# IMPROVEMENT OF QUALITY CHARACTERISTICS OF CANNED PEACHES

By

RUTCHARIN LIMSUPAVANICH

Bachelor of Science

Kasetsart University

Bangkok, Thailand

1990

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
May, 1993

IMPROVEMENT OF QUALITY CHARACTERISTICS

OF CANNED PEACHES

Thesis Approved:

Thesis Adviser

Dean of the Graduate College

ACKNOWLEDGMENTS

My sincere appreciation is expressed to my major adviser, Dr. Ibrahim A. Wahem, for his support, unlimited guidance, understanding, and invaluable source of knowledge throughout my master's program. Special appreciations are conveyed to research committee members: Dr. Lea Ebro and Dr. William Warde for their interest and assistance in my thesis.

Special thanks go to the panelists who provided their valuable time to help and make this research possible.

I am deeply indebted to my sisters and brothers-in-law, Jarernporn and Ekkehard Betsch and Jarernsri and Nakul Mitrpanont, my father and brothers back home in Thailand for their encouragements and constant supports both financially and emotionally.

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# CHAPTER I

# INTRODUCTION

Peaches (*Prunus persica*) are one of the most important fruits for processing due to their adaptability to new technologies and suitability for the improvement of new derived products (Monzini and Gorini, 1985). Canned peaches are admirable among all processed peach products. They are canned whole, in halves or slices and widely utilized as a part of desserts, pies or salads (Shewfelt, 1986). The consumption of canned peaches by the population has also taken part of the fresh market, especially during the off-seasons, however, the quality characteristics of canned peaches after processing are of concern.

## Important Quality Characteristics of Canned Peaches

The concentration of soluble solid or sugar content of peaches can be determined by using a hydrometer or a refractometer. The refractometry method is more practical, however, because it is faster and it requires only a small sample (Board, 1988). Shewfelt (1986) pointed out that sucrose is the major sugar presented in peaches and the sweetness is one of the major quality characteristics of canned peaches. Sugar plays an important role with acidity to bring out the flavor of canned fruit. It also has an effect on the appearance and consistency of the fruit. In the canning process, light (10%), medium (25%) and heavy (40%) syrups are added to the product. According to Woodroof (1986), the addition of sugar to canned products is also a good method to retard browning discoloration of peeled fruit.

Total acidity of peaches is expressed as citric acid. In contrast to pH values, the acidity of peaches is decreased as maturity of the fruits advances (Gonzalez et al., 1992). Acidity, sugar and volatile compound influence the flavor of peaches. Therefore, soluble solids/acid ratio is an important parameter affecting the quality of fresh and processed fruits. As maturity advances, the soluble solids/acid ratio increases, hence, in processing canned peaches with low soluble solids/acid ratio, the concentration of syrup should be high (Luh et al., 1986).

Ascorbic acid or vitamin C, a water soluble compound, is one of the essential nutrients required for the functional processes of every human body (Hunt and Groff, 1990). Deficiency of this vitamin results in unhealthy bone, problems with loose teeth and unhealthy gums. According to Klein (1987), as a result of its remarkably unstable condition, ascorbic acid is "a good indicator of nutritional value of fruits and vegetables". The vitamin is highly sensitive to many factors such as temperature, oxygen, light, pH, and metal ions. Klein (1987) pointed out that thermal processing results in the degradation of ascorbic acid. Ang et al. (1975) reported that ascorbic acid is more labile to heat than riboflavin and carotene. In general, the first step in the degradations of L-ascorbic acid into dehydroascorbic acid does not effect its nutritional value. Further degradations of dehydroascorbic acid result in the loss of its nutritional value and the browning discoloration of food products. During thermal processing, heat is a good catalyst accelerating the degradation of ascorbic acid. The longer the processing time the higher the rate of vitamin C degradation. In minimally processed foods, shorter processing time and lower storage temperature are practiced to minimize the loss of nutrients (Klein, 1987).

The color of the flesh of peaches varies from white to yellow-orange depending on their types and cultivars. Gonzalez et al. (1992) reported that the maturity of the fruits also influences their color quality. Principally, the color of peach's flesh is due mainly to carotinoid pigments and into less extent to anthocyanin pigments. The main pigments responsible for the yellow-orange color are xanthophylls which are oxygen-containing derivatives of carotinoid pigments (Shewfelt, 1986). The degradation of xanthophylls contributes to the formation of beta-carotene which is a vitamin A precursor. Katayama et al. (1971) found that xanthophylls are generated from beta-carotene during the ripening process of fruits. The fat soluble carotinoid pigments are heat stable but sensible to light intensity. Exposure of the pigments to light results in decolorization and the formation of cis isomers which have less vitamin A activity (Simpson, 1985). According to Biacs et al. (1992), carotinoids, specially xanthophylls are susceptible to oxidative degradation. Anthocyanins, the water soluble pigments, are responsible mainly for the reddish color of peach skin and to less extent to the color of the flesh (Shewfelt, 1986). The stability of the pigments is dependent on temperature and pH. The undesirable deep red to purple colors have been found in canned peaches (Shewfelt, 1986). This is due to the ability of anthocyanins to form complexes with metals and to its heat unstability. Peaches are susceptible to enzymatic browning discoloration. When peeled peaches are exposed to air, phenolase enzymes such as polyphenoloxidase and catechol oxidize anthocyanins into orthoquinone, a compound leading to browning discoloration. Citric acid solution or the combination of citric acid and ascorbic acid have been used to prevent this enzymatic discoloration. In a study by Ross et al. (1953), ascorbic acid solution was found more effective than citric acid in controlling enzymatic browning of peeled peaches.

Texture of peaches is also an important factor influences the quality of canned products. Firm texture and fresh appearance of canned fruits are preferred by consumers. Texture loss of fresh peaches is due to physiological degrading of pectic compounds by enzymes such as pectinmethylesterase and polygalactorunase (Lidster et al., 1986; Steele and Yang, 1960). Several attempts have been made to improve the texture characteristic of peaches and other canned fruits. Main et al. (1986) used calcium lactate solution to improve the firmness of frozen and the thermally processed strawberries. Javeri et al. (1991) reported that vacumm infusion of a mixture of pectinmethylesterase, from grapefruit, and calcium salt has a positive effect on the firmness of canned peaches.

Flavor of both fresh and processed foods is regarded very important factor by consumers. Basically, the volatile compounds present in foods which are detected by the olfactory receptors located in the human nasal cavity are responsible for food aromas. In combination with aromas, the four basic tastes of food (sweetness, sourness, saltiness, and bitterness) which are distinguished by the taste buds on the tongue are expressed as flavor. Peach flavor is primarily represented by aromatic components along with sweetness and sourness of the fruit. Kader et al. (1982) reported that titratable acidity and soluble solid contents of fresh peaches influence the flavor characteristics of canned products. Many studies of volatile constituents of peaches have been reported by Do et al., 1969; Horvat et al., 1990; Narain et al., 1990; Robertson et al., 1990. Narain et al. (1990) identified one hundred and 10 volatile substances from peaches including aldehydes, ketones, alcohols, esters, lactones, aromatic hydrocarbons, furans, and alkanes. Peach flavor is also influenced by such factors as types, cultivars, stage of maturity, preharvest and postharvest handlings. Do et al. (1969) pointed out that the advance of fruit maturity increased the concentration of volatile components. During ripening, the beta-oxidation of long-chain fatty acids to medium-chain-length components results in peachlike aroma of the fruit (Lidsay, 1985). Mainly, according to Robertson et al. (1990b), lactone compounds, especially gamma lactones are responsible for the aroma and flavor of peaches. However, Narain et al. (1990) found that benzaldehyde is a predominantly existed volatile in a semi-freestone peach cultivar (LSUAC 84-A3-54). Flavor of fruits is altered by means of processing or preservation. Lesschaeve et al. (1991) pointed out that volatile compounds of strawberry jam behaved differently with different cooking processes. Kanasawad and Crouzet (1990) supported the idea that thermal degradation of beta-carotene from plant tissues resulted in the production of some volatile compounds. The aromatic by-products of beta-carotene affect the flavor of heat treated foods. On the other hand, altering the concentration of nonvolatile constituents may also affect the flavor of thermally processed foods (Haard, 1986). Generally, Canning and freezing also caused flavor loss in peaches (Shewfelt, 1986). Shortening the processing period may retard flavor loss of canned peaches.

Although canned food products are subjected to heat sterilization after packing in hermetically sealed containers, their quality attributes are influenced by storage conditions (Cecil and Woodroof, 1963). Generally, storage temperature affects physical, chemical, and nutritional quality of foods. Rymal et al. (1968) reported that the major changes in the volatile flavor constituents of canned single-strength orange juice are due to storage temperature of the product. Basically, canned foods should not be kept under high temperature or extremely cold condition and should be stored in a dry area (Yamagushi and Wu, 1975). According to Woodroof (1986), storing canned fruits and juices at 27°C and above has adverse effects on the quality of the products. He also indicated that storing canned fruits at 21°C is generally practiced, but storing at 10°C or below is preferred for quality maintenance. Canned peaches should be kept in well ventilated warehouse at 20°C (Luh et al., 1986). High relative humidity warehouses should be avoided, since moisture condensation can occur, resulting in rusting of the external surface of the cans. The external rusting is considered to be risky when accumulated in sufficient amount to produce leakage. Freezing temperature causes the condensation of moisture content in the warehouse. Therefore, heat should be provided to the storage room during winter. Woodroof (1986) stated that the magnitude of storage temperature has adverse effects on the quality of canned fruits (flavor, color, texture, and nutritive values). Cecil and Woodroof (1963) reported that high temperature storage mostly affects flavor and color of the products, while freezing temperature mainly affects the texture. At a storage temperature of 37°C and higher, canned peaches were found to be considerably susceptible to browning discoloration, especially Maillard reaction (Luh and Phithakpol, 1972). Boggess (1974) reported that canned ripe babygold #6 peach stored at 24°C for 3-10 days were firmer than those stored at 1°C for the same period. Furthermore, the reduction in total acidity of the canned products and the viscosity of the added syrups were found to be faster in canned peaches stored at 24°C than those stored at 1°C. The loss of nutritive values of canned foods can also be influenced by post-canning storage temperatures. Vitamin C content is considered to be one of the most sensitive nutrients, especially under high temperature of storage with prolonged periods of time (Kramer, 1974).

Sensory Evaluation of food products has been widely practiced in the last few decades (Koster, 1990). One reason is that, it is important for producers to learn consumer preferences in order to develop a new product or improve an existing one to meet consumer needs (Koster, 1990; Schutz, 1990). Correlations between sensory analysis and objective analysis have been used to improve or develop instruments for measuring food texture. Basically, sensory evaluation methods are based on the individual sensations of judges or trained panelists to determine a specified attribute of the product. The statistical analysis of the data provided by the judges are used as guidelines for development or improvement of the products. Environments lead to discrimination of judgments should be avoided. For example, judging the aroma of foods is significantly influenced by its color (Christensen, 1983). Therefore, using of white light should be avoided if color leads to biased judgments.

According to Kader et al. (1982), the important organoleptic quality attributes of canned peaches are appearance (color and freedom from defects), texture, and flavor. Fruits with bright yellow color without discoloration, especially in the pit cavity, firm in texture with a good flavor are preferred. Numbers of studies on sensory analysis along with physical and chemical quality analyses of peaches have been reported (Kader et al., 1982; Li et al., 1972; O'Mahony et al., 1983; Robertson et al., 1990a). Generally, physical and chemical properties of fresh fruits can be used for predicting the sensory attributes of canned products. Kader et al. (1982) noted that a* stimulus (Hunterlab) or total carotenoid contents of fresh peaches are good indicators of the color of canned products. Furthermore, sweetness of canned fruits is influenced by the concentration and composition of the added syrup and the absorption ability of the fruits. O'Mahony et al. (1983) reported that the high vacuumed flame sterilized

(HVFS) canned peaches were rated to be firmer than those canned using conventional method. Li et al. (1972) reported that there was very weak correlation between sensory rating of color and flavor characteristics, and tannins including total phenols, leucoanthocyanidins, and flavanols of canned peaches. According to a study on consumer perceptions of selected fresh fruit quality, Bruhn et al. (1991) showed that consumer concerns centered on the flavor and textural changes during the ripening of the fruits, and 45% of the consumers were willing to pay more for peaches with satisfactory quality attributes. Jordan et al. (1990) indicated that over time, however, consumers constantly pay higher prices for color and size of fresh peaches. As far as consumer preferences are concerned, sensory evaluations of foods or fruit products should be conducted along with physical and chemical analyses.

## Objective

The objective of this study is to improve selected quality characteristics of canned peaches such as pH, total acidity, soluble solids, soluble solids/acid ratio, ascorbic acid, texture, color and flavor using short processing time, the addition of calcium lactate, sucrose and fructose, and storage temperatures (4°C and 25°C).

## Hypothesis

The previously stated quality attributes of canned peaches will not be improved by implementing short processing time, addition of calcium lactate, sucrose and fructose and storage temperatures.

## Format of Thesis

The format of this thesis is written in the style of Journal of Food Science, the publication of Institute of Food Technologists.

# CHAPTER II

## MATERIALS AND METHODS

### Processing

Firm ripe clingstone Peaches (Red Haven cultivar) were obtained from a local food store. Upon arrival at the Nutritional Sciences laboratory, the fruits were inspected and the blemished or defective ones were discarded. The sound fruits were hand washed with tap water to remove adhering dirt and then lye peeled by dipping the fruit in 10% sodium hydroxide solution for 45 sec at 100°C. The fruits were immediately removed from the sodium hydroxide solution and rinsed with tap water to remove the peel. Peeled peaches were immersed in citric acid solution at a concentration of 0.5% to prevent oxidative discoloration prior to processing.

Forty eight wide mouth Mason 66 Ball canning jars with their lids were sterilized in a boiling water bath. Jars were randomly filled with peeled peaches. Into each 12 jars, 300 ml of the following boiling solutions were added.

1. 10% sucrose
2. 10% sucrose and 0.5% calcium lactate
3. 7% fructose
4. 7% fructose and 0.5% calcium lactate

The jars were immediately sealed, coded and thermally processed in an open water bath at 100°C as follows:

Six jars of each of the 10% sucrose and 7% fructose treatments were processed for 20 min, and the another six jars were processed for 10 min.

Six jars of each of the 10% sucrose and 0.5% calcium lactate and 7% fructose and 0.5% calcium lactate treatments were processed for 14 min, and the another six jars were processed for 7 min.

After processing, jars were left at room temperature to cool down. Jars processed for 20 min and 14 min were stored at room temperature (25°C), while jars processed for 10 min and 7 min were stored at 4°C.

The reason for processing peaches packed with sugar and calcium lactate for shorter processing periods than those packed with sugar only is the dissociation of calcium lactate into $Ca^{++}$ and lactic acid. Lactic acid has an antimicrobial activity which allow minimizing the processing time (Pflug and Esselen, 1979). Furthermore, using of low storage temperature (4°C) also inhibited microbial growth. Therefore, peaches stored under refrigerated temperature were processed for shorter periods of time (7 and 14 min).

## Quality Analysis

After 2 months of storage, three jars from each treatment of canned peaches were randomly obtained and used for determining the following quality attributes in triplicates.

### pH and Total Acidity

For determining the pH and total acidity of the fruits, 10 g of the fruits were blended (1 min at low speed and 2 min at high speed) with 90 ml of distilled water using a Waring blender, while for determining the pH and total acidity of the syrup, 10 ml of syrup was diluted with 90 ml of distilled water. The pH was directly measured with a pH meter (Sargent Welch pH 8200) equipped with a glass electrode. For total acidity determination, the blended sample was titrated to a pH of 8.1 with 0.1 N NaOH solution (Wahem, 1990). The percentage of total acidity were obtained by calculating as following:

$$\text{Total acidity} = \frac{\text{ml of NaOH} * \text{N} * \text{eq. of citric acid} * 100}{\text{sample size} * 1000}$$

### Soluble Solid Contents

Abbe refractometer equipped with circulating pump (Isotemp Refrigerated Circulator, Fisher Scientific Model 910) to maintain the temperature consistant at 20°C was used for the determination of soluble solid contents of the fruit and the syrup. Three drops of syrup or fruit juice were used for direct reading of soluble solid contents (Wahem, 1990).

## Soluble Solids/Acid Ratios

Soluble solids/acid ratios of the fruits and the syrup were obtained by dividing the percentage of soluble solids by the percentage of total acidity (Wahem, 1990).

## Color

Minolta Chroma Meter (Series CR-200) was used for direct color measurement of the tristimulus L*, a*, and b* after calibrated with a white tile (L = 97.78 a = -.69 b = 2.31) (Trail et al., 1992). The tristimulus values were measured on the same area of the mesocarp of the fruit.

## Texture

Food Technology Corporation Texture System (model T-1200 G), equipped with standard shear compression cell (model CS-2), was used to determine the texture of the fruits. The thickness of each blade of the moveable 10 blades shear compression cell was 3.178 mm and the speed of the stroke was held constant at 30 sec. Fruits were halved and the stones were removed. The two halves of each fruit were placed in the cell under the stroke. The peak force required to shear and compress the fruit was recorded (Wahem, 1993).

Ascorbic Acid

Ten grams of fruit were blended with 90 ml of 1% oxalic acid solution in a Waring blender at low speed for 1 min and high speed for 2 min and then filtered through a #1 Whatman filter paper. Ten millimeters of the filtered mixture were tritrated with the 0.0125% Indophenol Dye solution to faint pink color (AOAC, 1980). The amount of ascorbic acid was calculated as follows:

mg ascorbic acid/100 g sample = (Dye Factor) (Y)

Where: Dye Factor = mg ascorbic acid per 1 ml dye

Y = ml of the dye solution used in the titration

## Sensory Evaluation

Canned peaches stored at 4°C were allowed to reach the ambient temperature prior to sensory analysis. Sensory evaluations (color, flavor, texture) were carried in triplicate. For each replication, one jar of each treatment was drained and each fruit was cut into 8 equal size slices. Two slices of each treatment were placed on a randomly precoded with three digit number white plate and then presented to each panelist. A cup of water at ambient temperature was provided to each panelist to rinse his/her mouth between samples. Six panelists with previous sensory evaluation training were asked to evaluate the organoleptic quality of peaches. Panelists were familiarized with score sheet and test materials prior to evaluation. Evaluations were conducted in a well ventilated sensory evaluation room equipped with individual booths, white lighting (75 w), and positive air pressure. Panelists were instructed to evaluate each sample for color, flavor, and texture using a 10-point scale where 10 was excellent in color, very pleasant in flavor including mouthfeel and aroma sensation, and very firm in texture by bite, and where 1 was very poor in color or discolored, very poor in flavor or unpleasant flavor including mouthfeel and aroma sensation, and very poor in texture or too soft in texture by bite (Wahem, 1990).

At the end of the experiment, data were collected and statistically analyzed using Analysis of Variance (ANOVA) method and Duncan's Multiple range test (SAS Institue, Inc., 1988). Correlation coefficients between selected subjective and objective measurements of quality attributes were calculated.

# CHAPTER III

# RESULTS

## Ascorbic Acid Content

There was no significant difference ($P > 0.05$) in ascorbic acid contents (mg/100 grams) of the fruit for canned peaches packed with 10% sucrose, processed in boiling water bath for 20 min and stored at 25°C (TR1), 10% sucrose, processed for 10 min and stored at 4°C (TR2), 10% sucrose and 0.5% calcium lactate, processed for 14 min and stored at 25°C (TR3), 10% sucrose and 0.5% calcium lactate, processed for 7 min and stored at 4°C (TR4), 7% fructose, processed for 20 min and stored at 25°C (TR5), 7% fructose, processed for 10 min and stored at 4°C (TR6), 7% fructose and 0.5% calcium lactate, processed for 14 min and stored at 25°C (TR7), and 7% fructose and 0.5% calcium lactate, processed for 7 min and stored at 4°C (TR8) (Table 1 and Fig. 1).

Table 1 and Fig. 2 show the effects of the previously mentioned treatments on the ascorbic acid contents of the syrup of canned peaches. TR2 was significantly higher in ascorbic acid contents of the syrup than TR3, TR4, and TR7. There was no significant difference, however, between TR1, TR2, TR5, TR6, and TR8, nor between TR1, TR3, TR4, TR5, TR6, and TR8 in ascorbic acid contents of the syrup.

## pH

Treatments had significantly ($P \leq 0.05$) influenced the pH of both the fruits and the syrup of canned peaches (Table 1, Fig. 3 and 4). The pH of the fruits of TR3 was significantly higher than that of TR2, and TR6, however, the pH of TR2 was significantly lower than that of TR1, TR3, TR4, TR5, TR7, and TR8. There was no significant difference in the pH of the fruits between TR1, TR3, TR4, TR5, TR6, TR7, and TR8, nor between TR2 and TR6.

The pH of the syrup of TR3 was significantly higher than that of TR2, TR4, TR6 and TR8. There was no significant difference in the pH of the syrup of TR1, TR3, TR5, and TR7 nor between TR1, TR4, TR7 and TR8. Furthermore, there was no significant difference in the pH of the syrup of TR4, TR6 and TR8, however, the pH of TR2 was significantly the lowest.

## Total Acidity

The percentage of total acidity, expressed as citric acid, of the fruits was significantly ($P \leq 0.05$) influenced by treatments (Table 1 and Fig. 5). TR2 was significantly higher in total acidity than TR1, TR3, TR4, TR5 and TR6, and TR8 was significantly higher than TR1, TR4 and TR5. There was no significant difference in total acidity between TR2, TR7 and TR8, nor between TR3.

The percentage of total acidity of the syrup of TR2 was significantly higher than that of TR5. The total acidity of all the remaining treatments did not show any significant differences from those of TR2 and TR5 (Table 1 and Fig. 6).

## Soluble Solid Contents

Treatments had significantly ($P \leq 0.05$) influenced the soluble solid contents of the fruits and the syrup of canned peaches (Table 1, Fig 7 and 8). The percentage of the soluble solids of the fruits of TR1, TR2, TR3 and TR4 ranked significantly higher than those of TR5, TR6, TR7 and TR8. The soluble solid contents of the syrup of TR1, TR2, TR3 and TR4 were significantly higher than those of TR5 and TR7. There were no significant differences in the soluble solid contents between TR1, TR2, TR3 and TR4, nor between TR1, TR2, TR3, TR6 and TR8. Although, there were no significant differences between TR5, TR6, TR7 and TR8 .

## Soluble Solids/Acid Ratios

Treatments had significant ($P \leq 0.05$) influence in the soluble solids/acid ratios of the fruits and the syrup of canned peaches (Table 1, Fig. 9 and 10). The soluble solids/acid ratio of the fruits of TR4 was significantly higher than those of TR2, TR5, TR6, TR7 and TR8. Furthermore, the soluble solids/acid ratio of the fruits of TR1 was significantly higher than TR2, TR7 and TR8. There was no significant difference in the soluble solids/acid ratios between TR1, TR3 and TR4, nor between TR1, TR3, TR5 and TR6. In addition, there was no significant difference in the soluble solids/acid ratios between TR2, TR3, TR5, TR6, TR7 and TR8. The syrup of TR1 was significantly higher in the soluble solids/acid ratios than those of TR5, TR7 and TR8. Furthermore, the soluble solids/acid ratios of the syrup of TR3 and TR4 were significantly higher than that of TR7. There were no significant differences, however, in the soluble solids/acid ratios between TR1, TR2, TR3, TR4 and TR6, nor between TR2, TR5, TR6, TR7 and TR8.

## Texture Measurements

The texture of the fruits of canned peaches was significantly ($P \leq 0.05$) influenced by the treatments (Table 1 and Fig. 11). The force (lbs/100 g) required to shear and compress the fruits of TR4 was significantly the highest. The fruits of TR3 and TR7 showed more resistant to the shear and compression forces than those of TR2, however, there was no significant difference in the texture measurements of TR1, TR3, TR5, TR6, TR7 and TR8.

## Color Measurements

Treatments did not significantly ($P \leq 0.05$) affect Hunter L* and b* color values of the fruits (Table 1, Fig. 12 and 13), however, they significantly influenced Hunter a* color values (Table 1 and Fig. 14). The Hunter a* values of the fruits of TR4 was significantly higher than those of TR2, TR3, TR5, TR6, TR7 and TR8. Also, the Hunter a* values of TR1 and TR6 were significantly higher than TR5's values.

There were no significant differences in the a* values of TR4 and TR1, nor between TR1, TR3, TR6, TR7 and TR8. Moreover, there were no significant differences in the a* values between TR2, TR3, TR5, TR7 and TR8.

## Sensory Evaluation

Treatments had significantly influenced the color, flavor and texture of canned peaches as evaluated by six panelists (Table 1, Fig.15, 16 and 17). TR1 and TR5 obtained the highest scores in color and they were significantly superior to TR2, TR3, TR4 and TR6. Panelists ranked TR6, TR7 and TR8 superior in color to TR2 and TR4. There were no significant differences in the color of TR1, TR5, TR7 and TR8, nor between TR3, TR6, TR7 and TR8. In addition, the color of TR2, TR3 and TR4 were not significantly different (Table 1 and Fig. 15). The flavor of TR1 as evaluated by the panelists obtained the highest scores and its scores were significantly higher than that of TR7 which were in turn higher than that of TR2. There were no significant differences in the flavor of TR1, TR3, TR4, TR5, TR6 and TR8, nor between TR3, TR4, TR5, TR6, TR7 and TR8 (Table 1 and Fig. 16). The scores of the texture as evaluated by the panelists of TR3, TR4 were the highest and were significantly higher than TR1, TR2, TR5, TR6 and TR8. There were no significant differences in texture between TR3, TR4 and TR7, nor between TR7 and TR8. TR5 was significantly inferior in texture followed by TR1, TR2 and

TR6 (Table 1 and Fig.17).

## Correlations between Some Subjective and Objective Measurements

Hunterlab L*, a* and b* values were positively correlated with the color of canned peaches as evaluated by 6 trained panelists (Table 2). The correlation between the flavor of peaches as evaluated by panelists and the soluble solids/acid ratios of the fruits was weaker than that of the panelists scores of peach flavor and the soluble solids/acid ratios of the syrup (Table 3).

# CHAPTER IV

## DISCUSSION

Objective and subjective methods were implemented to evaluate selected quality attributes of canned peaches as influenced by processing time, storage temperatures and the addition of sucrose, fructose and calcium lactate. Although, the results of analyzing for ascorbic acid contents, pH, percentage of total acidity, soluble solids and soluble solids/acid ratios of the fruits and the syrup of canned peaches were not in equality, they were mostly in the same trend. These variations most probably due to the short storage period and the large size of the fruits which were canned whole, resulting in insufficient diffusions.

Ascorbic acid contents of fruits and vegetables are normally used as indicators of their nutritional qualities (Klein, 1987). The results as shown in Table 1 and Fig. 1 indicated that decreasing the processing period, adding sucrose, fructose and calcium lactate and lowering the storage temperature had no significant influence on ascorbic acid contents of the fruits. When peaches were packed in 10% sucrose, processed for 10 min and stored at 4°C, however, the ascorbic acid contents of the syrup was significantly high compared to the other treatments (Table 1 and Fig. 2). Generally, the results show a slight decrease (not significant) in ascorbic acid contents of treatments with calcium lactate. These results are in agreement with Main et al. (1986) who reported a slight decrease in ascorbic acid contents of thermally processed strawberries. The addition of sucrose and fructose had no significant influence on the ascorbic acid contents of both the fruits and the syrup of canned peaches. Although, the implementations of short processing time and low storage temperature showed no significant effect on ascorbic acid contents in this study, they did help in retarding the loss of ascorbic acid. The previous statement is in agreement with Shinn (1979) who reported that the use of high-temperature short-time blanching minimizes the magnitude of the loss of ascorbic acid contents of vegetables. Furthermore, Shinn (1979) noted that at lower storage temperatures, especially refrigerated temperatures, the losses of ascorbic acid and other nutrients are reduced.

The results (Table 1, Fig. 3 and 4) show that the addition of calcium lactate slightly increased the pH of the fruits and the syrup of canned peaches. This increasing effect was significant on the fruits and the syrup of TR4. The increase in pH is due to the slight basic form of calcium lactate. These results agree with the findings of Main et al. (1986) who reported that treating strawberries with calcium lactate resulted in increasing the pH of the fruits.

Processing time and storage temperatures significantly influenced the pH of the fruits and the syrup of canned peaches. Samples processed for short time (7 and 10 min) stored at low temperature (4°C) had lower pH than those processed for longer time (14 and 20 min) stored at higher temperature (25°C). These results agree with Wahem (1990) who reported a decrease in the pH of canned tomatoes as a result of shortening the processing period.

As mentioned by Wahem (1988), while the pH of the fruit decreases, the total acidity increases. The results of this study (Table 1, Fig. 5 and 6) agree with Wahem's finding and show opposite trends between the pH and the total acidity of the fruits and the syrup of canned peaches. When peaches were processed in boiling water bath for 14 and 20 min in the presence of fructose and sucrose and stored at 25°C, the addition of calcium lactate had no significant effect on the total acidity of the fruits and the syrup of canned peaches. When calcium lactate was used with peaches processed in boiling water bath for 7 min and stored at 4°C in the presence of sucrose, however, the total acidity of the fruits and the syrup decreased. But, when sucrose was substituted with fructose and peaches were processed for 7 min and stored at 4°C, the total acidity of the fruits and the syrup increased. The reduction in the total acidity of treatments packed with sucrose in the presence of calcium lactate is due to the basic nature of calcium lactate which neutralized some of the naturally ocurring acids (Belitz and

Grosch, 1987). The increase in the total acidity of treatments packed with fructose in the presence of calcium lactate most propably due to the degradation of fructose under acidic conditions into acids during processing and storage (Belitz and Grosch, 1987).

Processing time and storage temperatures influenced the total acidity of the fruits and the syrup of canned peaches. Treatments recieved short processing time (7 and 10 min) and stored at 4°C had higher percentage of total acidity than those processed for long time (14 and 20 min) and stored at 25°C. These results indicate degradation of some of acids presented in peaches during processing for long time and storing at elavated temperature (Belitz and Grosch, 1987).

The results as shown in Table 1, Fig. 7 and 8 indicated that the addition of calcium lactate had no significant effects on the soluble solids of the fruits and the syrup of canned peaches. These results are in agreement with the researches of Morris et al. (1985) and Main et al. (1986) who reported that calcium lactate dip treatments of strawberries did not affect the soluble solid contents of the fruits. The results also show that soluble solids of the fruits of canned peaches packed with 10% sucrose were significantly higher than those packed with 7% fructose. In addition, the soluble solids of the syrup of canned peaches packed with 10% sucrose were also significantly higher than those packed with 7% fructose. Since fructose is sweeter (170) than sucrose (100), lower percentage of fructose was used to pack the peaches (Belitz and Grosch, 1987). The results showed that reducing the processing time and lowering the storage temperatures slightly increased the soluble solids of the fruits and the syrup of canned peaches. This may be due to the less pronounce effects of heat provided to degrade some of the soluble solids of the fruits and the syrup as a result of shorter processing periods and lower storage temperature.

Generally, as processing time and storage temperatures decreased, the soluble solids/acid ratios of the fruits and the syrup decreased. Except that, when the fruits were packed with sucrose and calcium lactate, processed for 7 min and stored at 4°C, the soluble solids/acid ratios of the fruits (significantly) and the syrup (not significantly) were higher than when the fruits were packed with sucrose alone, processed for 10 min and stored at 4°C. This is due to the basic nature of $Ca^{++}$ which neutralized some of the acids. When peaches were packed with sucrose, the soluble solids/acid ratios of the fruits and the syrup were higher than when they were packed with fructose. This is due to the higher percentage of sucrose used.

Texture is one of the important quality characteristics of canned peaches (Postlmayr et al., 1956). The results (Table 1 and Fig. 11) of this study indicated that the addition of calcium lactate had an effect on the force required to shear and compress the canned peaches. For instance, peaches packed with 10% sucrose and 0.5% calcium lactate, processed for 7 min and stored at 4°C (TR4) was significantly the firmest. The firming effect of calcium lactate is in agreement with work of Morris et al. (1985) and Main et al. (1986). The effect of calcium lactate as a firming agent is due to the reaction of $Ca^{++}$ with pectic substances resulting in the formation of calcium pectate crosslinkages in the middle lamella region of fruit cells (Main et al. 1986). Main et al. (1986) also found that calcium lactate was very effective in firming thermally processed fruits.

When fruits were packed with 10% sucrose and 0.5% calcium lactate, processed for 7 min and stored at 4°C, they had significantly the firmest texture. This is due mostly to the combined effects of short processing time, low storage temperature and addition of calcium lactate. Replacing sucrose with fructose did not have a significant effect on the texture of canned peaches. Fructose under acidic condition with application of heat is degraded into organic acid which reacted with the added $Ca^{++}$ competing the pectic substances (Berlitz and Grosch, 1987).

For color measurement of the canned products, Hunterlab L*, a*, and b* values were directly obtained using Minolta Chroma Meter (Series CR-200) (Trail et al., 1992). Hunterlab L* values indicate brightness or darkness of the fruits, where 100 indicates perfect white and 0 indicates perfect dark. Hunterlab a* values (hue) indicate redness or greeness, where -60 being absolutely green color and +60 being absolutely red. Hunterlab b* values (chroma) express the yellowness or blueness, with -60 indicating absolutely blue and 60 indicating absolutely yellow. The results of this study (Table 1, Fig. 12 and 13) show that treatments did not significantly influence Hunterlab L* and b* values. Therefore addition of calcium lactate, sucrose and fructose and processing time (7, 10, 14, and 20 min) and storage temperatures (4°C and 25°C) have no significant influences on the brightness and the yellowness of the fruits. The results (Table 1, Fig. 12 and 13) indicate that peaches packed with 7% fructose, processed for 20 min and stored at 25°C were the lightest (highest L* value) and the yellowest (highest b* value). Baumgardner et al. (1972) suggested that Hunterlab a* value is a good indicator of the color of peach flesh. Kader et al. (1982) also noted that using of a* value is a good and simple method for color determination of canned peaches. In this study, the a* values were negative indicating that the color of peaches fall in the green area of the scale (Table 1 and Fig. 14). The green color of peaches is caused by chlorophyll content of the fruit (Sistrunk, 1985). Canned peaches packed with 10% sucrose and 0.5% calcium lactate, processed for 7 min and stored at 4°C had the smallest negative a* value (less green/chlorophyll), while those canned with 7% fructose, processed for 20 min and stored at 25°C had the largest negative a* value (more green/chlorophyll). The results indicate that the addition of calcium lactate had no significant effects on the Hunter a* values of canned peaches. The exception was found with peaches that received less negative a* value (less greeen/chlorophyll) when they were packed with 10% sucrose and 0.5% calcium lactate, processed for 7 min and stored at 4°C compared to those packed with 10% sucrose, processed for 10 min and stored at 4°C. This is might be due to the replacement of $Mg^{++}$ in the chlorophyll ring with $Ca^{++}$ resulting in the formation of a less green compound. Packing canned peaches with 10% sucrose, processing for 20 min and storing at 25°C, and packing peaches with 10% sucrose and 0.5% calcium lactate, processing for 7 min and storing at 4°C resulted in significantly less negative a* value (less green/chlorophyll) than packing canned peaches with 7% fructose, processing for 20 min and storing at 25°C. This might be explained by the formation of pheophytin as a result of replacement of $Mg^{++}$ with $H^{+}$ which might be formed as a result of the degradation of fructose into organic acids.

The results of sensory evaluations for color, flavor, and texture of canned peaches as judged by six trained panelists are presented in Fig. 15, 16, and 17, respectively and summarized in Table 1. Peaches packed with 7% fructose, processed for 20 min and stored at 25°C were rated the best in color by the panelists, while peaches packed with 10% sucrose, processed for 10 min and stored at 4°C were rated the poorest in color (Table 1 and Fig. 15). The objective color measurements showed that peaches packed with 7% fructose, processed for 20 min and stored at 25°C were the brightest (highest L*) and yellowest (highest b*), but they were the greenest in color (highest negative a*). Furthermore, positive moderate correlations existing between L* (0.66), b* (0.62) and a* (0.56) and the sensory evaluation of the color (Table 2). Kader et al. (1982) reported that Hunterlab a* value is a good indicator of color of canned peaches. The results of this research agree with Kader's report and show that only Hunterlab a* values were significantly influenced by treatments.

Panelists rated canned peaches packed with 10% sucrose, processed for 20 min and stored at 25°C superior in flavor, while they rated peaches packed with 10% sucrose, processed for 10 min and stored at 4°C significantly inferior in flavor. Kader et al. (1982) reported that soluble solids/acid ratio is one of the most important factors influences peach flavor. This research indicates a very small correlation between soluble solids/acid ratios of fruits (0.16) and syrup (0.43), and flavor of canned peaches as evaluated by 6 panelists. The reason for the difference between the finding of this research and Kader's report is perhaps due to the fact that a lower amount of fructose which is sweeter than sucrose was used in conducting this experiment.

As shown in Table 1 and Fig. 17, the sensory evaluation for texture of canned peaches packed with the addition of calcium lactate obtained significantly higher scores than that of canned peaches packed without the addition of calcium lactate. Peaches packed with 10% sucrose and 0.5% calcium lactate, processed for 7 min and stored at 4°C were the best in texture as determined by objective and subjective measurements. The texture as measured by 6 trained panelists of canned peaches packed with 7% fructose, processed for 20 min and stored at 25°C was not significantly different from those packed in 10% sucrose, processed for 20 min and stored at 25°C, 10% sucrose, processed for 10 min and stored at 4°C, 10% sucrose and 0.5% calcium lactate, processed for 14 min and stored at 25°C, 7% fructose, processed for 10 min and stored at 4°C, 7% fructose and 0.5% calcium lactate, processed for 14 min and stored at 25°C, and 7% fructose and 0.5% calcium lactate, processed for 7 min and stored at 4°C. However, the panelists rated peaches packed with 7% fructose, processed for 20 min and stored at 25°C inferior in texture. this may be due to the different preferences of the panelists.

# CHAPTER V

## CONCLUSIONS

The addition of calcium lactate significantly improved the texture quality of canned peaches, especially with the addition of sucrose. The addition of calcium lactate slightly increased the pH and Hunterlab a* values and decreased the ascorbic acid contents.

Replacing sucrose with fructose resulted in a slight increase in total acidity of the fruits and the syrup of canned peaches, processed for 7 min in the presence of calcium lactate. The refrigerated storage temperature (4°C) had significantly affected the pH, total acidity, and the soluble solids of fruits and syrup of canned peaches. Canned peaches stored at 4°C, and processed for 7 min (with calcium lactate) and 10 min (without calcium lactate) were significantly higher in total acidity and soluble solid contents and lower in pH than peaches stored at 25°C and processed for 14 min (with calcium lactate) and 20 min (without calcium lactate). Although, processing time and the storage temperatures did not significantly affect ascorbic acid contents of the fruits and the syrup of canned peaches, the results showed that the loss of ascorbic acid contents at shorter processing time and lower storage temperature was less than that at longer procesing time and higher storage temperature. The results of sensory evaluations did not always correlate with the objective measurements, since there were some variations among panelists according to their personal preferences. For best quality of canned peaches, it is advisable for food processors to utilize calcium lactate and shorter the processing time. Further researches utilizing the concept of several hurdles to maintain the quality of canned peaches are needed.

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TABLE 1-THE EFFECTS OF PROCESSING TIME (PT), THE ADDITION OF CALCIUM LACTATE (CaL), SUCROSE (su), AND FRUCTOSE (fu), AND STORAGE TEMPERATURES (ST) ON THE QUALITY ATTRIBUTES OF CANNED PEACHES.

| Attributes | Treatments | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | TR1 | TR2 | TR3 | TR4 | TR5 | TR6 | TR7 | TR8 |
| Ascorbic Acid (mg/100g) | | | | | | | | |
| Fruits | 10.19a | 11.91a | 8.29a | 7.18a | 10.96a | 10.21a | 7.36a | 11.29a |
| Syrup | 7.13ab | 11.91a | 5.85b | 6.16b | 7.97ab | 7.18ab | 6.44b | 7.18ab |
| pH | | | | | | | | |
| Fruits | 4.03a | 3.54c | 4.14a | 3.91ab | 3.85ab | 3.79bc | 4.03ab | 3.88ab |
| Syrup | 4.06ab | 3.51d | 4.18a | 3.89bc | 4.19a | 3.8c | 4.06ab | 3.93bc |
| % Total Acidity | | | | | | | | |
| Fruits | 0.25c | 0.34a | 0.27bc | 0.26c | 0.25c | 0.27bc | 0.29abc | 0.33ab |
| Syrup | 0.28ab | 0.34a | 0.32ab | 0.33ab | 0.27b | 0.28ab | 0.32ab | 0.32ab |
| % Soluble Solids | | | | | | | | |
| Fruits | 9.08a | 9.33a | 8.97a | 9.77a | 6.87b | 7.87b | 7.07b | 7.93b |
| Syrup | 8.85ab | 8.87ab | 9.13ab | 9.73a | 6.63c | 7.77bc | 6.83c | 7.9bc |
| Soluble Solids/Acid Ratio | | | | | | | | |
| Fruits | 36.7ab | 27.4c | 33.3acb | 39.5a | 28.3bc | 29.5bc | 24.1c | 24.3c |
| Syrup | 31.6a | 26.0abc | 28.9ab | 29.9ab | 24.6bc | 27.4abc | 21.6c | 24.7bc |
| Texture (lbs/100 g) | 43.4bc | 32.6c | 66.2b | 101.85a | 50.5bc | 53.0bc | 62.9b | 59.4bc |
| Hunter L* | 52.1a | 52.1a | 52.3a | 53.2a | 54.3a | 51.3 | 52.4a | 52.3a |
| Hunter a* | -2.4ab | -4.1cd | -3.3bcd | -1.3a | -4.6d | -3.1bc | -3.7bcd | -3.4bcd |
| Hunter b* | 28.8a | 31.9a | 27.3a | 29.2a | 33.1a | 27.7a | 28.8 a | 29.2a |
| Sensory Evaluation | | | | | | | | |
| Color | 7.0a | 4.3c | 5.2bc | 4.7c | 7.2a | 5.8b | 6.2ab | 6.1ab |
| Flavor | 5.8a | 3.2c | 5.1ab | 5.1ab | 4.8ab | 5.6ab | 4.4b | 5.0ab |
| Texture | 4.6c | 4.6c | 6.5a | 6.6a | 3.5d | 4.9c | 5.8ab | 5.7b |

Values (in the same row) with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

TABLE 2-CORRELATION COEFFICIENTS BETWEEN SENSORY EVALUATION OF COLOR AND HUNTER L*, a*, AND b* VALUES OF CANNED PEACHES.

| Tristimulus | Color |
|---|---|
| | Correlation coefficient |
| L* | 0.66 |
| a* | 0.56 |
| b* | 0.62 |

TABLE 3-CORRELATION COEFFICIENTS BETWEEN SENSORY EVALUATION OF FLAVOR AND SOLUBLE SOLIDS/ACID RATIO OF THE FRUITS AND THE SYRUP OF CANNED PEACHES.

| Soluble Solids/Acid Ratio | Flavor |
|---|---|
| | Correlation coefficient |
| Fruits | 0.16 |
| Syrup | 0.43 |

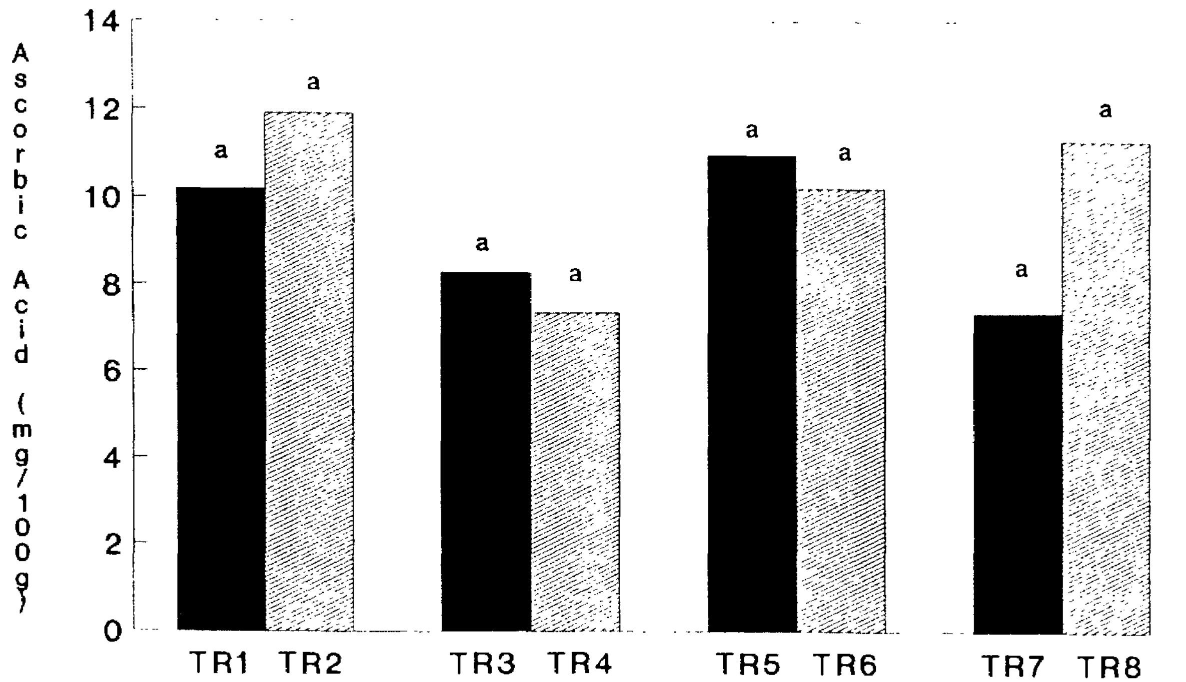


Fig. 1-The effects of processing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the ascorbic acid content of the fruits of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

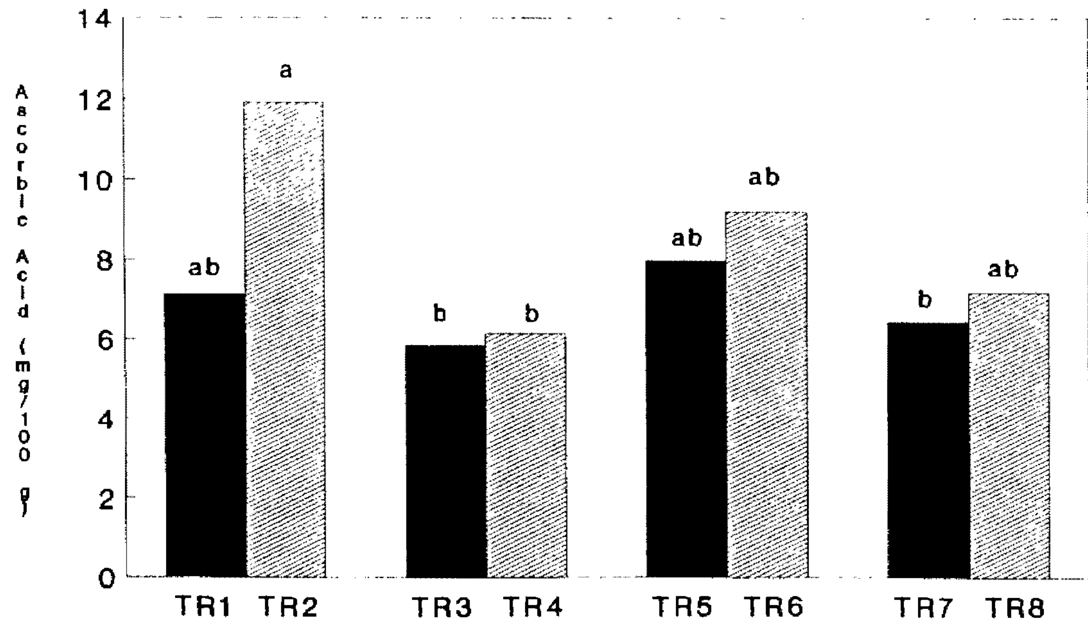


Fig. 2-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the ascorbic acid content of the syrup of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

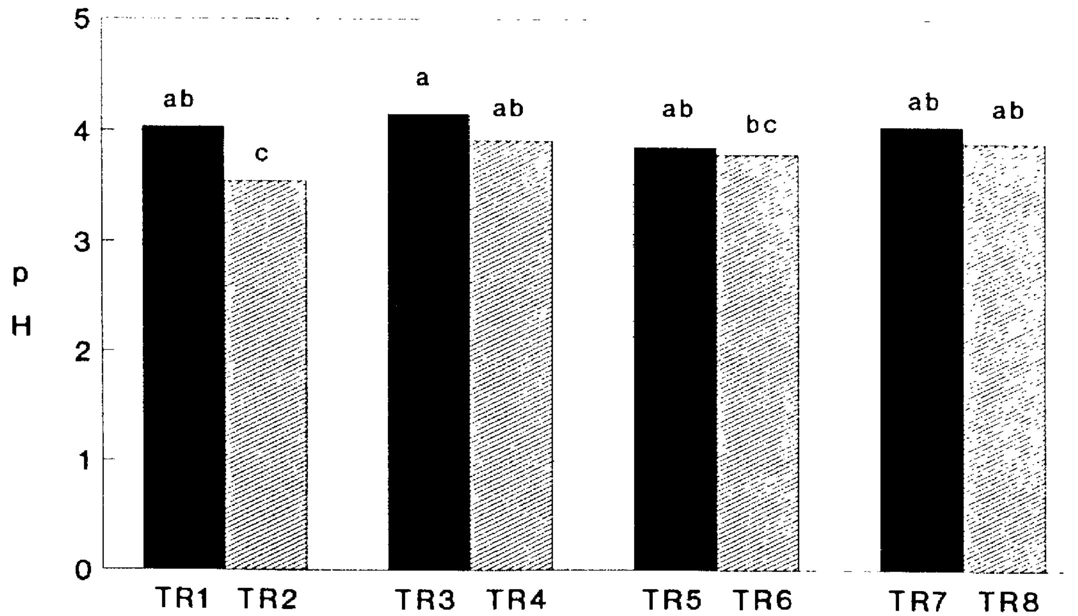


Fig. 3-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the pH of the fruits of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

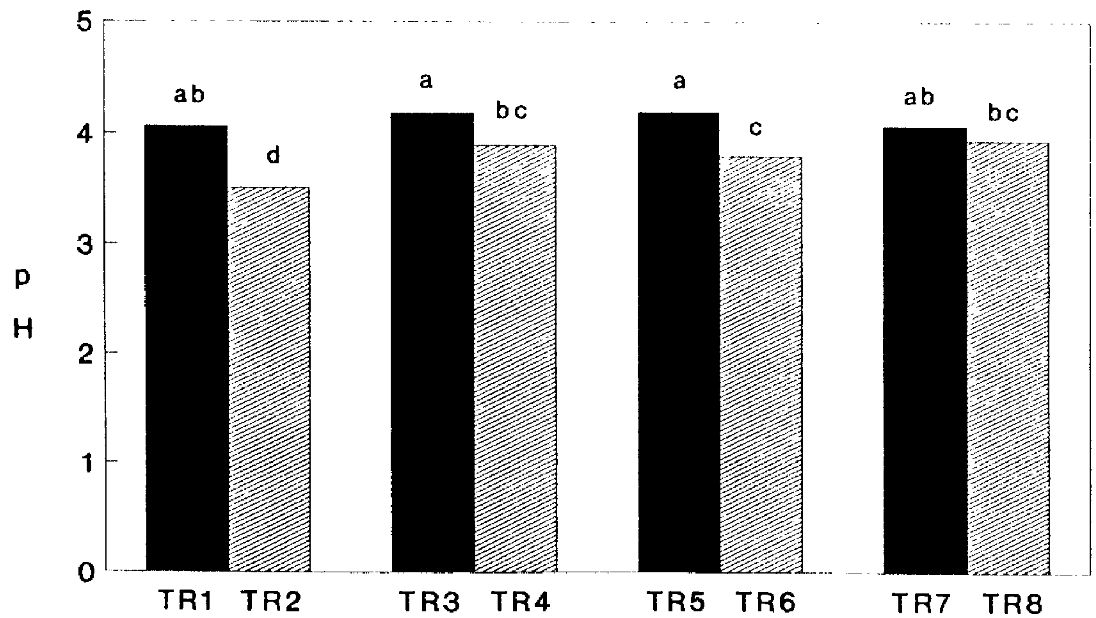


Fig. 4-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the pH of the syrup of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

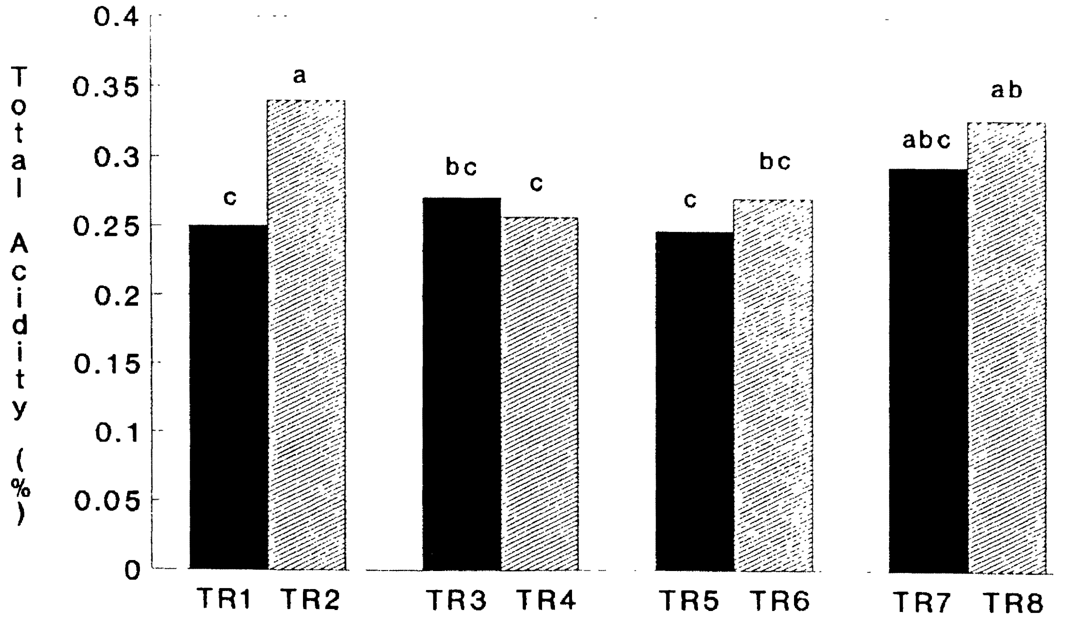


Fig. 5-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the total acidity of the fruits of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

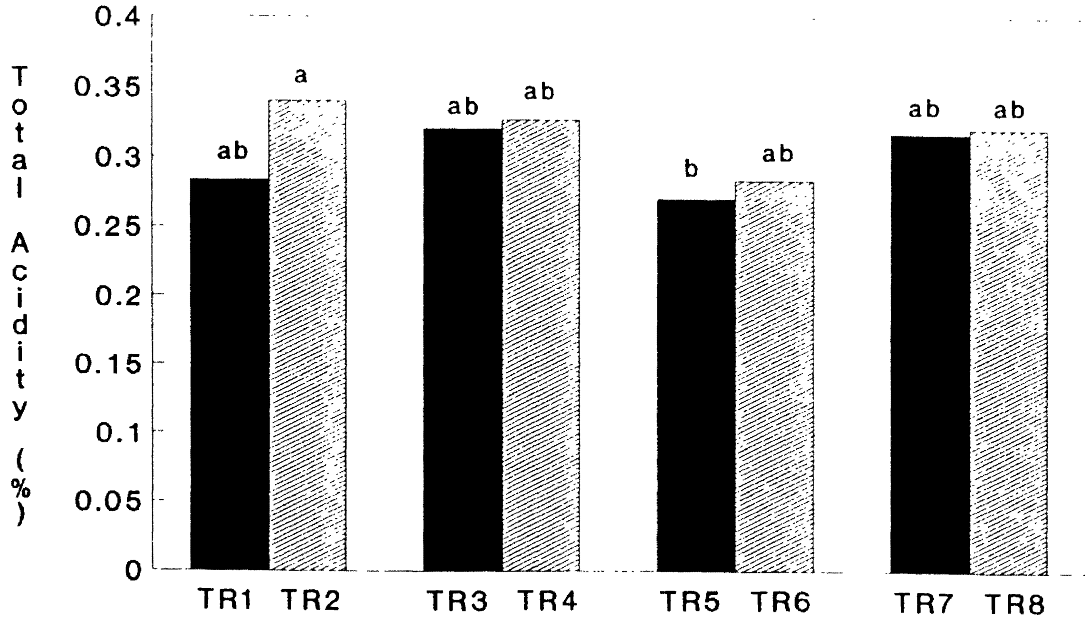


Fig. 6-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the total acidity of the syrup of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

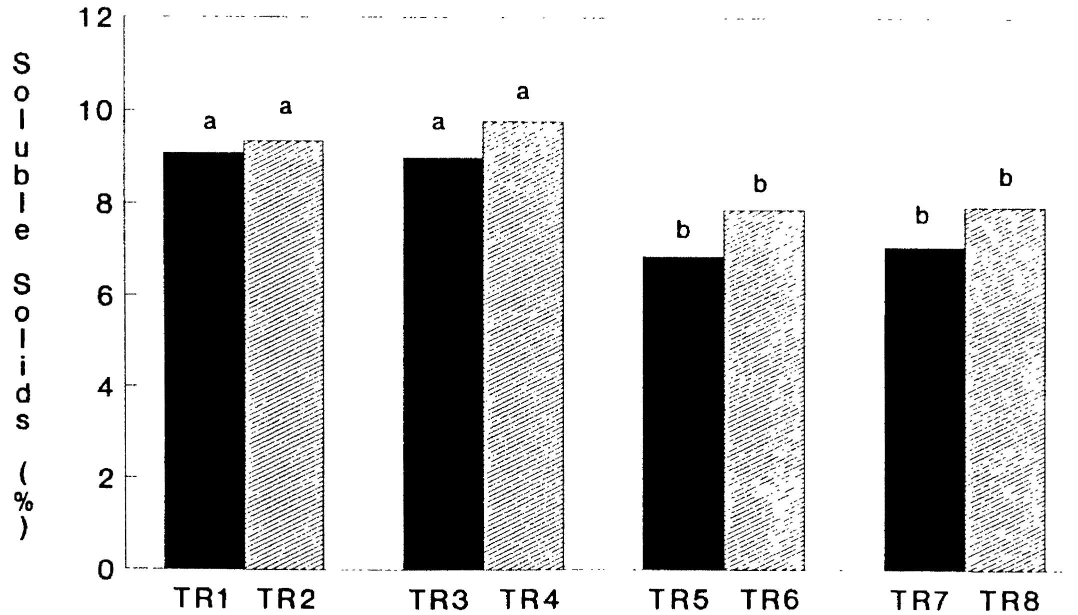


Fig. 7-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the soluble solid content of the fruits of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

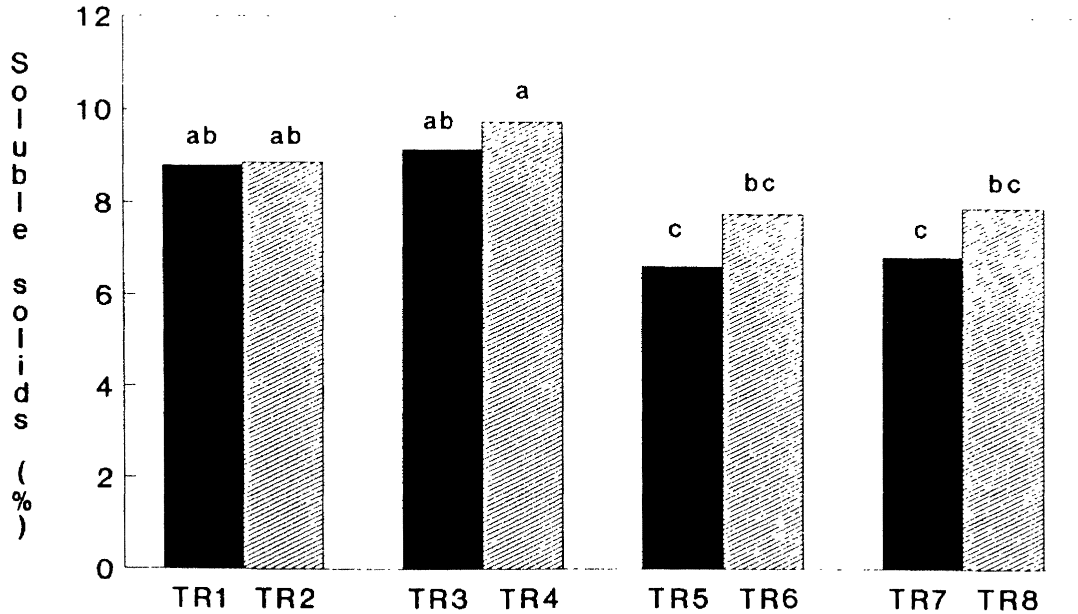


Fig. 8-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the soluble solid content of the syrup of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

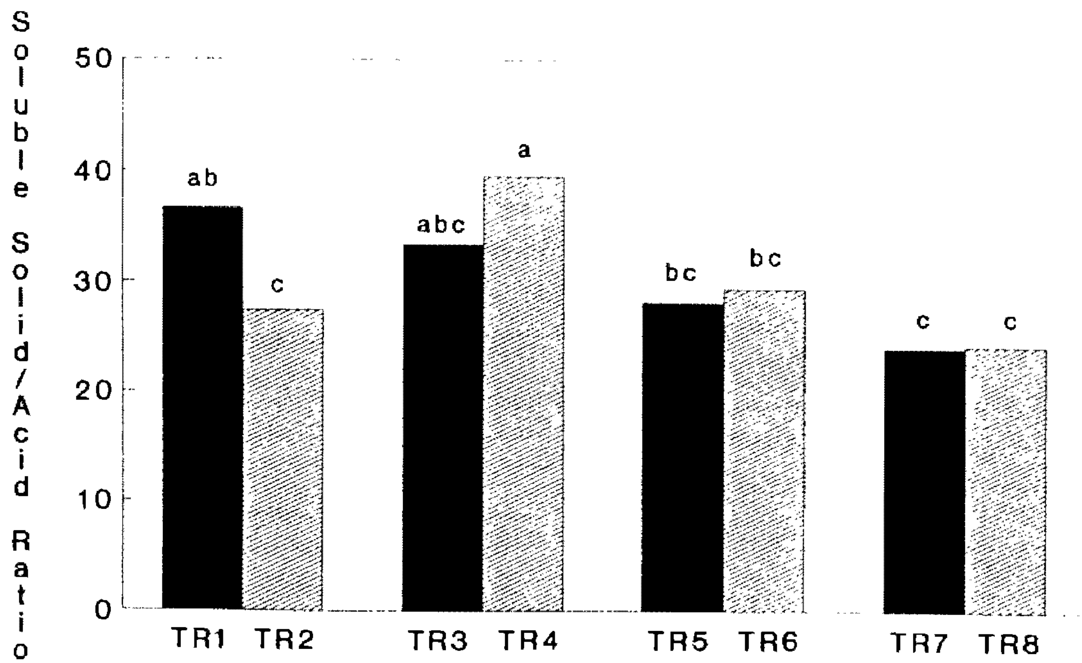


Fig. 9-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the soluble solids/acid ratio of the fruits of canned peaches.

Values with the same letter are not significantly different at P ≤ 0.05.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

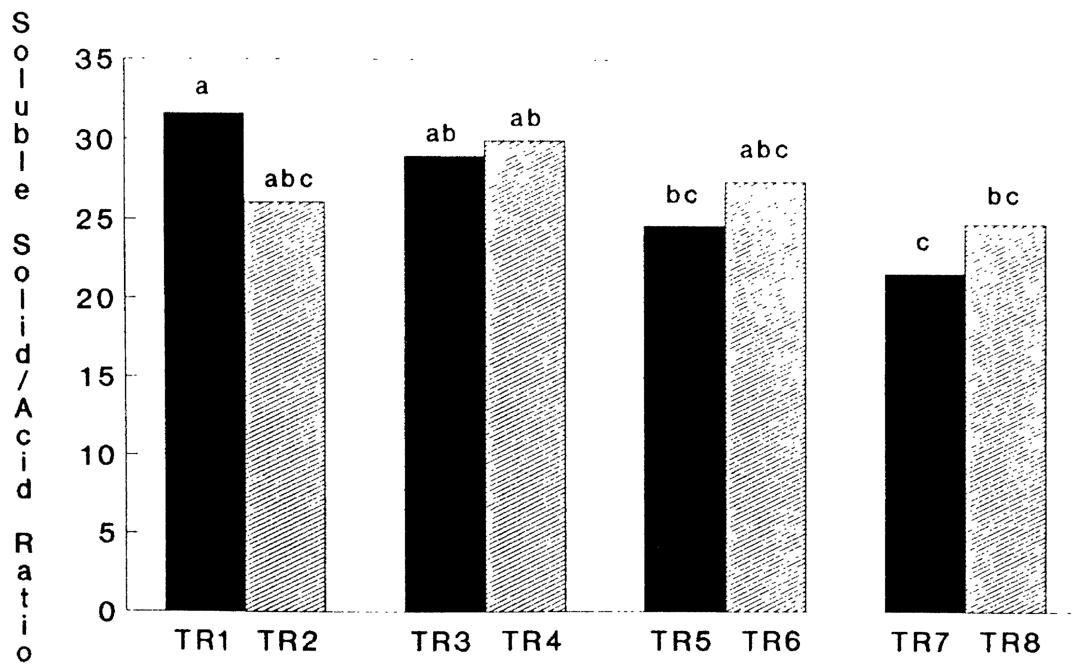


Fig. 10-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the soluble solids/acid ratio of the syrup of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

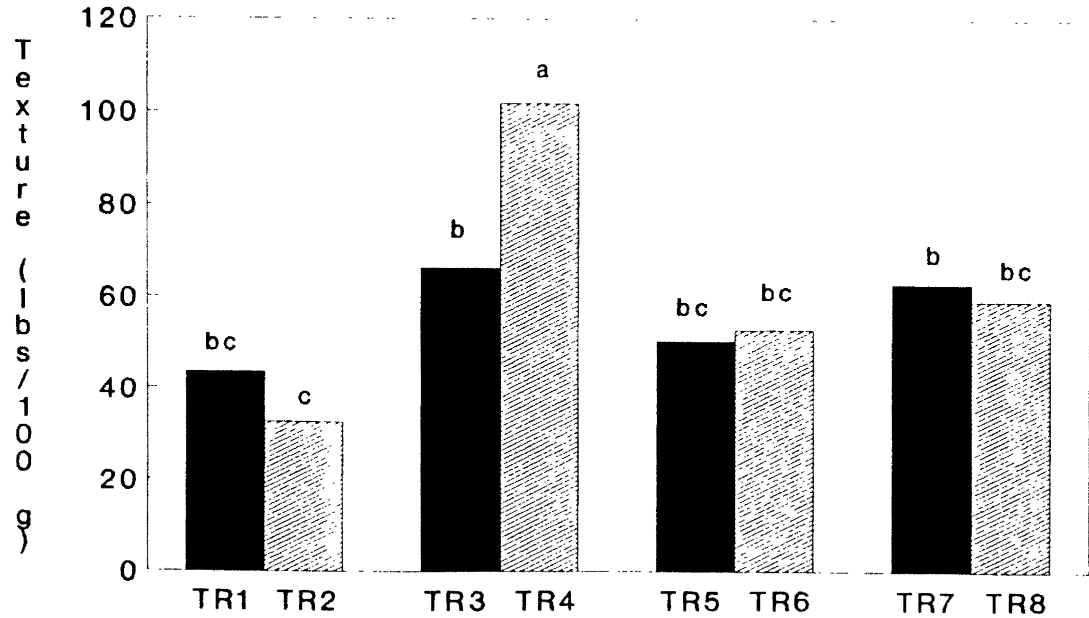


Fig. 11-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the texture of canned peaches as measured by Food Technology Corperation Texture System (model T-1200 G), equipped with standard shear compression cell (model CS-2) .

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

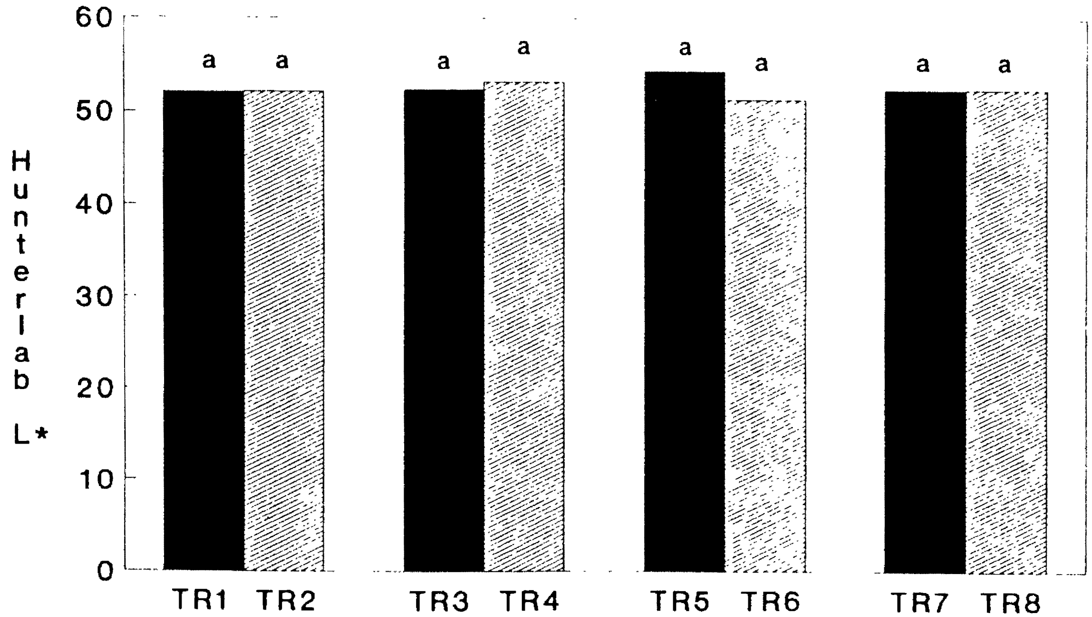


Fig. 12-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on Hunterlab L* values of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

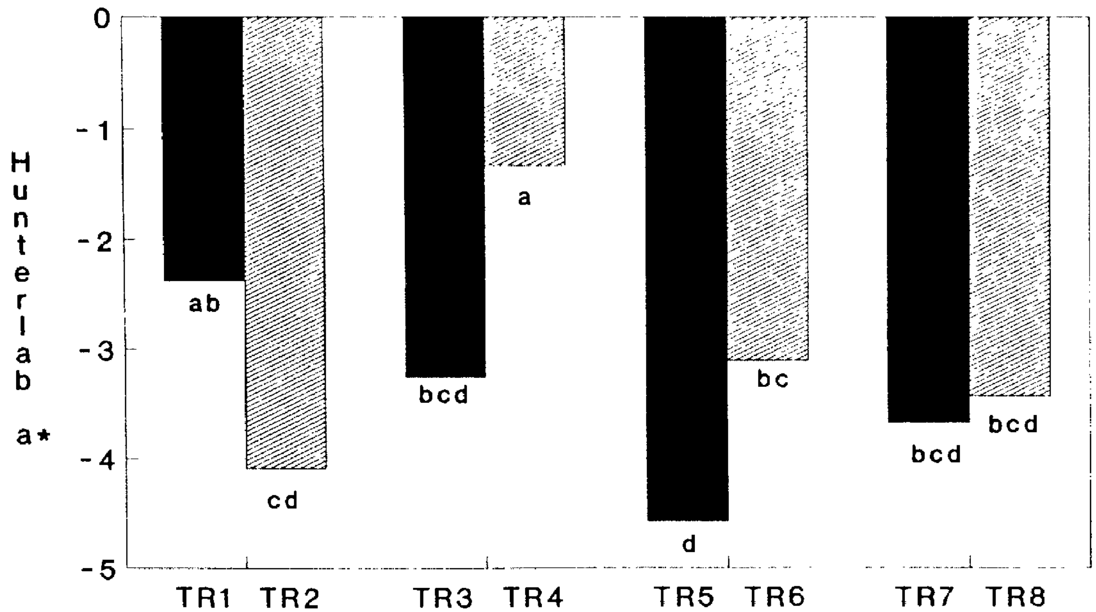


Fig. 13-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on Hunterlab a* values of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

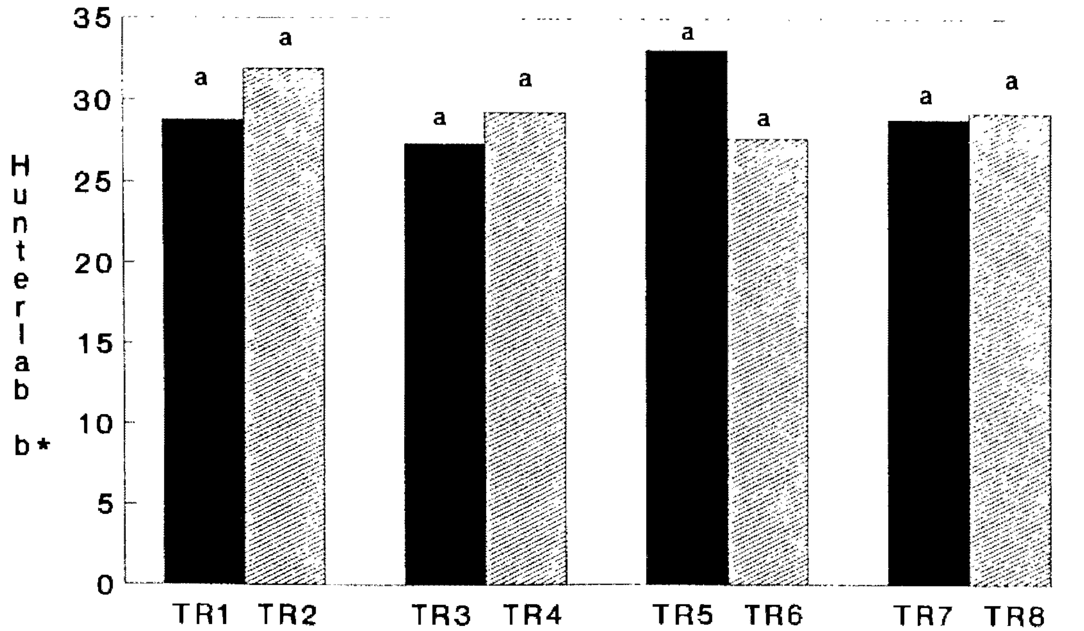


Fig. 14-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on Hunterlab b* values of canned peaches.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

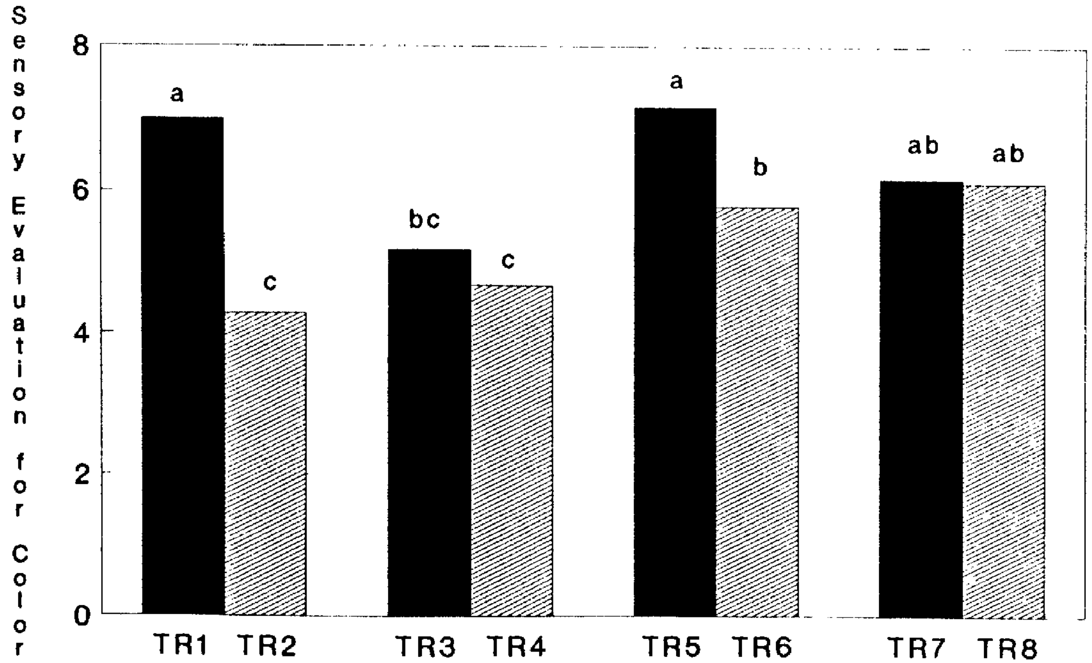


Fig. 15-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the color of canned peaches as evaluated by 6 trained panelists.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

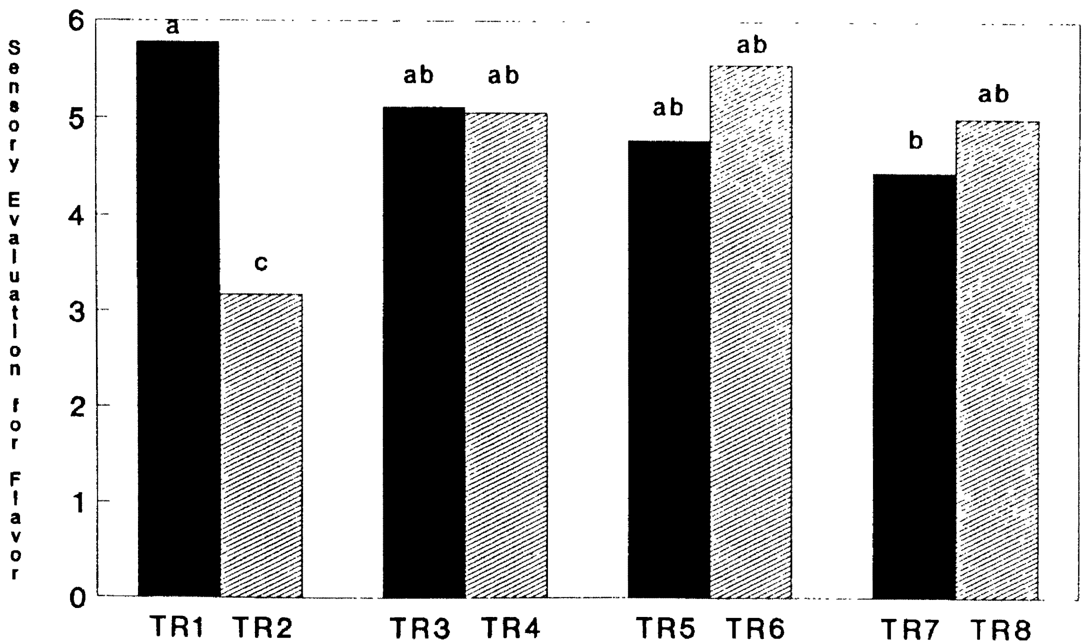


Fig. 16-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the flavor of canned peaches as evaluated by 6 trained panelists.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

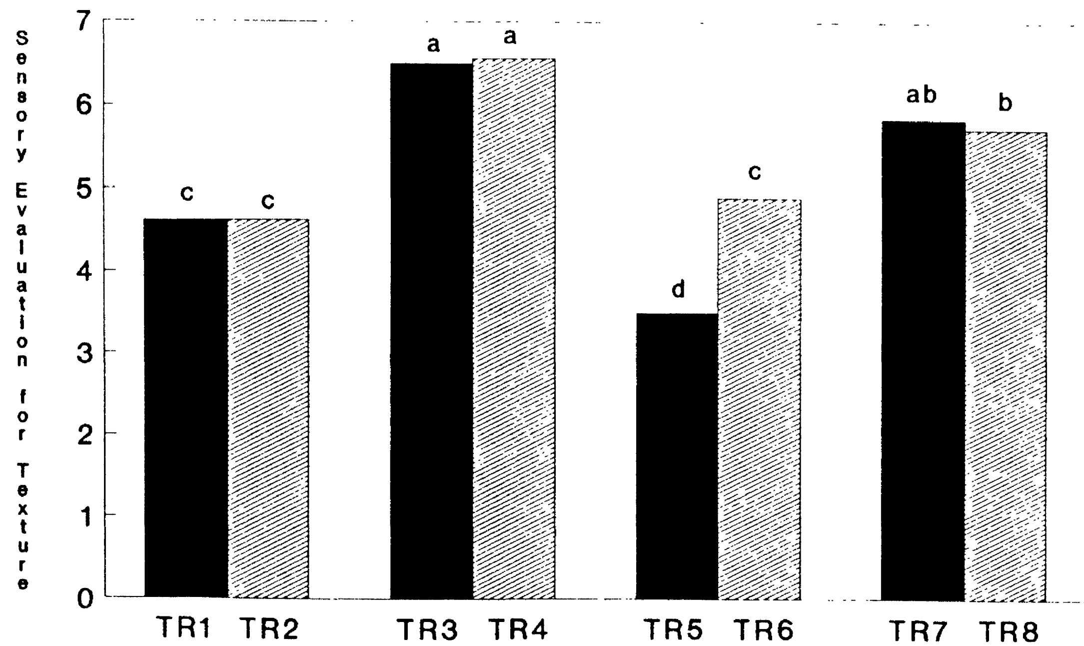


Fig. 17-The effects of precessing time (PT), the addition of calcium lactate (CaL), sucrose (su), and fructose (fu), and storage temperatures (ST) on the texture of canned peaches as evaluated by 6 trained panelists.

Values with the same letter are not significantly different at $P \leq 0.05$.

TR1: 10% su, 20 min PT, 25°C ST.
TR2: 10% su, 10 min PT, 4°C ST.
TR3: 10% su and 0.5% CaL, 14 min PT, 25°C ST.
TR4: 10% su and 0.5% CaL, 7 min PT, 4°C ST.
TR5: 7% fu, 20 min PT, 25°C ST.
TR6: 7% fu, 10 min PT, 4°C ST.
TR7: 7% fu and 0.5% CaL, 14 min PT, 25°C ST.
TR8: 7% fu and 0.5% CaL, 7 min PT, 4°C ST.

APPENDIXES

APPENDIX A

SENSORY EVALUATION SCORE SHEET

## SENSORY EVALUATION SCORE SHEET

**NAME:** ______________________________

**DATE:** __________

**QUALITY CHARACTERISTICS:**

| | | | | | |
|---|---|---|---|---|---|
| **C** | **:** | **COLOR** | **OFF** | **:** | **INEDIBLE** |
| **F** | **:** | **FLAVOR** | **POOR** | **:** | **EDIBLE; BUT THAT IS ALL** |
| **T** | **:** | **TEXTURE** | **FAIR** | **:** | **COULD EAT IT WITHOUT ENTHUSIASM** |
| | | | **GOOD** | **:** | **ENJOY IT; MINOR IMPROVEMENT DESIRABLE** |
| | | | **EXCELLENT** | **:** | **IN ALL RESPECTS; YOU KNOW OF NO IMPROVEMENT** |

| SENSORY RATING / SAMPLE CODE | OFF | | POOR | | FAIR | | GOOD | | EXCELLENT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| | | | | | | | | | | | |
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| | | | | | | | | | | | |

Write the quality characteristics in the columns corresponding to your rating for each sample.

**Other comments:** ______________________________________________

# APPENDIX B

# DATA FROM STATISTICAL ANALYSIS

Analysis of Variance Procedure

Dependent Variable: Ascorbic Acid of the Fruits (FVC)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 69.82312917 | 9.97473274 | 1.27 | 0.3258 |
| Error | 16 | 125.89006667 | 7.86812917 | | |
| Corrected Total | 23 | 195.71319583 | | | |

| R-Square | C.V. | Root MSE | FVC Mean |
|---|---|---|---|
| 0.356763 | 28.99369 | 2.805019 | 9.67458333 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 69.82312917 | 9.97473274 | 1.27 | 0.3258 |

Analysis of Variance Procedure

Dependent Variable: Ascorbic Acid of the Syrup (SVC)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 83.96202917 | 11.99457560 | 1.74 | 0.1707 |
| Error | 16 | 110.55406667 | 6.90962917 | | |
| Corrected Total | 23 | 194.51609583 | | | |

| R-Square | C.V. | Root MSE | SVC Mean |
|---|---|---|---|
| 0.431646 | 34.00723 | 2.628617 | 7.72958333 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 83.96202917 | 11.99457560 | 1.74 | 0.1707 |

Analysis of Variance Procedure

Dependent Variable: pH of the Fruits (FPH)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 0.71186250 | 0.10169464 | 4.46 | 0.0063 |
| Error | 16 | 0.36453333 | 0.02278333 | | |
| Corrected Total | 23 | 1.07639583 | | | |

| R-Square | C.V. | Root MSE | FPH Mean |
|---|---|---|---|
| 0.661339 | 3.872363 | 0.150941 | 3.89791667 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 0.71186250 | 0.10169464 | 4.46 | 0.0063 |

Analysis of Variance Procedure

Dependent Variable: pH of the Syrup (SPH)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 1.07453333 | 0.15350476 | 17.13 | 0.0001 |
| Error | 16 | 0.14340000 | 0.00896250 | | |
| Corrected Total | 23 | 1.21793333 | | | |

| R-Square | C.V. | Root MSE | SPH Mean |
|---|---|---|---|
| 0.882260 | 2.395710 | 0.094670 | 3.95166667 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 1.07453333 | 0.15350476 | 17.13 | 0.0001 |

Analysis of Variance Procedure

Dependent Variable: Total Acidity of the Fruits (FACID)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 0.02606667 | 0.00372381 | 3.37 | 0.0209 |
| Error | 16 | 0.01766667 | 0.00110417 | | |
| Corrected Total | 23 | 0.04373333 | | | |

| R-Square | C.V. | Root MSE | FACID Mean |
|---|---|---|---|
| 0.596037 | 11.79728 | 0.033229 | 0.28166667 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 0.02606667 | 0.00372381 | 3.37 | 0.0209 |

Analysis of Variance Procedure

Dependent Variable: Total Acidity of the Syrup (SACID)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 0.01318333 | 0.00188333 | 1.81 | 0.1546 |
| Error | 16 | 0.01666667 | 0.00104167 | | |
| Corrected Total | 23 | 0.02985000 | | | |

| R-Square | C.V. | Root MSE | SACID Mean |
|---|---|---|---|
| 0.441653 | 10.49589 | 0.032275 | 0.30750000 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 0.01318333 | 0.00188333 | 1.81 | 0.1546 |

Analysis of Variance Procedure

Dependent Variable: Soluble Solids of the Fruits (PCFSS)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 24.43656250 | 3.49093750 | 10.10 | 0.0001 |
| Error | 16 | 5.52833333 | 0.34552083 | | |
| Corrected Total | 23 | 29.96489583 | | | |

| R-Square | C.V. | Root MSE | PCFSS Mean |
|---|---|---|---|
| 0.815506 | 7.030872 | 0.587810 | 8.36041667 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 24.43656250 | 3.49093750 | 10.10 | 0.0001 |

Analysis of Variance Procedure

Dependent Variable: Soluble Solids of the Syrup (PCSSS)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 26.06239583 | 3.72319940 | 6.68 | 0.0008 |
| Error | 16 | 8.91500000 | 0.55718750 | | |
| Corrected Total | 23 | 34.97739583 | | | |

| R-Square | C.V. | Root MSE | PCSSS Mean |
|---|---|---|---|
| 0.745121 | 9.086887 | 0.746450 | 8.21458333 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 26.06239583 | 3.72319940 | 6.68 | 0.0008 |

Analysis of Variance Procedure

Dependent Variable: Soluble Solids/Acid Ratio of the Fruits (FRATIO)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 664.2736500 | 94.8962357 | 4.05 | 0.0098 |
| Error | 16 | 375.0013333 | 23.4375833 | | |
| Corrected Total | 23 | 1039.2749833 | | | |

| R-Square | C.V. | Root MSE | FRATIO Mean |
|---|---|---|---|
| 0.639170 | 15.92818 | 4.841238 | 30.3941667 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 664.2736500 | 94.8962357 | 4.05 | 0.0098 |

Analysis of Variance Procedure

Dependent Variable: Soluble Solids/ Acid Ratio of the Syrup (SRATIO)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 222.9836667 | 31.8548095 | 2.65 | 0.0505 |
| Error | 16 | 192.3817333 | 12.0238583 | | |
| Corrected Total | 23 | 415.3654000 | | | |

| R-Square | C.V. | Root MSE | SRATIO Mean |
|---|---|---|---|
| 0.536837 | 12.92172 | 3.467544 | 26.8350000 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 222.9836667 | 31.8548095 | 2.65 | 0.0505 |

Analysis of Variance Procedure

Dependent Variable: Texture of the Fruits as Measured by Food Technology Texture System (PCTEXT)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 8847.161116 | 1263.880159 | 5.22 | 0.0030 |
| Error | 16 | 3871.450915 | 241.965682 | | |
| Corrected Total | 23 | 12718.612031 | | | |

| R-Square | C.V. | Root MSE | PCTEXT Mean |
|---|---|---|---|
| 0.695607 | 26.48921 | 15.55525 | 58.7229583 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 8847.161116 | 1263.880159 | 5.22 | 0.0030 |

Analysis of Variance Procedure

Dependent Variable: Hunterlb L* Value (L)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
| --- | --- | --- | --- | --- | --- |
| Model | 7 | 17.03949583 | 2.43421369 | 0.27 | 0.9585 |
| Error | 16 | 146.32506667 | 9.14531667 | | |
| Corrected Total | 23 | 163.36456250 | | | |

| R-Square | C.V. | Root MSE | L Mean |
| --- | --- | --- | --- |
| 0.104304 | 5.757629 | 3.024122 | 52.5237500 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
| --- | --- | --- | --- | --- | --- |
| TREAT | 7 | 17.03949583 | 2.43421369 | 0.27 | 0.9585 |

Analysis of Variance Procedure

Dependent Variable: Hunterlb a* Value (A)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 21.37132917 | 3.05304702 | 5.49 | 0.0023 |
| Error | 16 | 8.89206667 | 0.55575417 | | |
| Corrected Total | 23 | 30.26339583 | | | |

| R-Square | C.V. | Root MSE | A Mean |
|---|---|---|---|
| 0.706177 | -23.09506 | 0.745489 | -3.2279167 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 21.37132917 | 3.05304702 | 5.49 | 0.0023 |

Analysis of Variance Procedure

Dependent Variable: Hunterlb b* Value (B)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 84.37374063 | 12.05339152 | 0.59 | 0.7529 |
| Error | 16 | 325.44598333 | 20.34037396 | | |
| Corrected Total | 23 | 409.81972396 | | | |

| R-Square | C.V. | Root MSE | B Mean |
|---|---|---|---|
| 0.205880 | 15.28640 | 4.510030 | 29.5035417 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 84.37374063 | 12.05339152 | 0.59 | 0.7529 |

Analysis of Variance Procedure

Dependent Variable: Color of the Fruits as Evaluated by 6 Panelists (COLOR)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 22.62502694 | 3.23214671 | 9.40 | 0.0001 |
| Error | 16 | 5.50001556 | 0.34375097 | | |
| Corrected Total | 23 | 28.12504250 | | | |

| R-Square | C.V. | Root MSE | COLOR Mean |
|---|---|---|---|
| 0.804444 | 10.12321 | 0.586303 | 5.79166625 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 22.62502694 | 3.23214671 | 9.40 | 0.0001 |

Analysis of Variance Procedure

Dependent Variable: Flavor of the Fruits as Evaluated by 6 Panelists (FLAVOR)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 13.48150130 | 1.92592876 | 4.66 | 0.0052 |
| Error | 16 | 6.61110778 | 0.41319424 | | |
| Corrected Total | 23 | 20.09260907 | | | |

| R-Square | C.V. | Root MSE | FLAVOR Mean |
|---|---|---|---|
| 0.670968 | 13.22335 | 0.642802 | 4.86111125 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 13.48150130 | 1.92592876 | 4.66 | 0.0052 |

Analysis of Variance Procedure

Dependent Variable: Texture of the Fruits as Evaluated by 6 Panelists (TEXTURE)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Model | 7 | 23.49996556 | 3.35713794 | 20.28 | 0.0001 |
| Error | 16 | 2.64815185 | 0.16550949 | | |
| Corrected Total | 23 | 26.14811741 | | | |

| R-Square | C.V. | Root MSE | TEXTURE Mean |
|---|---|---|---|
| 0.898725 | 7.708330 | 0.406829 | 5.27777833 |

| Source | DF | Anova SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TREAT | 7 | 23.49996556 | 3.35713794 | 20.28 | 0.0001 |

VITA

Rutcharin Limsupavanich

Candidate for the Degree of

Master of Science

Thesis: IMPROVEMENT OF QUALITY CHARACTERISTICS OF CANNED PEACHES

Major Field: Food Sciences

Biographical:

Personal Data: Born in Bangkok, Thailand, December 18, 1967, the daughter of Chong-hung Sae Lim and Hung-Juang Sae Lim.

Education: Graduated from Strividhaya School, Bangkok, Thailand, in February 1986; received Bachelor of Science degree in Animal Science, Faculty of Agriculture from Kasetsart University, Thailand in March, 1990; completed requirements for the Master of Science degree at Oklahoma State University in May, 1993.

Professional Experience: Assistant in Food Safety Project, Extension, Department of Entomology, Oklahoma State University, June, 1991 to February, 1992; Research Assistant, Department of Nutritional Sciences, Oklahoma State University, August, 1992, to May, 1993; Member of the Institute of Food Technologists.