EVALUATION OF CHEMICAL CHARACTERISTICS AND SHELF-LIFE OF FRESH CUT PAPAYA (*Carica papaya*) AND PINEAPPLE (*Ananus sativus*) AT DIFFERENT DAYS OF INTERVAL

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CERTIFICATE

This is to certify that the thesis entitled **"EVALUATION OF CHEMICAL CHARACTERISTICS AND SHELF-LIFE STUDY OF FRESH CUT PAPAYA (*Carica papaya*) AND PINEAPPLE (*Ananus sativus*) AT DIFFERENT DAYS OF INTERVAL"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN BIOCHEMISTRY**, embodies the result of a piece of bonafide research work carried out by **A.T.M SADEQUR RAHMAN**, Registration No. **14-06368** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

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DEDICATED TO

MY BELOVED PARENTS

AND

ALL OF MY TEACHERS

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ABSTRACT

The study was conducted to determine the shelf life of fresh cut fruits (papaya, pineapple) and to evaluate the acceptability of the fresh cut fruits when preserved at 0-4^0 C temperatures in refrigerator. Fresh-cut fruits consumption is increasing due to the rising public demand for convenience and awareness of fresh-cut fruit's health benefits. The entire tissue of fruits and vegetables is rich in bioactive compounds, such as phenolic compounds, carotenoids, and vitamins. The proximate chemical analysis of fresh cut fruits showed that TSS of pineapple and papaya was higher in 40% sugar solution which was found after 7 days of storage at (0-4)^0 C. Acid content was slightly varied among all the samples and the value for papaya was 0.18 in CMC solution and 40% sugar solution and 1.45% for pineapple in 40% sugar solution after 5 days of storage. Vitamin-C was decreased in all samples and the reasonable value for papaya was 51.25 mg/100g in 40% sugar solution and 52 mg/100g in CMC and for pineapple 29.20 mg /100g in 40% sugar solution 29.1 mg/100g in CMC solution after day 5. Moisture was decreased in all samples and the reasonable value for papaya was 73.9% in 40% sugar solution and 74.1% in CMC and for pineapple 74.8% in 40% sugar solution, 75.00% in CMC solution after day 5. Ash content was increased in all samples and the reasonable value for papaya was 0.95% in control treatment solution, 0.92% in 0.1% KMS solution and for pineapple 0.30% in 40% control treatment solution, 0.27% in 0.01 KMS solution after day 5. Microbial load was increased in all samples and in case of papaya the lowest value was 2100 in 0.1% KMS solution, where the value in 40% sugar solution and CMC coated are 3000, 3000 respectively. For pineapple the lowest value is 2200 in 0.1% KMS solution and the value in 40% sugar solution and CMC coated samples are 3400, 3100 at 5 days of preservation. The results found in this study suggest that the 40% sugar solution and CMC coating is an effective treatment to prolong the shelf-life of fresh cut papaya and pineapple.

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LIST OF ABBREVIATED TERMS

ABBREVIATION	FULL NAME
Et al.	and others
BBS	Bangladesh Bureau of Statistics
Cm	Centimeter
Mg	Meligram
°C	Degree Celsius
FAO	Food and Agriculture Organization
SAU	Sher-e-Bangla Agriculture University
^{0} BRIX	Degree brix
m	Meter
TSS	Total Soluble Solid
CMC	Carboxy-Methyle Cellulose
KMS	Potassium Meta Bi-Sulphate

CHAPTER-I

INTERODUCTION

CHAPTER I

INTRODUCTION

Fresh-cut products are fruits or vegetables that have been trimmed, peeled and/or cut into a fully usable product, which is subsequently packaged to offer consumers high nutrition, convenience and flavor while maintaining freshness. The USDA and FDA definitions for "fresh" and "minimally- processed" fruits and vegetables imply that fresh-cut (pre-cut) products have been freshly-cut, washed, packaged and maintained with refrigeration. These are in a raw state and even though processed (physically altered from the original form), they remain in a fresh state, ready to eat or cook, without freezing, thermal processing, or treatments with additives or preservatives (Anonymous, 1998a; Anonymous, 1998b). The International Fresh-cut Produce Association defines a fresh-cut product as fruits or vegetables that have been trimmed and/or peeled and/or cut into 100% usable product that is bagged or pre-packaged to offer consumers high nutrition, convenience and flavor while still maintaining freshness.

Pineapple (*Ananus sativus*) edible, juicy, multiple tropical sorosis fruit commonly known as "Anarash" in Bangladesh. It is a tropical fruit which grows in countries which are situated in the tropical and sub-tropical regions. Total pineapple production worldwide is around 16 to 18 million tons per year. There are several countries (e.g. Thailand, Brazil, India, Philippines and China) which contribute to the total production. The flesh and juice of the pineapple are used in cuisines around the world. In many tropical countries, pineapple is prepared and sold on roadsides as a snack. It is sold whole or in halves with a stick inserted. Whole, cored slices with a cherry in the middle are a common garnish on hams in the West. Chunks of pineapple are used in desserts such as fruit salad, as well as in some savory dishes, including pizza toppings, or as a grilled ring on a hamburger. Crushed pineapple is used in yogurt, jam, sweets, and ice cream. The juice of the pineapple is served as a beverage, and it is also the main ingredient in cocktails such as the piña colada and in the drink tepache.

In Bangladesh it was introduced through Assam and Manipur of India and was first cultivated in Sylhet in the beginning of 20th century. It is native to Brazil. It is now cultivated in almost all the districts of Bangladesh although Sylhet, Tangail, Dhaka, and Rangamati have more acreage under cultivation. About 20,000 hact. of land are now under pineapple cultivation with a total production of about 2,00,000 m tons per year (BBS 2009/2010). The cultivated varieties are Giant Kew (locally *kalendar*), Honey Queen (*jaldubi*), and Red Spanish (*ghorashal*).

Papaya (*Carica papaya*) belonging to the family Caricaceae was introduced in India in 16th century by the Portuguese. It is one of the few plants which produce fruits throughout the year. Papaya is a native of tropical America. It is now grown in all the tropical and sub-tropical countries, e.g. Australia, Hawaii, Taiwan, Peurto Rico, Peru, Florida, Texas, California in the USA, various parts of Central and South Africa, Pakistan, Bangladesh and India. Some of the important varieties are Washington, Honey Dew, Coorg Honey Dew, CO-1, CO-2, CO-3, CO-4, Pusa Delicious, Pusa Majesty, Pusa Giant, Pusa Dwarf, Pusa Nanha, Pusa Nahi. The ripe fruit of the papaya is usually eaten raw, without skin or seeds. The unripe green fruit can be eaten cooked, usually in curries, salads, and stews. Green papaya is used in Southeast Asian cooking, both raw and cooked. In Thai cuisine, papaya is used to make Thai salads such as som tam and Thai curries such as kaeng som when still not fully ripe. In Indonesian cuisine, the unripe green fruits and young leaves are boiled for use as part of lalab salad, while the flower buds are sautéed and stir-fried with chillies and green tomatoes as Minahasan papaya flower vegetable dish. Papayas have a relatively high amount of pectin, which can be used to make jellies. The smell of ripe, fresh papaya flesh can strike some people as unpleasant. In Brazil, the unripe fruits are often used to make sweets or preserves.The black seeds of the papaya are edible and have a sharp, spicy taste. They are sometimes ground and used as a substitute for black pepper.In some parts of Asia, the young leaves of the papaya are steamed and eaten like spinach.

People want ready fruits for consumption for saving their valuable time. Fresh cut fruits provide essential vitamins and minerals, fiber and other substances that are important for good health. Its nutritional quality is high, no further processing is needed for consumption and no preservative or cooking is required for consumption. Fresh-cut fruits are an important source of antioxidants, a large number of epidemiological studies have demonstrated that people who eat a diet rich in fruits and vegetables have a lower risk of developing cancer (Steinmetz and Potter 1996; Hashimoto and others 2002), cardiovascular diseases (Vinson and others 1995) and chronic conditions (Sanchez-Moreno 2002), such as cataracts, asthma, and bronchitis (Theoharides and Bielory 2004). These beneficial effects have been attributed in part to the presence of bioactive compounds with antioxidant activity, such as phenolic compounds, carotenoids, and vitamins, which can delay or inhibit the oxidation of bio-molecules (DNA, proteins, and lipids).

Importances of fresh cut fruits are people want ready fruits for consumption for saving their valuable time. Fresh cut fruits provide essential vitamins and minerals, fibre and other substances that are important for good health. Its nutritional quality is high, no further processing is needed for consumption and no preservative or cooking is required for consumption. With the above views in consideration, this research work was under taken to study the processing and quality aspects of fresh cut fruits. The research was conducted to determine how long fresh-cut fruits could be preserved with nutritive value at reasonable and hygienic condition. The major objectives of the study is to

- Investigate nutritional quality of fresh cut fruits (Papaya and Pineapple) at different days of interval.
- Extending the shelf life, this will meet up the increased demand for convenience food items.
- Find out the parameter which helps to preserve the fruits with high nutritional value.

CHAPTER-II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

The market for chilled fresh-cut produce has witnessed dramatic growth in recent years, stimulated largely by consumer demand for fresh, healthy, convenient and additive-free foods which are safe and nutritious. We preserve the fresh-cut fruits (papaya and pineapple) in the laboratory at different temperature with different treatments and in this chapter we discuss about what has been done previously on fresh-cut fruits.

"Fresh-cut (FC)" produce is defined as any fresh fruit or vegetable or any combination thereof that has been physically altered from its original form, but has not been processed by treatments such as heat or chemical preservative and remains in a fresh state (Garrett, 1997; King and Bolin, 1989). Fresh-cut produce includes peeled, trimmed, washed, cored, sliced or cut but still uncooked fruits and vegetables (Baldwin *et al.*, 1996; Lindsay *et al.*, 1999). Fresh-cut vegetables are known as ready-to-use, lightly processed, partially processed, fresh processed or minimally processed products (Carlin et al., 1990; Watada *et al.*, 1996; Cantwell, 2002).

Islam *et al.* (1993) harvested the fruits at edible maturity and observed the effects of thinning on size, yield and quality of papayas. Result showed length and Total Soluble Solids (TSS) of papaya increased with increasing of level of fruit thinning. The 75% fruit thinning level produces the lowest and heavier fruits, with the highest TSS (10.80%).

Papaya is mainly cultivated for its edible fruits as a fresh fruit and for use of drinks, jams, candies and dried fruit. Ripe fruits are usually eaten fresh and green fruits are also used as a cooked vegetable. Papaya also has several industrial uses. Biochemically, its leaves and fruits produce several proteins and alkaloids with important medical and industrial application. The latex of green fruits contain a proteolytic enzyme, papain, used in the beverage, food and pharmaceutical industries for production of chewing gum, chill-proofing beer, tenderising meat, treat digestive disorders, degum natural silk, extracted fish oil. It is also used in the cosmetic industry, in soap, shampoo and face lifting preparations (Nunez, 1982). Evolutionary, papain may be associated with protection from frugivorous predators and herbivores (Australian Government, Department of Health and Ageing, 2003).

Papaya cultivation, nutritional aspects, and applications Papaya (Carica papaya) is a tropical fruit originally from tropical Central and South America. The fruit is grown in every tropical and subtropical country (Salunkhe and Desai, 1984), due to its rapid growth, easy cultivation, fast economic returns, and adaptation to diverse soils and climates (Seelig, 1970). This perennial plant, incorrectly referred as a tree, is a large herb with a soft wooded hollow stem of rapid growth that reaches heights up to 9 m (Samson, 1986). The fruit is oval to practically round, sometimes pear shaped or elongated club-shaped and weighs up to 9 kg (Morton, 1987). Papaya is a melon like fruit; the ripe fruit has a sweet taste and agreeable flavor. Ripe papaya typically is consumed fresh for dessert, in fruit salad or processed. Unripe fruit is consumed cooked similarly to a vegetable or used in salad, especially in South East Asia. Other parts of the plant, such as root and leaves, are used as curative remedies because of their many medicinal properties (Cherian, 2000; Runnie et al., 2004).

Schlimme and Rooney, (1994); Watada *et al.*, (1996) reported that once harvested fruits are removed from their source of water, minerals and sustenance. Fruit tissues continue to respire by using available and stored sugars and organic acids and they begin to senesce rapidly. Post harvest quality loss is primarily a function of respiration, progression of ripening (climacteric rise), water loss (transpiration), and enzymatic discoloration of cut surfaces, decay (microbial), senescences and mechanical damages suffered during preparation, shipping, handling and processing.

Pinaki et al. (1997) conducted an experiment on banana fruits cv. Dwarf Cavendish with gibberellic acid (GA3 250 ppm) and other chemicals viz., 2% CaCl2 and Bavistin (100 ppm) or with their combinations and stored at ambient temperature (20-30°C) in paper boxes. They mentioned that GA3 alone in combinations with Bavistin were slowed the rate of increase in total soluble solids. The sugars, soluble portion of starch, organic acids, soluble pectin and vitamin C are the component of total soluble solids of banana fruits pulp. The effect of chemical dip, calcium 19 chloride plus ascorbic acid and modified atmosphere storage increased the total soluble solids of banana pulp. Sen (1996) compared the TSS content of fruit juice in three pineapple cultivars, namely MARDI hybrid, Singapore Spanish and Smooth Cayenne and he found 12.8%, 11.30% and 13.7% TSS in them, respectively. Krueger et al. (1992) reported the total soluble solid contents was low until about 120 days after anthesis but thereafter increased sharply up to ripening (collected pineapple fruits from various geographical origin and varying degrees of ripeness and found 11.2 to 16.20% TSS of pineapple fruit juice. Ghanta (1994) The total soluble solid contents was low until about 120 days after anthesis but thereafter increased sharply up to ripening .According to Kodikara et al. (1996) with ripening total soluble solid in the peel of papaya increased when fruits were treated with hot water double dip treatment.

Papaya is a wholesome fruit. Papaya has more carotene compare to other fruits such as apples, guavas, sitaphal and plantains (Mumtaz, 2005). The fruit in 100 grams contains protein (1.0 g), carbohydrate (13.5 g) and fibre (0.5 g). It is a good source of minor such as Calcium (31.0 mg), Potassium (337.0 mg) and Magnesium (0.8 mg).

Abeles *et al*., (1992); Brecht, (1995) during the climacteric ripening stage of many fruits (see also "Ripeness at Cutting"); there is a dramatic increase in respiratory CO_2 and C_2H_4 production. Non-climacteric fruit, leafy vegetables, non-fruit vegetables as well as roots and tubers, do not have a surge in C_2H_4 production and generally have only slightly increased respiration as senescence approaches. However, if severely wounded (e.g. by fresh-cut processing), a significant stress-induced production of CO_2 and oftentimes C_2H_4 occurs.

Demand for papaya is increasing due to its high content of vitamins (A and C) and minerals (K, P, Fe), and low content of sodium and calories; also, papaya contain basically no starch (Samson, 1986; Cano, et al., 1995; Wall, 2006). Papaya contains significant amount of papain and chymopapain, proteolytic enzymes. They have diverse uses as meat tenderizers, digestive medicine, in brewing applications, manufacture of chewing gums, and in pharmaceutical applications in the skin care and tanning industry (Nakasone and Paull, 1998).
The papaya is a good source of Ca^{++} and an excellent source of vitamins A, B_1, B_2 and C. Its protein content is approximately 5%. The nutritional value of the fruit depends on the variety, growing conditions, and ripeness upon consumption (Sankat & Maharaj, 1997).The principal carbohydrates encountered in the fruit are glucose, sucrose, and fructose, with glucose being the carbohydrate most present during the initial stages of development (Zhou & Paull, 2001), while sucrose, fructose and glucose are more abundant after ripening, when the percent of sugars varies between 10 and 13% (Chan et al., 1989 and Zhou and Paull, 2001).

Wijewardan and Guleri (2009) conducted an experiment on various coating oil where, the surface-coating of apple with 2% neem oil were significant on moisture content. Jones (2002) conducted an experiment to assess respiration and chemical changes of papaya fruit in relation to room temperature (40, 45, 50, 55 and 60°F) and reported that moisture content decreased with decreasing temperature. Similar results were also reported by Correa et al. (2008) in papaya. Moisture content of pineapple fruit was slightly decreased at the end of storage period (Hossain, 2000).

Barakat et al. (2012) reported that the biological control of postharvest treatments significantly increased TSS content of fruits and reduced fruit firmness and its contents of total acidity. The soluble solids in banana pulp mainly consist of sugars, soluble portion of starch, soluble pectin, organic acids vitamin C etc. Reis et al. (2004) reported that the effect of the chemical dip, calcium chloride + ascorbic acid + L-cysteine at 5% and modified atmosphere storage on the quality and shelf life of Papaya. Prata was investigated. Titratable acidity, mass loss and total soluble solids content increased with storage period. The chemical dip resulted in high total soluble solids contain.

King and Bolin, (1989); Watada *et al.*,(1990); Watada and Qi, (1999); Wiley, (1994)Fresh-cut processing increases respiration rates and causes major tissue disruption as enzymes and substrates, normally sequestered within the vacuole, become mixed with other cytoplasmic and nucleic substrates and enzymes. Processing also increases wound-induced C_2H_4, water activity and surface area per unit volume which, may accelerate water loss and enhance microbial growth since sugars also become readily available.

Morton (1987) reported that 81.3 to 91.2% moisture in pineapple fruit pulp. Pineapple fruits contain approximately 85% moisture. Salunkhe and Desai (1984) stated that 81.2 to 86.2% moisture in pineapple fruits. Rahman et al. (1979) found that fresh pineapple fruits contain 83.53% moisture and also mentioned that the moisture content of pineapple fruits slightly decreased with storage period.

While conventional food processing methods extend the shelf-life of fruits and vegetables, the minimal processing to which fresh-cut fruits and vegetables are submitted renders products highly perishable, requiring chilled storage to ensure a reasonable shelf-life. Preparation steps such as peeling or scrubbing slicing, shredding, etc remove the natural protection (peel or skin) of fruits and vegetables and cause bruises, rendering them susceptible to desiccation and wilting. This also exposes internal tissues to microbes and potentially deleterious endogenous enzymes. Among the possible consequences of mechanical injuries to produce are increase in respiration rate and ethylene production, accelerated senescence and enzymatic browning (Rosen and Kader, 1989).

The most common treatments, used to preserve the color and texture of fresh-cut products. Color preservation is, after safety, the most important attribute to be preserved, since frequently a product is selected for its appearance, particularly its color. Color has been considered to have a key role in food choice, food preference and acceptability, and may even influence taste thresholds, sweetness perception and pleasantness (Clydesdale, 1993).

Geetha and Thirumaran (2010) concluded that the shelf life of fruits increased under vacuum packing with room and refrigeration temperatures for one and four weeks, respectively. During storage moisture, acidity, vitamin C and total sugar decreased, whereas reducing sugar and total soluble solids (TSS) increased. OsunaGarcia et al. (2005) observed the effects of 1-methyl cyclopropene (1-MCP @1/100 and 200 ml/liter) on the shelf life and quality of papaya cv. Maradol, stored for 4 days at room temperature, 4 days under refrigerated conditions and 6 more days at room temperature. Alongside this, the effects of 200 ml 1-MCP/ litre on the shelf life and quality of papaya compared to a control were determined. Under room and refrigerated conditions, 1-MCP increased the shelf and quality life of papaya by inhibiting weight losses, delaying the development of external and internal color and C water bath. The residue was dissolved in 1 ml of chloroform and 1 ml of methanol. Analyses were performed using Waters 515 HPLC instrument equipped with Hewlett Packard series 1050 UV– Vis detector. Separation of beta carotene and lycopene in each sample was performed using a C18 (for carotenoids, C 30 column was used) (Vydac 20i TP 54, 25 × 0.46 cm) and a mobile phase mixture consisting of acetonitrile: tetrahydrofuran : methanol : triethylamine, of 80:14:6:0.1 (v/ v/v/v) containing 0.2% ammonium acetate at a flow rate of 1.0 ml/min, and monitoring at 450 nm. The results of betacarotene and lycopene were evaluated from triplicate analyses and were expressed as mean values ± SD. 2.6 Shelf life 21 evolution of soluble solids. The treatment also reduced the incidence of diseases and maintained fruit firmness for a longer time.

Microbial and chemical contaminations can greatly compromise the safety of horticultural produces. Microbial contaminations can be transmitted through improper cultural practices, by unsanitary worker practice and through contact with soil and unclean surfaces. Mechanical injury can accelerate the loss of water and vitamin C and can increase susceptibility to decay by pathogenic microorganisms (Kader, 2002).

Shindem et al. (2009) conducted an experiment to increase the shelf life and to minimize the post harvest losses of mango fruit cv. 'KESAR', under the influence of various plant extract treatments. Among the fruits treated with different plant extracts and wrapped in different wrapping materials, the fruits treated with neem oil (10%) proved to be the most effective with respect to slower increase in TSS, while slower decrease in ascorbic acid and acidity during storage. Sing el al. (2001) noticed that most of the wrapping papers or bags significantly reduced the percentage of physiological weight loss in the fruits. Total soluble solids content of ripe fruits was improved when the fruits were stored and packed in bags and papers. Reni et al. (2000) evaluated the storage stability of 12 papaya cultivars and after 4 months they observed that TSS in pulp decreased during storage with the ripening total soluble solids in the peel of papaya increased.

Good flavor is an important guarantee for repeat purchasing of fruits by consumers. Consumers are generally willing to pay more for desirable flavor (Ragaert *et al.* 2004). Growth of spoilage microorganisms can lead to off-odor or flavor development, as occurs when fresh produce begins to ferment (Kader and Mitcham, 1999).

Rodriguez and Iguina-de-George (1975) that evaluated of papaya nectars prepared from unpeeled papaya puree. It was found that the mature green papayas were ripened at room temperature, seeds were removed and unpeeled nectars were mashed and pulped. The pulp with 17.5% sugar added was heated at 87.8°C and frozen at -23.3°C. Water to dilute it to 33.3% pulp content, sucrose and citric acid were added. The resulting nectars was pasteurized, canned and stored at 29.4^0C for 12months. The chemical composition of the nectars did not changed significantly during storage although there were slight changes in the percentage of reducing sugars. Taste evaluation by a panel showed that overall quality of the samples remained acceptable throughout the storage period.

Phandis (1970) worked on improvement of papaya in India and reported that papaya contained 0.4% ash, whereas in another experiment Wilson (1980) found 0.66% ash in papaya. This difference might be due to variety characteristics.
Chan and Kowrk (1975) reported that the total sugars, redusing and non-redusing sugar in papaya to be 5.8% and 0.3% respectively. Whereas Wilson (1980) analyzed the chemical composition papaya and stated that the reducing and non-reducing and total sugar was 4.0%, 2.5% and 6.8% respectively.

Carmen *et al.* (1978) studied papaya and described that papaya is one of the largest tropical fruits; it has pulpy flesh. Its flavor and aroma are controversial, they are not as abundant and exotic as other tropical fruits but are quite characteristics. Papaya is usually eaten alone or mixture of tropical fruits peeled and cut in segment, cubes or balls. In mixtures it is useful for its texture and well defined organoleptic properties. The fruit can be easily converted into a thick puree and preserved by common methods and later used to manufacture papaya nectars. The puree can also be converted by shaking in vacuum evaporators. Fruit pieces or the puree can be dehydrated by different methods. Both types of products, however, are rarely found in commerce, as most their flavor and aroma is either changed or lost. In order to process papaya it must be at the proper ripening stage. The fruit usually collected green mature and it ripens under storage. Because of its size and fragile skin, transport and handling are critical. The fruit is affected by climate, is injured by chilling and during ripening, physical and chemical changes occur. Papaya pulp is one of the best sources, among fruits, of vitamins, specially vitamin A and C. During fruit maturation and processing changes occur in these compounds.

Minimal processing results in a convenience product, but it reduce the shelf life. As a result, the maintenance of quality is a challenge to the rapidly expanding minimal processing sector (Jiang and Joyce, 2002).

Fresh-cut products are highly perishable, the main reasons being the removal of skin (the natural protective layer) from their surface area and the physical stress they undergo, while peeling, cutting, slicing, shredding, trimming, coring, etc. (Watada *et al.*,1996; Rolle and Chism, 1987). Wounding results in increased production of ethylene, surface water activity, weight loss and respiration rates (Baldwin *et al.*, 1995; Watada *et al.*, 1996). It also results in cell wall breakdown (which leads to undesirable enzymatic reactions), leakage of ions and other cellular components, loss of moisture (Baldwin *et al.*, 1995) and finally results in decreased shelf life (Baldwin *et al.*, 1996; Avena-Bustillos *et al.*, 1994; Baldwin *et al.*, 1995; Jiang and Joyce, 2002; Watada *et al.*, 1996; Lindsay *et al.*, 1999). If not controlled these changes can lead to rapid senescence and deterioration of the product (Baldwin *et al.*, 1995). Consequently fresh-cut produce should be maintained at lower temperatures than that recommended for whole fruits and vegetables (Watada *et al.*, 1996). But even during refrigerated storage the fresh fruits and vegetables are characterized by active metabolism (Guilbert *et al.*, 1996).

Petronella (2011) reported that Pineapple is one of the most popular tropical fruit that is well known for its juicy sweet taste. This delicious fruit is also known as Pina, Nanas and Ananus.

This fruit is rich in nutrition. It has a high content of vitamins, minerals, fibers and enzymes. This fruit is totally fat free and so help to maintain an ideal body weight and provide a balanced diet for those who want to be fit. Pineapples are a good source of vitamin-C and cholesterol free. This healthy nutritious fruit can be eaten raw as well as can be used in preparing various tasty recipes. The sodium content of the fruit is also very low. The micro nutrients content of this fruit helps to protect us from many diseases like cancer, stroke and other heart problems. Pineapple juice also helps to kill intestinal worms and helps to relieve intestinal disorders. The chemicals that this fruit contain stimulate the kidneys and aids in removing toxic elements in the body. An enzyme called bromelain that blocks the production of kinins which is formed during inflammation. This helps reducing swelling brought by arthritis, gout, sore throat and acute sinusitis. Surgical wounds or any wounds received due to injury can be healed fast by having pineapple juice.. In all, the pineapple fruit has many beneficial effects to our body. For the patients of tuberculosis, the juice of this fruit is found to be very helpful and effective to cure the disease by dissolving the mucus. Pineapples are also rich in manganese that is needed for your body to build bone and connective tissues. Pineapple also strengthens the bones of older people as well as the growth of bones in younger generation.

Maria I.Gil, (2006) observed that after 6 days losses in Vitamin-C were less than 5% in mango, strawberry and watermelon pieces, 10% in pineapple pieces, 12% in kiwifruit slices and watermelon cubs. Cantaloup, mango and strawberry pieces lost 10-15%; pineapples lost the most at 25%.

The most prevalent method in maintaining quality or controlling decay in fruits and vegetables is rapid cooling at a low temperature with high relative humidity (Ghaouth *et al.*, 1991). Since it causes chilling injury in fruits and vegetables (El Ghaouth*et al.*, 1992b; Krochta and Mulder-Johnston, 1997) and effective control of temperature is difficult, other means of preservation have been sought, for example, modified atmosphere packaging (MAP), controlled atmosphere packaging (CAP), fungicidal treatment, etc. (Ghaouth *et al.*, 1991). Also, low temperature storage is not economically feasible in most developing countries (Li and Yu, 2000; Smith *et al.*, 1987).

Tournas, V.H.(2005a) reported that High numbers of yeast and mold populations were present on many ready-to-eat packaged salads, including lettuce, coleslaw, celery chunks, and baby carrots, and salad bar items including broccoli, cauliflower, iceberg and romaine lettuce, spinach, sliced green peppers, cucumbers, and tomatoes, ranging from 1.6 × 103 cfu/g on iceberg lettuce to 9.2 × 106 cfu/g on sliced tomatoes.

Maria I.Gil, (2006) reported thatthe TA of whole pineapple did not change until day 6. It was 0.76 and 0.74 at days 3 and 6, and at day 9 it decreased to 0.60. The decrease in TA or increasein pH was related to deterioration of fruit characteristics such as firmness and visual quality. When pineapple pieces wereexposed to light, a decrease in visual quality was observed mainly related to surface browning, whereas dark storage conditions provided a better visual quality (Table 1).

Modified Atmosphere Packaging (MAP) has been used to extend the postharvest shelf life of fruits by reducing respiration rate and delaying senescence (Drake *et al.*, 1987). However, it causes anaerobiosis, and the fruit fails to ripen properly (El Ghaouth *et al.*, 1992b). Research has been conducted on the optimum storage atmosphere for fresh whole produce, but limited information is available on optimum atmosphere for fresh-cut produce (Gunes *et al.*, 2001).

Sen (1990) reported that 0.6 g acid was present in 100 g edible portion of pineapple fruit which contained 63 mg vitamin C. The pineapple fruits contained 13.0 % sugar and 0.05 g mineral matters.

Controlled atmosphere Packaging (CAP) is helpful in extending shelf life of several whole fruits and vegetables but cannot be used with fresh-cut products because of the short handling period (Ahmad and Khan, 1987; Watada *et al.*, 1996). Respiration of the product becomes anaerobic when oxygen levels decline (McHugh and Senesi, 2000; El Ghaouth *et al.*, 1992a; Howard and Dewi, 1995; Li and Barth, 1998; Nisperos-Carriedo *et al.*, 1992). Therefore, restriction of oxygen leads to accumulation of ethyl alcohol or anaerobic metabolism that leads to off flavors (Purvis 1983).

CAP and MAP are not economically feasible in most developing countries (Li and Yu 2000), and they require the attention of skilled operators (Park *et al.*, 1994). Since these techniques often involve high capital and maintenance costs (Krochta and Mulder-Johnston, 1997) and require relatively skilled operators, it may be uneconomical to store small quantities of fruit in such stores; furthermore, regular inspection of fruit is difficult. (Smith and Stow, 1984; Smith *et al.*, 1987). Once the fruit is removed, it is again subjected to air and ambient temperature, which can result in a rapid loss of quality. Finally, we observed that various works has been done on fresh-cut fruits and many more are going on to increase the quality of fresh-cut fruits with good nutritive value.

During processing of fruits by peeling, trimming, slicing, and deseeding and by other methods affects the composition of fruits which is reflected in the nutritional value. Some of the losses in sugar, acids, vitamin-C and minerals are compensated by addition of these materials during processing (Woodd roof, 1975). When fruits are subjected to such unit operation the composition of fruits slightly changed due to different condition such as temperature, humidity, storage condition etc.

The moisture, protein, fat, ash, vitamin-C and acidity and in fresh Papaya and pineapple were found. The percentage of moisture, protein, fat, ash, vitamin-C and pH were observed in the present study (table 2.1) and these results were very close to those reported by Rodriguez and Iguana-de-George (1975).

Table 2.1: Chemical composition of fresh papaya and pineapple

Sample	Moisture content (%)	Ash (%)	Fat (%)	Acidity (%)	TSS (°Brix)	Vitamin-C (mg/100g)
Fresh papaya	88.4	0.89	0.13	0.18	9.3	62
Fresh pineapple	90	0.22	0.3	1.9	8.5	38

CHAPTER-III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

3.1 Materials

The fruits (fresh Papaya & Pineapple) were collected from the Horticulture department of BARI, Gazipur. Fruits were cleaned and preserved in refrigerator (0-4°C) until used for the chemical analysis. Sugar sample, Potassium Meta bi-sulphate (KMS), Carboxy-methyle cellulose (CMC) was collected from EH & AgroVet Ltd.,Dilshaj Mansion, Shymoli, Dhaka. The study of biochemical analysis was conducted in the laboratory of Biochemistry, Sher-e-Bangla Agriculture University, Laboratory of CP Bangladesh Co. Ltd., BARI and BCSIR.

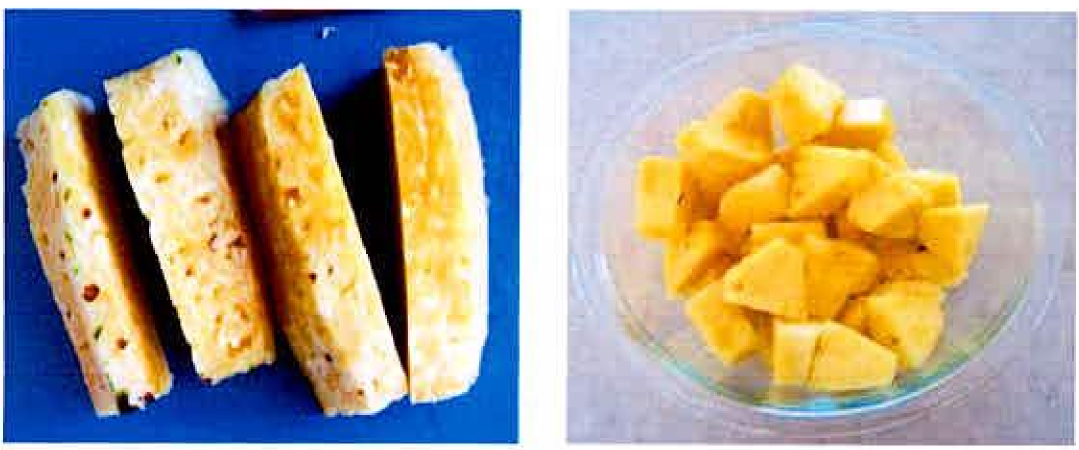
3.2 Experimental setup (Papaya and Pineapple):

Six different samples of pineapple and papaya were used for storage studies at 0 to 4°C in refrigerator from one to seven days. The effect of storage time (3, 5, 7days) on physical property (color), moisture and chemical properties acidity, vitamin-C, total soluble solids (TSS), ash and microbial load were studied.

3.3. Processing of fresh-cut pineapple and papaya

Fresh and fully mature but not over ripe papaya and pineapple were collected from the Horticulture Department of BARRI. Then these were properly washed, peeled and cut into desired size (1 inch*1inch). The cut sample were treated with sugar (20%, 40%) solution, KMS (0.1%, 0.01%) solution and coated with CMC solution. The treated samples were packed with Polyethylene paper and stored at $(0\text{-}4)^0$C temperature.

(a)



(b)

Figure 4.1: Preparation of fresh-cut fruits (a) papaya and (b) pineapple

3.4 Methods:

Fully mature but not over ripe and fresh papaya and pineapple was washed with water thoroughly. Then peelings, trimming were done to remove seed and core. Cut into desired size and dipped in different concentrations of (20%, 40%) sugar solution, (0.1%, 0.01%) Potassium meta bi-sulphate solution and 1.67% CMC solution. After completing the treatments, the samples were packaged and stored in refrigerator at 0-4°C.

The experiment was conducted with 6(six) samples which were as follows:

Table 3.1: Experimental set-up

Sample no.	Weight (gm)	Sugar (gm)	KMS (gm)	CMC (gm)	No treatment
1	70	25(20%)			
2	70	66.67(40%)			
3	70		0.167(.1%)		
4	70		0.033(.01%)		
5	70			1.67%	
6	70				----

Sample-1: Treated with 20% sugar solution.

Sample-2: Treated with 40% sugar solution.

Sample-3: Treated with 0.1% KMS solution.

Sample-4: Treated with 0.01% KMS solution.

Sample-5: Treated with 1.67% CMC solution.

Sample-6: Not Treated.

All samples were treated at (0 to 4) °C for 3, 5 and 7 days.

3.5. Flow Chart of operation:

Collection of fresh fruits

↓

Washing

↓

Peeling, trimming and deseeding

↓

Cutting into desired size (1inch*1inch)

↓

Weighting (70gm)

↓

Dipping (CMC, KMS, Sugar solution)

↓

Packaging and labeling

↓

Storage

Figure 3.1: Typical flow chart for processing fresh-cut fruits.

3.6. Color determination

The color of the sample was captured by digital camera and matched with standard color chart (from BCSIR).

3.7. Chemical analysis:

The raw and processed samples were analyzed for their titrable acidity, total soluble solids (TSS), vitamin-C, moisture, ash and microbial analysis. All the determinations were done three times and the results were expressed as mean value.

3.7.1 Titrable acidity Determination

1gm of sample was weighted and transferred into a conical flask. 60 ml of distilled water was added into the conical flask and mixed. 10ml of the mixed solution was taken into another conical flask and 1-2 drops of phenolphthalein indicator was added. Then it was titrated against standard sodium hydroxide solution (0.1N). The end point showed colorless to pink color and was persisted about 15 seconds (AOAC, 2004).

Finally the acidity of the sample was determined by the following equation:

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

Where,

T= Titre value

N= Normality of NaOH

E= Equivalent weight of acid

V1= Volume made up

V2=Volume of the sample taken for titration

W= weight of sample.

3.7.2 Total soluble solids (TSS) Determination

The TSS of the sample was measured with refractometer (Model: HI 96801). Specification of refractometer: Range: o to 85% Brix / 0 to 80^{0}C (32 to 176^{0}F), Temperature Compensation: Automatic between 10 and 14^{0}C (50 to 104^{0}F), Measurement Time: Approximately 1.5 seconds, Minimum Sample Volume: 100μL (cover prism totally), Dimensions: 19.2 (W) × 10.2 (D) × 6.7(H) cm. For this purpose, the refractometer was calibrated. Then the prism surface of the refractometer was wiped with soft tissue paper and few drops of sample juice were poured on the prism surface. Then the "read" button was pressed. The display showed the result as ^{0}brix.

3.7.3 Vitamin-C Determination

This method based on the reduction of 2-6 dichlorophenol indophenols dye by ascorbic acid.

3.7.3.1 Reagent preparation:

3.7.3.1.1 Preparation of metaphosphoric reagent:

5 gm metaphosphoric acid was taken in a100ml volumetric flask and the total volume was made 100ml with distilled water.

3.7.3.1.2 Preparation of dye solution:

0.1gm 2-6 dichlorophenol indophenole dye was taken into a 100ml volumetric flask and the total volume was made 100ml with distilled water.

3.7.3.2.1. standardization of dye solution

20mg of standard ascorbic acid was taken into a 100ml volumetric flask and the total volume was made 100ml with metaphosphoric acid reagent. From this solution 10ml was taken in a conical flask and 10ml metaphosphoric reagent was added to it. Then the mixed solution was titrated against dye solution. The end point was indicated by light pink color.

3.7.3.2.2. Estimation of ascorbic acid content

1gm or 1ml of sample was taken into a volumetric flask and the total volume was made 100ml with metaphosphoric acid reagent. Then 20ml of the sample solution was taken into another conical flask and titrated against dye solution. The end point was indicated by light pink color (AOAC, 2006).

3.7.3.2.3. Calculation:

A.10ml of standard solution ≡ 2mg of ascorbic acid

≡ x ml of dye

So, strength of dye, $$S = \frac{2}{X}$$

Where, x = volume of dye required to titrate 20 ml of standard solution.

Now, Total amount of ascorbic acid in the sample = B×D×S.

Where,

B = volume of dye required to titrate 20 ml of diluted sample solution.

S = Strength of dye.

D = Dilution factor, in this case 5.

3.7.4 Determination of ash

The sample is ignited at 600° C to burn off all organic material. The inorganic material which does not volatilize at that temperature is called ash. The procedure was described by Ranganna (1986).

3.7.4.1 Equipments

1. Balance
2. Muffle furnace
3. Desiccators.

3.7.4.2 Procedure

The temperature of the muffle furnace was fixed to 600°C and crucible was heated for 1h and transferred into desiccators; cooled them to room temperature and weighted (W_1). About 2 g sample was put into the crucible weighed (W_2). The sample was burned in a muffle furnace at

600° C for about 2 h. The crucibles were transferred into the desiccators and cooled them to room temperature and weighted (W_3). It was done immediately to prevent moisture absorption. The incineration repeated until constant weight was obtained.

3.7.4.3 Calculation

Weight of the sample taken = $W_2 - W_1$

Weight of the ash obtained = $W_3 - W_1$

$$\% \text{ Ash} = \frac{(W_3 - W_1)}{(W_2 - W_1)} \times 100$$

3.7.5 Determination of moisture

Moisture content if mustard sample was determined by conventional method i.e., drying in an oven at 100° C for overnight.

3.7.5.1 Procedure

Empty aluminum moisture dish was weighted (w_1) and 2.5 g sample was taken in a moisture dish and weighted (w_2). The sample was spread evenly and placed without lid in oven and dried samples overnight at 100° C. The dishes were transferred to desiccators to cool. Aluminum dish was weighed after cooling (w_3).

3.7.5.2 Calculation

$$\% \text{ Moisture} = \frac{(W_2 - W_3)}{(W_2 - W_1)} \times 100$$

3.7.6 Determination of total viable bacteria

For total viable count of microorganism present in the samples (Papaya, Pineapples), Standard pour plate method was followed according to the method described in "Recommended method for the microbiological examination of food" (M.A.Ali, 2008).

3.7.6.1 Preparation of media

Table 3.2: Composition of Agar media

Ingredients	Amount
Peptone	2.5 gm
Agar	9 gm
Beef extract	1.5 gm
Sodium chloride (NaCl)	1 gm
Distilled water	500 ml

All necessary ingredients were measured with the help of electric balance and taken them in a conical flask and mixed. The conical flask was heated for proper mixing. In the time of heating, the mixture was rotted with the glass rod. When the mixture was properly mixed, the mouth of the conical flask was blocked with cotton plug and covered with aluminium foil. Then the conical flask with media was placed in autoclave for sterilization (Temperature: 121°c, Pressure: 15 Ib/inch^2 and time: 15 mins.).

3.7.6.2 Preparation of dilution blank

In order to dilute the sample consecutively 1ml of the original sample was diluted stepwise through a series of tubes containing 9ml of distilled water. At first 9ml of the distilled water was taken in a sterile test tubes and then 1ml of the original sample was taken to the first test-tube with a sterile pipette. Water with the sample was vigorously shaken for homogenous distribution of the bacterial population in the solution. This tube was denoted as "A". From the tube "F-1" another 1ml aliquot was transferred to the second tube and this tube was denoted as "F-2". In this way "F-3", "F-4", "F-5", "F-6" was prepared until the desired dilution is achieved. Now the tube "F-1" has got the dilution 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6} respectively.

The dilutions were as follows:

Tube No.	Dilution	Volume of original fluid per ml	
1	1/10	0.1	or 10^{-1}
2	1/100	0.01	or 10^{-2}
3	1/1,000	0.001	or 10^{-3}
4	1/10,000	0.0001	or 10^{-4}
5	1/100,000	0.00001	or 10^{-5}
6	1/1,000,000	0.000001	or 10^{-6}

3.7.6.3 Procedure of plating

Now from the test-tube "F-1", 1ml of the sample solution was taken in a sterile petridish containing 9ml of agar medium. The agar with bacterial sample was mixed by rotating the petridish. This petridish was marked as "A". In this way "B", "C", "D", "E", "F" marked petridishes were prepared from the tubes "F-2", "F-3", "F-4","F-5" and "F-6"respectively. Then these petridishes were placed on a level surface for few minutes for solidifying the agar medium.

3.7.6.4 Incubation and colony counting

After solidification petridishes were placed in the incubator at 36^{0}C for 24 hours, the over loaded petridishes were avoided and the petridishes containing countable colony were selected. Colonies were counted with the aid of a magnifying glass and finally the total number of bacteria per gram of sample was calculated by the following equation:

Colony count (per ml) = Number of colonies (per plate) × Reciprocal of the dilution.

3.8. Statistical Analysis

The recorded data for each character from the experiments was analyzed statistically to find out the variation resulting from experimental treatments using MSTAT package program. The mean for all the treatments were calculated and analysis of variance of characters under the study was performed by F variance test. The mean differences were evaluated by Least Significance Difference test.

CHAPTER-IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

This chapter represents the results and discussion about the minimally processed fresh-cut-fruits (papaya and pineapple) of various durations and comparison among the results. This study is also concerned to investigate the various nutrients (Acidity, Vitamin-C, TSS, Moisture, Ash and Microbial load) at different interval of the shelf-life of papaya and pineapple.

4.1. Total soluble solid content of Papaya and Pineapple

TSS content of fresh cut fruits depends on many factors, such as temperature, humidity, storage condition etc.

Table 4.1: TSS (^{0}Brix) content of papaya and pineapple at different days (3,5,7)

Sample/ Treatment	TSS (Papaya) ^{0}Brix			TSS(Pineapple) ^{0}Brix		
	3 (Day)	5 (Day)	7 (Day)	3 (Day)	5 (Day)	7 (Day)
S1	10.9 ab	12.9 bc	13.4 c	9.9 a	14.2 b	15.60 a
S2	11.2 a	14.3 a	14.87 a	9.7 a	15.5 a	16.30 a
S3	10.2 bc	13.3 b	13.7 b	8.7 b	12.3 c	12.60 b
S4	10 c	11.9 d	12.5 e	8.6 b	10.8 d	12.80 b
S5	9.9 c	12.2 cd	13.13 d	8.8 b	10.2 d	11.80 b
S6	10.5 abc	12.8 bcd	13.2 cd	8.9 b	10.4 d	11.30 b
LSD	0.8763	0.9312	0.2074	0.3816	1.061	1.859
CV (%)	4.61	3.97	0.85	2.31	4.76	7.62

Figure in a column followed by a common letter do not differ significantly at 5% level by DMRT

Sample-1: Treated with 20% sugar solution.

Sample-2: Treated with 40% sugar solution.

Sample-3: Treated with 0.1% KMS solution.

Sample-4: Treated with 0.01% KMS solution.

Sample-5: Treated with 1.67% CMC solution.

Sample-6: Not Treated; All samples were treated at (0-4) °C for 3, 5 and 7 day's interval.

From table 4.1, it is observed that the Total Soluble Solids (TSS) is increased over the time. In case of Papaya, the lowest value of TSS is 9.9 and it was found in 0.01% KMS solution sample at 3 days. Statistically similar value is 10 and found in 0.1% KMS solution. The highest value 14.87 and it was observed in 40% sugar solution sample at 7 days. In case of Pineapple the lowest value of TSS is 8.6 and it was found in 0.01% KMS solution sample at 3 days. Observed similar values are 8.7, 8.8, and 8.9. The highest value was observed in 40% sugar solution sample at 7 days. The observed similar value is 15.60 at sample S1 after 7 days. There was variation in TSS value among different treatments; these were due to concentration and storage condition. The TSS value of papaya and pineapple were 14.3, 14.87^{0}Brix in 40% sugar solution and 15.5, 16.3 ^{0}Brix in CMC solution at day-5, 7. These results were significantly similar to the experimental result of Islam *et al.* (1993).

4.2. Acidity content of Papaya and Pineapple

The acidity increased over the time and it is observed from table 4.2. In case of papaya, the lowest value of acidity was found at sample S5 in CMC solution sample after 3 days and the highest value of acidity was observed at sample S6 in No treatment sample after 7 days. At day 5, the acidity content of Papaya in all samples significantly similar and these are 0.17, 0.18, 0.18, 0.19, 0.18, and 0.19 observed at **S1, S2, S3, S4, S4, S5 and S6**. In case of pineapple the lowest value of acidity was found in **S1** sample at 20% sugar solution sample after 3 days. The highest value was observed in S4 at 0.01% KMS solution sample after 7 days. The experimentally similar values at day-7 are 1.550, 1.540, 1.520 and 1.510 respectively. There was a little difference in the results of acidity between the report of Maria

I. Gil, (2006) and our study. This is because, Maria Gil studied at 5^0C temperature but we studied at $(0-4)^0$C.

Table 4.2: Acidity content of Papaya and Pineapple at different days (3,5,7)

Sample/ Treatment	Acidity (Papaya), %			Acidity (Pineapple), %		
	3 (Day)	5 (Day)	7 (Day)	3 (Day)	5 (Day)	7 (Day)
S1	0.16 bc	0.17 a	0.2000 bc	1.40 a	1.48 a	1.540 a
S2	0.16 bc	0.18 a	0.1867 cd	1.42 a	1.45 a	1.520 a
S3	0.15 cd	0.18 a	0.1800 d	1.42 a	1.46 a	1.540 a
S4	0.17 ab	0.19 a	0.2100 ab	1.44 a	1.49 a	1.573 a
S5	0.14 d	0.18 a	0.1900 cd	1.43 a	1.47 a	1.510 a
S6	0.18 a	0.19 a	0.2200 a	1.45 a	1.50 a	1.550 a
LSD	0.1819	0.02573	0.01819	0.1422	0.1522	0.1286
CV (%)	6.14	7.32	6.1	5.31	5.62	4.73

Figure in a column followed by a common letter do not differ significantly at 5% level by DMRT

Sample-1: Treated with 20% sugar solution.
Sample-2: Treated with 40% sugar solution.
Sample-3: Treated with 0.1% KMS solution.
Sample-4: Treated with 0.01% KMS solution.
Sample-5: Treated with 1.67% CMC solution.
Sample-6: Not Treated
All samples were treated at (0-4) °C for 3, 5 and 7 days interval.

4.3. Vitamin-C content of Papaya and Pineapple

Vitamin-C value is defined as miligrams of vitamin-C per 100 grams of sample. From the experimental result, it is seen that the vitamin-C content of the samples decreased over the time. In case of papaya, the lowest value of vitamin-C is 33.75 and it was found in 0.1% KMS solution sample at 7 days and the highest value of vitamin-C is 52.00 and it was observed in CMC solution samples at 5 days. The significantly same value is 51.25 and it is found in 40% sugar solution. In case of pineapple the lowest value of vitamin-C is 20.20 and it was found in 0.1%KMS solution sample at 7 days. The highest value is 29.20 and it was observed in 40% sugar solution sample at 5 days. The observed similar values are 19.10, 19, 28.90 and 28.00 were found at samples **S5**, **S1** and **S6** respectively.

Table 4.3: Vitamin-C content of Papaya and Pineapple at different days of interval (3,5,7)

Sample/ Treatment	Vitamin-C (Papaya) (mg/100g)			Vitamin-C (Pineapple) (mg/100g)		
	3 (Day)	5 (Day)	7 (Day)	3 (Day)	5 (Day)	7 (Day)
S1	44.00 b	45.8 b	43.50 b	27.40 bc	28.90 a	26.20 b
S2	49.90 a	51.25 a	49.50 a	26.10 cd	29.20 a	25.80 b
S3	33.90 d	35 d	33.75 d	21.20 e	21.80 c	20.20 d
S4	37.90 c	39.1 c	38.50 c	24.80 d	25.00 b	23.50 c
S5	49.90 a	52 a	49.00 a	28.90 ab	29.10 a	26.13 b
S6	39.94 c	40.25 c	38.50 c	29.20 a	28.00 a	27.80 a
LSD	3.033	2.5	1.887	1.705	1.953	1.376
CV (%)	3.91	3.13	2.46	3.57	3.96	3.91

Figure in a column followed by a common letter do not differ significantly at 5% level by DMRT

Sample-1: Treated with 20% sugar solution.

Sample-2: Treated with 40% sugar solution.

Sample-3: Treated with 0.1% KMS solution.

Sample-4: Treated with 0.01% KMS solution.

Sample-5: Treated with 1.67% CMC solution.

Sample-6: Not Treated

All samples were treated at (0-4) °C for 3, 5 and 7 days interval.

The variation of the results of vitamin-C in pineapple and papaya were due to different concentrations, methods and different storage temperature .The loss of vitamin-C in papaya and pineapple were around 10-14%, 8-12% at 4^0C after 5 days respectively and these values are supported by Maria Gil (2006).

4.4. Moisture content of Papaya and Pineapple

Our experimental result shows that's moisture content of all sample decrease over the times. Moisture content of food (fruit) items is very essential for the health of human as well as all living organ. In case of papaya, the lowest value of moisture content was found in **S6** after 7 days at no treatment sample. The highest values of moisture are 81.40, 81.10 and it was observed in 40% sugar solution and CMC solution at samples **S1** and **S5** respectively after 3 days. In case of pineapple the lowest value of moisture content was found in after 7 days at no treatment sample. The highest value was observed in **S5** after 3 days at CMC coated sample. The significantly similar values are 83.10, 82.20 and 81.57 were found at **S2, S1** and **S3**. The results of the moisture content were supported to the result of Schlimme and Rooney, (1994); Watada *et al.*, (1996). BARI (1987-88) reported that moisture content ranges varies from (7.41 to 8.38) %. These may be influenced by different level of storage conditions, humidity, harvesting conditions etc.

Table 4.4: Moisture content of Papaya and Pineapple at different days of interval (3,5,7)

Sample/ Treatment	Moisture (Papaya), %			Moisture (Pineapple), %		
	3 (Day)	5 (Day)	7 (Day)	3 (Day)	5 (Day)	7 (Day)
S1	80.10 ab	71.8 bc	62.00 b	82.20 abc	73.40 ab	60 bc
S2	81.20 a	73.9 ab	64.80 a	83.10 ab	74.80 ab	61.40 ab
S3	79.80 bc	71.5 c	61.20 bc	81.57 abc	72.90 bc	60.20 b
S4	78.70 c	70.5 c	59.90 c	81.20 bc	71.30 cd	60.20 b
S5	81.40 a	74.1 a	64.90 a	84.10 a	75.00 a	62.80 a
S6	76.90 d	69.8 c	57.20 d	80.10 c	69.57 d	57.80 c
LSD	1.319	2.108	1.702	2.586	1.943	2.212
CV (%)	0.91	1.61	1.52	1.73	1.47	2.01

Figure in a column followed by a common letter do not differ significantly at 5% level by DMRT

Sample-1: Treated with 20% sugar solution.

Sample-2: Treated with 40% sugar solution.

Sample-3: Treated with 0.1% KMS solution.

Sample-4: Treated with 0.01% KMS solution.

Sample-5: Treated with 1.67% CMC solution.

Sample-6: Not Treated

All samples were treated at (0-4) °C for 3, 5 and 7 days interval.

4.5. Ash content of Papaya and Pineapple

The ash content of all sample increase over the times and it is observed from our experiment. In case of papaya, the lowest value of ash is 0.84 and it was found in 0.01% KMS solution at sample S5 after 3 days. The highest values of is 0.97 and it was observed in no treatment samples at S6 after 7 days. The lowest value of ash in pineapple is 0.22 and it was found in 40% sugar solution at S2 after 3 days. The experimentally similar values are 0.23 and 0.23 at S1 and S5 respectively. The highest value was observed in S6 sample at no treatment samples after 7 days. The significantly similar value is 0.29 found in 0.01% KMS solution at same day. The ash content of papaya and pineapple were very closed to Phandis (1970), Wilson (1980) experimental result. Phandis (1970) worked on improvement of papaya in India and reported that papaya contained 0.8% ash, whereas in another experiment Wilson (1980) found 0.76% ash in papaya. This difference might be due to variety characteristics.

Table 4.5: Ash content of Papaya and Pineapple at different days (3,5,7)

Sample/ Treatment	Ash (Papaya), %			Ash (Pineapple), %		
	3 (Day)	5 (Day)	7 (Day)	3 (Day)	5 (Day)	7 (Day)
S1	0.90 ab	0.91 b	0.93 bc	0.23 bc	0.25 cd	0.27 bc
S2	0.89 b	0.90 bc	0.92 cd	0.22 c	0.24 d	0.25 c
S3	0.92 a	0.92 b	0.94 b	0.24 abc	0.25 cd	0.27 bc
S4	0.88 b	0.90 bc	0.92 cd	0.25 ab	0.27 b	0.29 ab
S5	0.84 c	0.88 c	0.91 d	0.23 bc	0.26 bc	0.27 bc
S6	0.92 a	0.95 a	0.97 a	0.26 a	0.30 a	0.32 a
LSD	0.2573	0.02573	0.01819	0.02573	0.1819	0.03151
CV (%)	1.49	1.7	1.11	6.18	4.68	5.9

Figure in a column followed by a common letter do not differ significantly at 5% level by DMRT

Sample-1: Treated with 20% sugar solution.

Sample-2: Treated with 40% sugar solution.

Sample-3: Treated with 0.1% KMS solution.

Sample-4: Treated with 0.01% KMS solution.

Sample-5: Treated with 1.67% CMC solution.

Sample-6: Not Treated

All samples were treated at (0-4) °C for 3, 5 and 7 days interval.

4.6. Microbial load content of Papaya and Pineapple

The microbial load increased over the time and it is observed from table 4.6. Microbial load or microbial colony form is very harmful for the shelf-life as well as nutritional composition of food product. For papaya, the lowest value of total bacterial colony or load was found in **S3** sample at 0.1% KMS solution after 3 days and the significant similar values are 2300 & 2800 observed at **S5** and **S2** sample respectively. The highest value of total bacterial colony count is 34000 and it was observed in **S6** no treatment samples at 7 days. The almost same values at day-7 are 29000 and 30000 observed in **S4 and S1** sample respectively. For pineapple the lowest value of total bacterial count is 2200 and it was found in **S3** at 0.1%KMS solution sample after 3 days and the highest value is over 40000 (not countable) was observed in no treatment sample (**S6**) at 7 days. The observed similar value is 30000 in sample **S1**.

There was a very little difference in the results of total bacterial count between the report of Tournas, V.H (2005a) and our study. This is because of total duration of time, temperature of storage and also the concentration raw ingredients.

Table 4.6: Microbial load content of Papaya and Pineapple at different days (3,5,7)

Sample/ Treatment	Microbial load (Papaya)			Microbial load (Pineapple)		
	3 (Day)	5 (Day)	7 (Day)	3 (Day)	5 (Day)	7 (Day)
S1	24000 b	25000 b	30000 a	25000 b	27000 a	30000 b
S2	2800 c	3000 bc	3600 b	3200 c	3400 c	3800 d
S3	2100 d	2400 c	2800 c	2200 d	2600 d	3200 c
S4	23000 b	24000 c	29000 a	2600 cd	2900 b	3400 c
S5	2300 c	3000 bc	3400 b	2800 cd	3100 c	3600 c
S6	28000 a	30000 a	34000 a	32000 a	34000 b	40000 a
LSD	1506	9042	1361	187.9	8890	1485
CV (%)	5.43	5.24	4.67	3.87	8.68	2.65

Figure in a column followed by a common letter do not differ significantly at 5% level by DMRT

Sample-1: Treated with 20% sugar solution.

Sample-2: Treated with 40% sugar solution.

Sample-3: Treated with 0.1% KMS solution.

Sample-4: Treated with 0.01% KMS solution.

Sample-5: Treated with 1.67% CMC solution.

Sample-6: Not Treated

All samples were treated at (0-4) °C for 3, 5 and 7 days interval.

CHAPTER-V

SUMMARY AND CONCLUTION

CHAPTER V

SUMMARY AND CONCLUTION

The experiment was concerned with the effect of sound quality as well as to investigate the commercial and nutritional aspect of fresh cut papaya and pineapple. The pineapple and papaya were collected from Horticulture department of BARRI, Gazipur and analyzed for color, acidity, Total Soluble Solids, vitamin-C, moisture, ash, microbial status and overall storage stability of fresh cut- fruits. The proximate composition of fresh papaya was 88.4% moisture, 089% ash, 0.18% acidity, 9.3° Brix TSS, 0.13% fat, 1.8% protein and 62mg/100g vitamin-C and the proximate composition of pineapple was moisture 90%, ash 0.22%, fat 0.3%, acidity 1.9%, TSS 8.5° Brix and vitamin-C 38mg/100g.

The chemical analysis of both fresh-cut fruits papaya and pineapple showed that S_2 samples of papaya and S_2 sample of pineapple content the highest total soluble solids (TSS). The TSS (total soluble solids) content observed 14.3^0Brix and 15.5^0Brix respectively in 40% sugar solution and 12.2^0Brix and 10.2^0Brix in CMC respectively at day-5.

The highest Vitamin-C content in papaya and pineapple were found 51.25mg/100g, 29.20mg/100g in 40% sugar solution and 52mg/100g, 29.1mg/100g in CMC respectively after 5 days storage at$(0\ -4)^0$C and these values are significantly differ from 3 and 5 days values. The variation of the results of vitamin-C in pineapple and papaya were due to different concentrations, methods and different storage temperature .The loss of vitamin-C in papaya and pineapple were around 10-14%, 8-12% at 4^0C after 5 days, respectively.

The highest acidity of fresh-cut papaya and pineapple were observed in S_6 sample and S_2 sample respectively at day 7. The acidity content observed 0.18% and 1.45% respectively in 40% sugar solution and 0.18 and 1.47 in CMC coated sample respectively at day-5. These values are significantly similar with Maria I. Gil, (2006). The moisture content in fresh cut papaya and pineapple range from 57.20 to 81.40% and 57.80 to 84.10 respectively at 3 to 7 days interval. The highest moisture content observed at papaya and pineapple were S5 (81.40%) sample and S5 (84.10%) sample at day 3. At day 5 the moisture content of papaya and pineapple were 73.9% and 74.80% at 40% sugar solution respectively and 74.10% and 75.00% at CMC coated sample. The highest ash content in papaya and pineapple were found

0.97% and 0.32% at no treatment samples respectively after 7 days storage at (0 -4)^{0}C and these values are significantly higher from 3 and 5 days values. The 40% sugar solution treated samples of papaya and pineapple gives ash content 0.90 and 0.25 respectively and CMC coated samples gives ash content 0.88% and 0.26 respectively. The microbiological studies revealed that microbial load or colony (bacteria) was comparatively higher (not countable, >40000) in no treatment in both papaya (S_6) and pineapple (S_6) than 40% sugar solution, 0.1% KMS solution and CMC coated sample at day 7. Storage studies were carried out for eight days at (0-4)^{0}C temperature and samples were taken for analysis at intervals of 3, 5 and 7 days. The lowest microbial load in S_3 (2400) and S_3 (2600) respectively in papaya and pineapple at day 5.

From the study, we observed that 40% sugar solution and CMC treated samples in day 5 were comparatively good among all the samples. So, we can say that fresh-cut fruits can be preserved with 40% sugar solution and coated with CMC up to 5 days at (0 to 4)^{0}C with good perceptible quality.

RECOMMENDATION

Papaya is mainly used as fruits and vegetables and pineapples are mainly used as fruits in almost throughout the countries. Processed and preserved fresh fruits item can be a good utilization of these product and the farmers can get high price which will indirectly enrich our national economy..

- 40% sugar solution and CMC coating is an efficient treatment to extend the shelf-life of fresh-cut papaya and pineapple.
- Further analysis should be done to know the different volatile compound such as β-carotene, Lycopen and other micro nutrients content.
- Different temperature effect can be applied to know further shelf-life information.
- Chemical composition and nutritional information suggests the future strategy for the nutritionist, health advisors and dieticians as to know how to make best use of fresh cut papaya and pineapple.
- Furthermore, since farmer would get proper price for their produce, productivity would be increased and sustained.

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APPENDICE

Appendice.1: Chemical composition of Pineapple (***Ananus sativus***)

Nutrient	Units	Value per 100 grams
Water	g	86.00
Protein	g	0.54
Ash	g	0.22
Carbohydrate, by difference	g	13.12
Fiber, total dietary	g	1.4
Sugars, total	g	9.85
Sucrose	g	9.85
Glucose (dextrose)	g	5.99
Fructose	g	1.73
Vitamin C, total ascorbic acid	mg	47.8
Vitamin A, IU	IU	58
Vitamin A, RAE	mcg_RAE	3
Carotene, beta	mcg	35

Source: http://foodscience.wikispaces.com/Pineapple

Appendice.2: Chemical composition of Papaya (*Carica papaya)*

Nutrient (Proximates)	Units	Value per 100 grams
Water	g	88.83
Protein	g	0.61
Total lipid (fat)	g	0.14
Ash	g	0.61
Sugars, total	g	5.90
Calcium, Ca	mg	24
Magnesium, Mg	mg	10
Potassium, K	mg	257
Sodium, Na	mg	3
Vitamin C, total ascorbic acid	mg	61.8
Vitamin A,IU	IU	1094
Vitamin A, RAE	mcg_RAE	55
Virtamin E (alpha-tocopherol)	mg	0.73
Vitamin K	mcg	2.6
Carotene, beta	mcg	276
Cryptoxanthin, beta	mcg	761
Lutein+Zeaxanthin	mcg	75

Source: http://foodscience.wikispaces.com/Papaya