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Physical–chemical changes during extraction and clarification of guava juice

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Pink guavas from Ibiapaba plateau (Serra Grande) in Ubajara country, CE, Brazil, were mashed and the pulp treated with 600 ppm of a pectic enzyme at 45°C for 120 min. The pulp so-treated was pressed to give an average juice yield of 84.70%. The pressed juice was cloudy and pink in colour but, after addition of fining agents and filtration, a clear juice with a light yellow colour was obtained. This clear juice was preserved by the Hot-pack method. During the extraction and clarification of the juice, some of the important physical and chemical changes were followed by measuring changes in total soluble solids (°Brix), acidity, viscosity, total phenolics content, colour, turbidity and ascorbic acid retention.

INTRODUCTION

Tropical fruit juices have become important in recent years due to the overall increase in 'natural fruit' juice consumption as an alternative to the traditional caffeine-containing beverages such as coffee, tea, or carbonated soft drinks (Jagtiani *et al.*, 1988).

By incorporating tropical fruits into fruit-juice blends, food technologists have been able to exploit their exotic flavours without adding artificial flavours. This is especially true with highly aromatic fruit such as guava (*Psidium guajava* L.), that may be able to compete in this market, either as guava juice or as mixtures with other juices (Floribeth & Lastreto, 1981).

The guava is one the easiest fruits to process, showing good characteristics for the industry, mainly due to high contents of vitamins C and A (Castro, 1983).According to Wilson *et al.* (1982), the guava does not show problems of a physical or biochemical nature in relation to texture, shape or pulp browning during the processing.

Fruit juices are usually cloudy, colloidal suspensions and in the case of orange and tomato this cloud is desirable (Babsky *et al.*, 1986).In lime and guava, however, a clear juice is usually more acceptable. Juices that have an unstable cloud or whose turbidity is considered 'muddy' or undesirable tend to be marketed as clear juices (Floribeth & Lastreto, 1981).

Manufacture of clear juice, from guava and many other tropical fruits is difficult. The colloidal particles which cause turbidity in the juices carry flavour substances and natural antioxidants. The fruits also have a large content of carotenoids which are retained in the structural tissue during pressing (Czyhrinciw, 1969).

The use of pectic enzymes in association with fining agents in fruit processing is essential to get better juice yields, improve filtration rate and produce clear juices of high quality for the concentration process (Pilnik & Vorange, 1989).The aim of this work was to investigate the physical and physico-chemical changes during the processing of clear guava juice and providing information for tropical fruit juice processing technology.

MATERIALS AND METHODS

Guavas from Ibiapaba plateau in Ubajara country, CE, Brazil, were washed with running water and trimmed; rotten fruits were discarded.The sound fruits were frozen to −30°C until they were needed for processing. Before processing, batches of 50 kg of fruits were thawed by leaving them overnight at room temperature, after which they were mashed in a fruit mill (S. Paulo, Brazil). The pulp was transferred to a water-bath system (S. Paulo, Brazil), with agitation (304 rpm) and heated to 45°C. 600 ppm of pectic enzyme (Clarex-L superconcentrate, Miles–Brasil Ltd, S. Paulo, Brazil) was dispersed in about 200 ml of water and added to the pulp. The optimum time for the enzyme treatment under the conditions enumerated above was determined in a preliminary experiment in which samples of the pulp were drawn out every 30 min during the course of enzyme treatment, immediately afterwards accomplishing the enzyme inactivation by heating the pulp to 90°C for 5 min. The results obtained are shown in Table 1.

After enzyme treatment, the pulp was pressed warm on a Sapec Universal hydraulic press (St Louis, Missouri,

Table 1. Changes in juice yield, total soluble solids content (°Brix), ascorbic acid content, acidity and viscosity of extracted cloudy juice during enzymic treatment of guava pulp (600 ppm Clarex-L, 45°)

Treatment time (min)	Yield (%w/w)	°Brix	Ascorbic acid (mg/100 g)	Titratable acid (g/100 g)	pH	Viscosity (Cps)
0	36.9	13.8	70.0	0.61	4.0	35.0
30	63.4	13.9	81.2	0.63	3.95	13.0
60	65.4	13.9	91.2	0.64	3.93	12.5
90	84.1	13.9	95.4	0.65	3.92	12.5
120	84.7	14.3	97.2	0.66	3.90	12.0
150	84.6	14.3	90.6	0.67	3.85	12.0

USA) and the cloudy juice obtained was treated with fining agents such as: 0.25 ml/litre of Baykisol 30 (30% of colloidally dispersed highly active silicic acid, Bayer AG, Leverkusen) and 5 min afterwards 700 ppm of 1% hydrogel solution (Leiner Paulista de Gelatinas Industria e Comercio Ltda, S. Paulo, Brazil); this technique was recommended by Enzyme Technology (1977).

The treated juice was kept at room temperature for approximately 15 min, to allow flocculation, immediately afterwards the juice was filtered through a felt filter and the clear juice obtained was preserved by Hot-pack method.

The juice was heated at a temperature between 90 and 95°C for 2 min. This treatment was followed by immediate bottling for further heat treatment at 100°C for 5 min. This heat treatment was followed by immediate cooling to 28°C. The essential steps in the extraction and clarification of the juice are shown in Fig. 1.

During the processing the physical and physio-chemical changes occurring during each phase of the

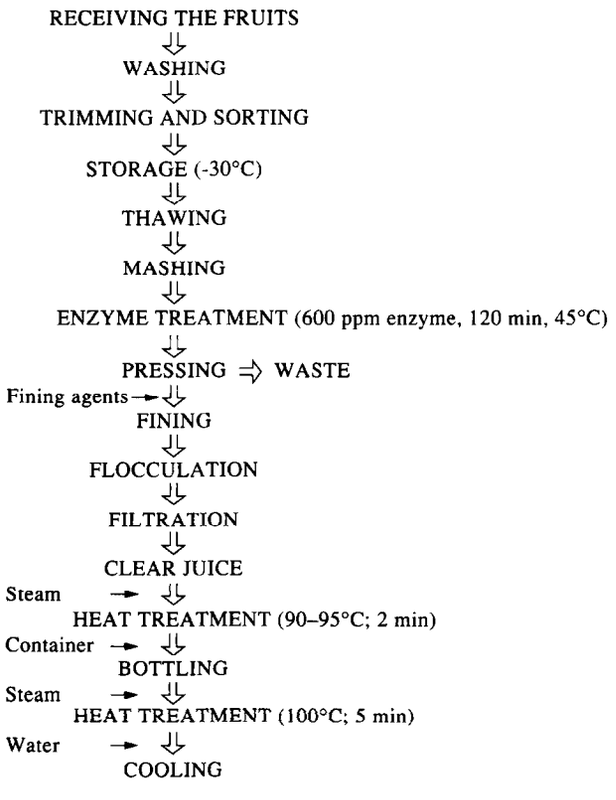

Fig. 1. Flow sheet for the production of clear guava juice.

clear guava-juice processing were determined: natural pulp, pulp treated by enzyme, cloudy juice, clear juice ,and clear juice preserved by Hot-pack method. The pH was determined with a Procyon pH N-4 pH meter; viscosity was determined at 20°C with a rotational viscometer (Rheomat, STV Contraves, Switzerland); ascorbic acid was determined according to Pearson (1976); soluble solids (°Brix) were determined with an AusJena refractometer; the titratable acid was determined according the method recommended by Instituto Adolfo Lutz (1985); total phenolics content was determined according to A.O.A.C. (1975); colour and turbidity according to the method recommended by Ranganna (1977).

RESULTS AND DISCUSSION

The effects of treating guava pulp with pectic enzyme for different periods is shown in Table 1. The results indicate that an enzyme treatment of the pulp for 120 min was adequate to achieve the maximum yield. A longer incubation time resulted in a decrease in the ascorbic acid content of the juice without an appreciable increase in the yield of juice. In the first 120 min of enzyme treatment, there was an increase in the ascorbic acid content (38.8%) of the juice due to its liberation, especially from the peel of the fruit which is known to have 2.2 times more ascorbic acid than the flesh and the centre of the fruit (Amoth, 1978; Berck, 1976). It is therefore quite reasonable to assume that, during the first 120 min of enzyme treatment, the amount of ascorbic acid released was greater than the amount that was degraded, but after 120 min of enzyme treatment the rate of ascorbic acid degradation dominated its liberation.

Imungi *et al.* (1980) obtained an increase of 10.6% of ascorbic acid in guava pulp treated with 400 ppm of pectic enzyme at 45°C during 90 min.

Six extractions of the juice on a pilot plant scale gave the following average results for cloudy juice: juice yield 84.7%, soluble solids content 15.7% °Brix, titratable acid 0.6%, pH 3.98, ascorbic acid content 104 mg 100 g and °Brix acid ratio 1.0.

Table 2 shows the physical and physico-chemical analysis results in different phases of the clear guava juice processing. As can be seen, there was a drastic decrease (62.9%) in viscosity between natural pulp

Table 2. Results of physical and physico-chemical analyses at different stages of clear guava juice (*Psidium guajava* L. var. *pomifera*) processing* with pectinolytic enzymes + baykisol −30 + hydrogel, preserved by the Hot-pack method

Determinations[a]	Stages of processing				
	Natural pulp	Pulp treated by enzyme	Cloudy juice	Clear juice	Clear juice Hot-pack
pH	3.8	4.2	3.8	3.75	3.87
Viscosity (cps)	650	241	12	11.5	11.8
Titratable acid (%)	0.331	0.298	0.521	0.555	0.532
Soluble solids (°Brix)	12.0	15.1	14.0	13.8	14.7
Reducing sugars (g/litre)	15.4	57.8	56.5	55.9	57.2
Ascorbic acid (mg/100 g)	80.1	85.4	84.2	80.9	58.7
Tannins (mg/100 g)	190	211.2	196	51.5	41.8
Colour (O.D.420 nm)	0.409	0.509	0.149	0.007	0.016
Turbidity (O.D. 660 nm)	–	–	0.114	0.004	0.009

*600 ppm of Clarex-L + 0,25ml of Baykisol − 30 + 700 ppm of 1% hydrogel solution. [a]Average of four determinations. (–) Not determined.

phase and treated pulp. This decrease could be attributed to the better physical and physico-chemical conditions for pectic enzyme activation in the complete dissolution of protopectin and subsequent soluble pectin degradation.

Jansen & MacDonnel (1945) achieved a decrease of 50% in the viscosity of pectic acid and pectinic acid solutions by polygalacturonase action that corresponding to hydrolysis of 2.0% of pectic substance.

The increase in reducing sugar content (275%) in the natural pulp phase and treated pulp is associated with the hydrolysis action of pectic enzymes (polygalacturonase and pectin lyases) on polygalacturonic chains as well as the hydrolysis of non-reducing sugar which is, according to Hernandez & Villegas (1986), very high in acid medium at higher temperatures (pulp treatment).

Floribeth & Lastreto (1981) detected an increase of 20% in reducing sugar content using a combination of pectic enzymes and cellulases to clarify apple juice. The enzymatic hydrolysis increased the galactose, arabinose and xylose contents in clear apple juice.

An important criterion for the quality of final product after heat treatment is the ascorbic acid retention. In this case, the decrease of ascorbic acid content (according to Table 2) was 26.7% in relation to the natural pulp. This decrease could be associated with the phases of the processing such as extraction, fining and heat treatment. In any case, the product that remains has a reasonable ascorbic acid content in relation to citrus fruit.

The increase of ascorbic acid content (6.61%) in the initial phases of the processing could be attributed to the enzymatic action, as has been indicated previously.

According to Table 2, there was an increase of 11.5% of total phenolics content (condensed tannins) during the initial phases of the processing. The decrease (73.7%) in total phenolics content just after fining suggests that most of the phenolics were precipitated by gelatin (hydrogel in association with silica sol), so the phenolic compounds remained with the filtered out particles and the pink colour of the initial cloudy juice was probably due to the presence of some of these phenolic compounds.

There was an increase in absorbance of treated pulp which could be attributed to non-enzymatic browning reactions such as: caramelization of the sugars, oxidation of ascorbic acid and Maillard reactions. The significant decrease (95.3%) between the cloudy juice and clear juice stage is due to fining agents, as mentioned previously.

In conclusion, this technique for clarifying guava juice (600 ppm of pectic enzyme; 45°C during 120 min in association with fining agents: silica sol and gelatin) showed good results. The product showed good stability in regard to the chemical and physico-chemical changes during processing that could affect nutritional and organoleptic characteristics.

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