QUALITY AND SENSORY EVALUATION OF BEVERAGE OF ASSAI AND PASSION FRUIT ENRICHED WITH UNRIPE BANANA PULP

Gisele Anne Camargo[1], Juliana Mieli[2], Patricia Prati[3], Rita de Cássia S. C. Ormenese[4], Flávio L. Schmidt[5]

Resumo

A preferência dos consumidores por alimentos mais saudáveis causou um aumento na produção de bebidas de frutas com características de saudabilidade tais como a presença de compostos bioativos que surtem efeito nutracêutico no organismo humano, e consequentemente uma demanda por pesquisa e inovação neste setor. O objetivo deste trabalho foi desenvolver uma bebida de frutas cremosa contendo açaí e maracujá e enriquecido com polpa de banana verde. Em uma primeira etapa, a bebida foi formulada com diferentes percentagens de polpa de banana verde (130, 150 e 170 g. kg^{-1}) avaliada utilizando teste afetivo aliado com a intenção de compra. Uma vez que a formulação foi preferida pelos consumidores, a bebida foi submetida a testes de pasteurização (imersão em água em ebulição), variando o tempo de tratamento térmico (12, 15 e 20 minutos), em seguida foi armazenada sob refrigeração e avaliada utilizando testes sensoriais afetivos (aceitabilidade e testes de intenção de compras). Foram realizadas análises físico-químicas das amostras: Acidez Total Titulável, Sólidos Totais, Sólidos Solúveis, Açúcares Totais e redutores, Vitamina C, Cor instrumental e pH. Os dados foram analisados utilizando análise de variância (ANOVA) e teste de Tukey. Desta forma, os resultados da análise sensorial, indicaram a melhor formulação como aquela contendo 170 g. kg^{-1} de polpa de banana verde; os tratamentos térmicos utilizados não influenciaram a aceitação sensorial da bebida, e as pontuações médias obtidas para os testes sensoriais foram entre 6,5 e 7,0. Os resultados indicaram que houve aceitação pelos consumidores do produto final. Portanto, foi possível produzir uma bebida de alta viscosidade com a polpa de banana verde com resultados satisfatórios em testes sensoriais realizados.

Palavras-chave: pasteurização, análise sensorial e bebida de frutas.

Abstract

Consumer preference for healthier food caused an increase in the production of fruit beverages with nutritional characteristics such as the presence of bioactive compounds that take effect nutraceutical in human organism, and consequently a demand for research and innovation in this sector. The objective of this work was to develop, smoothie beverage containing assai and passion fruit, and enriched with unripe banana pulp. Firstly, the beverage, which was formulated with different percentages of unripe banana pulp (130, 150 and 170 g. kg^{-1}) evaluated using affective test allied with the intent to purchase. Once the preferred formulation was defined, the beverage was subjected to pasteurization tests (immersion in boiling water), varying the thermal treatment time (12, 15 and 20 minutes), and was then stored under refrigeration and evaluated using affective sensory tests (acceptability and purchase intention tests). The physical-chemical determinations carried out for each treatment were as follows: Total titratable acidity, Total solids, Soluble solid, Total and reducing sugars, Vitamin C, Instrumental color and pH. The data was evaluated statistically using analysis of variance (ANOVA) and the Tukey Test. In this way, the results of the sensorial analysis indicated the best formulation as that containing 170 g kg -1 green banana pulp; the thermal treatment used, didn't influence the beverage's sensory acceptance; and the average scores obtained for the sensory tests were between 6.5 and 7.0 on a nine-point hedonic scale. The results indicated that there was good consumer acceptability of the final product. Therefore, it was possible to produce a beverage of high viscosity with the unripe banana pulp

[1] FRUTHOTEC/ITAL, pesquisadora científica, e-mail: camargo@ital.sp.gov.br.
[2] FEA/UNICAMP, Engenheiras de Alimentos, e-mail: ju_mieli@gmail.com.
[3] Pólo Centro Sul/APTA, pesquisadora científica, e-mail: pprati@apta.sp.gov.br.
[4] CCQA/ITAL, pesquisadora científica, e-mail: ritaorm@ital.sp.gov.br
[5] FEA/UNICAMP, professor, e-mail: schimdt@fea.unicamp.br.

with satisfactory results in sensory tests performed.
Keywords: pasteurization, smoothie and sensory analysis.

1 INTRODUCTION

Brazil has been maintained in recent years as the third largest producer of fruits. In 2010, national production volume surpassed the 37.2 million tons in an area of 2.2 million hectares (IBGE, 2012). Despite the importance of Brazil in world production of fruits, its international market share is still small, about 3.1% (FAO, 2010). Brazil finished exports in 2010 with a 2.6% reduction in volume, but in terms of foreign currency increased by 8.9% to $ 609 million (IBRAF, 2011). In terms of production value, the Brazilian fruit sector reached U.S. $ 20.3 billion in 2010, an increase of 16.2% over the previous year (IBGE, 2012).

Brazil is the third largest fruit producer in the world, and the food industry, conscious of Brazil's potential, is using technology to invest in a growing market: that of ready-to-drink fruit juices (MONTEIRO, 2006). The fruit is among the leading agribusiness segments generating income and employment, moreover, is an activity based on small and medium farms. In 2010, the segment was responsible for generating 5.4 million direct jobs, representing 27% of total labor, agricultural labor in the country. Moreover, the chain of horticulture generates three direct jobs and two indirect jobs for each $ 10.000 invested in the sector (IBRAF, 2011).

Following the global trend in finding a healthy diet and higher intake of functional foods, juices and nectars present themselves as an important market with an expected growth of 9.3% per year until 2014 (CANNADEAN INSTITUTE, 2011).

In Brazil, the natural and functional beverage industry is relatively new, and is going through fast growth, reaching significant figures. In the last five years, the market for functional foods and beverages grew by 82% and is expected to have expanded by 39% by 2014, data are from Euromonitor International (2011). This growth is due to the customer's interest in foods that are healthier and free from harmful chemical substances, such as pesticides.

The passion fruit's main characteristics are its intense flavor and acidity, which make it an interesting ingredient for use in the production of fruit beverages and juices. The main components of the soluble solids present in passion fruit juice are carbohydrates (32.4% sucrose, 38.1% glucose and 29.4% fructose). The passion fruit's acidity is due mainly to its citric acid content (83%), followed by its malic acid content (16%) and, in a smaller degree, by the presence of lactic acid (0.87%), malonic acid (0.20) and succinic acid (traces) (CHAN, 1993). Additionally, the main types of passion fruit (yellow passion fruit and purple passion fruit) are good sources of pro-vitamin A and niacin (MEDINA et al., 1980). Yellow passion fruit is an ovoid shaped fruit much appreciated for its unique exotic flavor and yellow to reddish-orange color due to the presence of

carotenoids. Its pulp has an intense acid flavor and water and sugar are usually added to obtain a palatable juice. (DELIZA; MACFIE; HEDDERLEY; 2004). Even when added in small quantities, passion fruit juice is capable of lending its intense flavor and aroma to various products. The juice's color is due to a mixture of carotenoid pigments, mainly β-carotein (MEDINA et al., 1980).

Assai, an exotic fruit from the Amazon, is rich in antioxidant components and is present in a variety of products associated with healthy benefits. Kuskoski et al. (2006) determined a high total count of polyphenols in frozen assai pulp. The idea of combining the high percentage of antioxidant substances found in assai with the intense flavor of passion fruit led to the development of an exotic and typically Brazilian beverage.

Unripe banana pulp was introduced into the product as an important source of micro and macronutrients: vitamins A, B1, and B2; nicotinic acid; sodium; potassium; magnesium; manganese; copper; phosphorus; sulfur; chloride; and iodide (VALLE; CAMARGOS, 2004) in addition to resistant starch. Resistant starch can be physiologically defined as the sum of starch and its by-products that are not digested nor absorbed in the small intestine of healthy individuals, but that can be fermented in the large intestine (EERLINGEN; DELACOUR, 1995; CHAMP, 1992). Like insoluble fibers, resistant starch possesses physiological effects related to its ability of increasing fecal volume and diluting potentially toxic and cancerous substances, apart from reducing plasmatic insulin, triglycerides, and LDL levels (ASP; AMELSVOORT; HAUTVAST, 1994).

Like every other unripe fruit, unripe bananas contain a maximum 2% of sugar and large quantities of starch, which are converted almost entirely to sugars during the ripening process. Another advantage of using unripe bananas is that, when added to food products, it doesn't make the product smell or taste like the fruit, because its characteristic taste hasn't developed yet (VALLE; CAMARGOS, 2004).

In the first part of this research (CAMARGO et al., 2010) it was detected that when added to beverages, unripe banana pulp results in an increase of viscosity and yield, in addition to providing a healthy product that is appreciated by consumers that search for this type of beverage. In Brazil, there is no legal standards for beverages or definition of the type "smoothie", however, based on products found in the market, such beverage may be basically a blended drink consisting of fruit juice, whole fruit and water; in other words, a chilled, sweet beverage made from fresh fruit, with greater viscosity. In addition to fruit, many smoothies include crushed ice, frozen fruit, or frozen yogurt. Smoothies are drinks that have high production costs and high levels of pulp, making them little accessible to the average Brazilian consumer. Through the use of unripe banana pulp, it is possible to produce a natural beverage, with high increased value and with a smaller production cost, reaching mainly small and medium-sized fruit producers or processors.

Pasteurization is a relatively mild heat treatment, in which food is heated to below 100 ºC. In low acid foods (pH > 4.5, for example milk) it is used to minimize possible health hazards from pathogenic micro-organisms and to extend the shelf life of foods for several days. In acidic foods (pH < 4.5, for example bottled fruit) it is used to extend the shelf life for several months by destruction of spoilage micro-organisms (yeasts or moulds) and/or enzyme inactivation. In both types of food, minimal changes are caused to the sensory characteristics or nutritive value (FELLOWS, 1988).

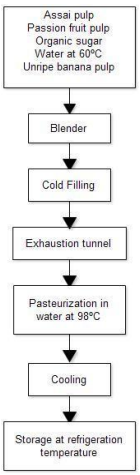
The objective of this work was to develop a smoothie-like beverage containing assai and passion fruit pulp, enriched with unripe banana pulp as a source of resistant starch.

2 DEVELOPMENT

2.1 Defining the formulation

Through preliminary testing and compliance to existing legislation (BRASIL, 2003), the following formulation was established for the beverage: sugar (200 g. kg^{-1}), assai pulp (350 g. kg^{-1}), passion fruit pulp (160 g. kg^{-1}), and Xanthan Gum (2 g. kg^{-1}). The Xanthan Gum served the purpose of guaranteeing the beverage's stability and decreasing the risk of phase separation, which is undesirable in the final product. The assai pulp used is classified as popular assai pulp, or type C, according to current legislation (BRASIL, 2000). Three concentrations of unripe banana pulp were tested: 130, 150 e 170 g. kg^{-1}.

After the preparation of the different formulations, the beverages were bottled in 300mL glass bottles and led to the exhaustion tunnel, closed hermetically with metallic lids and pasteurized for 15 minutes in boiling water, at a temperature of 98^{o} C. After cooling, the bottles were stored at the refrigeration temperature of 6ºC. Flowchart 1 presents a block diagram illustrating the beverage's production.



Flowchart 1 - Smoothie process

In order to increase banana pulp solubility, filtered water at 60ºC was added to it and mixed in a blender for approximately 2 minutes, after which the other ingredients were added. The products obtained were evaluated though sensory testing: Affective Tests of Ordering and Preference, as well as Purchase Intention Tests. The evaluation team was made up of 30 untrained tasters, of both genders, and each one received three samples in random order, coded with three-digit numbers.

The ordering and preference test required the taster to order the samples from less preferred to most preferred. The data obtained regarding the total preference for each sample was analyzed statistically with a 5% level of significance using the Friedman method, which is based on Newell and Mac Farlane's Table. This table defines the value of critical differences between ordering totals (STONE; SIDEL, 1993).

The purchase intention test required the taster to rate each sample according to a scale of one to five, varying from "1 – certainly not purchase" to "5 – certainly purchase." These results were analyzed using a frequency histogram (acceptability rate X percentage of tasters) (BENDER; DOUGLASS; KRAMER, 1982).

2.2 Pasteurization Tests

Once the percentage of unripe banana pulp to be added to the smoothie was defined, three distinct thermal treatments were used in order to evaluate their influence on the physical-chemical and sensory quality of the final product.

For these pasteurization tests, the target microorganism considered was the *Clostridium pasteurianum* (Tref = 100ºC, D = 0.1-0.5 min e Z = 7-9ºC) (LEITÃO; JUNQUEIRA, 1995). The lethal rates were calculated and the value of F obtained was equal to 0.5 (5D). Based on this data, and considering that the smoothie was packaged in 300mL bottles, a minimum pasteurization time of 12 minutes was established.

In order to evaluate the effect that different pasteurization times have on the smoothie's sensory attributes, the beverage was bottled in 300mL bottles, which passed through the exhaustion tunnel and were then immersed in boiling water in an open tank (Lee Metal Products Co. Inc.; Philipsburg, PA) during different times, according to the thermal treatments defined in Table 1. Temperature measurements were taken by the product type thermocouples Bakelite, manufactured by ECKLUND, which are fixed in the package. The thermocouple is located at the coldest point of the packaging. For glass bottles, this point is located the height of 2/3 of bottle (AUGUSTO; CRISTIANINI, 2008).

Table 1 - Treatments used in smoothie pasteurization

Treatment	Immersion time in boiling water (min)
1	12
2	15
3	20

Source: Elaboration by the authors

The physical-chemical determinations carried out for each treatment were as follows:

- Total titratable acidity: determined through titration, according to the method described by the Association of Official Analytical Chemists (AOAC, 1980); results are expressed in $g.kg^{-1}$ of citric acid.
- Total solids: determined indirectly through infrared humidity measurement using the Gehaka equipment, model IV2002 (Gehaka®, São Paulo, Brazil); results expressed in $g.kg^{-1}$ of total solids.
- Soluble solids: measured using a Carl Zeiss refractometer, model 32-G110d (Jena), according to the methodology established by the Association of Official Analytical Chemists (AOAC, 1980); results expressed in ºBrix.
- Total and reducing sugars: determined using the Lane & Eynon (1923) titration method, adapted by Horii & Gonçalves (1991) and the Redutec Equipment, model TE-0861 (Tecnal, Piracicaba, Brazil); results expressed in $g.kg^{-1}$ of total and reducing sugars.
- Vitamin C: determined according to the methodology of the Association of Official Analytical Chemists (AOAC, 2000), modified by Benassi (1990); method based on titration with previously standardized 2,6-dichloropehnol-indophenol; results expressed in $g.kg^{-1}$ ascorbic acid.
- Instrumental color: measured using the Color Eye-Macbeth colorimeter (Macbeth Division, Killmorgen Corp., Newburgh, United States). The coordinates of the color-reading system CIE LAB L*, a*, and b* were obtained using an iluminante D65 and a detection angle of 10º. The parameters L*, a*, and b* refer to the color scales of black-white (luminosity), green-red, and blue-yellow, in that order (QUINTEROS, 1995).
- pH: direct reading in digital potentiometer (Digimed, model DM20), according to the Association of Official Analytical Chemists (AOAC, 1997).

Assai pulp and the passion fruit pulp used respectto the physico-chemical minimum quality standards established by Brazilian law (BRASIL, 2000), which defines: for the passion fruit pulp; soluble solids equal to or greater than 11°Brix and total titratable acidity equal to or greater than 25.0 $g.kg^{-1}$; for the assai pulp: total solids between 400 $g.kg^{-1}$ and 600 $g.kg^{-1}$.

3. RESULTS AND DISCUSSION

3.1 Defining the formulation

Table 2 presents the scores obtained for the order of preference sensory test for the three different percentages of unripe banana pulp added to the smoothie formula.

Table 2 - Scores for the ordering of preference sensory test

Samples	**Totals**	**130 g.kg^{-1}**	**150 g.kg^{-1}**	**170.g kg^{-1}**
		49	65	69
130 g kg^{-1}	49	-	65 – 49 = 16 ^{ns}	69 – 49 = 20*
150 g kg^{-1}	65		-	69 – 65 = 4 ^{ns}
170 g kg^{-1}	69			-

Source: Elaboration by the authors

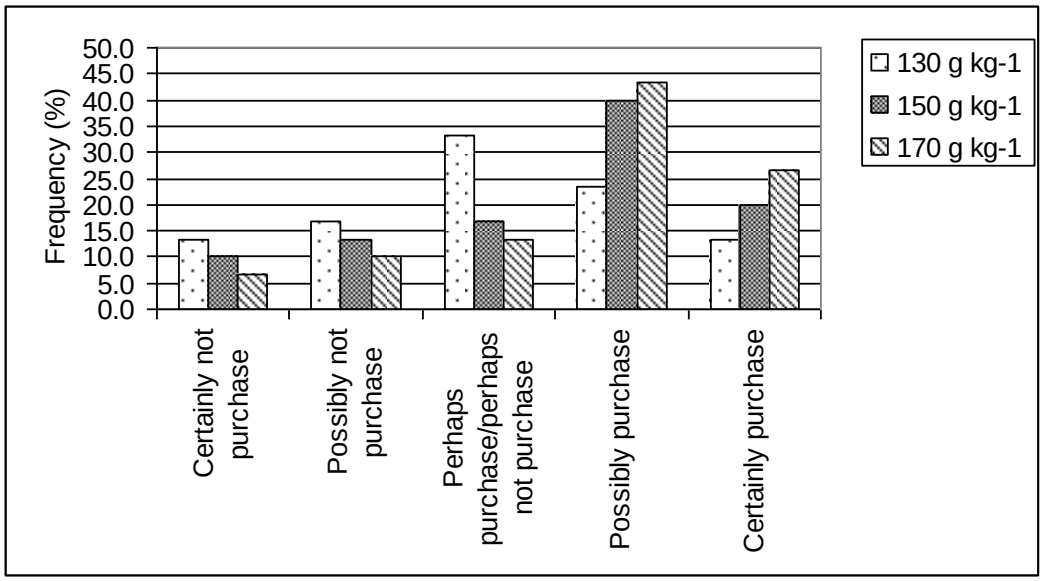
* The samples differ from one another at $p < 0,05$.

^{ns} The samples do not differ from one another at $p < 0,05$. Critical difference between ordering totals found in Newell and Mac Farlane's table for three samples and 30 tasters is 19.

The sample containing 170 g.kg^{-1} unripe banana pulp obtained the highest score when evaluated by the tasters (n = 69 points). Considering that the critical difference between ordering totals found in Newell and Mac Farlane's table for three samples and 30 tasters is 19, only the samples containing 130 g.kg^{-1} and 170 g.kg^{-1} unripe banana pulp presented significant difference ($p > 0.05$). The other samples did not differ significantly.

Picture 1 presents the results obtained in the comparative purchase intention test for the smoothie. The majority of tasters indicated that they would "possibly purchase" and "certainly purchase" all three samples, which indicated good taster acceptability of the smoothie, in general.

It is possible to observe in Picture 2 that the sample with 170 g.kg^{-1} unripe banana pulp clearly demonstrated the highest acceptability, presenting a high percentage of tasters that indicated they would "certainly purchase" (26%) and "possibly purchase" (43%).



Picture 1 - Frequencies for the smoothie purchase intention test for different unripe banana pulp content

3.2 Pasteurization tests

The temperatures reached in the bottles of smoothies were 70.5° C (at 12 min), 75° C (at 15 min) and 81.8°C (at 20 min).

The results of the physical-chemical analyses of the samples submitted to the different types of thermal treatments are expressed in Tables 3 and 4.

Table 3 - Results of physical-chemical analyses of the smoothies[ab]

Treatment	Titratable Acidity (g.kg $^{-1}$ citric acid)	Total Solids (g.kg $^{-1}$)	Soluble Solids (ºBrix)	Reducing Sugars (g.kg $^{-1}$)	Total Sugars (g.kg $^{-1}$)
1	5.8 ± 0.02[b]	705.0±3.11[d]	25.70±0.14[a]	20.0 ± 0.90[a]	220.0 ±0.00[a]
2	5.8± 0.00[b]	706.3 ± 2.69[b]	25.40±0.14[b]	16.5 ± 0.00[c]	217.1 ± 0.00[b]
3	5.8+ 0.02[b]	705.7 ± 0.00[c]	25.70±0.14[a]	18.5 ± 0.00[b]	211.2 ± 1.70[c]
NTT [c]	5.9± 0.05[a]	710.3 ± 2.55[a]	25.05±0.21[c]	5.6 ± 1.80[d]	210.6 ± 0.90[d]

Source: Elaboration by the authors
[a] The use of ± refers to standard deviation (SD).
[b] Different letters indicate statistical significative diference.
[c] No thermal treatment.

Table 4 - Results of physical-chemical analyses of the smoothies (continued)[ab]

Treatment	Vitamin C (mg ascorbic acid/100 ml)	pH	L*	a*	b*
1	0.84 ±0.00[d]	3.71 ± 0.01 [b]	20.47 ±0.04[c]	10.51 ±0.02[b]	10.59 ±0.05[c]
2	1.04± 0.32[c]	3.72 ± 0.03 [a]	21.61 ±0.07[a]	10.67 ±0.02[a]	11.28 ±0.07[a]
3	1.45± 0.29[b]	3.71 ±0.01 [b]	21.10 ±0.10[b]	10.40 ±0.02[c]	10.87 ±0.04[b]
NTT [c]	1.82± 0.29[a]	3.69 ± 0.01 [c]	19.77 ±0.03[d]	10.39 ±0.02[c]	10.61 ±0.07[c]

Source: Elaboration by the authors
[a] The use of ± refers to standard deviation (SD).
[b] Different letters indicate statistical difference between treatments
[c] No thermal treatment.

It is possible to observe that the beverage presented a high soluble solid content when compared to the content normally found in ready-to-drink juices. The addition of sugar was the main factor responsible for this increase, once the pulps used presented a percentage of soluble solids inferior to 10%.

The concentration of reducing sugars found in the samples submitted to thermal treatment was greatly superior to the percentage found in the untreated sample. This can be explained by the hydrolysis of non-reducing sugars that occurs with the temperature increase, once the beverage presented a low pH value (JIANMEI; CHUNG; SASKA., 2011).

The sample that was not submitted to thermal treatment presented the greatest ascorbic acid content, which varied statistically within 5% when compared to the thermally treated samples. This was expected, since ascorbic acid is degraded when exposed to heat (VILLELA; GILBERTO, 1948). However, the ascorbic acid content found in the samples submitted to more intense thermal treatments (Table 4) is superior to that of the samples submitted to the other thermal treatments, but this statement cannot be confirmed since standard deviation was high.

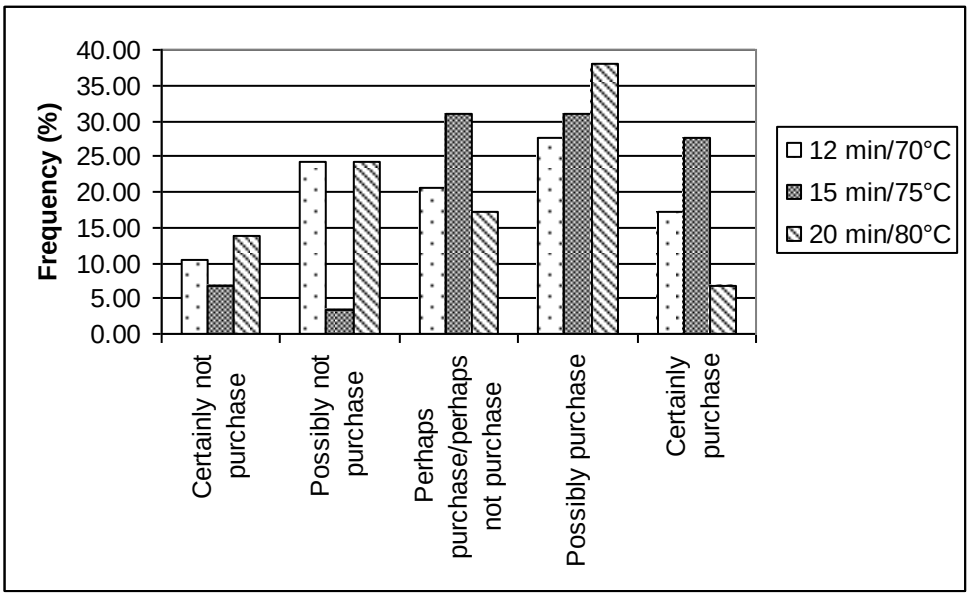
The pH of all samples was lower than 4.5, which is fundamental for the conservation of pasteurized beverages, since the acid environment inhibits the production of *Clostridium botulinum* toxins, as long as hygienic conditions are guaranteed during processing (BARRETT; SOMOGYI; RAMASWANY, 2005).

Regarding the instrumental color analysis, the sample submitted to thermal treatment 2 presented the highest values of L*, a* and b*, differing significantly ($p < 0.05$) from the samples submitted to the other thermal treatments; in other

words, this sample presented the light test color, with more intense hues of red and yellow.

The sensory analysis for overall acceptability was conducted for the smoothie samples submitted to the three different heat treatments, by use of a 9-point structured hedonic scale. According to the results of the sensory tests, it is possible to conclude that the smoothie sample submitted to Treatment 2 obtained a greater acceptance mean score (7,0) than the samples submitted to Treatments 1 and 3 (6,5). However, there was no significant difference at a level of 5% significance between the acceptance mean scores obtained by the different samples. In general terms, the product presented good acceptability, because the overall liking mean scores obtained were between the terms "6 – like slightly" and "7 – like moderately."

Picture 2 presents the results obtained in the smoothie's comparative purchase intention test. Considering that scores 4 and 5 (on the purchase intention scale) represent a positive purchase intention, score 3 represents indifference, and scores 1 and 2 represent a negative purchase intention, treatment 2 presented the largest positive purchase intention (58.6% as compared to the 44.8% presented by the other samples) and the smallest negative purchase intention (10.3% as compared to the 34.5% presented by treatment 1 and the 37.9% presented by treatment 3).



Picture 2 - Frequencies for the smoothie purchase intention test for different thermal treatments

4 CONCLUSIONS

The addition of unripe banana pulp to the smoothie proved viable, since its dilution was uniform for the percentage used and it didn't interfere negatively in the product's appearance and taste. The sensory testing conducted for the smoothie resulted in an average score between 6.5 and 7, on a 9-point hedonic scale used for the evaluation.

5 REFERENCES

AOAC (Association of Official Analytical Chemists) **Official methods of analysis of the Association of Official Analytical Chemists**. Washington DC, USA: AOAC, 1980.

AOAC (Association of Official Analytical Chemists) **Official methods of analysis**. Washington DC, USA: AOAC, 2000.

AOAC (Association of Official Analytical Chemists) **Official methods of analysis.** Gaithersburg: AOAC, 1997. Chapter 37: fruits and fruits products.

ASP, N.G., AMELSVOORT, J.M., HAUTVAST, J.G. Euresta physiological implication of the consumption of resistant starch in man. **European Flair-Concerted Action**, Cambridge, n.11, 1994.

AUGUSTO, P. E. D.; CRISTIANINI, M. Avaliação de erros na determinação de histórias térmicas de produtos processados termicamente com registradores internos de temperatura. **Brazilian Journal of Food Technology**, Campinas, p. 9-19, dez. 2008.

BARRETT, D.M., SOMOGYI, L., RAMASWAMY, H. **Processing Fruits: Science and Technology**. Florida: CRC Press, 2005.

BENDER, F.E., DOUGLASS, L.W., KRAMER, A. Factorial Experiments. In: BENDER, F.E., DOUGLASS, L.W., KRAMER, A. **Statistical Methods for Food Agriculture**. Westpor: Avi Pu. Co., 1982

BENASSI, M.T. **Análise dos efeitos de diferentes parâmetros na estabilidade de vitamina C em vegetais processados.** Dissertação de Mestrado, Faculdade de Engenharia de Alimentos/UNICAMP, Campinas, São Paulo, 1990.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento, Regulamento técnico para fixação dos padrões de identidade e qualidade gerais para suco tropical. Portaria n. 467, de 8 de setembro de 2003. Lex: **Diário Oficial da União**, n. 173, de 8 de setembro de 2003, seção 1, página 3.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento, Regulamento técnico geral para fixação dos padrões de identidade e qualidade para polpa de fruta. Instrução normativa Nº 1 de 7 de janeiro de 2000, **Diário Oficial da União**, n. 6, Brasilia, 10 de janeiro de 2000. Seção I., p. 54-58.

CAMARGO, G. A.; MIELI, J.; MOURA, S. C. S. R.; LUCCAS, V.; GERMER, S. Rheological Characteristics of assai and passion fruit smoothie fortified with unripe banana pulp. In: **Anais** XVIIth World Congress of the International Commission of Agricultural Engineering (CIGR). Book of Abstracts. Quebec, Canada. 2010.

CANNADEAN INSTITUTE. Market Beverage in Brazil. Pesquisa fornecida pela Associação Brasileira de Indústria de Refrigerantes, Néctares e Sucos (ABIR). Dados restritos. 2011.

CHAN, H. Passion fruit, papaya, and guava juices. In: NAGY, S., CHEN, C.S., SHAW, P.E. **Fruit Juice Processing Technology**. Florida, USA: Agscience, 1993**.**

CHAMP, M. Determination of resistant starch in foods and foods products: interlaboratory study. **European Journal of Clinical Nutrition**, London, n.46, p.51-162, 1992.

DELIZA, R., MACFIE, H.J., HEDDERLEY, D. The consumer sensory perception of passion-fruit juice using free-choice profiling. **Journal of Sensory Studies**, Malden, v.19, n.6, p.577–587, dec. 2004.

EERLINGEN, R.C., DELACOUR, X. Formation, analysis, structure and properties of type III enzyme-resistant starch. **Journal of Cereal Science**, London, n.22, p.129-138, 1995.

EUROMONITOR INTERNACIONAL. **Research – Soft Drink M&A Opportunities in 2011**. Disponível em: www.euromonitorinternational.com. Acesso em 20 de set de 2012.

FAO (Food and Agriculture Organization of the United Nations). Crops quantity production in Brazil (2010). http://faostat.fao.org/site/339/default.aspx. Acesso em: 27 de setembro de 2012.

FELLOWS, P. **Food Processing Technology - principles and practice**. England: VCH, 1988.

HORII, J., GONÇALVES, R.H. Um método alternativo para a determinação de AR e ART. **STAB Açúcar, Álcool e Subprodutos**, Piracicaba, n.10, p.45-47, 1991.

IBGE (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA). **Pesquisa de orçamentos familiares 2010-2011: análise da disponibilidade domiciliar de alimentos e do estado nutricional no Brasil**. Rio de Janeiro: IBGE, 2012.

IBRAF. **Retrospectiva Analítica 2010 – Cadeia Produtiva das Frutas**. 1. ed. São Paulo: IBRAF – Instituto Brasileiro de Frutas, 2011.

JIANMEI, Y.; CHUNG, C. C.; SASKA, M. The Behavior of Invert Sugar in Sugar Processing. **Technical Proceedings of the Sugar Industry Technologists**, Inc. 2011, Montreal, Canada. http://www.esugartech.com/SIT_2011_Behavior_of_Invert_Sugar_in_Sugar_Processing.pdf. Acesso em: 27 de setembro de 2012.

KUSKOSKI, E.M., ASUERO, A.G., MORALES M.T., FETT, R. Frutos tropicais silvestres e polpas de frutas congeladas: atividade antioxidante, polifenóis e antocianinas. **Ciência Rural**, Santa Maria, n.36, p.1283-1287, 2006.

LANE, H., EYNON, L. Determination of reducing sugar by means of Fehling's solution with methylene blue as internal indicator. **Journal of the Society of Chemical Industry**, London, n.42**,** p.32-37, 1923.

LEITÃO, M.F.F., JUNQUEIRA V.C.A. Microbiologia aplicada a esterilização de alimentos In: GERMER, S.P.M., MOURA, S.C.S.R. **Princípios de Esterilização de Alimentos.** Campinas: ITAL, 1995. (Manual Técnico, 10).

MEDINA, J.C., GARCIA, J.L., LARA, J.C., TOCCHINI, R.P., HASHIZUME, T., MORETTI, V.A., CANTO, W.L. **Maracujá: da cultura ao processamento e comercialização**. Campinas: ITAL/Governo do Estado de São Paulo, 1980.

MONTEIRO, S. Fruta para beber – O caminho para industrialização é alternativa para melhor aproveitamento da matéria-prima e oportunidade para fruticultores obterem melhores ganhos financeiros. **Revista Frutas e Derivados**. São Paulo, Ano 1, Edição 1, p. 28-31, abril, 2006.

QUINTEROS, E.T. **Processamento e estabilidade de néctares de acerola-cenoura.** Tese de Doutorado, Faculdade de Engenharia de Alimentos/UNICAMP, Campinas, São Paulo, 1995.

STONE, H., SIDEL, J.L. **Sensory Evaluation Practices.** New York: Academic Press, 1993.

VALLE, H.F., CAMARGOS, M. **Yes, nós temos bananas**. São Paulo: SENAC, 2004.

VILLELA, GILBERTO G. **Vitaminas, Métodos de Dosificación**, Libreria "El Ateneo", 1948, Buenos Aires, p.164-201.