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# Validation of a pulp-type candy (Pulpijamay) based on the by-product of the hibiscus flower (*Hibiscus sabdariffa*)

# Validación de un dulce tipo pulpa (Pulpijamay) a base del subproducto de la flor de jamaica (*Hibiscus sabdariffa*)

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**Abstract**

There is a diversity of sweets in confectionery according to times and countries, according to regions and religions where there is no limitation in the preparation of the sweet depending on the imagination of each confectioner. With the jamaica flower (*Hibiscus sabdariffa*) various food products are made and currently with pharmaceutical interest, certain products are attributed beneficial qualities in weight loss, favoring the digestive process in a good way, it is slightly laxative and is also diuretic, reason for which it has cleansing and detoxifying effects, despite these benefits, in general only the supernatant is used and the flower is discarded as organic waste. Therefore, in the present research work, it seeks the use of the pulp of the jamaican flower (*Hibiscus sabdariffa*) developing a sweet, carrying out tests with different binding substances and concentrations, obtaining samples of paste to later be mixed with sucrose, salt and chili pequin. The same procedure was carried out for gum arabic, glucose and the glucose-sucrose mixture. Physicochemical results were obtained from the product, such as pH, ºBrix and the desired viscosity for the Jamaica flower candy.

**Flor de Jamaica, Sweet, By-product**

**Resumen**

Existe una diversidad de dulces en confitería de acuerdo a épocas y países, según regiones y religiones donde no existe una limitante en la elaboración del dulce dependiendo de la imaginación de cada dulcero. Con la flor de jamaica (*Hibiscus sabdariffa)* se elaboran diversos productos alimenticios y actualmente con interés farmacéutico, a ciertos productos le atribuyen cualidades benéficas en la pérdida de peso, favoreciendo de buena manera el proceso digestivo, es ligeramente laxante y además es diurética, razón por la cual tiene efectos depurativos y desintoxicantes, a pesar de estos beneficios en general solo se utiliza el sobrenadante y la flor se desecha al medio como residuo orgánico. Por consiguiente, en el presente trabajo de investigación busca el aprovechamiento de la pulpa de flor de jamaica ( *Hibiscus sabdariffa* ) desarrollando un dulce, realizando pruebas con diferentes sustancias ligantes y concentraciones, obteniendo muestras de pasta para posteriormente ser mezcladas con sacarosa, sal y chile piquín. Se realizó el mismo procedimiento para la goma arábiga, la glucosa y la mezcla de glucosa-sacarosa, del producto se obtienen resultados fisicoquímicos como son el pH, los ºBrix y la viscosidad, que se deseaba para el dulce de flor de jamaica.

**Flor de jamaica, Dulce, Subproducto.**

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## Introduction

The development of confectionery in the world is closely linked to the use of sugar and sugar beet. This art dates back 3500 years, as demonstrated in Egyptian writings and in the Herculanium ruins, where a workshop was found with utensils similar to those of today. Confectionery products are considered to be those made with cane sugar, beet sugar and other edible sugars (glucose, fructose and destroza) added to foodstuffs such as flour, eggs, chocolate, fat, oils and fruit juices (Zamorano, 2008). The variety in confectionery confectionery is enormous, it changes according to times and countries, even regions and religions, and there is no limitation in the preparation of sweets, depending on the imagination of the confectioner.

There are three types of confectionery: a) bakery confectionery, b) sugar confectionery and c) chocolate confectionery. Sugar confectionery is further divided into two groups:

1) with sugars that are in non-crystalline form and 2) with all crystallised sugars. Confectionery containing non-crystalline sugars includes those made with fruit, glucose syrup and sucrose as main constituents, as well as a gelling agent that serves to keep the syrup more solid. Such agents can be starches, agar, alginates, pectins with the addition of water, examples of which are jams, jellies and pulp enchiladas (Kerstupp *et al*., 2001). Examples of sweets containing non-crystalline sugar are: hard candies, nougats, jams, fruit jellies, pastilles, gums and caramels and of crystallised sugar are fondans, fudges, marzipan, praline pastes, coated products, compressed tablets and crystalline nougats.

The objective of the research work is to take advantage of the by-product of the hibiscus flower (*Hibiscus sabdariffa*), which has attracted attention due to its nutritional characteristics, which provide a series of benefits in its consumption, such as: aid in the digestive process, laxative, diuretic, depurative, detoxifying, weight control, among others. The proposed area of opportunity is to take advantage of the pulp of the hibiscus flower, which is currently considered an organic waste product.

This value proposal consists of using this resource as the main raw material in the production of a sweet and sour, sweet and sour pulp, which would represent an innovation in the sector, producing a sweet from a by-product, thus giving added value, presenting an alternative consumption that can open up a new market, providing quality caloric intake, because it will not have chemical preservatives.

The structure of this article consists of the following points:

– A theoretical basis in which the characteristics of the hibiscus flower are provided, as well as information on the by-product of the same, in which its use is proposed to elaborate a pulp type sweet, within the theoretical outline the binding properties are also pointed out; such as sucrose, glucose and gum arabic.

– Continuing with the materials and methods, where the processing of the raw material is specified, providing its statistical analysis and methodology to be developed. Preliminary results of the physicochemical characterisation and sensory analysis (colour, appearance, consistency and flavour) are presented, and finally a discussion of results and conclusions is generated.

Based on the studies carried out, the following question is formulated: Does the sweet based on the by-product of the hibiscus flower (*Hibiscus sabdariffa*) meet the consumer's expectations?

## 1. Theoretical basis

The circular economy aims to valorise food biowaste such as hulls, seeds, stems, roots, pulp remains, bagasse, because they retain a high content of bioactive molecules. These by-products could be used as industrial raw materials (Gómez *et al*., 2021), as in this case the dried calyxes of hibiscus (*Hibiscus sabdariffa* L.) are generally used in the production of beverages, generating an extract with abundant organic acids, polysaccharides, phenolic compounds, flavonoids and anthocyanins with diverse pharmacological and antioxidant activities.

And at the same time a residue is generated as a by-product that preserves up to 50% of the same biologically active compounds of the extract, with a high content of dietary fibre (14. 6 %) (Amaya *et al*., 2017), where it can be used as a food ingredient due to its organoleptic characteristics, representing an alternative in the production of confectionery, candy pastes, coated products, jellies, among others.

The hibiscus flower (*Hibiscus sabdariffa*) belongs to the malvaceae family, better known as hibiscus rose or abyssinian rose, it is a shrub that can grow up to three metres (m) high, its flower is red thistle and has five to seven petals. The plant is an annual, it grows best in regions with tropical and subtropical climates, it is cultivated in the spring-summer season and harvested from October to November, although it can grow in arid climates.

The calyxes, or crimson-coloured fruit, are marketed in dehydrated form for the preparation of fresh drinks and infusions and is the product we commonly consume. On the American continent, Mexico is the main producer with 27.76 percent of world production, with 40 municipalities in 11 states: Campeche, Colima, Guerrero, Jalisco, Mexico, Michoacán, Morelos, Nayarit, Oaxaca, Puebla and Sinaloa.

The state with the highest production is Guerrero with 73.64 per cent; Ayutla, one of its municipalities, contributes 44.99 per cent of the national production (SIAP, 2019). The crop is a rainfed crop, sown by seed from June to August in soils with low fertility and low moisture retention, pest and disease control is minimal and harvesting is done manually, hence its social importance.

The composition of the calyxes of the hibiscus varies according to colour and genetic differences. The calyxes contain: anthocyanins 1.5 percent, organic acids 15-30 percent, mucilaginous polysaccharides 50 percent, flavonoids, saponins, phytosterols, pectin and fibre. Organic acids and anthocyanins have been shown to have antimicrobial and antioxidant activity. All these components have good bioavailability (Duke *et al*., 2003).

Hibiscus flower contains various compounds including alkaloids, ascorbic acid, anisaldehyde, anthocyanins, β-carotene, β-sitosterol, citric acid, malic acid, galactose, mucopolysaccharides, pectin, protocatechuic acid, polysaccharides, quercetin, stearic acid and wax (Hirunpanich *et al*., 2005). Beyond this, the wide range of substances that make up hibiscus gives it a large number of biological activities and positive health effects.

The hibiscus flower originated in India and has since been distributed to the tropics of the New World, probably brought from Africa to America by slaves. It has been intensively cultivated in the tropical and subtropical regions of India, Thailand, Senegal, Egypt, the United States, Panama and Mexico (Fellows & Hampton, 1992). Hibiscus is currently cultivated in the states of Campeche, Colima, Guerrero, Jalisco, Michoacán, Nayarit, Oaxaca, and Puebla, see figure 1.

**Figure 1** Hibiscus flower *(Source/ Own)*

The hibiscus flower is used to make various food products and nowadays it is even of pharmaceutical interest. Hibiscus flower tea is one of the products that has been widely used for many years and currently has been attributed various qualities, one of which is that it can be beneficial for weight loss, as it favours the digestive process, is slightly laxative and is also diuretic, which is why it has depurative and detoxifying effects, including for treating cholesterol, triglycerides, hyperlipidemia and the kidneys; In the food sector, hibiscus jams are also made, which is a molasses obtained from hibiscus concentrate and mixed with the ground flower, which has a sweet and sour taste and a smooth consistency (Salazar & López, 2009).

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However, although the use of hibiscus flower is very wide and abundant, it is observed that the food industry, restaurants and cafeterias, etc. have only used the infusion to make the aforementioned products, discarding the organic residue of hibiscus flower into the environment, where it can be reused and given added value. As a result of this, a proposal was developed in which the hibiscus flower by-product was considered to make a sweet, in such a way that tests were carried out with different binding substances and concentrations, in order to properly establish the processing technique of the paste and obtain a product with better viscosity, and the microbiological quality of the sweet was also determined.

Due to its functional components, it is used in traditional medicine as an alternative for the treatment of the circulatory system, high blood pressure, cholesterol, diabetes, obesity, colds, coughs, as a diuretic, for its antioxidant properties, and in the development of anticarcinogens. Supplements containing hibiscus with other antioxidants, vitamins or lactobacilli are currently available and are marketed as food supplements. For their part, (Guardiola & Mach, 2014) demonstrated the therapeutic effect of hibiscus extracts, thanks to their composition rich in phenolic compounds, on oxidative stress, lipid profile, hypertension and atherosclerosis. The flowers contain several natural antioxidant compounds that also act against various viruses and bacteria. Hibiscus acid and its derivatives can be sterilised and stored at room temperature. Their stability allows them to be applied in food, pharmaceutical, agricultural and cosmetic products, because they are a potential alternative in the control of multi-resistant pathogenic bacteria such as Salmonella and E. coli (Portillo *et al.* Coli (Portillo *et al*., 2019).

The basic principles for the production of confectionery are the realisation of a material balance for the formulation, preparation and mixing of the ingredients, the concentration of the mixture to the desired temperature, cooling, moulding, as well as its packaging. Factors affecting the production and storage of confectionery include: the degree of sugar inversion, time, temperature, concentration, residual moisture in the confectionery and the addition of other ingredients. (Fellows & Hampton, 1992).

According to CODEX STAN 296-2009, for jams, jellies and marmalades that are intended for direct consumption, including for catering use or for repackaging if necessary, this standard applies. It defines jellies as the product prepared from the juice and/or aqueous extracts of one or more fruits, mixed with foodstuffs that impart a sweet taste, with or without the addition of water and processed to a semi-solid jelly-like consistency (STAN, 2009).

## By-product

Among other uses of *hibiscus sabdariffa*, it is used to prepare infusions as tonics, laxatives, which are used to reduce fever, as well as in chewing gum products; the flower together with the leaves have emollient, diuretic laxative and anti-inflammatory effects similar to those of phenyl butazone, the calyx and flower are used to preserve, tan and produce jellies and juices as well as products with a viscous consistency (Bata & Santhankumari, 1991).

In the fruit and vegetable industry, larger quantities of residues are generated from the processing of fruits or vegetables, attracting particular attention as economical, functional and novel ingredients. However, currently these types of waste are used as fertiliser, substrate in biogas production, some are disposed of in landfills or even incinerated causing additional cost to the producer, generating an environmental and economic impact, thus a loss of valuable nutrients (Angulo *et al*., 2012). In view of the trend towards more sustainable and healthier production systems, the food industry is looking for effective proposals in these by-products or "bio-waste" in such a way that it can provide the waste with an added value that helps to reduce the environmental impact caused by its disposal in the process in which it was used (May & Guenther, 2020).

An example is the soft fruit juice industry in general, during the processing to obtain juice, a solid residue called press cake, pomace or bagasse is obtained, representing 20-30 % of the total berry (Muceniecea *et al*., 2019). This by-product could be an attractive alternative source of valuable bioactive compounds due to its low cost and biorenewable nature, and could be very interesting within food product innovation due to the recovery of value-added ingredients it can present (Struck *et al*., 2016).

Composition as the development of new methods of waste valorisation, helps to convert bagasse from soft fruits into products with high value for potential use in the treatment or prevention of chronic diseases (Muceniecea *et al*., 2019). The use of by-products is increasingly widespread in the food industry, forming part of the final food composition, not only because of the nutritional benefits they present, but also because they show diverse uses as food additives, providing colour to the final product, or as antimicrobial agents to improve shelf life..

**Figure 2** By-product of Hibiscus Flower *(Source/ Own)*

The incorporation of bagasse has several applications, among which are, on the one hand, fortification (addition) and on the other hand, the substitution of some ingredient of the composition in the original product (Figure 2); in both cases, changes are produced in the composition of dietary fibre, vitamins and phenolic compounds of the product. Despite the fact that their incorporation may influence by modifying certain physical and technological properties of the original product, it also allows endowing the product with numerous effects such as controlling and reducing blood sugar release, counteracting peaks of hyperglycaemia (hypoglycaemic effect) or reducing the risk of suffering from certain cardiovascular diseases (Quiles *et al*., 2018) (Tańska *et al*., 2016).

Recent studies show the potential use of bagasse from soft fruits in different food products, providing all of them with added value due to the fact that it is a rich source of natural phytochemical compounds. However, given the variability of foods in which it can be included, it exerts a different effect on each of them.

As in the case of bakery products and meat products, it extends the shelf life of the food as a result of its antioxidant role, preventing the development of unpleasant odours or flavours, a consequence of lipid oxidation, and therefore helps to combat altering pathogenic microorganisms. Finally, in dairy products, it has an antioxidant and physiological effect on patients with diabetes, reducing blood glucose levels. Each application requires a thorough investigation of the possible level of bagasse incorporation to produce foods with satisfactory sensory properties. To achieve this goal, adaptation of the product formulation or manufacturing process may be necessary. Bagasse from the soft fruit industry is therefore an interesting opportunity to improve waste management and to obtain foods with ingredients high in dietary fibre and phytochemicals.

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### Binding properties

The term gums is used to refer to polysaccharides or their derivatives, obtained from plants or by microbiological processing, which, when dispersed in cold or hot water, produce viscous solutions or mixtures (Whistler & Daniel, 1985).

The food processing industry, as well as other industrial applications of gums, take advantage of their physical properties, especially their viscosity and colloidal structure. At the same concentrations, gums with relatively linear molecules, such as gum tragacanth, form more viscous solutions than spherical shaped gums such as gum arabic for example (Considine & Considine, 1983); they are generally used in a concentration range between 0.25 to 0.50% which shows their great ability to produce viscosity and form gels (Bemiller & Whistler, 1996).

**Sucrose**

The specific property of sucrose is its ability to split or invert, resulting in a mixture of equal parts of glucose and fructose, i.e. invert sugar. This process depends on factors such as pH, temperature, cooking time, size of molecules in solution and water hardness, and occurs in cooking processes of slightly acidic syrups. This property represents one of the major problems in the confectionery industry, because if not properly controlled, it leads to a shorter shelf life at temperatures above 32 °C and relative humidities below 70%. Sucrose is a carbohydrate with a very high solubility capacity, which has an impact on other properties including confectionery production processes in general.

**Glucose**

Glucose is also called dextrose because of its dextrorotatory capacity, defined as the most important molecule in nature, it can be found in various forms, it is the basis of starch, cellulose, glycogen and forms part of sucrose, it is found free in fruits and in honey. It is a less sweet sugar than sucrose, an interesting property of this monosaccharide is the effect of freshness that provides when taken to the mouth, this feature is used for the production of various confectionery products such as: tablets, sweet and sour powders, chewing gum, or as ingredients in the partial replacement of sucrose as it is a carbohydrate that provides half of the caloric intake; sucrose is used in reduced calorie products, its presence in formations intensifies Maillard reactions and increases softness and hygroscopicity in confectionery products (Marshmallows).

**Gum Arabic**

Known as gum acacia, considered the best of the gums, it is the sap exuded from various species of acacia trees. Chemically, gum arabic is a neutral or slightly acid salt of a complex polysaccharide containing calcium, magnesium and potassium ions in its molecule; and is made up of six carbohydrates: galactose, rhamnose, arabinopyranose, arabinofuranose, glucouronic acid and 4-o-o-methylglucouronic acid (Prakash & Manguino, 1990). This gum is a heterogeneous material in terms of the protein that is part of the structure.

Gum arabic dissolves rapidly in cold or hot water, the least viscous and most soluble of the hydrocolloids (Dziezak, 1991), noting that more than half of the gum arabic produced in the world is used in the preparation of sweets and confectionery, in order to retard the crystallisation of sugar and promote emulsification; The flavour industry uses gum arabic as a fixative and encapsulant to avoid oxidation and volatilisation of its components, while in beer brewing it promotes foam stabilisation; and due to its protein component, this gum is used as an emulsifier.

It is currently used to improve chewing, it is a means to fix flavouring preparations and as a Milllard agent, when applied as the only colloidal ingredient, solutions should be prepared at 40-50% by weight and when used in combination with other agents, this proportion should be adjusted to the requirements of the formula (Ramírez & Orozco, 2014).

**°Brix and pH**

The concentration of sucrose solutions can be measured by the refraction of light through the solution. When a solution contains more sugar, its refractive index will be higher. It is advantageous to measure the concentration by means of a refractometer to save time and effort. Based on the principle of refraction, the Brix degree has been introduced to express the concentration of sucrose solutions. The Brix degree is only defined at a temperature of 20 °C. At this temperature, Brix is equivalent to the weight percentage of sucrose in an aqueous solution.

In practice, aqueous solutions are classified as acidic if the pH is less than 7.0, basic if the pH is less than 7.0 and neutral if the pH is equal to 7.0.

**Materials and methods**

**Raw material processing**

In the facilities of the Instituto Tecnológico Superior de Villa La Venta (ITSLV), the pulp was processed. Subsequently, a quantity of hibiscus flower by-product was used, firstly performing a visual inspection of the hibiscus flower to verify its colour, smell and size, checking that it did not show artificial colouring, and then removing any debris or foreign bodies, after which it was rinsed with purified water.

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Once the flower was cleaned, it was immersed in purified water at 95 ºC for 10 min. After this blanching process, the flower was separated from the supernatant with a strainer. With an industrial type blender, the hibiscus flower (leftover) was processed with water in quantities (1:50) for 15 min. until a homogeneous and smooth paste was obtained. Once the paste was obtained, it was placed in a glass bowl and the following mixtures were made with sucrose, gum arabic and glucose as binders in the hibiscus flower paste. Nine samples of 150 g. were weighed and then mixed in triplicate with different amounts of sucrose, salt and piquín chili were added.). The sucrose was melted in a pewter pot and then mixed with the organic residue, adding the salt and the piquin chili, the mixture was homogenised until it reached a temperature of 110ºC, allowing the consistency, allowing it to cool for 10 min. and then packaged in plastic cups. The same procedure was carried out for the gum arabic and glucose. In addition, a sucrose-glucose mixture was made and added to the paste, see (figure 3).

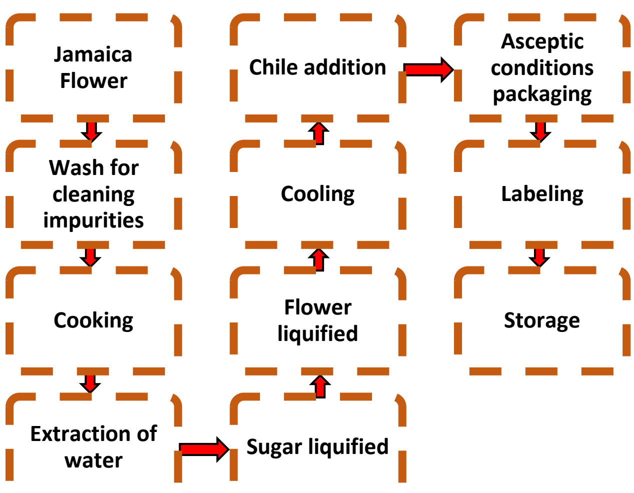



**Figure 3** Diagram of the pulpijamay sweet process
*(Author's own)*

Once the mixtures to be analysed were obtained, samples were collected in triplicate and taken to the laboratory of the Instituto Tecnológico Superior de Comalcalco, Tabasco to determine physicochemical characteristics such as: pH, ºBrix and viscosity. For the control of the different determinations and to obtain a quality product, it was compared with a control sample of a sweet similar to pelón pelo rico. The microbiological analyses were carried out according to NOM-111-SSA1-1994, goods and services, by the method of counting moulds and yeasts in foodstuffs.

Using the culture medium potato agar - dextrose, in dehydrated form using phosphate buffer solution and sown in Petri dishes, placed in an incubator for 5 days at a temperature of 27 ºC.

## Statistical analysis

In order to find significant differences between the viscosities of the candy pastes, ANOVAs were performed where variability was observed and a Tukey's a posteriori analysis was performed at $\alpha=0.05$. Statistical analyses were performed with STATISTICA ® version 8 (StatSoft, Inc.).

## Preliminary results

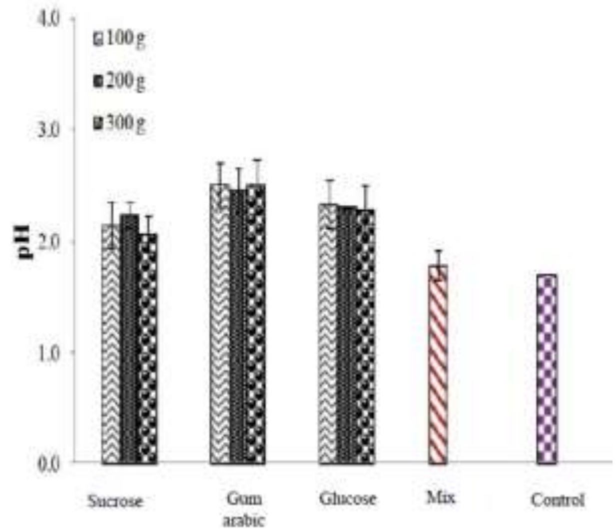
## Physicochemical characterisation

In the determination of the pH parameter, these values showed significant differences ($P<0.001$), the gum Arabic indicated lower acidity, while the mixture and control samples showed higher acidity (Graph 1), with no significant differences between the two ($P=0.971$), which indicates that the mixture sample is the most similar to the control sample, which means that it is a sweet that provides the desired characteristics in the product.

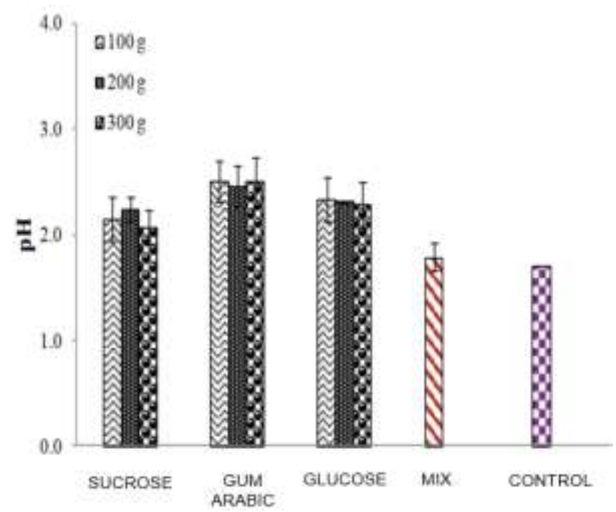
With respect to the ºBrix these data showed significant differences ($P<0.05$) where the gum arabic does not indicate sugar levels (Graph 2), on the contrary, it is observed in the glucose mixture and control higher levels of glucose, without statistical differences between both ($P=0.996$). The effect of carbohydrate content with respect to ºBrix was more evident with the sucrose sample, as an increase in this parameter was observed with respect to the grams used.

Viscosity was influenced by the type of carbohydrate added, obtaining significant differences ($P<0.001$), with the sucrose sample indicating higher viscosity, while the gum arabic sample indicated lower viscosity, but no significant differences were observed between the gum arabic, glucose and mixture samples (Graph 3).

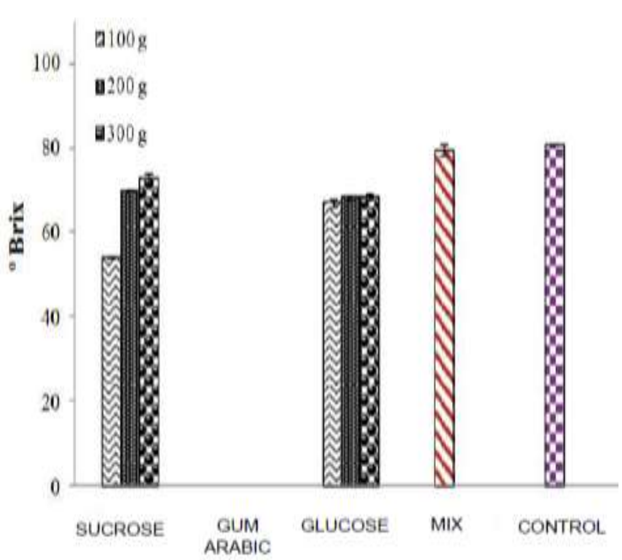
With regard to the microbiological results, no CFU (Colony Forming Units) of moulds or yeasts were found.




**Graph 1** Average pH values with the different binders: sucrose, gum arabic and glucose with 100, 200 and 300 g of each, a sucrose-glucose mixture and the control. The bars indicate the standard deviation
*(Own Authorship)*



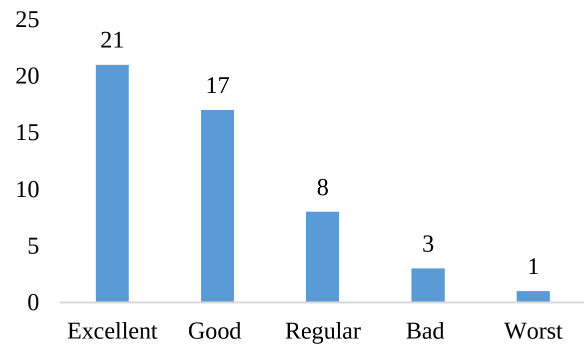

**Graph 2** Average ºBrix values with the different binders: sucrose, gum arabic and glucose with 100, 200 and 300 g of each, a sucrose-glucose mixture and the control. The bars signify the standard deviation.



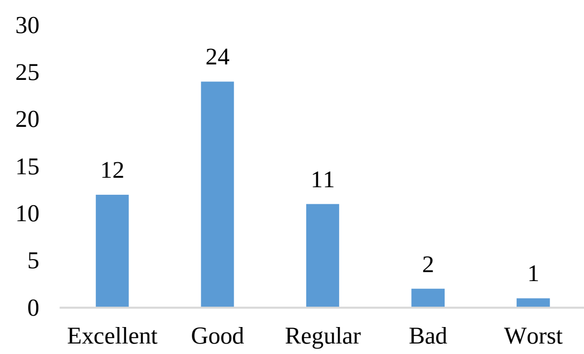

**Graph 3** Average viscosity values with the different binders: sucrose, gum arabic and glucose with 100, 200 and 300 g of each, a sucrose-glucose mixture and the control. The bars signify the standard deviation

**Sensory analysis of the pulpijamay sweet.**

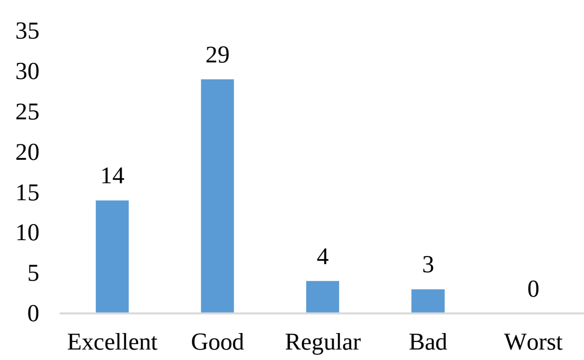
In the development of new products, sensory evaluation is important in order to be able to interpret consumer preferences (Anzaldúa, 1994). Therefore, a sensory analysis of the pulp was carried out, indicating its organoleptic characteristics such as colour, appearance, flavour and consistency, by means of consumer judges with hedonic scales, obtaining data represented in the following graphs:



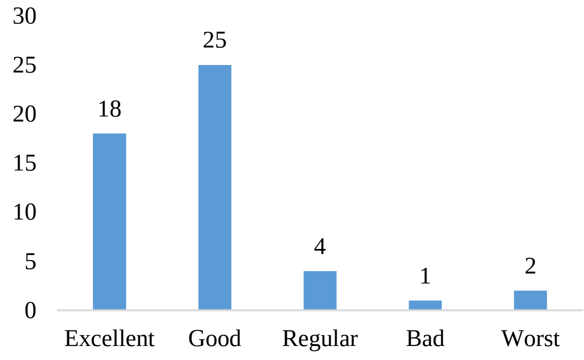

**Graph 4** Sensory evaluation of the colour of the pulpijamay sweet
*Author's Own*




**Graph 5** Sensory evaluation of the appearance of the pulpijamay sweet
*Author's Own*




**Graph 6** Sensory evaluation of consistency of pulpijamay sweet
*Author's Own*




**Graph 7.** Sensory evaluation of the taste of the pulpijamay sweet
*Author's Own*

Graph 4 of the sensory evaluation of the colour of the pulpijamay sweet shows the results obtained from the affective sensory tests carried out on consumers. Ninety-two percent of the people who carried out the test answered that they liked the colour and only 8% of the judges answered that they did not like it.

To continue in graph 5, the appearance is presented, which indicates that 24% is excellent and 48% represents that it is good, being within the taste of the judges. In graph 6, the evaluation of consistency registers 28% excellent, 58% good and only 6% bad; and to conclude in graph 7, the evaluation of taste, which is the most representative in a food, indicates 36% excellent and 50% good acceptance respectively.

## Discussion of results

The results obtained show that the calyx of the hibiscus flower is the raw material for a by-product with commercial value in the market, due to the fact that the characteristics of a sweet to commercial product were obtained, in addition to the fact that when the sensory tests were carried out, this new product was widely accepted by the public, This suggests that the hibiscus flower can be used in a 100%, in such a way that agrees with previous works, where it is mentioned that can be obtained usable by-products mostly vegetables and fruits that have portions that are not used for human or animal consumption, and represent different percentages from 25 to 60% of inedible part; as in the case of some fruits with very thick skins or large seeds.

From the different treatments that were carried out with the hibiscus flower, it was determined that the viscosity that did not show significant differences with the control was the glucose-sucrose mixture, which indicates that this treatment was the binder that gave the new product the desired consistency.

Whereas gum arabic did not show a consistent viscosity due to its molecular structure, which does not allow it to give the products a high viscosity (Dziezak, 1991).

(Dziezak, 1991). As part of the results obtained, it can be said that the product obtained does not lose its characteristic aroma.

In relation to gum arabic, it is known that as it is a neutral polymer, it did not register °Brix (sugars), so it was used, looking for a suitable consistency.

However, the results were not encouraging, possibly due to the low pH and unsuitable viscosity. (Dziezak, 1991) mentions that chemically, gum arabic is a neutral salt, less viscous and is widely used in the manufacture of sweets and confectionery, with the aim of delaying the crystallisation of sugar.

In the case of sucrose, it showed 54.1 °Brix so that it registers a favourable viscosity and a pH of 2.14 is reflected, which is close to the required results and is also close to the characteristics of a desired product.

Finally, the glucose sample achieved the best results in the parameters obtained with a pH of 1.88 with 81 °Brix and a viscosity of 64200 centipoise, being this the best option, in this way it was foreseen to make the aforementioned mixture, fulfilling the desired, required and acceptable characteristics for the product.

(Durward, 2007) mentions that combinations of substances are necessary for the preparation of fruit jellies such as: pectin, citric acid, sugar and water, since the combination of these agents and substances is required within established limits.

As is known in this research, the results were determined with the combination of two types of binders that were the most appropriate to obtain the characteristics of the product in relation to viscosity, pH, °Brix, in the mixture, because this presented greater approximation with the control and it was not necessary to add pectin and citric acid, since the residues of hibiscus flower contains these compounds and are of great nutritional value to humans as they are: ascorbic acid, citric acid, malic, protocatechuic, stearic, and polysaccharides that retard the appearance and inhibition of microorganisms such as moulds and yeasts in the sweet, making it a natural additive.

The sweet does not present fungi and yeasts CFU/g in any of the studies carried out in terms of its microbiological activity; in the total count of the same indicates that there was no growth, which shows a clear stability of the product and sterility in storage conditions at room temperature.

(Cerezal & Duarte, 2005) mentioned that the sweetened pulp of the prickly pear in comparison with the jam showed results of mould and yeast CFU/g of <1*10 1. There are related studies of hibiscus acetosella, which contain antimicrobial compounds that inhibit the growth of moulds and yeasts, so these compounds are also found in hibiscus sabdarifa, containing flavonoids, cyanidin, phenolic, polyphenols, anti-cyanins and carotenoids.

According to previous studies, hibiscus flower water is not rich in fibre, but it is favourable because it does not need artificial colouring and flavouring as other bottled waters are, where they are coloured and promise an unaltered quality of their main ingredient. The compound richest in fibre and antioxidant is the hibiscus calyx and the decoction residue, thus offering a high nutritional quality in this natural raw material. As a result of these studies, the interest in using a by-product of the hibiscus flower is justified, because of the great benefit it provides.

## Conclusions

Through this research "Validation of a pulp type candy (Pulpijamay) based on the by-product of the hibiscus flower (*Hibiscus sabdariffa*)" it can be affirmed that it was possible to carry out the validation of the candy based on the by-product of the hibiscus flower (*Hibiscus sabdariffa*).

The mixture of glucose and sucrose with the hibiscus flower paste showed a greater similarity with the control (Pelón pelo rico) so that it was possible to decide for this mixture, due to the parameters of pH, ºBrix and viscosity which are the most optimal characteristics for the quality of the product that was desired in a sweet based on hibiscus flower (*Hibiscus sabdariffa*), and also indicated in any of the tests to have good microbiological quality.

The analyses revealed no presence of microorganisms in the hibiscus flower by-product, which indicates that good safety and hygiene practices were followed during the production process.

In accordance with the objective, it was possible to obtain the expected results in terms of the desired paste viscosity with the combinations of different binders.

As a result, a new proposal for the use of the hibiscus flower by-product was obtained, thus contributing to the management and exploitation of this resource, giving it added value.

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