

Title for paper: Quality and Vitamin C Changes during Storage of Lime Juices
in Northern Thailand.

Key words: Lime juices, Vitamin C, Storage

Name of author: Miss Wanicha Supraditaporn¹
Asst. Prof. Dr. Wissanee Supraditareporn²

Mailing address:

¹ Pharmacist, Professional level Ministry of Public Health
Uthai Thani Provincial Public Health Office, Muang District,
Uthai Thani 61000 Thailand.

² Division of Agro-Industry, Chiang Mai Rajabhat University
202 Chang Phuak Road, Muang Chiang Mai, 50300 Thailand.

Phone number: 66 86 7359919

E-mail: wanichas@hotmail.com¹
wissanee.sup@gmail.com²

ABSTRACT

The research was conducted to study the keeping quality and Vitamin C changes during storage of lime juices in Northern Thailand to solve the problem of lime surplus in season. Nowadays, most Northern Thai consumer directly squeezed juice from fresh limes. Lime juice is a sort of vitamin C content and unique sour taste. Consumption of vitamin C has long been known to be correlated with maintaining a healthy body. Lime juice is usually purchased in glass bottles, plastic or flexible containers that are kept in refrigerators or in boxes containing ice cubes or at room temperature. Lime juice had total soluble solid 8.86 ± 0.12 brix, pH 2.87 ± 0.06 , titrable acidity (as citric acid) 7.19 ± 0.44 and ascorbic acid (or Vitamin C) 33.18 ± 0.16 mg/100 ml. Lime juice quality depends on the raw material, processing condition and storage condition. Furthermore, the lime juice quality at 4°C, -18°C and room temperature (25°C) were evaluated. It was observed that 4°C and -18°C, the lime juice still had a good quality throughout the storage time; however ascorbic acid content was reduced. It was found that the end of storage time at each temperature condition should be in 1 day at room temperature and more than 30 days at -18°C.

Introduction

Lime (*Citrus aurantifolia*) is one of important products in Thailand. Lime is an excellent source of vitamin C. Consumption of this vitamin has been correlated with a reduction in the incidence of certain cancers (Vinson *et al.*, 2002). Beside these researches, Kabasakalis *et al.* (2000) found that if the juices stored in open containers in a refrigerator for 31 days, the ascorbic acid loss was around 60 to 67%. Lime juices had a great specialty on its colour, flavour, taste and nutritional contents.

Production of limes in Northern Thailand can be done under a wide range of climatic conditions. Lime occupies large growing area in Thailand and was produced as high yield. Lime spoilage under the hot ambient temperature of tropical climates. Post harvest losses in lime fruits have been observed too much due to which fruit loses its quality (Tariq *et al.*, 2001a). Lime juice quality depends on the raw material, processing conditions, storage conditions and packaging materials. The usual practice washing of fruits after harvest was an effective method for remove spores from the surface of fruits (Tariq *et al.*, 2001b). Storage temperature was the prime limiting factor for shelf life of this product. Much work had been done on the development, pasteurization, characterization and nutritional of lime juice but there is no reported study of the specific chemical properties of the fresh lime juices after production and during their storage periods at different storage temperatures. Thai people consume 3 liters/head/year of all fruit juices. According to market research carried out in Thailand (Thailand Institute of Scientific and Technological Research, 2004). Although there had some commercial lime juice sold in local market, they are not 100% natural lime juice because some artificial acids and flavours are mixed into them.

The Objectives

The purpose of this research was to study quality and vitamin C changes during storage of lime juices. Survey the background of lime juices production consumer behavior and the effect of temperature on the keeping quality of the fresh lime juices prepared from some Thailand communities, to solve the problem of lime surplus in season.

Research Methodology

1. The research was conducted to study the keeping quality and Vitamin C changes during storage of lime juices.

2. Survey the background of lime juices production and consumer behaviour in some Northern Thailand communities, do intensive interview using questionnaires, statistical analysis by percent, means and present in descriptive report. Consumer survey questionnaires which had 2 parts, general and specific information about lime juice product with 200 consumers in some Thailand communities. The general information was gender, age, education, career and income. For the specific information were all question about lime juice products include type of products and frequency of consuming. The consumers were selected by random sampling.

Raw materials

Lime juice was prepared from fresh. Samples were obtained from a local market in Northern Thailand during the harvest season. Random sample of a uniform size and colour were taken. Squeezed juice from fresh limes with stainless press. The lime juice was filtered to remove its pulp. Samples of the filtered juice was placed in a sterilized bottle and kept for all the experiments in this study.

Fresh lime juice was prepared at 3 different storage temperatures 4, -18°C and at room temperature (25°C). Subsequently, the lime juice was analyzed for Vitamin C and chemical properties.

Methods

Chemical Composition analysis: Lime juice was extracted and analyzed pH, total soluble solids, titratable acidity and ascorbic acid.

Total soluble solids (TSS) of lime juices were measured by a hand refractometer (Atago, Japan) and corrected to the equivalent reading at 20°C (AOAC, 1995).

The titratable acidity (TA) was measured by diluting 10 g of the lime juice with 250 mL distilled water and titrated against 0.1 N NaOH to a pH 8.1 as the end-point by using a pH meter (AOAC, 1995) and expressed in g acid per 100 mL based on citric acid. Ascorbic acid (Vitamin C) was determined by the methods of (AOAC, 2000).

Measurements were done in triplicate.

Research Result

1. The research was conducted to study the keeping quality and chemical changes during storage of lime juices

Fresh lime juice had total soluble solid 8.86 ± 0.12 brix, pH 2.87 ± 0.06 , titrable acidity (as citric acid) 7.19 ± 0.44 and ascorbic acid 33.18 ± 0.16 mg/100ml (as presented in Tables 1).

Table 1 - *Composition of lime juice used as raw material*

Chemical analysis	Assay
Total soluble solid (brix)	8.86 ± 0.12
pH	2.87 ± 0.06
Titrable acidity (as citric acid)	7.19 ± 0.44
<i>Ascorbic acid</i> (mg/100ml)	33.18 ± 0.16

Note: Values are means \pm standard deviations.

Table 2 - *Composition of Ascorbic acid (mg/100ml) in lime juice*

Storage time(day)	Storage temperature (-18° C)	Storage temperature (4° C)	Storage temperature (25° C)
0	33.18	33.18	33.18
1	33.13	31.49	19.67
2	33.10	29.21	ND
3	33.03	26.16	ND
6	31.20	24.78	ND
9	29.21	25.54	ND
12	28.45	12.44	ND
15	28.29	12.34	ND
18	24.72	ND	ND
21	22.65	ND	ND
24	22.18	ND	ND
27	20.80	ND	ND
30	19.86	ND	ND

Note: Ascorbic acid in lime juice (mean from 3 replicates)

ND = Not detectable

Lime juice was prepared at 3 different storage temperatures 4, -18°C and at room temperature (25°C). Subsequently (as presented in Tables 2), the lime juice was analyzed for ascorbic acid (mg/100ml). It was found that the vitamin C content decreased during storage of lime juices. It was observed that 4°C and -18°C, the lime juice still had a good quality throughout the storage time; however ascorbic acid content was reduced. It was found that the end of storage time at each temperature condition should be in 1 day at room temperature and more than 30 days at -18°C. Unfortunately, the concentration of this vitamin was reduced during storage of the juices (Li *et al.*, 1989; Lee and Coates, 1999; Johnston and Bowling, 2002).

2. Survey the background of lime juices production and consumer behavior in some Thailand communities by field trip, do intensive interview using questionnaires, statistical analysis by percent, means and present in descriptive report.

The consumer survey with 200 consumers found that the consumer was difference in gender, age, and income. The 51% of consumer was female and 49% of consumer had bachelor degree they had income 6,000-18,000 Bath per month. The reasons that consumer decided to purchase lime juice because of its high vitamin C content and desirable flavour. Lime juice is usually purchased in plastic bag, glass jars, bottle or flexible containers that are kept in refrigerators or in boxes containing ice cubes or at room temperature.

Demographic Data of Respondents

The demographic data of the respondents was analyzed by gender, age and educational level (as presented in Tables 3, 4 and 5).

Table 3 - *Amount and Percentage of Respondent's Samples by Gender*

Gender	Amount	Percentage (%)
Male	98	49
Female	102	51
<i>Total</i>	200	100

As shown in Table 1, the highest number and percentage of respondents based on gender was female (102 persons [51%]) male (98 persons [49%]), respectively.

Table 4 - *Percentage of Respondents by Age*

Age	Amount	Percentage (%)
61 years old and over	32	16
21-60 years old	104	52
Below 20 years old	64	32
<i>Total</i>	200	100

As shown in Table 4, the respondent samples in highest number (104 persons [52%]) between 21-60 years of age ; followed by respondents representing 20 years of age or below were (64 persons [32%]); and lastly, ages older than 61 years were ; (32 persons [16%]).

Table 5 - *Respondents by Educational Level*

Educational level	Amount	Percentage (%)
Higher than bachelor degree	40	20
Bachelor degree	98	49
High school	62	31
<i>Total</i>	200	100

As shown in Table 5, the highest number of respondents was 98 persons (49%) having bachelor degrees; second highest respondent group was 62 persons (31%) having high school degrees; and lastly, 40 persons (20%) having higher degrees than bachelor degrees.

Conclusion

Quality of lime fruits determines juice quality. Using mature and good quality lime fruit is critical to process high quality lime juice. Limes are non-climacteric fruit, meaning that they do not ripe any more after harvest. Therefore, fruit must be ripe on the tree and harvested at a time when sugar content, acidity, colour and flavour are best for juice processing. During harvest, transportation, and storage the fruit must be carefully handled to maintain freshness and quality. For example, in storage, the temperature, humidity and cleanliness should be controlled to prevent fruit decay and damage caused by bacteria, molds, yeasts, insects, and other pests. (Jian Yang, 2016)

The research was conducted to study the keeping quality and chemical changes during storage of lime juices in Northern Thailand to solve the problem of lime surplus in season. Nowadays, most Thai consumer directly squeezed juice from fresh limes. Although there had some commercial lime juice sold in local market, they are not 100% natural lime juice because some artificial acids and flavors are mixed into them. Lime juice is a sort of vitamin C content and unique sour taste.

Storage temperature was the prime limiting factor for shelf life of lime juice. However various effects of low temperatures on the keeping quality of the fresh lime juices can be considered to make freshly lime juice economically feasible to market. Their safety and shelf life were considered in terms of microbiological registration and their chemical changes.

Survey the background of lime juices production and consumer behavior in some Northern Thailand communities the recent trends show that the consumer preference towards un-pasteurized lime juice is increased due to its superior taste, aroma and nutritive values. Moreover, they suggested that their safety and shelf life of lime juice were considered. Lime juice quality depends on the raw material, processing conditions, storage conditions and packaging materials. They suggested that the cost of lime juice should not expensive as a consequence of their income.

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