A STUDY ON THE PROCESSING AND PRESERVATION OF GINGER JUICE

A Thesis

By

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Student ID. 1105026
Registration No. 1105026
Semester: January – June, 2012

MASTER OF SCIENCE (MS)

IN

FOOD ENGINEERING AND TECHNOLOGY

Department of Food Engineering & Technology
Hajee Mohammad Danesh Science & Technology University, HSTU
Dinajpur

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DEDICATED TO

OUR BELOVED PARENTS

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ABSTRACT

The study was concerned with the juice of ginger and shelf-life analysis of ginger juice. The fresh ginger and ginger juice were analyzed for proximate composition, microbiological status, sensory attributes and overall storage stability. Fresh gingers were processed in sugar and other preservatives. The proximate composition of fresh ginger was moisture content 87.4%, protein content 1.6%, fat content 0.8%, ash content 1.0%, and vitamin-C 4 mg/100gm.The developed juice showed that proximate compositions were reduced slightly in all the samples. Vitamin-C content decreased in all the samples. This vitamin was lost by oxidation and heat following first-order kinetics which stated that concentration has exponential relationship with time. The microbiological studies revealed that total viable counts (bacteria, yeast and mould) were a small in juice. The acceptability of processed juice was evaluated by the panelists using 1-9 hedonic scale. The panelists tasted the products and assigned marks for color, flavor, pungency and overall acceptability. The mean score for color , flavor, pungency and overall acceptability showed secured score within the acceptable limit ranging from 6.30 to 8.0, ranking' like slightly' to' like very much'. Storage studies were carried out up to four months at room temperature (25°C). The interval was 15 days up to first two months and one month interval for the next two months. Ginger is an important crop in our country mainly as spices. We should encourage the processing and preservation of juice commercially in our country. Thus we can help to improve our national economy as well as life style.

LIST OF CONTENTS

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Ginger (*Zingiberofficinale*) the underground rhizome of the *zingiberousherbaceous* plant, is originated in the Southeast Asia. In Bangladesh, it is known as 'Ada'. It is one of the earliest oriental spices knownto Europe and is still highlydemand in today.

The largest ginger producing country is India, which produces about 50% of the world's total production and is the largest exporter. Other important producers are China, Taiwan, Nigeria, Sierra Leon, Jamaica, Thailand and Australia. Those countries importing the biggest amounts are the United Kingdom, United States and Saudi Arabia (Purseglove, 1972). In Bangladesh, ginger grows well in Rangpur, Nilphamari, Khulna, Rangamati, Bandarban and Khagrachori districts and the total area of cultivation and the annual production of ginger were 31,000 acres and 45,000 metric tons respectively (BBS, 2011).Ginger requires warm and humid climate for better growth and it is well suited for the cultivation in hilly region. Its sowing period is March-May and harvesting period, November- December of the year.

The aroma of ginger is pleasant and spicy and its flavor penetrating and biting due to presence of antiseptic or pungent compounds, which make it indispensable in the manufacture of a number of food products like ginger bread, confectionery, ginger ale, curry powders, certain curried meats, table sauces, in pickling and in the manufacture of certain soft drinks like cordials, ginger cocktail, carbonated drinks, bitters etc. Ginger is also used for the manufacture of ginger oil, oleoresin, essences, tinctures etc (Pruthi, 1998).

Ginger is seasonal in nature and available in large quantities during the peak season in the local market. But this is a perishable commodity and cannot be kept as a fresh commodity for longer time after harvesting. In relation to spice and/or food, we have two major problems in Bangladesh. One is insufficient production and the other is post harvest losses. If spoilage/post harvest losses could be reduced to an acceptable level by proper preservation: farmers would get proper price of their products and thus be encouraged to increase yield and production. Only a small portion of ginger produced is

processed and preserved by housewives and small processors by traditional method like sun drying.

The dried ginger is usually utilized in the form of powder. The fresh ginger is used as paste prepared by grinding ginger on stone-slab by grinding stone. The pastes prepared from various spices are always preferred due to their original flavor and pungency than the dried powder. However, these pastes must be used fresh and this paste deteriorates quickly. Moreover, preparation of these pastes is time consuming and laborious. On the other hand the powders from ginger and other spices are easy to adulterate with worthless material which only increases bulk to the spice but add nothing else and this makes it more important for the buyer to deal with an established reputable spice manufacturer. Moreover, the aroma and strong pungent, flavor is due to the presence of essential oils, evaporate quite quickly during storage particularly if the spice has been ground.

The ginger juice, as a convenience food ingredient, may find its widespread use in the industry. The catering industry is itself made up of a variety of outlets such as hotels, restaurants, canteens, hospitals, nursing homes, school meals and prisons. Higher incomes and more active life styles in recent years have resulted in consumers seeking high quality, convenient food items in the markets. The ginger juice, for its anticipated widespread use, may help fill the needs of consumers for a convenient food ingredient.

Considering the above facts the present investigations was undertaken with the following objectives:

1. To prepare ginger juice from fresh ginger
2. To study the shelf life of ginger juice.
3. To study the effect of different types of preservatives.

CHAPTER II

REVIEW OF LITERATURE

Information on utilization of ginger in the form of pastes is very limited or unavailable. Some literatures are available on the cultivation, production, composition, properties, form of utilization and processing of different spices including ginger. This reviews mostly concerns summarization of information relevant to the present study.

Ginger and its composition

In Bangladesh, ginger is widely used as spice. It has high medicinal value and used in Allopathic and Hamdard medicine (Parry, 1969).

Anonymous (1989) reported that the proximate nutrient composition of (per 100 mg) ginger are moisture 80.9 gm, minerals 1.2 gm, fiber 2.4 gm energy 67 kilocalories, protein 2.3 gm, fat 0.9 gm, calcium 20 mg, iron 2.6 mg, carotene 40 µgm, vitamin B1 0.06 mg, Vitamin B2 0.03mg and Vitamin-C 6 mg.

Dubichev *et al.* (1991) reported that the mean biologically active compounds found in the rhizome were salidroside, rosiridin and the cinnamyl glycosides rosavine, and rosine. The content of rosavin in fresh rhizomes from roseroot stonecrop plants cultivated in Moscow province was 2%. This decreased rapidly during storage of rhizomes, during pulping and extraction owing to auto fermentation, reaching e.g.0.29% after 30 min at 40 °C. Negligible change occurred in the contents of the glycosides or rosanin, whose only difference from rosavin is that its terminal arabinose residue is furanose rather than pyranose.

John and Ferreira (1997) reported statistically significant differences ($p<0.05$) in mass in fresh rhizomes, moisture and crude fiber content but not in the oleoresin and ginger oil content. In Brazilian ginger, the mass of fresh rhizonies with high moisture contents but lowest in the crude fiber on wet basis. In Taiwan ginger, they recorded that a high crude fiber content of 6.8% on dry basis the best results in terms of oleoresin (3.06%) and oil (0.52%) contents. However the dry ginger recovery was highest (27.5%) with West Indies ginger. Thus among these studied Brazilian ginger gave better results for early harvesting

ginger industry. For the drying and extraction industries respectively, the selections West Indies ginger and Taiwan ginger are preferable.

Koketsu, *et al.* (1997) conducted studies on 2 grades of ginger produced in Brazil. Ginger (large rhizomes) and caliper (small rhizomes). Data are given for proximate composition volatile and nonvolatile extract content of the rhizome essential oil yield, and density, refractive index, optical rotation and composition of the essential oil. These 2 ginger types deferred in properties of the rhizome and essential oil. Brazilian ginger essential oils tended to gave a lemon aroma note, attributable to presence of citral, this aroma note was more marked for gigantic than for caliper samples and paroled differences in citral content. No evidence of varieties within the gigantic troop was observed.

Leung *et al.* (1972) reported that the proximate nutrient composition of (per 100 gm) ginger are food energy 46 cal, moisture 87.4 gm, protein 1.6 gm, fat 0.8 gm, total carbohydrate 9.2 gm, ash 1 gm, calcium 19 gm , phosphorus 32 mg, iron1.3 mg, potassium 316 mg, beta-carotene equivalent 55 µg, thiamine 0.01 mg, riboflavin 0.03 mg, niacin 1.7 mg, ascorbic acid (Vit-C) 4mg. Dry ginger has the composition of food energy 301 cal, moisture 10.2 gm, protein 7.6 gm, fat 2.9 gm, total carbohydrate 72.4 gm, as 6.9 gm, calcium 180 mg, beta-carotene equivalent 120 µg, thiamine 0.16 mg, riboflavin 0.27 mg, niacin 8.4 mg, ascorbic acid (Vit- C) 0 mg.

Macleod and Pienis (1984) examined Sidda and Chinese varieties and prepared essential oils of both fresh and dried samples. Both varieties had relatively high oil content (between 1.8 and 4.3%) and total aroma volatiles (about 5 mg/g for dried samples).Analysis showed terpenes were the main aroma components. A number of the identified volatiles have not previously been reported, including trans-beta-ocimene, ethyl alcohol, terpinen-4-01 myrtenal. Guanene, alphacubene, delta-cadinene and farnesol were found.

Nambudri *et al.* (1975) found that commercial dried gingers have been reported to provide oleoresins in yields of 3.5-10% and to contain 15-30% of volatile oil (Wintertonand Richardson, 1965, Connell, 1970 Lewis et al., 1972; Baves, 1974). The pungent principle content of the oleoresins in again less certain owing to short comings in analytical methods but it is believed to be in the range of 17-30% for fresh extracts.

Natarajan *et al.* (1972) reported that in 26 verities of ginger, ranges were volatile oil 1 to 2.7, acetone extract 3.9 to 9.3, crude fiber 4.79 to 9.8 and starch 40.4 to 50%. Contents of first 3 increased steadily from September to December. Peeling for 60s in abrasive peeler was conductive to the production of high grade ginger, but hand peeled ginger was better in uniform size and color. The optimum temperature for drying of ginger was 60°C.

Nobrega, *et al.* (1977) reported the chemical composition of ginger (*Zingiber offcinale Roscoe*) essential oils extracted either with ethanol, isopropanol or supercritical CO_2 was determined and compared. Frozen ginger was cut, ground in a domestic food processor and dried to 14% moisture particle size distribution was determined in a sieve shaker with 648 mesh sieves organic solvent extraction was carried out in supplicate for 1-6 hours with constant shaking, using 10 gingers and 10-100 ml solvent. Ethanol and isopropanol extracts (2 hours) had the same composition (irrespective of solvent vol), and contained monoterpines, sesquiter penes and fatty acids. After 1 and 2 hour CO_2 of extraction, concentration of gingerol was much higher (14.07 and 80.71% of total extract respectively) than in the ethanol and isopropanol extract (1.32-3.81%). It is suggested that the much higher gingerol concentration of the 2 hours CO_2 extract could be due to a vacuum pressure effect during depressurization of the system which could have promoted cell rupture and gingerol extraction.

Pruthi (1998) found that dry ginger has the composition of moisture 6.9%, protein 8.6%, fat 6.4%, fibre 5.9%, carbohydrate 66.5%, ash 5.7%, calcium 0.1%, phosphorus 0.15%, iron 0.011%, sodium 0.03%, potassium 1.4%, vitamin A 175 IU/100 gm, Vitamin B1 0.05 mg/100 gm, Vitamin B2 0.13 mg/ 100 gm, niacin 1.9%, vitamin-C 13 mg/ 100 gm. and calorific value (food and energy) 380 k cal/100 gm.

Purseglove *et al.* (1988) found that the crude fiber content of unpeeled may be as high in the range of 1.5-6.0 %. The volatile oil content of commercial dried gingers has been reported to be 0.5-4.4% but for the major types the range is usually 1-3%. The abundance of the pungent constitute, the gingerols, in dried ginger is less certain owing to inadequacies in current analytical methods, but it is probably in the range of 1-2% for freshly prepared commercial dried ginger.

Salzer (1975) has reported that the fatty acid of oil in dried sample contained saturated and unsaturated fatty acids in a ratio of 46:53; and the major component acids were found

to be palmitic, oleic and linoleic acids, each having a relative abundance of about 23 percent. By Singh et al. (1975) revealed a predominance of saturated acids in the fatty oil, and linolenic acid as the major individual fatty acid. The second subject concerns the flavour of preserved ginger. Leveringtan (1969) has attributed the characteristic fermented foavour of Chinese ginger to yeast formation which proceeds either during the syruping stages or during the subsequent storage period.

Processing of ginger and other spices

Ahmed *et al.* (2002) reported that processed garlic paste was prepared from fresh garlic so that a convenient, shelf stable product with fresh garlic odour could be manufactured. The prepared paste contained 10% sodium chloride with a pH value of 4.1. The product was thermally processed at selected temperatures (60, 70, 80 and 90 °C) for a residence time of 15 min and stored at 10 ±2 °C. The effects of thermal treatment and storage of the product on the Hunter color values (lightness index, L; greenness and redness, a; and yellowness and blueness, b) were studied. Among various color combinations Lab described well the variation of total color with process temperature and storage period.

Alam (2003) conducted a feasibility study on the preparation of turmeric paste and observed the effects of preservatives (KMS and sodium benzoate) on the keeping quality of turmeric paste. The study showed that turmeric paste trated with 0.5% or 1% citric acid plus 1000 ppm of sodium benzoate of mixed preservatives, when stored in polyethylene bag or plastic bottle at room temperature, were acceptable up to 120 days of storage. The refrigerated storage extended the shelf life of turmeric paste up to 180 days when treated with 1000 ppm sodium benzoate plus 1% citric acid in both polyethylene bag and plastic bottles. Thus turmeric paste was found more stable in both room and refrigerated storage using 1% citric acid plus 1000 ppm sodium benzoate. The study showed that turmeric paste without any preservative could be kept up to 9 days only in polyethylene bag and 15 days in plastic bottle at room temperature.

Anonymous (1953); Sundaram, (1960) reported that the ginger was bleached with sulphur. For this, ginger after liming but before the final drying, was treated with sulphur dioxide, and produced by burning sulphur in specially constructed rooms, thus providing a white product. However, this practice has now been abandoned, due to high cost of sulphur and to the prohibition by importing countries of sulphur dioxide residues in the

spices. Bleached ginger is favoured in Middle East countries and also in India, whereas in European and American market the unbleached spice is preferred.

Anonymous (1970) published a more general standard for 'Ginger whole, in pieces, and ground', BS 4593, based on the International Standards-organization Recommendation R. 1003, published in 1969. In this, the ginger whole and in pieces, is described as the dried peeled or unpeeled rhizome of *Zingiber bffmale Roscoe*, in pieces irregular in shape and not less than 20 mm I length or in small cut pieces, very pale buff to pale brown in color, fibrous, either clean peeled, separated or coated, washed and dried in the sun. The ginger may be garbled by removing pieces that are too light, and it may also be lime bleached. The ginger whole and in pieces may be graded on the basis of its size, place of production, fiber and fibrous content and the method of treatment of the rhizomes.

Bhuyan *et al. (1990)* conducted investigation on the Siliguri variety of ginger in order to study its drying characteristics. The quality of dried ginger was also evaluated by determining its volatilw oil and oleoresine content. A small capacity tray dryer was designed and built and its performance tested. The heat utilization factor, coefficient of performance, overall thermal efficiency and uniformity of drying of sliced ginger on each of the trays were determined. The dryer performed satisfactorily. The air temperature of 60 °C was found to be the most suitable for drying ginger slices.

Brown and LIoyod (1972) carried out exploratory investigation into the storage of ginger in acidified sodium metabisulphite solution and in salt brine with and without fermentation. The main conclusion was that the use of an acidified sodium metabisulphate solution led to excessive losses of sound ginger. However, the use of equilibrium 16% salt brine with 1.0% acid or 0.5 sulphur dioxides resulted in an overall gain in drained weight of ginger after syruping. The inclusion of sulphur dioxide in the brine served to prevent the development of a brown color in the ginger syruping (Maillard reaction), which was the normal feature in Chinese ginger. Ginger from those two brine treatments was preferred on the basis of its much higher recovery, crisp texture and more desirable flavor.

Gupta (1974) stated that among the exotics, 'Ta-kuang' and 'Chu-Chiang' and popular cultivars from Taiwan, known for their soft, almost fibreless ginger and are in large demand for the production of ginger preserve. Investigations of harvesting have shown

that the green ginger crop is ready from the fifth month after sowing. It has been observed that the contents of crude fiber, total lipids and protein change at different stages of ripening and green ginger, for use as a fresh vegetable or for preserving, should be harvested within 195 days of planting out. After this stage, the crude fiber increase and the fat and protein contents decrease.

Gupta (1974) gave a very brief resume of the process of ginger preservation in syrup, which showed clearly that the Indian industry has profited by the Australian researches. The fruit preservation and

Kulahrestha *et al.* (1972) reported that for oil based and vinegar based pickles, raw gingers had high microbial counts and pathogens. Cooked ginger, salt, garlic, mustard oil and vinegar showed no viable bacteria. Ginger contained 3x 102 yeast or moulds/gm dhanya, red chilies, clove and cinnamon, black pepper, jeera and snof contained 52*105, 62*103, 94*105, 14*103, 31*106 and 7*102 total plate counts respectively. The decontamination of the ingredient prior to food preparation and changes to food processing practice were able to reduce microbial contamination to very low levels.

Kumar *et al.* (2000) stated that traditionally turmeric is processed by boiling whole rhizomes in water after harvest for about 45 minutes to one hour followed by sun drying which normally takes about 10 to 12 depending upon the place of cultivation. Astudy was carried out in Myladumpara, Kerala, India during 1998 and 1999 seasons to evaluate the effect of different processing techniques on the recovery of total curcurnin for two of the high yielding varieties with high curcurnin content viz. Prabha and Prathibha, collected from Peruvannamuzhy farm of tile Indian Institute of Spices Research.

Okwuowulu and Nnodu (1988) observed that yellow ginger giwa was harvested 4,5,6,7 and 8 months post planting and dipped in 750 ppm (active ingredient) benomy (BL) or 150 ppm gibberellc acid or water. Dipped rhizomes were air dried for 24 hours then packed in most sawdust (67% moisture, maintained by sprinkling with water) and examined dipping in BL or GA controlled rotating but no weight loss or spouting. BL or GA was most effective in inhibiting all deteriorative changes. Harvest data significantly effected storage quality. Six months post planting being the optimum storage for harvest.

Mantri and Agarwal (1991) reported that the multistage dehydration process reduced the drying time if the single stage process while improving or at least maintaining the quality of dried ginger. Volatile oil, oleoresin and crude fiber were statistically significant biochemical factors for quality determination of ginger powder. Total ash was a non-significant factor. All the organoleptic quality factors and consumer acceptance were statistically significant. Ginger may be dehydrated at 85 °C up to a moisture content 50% (wb) during the first stage and then be dried at 65 °C up to moisture content 12% (wb) for reducing drying time and maintaining quality of ginger.

Mariah *et al.* (2002) reported that antioxidative effects of ginger extract on suimi during frozen storage. A study on the efficiency of ginger collected from Malaysia as an antioxidant was conducted on fish surimi stored chilled at 4 °C for 6 says and at frozen temperature of 18 °C for 6 weeks. Changes in antioxidant activity value (AOA), thiobarbituric acid value (TBA) and total polyphenols were evaluated. Three treatments were tested, control (T_1) was scrim without ginger, T_2 was scrim with extracted ginger and T_3 was scrim with minced ginger with both having a fixed concentration of 800 ppm. AOA values of ginger treatments T_2 and T_3 were significantly reduced during frozen and chilled storage when compared to values of control (T_1). Extracted ginger (T_2) showed the most desirable result for TBA values in both chilled and frozen treatments followed by T3 and T1 respectively. This study indicated that ginger extracts had properties, which enhance preservation of chilled and frozen scrim, based from deterioration values derived from TBA test.

Mukhedee *et al.* (1995) reported that storage of ginger at 25-30 °C in closed polyethylene bags reduced weight loss but increased sprouting and rooting which could be prevented by gamma irradiation. Rotting caused by *Sclerotiun* (Corticium) *rolfsii* was, however a major cause of spoilage during extended storage. The efficacy of the antagonist was demonstrated rhizomes under simulated market conditions using artificially inoculated rhizomes. The recommended procedure consists of dipping washed air dried rhizomes in Tricoderma suspension air-drying, packing in 250 gauge LDPE bags followed by irradiation, gamma. Rhizomes thus treated remained in good marketable condition for up to 2 months at ambient temperature without sprouting loss of quality and <5% weight loss.

Richardson (1967) carried out controlled storage tests on whole sliced ginger and ground ginger packed in several forms of multi-wall paper bags, the most likely package for commercial use. He determined the contents of volatile oil and oleoresin for all samples at the end of each month for five months. The results indicated that there was no significant change in oleoresin content in either the sliced or ground products. Packages of sliced ginger were found to have retained their full oleoresin and volatile oil contents, but the oil contents of all samples of ground ginger decreased by about 50%.

Seely (1975) reported that the fresh ginger were cured at 25-35 °C and RH 83-93% for 1-7 days, then stored at 12 °C/RH 95%. As cunning time increased weight loss on storage increased. As RH increase, weight loss decreased. Mould growth observed under all condition was especially prevalent at 35 °C and higher curing times. Main components affecting non-enzymatic browning in stored ginger pastes were examined in 5 model solution stored at 40 °C for 30 days. Sugars, organic acids, ascorbic acid, amino acids and gingerols were monitored during storage.

Shams-Ud-Din *et al.* (2001) conducted a feasibility study on the preparation of chili paste and observed the effects of preservatives (KMS and sodium benzoate) on the keeping quality of chili paste. The study showed that chili paste packed in polyethylene bags with 750 ppm of KMS or sodium benzoate could be preserved for 21-28 days at room temperature. The chili pastes without preservative got spoiled within 2-3 days. This investigation opens the further possibility of conducting detailed work involving chili and other spice pastes, various packaging materials, other preservatives at different concentration and combinations, different storage temperatures, effects of different treatments on the composition of the products and other aspects.

Yoon Hee *et al.* (1995) observed that drying ginger in the sun improved its qualities but took longer time than that of in hot air. As the temperature of hot air increased, browning of ginger slices increased, Sun drying was better than hot air drying in respect to the sensory test of color, flavor and taste of powders. Sulphating pretreatment minimize browning and microorganisms in dried ginger. Storing ginger powder in polyethylene, polypropylene and glass bottles at low and room temperature, moisture content, browning and caking increased with storage time but total sucrose content decreased during 10minths of storage. Without packaging moisture content of powders reaches equilibrium within a short time at RH <5% relative humidity and higher temperatures. Powder of

larger particle size had higher moisture content. Growth of moulds began at RH>84% and temperature>35 °C. Higher temperature and relative humidity gave more browning and caking of ginger significant. Ginger might be dehydrated at 85 °C up to a moisture content 50% (wb) during the first stage and then be dried at 65 °C up to moisture content 12% (wb) for reducing drying time and maintaining quality of ginger.

Zainun *et al.* (2002) observed that storage stability of ginger paste convenient and shelf stable ginger paste with the odor characteristics of fresh ginger was developed. The paste was drawn at random, immediately after pureeing and periodically during subsequent storage for color, odor and pungent taste. This product was found to have a fair life under refrigeration but degradation of color, odor and taste made the ginger paste unacceptable one week after storage at ambient temperature. Studies on utilization of ginger paste in some Malaysian cuisine were also conducted.

Technological investigations were commenced by Liverington (1969) and continued by Brown (1969) and Brown and Lioyd (1972), they including the correct time of harvesting quality, grading, the techniques of ginger storing in brine and in sodium metabisulphite, softening and cooking methods of preparation of the syrup investigation of the vat system hy which the ginger is processed, effects of syrup temperatures flow rates and the sucrose reducing sugar ratio on processing, the techniques of processing and syrup concentration for obtaining the maximum dried weight of syrupy ginger with the minimum shrinkage.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted in the laboratory of the Department of Food Engineering and Technology, Hajee Mohammad Danesh Science & Technology University, Dinajpur from June 2011 to July 2012.

3.1 Materials

The ginger (*Zingiberofficinale*) collected from the local market was used in the thesis experiment. Preservatives such as potassium metabisulphite (KMS, $K_2S_2O_5$), sodium benzoate (C_6H_5-COONa), citric acid, and other chemicals were used from the laboratory stock. Polyethylene terephthalate (PET) and plastic bottles were used as packaging materials. The capacity of each bottle was 100 ml.

3.2 Apparatus Required

i. Blender
ii. Filter cloth
iii. Saucepan
iv. Measuring cylinder
v. Pipette
vi. Oven

3.3 METHODS

Fresh raw ginger was selected and washed with water properly. Then extracted the juice by using blender and then filtered with cloth by pressing hand. After juice extraction these were measured in a ratio of (1.22:1) water: sugar and made syrup of sugar, water and citric acid. Then boiled the juice at 80-90 °C and after that added the KMS and bottled.

The experiment was examined with three samples which vary with the amount of water and sugar and preservatives.

Table 3.1: Various ingredients of ginger juice in various samples

Ingredients	S-1	S-2	S-3
Juice (ml)	85	75	75
Water (ml)	150	160	170
Sugar (gm)	35	25	15
Citric acid (ml)	1.50	1.50	1.50
KMS (gm)	30	40	50

3.4 Flow chart for ginger juice preparation:

Selection of raw ginger

↓

Washing

↓

Boiling at 80-90 °C for 5 minutes

↓

Extraction of juice at 30 °C

↓

Filtration of juice with 20 meshes

Contd...

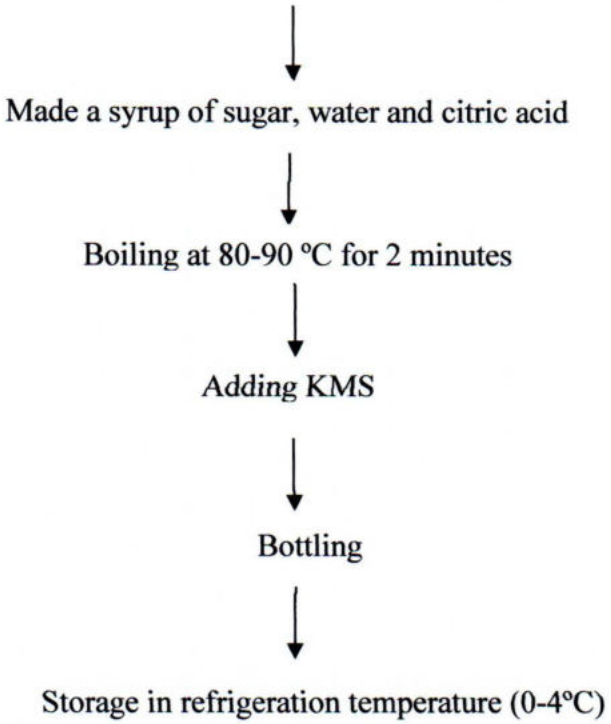


Figure 1: Flow chart of ginger juice preparation

3.5 Proximate Analysis of Ginger

3.5. 1. Determination of moisture content

Moisture content was determined adopting AOAC (2001) method.

Procedure

First of all, weight of empty previously dried (1 hour at 100°C) crucible with cover was taken and 10g of sample was placed on it. Then the crucible was placed in an air oven (thermostatically controlled) and dried at temperature of 100°to105°C for 24 hours. After drying, the crucible was removed from the oven and cooled in desiccators. It was then weighted with cover glass. The crucible was again placed in the oven and dried for thirty minutes, took out of the dryer, cooled in desiccators and weighted. Drying, cooling and

weighing were repeated until the two consecutive weights were the same. From these weights the percentage of moisture in different samples was calculated as follows

$$\% \text{ moisture} = \frac{Lossin Weight}{Weight of Sample} \times 100$$

3.5. 2. Determination of ash

AOAC method (2001) was used to determine the total ash content.

Procedure

2 ml sample was taken in a dry, clean porcelain dishes and weighted accurately. Hot air oven method was applied to remove the moisture. Then the sample was burned using an electric heater. This was done to avoid the loss of sample in the muffle furnace at higher temperature of 550°C and ignited until light gray ash resulted (or to constant weight). The sample was then cooled in a desiccators and weight. The ash content is expressed

$$\% \text{ ash} = \frac{\textbf{Weight of residue}}{\textbf{Weight of Sample}} \times 100$$

3.5. 3. Acidity

10 gm sample was taken with distilled water. It was transferred into 100 ml volumetric flask with distilled water. Then filtered and 10 ml sample was taken in a conical flask and added 60 ml distilled water and 2-3 drops of phenolphthalein indicator. The solution was titrated against standard sodium hydroxide. The end point was shown colorless to pale pink and will stand 15 seconds. Per-cent Acidity was calculated according to the following formula:

$$\% \text{ acidity} = \frac{E \times N \times V1 \times 100}{W \times V2 \times 1000}$$

Where,

E= Equivalent weight of citric Acid

N= Normality of Alkali (NaOH)

V_1 = Volume made up

V_2 = ml of extract taken for estimation

T = Titrate value

W = Weight of sample taken

3.5.4 pH

The pH was first standardized using buffer pH 6.2 then for determining the pH of ginger juice. Again pH meter was standardized using this buffer and checked the pH of the studied samples.

3.5. 5. Determination of vitamin C

The reagents used for the estimation of vitamin C were as follows:

- Metaphosphoric acid (3%)
- Standard Ascorbic acid solution
- Dye solution

For estimation of vitamin C, the following steps were followed:

Standardization of dye

5 ml standard ascorbic acid solution was taken in a conical flask and 5ml. Metaphosphoric acid (HPO_3) was added to it and shaken. A micro burette was filled with Dye solution and the mixed solution was titrated with dye using Phenolphthalein as

indicator to a pink colored end point, which persisted at least for 15 seconds. A dye factor was calculated using the following formula:

$$\text{Dye factor} = 0.\frac{5}{\text{Titrate Value}}$$

Preparation of sample

10 ml sample was taken in a blender machine and homogenized with 3% Metaphosphoric acid and then blended materials were filtered. The filtered was transferred to a 100 ml. volumetric flask and the volume was made up to the mark with Metaphosphoric acid solution.

Titration

5 ml of Metaphosphoric acid extracted sample was taken as an aliquot and titrated with standard dye solution, using phenolphthalein indicator to a pink coloured end point, which persisted at least for 15 seconds.

Vitamin C content was calculated by using the following formula:

$$\%\text{mg of vitamin C per 100 gm sample} = \frac{T \times D \times V1}{V2 \times W} \times 100$$

Where,

T= Titer

D= Dye factor

V_1= Volume made up

V_2= Aliquot of extract taken for estimation

W= Weight of sample taken for estimation

3.5. 6. Crude fat determination

The crude fat determined by continuous Soxhlet extraction apparatus.

Procedure

The sample remaining after moisture determination was transferred to a thimble and plugged the top of the thimble with a wad of fat free cotton. Drop the thimble into the fat extraction tube in a Soxhlet apparatus. The bottom of extraction tube was attached to a Soxhlet flask. Approximately 75ml or more of anhydrous ether was poured through the sample in the tube into the flask. The top of the fat extraction tube was attached to the condenser. The sample was extracted for 16 gms or longer on a water bath at 70° to 80°C. At the end of the extraction period, the thimble from the apparatus was removed and distilled off most of the petroleum ether by allowing it or collected in Soxhlet tube. The petroleum ether was poured off when the tube was nearly full. When the petroleum ether had reached small volume, it was poured into a small, dry beaked through a small funnel containing plug cotton. The flask was raised and filtered thoroughly, using ether. The ether was evaporated on steam bath at low temperature and was then dried at 100°C for 1 hour, cooled and weighted. The difference in the weights gave the ether soluble material present in the sample. The percent of crude fat was expressed as follows:

$$\%\ \text{crude fat} = \frac{\text{Weight of petroleum} - \text{Ether soluble material}}{\text{Weight of sample}} \times 100$$

3.5. 7. Crude protein determination

Digestion

About 2 ml sample was weighed and was transferred into the 250ml Kjeldahl flask. About 25ml of concentrated H_2SO_4 and 2gm of crystal mixture were added to the flask. The flask was placed in an inclined position on the stand in the digestion chamber and digested. Then the contents of the digest in pale blue. After digestion the flask was cooled carefully and added slowly 30-40 ml of water in 5ml portion with mixed and made the volume 100ml with distilled water. A blank digestion was carried out without the sample and made the digest to 100ml.

Distillation

5ml of aliquot was taken for distillation in a distillation flask. 10ml of 2% boric acid solution, 10-15ml of ammonia free water and 2 drops of mixed indicator were taken in a 100ml conical flask. The distillation apparatus was connected up with the delivery tube dipping below the boric acid solution in the conical flask. To the distillation flask, about 40ml of 40%NaOH solution was added and the ammonia was distilled off into the boric acid solution. The boric acid was changed from bluish purple to bluish green.

Titration

The micro burette was filled with 0.01 N HCl until the blue color disappears. The blank distillation was carried out and titrated.

Calculation

$$\% \text{ Nitrogen} = \frac{\{\text{Sample titre} - \text{Blank titre}\} \times \text{Normality of HCl} \times \text{Vol made up of degest} \times 100}{\text{Aliquot of the degest} \times \text{Weight of the sample taken} \times 100} \times 100$$

% Protein = % Nitrogen × Protein Factor

= % Nitrogen × 5.50

3.6. Microbiological examination

3.6. 1. Determination of total viable bacteria

For total viable count of microorganism present in ginger juice, standard plate count method was followed according to the method described in "Recommended method for the microbiological examination of food "American Public Health Association (2001).

Preparation of media

In this study dextrose tryptophene Agar (DTA) from Difco Laboratories Detriot, USA was employed. The composition of DTA media was as follows.

Table 3.2: Different ingredients for the preparation of media

Ingredients	Amount(gm)
Tryptophene (peptone)	5
Dextrose (glucose)	1
Yeast extract	2.5
Agar	14
Total	22.5

22.5gm of DTA was dissolved in 1000ml cold distilled water and heated to boiling to dissolve the ingredients completely. Then media was filled into different screw cap bottles and sterilized at 121°C for 15 min in an autoclave. After sterilization the media was kept in water bath at 45°C until used.

Preparation of dilution blanks

Dilution blanks were prepared by buffered distilled water. The buffered distilled water was filled into screw cap bottles 100ml each. Bottles were sterilized at 121°C for 15 minutes after sterilization each bottles contain 99ml buffered distilled water.

Procedure of plating

10 ml ginger juice was poured into 100ml of buffered distilled water. 1 ml lemon juice was transferred into 99ml buffered distilled water and the sample shaken up and down movement for 25 times at a height about 30 cm(1 ft) at a time interval not exceeding 7 seconds the solution was made in 1:10, 1: 10^2 , 1:10^3 , 1: 10^4 , 1:10^5 , 1:10^6 dilutions in the sterilized buffered distilled water. 1ml and 1/10 ml from each dilution were placed into sterilized Petri dishes. Then the mouth of the agar bottle was flamed and 10-15 ml poured into each Petridis, rotating and tilting gently and allowed them some time for solidification.

Incubation and colony count

After solidification Petri dishes were placed in the incubator at 37°C for 48 hrs, the overloaded Petri dishes were avoided and the Petri dishes containing countable colony was selected. Colonies were counted with the aid of a magnifying glass and multiplied by dilution number.

3.6. 2. Determination of yeast and mould

Test and mould count of ginger juice was done according to the method as described in the "Recommended method for the Microbiological Examination of Food" (APHA, 2001)

Preparation of media

In this study potato dextrose agar (PDA) was used to enumerate the yeast and mould count of ginger juice. The media was prepared in the laboratory according to the method described in the "Laboratory Manual, Method of analysis of Milk and its products", (Milk Industry Foundation, 2001).

Table 3.3: The formula of preparation of PDA media

Formula	
Infusion from 200 gm potato	1000ml
Dextrose, commercial	20gm
Agar	15gm
Tartaric acid,USP,10% solution sterilized	2.5ml /100ml

200gm of previously peeled and sliced potato was taken in 1000ml of distilled water and boiled for an hour. After boiling, straining was designed through double thickness clean cloth. Volume was restored to origin. Then 20gm of commercial dextrose and 15gm of agar were added to the potato infusion solution. Later for complete dissolution the mixture was heated and dispensed into several 200 ml screw cap bottles and sterilized at

121°C at 15 psi for 20 minutes. The media was then stored at refrigeration temperature. Before pouring into Petri dishes the media was melted through boiling and around 2.5 ml of 10% tartaric acid was added per 100 ml media (at 45°C) to reduce the pH value to 3.5±0.1.

Preparation of dilution blanks

Dilution blanks were prepared by buffered distilled water. The buffered distilled water was filled into screw cap bottles 100ml each. Bottles were sterilized at 121°C for 15 minutes after sterilization each bottles contain 99 ml buffered distilled water.

Procedure of plating

Same as Total Viable Count of ginger juice without the media of Potato Dextrose Agar.

Incubation and colony count

After solidification of agar, the plates were inverted and incubated at 37°C for 3 days. After incubation, the plates were taken out from the incubator and colonies were counted. Yeast colonies were characterized by their smooth, moist and elevated surface, where mold colonies were identified by their profuse growth of hyphae. Finally the colony number was multiplied by the dilution and the counts per gm of sample were recorded.

3.7. Sensory evaluation of ginger juice

Ginger juice was tasted by a panel of 10 Judges. The panelists were untrained and selected from the M.S. students and staffs of the Department of Food Engineering and Technology of Hajee Mohammad Danesh Science and Technology University, Dinajpur. All the judges consists the panel were conversant with the factors govern the quality of the products. The products were served to each judge who independently examined the following characteristics (a) Colour (b) Flavor (c) Pungency (d) Overall acceptability.

The relative importance of each factor was compared on a 9 points hedonic scale. The rating scores were as follows:

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

3.8. Storage Study of Ginger Juice

Three different samples of ginger juice were used for storage studies at room temperature (25°C-27°C) from 0-4 months. The effect of storage time (30, 60, 90 and 120 days) on physical properties such as color, flavor and pungency of the juices were studied. All the samples of ginger juice were in good condition up to 4 months of storage.

CHAPTER IV

RESULTS AND DISCUSSION

The ginger juice is moderately perishable and subject to quick deterioration during storage. The present study was undertaken to assess the stability of the ginger juice treated with preservatives at different concentration during storage at different conditions.

4.1. Proximate composition of fresh ginger and ginger juice:

The fresh ginger was analyzed for moisture 6.9%, protein 8.6%, fat 6.4%, and ash 5.7%, vitamin C (ascorbic acid) 13 mg/100gm respectively by Pruthi (1998).

The average analysis of ginger juice were analyzed for moisture 94.97%, protein 1.08%, fat 1.17%, ash 0.71%, vitamin C(ascorbic acid) 15.67%, acidity 0.13% respectively.

Pruthi (1998) found that dry ginger has the composition of moisture 6.9%, protein 8.6%, fat 6.4%, fibre 5.9%, carbohydrate 66.5%, ash 5.7%, calcium 0.1%, phosphorus 0.15%, iron 0.011%, sodium 0.03%, potassium 1.4%, vitamin A 175 IU/100 gm, Vitamin B1 0.05 mg/100 gm, Vitamin B2 0.13 mg/ 100 gm, niacin 1.9%, vitamin-C 13 mg/ 100 gm. and calorific value (food and energy) 380 k cal/100 gm.

Very few literatures were found on proximate composition of ginger juice. So it is very hard to compare the proximate composition of the prepared products with others.

Table 4.1: Chemical composition of sample-1, 2 and 3

No. of Sample	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Acidity (%)	Vit C (mg/100gm)	pH
S-1	95	1.12	1.02	0.65	0.10	15	4.5
S-2	95.9	1.23	0.99	0.88	0.18	18	4.8
S-3	94	1.16	1.22	0.61	0.12	14	4.4

4.2. Microbiological study of processed ginger juice

4.2. 1. Effect of preservatives on the growth of total viable count of bacteria at different storage periods:

The study was performed by standard plate count (S.P.C) method. The total viable bacterial load was not uniform. The total bacteria were counted as total number of bacteria per gm of sample. The total number of viable bacteria was counted by multiplying the colony forming unit (cfu) with dilution number. The total number of viable bacteria in different samples at different storage period has been shown in Appendix –I (Table 1.1) and variation of bacterial load in different ginger juice shown in Fig sample S-1 showed maximum count and sample S-2 showed minimum count. After 60 days storage of ginger juice by bottling with preservatives very little difference was observed in microbiological load compared to that of 30 days storage for both cases.

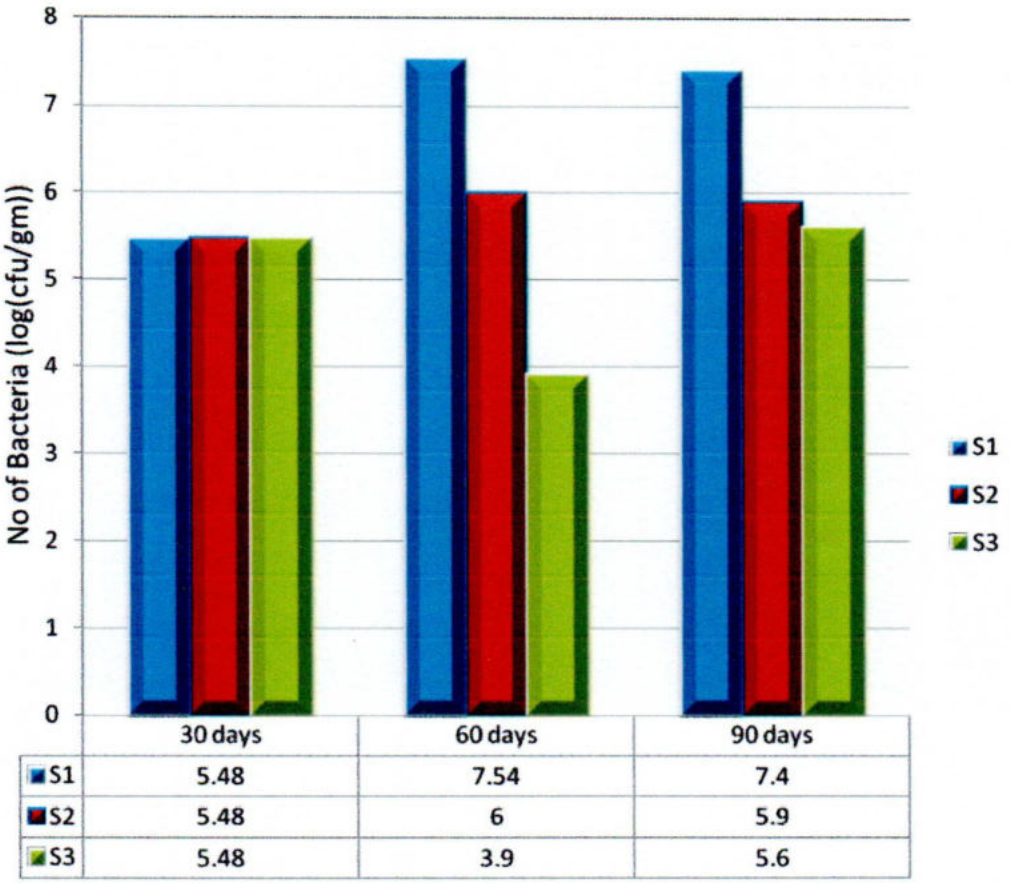
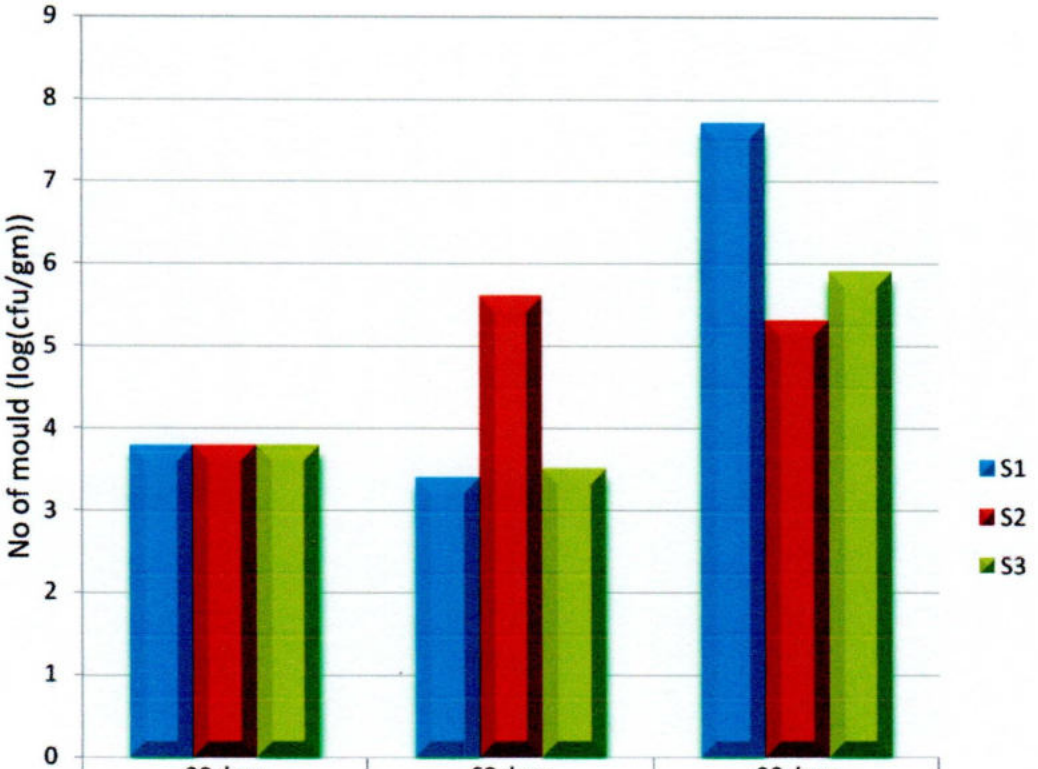


Fig. 2: Effect of preservatives on the growth of bacteria at different storage period.

4.2. 2. Effect of preservatives on the growth of total viable count of mould at different storage period:

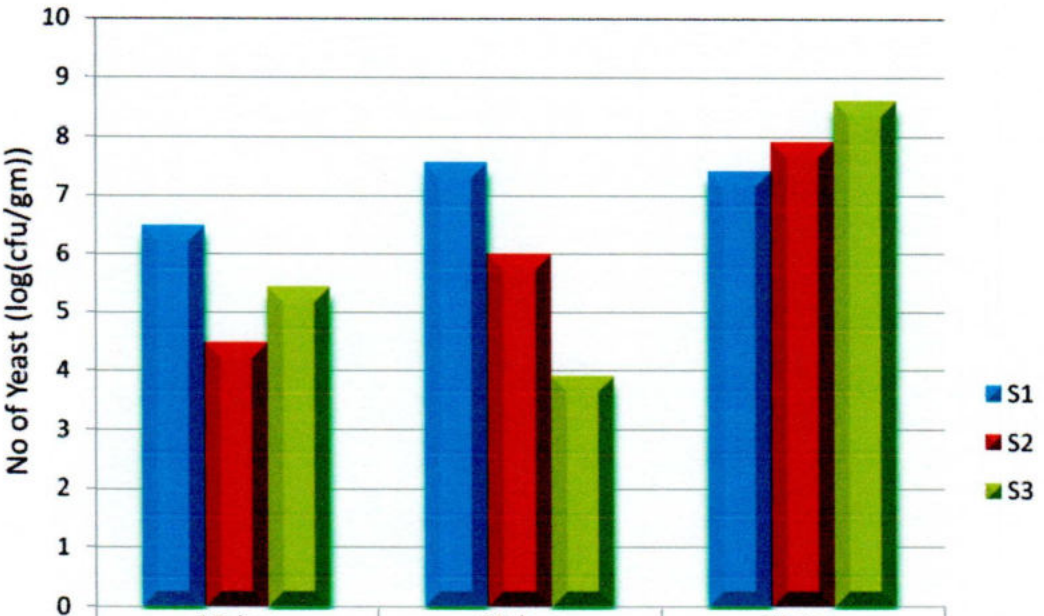


	30 days	60 days	90 days
S1	3.79	3.4	7.7
S2	3.79	5.6	5.3
S3	3.79	3.5	5.9

Effect of preservatives on the growth of mould at different storage period

Fig. 3: Effect of preservatives on the growth of mould at different storage period.

4.2. 3. Effect of preservatives on the growth of total viable count of yeast at different storage periods:



	30 days	60 days	90 days
S1	6.48	7.54	7.4
S2	4.48	6	7.9
S3	5.42	3.9	8.6

Effect of preservatives on the growth of yeast at different storage period

Fig. 4: Effect of preservatives on the growth of Yeast at different storage period.

4.3. Sensory Evaluation of Ginger Juice

The mean scores for color, flavor, pungency and overall acceptability of ginger juice are presented in Table 4.2, (Appendix II Table 2.1 to 2.12).

Table 4.2: Mean score for color, flavor, pungency and overall acceptability of various ginger juice samples

Sample code	Sensory attributes			
	Color	Flavor	Pungency	Overall Acceptability
S -1	6.2	6.8	6.1	5.9
S -2	7.0	6.7	5.5	6.2
S -3	6.4	6.7	5.9	6.1

Sample means having the same letter suffix do not differ at 1% ($p<0.01$) level of statistical significance.

A two-way analysis of variance (ANOVA) (Appendix II Table 2.1) was carried out for color preference and result revealed that there was slightly significant ($p<0.01$) indifference in color acceptability among all the samples. In case of color preference among the samples a two-way analysis of variance (ANOVA) (Appendix II Table 2.2) showed that there was significant ($p<0.01$) difference in color acceptability among the ginger juice.

In case of flavor preference among the samples a two-way analysis of variance (ANOVA) (Appendix II Table 2.4) showed that there was no significant ($p<0.01$) indifference in flavor acceptability among the ginger juice. From the calculation and table the result revealed that the flavors of different samples were equally accepted.

A two-way analysis of variance (ANOVA) (Appendix II Table 2.8) was carried out for pungency preference and result revealed that there was slightly significant ($p<0.01$) indifference in pungency among all the samples. In case of color preference among the samples a two-way analysis of variance (ANOVA) (Appendix II Table 2.2) showed that there was significant ($p<0.01$) difference in pungency acceptability among the ginger juice.

It is apparent from the result of the ANOVA (Appendix II Table 2.11) that there were significant ($p<0.01$) difference in overall acceptability of the sample tasted. It is shown from Table 4.2 that the sample -2 is the highly acceptable securing out of three samples. However, all the samples were acceptable to the panelists.

4.4. Storage studies of Ginger Juice

Three different samples of ginger juice were used for storage studies at room temperature 25°-30°C and 0- 120 days. The effect of storage time (30, 60, 90 and 120 days) on physical properties such as color, flavor and pungency of the juices were studied. All the samples of ginger juice were in good condition up to 4 months of storage.

Table 4.3: Storage condition of ginger juice at 30, 60, 90 and120 days

Storage period (days)	Sample code	Color	Flavor	Pungency	Visual fungal growth
30	Sample-1	Good	Good	High	Not Visual
	Sample-2	Good	Good	Moderate	Not visual
	Sample-3	Good	Good	High	Not visual
60	Sample-1	Good	Good	Moderate	Not visual
	Sample-2	Good	Good	Moderate	Not visual
	Sample-3	Slide dark	Good	Moderate	Slide visual
90	Sample-1	Good	Slide change	Slide change	Not visual
	Sample-2	Good	Good	Moderate	Not visual
	Sample-3	Brown dark	Slide change	Slide change	Mould growth
120	Sample-1	Slide dark	Low	Change	Mould
	Sample-2	Good	Good	Moderate	Not visual
	Sample-3	Concentrate dark	Low	Spoil	Spoil

CHAPTER V

SUMMARY AND CONCLUSION

The research work was accomplished in the laboratory of the Department of Food Science and Nutrition and the Department of Food Engineering and Technology under the faculty of Agro-Industrial and Food Process Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur, for the exploration of appropriate method of ginger juice preparation. The study also implies the prospects of processing and preservation of ginger juice.

The gingers were collected from local market and were analyzed for proximate composition, microbiological analyses, sensory attributes and overall storage stability. Fresh ginger juice was processed by water, sugar and preservatives. The proximate composition of fresh ginger was moister content 80.9 gm, protein content 2.3 gm, fat content 0.9 gm, ash content 5.7 gm and vitamin-C 13 mg/100gm. The average composition of processed ginger juice was moisture content 94.97%, protein1.08 %, ash 0.71%, fat 1.17%and vitamin C 15.67 mg/100gm depending on the processing media. The chemical analysis of the juice showed that moisture content was highly reduced in all the samples. But the compositions of fresh ginger and ginger juice were found satisfactory. The analysis also showed that ash content and acid content were substantially decreased in all samples. Vitamin-C content decreased in all the samples. Vitamin-C is lost by oxidation and heat following a first-order kinetics, which states that concentration has exponential relationship with time.

The microbiological studies exposed that total viable counts (bacteria, yeast and mould) were moderate in juice. The total number of bacteria mould and yeast increased to a little bit at the end of storage period i.e., after two months. The acceptability of processed juice

was evaluated by the panelist using 1-9 hedonic scale. The panelists were selected randomly from both teachers and students under the University Campus of HSTU, tasted the juice products and assigned marks for color, flavor, pungency and overall acceptability. The mean score for color, flavor, pungency and overall acceptability showed that all samples secured score within acceptable limit ranging from 1 to 9 ranking as 'Dislike extremely' to 'Like extremely'. The score of panel test indicated that among three samples, the sample S-2 was more acceptable.

Storage studies were carried out for four months at room temperature (25°C) and samples were taken at an interval of 30 days. The samples were then observed for some parameters such as color, flavor, pungency and visual fungal growth etc. It also revealed that all the samples were found to be shelf stable up to six months. This study indicates a good prospect of processing of ginger by juice. Further investigation is necessary to study the shelf life, economic and safety aspects of the products before commercial exploration.

Since ginger is produced all over the country actually highest in hill tracts so it has availability on the market. For the availability of ginger we can process for juice as well as to develop the economy.

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APPENDICES

APPENDIX I

Table 1: Microbial studies data of various ginger juice samples

Table 1.1 The growth of total count of bacteria log (cfu/gm) at different storage periods at room temperature

Types of Sample	Bacterial count on 30 days of juice preparation		Bacterial count on 60 days of juice preparation		Bacterial count on 90 days of juice preparation	
	cfu/gm	Log (cfu/gm)	cfu/gm	Log (cfu/gm)	cfu/gm	Log (cfu/gm)
S-1	10×10^{2}	5.48	35×10^{6}	7.54	25×10^{6}	7.4
S-2	10×10^{3}	5.48	10×10^{5}	6.0	15×10^{5}	5.9
S-3	10×10^{3}	5.48	8×10^{5}	3.9	20×10^{5}	5.6

Table 1.2 The growth of total count of mould log (cfu/gm) at different storage periods at room temperature

Types of Sample	Mould count on 30 days of juice preparation		Mould count on 60 days of juice preparation		Mould count on 90 days of juice preparation	
	cfu/gm	Log (cfu/gm)	cfu/gm	Log (cfu/gm)	cfu/gm	Log (cfu/gm)
S-1	10×10^{2}	3.79	23×10^{6}	3.4	15×10^{6}	7.7
S-2	15×10^{2}	3.79	30×10^{5}	5.6	56×10^{5}	5.3
S-3	8×10^{3}	3.79	14×10^{5}	3.5	36×10^{5}	5.9

Table 1.3 The growth of total count of yeast log (cfu/gm) at different storage periods at room temperature

Types of Sample	Yeast count on 30 days of juice preparation		Yeast count on 60 days of juice preparation		Yeast count on 90 days of juice preparation	
	cfu/gm	Log (cfu/gm)	cfu/gm	Log (cfu/gm)	cfu/gm	Log (cfu/gm)
S-1	30×10^{4}	6.48	18×10^{6}	7.54	27×10^{6}	7.4
S-2	20×10^{4}	4.48	17×10^{5}	6	28×10^{5}	7.9
S-3	15×10^{4}	5.48	28×10^{5}	3.9	25×10^{5}	8.6

APPENDIX II

Table 2: Sensory evaluation of ginger juice

Table 2.1: Rating score for color of ginger juice

No. of Judge	Sample code	Sample code	Sample code
	Sample -1	Sample -2	Sample -3
1	5	7	6
2	8	9	8
3	4	6	5
4	6	5	4
5	6	6	6
6	6	8	7
7	8	9	7
8	6	7	7
9	8	7	7
10	5	6	7
Total	62	70	64
Mean	6.2	7.0	6.4

Hedonic scale used; 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

Table 2.2: ANOVA (Analysis of Variance) for color

Sources of variance	Degree of freedom	Sum of squares	Mean squares	F-value	
				Calculated	Tabulated (1%)
Products	2	3.467	1.733	2.9620	
Judges	9	35.467	3.941	6.7342	0.0773
Error	18	10.533	0.585		
Total	29	49.467			

Table2.3: Duncun's Multiple Range Test (DMRT) value for color

Types of sample	Original order of means	Types of sample	Ranked order to means
S-1	5.00 ^{c}	S1	8.00 ^{a}
S-2	8.00 ^{a}	S2	5.00 ^{b}
S-3	4.00 ^{c}	S3	4.00 ^{c}

Table 2.4: Rating score for flavor of ginger juice

No. of Judge	Sample code	Sample code	Sample code
	Sample -1	Sample -2	Sample -3
1	7	6	5
2	7	6	6
3	7	6	8
4	4	5	7
5	6	7	6
6	7	6	6
7	9	7	6
8	7	8	7
9	7	8	8
10	7	8	8
Total	68	67	67
Mean	6.8	6.7	6.7

Hedonic scale used; 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

Table 2.5: ANOVA (Analysis of Variance) for flavor

Sources of variance	Degree of freedom	Sum of squares	Mean squares	F-value	
				Calculated	Tabulated (1%)
Products	2	0.067	0.033	0.0347	
Judges	9	16.533	1.837	1.9151	0.1151
Error	18	17.267	0,959		
Total	29	33.867			

Table 2.6: Duncun's Multiple Range Test (DMRT) value for flavor

Types of sample	Original order of means	Types of sample	Ranked order to means
S-1	7.000 [a]	S1	7.000 [a]
S-2	7.000 [a]	S2	7.000 [a]
S-3	7.000 [a]	S3	7.000 [a]

Table 2.7: Rating score for pungency of ginger juice

No. of Judge	Sample code	Sample code	Sample code
	Sample -1	Sample -2	Sample -3
1	4	3	5
2	6	5	5
3	8	8	8
4	7	4	5
5	5	6	8
6	5	4	4
7	6	5	5
8	8	8	7
9	5	5	5
10	7	7	7
Total	61	55	59
Mean	6.1	5.5	5.9

Hedonic scale used; 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

Table 2.8: ANOVA (Analysis of Variance) for pungency

Sources of variance	Degree of freedom	Sum of squares	Mean squares	F-value	
				Calculated	Tabulated (1%)
Products	2	1.867	0.933	1.3846	
Judges	9	50.167	5.574	8.2692	0.2758
Error	18	12.133	0.674		
Total	29	64.167			

Table2.9: Duncun's Multiple Range Test (DMRT) value for pungency

Types of sample	Original order of means	Types of sample	Ranked order to means
S-1	6.100 [a]	S1	6.100 [a]
S-2	5.500 [a]	S2	5.900 [a]
S-3	5.900 [a]	S3	5.500 [a]

Table 2.10: Rating score for overall acceptability of ginger juice

No. of Judge	Sample code	Sample code	Sample code
	Sample -1	Sample -2	Sample -3
1	5	7	8
2	3	5	4
3	7	7	7
4	5	5	5
5	8	7	6
6	6	6	7
7	6	6	6
8	7	7	6
9	6	6	7
10	6	6	5
Total	59	62	61
Mean	5.9	6.2	6.1

Hedonic scale used; 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

Table 2.11: ANOVA (Analysis of Variance) for overall acceptability

Sources of variance	Degree of freedom	Sum of squares	Mean squares	F-value	
				Calculated	Tabulated (1%)
Products	2	1.267	0.633	0.9448	
Judges	9	24.833	2.759	4.1160	0.0052
Error	18	12.067	0.670		
Total	29	38.167			

Table 2.12: Duncun's Multiple Range Test (DMRT) value for overall acceptability

Types of sample	Original order of means	Types of sample	Ranked order to means
S-1	5.900 [a]	S1	6.400 [a]
S-2	6.200 [a]	S2	6.200 [a]
S-3	6.400 [a]	S3	5.900 [a]

APPENDIX III

TASTE TESTING OF ----------

Name of Taster: ---------- Date: ----------

Product: ----------

HEDONIC RATING TEST OF ---------- (1-9)

Please taste the sample and give numerical score ranging from (1-9) in the appropriate space.

Property	Sample Identity		
	S-1	S-2	S-3
Color			
Flavor			
Pungency			
Overall acceptability			

Hedonic scale used:

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