Senior Project

"Clear Guava Syrup For Soda Mixed"

by
Ms. Pear Tippawongse
1996

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Abstract

Nowadays, fruit juices are very popular with consumers. Guava Juice is one of the popular fruit juice products. Consumers prefer to drink clear fruit juice, so clear guava juice development is a subject of much research in order to please consumers. One of the problems concerning is that the juice storage period is very short. Therefore guava juice is kept in the form of syrup to provide a longer shelf-life. In clear guava juice production, a pectinase enzyme was added at a concentration of 0.01% and 0.02% at a temperature of 50°C, 55°C, and 60°C. Holding time of 1, 2, and 3 hours with shaking use also employed to improve % yield and clearness of juice. Sugar was added into the juice to 46°Brix to produce guava syrup and served to the consumer with soda so that syrup : soda ratio was equal to 1 : 3. It was found that the best one was the Sarie guava syrup that was produced by using a pectinase concentration of 0.02% at 50°C for 3 hours giving a yield and turbidity of 73% and 0.263 respectively.

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Introduction

Guava (*Psidium guajava* L.), a member of the dicotyledon family Myrtaceae, is a native of tropical America. It is the most important fruit in a family, which includes jaboticaba (*Myrciaria*), guavasteen *(Feijoa)*, Surinam cherry *(Eugenia)*, rose apple *(Syzygium)*, and the spices cinnamon, clove, allspice, and nutmeg. Guava was reported to be growing in Mexico and Peru when European explorers first visited. It has subsequently been introduced throughout the tropics and subtropics. Guava can withstand temperatures as high as 32°C and as low as 3°C.

World trade in the processed guava products--canned slices in syrup, purees, juices, paste or pulp, and jelly—is limited. Recorded shipments in 1972 were 3,000 tonnes. Much of this production was from South Africa, with 1,000 tonnes of the white-fleshed dessert fruit processed into canned slices; most of this was then shipped to the United Kingdom and New Zealand.

Nowadays, fruit juices are very popular with consumers. Guava Juice is one of the popular fruit juice products. Consumers prefer to drink clear fruit juice, so clear guava juice development is a subject of much research in order to please consumers. One of the problems concerning is that the juice storage period is very short. Therefore guava juice is kept in the form of syrup to provide a longer shelf-life.

Literature Review

Guavas are cultivated or grow wild throughout the tropical and subtropical regions of the world, and the fruit is primarily consumed fresh locally. India leads the world in guava production with and estimated 165,000 tonnes (metric tons) of fresh fruit. Other major producers of fresh or processed fruit are Mexico, 127,000 tonnes; Pakistan, 105,000 tonnes; Colombia, 29,000 tonnes; Egypt, 28,000 tonnes; Brazil, 27,000 tonnes; South Africa, 11,000 tonnes; Venezuela, 4,000 tonnes; the Dominican Republic, 3,000 tonnes; Puerto Rico, 3,000 tonnes; Jamaica, 3,000 tonnes; Kenya, 3,000 tonnes; Australia, 3,000 tonnes; and Hawaii, 2,000 tonnes. Total world production is estimated to exceed 500,000 tonnes.

Botany

The guava is a low tree or shrub, 2 to 8 m high, commonly multiple trunked with wide-spreading branches. The trunk is often mottled in appearance with a reddish-brown outer scale bark and a lighter colored inner bark. Younger branches are square with leaves that are oval or oblong, prominently veined, 7 to 15 cm long, and commonly hairy underneath. The flowers are perfect, 2 to 3 cm across, with an irregularly split bell-shaped green calyx, four to six white petals, and numerous white stamens with yellow anthers. The ovary is inferior. The fruit is a berry with a fleshy pericarp, a seed cavity with fleshy pulp, and numerous small, hard, kidney-shaped seeds. The calyx is persistent on mature fruit. Fruits may be round, ovate, or pear-shaped, 3 to 10 cm in diameter and weighing from 50 to 500 gm. The skin color of ripe fruit is commonly yellow. Flesh color may vary from white, which is found in the sweet dessert fruit that are commonly processed into canned slices, to pink, salmon, or carmine. Numerous sclereids (stone cells) occur in the fleshy part of the fruit.

Besides the common guava, only one other species has been suggested as having commercial potential; *P. cattleianum* Sabine, which is red fruited, and *P. cattleianum* f. *lucidum* Degener, which is yellow fruited. Although these fruit are only 2 to 4 cm in diameter, they can be processed into mechanical harvesting. In addition, these guava lack sclereids in the fruit.

There are two major types of guava, the white-fleshed, sweet, dessert type and the pink-fleshed, sour type commonly processed into juice or jelly. In many areas, the guava trees grow wild and the cultivated trees are grown from seedlings. Quality of fruit from these trees varies greatly, and they commonly produce nonuniform processed products. Some countries, however, have selected cultivars best suited to their areas. In Hawaii the pink-red acid fruits were selected. Recommended for processing are the cultivars Beaumont and Ka Hua Kula. Nine other unnamed cultivars have also been tested recently. In South Africa four cultivars have been selected: Fan Retief for commercial fresh fruit production, and Malherbe, Saxon, and Van Zyl for canning and for home gardens. Van Zyl is white fleshed and the others have rose-colored flesh.

In India cultivars were initially selected in the state of Uttar Pradesh followed by introduction to the other states. However, certain local cultivars are known only in their specific localities. The following is a list of important cultivars from the different states in India.

1. **Andhra Pradesh**—*Seeded types:* Red-fleshed, Banarasi, Smooth-green, Smooth-white, No. 49, allahabad Safeda, Chittidar, Safeda, Hafsi; *Seedless types* (probably triploids): Nagpur, Saharanpur;
2. **Assam**—Madhuri-am, Safri, Soh-pryiam, Am-Sophri, and other Uttar Pradesh types;

3. **Bihar**—Safeda Allahabad, Seedless, Harijha, Red-fleshed, Chittidar;
4. **Maharashtra**—Lucknow 49, Lucknow 24, Lucknow 26, Kothrud, Sindh, Dharwar, Nasik, Dholka, Seedless;
5. **Tamil Nadu**—Nagpur Seedless, Hafsi, Chittidar, Bangalore, Anakapalle, Banarasi, Smooth-green;
6. **Uttar Pradesh**—Safeda Allahabad, Red-fleshed Seedless, Chittidar, Apple-color, Karela, Hafsi;
7. **West Bengal**—Bauripore and other Uttar Pradesh types.

The three best known cultivars from Uttar Pradesh are Safeda, Chittidar, and Darela. The most popular of these is Safeda, which is a round, smooth-skinned, white-fleshed, sweet guava. Chittidar is similar to Safeda with white pulp, but with red spots on the skin. Karela is elongated, pear shaped with rough skin and sweet white pulp. Two other cultivars grown in Uttar Pradesh are Hafsi, which is red fleshed, round, smooth skinned, and sweet (but not as sweet as Safeda and Karela), and seedless, which is similar to Karela, but without seed. The seedless cultivar is not recommended for commercial production because it is not a profuse bearer, and the fruits are often small. The cultivar Harija is mostly cultivated in Bihar State. It is a sound, white-fleshed fruit of good eating quality. Cultivars selected as promising for the South Indian Plains included:

1. **Smooth-green**—an erect-growing, fairly vigorous tree yielding 600 to 1,000 smooth-skinned, few-seeded, medium-sized, white-fleshed fruits of fair eating quality and good flavor;
2. **Smooth-white**—a tree of medium vigor yielding 400 to 1,000 smooth-skinned, many-seeded, average-sized, white-fleshed fruits;

3. **Allahabad**—a vigorous, high-yielding (800-1,000) tree, producing large, few-to many-seeded, white-fleshed fruits of soft texture and pleasant flavor;
4. **Banarsi**—a tree of low vigor, yielding 500-1,000 smooth-skinned, many-seeded, white-fleshed fruits;
5. **Red-fleshed**—a very vigorous tree bearing 800-2,000 small-sized, many-seeded, pink-fleshed fruits of average eating quality;
6. **Nagpur Seedless**—a vigorous tree yielding 300-500 seedless or very-few-seeded, small-to medium-sized, white-fleshed, irregularly shaped fruits of good eating quality;
7. **Saharanpu Seedless**—a moderately vigorous tree bearing 200-700 seedless or very-few-seeded, medium-sized, white-fleshed, irregularly shaped fruits of good eating quality;
8. **Lucknow 46**—a bushy tree of medium vigor bearing 500-2,000 pyriform, many-seeded, white-fleshed fruits of fair eating quality;
9. **Lucknow 49**—a dwarf spreading tree of medium vigor, yielding 400-1,000 large-sized, round, many-seeded, white-fleshed fruits of excellent eating quality, comparing favorably with the best specimens of Safeda;
10. **Nasik**—a pear-shaped fruit with a long, high neck from the Maharashtra-Deccan;
11. **Dharwar**—an elliptically shaped fruit. Both the Nasik and Dharwar varieties are known for their hard flesh and good storage qualities during transport, but they also have thin-fleshed shells and many seeds. Some of these varieties are pink fleshed.

Horticulture

Guavas grow well in most types of soil and in most climates in the tropics and subtropics. In some countries they have escaped cultivation and grow wild. In some areas they are considered a weed. In Hawaii they are found growing in almost every soil type from recent lava flows to old weathered oxisols, and in the 500-cm annual rainfall belt (with continuous free-standing water) to desertlike areas with annual rainfall of less than 25 cm. In South Africa guavas can grow in areas of average maximum temperatures of 32°C and average minimum temperatures of 3°C. Guavas can also produce root shoots if the above-ground shoots are killed by frost. These hardy characteristics make guava one of the easiest crops to grow commercially.

Production studies in Hawaii show that areas where the minimum monthly temperature is 7°C during the flowering period have a large number of aborted flowers resulting in noncommercial yields. Areas only 4 to 5°C higher had good yields. Annual rainfall between 100 and 380 cm produces satisfactory growth. Although guava is tolerant of poor soil conditions, it responds well to fertilizers and well-drained soils. Because flowers are produced on new growth, the plant does not become vegetative even in very fertile soils.

For uniform quality and production, guava should be propagated by asexual means: cuttings, graftage, or air layers. However, root stock is commonly grown from seed. Seeds should be obtained from clean, ripe fruits, washed to remove the pulp, treated with fungicide, planted in sterile soil, and covered to a depth of about 1 cm. When seedlings are about 4 cm tall, they should be transplanted into 1-liter containers. In about 5 to 7 months, they should be about 30 cm tall and may then be transplanted into 4-liter containers. When the seedlings are about 1 cm in diameter and 25 cm tall, they are ready for graftage by any accepted method. In Hawaii, the Forkert, a modified patch-bud method, is recommended. In Australia small oval patches, about 1 cm in diameter, are made with a punch for perfect matching of the stock and scion. Whip grafting is recommended in South Africa.

Three-node green-wood stem cuttings, with leaves removed from the bottom node, are recommended in Hawaii. The cuttings should be treated with 2% indolebutyric acid in talc and placed under mist with 27 °C bottom heat. The cuttings should be well rooted in 6 to 8 weeks and should be transplanted into 1-liter containers. After 4 to 6 months the plants should be ready for planting in the field. Guava may also be propagated by root cuttings, but this method is not adaptable to large-scale production. For air layers, a straight shoot should be ring girdled about 50 cm from the tip, the cambium should be scraped, the girdle covered with damp moss, and then wrapped with plastic.

Although planting designs differ, three researchers have recommended planting about 200 trees per hectare. In Hawaii, two designs have been recommended: (1) spacing 5.5 x 9 m to allow trucks to enter the field for mechanical harvesting, and (2) an equilateral triangle (quincunx) design with 6.6 m between rows and 7.6 m between trees in rows. The later design allows maximum space for each tree canopy. In the Ivory Coast spacing 6 x 6 m to 8 x 8 m with pruning is recommended. In South Africa studies of four different pruning systems/tree shapes, show the highest yields from cup-shaped trees, then flat crown, severe pruning, and hedge. Greatest average fruit size followed a reverse trend. The cultivars Hafsi, Chittidar, and Safeda have been reported to be suitable for the Cordon system in India, but no planting distances were given. The Cordon system for peaches uses 4 x 1 m spacing.

Analysis of the fourth leaf of an actively growing major terminal shoot with the first expanding young leaf as number 1 has been recommended as a guide to fertilizer application. Optimum values on an oven dry basis are nitrogen, 1.7%; phosphorus, 0.25%; potassium, 1.5%; calcium, 1.25%; magnesium, 0.25%; sulfur, 0.18%; zinc, 20 ppm; manganese, 60 ppm; copper, 8 ppm; and boron, 20 ppm. In a study of ten selected cultivars, 0.2 kg of 14-14-14 fertilizer was applied per tree, quarterly in the first year, and 0.4 kg in the second year. In the third, fourth, and fifth years, 1.4, 2.3, and 3.2 kg of 10-20-20 fertilizer was applied, respectively, three times per year. Yields were: year 3, 122 kg per tree per year; year 4, 182 kg; and year 5, 258 kg. In the Ivory Coast, 10-7.5-10 fertilizer, at the rate of 80 g per tree per year was given to young trees, and 10-5-6.7 fertilizer, at the rate of 500 g per tree per year, was given to 7-year-old trees. With these fertilization rates, production from nine cultivars averaged 2.1 kg per tree in year 3, 35.2 kg in year 4, 109.1 kg in year 5, 174.3 kg in year 6, and 268.3 kg in year 7. Yield figures for small orchards (probably seedlings) in Hawaii averaged: year 3, 12.8 kg per tree, per year; year 4, 34kg; year 5, 71 kg; year 6, 142 kg.

Because the guava produces fruit on new growth, the yearly cycle of flowering and fruiting is dependent on new growth. New growth can be induced by rainfall-irrigation, fertilization, pruning, or artificially induced leaf drop, using growth regulators. In Hawaii a dry period in January followed by rainfall in February produces fruit that is harvested in August through December, with a peak in September. A second period of rainfall in August, after a drier summer, produces fruit in January through April, with a peak in February. Production in the wild is greater from July through December than from January through June. In cultivated orchards, the greater production is from January through June. Similar rainfall patterns in March and September in the Ivory Coast produce peaks of production in August through October, with a peak in September, and in March and April. In the Ivory Coast over 70% of the production is from July through December. In Puerto Rico two production periods occur in nonirrigated fields. These are late-summer/early-autumn, and late-winter/early-spring. The summer-autumn harvest is heavier, but with small individual fruits. With irrigation every two weeks, except when rainfall has been 1.27 cm or more during the preceding 2-week period, fruit production is continuous throughout the year with the same orchard-management practices.

The crop-cycling program developed by the University of Hawaii and Australian workers uses pruning, fertilization, irrigation, and/or defoliation with ethephon and urea to induce new shoots and flowering. The entire cycle is 9 months long, with fruit production during the eight and ninth months after treatment. By staggering the cycle in different parts of an orchard, continuous year-round production can be achieved.

Several diseases have been reported in Hawaii. Mucor rot *(Mucor hiemales)* first appears on mature green fruit. Rhizopus rot *(Rhizopus stolonifer)* is a fruit rot that is similar in appearance to mucor rot. Firm rot appears as firm, water-soaked areas on fruits and may be caused by bruising. Blossom-end rot appears to be caused by calcium deficiency. Fruit spots, a disease that may related to *Guignardia musae*, appears as gray-black circular masses on ripening fruit. In India anthracnose of guava, caused by *Colletotricum psiddi*, is a serious disease in the rainy season. The disease is characterized by the appearance of brown, round, decayed spots; the fruits then turn brown and shrivel. Another disease is fruit canker caused by *Physalospora psiddi.* The green fruits are affected superficially, showing brown, elevated, necrotic areas. Fusarium wilt in India affects the entire tree. The symptoms of this disease are yellowing, dying, and abscission of the leaves, starting at the top of the tree. As wilting starts, discoloration of the cambium region can be detected. The affected branches die successively, and ultimately the whole tree dies.

In Hawaii insect and mite pests of guava include green *scale (Coccus viridis)*; red-banded thrips *(Selenothrips rubrocinctus)*; coconut mealybug *(Nipeacoccus nipea)*; striped mealybug *(Ferrisia virgata)*; red and black flat mite *(Brevipalpus phoenicis)*; Chinese rose beetle *(Adoretus sinicus)*; Fuller's rose beetle *(Pantomorus cervinus)*; transparent-winged plant bug *(Hyalopeptus pellucidus)*; guava moth *(Anua indiscriminata)*; spiraling whitefly *(Aleurodicus dispersus)*; Oriental fruit fly *(Dacusdorsalis)*; and Mediterranean fruit fly *(Ceratitis capitata)*. In South Africa pests include Natal fruit fly *(Ceratitis rosa)*; Mediterranean fruit fly; stripped mealybug; long-tailed mealybug *(Pseudoccus longispinus)*; guava scale *(Pulvinaria psidii)*; palm scale *(Hemiberlesia lataniae)*; false codling moth *(Cryptophlebia leucotreta)*; coconut bug *(Pseudotheraptus wayi)*; and fruit bats. Insect pests in India include bark-eating caterpillars. Guava weevils, guava scale, and fruit files. Birds and fruit-eating bats also cause serious damage.

Harvesting and Handling

Development of guava fruit follows a single sigmoid pattern. The weight of the fruit increases moderately for 50 days after anthesis. From 50 to 110 days fruit weight increases rapidly and then slows after 110 days. Fruit volume follows a similar pattern, but with some volume increases after 110 days. Fruits are ready for harvesting at 120-150 days after anthesis, dependent on climate. In India, the cultivar Allahabad Sefeda ripened in about 120 days during the summer and 150 days during the winter.

In the cultivar Beaumont, the fruit-detachment force declined from 7 kg at 115 days to less than 0.5 kg by day 130. A similar decline in deformation force from more that 14 kg to less than 4 kg also occurred along with a loss in skin chlorophyll. Fruit with a detachment force of less that 4 kg were fully yellow. In the cultivar Allahabad Safeda, measurments of pressure (Magness Taylor) at 100 days show values of more that 14 kg; 110 days, 13 kg; 115 days10.5 kg; 120 days, 8.2 kg; 125 days, 5.9 kg; 130 days, 5 kg; 135 days, 3.9 kg; and 140 days, 1.6kg. The softening of the flesh progressed from the core and could be first detected by thumb pressure when the fruit was 115 days old, as a slight softening of the fruit. At 125 days the fruit was yellow, except for a slight tinge of green at the stalk and blossom end. At 130 days, the yellow color darkened somewhat, and the fruit showed maximum content of sugars and good flavor. The flesh was soft in texture and yellowish in color throughout.

The auxin 2,4-D, at rates of 1 to 20 ppm, accelerated the maturity and ripening of guava by up to 15 days earlier than other controls. MH-40, at rates of 100 to 1,000ppm, retarded the ripening by 20 to 25 days. Daminozide (Alar), at 1,000 ppm applied 20 days before harvest, effectively retarded the activity of cellulase and pectin methylesterase. Thus, growth regulators may be used in the future to extend the harvest season by 30 to 45 days and to reduce spoilage during storage and shipment.

Guava fruits are most commonly harvested by hand. In orchards harvested by hand the higher branches are pruned to reduce the use of ladders. Experimental orchards, designed for shake harvest, have trees with one main trunk to facilitate attachment of the shaker.

Firm, yellow or half-yellow, mature fruit with no signs of insects or fungus disease should be harvested. It is important not to harvest overripe fruits, as they are easily damaged in transport and handling. Fruit-harvest intervals should not be more than 3 to 4 days; this prevents harvesting of overripe fruit. Fruits that have fallen are discarded. Green fruits also should not be harvested, as they do not develop the quality of ripe fruits. The guava are usually harvested into field containers, then brought to trucks or trailers, and dumped into boxes for transport to the processing plant.

The guava is a highly perishable fruit; therefore, it is important to select the right type of fruit and packing material for transport. Shallow wooden boxes should be used to protect the fruit from external hazards and from internal crushing from upper fruit in containers that are too deep. In Hawaii, tomato boxes are recommended instead of orange crates because of their shallow depth.

For long-distance shipments soft filling or cushioning material should also be used. Good ventilation is important to prevent build up of heat and humidity, which promotes microbial spoilage. If ripe fruit needs to be shipped. It might better be held in a cool or shady area and transported during the cooler night temperatures. The best practice would be to ship unripe fruit and ripen it under controlled conditions at the processing plant.

In India there are no standardized containers, and baskets vary from large to small, deep to shallow, and flat to conical and cylindrical. Packing materials commonly used are dry grass, paddy straw, or dry, crushed leaves. These materials are usually used only for shipping and appear to be adequate for short-distance transport in bullock carts, but are not ideal for rail shipment of over 500 miles. Wooden crates or corrugated cartons with ample resilience and ventilation are better. Hessian bags are not sufficient for even short-distance transport.

Storage

The common guava *(P. guajava)* and the yellow and purple Cattley guava *(P. cattleianum)* are both climateric fruits. In full-sized pale-green fruit, the peak in carbon dioxide and ethylene production at 20°C occurs about 5 to 6 days after harvest. Biochemical and color changes accompany the ripening process. Studies of two processing guava cultivars in Australia showed the fruit to be eating ripe after 5 days storage at 20 °C. After 7 days at 20 °C, the skins were discolored and some rotting had occurred. Storage at 0 to 10 °C extended the postharvest life for about 2 weeks. Storage at 0 °C reduced rotting, but caused chilling injury to the pulp, resulting in darkened flesh. Pulp injury occurred the least at 5 °C, and this was considered to be the optimum storage temperature. Some fruits were dipped in a solution containing 2 g of benomyl in 1 liter of water at 48 °C for 5 min to control. Treatment with ethylene before storage appeared to have no effect. In India, fruits of the cultivars Allahabad, Seedless, and Red-flesh, stored at 8 to 10 °C and 85 to 90% relative humidity, had a storage life of 2.5 weeks. The heat of respiration was 7040 to 7700 BTU per ton of fruit, per 24 hr, and the physiological loss in weight was 14%.

Storage life of mature fruit at room temperature (22-35 °C) is enhanced by use of wax coatings containing 6 parts refined sugarcane wax, 2 parts triethanolamine, 1 part oleic acid, and 0.5% orthophenyl phenate as fungicide. After 10 days storage, total soluble solids and specific gravity were similar; however, fruit pressure was 4.4, 5.6, and 8.3 lb and the physiological loss in weight was 5.42, 3.96, and 3.64% in control, 8% waxol and 12% waxol-treated fruits respectively. Also, fruit wastage in control, 8% waxol, and 12% waxol-treated fruits, after 7 days, was 16.2, 8.2, and 4.8%, and after 10 days, 66.2, 38.2, and 24.3% respectively. Treatment with sugarcane wax or a mixture of carnauba wax and paraffin increased the storage life (based on 10% spoilage) from 4 to 6 days.

Recent experiments indicate that the storage life of mature fruit may be extended up to 1 week at room temperature by using modified atmospheres during storage. However, a modified atmosphere (7.5 and 10% carbon dioxide), in addition to carnauba-resin or carnauba-paraffin wax, did not appear to affect storage life. Low temperature (8 to 10 $^{\circ}$C) in addition to these waxes increased storage life to 21 days with no wastage due to disease. The carnuba-paraffin emulsion also imparted a gloss to the fruits that was normally lost during storage.

Fully ripe guava should be processed without delay, but if necessary, they can be held for about a week at 2 to 7 $^{\circ}$C with only a small loss in vitamin C content. Storage at 0 $^{\circ}$C for up to 2 weeks is used commercially in Hawaii.

Biochemical and Nutrient Composition

Because of the guava's relatively low seed content (1.6-4.4%), its edible portion is relatively high, which not only increases its yield for processing purposes but also increases its nutrient attractiveness. Nutritionally, guava is an excellent source of ascorbic acid, ranging well over 100 mg per 100 g; it is also an excellent source of niacin, the edible portion containing more than 1 mg per 100 g. It contains calcium, iron, phosphorus, and vitamins such as thiamine and riboflavin in appreciable quantities. However, because of its unusually high content of ascorbic acid and it's pleasing but delicate flavor, guava has been researched throughout the world. A survey on the ascorbic acid content of guavas is shown in Table 1.

The chemical composition of different guava varieties grown in India is presented in Table 2.

In the early 1940s the exceptionally high content of ascorbic acid in guavas Seasonal differences in the ascorbic acid content of Indian guavas, with the winter crop having 268 mg, and the rain crop having 240 mg per 100 grams. Within each fruit, the ascorbic acid content is highest in the skin, with decreasing amounts found in the inner pulp. Guavas contain 74-87% moisture, 13-26% dry matter, 0.5-1.0% ash, 0.4-0.7% fat, and 0.8-1.5% protein.

Table 1 **Ascorbic Acid in Several Varieties of Guava.**

Location	Variety	Ascorbic acid (mg/100 g)
Florida	Red Cattley	29.1
Florida	Yellow Cattley	39.1
Florida	Common Cattley	23-486
Hawaii	Red or White Cattley	25-50
Hawaii	Common	96-306
California	Common	50-352
Puerto Rico	Common	202-442
India	Country	299
India	Hill	11-19
Australia	Large Yellow	110

From : "Tropical and Subtropical Fruits" (1980)

Table 2 **Chemical Composition of Guavas Grown in India.**

Variety	°Brix	Percentage of acid	Ascorbic acid (mg/100g)
White-fleshed			
Apple color	15.6	0.49	117.5
Behat coconut	14.9	0.59	272.5
Chittidar	13.1	0.53	172.5
Dharwar	13.9	0.49	232.3
Habshi	15.4	0.34	135.0
Lucknow-42	10.1	0.50	140.0
Lucknow-49	13.5	0.62	364.5
Mirzapuri	11.7	0.68	205.0
Nasik	12.9	0.50	181.7
Safeda Allahabad	14.3	0.61	217.8
Sindh	12.9	0.50	102.5
Smooth-green	12.4	0.40	142.6
White Supreme Ruby	13.2	0.60	319.0
Red-fleshed			
Anakapalle	10.3	0.38	192.5
Florida Seeding	12.8	2.12	177.5
Hybrid Red Supreme	10.9	1.52	157.5
Kothrud	11.1	0.48	80.0
Red-fleshed Allahabad	12.4	0.40	62.5

From : "Tropical and Subtropical Fruits" (1980)

Carbohydrates are the principal nonaqueous constituents of guava. Of the total carbohydrates (14.8 g/100g), 5.82 g are the sugars: fructose, glucose, and sucrose. In guava fructose is the dominant sugar, constituting 58.9% of the sugars, followed by glucose, 35.7%, and sucrose, 5.3%. The presence of trace amounts of sedoheptulose

(0.04%) in ripe guavas. Differences in acid content between the cultivated (Beaumont) variety and the wild types were determined .The total acidity of cultivated and wild guavas was 18.4 and 14.08 mg per 100 g respectively. The Beaumont fruit had 128 mg of ascorbic acid per 100 g. The polybasic organic acids were separated and quantitatively determined by gas liquid chromatography, and the results are shown in Table 2. Malic and citric acids were found in Beaumont guavas in approximately equal amounts, 0.47 and 0.53% by weight respectively. These acids are about 20 times more abundant than lactic acid, which is present in the amount of only 0.025%. In wild guava extract we measured 0.18% malic, 0.54% citric, and 0.012% lactic acid. The relative abundance of these acids in guava is responsible for its tart flavor and also for its relatively low pH of 3.2 to 4.1.

The pink coloration in guavas has been attributed to the presence of lycopene. The lycopene content in the Beaumont variety was found to be 5.87 mg/100 g fruit. In nine newly developed cultivars with pink to red coloration, the lycopene content was found to range from 4.78 to 6.90 mg/100 g fruit.

The volatile flavor constituents of guava have been reported by several workers. Earlier reports centered on the characterization of guava essences or oils, which provided limited information on the identity of flavorants. Advances in gas chromatographic-mass spectral methods permitted the unequivocal identification of several volatile compounds. 22 compounds in Hawaiian guavas of which methyl benzoate, hexanol. *p*-phenylethyl acetate, methyl cinnamate, cinnamyl acetate and *β*-ionone are believed to play predominant roles in the flavor and odor of the fruit. Using South African guavas, identified 16 new compounds. A flavor evaluation of each newly identified compound was not given.

Changes in the volatile composition of guava puree during enzymatic liquefaction (pectinase/cellulase treatment) indicated the generation of a new set of volatiles not found in untreated guava pulp C_6 carbonyls and esters also decreased.

Processing

1. Guava Puree

Guava puree, also known as guava pulp, is a liquid product prepared by pureeing or pulping whole guavas. Puree is most commonly manufactured into nectars, various juice drink blends, syrups, ice cream toppings, and jams and jellies. A guava puree process that was developed in Hawaii and is in commercial use worldwide is described as follows: The firm, ripe fruits are delivered to the processor usually in 13.61 kg to 18.14 lug boxes. The fruit can be stored for up to 1 week at 7.2 - 10°C until enough fruit has been collected to warrant a processing run. The fruit is placed into a dump tank, which serves to soak and wash the fruit, and also to separate out the overripe and immature fruit (which tends to sink to the bottom of the tank) form the batch to be processed. The fruit which floats is picked up on a moving conveyor belt; it is inspected and sorted for decay, insect damage, and foreign materials such as leaves, dirt, and other trash. This washed fruit is first passed through a chopper or slicer to be broken up, and then is fed into a pulper. The pulper removes the seeds and fibrous tissue and forces the remainder of the product through a perforated stainless steel screen. (The holes in the screen are between 0.033 and 0.045 in. The pulper is fed at a constant rate to insure efficient operation. The purred material coming from the pulper is next passed through a finisher, which removes the stone cells from the fruit and provides the optimum consistency to the product. The finisher is equipped with a screen containing holes of approximately 0.020 in. A smoother texture of guava puree can be attained by passing the guava pulp through a mustard mill, which effectively grinds up the stone cells. It has been our observation, however, that the incorporation of excessive amounts of milled stone cells into the puree discolors it. Other methods of removing stone cells include using a finer screen (0.017 in.). in the finisher or using a centrifuge having a 12 in. solid bowl spinning at 2100 rpm.

Yield data computed on the basis of a 0.033-in. screen in the pulper and a 0.020-in. screen in the finisher showed 12.0% is waste as seed and 5.5% waste as stone cells.

After the guava puree is produced, it may be preserved through further processing operations such as freezing, canning, aseptic packaging, dehydration or used in the manufacture of other preserved products such as jams, jellies, and syrups.

2. *Frozen Guava Puree*

Perhaps the best way to preserve the flavor and color of guava puree is by freezing; the material passing through the finisher can be packaged and frozen with no further treatment. It is not necessary to heat the product to inactivate enzymes or for any other reason. A slush freezer may be installed in the processing line to chill the product before it is poured into containers.

The material can be frozen in many types of cartons or cans; however, a plastic bag inside a fiber box is commonly used and is probably the least expensive. The boxes of puree should be frozen quickly to protect the product quality. The puree should be frozen in a blast freezer at approximately-29°C and stored at -17°C.

3. Frozen Guava Nectar

Various fruit nectars, including guava nectar and blends of guava with orange and grapefruit juices, and made by blending fruit purees and 14-15° Balling syrup or purees and various fruit juices and preserving by freezing at -17°C or by canning.

4. Guava Nectar Blends

Blends of Valencia orange juice with guava puree (3 : 1 w/w) were found to be pleasing, as was also a blend of grapefruit juice and guava puree (3 : 1 w/w).

Guava juice has also been fortified with acerola juice. Sufficient water was added to sliced guavas to almost cover the fruit, which was then boiled for 15 to 20 min. The mixture was poured into a muslin bag and hung to drain. Sugar was added in a ratio of 1 part sugar to 8 parts juice (extract). Sufficient acerola juice was added to bring the concentration of the product as consumed to approximately 60-70 mg ascorbic acid in the frozen product (90%), as compared to the bottled (67%).

5. Frozen Guava Nectar Base

Guava nectar base is a combination of puree and sugar in such proportions that it may be diluted with water by the consumer in the same manner that many other fruit juice concentrates and nectars are prepared. For the Hawaiian palate an optimum dilution of 2.5-3 parts water to 1 part nectar base was determined by a taste panel. The formula for the nectar base was 45.36 kg guava puree at 7°Brix and 21.77 kg sugar. Citric acid is added to the mixture to adjust the pH to 3.3-3.5. After the mixture has been blended, it should be pumped through a slush freezer. It should then be poured into suitable containers, and frozen immediately at -17.8°C or below.

6. *Canned Guava Puree*

Guava puree may also be canned and heat processed as follows : The puree is heated to 85°C in an open kettle, poured into cans with a head space of ¼ in. and sealed. The cans are inverted while they are still hot to sterilize the lid. The cans are allowed to air cool slowly (15-20 min) to allow the sterilization process to complete before they are cooled in a water bath. It has been our experience that this type of severe heat treatment induces deleterious changes such as loss of color and flavor. Less severe heat treatments include heating the puree in flash pasteurizer or heat exchanger to a temperature of approximately 90.6°C for about 1 min. followed by filling the cans, sealing, and cooling. The air cool time after hot filling depends on the filling temperature and the size of the container. For a 301 x 309 can and a fill temperature of 82°C, an air cool time of 10 min plus 8 min in boiling water also determined to be microbiologically safe. The process time developed was much less that the 40 min. at 85°C.

The cans should be cooled rapidly to 38-41°C by either a water shower or a bath before they are cased and stacked in a warehouse. Cooling the cans to only 37.8-40.6°C leaves enough residual heat to permit the cans to dry off, thus avoiding corrosion on the can exterior.

7. *Aseptic Processing and Packaging*

As tin plate and energy costs become higher, alternative packaging becomes more attractive. The bag-in-box aseptic packing system is attractive because it requires no product refrigeration and because the container is disposable. Tropical fruit products such as guava, which are destined for transoceanic shipments from lesser developed areas to industrially developed markets, are likely candidates for aseptic processing. Guava puree has been successfully packaged aseptically in Hawaii, and at present it is a viable commercial venture with several million pounds being exported annually. Guava puree is prepared as described above and processed aseptically by first heat sterilizing the puree in a Cherry-Burrell swept surface heat exchanger at 93°C for 38 s before cooling in another swept surface heat exchanger at 24°C. The puree is then piped under aseptic conditions to a Scholle aseptic filler, which is used to fill 1-gal bags. [The multi-ply, metallized, polyester/evapolyethylene bags (Scholle #804AM) were previously sterilized by the supplier using gamma irradiation.] The product was fairly stable after 6 months storage under ambient temperatures with significant losses in ascorbic acid (30%) and changes in flavor and color, but these losses were not considered ditrimental to marketing since canning and storing guava puree under identical conditions resulted in inferior product quality. Further studies in an attempt to improve the quality of aseptically packaged guava puree by deaerating the puree prior to heat processing showed that deaeration was not feasible.

8. Guava Nectar form India

In India the commercial manufacture of guava nectar consists of selecting a good variety (e.g., Safeda), washing the fruit well, avoiding inclusion of greenish portions, taking preferably yellow- to white-fleshed guava, removing the calyx, cutting the fruit into 2-4 parts, softening it by heating with water (15 parts water to 100 parts fruit, to compensate for evaporative losses), then pulping the fruit through an 1/8-in. sieve, and finishing the puree through a 1/16-in. sieve. The nectar formula is 25% puree, 10% sugar, and 65% water. The Brix is maintained at 17-18° and acidity at 0.32-0.35% as anhydrous citric acid. The nectar is then pasteurized in a heat exchanger. At Hyderabad another process to manufacture guava is used; it consists of washing the guavas in soaking tanks, then elevating the guavas to crusher heater where they are preheated for 3-5 min at 70°C before being passed through a pulper. The pulp is blended with 30% water, the soluble solids are kept at 15-16°Brix and acidity at

0.55%. The product is passed through a colloid mill and is vacuum deaerated and packed into A 2½, 0.45 g tall cans and 155.93 g tins.

9. Cloudy Guava Juice

Two types of guava cloudy juice are prepared in Uttar Pradesh (India) as follows: one product contains 55-60% pulp, the other consists of 85% pulp. The fruits are washed, peeled, cut into pieces, and passed through a pulper and finisher fitted with 1/32-in. and 1/64-in. screens respectively. The pulper is fitted with brushes. Soluble solid content of the guava pulp is around 13-14°Brix, and the acidity is 0.20-0.25%. The pulp, citric acid, and 70°Brix syrup are heated and blended, yielding a final Brix of 15 and acidity of 0.20-0.30%. Ascorbic acid is added at the rate of 0.01%. The prepared product is poured hot into bottles (110 ml or 190 ml), capped, and processed in boiling water for 25 min, followed by cooling to and ambient temperature.

10. Clarified Guava Juice

A clarified guava juice can be used in the manufacture of clear guava jelly or in various juice drinks. It will have a light amber or light pink coloration since most of the pink pigments in the guava remain with the solid material.

In Hawaii a clear juice is prepared from guava puree which has been depectinized enzymatically. About 0.1% by weight of Pectinol 10-M (or an equivalent amount of any pectin-degrading enzyme) is mixed into the puree at room temperature. Heating of the product to 49°C greatly speeds the action of the enzyme. After 1 hr clear juice is separated from the red pulp by centrifuging or by pressing in a hydraulic juice press. A batchtype of continuous-flow centrifuge can be used on the depectinized puree with no further treatment.

If a hydraulic press is used, diatomaceous earth must be mixed into the depectinized puree to facilitate the pressing operation. About 0.5 to 1.0% of a coarse-grade filter aid (Celite 545 or equivalent) is mixed into the puree with a power stirrer. The puree is poured into nylon press cloths or bags and juice is expressed by applying pressure. This press juice usually contains some suspended solids and must be further clarified in a filter press. The clear juice effluent from the filter press can be preserved by freezing or by pasteurization in hermetically sealed cans. The clear juice can be used in preparation of beverages or jelly.

After the pressing stage the clear guava juice should be heated sufficiently to inactivate the pectic enzymes. This is best done in a plate heat exchanger, and while a few minutes at 74°C or more is usually sufficient, the actual time-temperature relationship will depend on the pectic enzyme used.

Following the inactivation of the enzyme the juice may be further clarified by being passed through a filter press with the addition of a suitable pressing aid such as diatomaceous earth.

After clarification the juice may be forzen in a suitable container or it may be canned and heat processed.

In India clear guava juice is prepared from the white-fleshed Allahabad variety as follows: The washed and trimmed fruit is blanched for 3-5 min to inactivate the oxidative enzymes prior to pulping. After blanching, the fruit is passed once through a screw press fitted with a coarse sieve of 20-30 mesh, and the residue is passed through again for maximum recovery of the pulp. An APV pulper fitted with a brush and sieve, or an Apex comminuting mill, is employed because of its advantages for preparating pulp on a large scale. Pectinol 10-M (0.5 - 10%) is added to the puree and allowed to react overningt (18 hr) at room temperature. The juice is then extracted from the depectinized puree with a basket press, with juice yields of 65-80%.

The clarified juice was heated quickly to 85°C and immediately filled hot into cans which were hermetically seamed and cooled (after holding for about 2 min to sterilize the lid). For bottling the juice, filling at 85°C and air cooling were found satisfactory.

The production of a clear guava juice from pink guavas in Kenya. Frozen guavas were thawed, mashed in a fruit mill, heated to 45-50°C (treated with 400 ppm of pectic enzyme for 90 min), and pressed in a hydraulic plate press to yield 72.7% of a cloudy pink juice. The cloudy juice was then heat treated to inactivate the enzymes in a plate heat exchanger at 72-75°C for 20 s followed by immediate cooling to 25-27°C. The cloudy juice was then filtered through a plate filter to yield a light yellow clear juice. This clear juice was concentrated on a steam-heated falling-film evaporator with an aroma-recovery section under a vacuum of 253 mbar at 68-70°C with a product temperature of 45°C. To reach concentrates greater than 20°Brix, recycling of the product was required. Using this method, concentrates of 61.6°Brix could be attained.

11. Guava Syrup

Guava puree can be used in preparation of syrups to impart desirable natural flavors and colors. These syrups are satisfactory for pancake or waffle syrups, ice cream toppings, or for similar dessert uses.

Table syrups usually contain more than 65% sugar by weight, which makes them resistant to microbial spoilage. However, it has been found that antimicrobial agents must be added to ensure the necessary microbial stability required after the bottle is opened. The syrup formulation for guava is as follows : To 9 kg guava puree, 18 kg 64°Brix pineapple ion-exchange syrup are stirred in while heating to 65.6° C next an additional 18 kg sugar is stirred in, and the mixture is heated to 88°C, poured into glass containers or cans while still hot, then the containers are sealed and heated for 3 min to sterilize the lid. The containers are then cooled in a water bath.

12. Guava Concentrate

For shipment to overseas markets it may be advantageous to concentrate either the puree or the juice.

Much of the research on guava concentrate has been done at the U.S. Department of Agriculture, Hawaii Fruit Laboratories. Guava puree that was prepared as previously described was concentrated in either a Precision rising-film vacuum evaporator or a continuous centrifugal-flow evaporator (Centritherm-CT 1B, Alpha-Laval). Before concentration the purees are depectinized with 0.1-0.2% pectinase (Pectinol 10-M) for 1-2 hr to decrease the viscosity. Using the rising-film evaporator, the guava puree was concentrated 3.5 fold from an original 8.8 to 30.5°Brix at a vapor temperature of 50°C. Using clear guava juice, from which all the pulp has been removed, an 8-fold concentrate was obtained. When guava puree was concentrated in the centritherm evaporator, a 2.5-fold concentrate was prepared by recycling the puree at a reduced pressure of 62-72 mm Hg and a vapor temperature of 42-45°C until the puree was 22.5°Brix.

Means of stabilizing these concentrates at refrigerated temperatures (2-7°C) have been devised, making it possible to transport the concentrates overseas at above-freezing temperatures. The method involves the addition of potassium sorbate to a level of 1000 ppm to a 2.5-fold concentrate, 22.5°Brix. After 5 months storage at

7°C no gross signs of spoilage were present. Flavor and aroma quality were good and did not deteriorate appreciably until the fourth month in storage. Using irradiation at 100 krad and subsequent storage at 7°C the storage life of guava puree was prolonged.

13. Guava Concentrate Beverage Base

Guava concentrates can be mixed with sugar and other materials to produce beverage bases and fountain syrups. These products mixed with water or sparkling soda result in consumer beverages. Two methods for preparing the beverage bases; one method uses heat sterilization as a means of preservation and the other method uses antimicrobial agents as preservatives. For the heat sterilization method 18 water is mixed with 283.5 g gum tragacanth until dissolved; 27.22 kg 3.3-fold guava puree concentrate (25.4°Brix), 64.4 kg sugar, and 1.5 kg citric is then mixed in, and the resulting mixture is pumped into a homogenizer. The homogenate is pumped to a heat exchanger, where the product is heated to 88°C and hot filled into glass bottles or tin cans, sealed, inverted for 4 min, and cooled in a water bath. The second method, which makes use of antimicrobial agents, is similar to this method with the exception that sodium benzoate 56.7 g and potassium sorbate 56.7 g are added prior to homogenization and the bottles are filled directly after homogenization, which eliminates the need for pasteurization.

Objective

1. To study optimum condition of enzyme pectinase used for clarifying guava syrup from various varieties of guava.
2. To study optimum color for guava syrup.

Materials and Methods

Materials

1. Raw materials

    1.1 Guava : Sarie variety, Vietnum variety and Shithong variety

    1.2 Sugar

    1.3 Artificial color : Apple Green Color of Rayner's Brand

Components :	Titracine 19140	2.2%
	Citric acid	0.6%
	Brillian Blue FCF 42090	0.2%

2. Chemicals

    2.1 Pectinase (Cinnamon Co., Ltd.)

    2.2 Sodium Hydroxide

    2.3 Sulfuric acid

    2.4 Iodine Solution

    2.5 Starch Solution

    2.6 Phenolphthalein

3. Equipments

    3.1 Waterbath shaker

    3.2 Pipette

    3.3 Erlenmeyer flask

    3.4 Unbleached Muslin Cloth

    3.5 Refractometer

    3.6 Blender

    etc.

Method

A. <u>To study optimum condition of enzyme pectinase used to clarify guava juice from many variety of guava.</u>

1. Raw material preparation.

    1.1 Weight and wash Sarie, Vietnum, and Srithong guava

    1.2 Cut into 4 pieces and remove the seed.

    1.3 Cut into small pieces.

    1.4 Blend guava with water by using ratio 1: 1

    1.5 Filter by using 4 folds of unbleached muslin cloth.

    1.6 Add pectinase 0.01% and 0.02% at 50°C, 55°C, and 60°C, and hold for 1, 2, and 3 hours under shaking condition (250 rpm.)

    1.7 Filter by using 4 folds of unbleached muslin cloth.

    1.8 Weight the guava juice.

    1.9 Keep the juice for analysis at 5°C.

2. Analysis of clear guava juice.

    2.1 Physical analysis

        2.1.1 Total Soluble Solid (TSS)

        2.1.2 pH

        2.1.3 Turbidity (optical density)

    2.2 Chemical analysis

        2.2.1 Acidity (AOAC, 1984)

        2.2.2 Ascorbic acid (Iodometry Method)

B. To study optimum artificial color for guava juice

1. Add artificial green color 0.014%, 0.028%, 0.042%, and 0.056% into guava juice.
2. Test color acceptance by using Ramking Test.

C. To study the suitable variety of guava for producing clear guava juice.

1. Production of clear guava juice
    - 1.1 Weight and wash Sarie, Vietnum and Srithong guava.
    - 1.2 Cut into 4 pieces and remove the seed.
    - 1.3 Cut into small pieces.
    - 1.4 Blend guava with water by using ratio 1 : 1.
    - 1.5 Filter by using 4 folds of unbleached muslin cloth.
    - 1.6 Add pectinase 0.02% at 50oC and hold for 3 hours under shaking condition (250 rpm).
    - 1.7 Filter by using 4 folds of unbleached muslin cloth.
    - 1.8 Weight the guava juice.
    - 1.9 Keep the juice for producing guava syrup.
2. Production of guava syrup.
    - 2.1 Add sugar into the juice to 46^{o}C Brix.
    - 2.2 Add color 0.028%.
    - 2.3 Add KMS 0.01%.
3. Keep clear guava syrup at 3-5^{o}C for analysis.

4. Analysis of clear guava syrup.

    4.1 Physical analysis

        4.1.1 Total Soluble Solid (TSS)

        4.1.2 pH

        4.1.3 Turbidity (optical density)

    4.2 Chemical analysis

        4.2.1 Acidity

        4.2.2 Ascorbic acid

    4.3 Sensory analysis

        4.3.1 Mix guava syrup with cold soda by using ratio syrup : soda as 1 : 3.

        4.3.2 Sensory evaluation by using 20 panelists.

Result and Discussion

A. Effect of enzyme concentration, holding time, and holding temperature on clear guava juice produced from various varieties of guava.

I. Sarie Variety

Table 3 Some physical and chemical properties of clear guava juice produced from Sarie Variety.

Temp	Time/% enz.	pH	TSS	% Acdity	% Vitamin C
50°C	Control	3.85	4	0.165	43.12
	1 hr/ 0.01%	3.85	4	0.16	35.33
	1 hr / 0.02%	3.85	4	0.16	40.74
	2 hr / 0.01%	3.85	4	0.165	45.85
	2 hr / 0.02%	3.85	4	0.16	39.65
	3 hr / 0.01%	3.85	4	0.15	42.81
	3 hr / 0.02%	3.85	4	0.165	42.9
55°C	Control	3.9	4	0.16	49.85
	1 hr/ 0.01%	4.0	4	0.17	38.28
	1 hr / 0.02%	3.95	4	0.165	42.68
	2 hr / 0.01%	1.0	4	0.165	44.88
	2 hr / 0.02%	3.95	4	0.165	45.54
	3 hr / 0.01%	3.95	4	0.16	45.89
	3 hr / 0.02%	3.95	4	0.16	43.34
60°C	Control	3.8	3.85	0.165	43.34
	1 hr/ 0.01%	3.85	3.9	0.16	41.45
	1 hr / 0.02%	3.8	3.9	0.165	36.74
	2 hr / 0.01%	3.85	3.75	0.155	38.63
	2 hr / 0.02%	3.85	4.0	0.165	45.37
	3 hr / 0.01%	3.75	4.05	0.175	45.01
	3 hr / 0.02%	3.75	3.8	0.17	41.58

From table 3, it was observed that pH, Total Soluble Solid, acidity, and Vitamic C of the Sarie guava juice produced by using 0.01% and 0.02% pectinase at 50°C, 55°C and 60°C for 1, 2 and 3 hours had no significant difference.

Table 4 : Effect of enzyme concentration, holding time, holding temperature and Sarie Variety on clear guava juice production.

A = Temperature		C = % enzyme					
		0.01%			0.02%		
		B = time (hr)			B = time (hr)		
		1	**2**	**3**	**1**	**2**	**3**
% Yield	$50^{\circ}C$	21.25	50.25	66.5	48.75	55.75	73.25
	$55^{\circ}C$	51.25	51.5	64	55	54	65.5
	$60^{\circ}C$	56.25	73	72.25	66.25	60.25	72.25
Turbidity							
	$50^{\circ}C$	0.807	1.127	0.4675	0.3435	0.6055	0.263
	$55^{\circ}C$	0.7535	1.065	0.9015	0.3345	0.473	0.285
	$60^{\circ}C$	1.3445	1.504	1.4775	1.4625	1.6595	1.1565

From table 4, it was found that the juice was treated with 0.01% pectinase at $50^{\circ}C$ for 1, 2 and 3 hours gave the lowest % yield were 21.25%, 50.25, and 66.5% respectively. While the highest % yield at 0.01% pectinase at $60^{\circ}C$ for 1, 2 and 3 hours were 56.25%, 73%, and 72.25% respectively. At the 0.02% pectinase, % yield was similar to 0.01% pectinase. When turbidity was considered, it was observed that the turbidity of juice produced at $60^{\circ}C$ by using 0.01% pectinase for 1, 2 and 3 hours (1.3445, 1.504, and 1.4775 respectively) were the highest. While the lowest were the juice produced at $50^{\circ}C$ for 1, 2, and 3 hours (0.807, 1.127 and 0.4675 respectively). At the concentration 0.02% pectinase, turbidity were similar to 0.01% pectinase. So, the result at $60^{\circ}C$ were not considered.

When the concentration of pectinase were considered, it was noticed that at 0.01% pectinase gave the lower in % yield and higher turbidity than 0.02% pectinase such as 0.01% pectinase at 50^{o}C for 1, 2, and 3 hours, % yield were 21.25%, 50.25%, and 66.5% respectively, while 0.02% pectinase at the same temperature and holding time as 0.01% pectinase, % yield were 48.75%, 55.75%, and 73.25% respectively. So, 0.01% pectinase was not considered.

When the holding times were considered, it was found that % yield at 50^{o}C and 55^{o}C for 3 hours gave the highest % yield (73.25%, 65.5 % respectively) and the lowest % yield at 50^{o}C and 55^{o}C were 48.75% and 55% respectively for 1 hour. For the turbidity, it was observed that at 3 hours holding time gave the juice that contain the lowest turbidity at 50^{o}C and 55^{o}C (0.263 and 0.285 respetively). So, the juice that produced by using 0.02% pectinase for 3 hours at 50^{o}C and 55^{o}C were considered. It was noticed that at 50^{o}C % yield (73.25%) and turbidity (0.263) were better than at 55^{o}C.

The guava juice from Sarie Variety was clarified by using 0.02% pectinase at 50^{o}C for 3 hours gave the highest % yield (73.25%) and the lowest turbidity (0.263).

II. Vietnum Variety

Table 5 Some physical and chemical properties of clear guava juice produced from Sarie Variety.

Temp	Time/% enz.	pH	TSS	% Acdity	% Vitamin C
50°C	Control	3.7	3.25	0.135	34.32
	1 hr/ 0.01%	3.75	3.55	0.165	40.74
	1 hr / 0.02%	3.7	3.2	0.135	35.38
	2 hr / 0.01%	3.7	3.15	0.15	39.07
	2 hr / 0.02%	3.7	3.65	0.165	41.36
	3 hr / 0.01%	3.75	3.5	0.14	39.65
	3 hr / 0.02%	3.65	3.35	0.16	34.41
55°C	Control	3.65	3.5	0.14	42.24
	1 hr/ 0.01%	3.7	3.35	0.155	42.46
	1 hr / 0.02%	3.65	3.35	0.155	42.81
	2 hr / 0.01%	3.7	3.45	0.16	42.29
	2 hr / 0.02%	3.6	3.4	0.155	42.9
	3 hr / 0.01%	3.65	3.4	0.16	41.23
	3 hr / 0.02%	3.65	3.5	0.16	43.12
60°C	Control	3.65	3.55	0.16	42.24
	1 hr/ 0.01%	3.65	3.55	0.15	42.24
	1 hr / 0.02%	3.65	3.55	0.15	42.15
	2 hr / 0.01%	3.6	3.55	0.155	43.12
	2 hr / 0.02%	3.65	3.55	0.155	44
	3 hr / 0.01%	3.7	3.55	0.155	43.34
	3 hr / 0.02%	3.7	3.55	0.155	42.54

From table 5, it was observed that pH, Total Soluble Solid, acidity, and Vitamic C of the Vietnum guava juice produced by using 0.01% and 0.02% pectinase at 50°C, 55°C and 60°C for 1, 2 and 3 hours had no significant difference.

Table 6 : Effect of enzyme concentration, holding time, and temperature on % yield and turbidity of clear guava juice produced from Vietnum Variety.

A = Temperature		C = % enzyme					
		0.01%			0.02%		
		B = time (hr)			B = time (hr)		
		1	**2**	**3**	**1**	**2**	**3**
Yield	$50^{\circ}C$	48.25	61.25	42.75	56	56.5	49
	$55^{\circ}C$	49	53	51.5	56	50.25	47
	$60^{\circ}C$	56.75	59.5	60.75	59.75	58.75	66.75
Turbidity							
	$50^{\circ}C$	0.2285	1.7235	0.383	0.3395	0.3965	0.2445
	$55^{\circ}C$	0.2125	0.598	0.526	0.3285	0.565	0.222
	$60^{\circ}C$	1.123	1.246	1.121	1.263	1.164	1.048

From table 6, it was found that the juice was treated with 0.01% pectinase at $50^{\circ}C$ for 1, 2 and 3 hours gave the lowest % yield were 48.25%, 61.25, and 42.75% respectively. While the highest % yield at 0.01% pectinase at $60^{\circ}C$ for 1, 2 and 3 hours were 56.75%, 59.5%, and 60.75% respectively. At the 0.02% pectinase, % yield was similar to 0.01% pectinase. When turbidity was considered, it was observed that the turbidity of juice produced at $60^{\circ}C$ by using 0.01% pectinase for 1, 2 and 3 hours (1.123, 1.246, and 1.121 respectively) were the highest. While the lowest were the juice produced at $50^{\circ}C$ for 1, 2, and 3 hours (0.2285, 1.7235 and

0.383 respectively). At the concentration 0.02% pectinase, turbidity were similar to 0.01% pectinase. So, the result at 60°C were not considered.

When concentration of pectinase were considered, it was noticed that at 0.01% pectinase gave the lower in % yield and higher turbidity than 0.02% pectinase such as 0.01%, pectinase at 50°C for 1, 2 and 3 hours % yield were 48.25%, 67.25%, and 42.75% respectively while 0.02% pectinase at the same temperature and holding time as 0.01% pectinase, % yield were 56%, 56.5%, and 49% respectively. So, 0.01% pectinase was not considered.

When the holding times were considered, it was found that % yield at 50°C and 55°C for 3 hours gave the highest % yield (49% and 47% respectively) and the lowest % yield at 50°C and 55°C were 56% and 50% respectively for 1 hour. For the turbidity, it was observed that at 3 hours holding time gave the juice that contain the lowest turbidity at 50°C and 55°C (0.2445 and 0.222 respetively). So, the juice that produced by using 0.02% pectinase for 3 hours at 50°C and 55°C were considered. It was noticed that at 50°C. % yield (49%)and turbidity (0.2445) were better than at 55°C.

The guava juice from Sarie Vietnum Variety was clarified by using 0.02% pectinase at 50°C for 3 hours gave the highest % yield (49%) and the lowest turbidity (0.2445).

III. Srithong Variety

Table 7 Some physical and chemical properties of clear guava juice produced from Srithong Variety.

Temp	Time/% enz.	pH	TSS	% Acdity	% Vitamin C
50°C	Control	3.85	4	0.17	42.68
	1 hr/ 0.01%	3.9	4	0.165	42.68
	1 hr / 0.02%	3.9	4	0.155	41.62
	2 hr / 0.01%	3.8	4	0.17	43.12
	2 hr / 0.02%	3.85	4	0.16	42.68
	3 hr / 0.01%	3.8	4	0.16	43.12
	3 hr / 0.02%	3.9	4	0.165	42.68
55°C	Control	3.85	4	0.165	42.68
	1 hr/ 0.01%	3.75	4	0.165	42.81
	1 hr / 0.02%	3.8	4	0.17	41.98
	2 hr / 0.01%	3.85	4	0.17	42.68
	2 hr / 0.02%	3.8	4	0.165	43.34
	3 hr / 0.01%	3.8	4	0.165	43.25
	3 hr / 0.02%	3.8	4	0.17	43.12
60°C	Control	3.8	3.9	0.165	42.68
	1 hr/ 0.01%	3.85	3.9	0.165	41.8
	1 hr / 0.02%	3.9	4	0.165	42.68
	2 hr / 0.01%	3.7	4	0.165	43.12
	2 hr / 0.02%	3.6	3.9	0.165	42.81
	3 hr / 0.01%	3.8	3.9	0.165	42.68
	3 hr / 0.02%	3.8	3.9	0.165	40.61

From table 7, it was observed that pH, Total Soluble Solid, acidity, and Vitamic C of the Srithong guava juice produced by using 0.01% and 0.02% pectinase at 50°C, 55°C and 60°C for 1, 2 and 3 hours had no significant difference.

Table 8 : Effect of enzyme concentration, holding time, temperature on % yield and turbidity of clear guava juice produced from Srithong Variety.

A = Temperature		C = % enzyme					
		0.01%			0.02%		
		B = time (hr)			B = time (hr)		
		1	**2**	**3**	**1**	**2**	**3**
Yield	$50^{\circ}C$	53.5	58	60	54.5	59.5	61.75
	$55^{\circ}C$	54.25	58.25	59	56.75	57.75	60.5
	$60^{\circ}C$	59.5	63.5	69.25	61.25	66.75	70.75
Turbidity							
	$50^{\circ}C$	0.748	0.4825	0.1925	0.724	0.486	0.2
	$55^{\circ}C$	0.7915	0.585	0.216	0.673	0.502	0.216
	$60^{\circ}C$	1.4265	1.2675	1.0815	1.406	1.2715	0.585

From table 6, it was found that the juice was treated with 0.01% pectinase at $50^{\circ}C$ for 1, 2 and 3 hours gave the lowest % yield were 53.5%, 58% and 60% respectively. While the highest % yield at 0.01% pectinase at $60^{\circ}C$ for 1, 2 and 3 hours were 59.5%, 63.5%, and 69.25% respectively. At the 0.02% pectinase, % yield was similar to 0.01% pectinase. When turbidity was considered, it was observed that the turbidity of juice produced at $60^{\circ}C$ by using 0.01% pectinase for 1, 2 and 3 hours (1.4265, 1.2675, and 1.0815 respectively) were the highest. While the lowest were the juice produced at $50^{\circ}C$ for 1, 2, and 3 hours (0.748, 0.4825 and 0.1925 respectively). At the concentration 0.02% pectinase, turbidity were similar to 0.01% pectinase. So, the result at $60^{\circ}C$ were not considered.

When concentration of pectinase were considered, it was noticed that at 0.01% pectinase gave lower in % yield and higher turbidity than 0.02% pectinase such as 0.01%, pectinase at 50°C for 1, 2 and 3 hours % yield wer 53.5%, 58%, and 60% respectively while 0.02% pectinase at the same temperature and holding time as 0.01% pectinase, % yield were 54.5%, 59.5%, and 61.75% respectively. So, 0.01% pectinase was not considered.

When the holding times were considered, it was found that % yield at 50°C and 55°C for 3 hours gave the highest % yield (61.75%, and 60.5% respectively) and the lowest % yield at 50°C and 55°C were 54.5% and 56.75% respectively for 1 hour. For the turbidity, it was observed that at 3 hours holding time gave the juice that contain the lowest turbidity at 50°C and 55°C (0.2 and 0.216 respetively). So, the juice that produced by using 0.02% pectinase for 3 hours at 50°C and 55°C were considered. It was noticed that at 50°C % yield (61.75%) and turbidity (0.2445) were better than at 55°C.

The guava juice from Srithong Variety was clarified by using 0.02% pectinase at 50°C for 3 hours gave the highest % yield (61.75%) and the lowest turbidity (0.2).

B. The optimum color for guava juice

Table 9 Percentage of consumer's acceptance for green color that added into the syrup at various concentration

Color concentration (%)	Consumer's acceptance (%)
0	4
0.014	16
0.028	46
0.042	24
0.056	10

The color used for clear guava syrup was Apple green color of Rayner's Brand at 0%, 0.014%, 0.028%, 0.042% and 0.056%. For the likeness test, it was found that at 0.028% color % acceptance was the highest (46%) and the lowest was the concentration at 0% (4%). So, 0.028% color was used in the guava syrup production.

C. <u>The guava syrup for soda mixed that preduced from various varieties</u>

Table 10 Sensory evaluation of guava syrup for soda mixed that produced from various varieties.

Variety	Color	Flavor	Clearness	Overall
Sarie	6.6	6.2	6.7	6.7
Vietnum	6.3	6.7	6.7	6.7
Srithong	7.0	6.8	7	7.2

From table 10, it was found that no significance at 95% profidence in color, flavor, clearness and overall from guava syrup preduced from Sarie, Vietnum and Srithong variety.

Table 11 Some properties of guava juice from various varieties.

Variety	% yield	Turbidity	Price /kg
Sarie	73.25	0.263	30
Vietnum	49	0.2445	45
Srithong	61.75	0.2	60

From table 11, it was found that Sarie variety gave the highest in % yield (73.25 %), the lowest in turbidity (0.263) and the lowest in price /kg (30). So, Sarie variety was the best variety for producing clear guava syrup production.

Conclusion

A. The optimum clarifying condition of guava juice for guava syrup production were the use of 0.02% pectinase at 50^{o}C, 3 hours for Sarie, Vietnum and Srithong variety.

B. The optimum color for guava juice was 0.028% of Apple green color of Rayner's Brand

C. Sarie Variety of guava is the best variety for clear guava syrup production because it gave 73% yield, turbidity 0.263 and low price (30 B /kg).

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Appendix

Appendix A
Chemical Analysis

1. Acidity (AOAC, 1984)

1.1 Chemical

1.1.1 0.1 % NaOH

1.1.2 Phenolphthalein

1.2 Method

1.2.1 Pipette 10 ml of sample into 125 ml Erlenmeyer flask.

1.2.2 Drop 2-3 drops of phenolphthalein.

1.2.3 Titrate with 0.1% NaOH.

1.2.4 Calarlate % acidity as citric acid.

1.3 Calculation

$$\%\ \text{Acidity} = \frac{\text{N of NaOH x Volume of NaOH x MW x 100}}{\text{Volume of sample x 100}}$$

$$\%\ \text{Acidity as citric acid} = \frac{\text{0.1 x Volume of NaOH x 64 x 100}}{\text{10 x 1000}}$$

2. Ascorbic acid (Iodometry method)

2.1 Chemical

2.1.1. 1 M H_2SO_4

2.1.2 Starch solotion

2.1.3 0.01 M I_2

2.2 Method

2.2.1 Pipette 25 ml of sample into flask .

2.2.2 Add 50 ml of distilled water.

2.2.3 Add 25 ml of 1M H_2SO_4.

2.2.4 Add 3 ml of starch solution.

2.2.5 Titrate with 0.01 M I_2.

2.2.6 Calculate the % Ascorbic acid .

2.3 Calculation

% Ascorbic acid = Volume of Iodine used x 7.04 x 10^{-2}

Appendix B
Statistical Analysis

Appendix table 1 : The analysis of variance of % yield guava juice produced from Sarie Variety.

SOV	df	SS	MS	f
Trt	17	4,460.32		
A	2	1,092.17	546.09	18.73*
B	2	1,994.00	997.00	34.19*
C	1	158.34	158.34	5.43*
AB	4	592.96	148.24	5.08*
AC	2	221.72	110.86	3.8
BC	2	262.89	131.450	4.51*
ABC	4	138.24	34.56	1.19*
Error	18	524.87	29.16	
Total	35	4,985.19		

Appendix table 2 : The analysis of variance on turbidity of guava juice produced from Sarie Variety.

SOV	df	SS	MS	f
Trt	17	7.86		
A	2	5.40	2.7	482.14*
B	2	0.678	0.339	60.54*
C	1	0.962	0.962	171.79*
AB	4	0.107	0.027	4.82*
AC	2	0.483	0.2415	43.125*
BC	2	0.033	0.0165	2.95*
ABC	4	0.197	0.049	8.75*
Error	18	0.1	0.0056	
Total	35	7.96		

Appendix table 3 : The analysis of variance on % yield guava juice produced from Vietnum Variety.

SOV	df	SS	MS	f
Trt	17	1.317		
A	2	630.04	315.02	80.36*
B	2	74.29	37.145	9.48*
C	1	28.44	28.44	7.26*
AB	4	377.17	94.29	24.05*
AC	2	16.10	8.05	2.05
BC	2	115.85	57.930	14.78*
ABC	4	75.11	18.78	4.79*
Error	18	70.5	3.92	
Total	35	1.387.5		

Appendix table 4 : The analysis of variance on turbidity of guava juice produced from Vietnum Variety.

SOV	df	SS	MS	f
Trt	17	5.37		4169.64**
A	2	4.67	2.335	277.68**
B	2	0.311	0.1555	76.79**
C	1	0.043	0.043	49.11**
AB	4	0.110	0.0275	15.18*
AC	2	0.017	0.0085	142.86**
BC	2	0.160	0.08	26.34*
ABC	4	0.059	0.01475	
Error	18	0.01	0.0056	
Total	35	5.38		

Appendix table 5 : The analysis of variance on % yield of guava juice produced from Srithong Variety.

SOV	df	SS	MS	f
Trt	17	781.5		
A	2	427.875	213.94	170.81**
B	2	289.04	144.52	119.44**
C	1	23.36	23.36	19.31*
AB	4	31.96	7.99	6.60*
AC	2	1.93	0.965	0.8
BC	2	0.1	0.05	
ABC	4	7.235	1.81	
Error	18	21.75	1.21	
Total	35	803.25		

Appendix table 6 : The analysis of variance on turbidity of guava juice produced from Srithong Variety.

SOV	df	SS	MS	f
Trt	17	5.93		
A	2	3.79	1.895	63.17*
B	2	1.840	0.92	30.67*
C	1	0.058	0.058	1.93
AB	4	0.030	0.0075	0.25
AC	2	0.047	0.0235	0.78
BC	2	0.030	0.015	0.5
ABC	4	0.135	0.034	1.13
Error	18	0.54	0.03	
Total	35	6.47		

Questionnaire for Ranking Test. (Color testing)

Name : ______________________ Date : ________________

Please rank these samples according to your likeness of color for guava juice. The color that you like the most is ranked in number 1 and the color that you dislike the most is ranked in number 5.

786 __________

953 __________

371 __________

521 __________

415 __________

Appendix table 7 **Ranking Test for color testing.**

The reseacher wished to compare five ranges artificial color (0%, 0.014%, 0.028%, 0.042%, 0.056%) for the optimum color for guava juice. A panel of 50 students is used.

Subject no.	Concentration of color				
	0 %	0.014 %	0.028 %	0.042 %	0.056 %
1	5	2	1	3	4
2	5	4	1	2	3
3	5	4	3	1	2
⋮	⋮	⋮	⋮	⋮	⋮
48	5	4	3	1	2
49	5	4	3	1	2
50	4	1	2	3	5
	223	**146**	**86**	**119**	**176**

Use Friedman's Test

$$T = \left[(12 / bt(t+1)) \cdot (\textstyle\sum_{j=1}^{t} x2 . j) \right] - 3b(t+1)$$

b = no. of subjects , t = no. of samples , x = rank sum

$$T = \left[(12 / (50)(5)(5+1)) \cdot (223^2 + 146^2 + 86^2 + 119^2 + 176^2) \right]$$

$$- 3(50)(5+1)$$

$$= 998.624 - 900 = 88.624$$

Compare T with x^2 at df = t - 1 = 4 at 0.05 significant level = 9.49

At the value of T = 88.624 is greater than 9.49 . Conclude that the samples are significantly different at $\alpha = 0.05$

$$LSD_{rank} = Z_{\alpha/2} \sqrt{b\,(t)\,(t+1)\,/\,b}$$

$$= 1.96 \sqrt{(50)(5)(5+1)\,/\,(50)}$$

$$= 10.74$$

Any two samples whose rank sums differ by more than $LSD_{rank} = 10.74$ are significantly different at $\alpha = 0.05$

Questionnaire for 9 points Hedonic Scale.

Name : ______________________ Date : ________________

Please evaluate samples of guava juice , score is based on hedonic testing system , ic , preference of panelist as follow :

	Score
Like extremely	9
Like very much	8
Like moderately	7
Like Slightly	6
Neither like nor dislike	5
Dislike slightly	4
Dislike moderately	3
Dislike very much	2
Dislike extremely	1

	728	479	503
Color	____	____	____
Flavor	____	____	____
Clearness	____	____	____
Appearance (overall)	____	____	____

Comments : ____________________________________

Appentdix table 8 : **The analysis of variance on color of clear guava syrup produced from Sarie, Vietnum and Srithong variety.**

Blocks	Samples			x.j	$\bar{x}$.j
	s_1	s_2	s_3		
1	6	6	6	18	6
2	9	6	7	22	7.33
3	6	6	5	17	5.67
4	5	6	7	18	6
5	8	7	8	23	7.67
6	8	6	7	21	7
7	6	9	8	23	7.67
8	6	6	5	17	5.67
9	3	2	7	12	4
10	7	7	8	22	7.3
11	7	7	7	21	7
12	6	5	7	18	6
13	9	7	8	24	8
14	8	7	6	21	7
15	6	6	6	18	6
16	7	7	8	22	7.3
17	6	7	8	21	7
18	7	6	7	20	6.67
19	5	6	7	18	6
20	7	7	7	21	7
xi.	132	126	139	$\bar{x}$.. = 397	
xi.	6.6	6.3	6.95	$\bar{x}$.. = 6.62	

$$CF = (397)^2 / (20)(2) = 2626.82$$

$$SS_{total} = (6^2 + 9^2 + ...+ 7^2 + 7^2) - CF$$

$$= 2719 - 2626.82 = 92.18$$

$$SS_{trt} = \left\{ \left[(132)^2 + (126)^2 + (139)^2\right] / 20 \right\} - CF$$

$$= 2631.05 - 2626.82 = 4.23$$

$$SS_{bl} = \left\{ \left[18^2 + 22^2 + ... + 18^2 + 21^2 \right] / 3 \right\} - CF$$

$$= 2677.67 - 2626.82 = 50.85$$

$$SS_e = 92.18 - 4.23 - 50.85$$

$$= 37.1$$

<u>ANOVA</u>

SOV	df	ss	ms	f
Total	tr-1 = 59	92.18		
Treatments	t-1 = 2	4.23	2.115	2.16
Blocks	r-1 = 19	50.85	2.68	
Error	38	37.1	0.98	

At the 1% level of significance, the value of F is 2.82 that is greater than computed f (2.16), there is no significant different. So the varieties aren't effect color of the clear guava syrup production.

Appendex table 9 : The analysis of variance on flavor of clear guava syrup produced from Sarie, Vietnum and Srithong variety.

Blocks	Samples			x.j	$\overline{x}$.j
	s_1	s_2	s_3		
1	8	9	6	23	7.67
2	6	6	7	19	6.33
3	5	6	4	15	5
4	6	5	8	19	6.33
5	7	8	5	20	6.67
6	7	8	6	21	7
7	6	7	8	21	7
8	5	6	5	16	5.33
9	3	4	7	14	4.67
10	7	6	6	19	6.33
11	8	7	6	21	7
12	4	6	7	17	5.67
13	6	6	8	20	6.67
14	6	7	9	22	7.3
15	6	7	8	21	7
16	7	6	6	19	6.3
17	6	6	8	20	6.67
18	7	8	8	23	7.67
19	7	7	6	20	6.67
20	6	8	7	21	7
xi.	123	133	135	x.. 391	
$\overline{x}$i.	6.15	6.65	6.75	$\overline{x}$.. 6.52	

$$CF = (391)^2 / (20)(3) = 2548.02$$

$$SS_{total} = (8^2 + 6^2 + ...+ 6^2 + 7^2) - CF$$

$$= 2639 - 2548.02 = 90.98$$

$$SS_{trt} = \left\{ \left[(123)^2 + (133)^2 + (135)^2\right] / 20 \right\} - CF$$

$$= 2552.15 - 2548.02 = 4.13$$

$$SS_{bl} = \left\{ \left[(23^2 + 19^2 + ... + 20^2 + 21^2)\right] / 3 \right\} - CF$$

$$= 25785.67 - 2548.02 = 37.65$$

$$SS_e = 90.98 - 4.13 - 37.65$$

$$= 49.2$$

ANOVA

SOV	df	ss	ms	*f*
Total	tr-1 = 59	90.98		
Trt	t-1 = 2	4.13	2.065	1.6
Bl	r-1 = 19	37.65	1.98	
Error	38	49.2	1.29	

At the 1% level of significance, the value of F is 2.82 that is greater than computed *f* (1.6), there is no significant different. So the varieties aren't effect the clear guava syrup production.

Appendix table 10 : **The analysis of variance on clearness of clear guava syrup produced from Sarie,Vietnum, Srithong Variety.**

Blocks	Samples			x.j	$\bar{x}$.j
	s_1	s_2	s_3		
1	6	6	6	18	6
2	8	6	7	21	7
3	6	6	6	18	6
4	8	8	8	24	8
5	9	9	9	27	9
6	8	6	7	21	7
7	8	8	8	24	8
8	5	6	7	18	6
9	7	6	5	18	6
10	7	7	7	21	7
11	6	6	8	20	6.67
12	3	7	6	16	5.3
13	6	8	9	23	7.67
14	7	8	9	24	8
15	6	6	6	18	6
16	7	6	6	19	6.3
17	5	6	7	18	6
18	7	7	7	21	7
19	6	5	6	17	5.67
20	8	7	7	22	7.3
xi.	133	134	141	x.= 408	
$\bar{x}$i.	6.65	6.7	7.05	$\bar{x}$.= 6.8	

$$CF = (408)^2 / (20)(3) = 2774.4$$

$$SS_{tot} = (6^2 + 8^2 + \ldots\ldots + 6^2 + 7^2) - CF$$

$$= 2858 - 2774.4 = 83.6$$

$$SS_{trt} = \left\{ \left[(133)^2 + (134)^2 + (141)^2\right] / 20 \right\} - CF$$

$$= 2776.3 - 2774.4 = 1.9$$

$$SS_{bl} = \left\{ \left[(18^2 + 21^2 + \ldots + 17^2 + 22^2)\right] / 3 \right\} - CF$$

$$= 2828 - 2774.4 = 53.6$$

$$SS_e = 83.6 - 1.9 - 53.6 = 28.1$$

ANOVA

SOV	df	ss	ms	*f*
Total	tr-1 = 59	83.6		
Treatments	t-1 = 2	1.9	0.95	1.28
Blocks	r-1 = 19	53.6	2.82	
Error	38	28.1	0.74	

At the 1% level of significance, the value of F is 2.82 that is greater than computed *f* (1.28), there is no significant different. So the varieties aren't effect the clear guava syrup production.

Appendix table 11 : The analysis of variance on Overall of clear guava syrup produced from Sarie, Vietnum and Srithong variety.

Blocks	Samples			x.j	$\bar{x}$.j
	s_1	s_2	s_3		
1	7	8	6	21	7
2	9	6	7	22	7.3
3	6	5	5	16	5.3
4	7	6	8	21	7
5	7	8	6	21	7
6	7	8	6	21	7
7	7	7	8	22	7.3
8	6	6	6	18	6
9	3	5	7	15	5
10	7	7	7	21	7
11	7	7	7	21	7
12	7	4	8	19	6.3
13	7	7	8	22	7.3
14	7	8	9	24	8
15	6	6	6	18	6
16	6	7	8	21	7
17	7	7	7	21	7
18	7	8	9	24	8
19	6	7	8	21	7
20	7	7	7	21	7
xi.	133	134	143	x..= 410	
xi.	6.65	6.7	7.15	$\bar{x}$..=6.83	

$$CF = (410)^2 / (20)(3) = 2801.67$$

$$SS_{tot} = (7^2 + 9^2 + ...+ 8^2 + 7^2) - CF$$

$$= 2874 - 2801.67 = 72.33$$

$$SS_{trt} = \left\{ \left[(133)^2 + (134)^2 + (143)^2\right] / 20 \right\} - CF$$

$$= 2804.7 - 2801.67 = 3.03$$

$$SS_{bl} = \left\{ \left[(18^2 + 21^2 + ... + 17^2 + 22^2) \right] / 3 \right\} - CF$$

$$= 2834.67 - 2801.67 = 33$$

$$SS_e = 72.33 - 3.03 - 33 = 36.3$$

ANOVA

SOV	df	ss	ms	*f*
Total	tr-1 = 59	72.33		
Treatments	t-1 = 2	3.03	1.515	1.58
Blocks	r-1 = 19	33	1.74	
Error	38	36.3	0.96	

At the 1% level of significance, the value of F is 2.82 that is greater than computed *f* (1.58), there is no significant different. So the varieties aren't effect the overall of the clear guava syrup production.