LWT - Food Science and Technology 97 (2018) 31–38

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Banana liqueur: Optimization of the alcohol and sugar contents, sensory profile and analysis of volatile compounds

Milton de Jesus Filho[a,*], Laísa Bernabé do Carmo[a], Suzana Maria Della Lucia[a], Sérgio Henriques Saraiva[a], Adilson Vidal Costa[b], Vanessa Moreira Osório[b], Luciano José Quintão Teixeira[a]

[a] Department of Food Engineering, Centro de Ciências Agrárias e Engenharias, Federal University of Espírito Santo, Alto Universitário, s/n, 29500-000, Alegre, ES, Brazil

[b] Department of Chemistry and Physics, Centro de Ciências Agrárias e Engenharias, Federal University of Espírito Santo, Alto Universitário, s/n, 29500-000, Alegre, ES, Brazil

ARTICLE INFO

Keywords:
Fruit processing
Acceptance
Optimized descriptive profile
SPME
Desirability function

ABSTRACT

The objective of this study was to evaluate the acceptability of liqueur based on its sensory profile, physicochemical composition and presence of the volatile compounds responsible for the aroma of the banana and banana liqueur. Sensory acceptance was conducted to investigate the effect of alcohol content of the extracting solution on produced liqueurs. In addition, liqueurs were elaborated using different contents of alcohol and sugar, which were evaluated as for pH, soluble solids, refractive index, density, absorbance, colorimetric parameters, besides the sensory analysis to judge the overall impression and the purchase intention of the products. A sensory characterization of the samples was performed by the Optimized Descriptive Profile (ODP) method. The volatile compounds were determined by solid phase microextraction and injected into the gas chromatograph coupled to the mass spectrometer. Adjusted models showed that the alcohol content of 61.87 °GL of the extractive solution and alcohol (17.29 °GL) and sugar (289.89 $g\,L^{-1}$) content of the final product may show greater acceptance and intention to purchase banana liqueur. In the ODP, the samples differed based on their adherence, alcoholic aroma, alcoholic taste and sweet taste. Volatile compounds characterized as esters were found on the banana and liqueur.

1. Introduction

Banana (*Musa* spp.) is considered one of the most consumed tropical fruits in the world (FAO, 2015). It has wide acceptance due to the attractive flavor, composition rich in energy source from soluble sugars and starch degradation as well as a source of minerals such as potassium, and vitamins (Adão & Glória, 2005), in addition to its aroma being one of the most important sensory attributes in determining quality. According to some studies, the volatile compounds that contribute most to the aroma of the banana are esters, followed by aldehydes, alcohols and ketones (Bugaud & Alter, 2016).

Brazil and Costa Rica have large plantations intended for foreign markets; however, part of the banana production does not meet the minimum standards for export, leading to a waste of 40%–50% of the volume produced from the fruits, which has significant cost implications. The high perishability of banana is also well-known, entailing storage-related problems. Thus, the processing of this fruit is an alternative way to avoid or reduce the waste (Sampaio et al., 2013).

Therefore, among the many ways to use banana as a raw material in food processing, one of the possibilities is in the making of liqueur, which constitutes a refined form of utilization of these fruits, besides adding value to the production and increasing rural household income (Souza & Bragança, 2001). In addition, its processing is of easy execution, the final product is commercialized at room temperature and shows extensive shelf-life (Teixeira, Ramos, Chaves, Silva, & Stringheta, 2005).

According to Brazilian legislation, liqueur is the beverage with an alcohol content from 15% to 54% v.v-^{1}, at 20 °C, and a percentage of sugar superior to 30 $g\,L^{-1}$, prepared with potable ethylic alcohol or simple distilled alcohol, both of agricultural origin, or with alcoholic beverages, added with extracts or substances of vegetable or animal origin, flavoring substances, dyes and other additives (Brasil, 2009).

Liqueurs are products that go through a simple process. However, during the processing, some variations may occur, and the stage of development of the fruit extract can be considered one of the most important stages in the quality assurance of the final product.

* Corresponding author.
E-mail address: miltonfilhoea@gmail.com (M. de Jesus Filho).

https://doi.org/10.1016/j.lwt.2018.06.044
Received 28 September 2017; Received in revised form 7 June 2018; Accepted 20 June 2018
Available online 20 June 2018
0023-6438/

According to Surena (1996), the proportion of fruits and solvents, ethanol concentration and extraction and maturation time can lead to liqueurs with different aromas and tastes. Besides, the appropriate combination of alcoholic content, the amount of sugar and fruit aroma may have a key role in the acceptance of liqueur by consumers (Teixeira, Ramos, Chaves, & Stringheta, 2007).

Response Surface Methodology (RSM) is based on the analysis of response as influenced by several factors and its goal is to determine the optimal condition of the response (Bezerra, Santelli, Oliveira, Villar, & Escaleira, 2008). Zhu, Han, Chen, and Han (2010) applied RSM to obtain the optimum level of different variables to optimize the microwave-assisted extraction of astaxanthin from *Phaffia rhodozyma*.

Thus, the objective of this work was to study the effect of alcohol and sugar content in the physicochemical characteristics, acceptance and the sensory profile of banana liqueur.

2. Material and methods

For the elaboration of the banana liqueur, the raw materials used were bananas of the Prata variety, refined sugar, grain alcohol and distilled water. All materials were obtained from the local market of the city of Alegre, Brazil. In order to carry out the experiment, healthy bananas were used, without imperfections, without rot and in maturation scale 7, characterized by the yellow fruit with brown spots (PBMH & PIF, 2006).

2.1. Chemicals and reagents

In the elaboration of the liqueurs cereals alcohol at 95°GL Emfal brand (Betim, MG, Brazil) was used. For the analysis of volatile compounds by GC-MS, the C_9-C_{26} hydrocarbon mixture and the isoamyl acetate analyte standard were obtained by Sigma Aldrich (St. Louis, MO, USA) and NaCl by Alphatec (Macaé, RJ, Brazil), with purity higher than 95%.

2.2. Liqueur processing

The fruits were placed at a concentration of 40% $m.v^{-1}$ in infusion in cereal alcohol for 21 days (Teixeira, 2004, p. 81) and after the time of extraction, the infusion fluid was filtered in a nylon filter.

Refined sugar was used in proportion of 3 parts sugar to 2 parts water in the preparation of the syrup. A mixture of the sugar syrup, the hydroalcoholic extract and distilled water in proper proportions was made, so that the final product presented alcohol and sugar content as the desired formulation.

The real alcoholic content was determined using the conversion table of relative density at 20 °C after distillation of the sample in the microdistiller TECNAL, model TE 012. The alcohol content was corrected by the correction factor (Zenebon, Pascuet, & Tiglea, 2008).

2.3. Sensory analysis

The study was approved by the Research Ethics Committee of the Center for Health Sciences of the Federal University of Espírito Santo (UFES), ES, Brazil, under number 1.355.093.

2.3.1. Acceptance

The tests were performed by 74 consumers (over 18 years), in individual booths, under white light. Ten mL of the samples were presented at room temperature in a random and monadic way.

In order to evaluate the effect of the alcohol content on the infusion stage, a sheet containing a nine-point hedonic scale for the attributes color, aroma, taste and overall impression (Reis & Minim, 2013) was used. The final liqueur was standardized with the same alcohol content (18°GL) and amount of sugar (300 g L^{-1}) and evaluated after 15 days of aging (Penha, Della modesta, Gonçalves, & Silva, 2003). For the study of the alcohol and sugar contents a sheet containing a nine-point hedonic scale to assess the overall impression (Reis & Minim, 2013) and a 5 point scale to evaluate the purchase intention (Dutcosky, 2015) was used. The alcohol and sugar contents used are shown in Table 1.

Table 1
Coded and real values of alcohol and sugar contents.

Assay	Alcohol content		Sugar content	
	Coded Values	Real values (° GL)	Coded values	Real values ($g.L^{-1}$)
1	−1	16.87	−1	221.80
2	1	21.13	−1	221.80
3	−1	16.87	1	328.19
4	1	21.13	1	328.19
5	−1.41	16.00	0	275.00
6	1.41	22.00	0	275.00
7	0	19.00	−1.41	200.00
8	0	19.00	1.41	350.00
9	0	19.00	0	275.00

2.3.2. Optimized Descriptive Profile (ODP)

The sensory profile of the liqueurs studied was determined by the technique proposed by Silva et al. (2012). The recruitment of participants was made through the distribution and filling out of questionnaires that identified the time availability of the evaluators, who had familiarity with sensory attributes and skills in using non-structured scales. In addition, it was taken into consideration the habit of consuming bananas and liqueur, age (over 18 years) and the health conditions of the participants.

For the preselection of the evaluators, four triangle tests were applied using banana liqueur made with 18° GL and 300 g L^{-1} of sugar and banana liqueur made with 18° GL and 300 g L^{-1} of sugar, but added 3% more sugar. The selected evaluators were the ones who presented a minimum of 50% score on the triangle tests since the samples of liqueurs utilized on this test set are considered of difficult analysis.

The gathering of the descriptive terms was made by means of an open discussion utilizing the previous list methodology. The previous list brought to the session was based on works by Penha et al. (2003). The descriptive terms evaluated in the samples were: adherence, viscosity, banana aroma, alcoholic aroma, alcoholic taste and sweet taste.

Before the analysis of the samples was carried out, the familiarization of the participants with them and references was made, so that the evaluators could recall the terms defined and its references. The evaluation was carried out by the attribute-by-attribute protocol, using an unstructured 9 cm scale. The analysis of each attribute was held in three repetitions per 13 evaluators.

2.4. Physicochemical analysis

Colorimetric analysis were performed with the aid of a colorimeter (Konica Minolta brand, model Spectrophotometer CM-5) through direct reading of transmittance in a three-dimensional system using the CIELAB color scale, obtaining the coordinates L*, a*, b*, C* and h (Caner & Aday, 2009).

The pH was measured in digital bench pHmeter ION LAB® (model Phb500), according to the AOAC methodology (2005).

Absorbance analysis was performed through a photonics 2000 UV spectrophotometer with a wavelength of 400 nm (AOAC, 2005, pp. 1058–1059).

The soluble solids content and the refractive index were determined on direct reading in digital bench refractometer DR-A1, ATAGO (AOAC, 2005, pp. 1058–1059).

Density analysis was performed by means of the hydrometer YKD 01 brand Sartorius, connected on a scale of the same brand (Machado, 2009, p. 69).