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THERMAL PROCESS REQUIREMENT AND STORAGE STABILITY OF CANNED GUAVA DRINK

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BY

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A thermal process for canned guava drink was evolved on the basis of inactivation of pectinesterase (PE), the most heat resistant enzyme naturally present in guava. The thermostability of PE in guava drink was determined according to the thermal inactivation time tube method. The kinetics of thermal inactivation of PE in guava drink showed it obeyed first-order reactions. The thermal inactivation time curve of the enzyme was analogous to the thermal death time curve of bacteria. As the heat resistance of spoilage microorganisms is lower than PE in acidic conditions, the enzyme was used in the thermal process evaluation of canned guava drink.

The F and D values of PE in the guava drink (pH 3.7) at 100.4°C were 1.0 minute and 0.67 minute, respectively. The F value was equivalent to 1.5 D. This data was used as the basis for the calculation of process time by the formula method. The heat penetration study was carried out in 300 x 305 cans. The process requirements under different initial temperatures were determined. It was found that when the filling temperature was 75°C, to achieve $F^{21}_{100.4}$ = 1.0, no processing was required if 1.5 D process was considered as the minimum lethality. For 2 D process, the filling temperature required was 80°C.

The microbial and storage stability study of the canned drink showed that the process rendered the product microbiologically safe and organoleptically acceptable. The 1.5 D was the minimum safe process for the canned guava drink. However, a 2 D process is recommended for commercial processing, when variation of PE concentration in guava is taken into consideration.

Significant changes during storage of canned guava drink processed with 2 D and 3 D indicated the effect of heat treatment levels on the quality of the product. Storage temperature had appreciable effect on the ascorbic acid content, colour, cloudiness, acidity, pH, viscosity and total soluble solid. Sensory quality scores were most affected by storage

temperatures rather than the heat processing levels. Thus, a 2 D process and storage at refrigerated temperatures (5^{o}C) is recommended for canned guava drink as it was the most stable during storage.

Abstrak Tesis Yang Dikemukakan Kepada Senat Universiti
Pertanian Malaysia Sebagai Memenuhi Syarat
Keperluan Untuk Ijazah Master Sains

KEPERLUAN PEMPROSESAN TERMA DAN KESTABILAN PENYIMPANAN MINUMAN JAMBU BATU DALAM TIN

Oleh

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Suatu ketetapan pemprosesan terma untuk minuman jambu batu dalam tin telah dibuat berdasarkan penyahaktifan enzim pektinesterase (PE). PE merupakan enzim semulajadi yang terdapat dalam jambu batu. Kestabilan terma PE di dalam minuman jambu batu telah ditentukan mengikut kaedah tiub masa penyahaktifan terma. Kinetik bagi penyahaktifan terma PE menunjukkan ianya mematuhi tindakbalas tertib-pertama.

Keluk masa penyahaktifan terma (TIT) bagi enzim tersebut menyerupai keluk masa kemusnahan terma (TDT) bakteria. Dalam keadaan berasid, kerintangan haba bagi mikroorganisma perosak lebih rendah daripada PE. Dengan demikian, enzim tersebut

digunakan sebagai asas penilaian pemprosesan terma pengetinan minuman jambu batu.

Nilai-nilai F dan D bagi PE di dalam minuman jambu batu (pH 3.7) pada 100.4^{o}C adalah masing-masing 1.0 min dan 0.67 min. Nilai F adalah setara dengan 1.5 D. Data ini digunakan sebagai asas pengiraan masa pemprosesan dengan menggunakan kaedah formula. Ujian penusukan haba telah dijalankan dalam tin berukuran 300 x 305. Keperluan pemprosesan bagi suhu awal yang berlainan telah ditentukan. Didapati jika pemprosesan dilakukan berdasarkan kemusnahan minimum 1.5 D, tiada pemprosesan diperlukan bila suhu pengisian 75^{o}C. Bagi pemprosesan 2 D, suhu pengisian yang diperlukan adalah 80^{o}C.

Kajian kestabilan mikrob dan penyimpanan minuman jambu batu menunjukkan pemprosesan tersebut selamat daripada segi mikrobiologi dan baik daripada segi organoleptik. Pemprosesan 1.5 D adalah tahap minimum yang selamat bagi pengetinan minuman jambu batu. Walau bagaimanapun, pemprosesan 2 D disyorkan untuk pemprosesan komersial apabila variasi kepekatan PE di dalam jambu batu diambil kira.

Perubahan bererti semasa penyimpanan minuman jambu batu yang diproses pada 2 D dan 3 D menunjukkan kesan paras perlakuan haba terhadap kualiti produk. Suhu penyimpanan memberi kesan

yang ketara ke atas kandungan asid askorbik, warna, kekeladakan, keasidan, pH, kelikatan dan jumlah pepejal larut. Suhu penyimpanan memberi kesan yang lebih ketara pada skor atribut deria berbanding dengan paras pemprosesan haba. Oleh itu, pemprosesan 2 D dan penyimpanan dingin ($5^{o}C$) disyorkan bagi minuman jambu batu yang ditin. Keadaan ini menghasilkan minuman yang paling stabil semasa penyimpanan.

CHAPTER I

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the fruits that has been cultivated on a commercial scale. There are approximately 1,322 hectares of guava farms in Peninsular Malaysia. Its total production for the year 1990 was about 25,200 metric tonnes. About 70% of this was of the *Vietnamese* variety, and 26% of the *Taiwan* variety. The seedless, *Glohmsahlee* and *Kampuchea* varieties constitute around 1% to 2%, respectively (FAMA, 1988; FAMA, 1989; Malaysia 1989).

Salmah (1985) found that the *Vietnamese* variety contained the highest amount of vitamin C compared to several other local guava varieties. Aside from its high ascorbic acid content, the flavour of guava is its most distinguishing characteristic. Guava of the *Vietnamese* variety was found to be suitable for processing (Salmah and Suhaila, 1987).

Guava can be processed into various products such as puree, juice, nectar, jellies, jams, cheese, ketchup, juice powder and canned product. Guava drink is one of the tropical fruit beverages that has a good demand in the world market.

Thermal processing is an important step in guava processing. Fruit products such as puree and juices should be processed at such temperatures and for such time periods as would render them sterile without impairing their flavour and the nutritional values. Therefore, it is important to find the optimum time and temperature relationship required for the pasteurisation of fruit juices.

Different fruit juices require different amount of heating. The severity of the heat treatment and the resulting extension of shelf life are determined mostly by the pH of the product. Since fruit juices are considered as acid food, severe heat treatment is not necessary. It is sufficient to process them at 100^{o}C or below (Woodroof, 1986).

Guava contains enzymes such as ascorbic acid oxidase, polyphenoloxidase, peroxidase and pectinesterase. Pectinesterase is the most heat stable enzyme in guava pulps (Garces, 1963; Nath and Ranganna, 1983). In guava pulp (Garces, 1963), the inactivation time of peroxidase was found to be minimum (7.5 minutes at 65^{o}C) and that of pectinesterase was found to be maximum (5 minutes at 98^{o}C). The presence of pectinesterase will hydrolyse the pectin molecules resulting in sedimentation of the colloidal particles in puree and juices.

The enzymes as well as the organisms present in the juice have to be inactivated in order to avoid undesirable changes during storage. Thermal inactivation is extensively used as it simultaneously destroys microorganisms (Whitaker, 1972). Temperatures of 70° to 75°C are sufficient to destroy normal microbial population. However, to inactivate pectinesterase, heating at temperatures of 90° to 100°C is required (Desrosier, 1977).

Since pectinesterase is the most heat stable enzyme, it has to be considered in guava juice processing. Lund (1975b) suggested considering enzymes instead of microorganisms in thermal process evaluation of acid foods. In thermal process calculation based on enzyme inactivation, the most heat-resistant enzyme is selected as the basis of the process, just as the most heat-resistant pathogenic or spoilage organism is used for microbial inactivation.

Thermal processing of guava pulp has been evaluated based on destruction of pectinesterase and microorganisms. It was found that the thermal resistance of pectinesterase was higher than that of microorganisms (Nath and Ranganna, 1983).

According to Chan (1983), pasteurisation of guava nectar is best done in a plate heat exchanger and a few seconds at a temperature of 73.9°C or more are usually sufficient. However,

Luh (1980a) recommended that flash pasteurisation of guava drink (nectar) should be done at 82.2^{o} - 87.8^{o}C for 60 seconds.

The objective of the study was to establish the thermal process requirement for processing of canned guava drink. Since pectinesterase is the most heat stable, the thermostability of the enzyme was determined and used as the basis for the thermal process evaluation. Storage stability of the canned guava drink processed at different heat treatment levels and stored at different temperatures was also evaluated.

CHAPTER II

LITERATURE REVIEW

Guava

Traditionally, production of fruits in Malaysia has been aimed mainly to meet the demands of the fresh market. However, with the country's interest in general fruit processing and development of the food products, the trend has been to upgrade fruit growing from the present subsistence level to a more profit oriented plantation scale. Guava is one of the fruit items that has been cultivated on a commercial scale (FAMA, 1989). The potential of the guava industry in Malaysia is excellent (Chan and Tee, 1976).

The guava (*Psidium guajava* L.) varieties found in Malaysia are *GU 3, GU 4, GU 5, GU 6, GU 7, GU 8 (Kampuchea), GU 9 (Glohmsahlee or Hamsari), GU 10 (Kloontau), Maha 1, Pahang 4, Serdang Bharu, Lebai Melaka, Beaumont, Laknow, Indian guava, Allahabad safeda, Taiwan round, Taiwan long, Vietnamese, Hong Kong Pink, Malacca seedless, Bentong seedless, Thai seedless* and *Indonesian seedless* (Chan and Tee, 1976; FAMA, 1989; Malaysia, 1989). However, only a few varieties are grown on large scale. Based on the guava production in 1987, about 70% was of the

Vietnamese variety, followed by *Taiwan* variety, 26%. The *seedless*, *Hamsari* and *Kampuchea* varieties constitute around 1% to 2%, respectively (FAMA, 1988).

Biochemical Characteristics of Guava

Nutritionally guava is an excellent source of ascorbic acid. Wilson (1980) reported that the average vitamin C content was as high as 336.8 mg/100 g fruit. By far, the guava is more nutritious than most of the imported fruits (such as apple, grape, pear, mandarin orange, avocado) in terms of vitamin C content (Chan and Tee, 1976). Ascorbic acid is not distributed uniformly in the fruit tissues. The skin and outer flesh of guava fruit contain most of the ascorbic acid (Agnihotri *et al.*, 1962; El-Zorkani, 1968; Salmah, 1985; Braverman, 1963).

High vitamin C content is an important factor in selecting fruit types for processing. Salmah (1985) found that the *Vietnamese* variety contained the highest amount of vitamin C (180 mg/100 g fruit) compared to several other local guava varieties. Ripening the fruits to a yellow-green stage would further increase the vitamin C content (Salmah *et al.*, 1988).

The total sugar values in guava range from 4.3% to 9.0% (Wilson, 1980). Glucose is the predominant sugar, followed by

Table 1

Nutrient and Proximate Composition of Guava Fruit

Composition	Average*
Proximate Composition	
Energy	46.0 kcal
Moisture	81.2 g
Protein	1.1 g
Fat	0.2 g
Carbohydrate	10.0 g
Fibre	6.8 g
Ash	0.7 g
Minerals	
Calcium	33.0 mg
Phosphorus	15.0 mg
Iron	1.2 mg
Sodium	23.0 mg
Potassium	29.0 mg
Vitamins	
Ascorbic acid	152.0 mg
Carotene	60.0 µg
RE	10.0 µg
B1	0.1 mg
B2	50.0 µg
Retinol	0 µg
Niacin	1.1 mg

*per 100 g edible portion

Adapted from Siong *et al.* (1988)

fructose and sucrose (Salmah, 1989). The total soluble solids of the mature and ripened *Vietnamese* variety range from 6% to 7% (Salmah *et al.*, 1988). The predominant organic acids in a white-variety guava was citric acid. Malic and glycolic acids present in much lesser amounts (Fang, 1965). The acidity of guavas range from 0.33% to 0.99% and the pH from 3.0 to 5.4. The more acid fruits are better for processing than sweeter fruits (Wilson, 1980; Luh, 1980a; Salmah, 1989).

The acidity plays an important part in the flavour acceptance of the fruit and its processed products. Because of the low acid, high sugar and total soluble solids contents, the sugar-acid ratio and brix-acid ratio of guava are generally high but quite variable (Wilson, 1980). For the *Vietnamese* variety, the highest value of the brix-acid ratio was 16.3, obtained after ripening the fruits to a yellow-green stage (Salmah *et al.*, 1988).

Guava is a potential source of pectin (Pruthi *et al.*, 1960; Verma and Srivastava, 1966; Shastri and Shastri, 1975; Wilson, 1980). Values for total pectin range from 0.5% to 1.8%. The methoxyl content of purified guava pectin is relatively low (about 55%), but pectin with characteristics similar to those of commercial pectins has been prepared. The yield of pectin

(about 11% on dry weight basis) is larger than yields from citrus or pasion fruit peel (Muroki and Saint-Hilaire, 1977). Good gel can be obtained at 65% soluble solids at pH 2.1 to 2.4 (Luh, 1980a).

The function of pectin in fruit juices is to hold the colloidal material together and maintain them dispersed in solution, thus contributing to the haze (commonly referred to as 'cloud') or body of the juice. Other product characteristics affected by pectin include viscosity, colour stability and flavour.

The enzyme, pectinesterase is also present in guava (Rieckehoff and Rios, 1956; Garces, 1963; Shastri and Shastri, 1975). They found most of the activity of the enzyme associated with the peel and considerably less activity associated with the flesh. The enzyme activity was fairly high at immature stage, decreased considerably at mature stage, again increased as the fruits became ripe. The activity was maximum at overipe stage (Pal and Selvaraj, 1979). With the presence of pectinesterase, pectin molecules can easily be hydrolysed resulting in sedimentation of the colloidal particles (cloud loss) in fruit puree and juices. In guava processing, pectinesterase has to be inactivated.