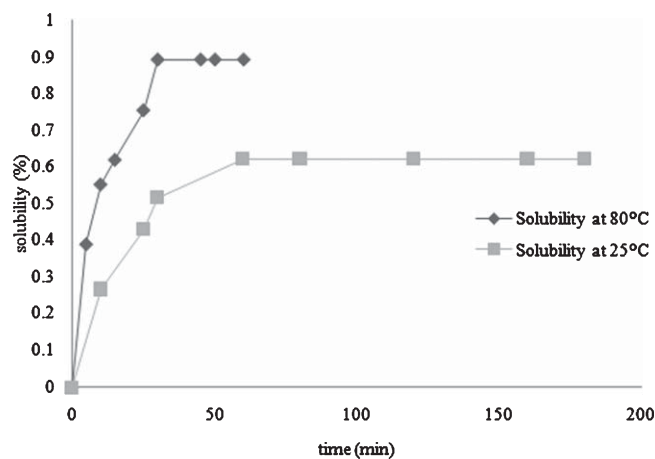


Fig. 1. Solubility kinetic of LBG solutions at 25 and 80°C.

Table 3
Strawberry jams analysis

Samples	pH	SD	Acidity	SD	Brix	SD
J1	3.22 ^b	0.02	0.67 ^a	0.01	61 ^b	1
J2	3.39 ^a	0.01	0.70 ^a	0.01	55 ^c	1
J3	3.46 ^a	0.01	0.67 ^a	0.02	58 ^{bc}	2
J4	3.2 ^b	0.03	0.70 ^a	0.03	56.66 ^c	1.73
J5(control)	3.08 ^c	0.01	0.67 ^a	0.05	67 ^a	1

^aEach value is the average of three replicates $\pm$ standard deviation. In each column, different letters indicate significant difference ($P < 0.05$).

Table 4
The mean scores of sensory evaluation and consumers testing

Jams Treatment	Overall acceptance	Color	Odor	Sweet	Strawberry aroma	Acidity	Aftertaste	Consistency
J1	6.2 ^{ab}	3.6 ^a	3.7 ^a	3.9 ^a	3.5 ^a	1.9 ^a	1.6 ^a	2.00 ^c
J2	6.3 ^{ab}	3.0 ^a	3.9 ^a	3.8 ^a	3.3 ^a	1.9 ^a	1.8 ^a	3.5 ^{ab}
J3	5.4 ^{ab}	2.8 ^a	3.1 ^{ab}	4.1 ^a	3.1 ^a	2.4 ^a	2.4 ^a	3.2 ^{ab}
J4	6.8 ^a	3.0 ^a	2.5 ^{bc}	3.3 ^a	2.7 ^a	2.4 ^a	2.2 ^a	4.00 ^a
J5(control)	4.1 ^b	3.3 ^a	1.7 ^c	3.9 ^a	1.4 ^b	2.7 ^a	2.8 ^a	3.1 ^b

Mean preference consumers			
	Cluster1	Cluster 2	Cluster 3
J1	7.07	4.89	6.08
J2	7.16	6.86	6.64
J3	6.60	7.03	4.54
J4	7.19	7.89	4.43
J5(control)	5.98	2.655	2.86

^aEach value is the average of three replicates $\pm$ standard deviation. In each column, different letters indicate significant difference ($P < 0.05$).

of protein (4.46 ± 0.82 g/100), and a high level of total carbohydrates (16.67 ± 0.46 g/100 g). The average pH value acquired in this study was 6.29 ± 0.012 and the Brix degree was low (0.71 ± 0.01).

As shown in Fig. 1, LBG is partially soluble in cold water at 25°C (50%/ 30 min) and must be heated to achieve maximum solubility at 80°C (90%/30 min). The results showed that maximum solubility of carob gum at 25°C was $62.26 \pm 0.85\%$ after 180 min, while it was at 80°C $89.13 \pm 1.09\%$ after 60 min.

Table 3 showed the results of strawberry jams analysis prepared with the addition of hydrocolloids. The acidity tested is almost equivalent; they varied from 0.67 to 0.70 g/100 g of citric acid. The highest acidity is observed in commercial sample (J5) (0.70 ± 0.01), while the lowest is obtained in jam with LBG (J2; 100 %), jam with pectin (J3; 100 %), jam with LBG (50%), and pectin (J4; 50%) and jam without gum (J1) with 0.67 ± 0.01 g/100 g of citric acid, respectively. The data obtained showed that the samples were not significantly different in their pH values. J5 has the lowest pH value (3.08 ± 0.01), while J3 has the highest result (3.46 ± 0.01). The J5 presented a significantly higher amount of degree of Brix (67.66 ± 1.52 %) compared to the other samples while, the J2 and J4 showed the lowest contents (55 ± 1 and 56.66 ± 1.73 , respectively).

The results of the sensory evaluation are represented in Table 4. The samples were not different significantly ($p > 0.05$) in the color, odor, sweet, acidity, and strawberry aroma. As can be observed, the overall appreciation and consistency (texture) are obtained by sample J4 with 6.8 and 4.00 points, respectively. The low consistency score of J1 could be due to the preparation (made without gums or hydrocolloids).

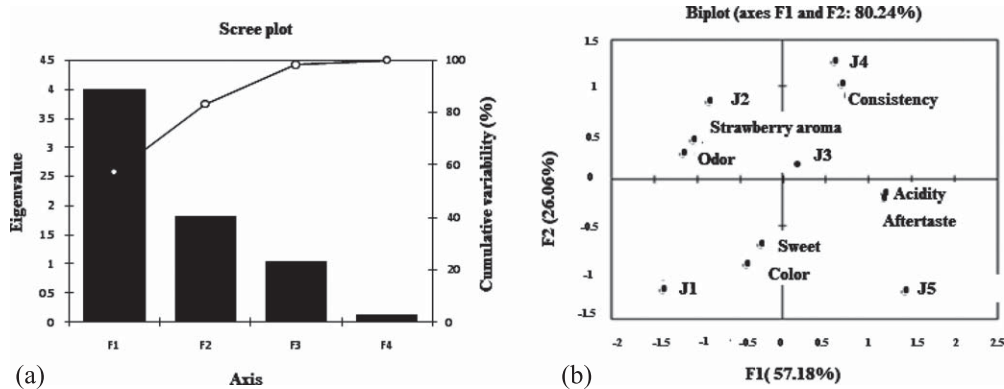


Fig. 2. a) Scree plot of trained panelists; b) Principal component of PCA analysis of trained panelists of jams and sensory descriptors.

The results of the Scree plot of PCA of semi trained panelists (Fig. 2a) revealed that based on eigenvector loadings, only the first two axes (F1 and F2) were the most meaningful/principal axes. The first principal component (F1) with an eigenvalue of 4.00 was able to clarify 57.18% of the total variation while the first (F2) with eigenvalue of 1.82 elucidated 26.06% of the variation and both the PCA's (F1 and F2) explained 83.24% of the total variation.

According to the PCA's data (Fig. 2b), it can be established that the product J4 (50% pectin and LBG) and J3 (LBG 100%) were in the same quadrant of the viscosity (consistency). Also, J2 (Gum 0%) differs from other jams by the odor and the strawberry aroma, J1 (100%) by the sweet, the taste and the color while the sample J5 (commercial) by the aftertaste and its acidity. The highest consistency of strawberry jam (J4) was probably due to the mixture of LBG with pectin at 50%. This mixture was a favor to permit the two gums to interact synergistically so that together they create a denser gel than either one alone (J3 pectin alone (3.2) and J2 LBG (3.5)).

The internal preference map (Fig. 3a), showed that 96.86% of the variation in consumer acceptance of strawberry jams, with 80.36% and 16.50% in the first and second dimensions, respectively. The first dimension separated the treatments into two groups: 1) J4 (50% LBG + 50% pectin) + J3 (pectin addition) and J1 (without addition) + J2 (LBG 100%). The second dimension separated the treatments into a third group composed of J5 (control).

The Hierarchical Cluster Analysis (HCA) is a classification method that allows visualizing the progressive grouping of data. The results are assembled in dendrogram; it makes it possible to represent the different classes created by naive consumers. The dendrogram (Fig. 3b) showed three similarly distributed segments, according to the number of people, with the first having 33 people (cluster 1), the second having 7 people (cluster 2) and the third having 48 people (cluster 3). The J4 (with 50% LBG + 50% pectin) sample had the highest values about the overall acceptance (Table 4), varying from 7.897 to 4.432 in segment 1. However, in segment 2, sample J2 (100% LBG) had the highest value for overall acceptance, with 7.161 ($p < 0.05$).

The external preference map (Fig. 4) explained that most consumers were located to the right side of the map providing evidence that most samples appreciated were J4 and J2 (rate of 80–100%). These samples were distinguished by the addition of LBG (100%) or a mixture of 50% pectin + 50% LBG. On the other hand, product J5 (commercial) was not well accepted amongst consumers.

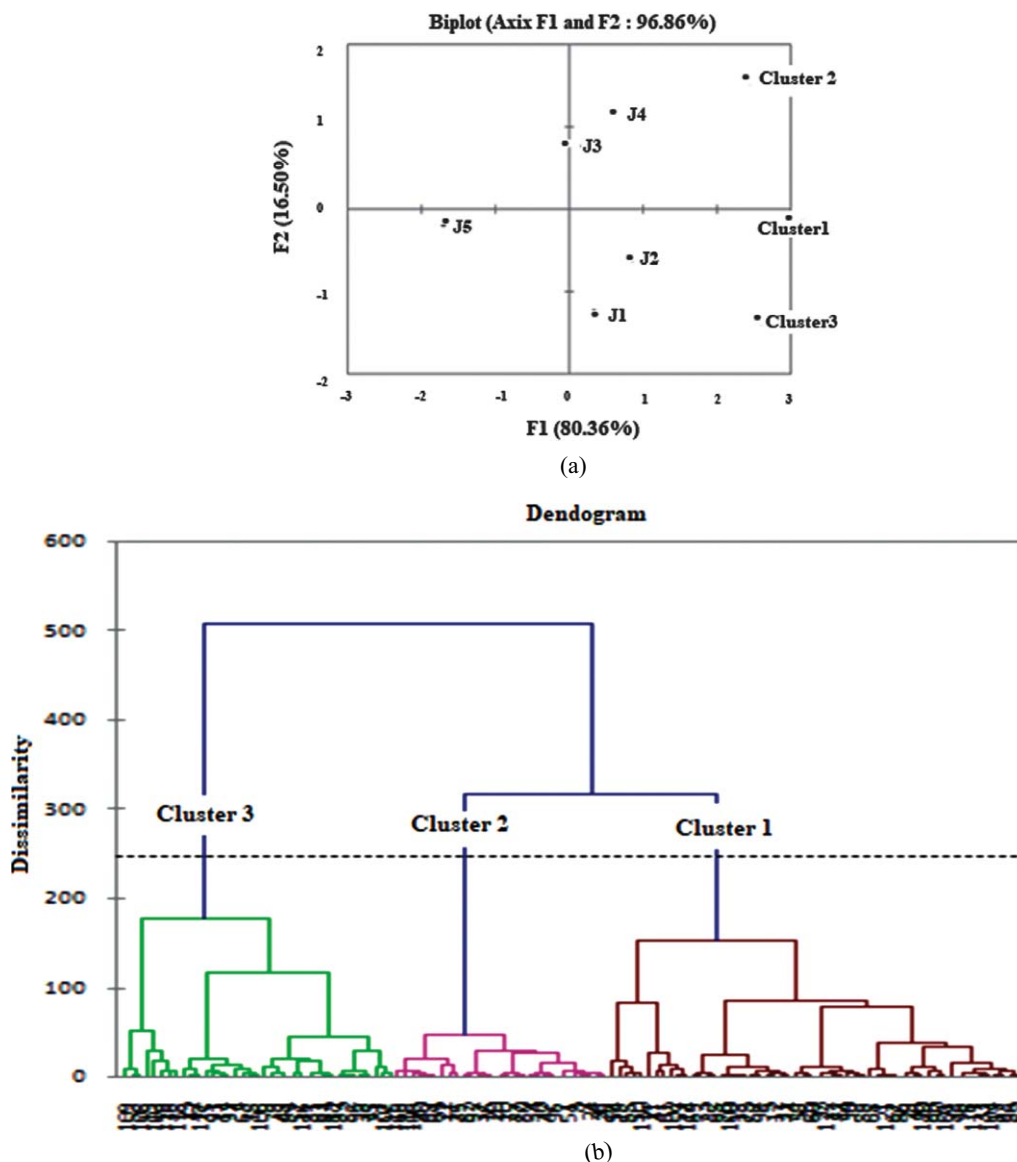


Fig. 3. a) Internal preference map of consumers; b) Dendrogram of consumers of strawberry jams.

5. Discussion

In this research, seeds of Algerian carob trees grown in Bejaia city were used to produce LBG. Our results were close to those reported (50 % of endosperm and ~20% of germ) by Dakia et al. [11] and higher than the value (46.04%) of Mekhoukhe et al. [35] using acid treatment. Pollard et al. [21] reported that extraction yield depends on the separation procedure from seed. According to Dakia et al. [32], the extraction of LBG by water extraction might be chosen for its bigger yield.

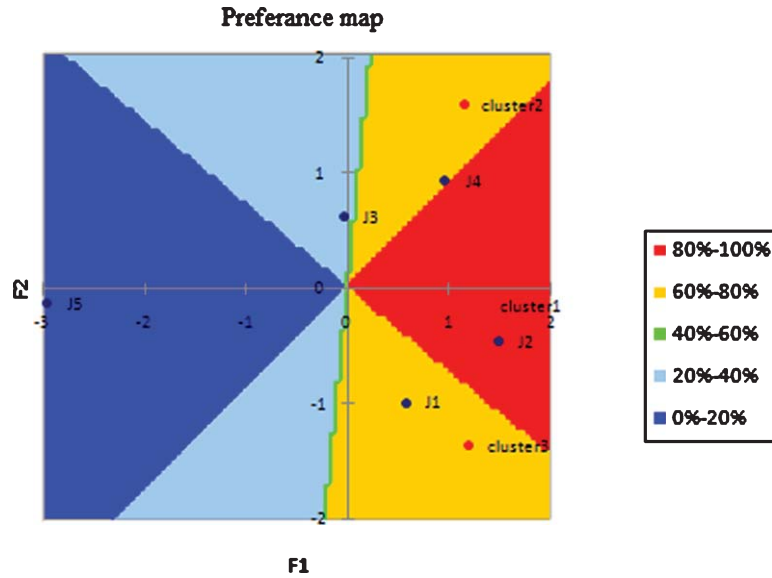


Fig. 4. External preference mapping of consumers clusters and strawberry jams.

The pH is an expression of the activity of hydrogen ions and the low pH value increases the acidity of the environment [3]. LBG is a nonionic, neutral polysaccharide with a pH range of 5.0 to 6.5 [21]. These results are close to those obtained ($\text{pH } 6.52 \pm 0.02$) by Kivrak et al. [36].

The degree of Brix measures the weight in grams of soluble solids (sugar in fruits) contained in 100 g of product [37]. Our results were similar to those reported (0.73 bx°) by Kivrak et al. [36].

LBG is insoluble in most organic solvents; it's partially soluble in water at room temperature and soluble in hot water. They need heating to over 85°C for 10 min for total solubility [1]. These observations are similar to those recorded by Dakia et al. [32] and Farahnaky et al. [38].

As reported by Deuel and Neukom [1] and Dakia et al. [32], the variation in solubility recorded is probably due to the properties of some substances of high molecular weight (such as galactomannans but having a low level of galactose residues) which are soluble at high temperature, nevertheless, they are less soluble at low temperature, displaying that the LBG is not homogeneous galactomannan.

According to literature reports, the solubility of LBG does not exceed 90%, although it can vary depending on many factors, namely the granulation of the gum (particle size), the temperature, and the ionic strengths [20, 21].

The acidity of the samples reflects its high levels of organic acids. In the strawberry fruit, the most dominant organic acid is citric acid [39]. Our results are in agreement with those reported (0.68) by Khan et al. [40], but higher than those reported (0.28 to 0.46%) by Kang and Cho [41] prepared with 20% resistant starch. However, they are slightly lower than those reported (0.53–0.75 %) by Rodrigues et al. [42] of strawberry jams, blueberry, and blackberry from Brazil with 1% high methoxyl pectin.

Usually, strawberry jams pH values are ranged between 3.2 and 3.4 [43]. Our findings are close to those obtained (3.23 with LBG and 3.41 with pectin) by Razak et al. [44] in mango filling.

Generally, a strawberry jam should have a Brix degree between 60 and 55%, which allows for better preservation [41]. The results obtained in this study are very close to those revealed (62– 66 %) by Rodrigues et al. [42] and by Guichard et al. [45] that ranging from 60 to 63%.

No reports have been established regarding the physicochemical of strawberry jams formulated with carob gum in the literature. However, Kang and Cho [41] have developed a strawberry jam by incorporating starch as a

gelling agent at different concentrations and have reported larger pH values ranging from 3.98–4.11. This rise is possibly related according to Kim and Kim [46] to the influence of the added thickener (starch). Razak et al. [44], have announced that the concentrations and type of the hydrocolloids applied may affect the physicochemical properties of the mango filling.

LBG forms less viscous solutions than guar (viscosity at 1%–3000 mPa.S at 25°C compared to 5000 mPa.S for guar) [18, 24]. Indeed according to Pederson [47] and Pollard et al. [21], synergistic issues occur when LBG is mixed with other hydrocolloids. It is generally used in a mixture with xanthan to manufacture elastic gels. In fact, the aggregated structure of LBG can also confer better textural properties than other hydrocolloids [24].

No information has been reported in the literature for the exploitation of LBG alone or mixed with other hydrocolloids or gums in jam products as an ingredient.

Gaspar et al. [48] have optimized the production of reduced calorie grape juice jelly founded on the development of a mixture of xanthan, LBG, and gellan gums. According to a Portuguese analytical panel test, the best reduced-calorie grape juice jelly is produced with 39.3% total sugar with proportions 1:1:1.7 of gellan, xanthan and LBG, respectively. Khouryieh et al. [49] reported that in the production of three jelly using sucralose, low-methoxyl pectin, and maltodextrin with either xanthan gum or LBG singly or in combination, this last one was more acceptable by consumers for all the sensory attributes in contrast to the jelly commercially available in the retail market. In another investigation, Javanmard et al. [50] formulated a series of mango jams employing different hydrocolloid solutions (high methoxyl pectin (HMP), carboxymethyl cellulose (CMC), and sago starch) as regards the sensory evaluation, panelists have judged the overall acceptability of mango jams with 6% sago starch. In a study conducted by Kavaya et al. [51], the panelists preferred where jam gum Arabic was used together with pectin at level 5% in pineapple and red plum jam.

6. Conclusion

LBG is considered as the first galactomannan exploited as an additive in industries mostly in food one. In this investigation, LBG was extracted by water extraction from Algerian carob seeds (yield: $51.625 \pm 2\%$). Chemical composition of this gum showed that it consists mainly of sugars (a major constituent) with a content of $16.67 \pm 0.46\%$, and contains small amounts proteins and lipids which were $4.46 \pm 0.82\%$ and $0.84 \pm 0.05\%$ respectively. They also provided information on the pH of the gum which is close to neutrality, 6.29 ± 0.012 , and on its solubility, which increases at high temperatures ($\sim 89\%$) compared to low temperatures.

In this study, the LBG was used successfully in the strawberry jam's formulation. This gum supplementation had no negative effects on its physicochemical properties. The elaborated product is appreciated by a large part of the tasters (80%), the same results have shown that it is characterized by a good smell, consistency, and aroma pleasant. This investigation showed that formulating jam using LBG alone or a combination with pectin may be achieved with acceptable sensory attributes. Therefore, such characteristics may qualify LBG as a natural substitute for thickeners used by jam industries or may be exploited in other products such as ice cream, dairy products (yoghurt and cream cheese). These properties of LBG allow its use as interesting additives for several industries, in particular for the food industry, since they support the application mostly of jam with acceptable rheological and physical properties.

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Conflict of Interest

The authors announced that there is no conflict of interest.

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