PREPARATION OF CANDY USING BANANA, PINEAPPLE AND GINGER.

काशी हिन्दू विश्वविद्यालय BANARAS HINDU UNIVERSITY

THESIS

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MASTER OF SCIENCE

IN

DAIRY SCIENCE AND FOOD TECHNOLOGY

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Respected sir,

I have great pleasure in forwarding the thesis entitled ‘’PREPARATION OF CANDY USING BANANA, PINEAPPLE AND GINGER” submitted by Ms. Neha Yadav, ID. No. FST-18412FST012, in partial fulfilment of the requirements for the degree of Master of Science in Food Science and Technology, from Department of Dairy Science and Food Technology, Institute of Agriculture Sciences, BHU Varanasi.

I certify that the entire scheme of investigation, presented here in, was planned and carried out solely by the candidate under my guidance. To the best of my knowledge, the data presented in the thesis are genuine and original.

Thanking you.

FORWARDED BY Yours faithfully,

(HEAD OF DEPARTMENT DR. ANIL KUMAR CHAUHAN

(SUPERVISOR)

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Place:

Date: *Neha Yadav*

CONTENTS

LIST OF ABBREVIATIONS

ºC	Degree Celsius
+ve	Positive
AOAC	Association of Official Analytical Chemists
$Ca(OH)_2$	Calcium Hydroxide
cfu	Colony forming unit
df	degree of freedom
FFA	Free fatty acid
g	gram
H_2SO_4	Sulphuric acid
HCL	Hydrochloride
ml	milliliter
N	Normality
NaCl	Sodium chloride
NaOH	Sodium hydroxide
Pred	Predicted
R	Correlation coefficient
TPA	Texture profile analysis
-ve	Negative
TPC	Total Plate Count

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INTRODUCTION:

BANANA (*Musa paradisiaca*) is a central fruit crop of the tropical and subtropical regions of the world (Mohapatra *et al*., 2010). Banana is an edible fruit-botanically a berry belonging to the genus Musa, produced by several kinds of herbaceous flowering plants. They are the fourth most consumed food crop, the most consumed non-cereal food and the most consumed staple food in the world.Banana is mainly cultivated for its ripened fruits, cooked vegetables and leaves in India and many other countries including Bangladesh (Khanum *et al*., 2000).

India is the largest producer of fruit after china, with an annual production of 76.61 million tons from an area of 4.06 million hectares. A large variety of fruits are grown in India such as mango, banana, citrus, guava, grape, pineapple, apple, and papaya are the major ones. The major fruit growing states are Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Bihar, Uttar Pradesh, Madhya Pradesh and Gujarat (NHB, 2000). Banana ranks first in the world, occupying for about 34.2 percent of the total production of fruits(Murasoli.M, 2016).The fruit is usually elongated and curved with a rind which may be green, yellow, red, or brown when ripe. The fruit usually grow in clusters hanging from top of the plant. Theedible seedless (parthenocarpy) bananas are *Musa acuminate* and *Musa balbisiana*. Important banana growing states are Kerala, Tamil Nadu, Maharashtra, Assam, Mysore, Andhra Pradesh, Madhya Pradesh and west Bengal. Banana is fourth most important crop grown after rice, wheat, and corn (Murasoli. M and Jambulingam S.,2016). Banana is tropical fruit of India and one of the most nutritious fruit with easily digestible carbohydrate. Banana is a rich source of carbohydrates and is rich in vitamins particularly vitamin B complexes. It is a good source of potassium, phosphorus, calcium and magnesium. The fruit is easy to digest, free from fat and cholesterol. Banana powder is used as first baby food. It helps in reducing risk of heart diseases when used regularly and is recommended for patients suffering from high blood pressure, arthritis, ulcer, gastroenteritis and kidney disorders (NHB, 2001-02). It is the best fruit with delicious taste, attractive taste, and higher nutritional value. They are usually exported in semi ripe but slightly unripe conditions (when they have to be exported to longer distance). Ripe fruits are delicious and used for table purpose.In India, there are many items can be prepared by raw banana as fried chips, raw banana slices, flour, flakes, etc. and after its ripening they are used for its delicious taste, delightful flavor, and soft texture. Ripe banana fruits are processed and used for preparing various products such as leather, toffee, powder, drinks, figs, jams, puree, paste, wine, vinegar, etc. All parts of banana plant have medicinal applications, the flower in bronchitis and dysentery and on ulcers; cooked flower are given to diabetics; the astringent plant sap in case of hysteria, epilepsy, leprosy, fevers, hemorrhages, a cute dysentery and diarrhea, and is applied on hemorrhoids, insects and other stings and bites (ISSN: volume7).

PINEAPPLE(*Ananascomosucs*)is a compound fruit and matures within 18-22 months after plantation. It has exceptional juiciness and a vibrant tropical flavor that comes balances the tastes of sweet and tart. It is the major fruit of Bangladesh. It is the leading edible member of the family Bromeliaceae which embraces about 2000 species (Jakia Sultana Jothi*et al*.,2004). The pineapple fruit is known to have a good source of vitamin A and B and a rich in vitamin C. It contained enzymes, bromelain and pineapple leaf was a good source of chlorophyll(Jakia Sultana Jothi *et al*.,2004). Pineapple contains considerable amount of calcium, potassium,

vitamin C, carbohydrates, crude fiber, water and different mineral that is good for digestive system and helps in maintaining ideal weight and balanced nutrition (International journal of nutrition and food science, 2015). Pineapples may be consumed fresh, canned, juiced and found in wide array of food stuffs- dessert, fruit, salad, candy etc. vitamin C is the body's primary water-soluble antioxidant, against free radicals that attack and damage normal cells (International journal of nutrition and food science, 2015).

GINGER *(Zingiberofficinale)*is a perineal herbwith thick tuberous rhizomes. Itbelongs to the family Zingiberaceae. Its roots are used as spice in cooking throughout the world (Adulyatham, 2001). Ginger contains up to 3% of an essential oil that causes the fragrance of the spice (O'hara *et al*.,1998). The pungent taste of ginger is due to gingerol, zingerone, and shogaol (Sharma,2002). The rhizome contains some proteolytic enzyme known as Zingibain (Thompson *et al*., 1973; Ichikawa *et al*.,1973). Nowadays, ginger there is great importance of the consumption of ginger due to is medicinal property. Gingerol increase the motility of gastrointestinal tract and have analgesic, sedative and antibacterial properties (Malu *et al*., 2009). Ginger stimulates the production of saliva (O'hara *et al*., 1998). It promotes the release of bile (Opdyke, 1974; Kato *et al*, 1993). It is used as a stimulant and carminative and also for dyspepsia and colic (O'hara *et al*,1998). Ginger is used to decrease the pain from arthritis, may have blood thinning and lowering cholesterol and is also useful for heart diseases and lung diseases (Kuschener and Stark, 2003). Ginger is effective for treating nausea caused by seasickness, morning sickness and chemotherapy. It is also used for treatment of inflammation, cold, heat cramps, and diabetes (Al-Amin, 2006; Afshari, 2007). Ginger is also used for disguising the taste of medicines.

CANDY is a sweet confectionery prepared from fruits and vegetable (ginger, beetroot) by impregnating them with sugar syrup followed by draining or excessive syrup and then drying the product to a shelf stable state (Ralph S Paffenbarger, 1998). Candies can be prepared from fruits and vegetables like apple, ginger, mangoes, guava, carrots, and citrus peels. Most suitable fruits for the preserves and candy are pineapple, cherry, papaya, banana, aonla etc. And also, there are huge requirement for this type of product from the point of health and nutrition. Candy is also called as sweets or lollies.

Physically candy is characterized by the use of sugar or sugar substitutes such as honey, stevia, xylitol etc. in a significant amount. Candies are usually made in smaller pieces. Unlike sweet pastries served for dessert curse at the end of meal, candies are normally eaten with fingers in between meal or anytime you want. Candy consumption can be useful while doing difficult task, a shot of sugar makes people preserve longer and keeps them focused as well as the act of chewing can improve your mood, reduce stress, increase mental focus (Harvard School of public health, 2011). The shelf life depends on the type of candy, packing and storage conditions. Moisture plays critical role in determining the quality and shelf-life of sugar-based confections. Barrier packaging films protect the candy from air whereas edible films inhibit moisture migration between different moisture domains within a confection (Roja Ergun, 2010).Considering the above facts, the present investigation was undertaken with the following objectives:

1.Preparation of banana candy using pineapple, ginger.

2.Proximate analysis of prepared banana candy.

3.To study the shelf-life using physico-chemical, sensory and microbial properties of banana candy.

JUSTIFICATION: Bananas are nature's version of candy; they are so naturally sweet that they make anything you pair them with taste like dessert, a much healthier version of it. Our body actually needs carbs to fuel our body and unlike processed sweet treats, a banana candy is a natural occurring sugar as accompanied by vitamins and minerals, so it can be easily consumed by diabetic patients. Banana candy is also rich in fiber, which slows down the digestion of sugar and helps keep you feeling full. People on weight loss routine can have banana candy as it does not contain much amount of added sugar and it is also rich in fiber and potassium. If you go too long without eating your body craves for refined grains or simple sugars so banana candy is a good option, to have it anytime anywhere. As the banana also contains starch, which gets fermented by bacteria to form butyrate, which is a short chain fatty acid that have beneficial effect on gut health. Pineapple is also used here as it contains nutrients, antioxidants and other useful enzymes that can help fight disease and inflammation. Consumption of candy incorporated with pineapple helps in aiding digestion, boosting up immunity and fast recovery from any injury. Candy which constitute of ginger is deliciously beneficial to our health as ginger is a well-known stomach soother to help fight motion sickness and nausea, beyond that it is also beneficial in fighting cancer, obesity and anti-inflammatory responses in body.

REVIEW OF LITERATURE

CANDY

Candy is sweet food prepared from fruits and vegetables (beetroot, ginger) by saturating them with sugar syrup and draining of excess of syrup from them and then drying the product to the stable shelf life. Fruits and vegetables like mango, apple, ginger, guava, carrot, citrus, etc are used to make candies(Mehta and Bajaj, 1984). But in this research, we are preparing a banana-based candy using ginger and pineapple because of their nutritional properties.

Candy has played important role in traditional cultural activities and even in celebrations for hundreds of years. Candy contributes relatively small proportion of added sugar andcaloriesto the total diet and the recent research suggests that current level of candy consumption is not associated with the risk of weight gain and cardiovascular disease in children and adults (Sheel *et al*., 1997). Studies have shown that candy carrying the sugar can help the people to focus better and stay on task when they are working on something. Whether it is a homework or an assignment or an issue to your job, the solution to figuring out difficult problem could be as simple as sugar jolt. You may feel as candy, makes everything better, but now we have the science to back it up. Candy happiness is real thing, and there are real health benefits of candy. When you eat candy, the sugar goes into your stomach where it quickly enters the bloodstream. Once in your blood stream, it does not take long to reach your brain, it works like magic.

This chapter deals with the scientific work carried out by researchers related to the preparation of banana-based candy using ginger and pineapple, and study their nutritional aspects. The investigation was done by considering three basic requirements:

1. Preparation of banana candy using ginger and pineapple.
2. Proximate analysis of prepared banana candy.
3. To study the shelf-life using physio-chemical, sensory and microbial properties of banana candy.

BANANA

Name: Musa paradisiaca

Parts used: fruit (pulp)

Taxonomic Hierarchy

Kingdom: Plantae

Subkingdom: Tracheobionta

Super division: Spermatophyta

Division: Magnoliophyta

Class: Liliopsida

Subclass: Zingiberidae

Order: Zingiberales

Family: Musaceae

Genus: Musa

Species: Musa paradisiaca

PHYSICAL CHARACTERISTICS OF BANANA

Banana fruit is strongly recommended by nutritionists (Chandler,1995), and highly appreciated by consumers because of its sweetness and flavour. Ripe banana fruits are used and processed for preparing toffee, powder, drinks, figs, jams, puree, candy, vinegar, paste, wine etc. The waste (damaged fruits, peels, stalks, pseudo-stem, rhizome) generated by excess of banana production can be minimized either utilizing the fruits by preparing candy or any other attractive confectionary items for children (Mahmoud Soltani *et al*.,). A healthy diet consists of eating variety of foods from five food groups (starch, fruits and vegetables, milk and dairy food, protein, fats and sugars) but in correct proportion.Sweet desert type of banana is generally eaten raw(fruit), whereas cooked type of bananas is steamed, boiled, roasted(food). Any foods containing carbohydrates should be main part of our daily meals. In unripe bananas the carbohydrates are mostly starches. In the processing of ripening the starches are converted to sugars; fully ripe banana has 1-2% starch. According to UNCST(Uganda National Council for Science and Technology) eating variety of foods that provides nutrients helps to maintain health, feels good, and provide energy. These nutrients include protein, carbohydrates, fat, water, vitamins, and minerals. Banana belongs to the food group which is a reliable source of starch, energy and dietary fibre. Banana is a perennial herb which looks like tree, very commonly found in tropical and subtropical area.

BANANA PRODUCTION IN INDIA

India is the largest producer of fruit after China, with annual production of 86 million tonnes from an area of 4.06 million hectares, (NHB,2000). The total area under banana cultivation is over 200,00 hectares. Important banana growing states are Kerala, Tamil Nadu, Maharashtra, Assam. Mysore, Andhra Pradesh, Madhya Pradesh and West Bengal. Banana is fourth most important crop after rice, wheat, corn. The biological composition of fruits depends on the abiotic factors such as climate, cultivation methods, soil type and storage conditions, cultivator. There are around 200 varieties of banana grown in India, of which dozens of commercial importance include Barsai, Horichal, Nendran, Monthan, Povan, Safed vechi, Grand Naine, etc. They are usually exported in semi ripe stage but unripe in some conditions (when they are travelled to longer distances). Ripe fruits are delicious and used for table purpose. Edible banana is originated in Indo-Malaysian region reaching to northern Australia. They were known in the Mediterranean region in the 3rd century B.C and are believed to have been first carried to Europe in the 10th century A.D early in the 16th century. Portuguese mariners transported the plant from the West African coasts to South America. It even spread into the islands of the pacific and to the west coasts of Africa as early as 200-300 B.C (Rahman *et al*.,2003). In India, it is mostly found in Tamil Nadu, Andhra Pradesh, Bihar, Madhya Pradesh, West Bengal, Gujarat, Maharashtra, Uttar Pradesh Its fruit is very tasty and nutritious

with high-calorie content (Anonymous *et al*., 1962). The most important banana producing states in India including its percentage productivity is shown in Fig. 1.1

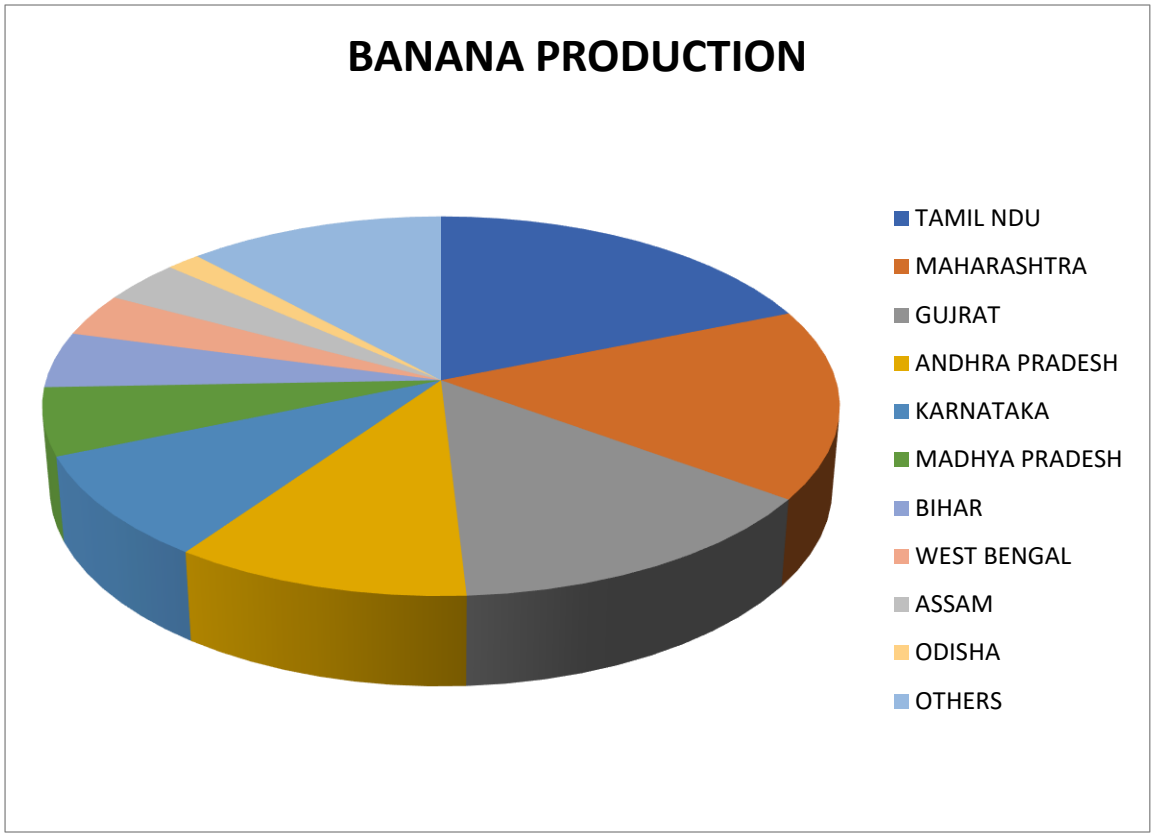

Fig. 2.1 Banana production in India(Priyanka Kumari, agriculture university, 2015)

NUTRITIONAL AND CHEMICAL COMPOSITION OFBANANA

The nutritional composition of ripened banana studied by various researchers is as shown in table 2.1

Table 2.1 Nutritional and chemical composition of ripened banana

Constituents	Range	References
Moisture(%)	63.8-76.0	US Sente(1997), Ockerman(1978), Paul and Southgate(1978), Gopalan *et al*.,(1978), CIQUAL-CNEV(1993), Yousaf *et al*, (2006).
Total sugar(%)	14.20-20.18	Ockerman,(1978)
Reducing sugar(%)	4.10-18.89	Ockerman(1978), Yousaf *et al*.,(1978), Ramesh Kumar *et al*.,(2008)
Non reducing sugar(%)	0.00-16.08	Ockerman(1978), Yousaf (1978), Ramesh Kumar *et al*.,(2008)
Starch(%)	2.93-7.00	Ockerman(1978), Paul and Southgate(1978)
Fiber(%)	0.4-2.0	Gopalan *et al*.,(1978), CIQUAL-CNEV(1993)
Pectin(%)	0.34-1.10	Ockerman(1978)
Tannins(%)	0.007-0.050	Kotecha *et al*.,(1994), Yousaf *et al*.,(2006).
Total carbohydrates(%)	21.8-27.2	Gopalan *et al*.,(1978), CIQUAL-CNEV(1993)
Protein(%)	0.48-1.50	U.S Sente(1997), Ockerman(1978), Paul and Southgate(1978), CIQUAL-CNEV(1993).
Fat(%)	0.20-0.90	U.S Sente(1997), Ockerman(1978), Paul and Southgate(1978), CIQUAL-CNEV(1993).
Ash(%)	0.28-0.90	U.S Sente(1997)
Potassium(mg%)	350-385	Paul and Southgate(1978),CIQUAL-CNEV(1993)
Magnesium(mg%)	30-42	Paul and Southgate(1978),CIQUAL-CNEV(1993)
Phosphorus(mg%)	22-36	U.S Sente(1997), Gopalan *et al*.,(1978), CIQUAL-CNEV(1993)
Calcium(mg%)	8-17	Paul and Southgate(1978), Gopalan *et al*.,(1978), CIQUAL-CNEV(1993)
Iron(mg%)	0.4-0.9	U.S Sente (1997), Gopalan *et al*.,(1978), CIQUAL-CNEV(1993)

Vitamin C (mg%)	7-12	U.S Sente(1997), Paul and Southgate(1978), Gopalan *et al*(1978), CIQUAL-CNEV(1993), Yousaf *et al*.,(2006)
Niacin(mg%)	0.5-0.7	U.S Sente(1997), Gopalan *et al*.,(1978),CIQUAL-CNEV(1993)
Vitamin B6 (mg%)	0.47-0.51	Paul and Southgate (1978), CIQUAL-CNEV (1993)
Riboflavin (mg%)	0.05-0.07	U.S Sente (1997),Paul and Soouthgate(1978), CIQUAL-CNEV(1993)
B-carotene(mg%)	0.050-0.078	U.S Sente(1997), Gopalan *et al*.,(1978), CIQUAL-CNEV(1993)
Thaimine (mg%)	0.04-0.05	Paul and Southgate(1978), Gopalan *et al*.,(1978), CIQUAL-CNEV(1993).

According to the data by various researches shows that the moisture and total sugar content in banana varies from 63.8-76.0 per cent and 14.20-2018 per cent, respectively. Reducing sugar consists of plenty of carbohydrate. Glucose and fructose are the main reducing sugar present in banana while non-reducing sugar present there is sucrose. Banana contains 2.93-7.00 per cent starch, 0.4-2.0 per cent fibre while pectin ranges from 0.34-1.10 per cent. Pectin gives viscous body and stabilizes the banana. Total protein in the pulp ranges from 0.48-1.50 per cent while the carbohydrate present there varies from 21.8-27.2 per cent. The amino acid that are majority present in banana are aspartic acid, histidine, leucine, and valine with total amino acid content of 3517 milligram per hundred grams(Aksar,1973).

Fat content of banana ranges from 0.20-0.47 per cent (Ockerman, 1978). Potassium, magnesium, phosphorous, calcium, and iron are the main minerals present in banana, where potassium ranges from 39-58 per cent of total mineral present. Banana has been also reported to constitute niacin, vitamin B6, riboflavin, β-carotene, ascorbic acid in good amount.(Paul and Southgate,1978; Gopalan *et al*.,1978).

HEALTH BENEFITS OF BANANA

As banana is rich in fibre, it helps in slowing down the digestion of sugar and helps you to give feeling of filled stomach, so it will be beneficial for the children suffering from malnutrition and other diseases (Murasoli. M and Jambulingam, 2016). Complex carbohydrates are found in banana, its natural sugar entering in the blood streams of children keeps them healthy. Banana also contains tryptophan,protein which gets converted to serotonine by our body. Serotonine is one of the “feel good hormone” known to help you relax, improve your mood

and gives you feeling of health and wellness. Presence of tryptophan, helps people suffering from seasonal affective disorder (SAD).

1.HIGH FIBRE CONTENT

Banana is loaded with fibre, both soluble and insoluble. The fibre which is soluble has the tendency to slow down the digestion and keeps you feeling full for longer time, which is why bananas are often included in the breakfast meal so that you can start your day without having to worry about the next meal.

2.HEART HEALTH

High fibre food is good for heart. According to the study done by the university of Leeds in UK in year 2011, increasing the consumption of fibre-rich foods such as bananas can lower the risk of both cardiovascular diseases (CVD) and coronary heart diseases (CHD).

3.EASE IN DIGESTION

Banana has sweet and sour taste according to Ayurveda. The sweet taste is aid to bring about sense of heaviness but the sour taste is known to stimulate pepsin (the digestive juices), thereby supporting digestion and helping in building up metabolism.

4.POWER HOUSE OF NUTRIENTS

Banana is heavyweight when it comes to nutrition. It is loaded with essential vitamins and minerals such as potassium, calcium, manganese, magnesium, iron, folate, niacin, riboflavin, and B6. These all contribute to proper functioning of body and keeps you healthy.

5.HIGH SOURCE OF POTASSIUM

The high content of potassium in bananas makes it super fruit. This mineral is known for its numerous health benefiting properties-it helps in regulating heartbeat, blood pressure, and keeps the brain alert. So, make sure you add bananas in your diet to keep you heart and brain healthy.

6.BLOOD PRESSURE

It is known fact that salt is culprit when it comes to high blood pressure. Bananas have low salt content and high potassium content and these properties contribute to making it and ideal for those undergoing this condition.

7.HELPS FIGHT ANAEMIA

Due to high iron content, it helps people suffering from anaemia(Meghan ware, 2020).

PINEAPPLE

Pineapple (Ananascomosus) is leading edible member of family Bromeliaceae which embraces about 2000 species. India is the world's 5^{th} largest producer of pineapple with 8% of world production of 1.3mn tones(Jacob and Soman, 2006)

PHYSICAL CHARACTERS

There are several cultivators of pineapple under cultivation under different parts of world. In India only Kew or Gaint Kew, Queen and Mauritius are cultivated on commercial basis. Kew is the most important, leading commercial variety grown in India. The fruit ripened during October to December are acidic and therefore are used for processing. It is late fruiting variety and ripens in August and September (non.,1985). According to Sen(1990) and Kumar et al.,(1991), the fruit weight of pineapple or giant pineapple varies from 1.6 to 3.0kg. Similarly, Bhat et al.,(1997) recommended the optimum average fruit weight is 2.1kg for making canned products. The core is the central axis of the individual fruit that is removed during processing of the pineapple (Tessellarand Joslyn, 1971).

CHEMICAL COMPOSITION

The chemical composition of pineapple fruit depends upon variety of factors which include variety, nutrition, exposure to light, weather, insects' diseases.

Mookerji *et al*.,(1969) found that total soluble solid content in fruits of cultivar pineapple increases gradually and was maximum(16.5%) ripening, while, Baht *et al*.,(1997) observed that fruit of giant pineapple contained 14% total soluble solids. Nakloh *et al*., (1985) found that summer fruits of pineapple had higher total soluble solids than winter fruits and also observed that peduncle was richest in the total soluble solids. The moisture content in the fruits of pineapple at ripening was found to be 78.52% (Mookerji *et al*.,1969). Organic acid is also responsible for sourness of fruit. Jayaraman *et al*.,(1975) reported that acidity of edible portionof pineapple was 0.87%.

Ascorbic acid plays an important role in human nutrition.According to Kerns *et al*., (1936) the vitamin C was not distributed uniformly within the fruit pineapple, but showed great concentrate in the inner surface of the shell with small amount located in regions near the corn. Sugar are related with sweetness, flavour, colour, and structure of fruit. Mookerji *et al*.,(1969) found that ripened fruit of pineapple contain 5.1% reducing and 9.0% non-reducing and 14.0% total sugar. Carotene, which is precursor of vitamin A, is found in most of fruit in varying quantity. Pineapple is good source of carotene. According to Mookerji *et al*., (1969), the ripened fruit consist of 0.39% ash content.

Table 2.2 Nutritional Values of Pineapple Fruit (Md. Farid Hussain Shaheen Akhtar, 2015)

NUTRITION	VALUES
TSS	13.3%
Moisture	87.3%
Acidity	2.03%
Reducing sugar	10.5%
Non-reducing sugar	7.4%
Ash content	1.8%

Pineapple is having many health benefits it containsenzymebromelain, which is found to have useful anti-inflammatory, effective in reducing swelling and assisting in the treatment of conditioned such as acute sinusitis, sore throat, arthritis and gout.

Pineapple can be utilized for the production of dried powder, jam, pulp, canning etc. The major products are canned slices, chunks, crush, juice (Jacob and Soman, 2006).

GINGER

Ginger (*Zingiber officinale*) is tropical monocotyledon and herbaceous perennial rhizome belonging to the order Scitamineae and family Zingiberaceae. It is believed to be the native of south east Asia from where it was introduced to Africa and Caribbean regions(Purse glove et al., 1981). The total ginger production in the world is 32,70,762 tones with total average of 4,07,773 hectares. India, Nigeria, China, Indonesia and Nepal are major producers of ginger. In India ginger is grown in an area of 165 thousand hectares with production of 1109 thousand tone(NHB,2017).

Ginger is spice and medicinal plant gaining attention in the pharmaceutical, food and chemical industries as being an excellent source of several bioactive phenolics, including non-volatile pungent compounds such as gingerols, Pardols, Shogaols, and Singerones(Srinivasan,2016). The pungency of fresh ginger is due to the presence of gingerol. Ginger has potent antimicrobial and antioxidant activity part from countering liver toxicity by increasing bile secretions(Pwer,2009). In addition to the medicinal activities plants extracts also serve as natural larvicidal agent (Kalaivani *et al*.,2012).

Ginger is presently used in various forms like fresh, dried as saunth and ginger powder, pickles, ginger preserves or candies, ginger juice for making squashes and appetizers etc. Essential oil and oleoresin from ginger are utilized for the preparation of soft drinks, non-alcoholic beverages and vitaminized effervescent soft drinks(Peter,1999).

Fig.2.2Raw Materials

CHANGES IN CHEMICAL COMPOSITION OF CANDY DURING STORAGE

The chemical composition of banana candy depends upon the variety and method of preparation.

Moisture

The moisture content was found to be decreased from 18.8 to 18.3% in Aonla candy stored for 135 days at room temperature(Tripathi *et al*.,1988). The loss in moisture content of pear candy was between 20.1 to 19.3% (Rani and Bhatia, 1985). There was 5% reduction in Ber candies stored for one year at room temperature(Gharte, 1984). Kaikadi(1994) reported reduction in moisture of Ber candy from 19.7 to 13.0% at refrigerated temperature after 180 days of storage.

Total soluble solids

TSS content of per candy gradually increased from 74° to 75°brix under refrigerated storage for 24 weeks. The TSS content of Aonla preserve continued to increase from 75°to 78°brix after six months of storage at room temperature(Jain *et al*.,1983). The TSS content increased to 79°brix during storage at ambient temperature and to 83°brix during storage at 37°C temperature for 16 weeks(Rani and Bhatia,1985). Gharte (1984) reported an increase in TSS of Ber candy from 7.0 to 83.0 during storage for three months at room temperature.

Acidity

In case of per candy acidity decreased from 0.17 to 0.09% under refrigerated temperature and is reduced to 0.17 to 0.07% when stored at room temperature for 24 weeks(Rani and Bhatia, 1985). The freshly prepared aonla candy had 0.72% acidity which decreased to 0.70 % during storage for 135 days at room temperature.(Tripathi *et al*.,1988). The acidity of fresh apple

candy decreased from 1.40 to 1.34% after three months storage at room temperture while, it is reduced from 1.40to 1.36% under refrigerated condition.

Reducing sugars

In aonla candy, reducing sugar increased from 40.0 to 45.6% during storage for 135 days at room temperature.(Tripathi *et al*., 1998). In Ber candy, reducing sugar increased from 30.9 to 47.9% during storage of 1 year reported by, (Gupta *et al*., 1980). The reducing sugar content in aonla preserve increase from 35.5 to 41.8% after six months storage at room temperature(Tripathi *et al*.,1988). In per candy, reducing sugar increased from 34.7 to 36.4% under refrigerated temperature and to 39.5% at room temperature after 24 weeks while it increased to 45.6 at 37°C after 16 weeks(Rani and Bhatia,*et al*.,1985).

Total sugar

The total sugar content of ber candy increased from 82.1 to 85.9% during storage for one year(Gupta *et al*.,1980). The total sugar content of aonla candy was reported to increase from 65.5 to 67.0% during storage from 135 days(Tripathi *et al*.,1988). The total sugar content increased from 74.9 to 78.95% in per candy after 24 weeks of storage at refrigerated condition and from 74.9 to 79.0% at room temperature(Rani and Bhatia *et al*., 1985).

Tannins

The tannin content in aonla candy was reported to decrease from 0.22 to 0.20% during storage for 135 days(Tripathi *et al*., 1983) it was also reported to decrease the tannin content from 0.32 to 0.29% in aonla preserve when stored for 135 days(Jain *et al*., 1983)

CHANGES IN SENSORY PARAMETERS OF CANDY DURING STORAGE

Colour and appearance

Gupta *et al*.,(1980) observed that the colour of freshly made ber candy was dark yellow which became dark brown after storage for one year. The decrease in colour and appearance was found to be faster under room temperature storage than at refrigerated temperature. Tripathi et al., (1988) reported that the colour and appearance gradually decreased in ml candy after 135 days storage period. The similar results were also reported in per candy after storage for 24 weeks at room refrigerated temperature(Rani and Bhatia, 1985).

Texture

The score for texture was reported to decrease with advancement of storage period in amla candy(Tripathi *et al*., 1988), per candy(Rani and Bhatia,1985) and ber candy(Gupta *et al*., 1980; Kaikadi, 1994).

Flavour

The flavour gradually decreased with advancement of storage period in ber candy(Gupta *etal*., 1980;Kaikadi,1994), in aonla candy (Tripathi *et al*.,1988) and in per candy(Rani and Bhatia,1958).

Taste

In aonla preserve taste improved with increase in storage period(Tripathi *et al*.,1988). In aonla candy, the taste decreased up to three month and then increased little(Tripathi *et al*.,1988). Similar results were reported in ber candy (Gupta *et al*., 1980).

Overall Acceptability

The overall acceptability was reported to be rejected. Rani and Bhatia (1985) checked per candy stored at high temperature(37°C) and reported that it deteriorated faster and was acceptable only till 16 weeks. Tripathi *et al*., (1988) evaluated aonla candy for organoleptic parameters and found that the product exhibited maximum acceptability just after its preparation which declined during the course of storage. Whereas the candy stored at room temperature and refrigerated temperture was acceptable even after 40 weeks of storage.

SENSORY SHELF LIFE (SSL)

Sensory shelf life is defined as “the time period during which the product’s sensory characteristics and performance are as intended by the manufacturer. The product is consumable or using during this period, providing the end user with the intended sensory characteristics, performance and benefits. Sensory evaluation is form of subjective test, and fuzzy logic tool has been reported to remove this subjectivity in analysing linguistic judgement (ASTM,2005).

MICROBIOLOGICAL STUDIES DURING STORAGE

The most serious constraint for shelf life enhancement is the activity of microorganisms. Rahman and Perera (1999) reported that several efforts were made for an improvement in quality retention of products by altering processing strategy and pre-treatment methods in recent years.

MATERIALS AND METHODS

The present study was conducted in the research laboratory of Department of Dairy Science and Technology, Institute of Agriculture Science, Banaras Hindu University during the year 2019-2020. In this section the details regarding to the materials and method used for the study are described.

Table 3.1 Instruments used in manufacturing and analysis of candy

Name	Company, Model and Country
Electronic weighing balance	Mettler Toledo, JB I 603-CIF act, Switzerland
Texture profile analyze	TA. XT plus texture profile analyzer, stable micro systems, UK
Vortex shaker	Macro scientific norks Pvt. Ltd, Delhi
Hot air oven	Per fit, 992110, India
Laminar air flow	Labtech LCB 1201v, Diahann Pvt.Lmt, India
Centrifuge machine	Sigma, 3-30K, Germany
High pressure steam sterilizer (vertical autoclave)	Tommy, SX-500,Japan
Soxhlet apparatus	SOCS PLUS,SCS-4, Chennai
Incubator	Remi, India

3.2 Selection of Raw Material.

The fruit the Banana(Musa X paradisiasca), was purchased from local market of Varanasi, Uttar Pradesh along with Pineapple, Ginger, Salt, Honey etc.

3.3Chemicals

All chemicals used in this study were of analytical grade.

3.4 Experimental set-up

The equipment's used were knife, electronic balance, Soxhlet, hot air oven, muffle furnace; salient features of the major equipment's are described below.

3.4.1 Electronic balance

A top pan electronic balance of high accuracy with least count of 0.01g was used for weighing the samples.

3.4.2 Soxhlet

A Soxhlet extractor is a piece of laboratory apparatus (Laurence M.Hardwood) invented in 1879 by Franz von Soxhlet(Soxhlet, F. Die). It was originally designed for the extraction of a lipid from a solid material. However, a Soxhlet extraction is not limited to the extraction of lipids. Typically, a Soxhlet extraction is only required where the desired compound has a limited solubility in a solvent, and the impurity is insoluble in that solvent. Ifthe desired compound has a significant solubility in a solvent then a simple filtration can be used to separate the compound from the insoluble substances.

3.4.3 Muffle Furnace

A muffle furnace is a furnace with an externally heated chamber, the walls of which radiantly heat the contents of the chamber, so that the material being heated has no contact with the flame. Muffle furnace are most often utilized in laboratories as a compact means of creating extremely and accurate temperatures. A muffle furnace is also known as a retort furnace.

3.4.4 Packaging materials

Polyethylene bags of 150 gauges were used for packaging of candy.

3.5 Method

Preparation of candy

The bananas were peeled and so as pineapple and ginger too. Then we will make paste of ginger and pineapple. This paste will be mixed with peeled banana and will be desiccated to heat. When it starts little boiling, we will be adding 0.1% salt for enhancing its taste with continuous stirring. Then after 5 minutes we will be adding 50% honey with 3% pectin acid with continuous stirring. After 20-30 minutes flame will be off. Finally, it was allowed to cool at ambient temperature and then thick paste was rolled into candies with desired shape and size. Making candy with help lubricant ghee.

Ingredients	Amount 1kg
Banana	50g
Pineapple	150g
Ginger	5g
Pectin	3g
Salt	1g

PROCEDURE OF METHODOLOGY

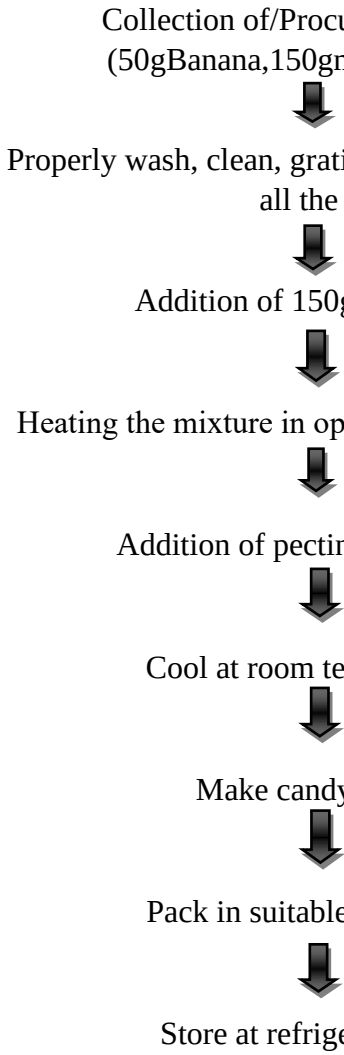

Fig. 1 Flow chart of preparation of banana-based candy.

3.6 Experimental Design

The different variations in the ingredients level have been shown in the Table 3.2 below.

Table 3.2: Experimental Design with actual variable level.

INGREDIENTS	VARIATIONS			
	TRIAL 1	TRIAL 2	TRIAL 3	TRIAL 4
BANANA	50g	60g	50g	80g
PINEAPPLE	40g	60g	150g	120g
GINGER	3g	8g	5g	6g
PECTIN	3g	3g	3g	3g
HONEY	100g	90g	150g	110g
SALT	1g	2g	0.5g	1g
TOTAL WEIGHT	205g	205g	205g	205g

TRIAL 1

TRIAL 2

TRIAL 3

TRIAL 4

Fig No.3.1 Fresh Banana Candy

3.7 Physio-Chemical analysis of freshly prepared candy

3.7.1 Texture analyses (TA)

Textural parameters of product like hardness, springiness, chewiness, gumminess, cohesiveness and resilience were analysed using texture analyser (TA. XT plus texture profile analyser, Stable Micro Systems, UK).

Table 3.3 Texture analysis setting for texture profile analysis of banana candy.

TA settings	Mode:	Measure force in compression
	Option:	Return to start
	Pre-test speed:	2 mm/s
	Test speed:	1 mm/s
	Post-speed:	5 mm/s
	Distance:	10 mm
	Trigger force:	Auto-25g
	Tare mode:	Auto
	Date acquisition:	200 pps
Accessory	Backward extrusion ring	Part code A/BE Batch No. 12172
	Heavy duty platform	Part code HDP/90 Batch No. 12053

3.7.1.1 Texture analysis of Banana Candy

Sample preparation and analysis

Candy Analysis

After making the candy was firstly bought to room temperature. It was then wrapped with a suitable film, so that the moisture distributes itself evenly overnight. The candy triplicates and analysed by using Backward Extrusion Ring (Part Code A/BE) probe.

The attributes studied from the texture profile curves were-

Hardness

Hardness is defined as the maximum peak force during the first compression cycle(first bite) and has often been substituted by term firmness. Within the TPA macro, this parameter was displayed as force2. Units were kg, g, or N.

Gumminess

Gumminess is defined as the multiplication of product hardness and cohesiveness. A semisolid food is characterized by high degree of cohesiveness and low degree of hardness. It was calculated as force 2xcohesiveness. No units are defined moisture (AOAC, 1980)for this parameter.

Chewiness

It is a product of gumminess and springiness. It was calculated as force 2 x cohesiveness x springiness. There are no units for this parameter.

Resilience

The resilience is a measurement of how the samples recover from information both in terms of speed and forces derived. There is no unit for this parameter.

3.7.2 Moisture (AOAC, 1980)

Weighed sample of finely ground material(5g) is dried in a hot air oven for 8 hours at 105ºC. In case wet of samples. It is dried to constant weight. China crucible with dried material is transferred immediately to a desiccator cooled and weighed.

$$\text{Moisture \%} = \frac{\text{loss in wt.(g)}}{\text{Wt. of the sample(g)}} \times 100$$

3.6.1 Crude fat or ether extract

The fat content in banana candy was of estimated by following the protocol(AOAC,2000).

Procedure

5gm of homogenized sample was taken in a thimble and the thimble was placed in previously weighed Soxhlet beaker. The beakers were then placed in the extractor (Socs Plus). Then the extractor was filled with petroleum ether and their tops were covered with cotton plugs. The Soxhlet apparatus was then switched on with a set temperature of 70ºC for $1_{1/2}$h. after completion of extraction, the temperature was increased upto 130ºC for 10min, for the complete removal of moisture. The beakers were removed from Socs Plus apparatus and cooled in desiccators. The cooled beakers were then weighed.

$$\text{Fat \%} = \frac{w2-w1}{S} \times 100$$

Where, weight of residue= weight of beaker after drying (w2) - weight of empty beaker(w1).

S= weight of sample

3.7.3Total soluble solids

The TSS content of candy was determined with the help of Erma hand refractometer 0-32 range in duplicate (A.O.A.C 1990). The prism of refractometer was washed with water and wiped dry after each reading.

3.7.4Titratable Acidity

The acidity of candy was determined by using the procedure as reported by Rangana (1986).

Reagents

1. Std NaOH (0.1N): prepared by dissolving 4.0g NaOH in water to make up 1000ml volume.
2. Indicator: Phenolphthalein (reagent grade 0.05%)

Procedure

In conical flask, 5ml of candy was taken. About 10ml of water was added to it and titrated against 0.1 N NaOH using phenolphthalein as an indicator until permanent faint pink colour developed. The acidity was calculated and expressed in terms of anhydrous citric acid in percent.

$$\textbf{Acidity (\%)} = \frac{0.1(\text{NOH}) \times \text{titre} \times 0.64 \times 100}{\text{Volume of sample taken}}$$

3.7.5 Reducing Sugar

The reducing sugars were determined by the volumetric method of lane and Eynon(1923) as reported by Rangana (1986).

Reagents

1. Fehling solution (A): prepared by dissolving 69.28g copper sulphate in distilled water and then dilute to one litre with distilled water.
2. Fehling solution (B): prepared by dissolving 246g Rochelle salt and 100g sodium hydroxide in distilled water and volume made to one litre.
3. Methylene blue indicator: reagent grade
4. Neutral lead acetate solution (45 per cent): prepared by dissolving 45g of lead acetate in water to make 100ml.
5. Potassium oxalate solution (22 per cent): prepared by dissolving 22g of potassium oxalate in water to make 100ml.
6. Standard invert sugar solution (2.5mg/ml): 9.5g sucrose was taken and transferred to one litre volumetric flask containing 100ml water and 5ml concentrate HCL. The contents were mixed, allowed to stand for 3 days to 20 to 30°C for inversion and volume was made to 1000ml. then 25ml of this standard solution was pipetted into 100ml volumetric flask and added with 50ml water. Few drops of phenolphthalein indicator were added and the solution was neutralized with 20per cent sodium hydroxide solution until the solution turned to pink. The solution was then acidified with 1 N HCL by adding drop wise until one drop caused the pink colour to disappear. The volume was made to 100ml with distilled water. This solution continued 2.5mg reducing sugar/ml.

Preparation of samples

In 250ml volumetric flask, 25ml juice was taken. Then 100ml water was added and contents were neutralized with 1N NOH solution. For clarification, 2ml lead acetate solution was added. The excess of lead acetate was precipitated with potassium oxalate solution and the volume was made to 250ml with distilled water was mixed and allowed to stand for sometime and then filtered.

Procedure

In 250ml conical flask 5ml each of Fehling A and Fehling B solution were pipetted and diluted to about 50ml with distilled water. The mixture was heated to boiling. During boiling, the clarified sample was added carefully through the burette until the brick red colour appeared. Then 2-3 drops of methylene blue indicator were added and the titration was continued until brick red precipitate was formed. Titration was also performed on standard invert sugar solution(2.5mg RS/ml) to workout factor of sugar equivalent(mg) to 10ml Fehling solution.

The reducing sugars content was calculated and expressed in per cent as below:

$$\textbf{Reducing sugar (\%)} = \frac{\text{sugar factor x titre x dilution(250ml)}}{\text{Volume of original sample(25ml)}} \times 100$$

3.7.6Total Sugar

The total sugars were estimated by volumetric method of Lane and Eynon(1923) as reported by Rangana(1986). The estimation was carried out by pipetting out 50ml clear sample filtrate from reducing sugar determination into 250ml conical flask, 5g citric acid and 60ml of water was added. This content was boiled gently for 10minutes to complete the inversion of non-reducing sugars, cooled and neutralized with 1N NaOH using phenolphthalein as indicator. The volume was then made up to 250ml and total sugars were estimated by the procedure reported for the reducing sugars given earlier.

$$\textbf{Total sugars (\%)} = \frac{\text{sugar factor x titre x 250}}{\text{Vol. of sample filtrate(ml)}} \times \frac{250}{\text{vol. of original sample}} \times 100$$

3.7.7Ascorbic Acid

Ascorbic acid content in the juice was estimated by using 2,6 dichlorophenol indophenol dye as reported by Rangana (1986) as follows:

Reagents

1. Metaphosphoric acid(3 per cent): in 100ml distilled water 3gm metaphosphoric acid was dissolved.

Dye solution: Sodium salt of 2,6 dichlorophenol indophenol dye(50mg) was dissolved in about 150ml hot distilled water containing 42mg sodium carbonate. The mixture was cooled and diluted with distilled water to make 250ml volume. The dye solution was prepared fresh for every analysis.

2. Standard ascorbic acid solution(0.1mg/ml): L-ascorbic acid(100mg) was dissolved in 3.00per cent metaphosphoric acid and the volume was made to 100ml of this stock solution 10ml were distilled with metaphosphoric acid to 100ml.

Procedure

Standardization of dye

Standard ascorbic acid solution(5ml) was mixed with 5ml of 3.00per cent metaphosphoric acid. It was then titrated with dye solution until faint pink colour appeared and persisted for about 15 seconds.

The dye factor was calculated as 0.5/titre.

Estimation of ascorbic acid

Sample of 10ml was diluted to 100ml with 3.00 per cent metaphosphoric acid and filtered. Ten millilitre extract of each sample was titrated with dye and ascorbic acid content of the sample was calculated taking into consideration of the dye factor. The result was expressed as mg ascorbic acid per 100g fruit.

Determination

An aliquot(10ml) was pipetted out in conical flask and titrated with 2,6-dichlorophenol indophenol dye and burette reading at pink colour development for 15 seconds was recorded. Ascorbic acid content in the sample was calculated in mg/100ml as per formula.

$$\textbf{Ascorbic acid}\ (\text{mg}/100\text{ml}) = \frac{(\text{titre-blank}) \times \text{dye factor} \times \text{vol. of extract}}{\text{ml of extract taken for titration(ml)}} \times \frac{100}{\text{vol. of sample taken (ml)}}$$

Storage of banana candy

The banana candy was stored for 30 days at ambient temperature after packaging in 150 gauges sealed polyethylene bags and periodically analysed for changes in chemical, sensory and microbiological properties.

Chemical analysis of candy

The candy will be crushed in pestle and mortar to obtain pulp of uniform consistency. The pulp was analysed for the constant TSS, moisture, acidity, reducing sugars, total sugar.All the analysis was performed in duplicate and mean values are reported.

3.8 Sensory evaluation of candy

Sensory evaluation of banana candy was carried out according to method of Amerine *etal*.,(1965) on 9-point hedonic rating test method as recommended by Rangana 2001. At time samples were kept for organoleptic evaluation. The average scores of five semi-trained judges for different quality characteristics viz. Colour and appearance, texture, flavour, taste and overall acceptability were recorded. This test measures the consumer acceptability. The detailed procedure is given below. A semi trained panel consisting of 6 judges of different age groups having different eating habits was constituted to evaluate the quality. The judges were selected from the faculty members and the staff of the Department of Dairy Science and Food Technology, Department of Horticulture, B.H.U(Varanasi). The judgment was quantified by appropriate analysis for determining the significance of variation of average scores and the contribution of the individual qualitycharacteristics to the overall quality. Samples were served to the panellists and they were asked to rate the acceptability of the product through sense organs. Different attributes viz. colour and appearance, consistency flavour and taste were rated on the basis of 9-point hedonic scale ranging from 1 to 9. A scorecard was supplied to each panel member at the time of evaluation.

3.9Microbial quality of candy

Microbial count was recorded using standard plate count(SPC). One colony was counted as microbe. The Nutrient Agar(NA) was prepared and used as growth medium. The petri dishes were incubated at 37± 0.5°C for 48 hrs for counting bacterial and fungal colonies. Total count was taken long pinpoint colonies. Colony counter with magnifying lens was used.

RESULTS AND DISCUSSION

The present study was undertaken with the prime objective of process optimization for banana candy utilizing banana pulp, pineapple pulp, ginger was optimized using different trials, which evaluates individual and interactive effects of the independent variables. Finally, the product was assessed for its storage stability. The preserved candies were analyzed for chemical constituents and evaluated for sensory qualities at 30 days interval for 6 months. The microbial study of stored samples was also done.

4.1 Physical Properties of fresh banana fruit

The physical properties of fresh banana fruits are presented in Table 1. The fruit is about 6.8 inches, about 4.7 inches in girth at the middle, curved, angled ridges five and in distinct at full maturity. Skin thick, yellow when ripe and easily peels off from the pulp; pulp firm, pale, yellow colored, sweet.

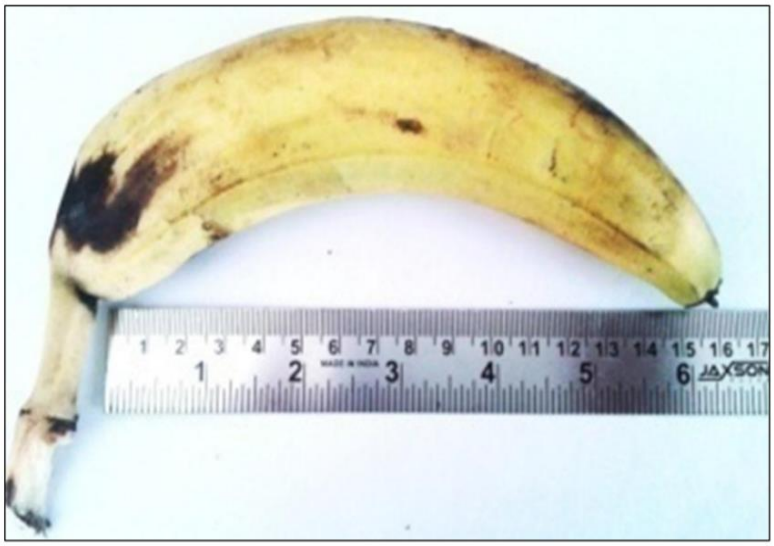

Table4.1. Physical characteristics of banana fruit

Sr. no.	Parameters	Banana fruit
1.	Shape	Cylindrical long
2.	Size	Medium to large
3.	Color	Yellow
4.	Weight of fruit	12.5g
5.	Length of fruit	6.8inch
6.	Breadth of fruit	4.7inch

Banana fruit are cylindrical long in shape, light green to yellowish in color with average 6.8 inch-long and 4.7-inch breadth and 12.5g in weight.

4.2 Chemical Composition of fresh Banana Candy

The chemical composition of freshly made banana candy is given in Table 3.

Table 4.2. Chemical composition of fresh banana candy

Treatments	Moisture (%)	TSS (%)	Reducing sugars (%)	Non-reducing sugar (%)	Total sugars (%)	Acidity (%)	Ascorbic acid (mg/100g)
T1	20.00	70.33	25.65	32.45	60.35	0.76	115.02
T2	19.85	69.12	25.00	32.00	59.75	0.75	114.11
T3	19.25	68.88	24.78	31.95	59.35	0.68	113.68
T4	18.65	68.50	24.25	31.11	59.05	0.64	112.05
Mean	19.43	79.57	24.91	31.87	59.62	0.51	113.71
S.E±	0.02	0.02	0.01	0.01	0.01	0.01	0.01
CD at 5%	0.04	0.03	0.02	0.02	0.03	0.02	0.03

4.2.1 Moisture

The moisture content in freshly prepared banana candy ranged from 18.65-20.00 percent. The candy prepared in first trial at 50ºC exhibited higher moisture content than other samples. The moisture content is decreased by increasing temperature during candy preparation.

Kadam *et al*., (1991) reported 18.8 and 17.1 percent moisture content in ber candies prepared from Umran and Kadaka cultivator. The moisture content of candies prepared from four different cultivator of aonla with cardamom and ginger flavor varied from 16.60 to 16.90 percent (Nayak *et al*., 2011).

4.2.2 Total soluble solids (TSS)

The TSS of freshly prepared candy does not have much variations. The TSS ranged from 68.95 to 70.33ºbrix for trial 1 to trial 4. However, as the temperature is increasing the TSS is decreasing gradually, because asexcess of heat is introduced it will inhibit the solubility.

The TSS content of fresh aonla candy was 70º brix (Tripathi *et al*., 1998), in ber candy 80ºbrix (Kaikadi., 1994) and 74 to 76ºBrix in pear candy (Rani and Bhatia, 1985). The TSS content of candies prepared from four different cultivators of aonla with cardamom and ginger flavored varied from 75.10-75.20ºbrix (Nayak *et al*., 2011).

4.2.3 Acidity

In fresh banana candy, acidity range from 0.64 to 0.76 percent. The candy prepared in first trial had acidity 0.76%. In trial 2 the acidity slightly decreases with increase in temperature because we know that increase in temperature will increase the (H+) ions due to decreased tendency of forming hydrogen bonds, thus leading to decrease in acidity. Gharate (1984) reported 0.22-0.47 percent acidity in ber candies. Apple candy had 1.4 percent acidity (Sharma *et al*., 1998). The acidity content of candies prepared from four different cultivators of aonla with cardamom and ginger flavor varied from 0.48-0.56 percent. (Nayak *et al*., 2011).

4.2.4 Reducing sugar

The fresh candy contained 25.65-24.25 percent reducing sugars. Reducing sugars content in banana segments was increased after processing into candy. The candy prepared in first trial exhibited higher value of reducing sugars. The increase in reducing sugars of candy can be attributed to the inversion of sucrose due to high acidity of the product.

The reducing sugar content of aonla candy was reported to vary from 28.4-50 percent (Tripathi *et al*., 1998). While for ber candy it varied from 31-50 percent (Kaikadi.,1994). The reducing sugar content of candies prepared from four different cultivators of aonla with cardamom and ginger flavor varied from 35.00-38.10 percent (Nayak *et al*.,2011).

4.2.5 Non-reducing sugar

The non-reducing in freshly prepared aonla candy ranged from 32.5 to 31.12 percent.

The non-reducing sugars contents of candies prepared from different cultivators of aonla with cardamom and ginger flavor varied from 27.80-29.20 percent(Nayak *et al*., 2011). Ber candy contained 35.51 percent non reducing sugar (Gupta *et al*., 1980; Gupta, 1983) and 38.30 percent (Gharate, 1984). About 3.51 percent of non-reducing sugars were reported in apple candy (Sharma *et al*., 1998).

4.2.6 Total sugar

The fresh banana candy contained 60.4 to 59.10 percent total sugars. The candy prepared in first trial exhibited higher total sugar. An increase in total sugar in finished candy was obviously due to honey impregnation into the fruit tissue during preparation.

The total sugars content of candies prepared from four different cultivators of aonla with cardamom and ginger flavor varied from 64.30-66.60 percent (Nayak *et al*., 2011). While it was 70.65 percent in apple candy (Sharma *et al*., 1998) and in ber candy ranged from 71.14-79.21 percent (Unde *et al*., 1998).

4.2.7 Ascorbic acid

The ascorbic acid content of fresh banana candy was found to be in the range of 115 to 112.05 mg/100g. Reduction in ascorbic acid was observed earlier in preparation of aonla preserve and candy (Tripathi *et al*., 1988). The ascorbic acid content was reduced from 120 mg/100g in fresh ber fruits to 4.12mg/100g in ber candy (Gupta *et al*., 1980). The ascorbic acid content of candies prepared from four different cultivators of aonla with cardamom and ginger flavor varied from 104.90-132.80mg/100g (Nayak *et al*., 2011).

4.3 Changes in chemical composition of candy during storage

4.3.1 Moisture

The data regarding change in moisture(%) content of banana candy during storage is presented in Table 4. The moisture content of candies was found to significantly decrease with an increase in storage period. The decrease in moisture content in various banana candies with an increase in storage period might be due to the evaporation of moisture from the product during storage at ambient condition. The reduction of moisture content varied from 20.00 to 18.65 percent. The candies in trial 1 shows moisture 20.00 at 0 days which got decreased to 19.25, the decrease in moisture content is due to evaporation of moisture from the product during storage at ambient temperature. Whereas the candy made in trial 3 shows least variation in moisture content, due to which we are considering it appropriate candy.

Table 4.3 Change in moisture (%) of banana candy during storage

Treatments			Storage	
	0	10	30	60
T1	20.00	19.85	19.45	19.25
T2	19.85	19.22	19.05	18.75
T3	19.55	19.75	19.95	18.10
T4	18.65	18.05	17.95	17.55
Mean	19.43	19.01	18.7	18.5
S.E±	0.03	0.02	0.02	0.02
CD at 5%	0.07	0.06	0.05	0.07

The moisture content of candies was significantly high in trial 2.

Decrease in moisture with storage of candies were also reported by Tripathi *et al*., (1998) in aonla candy, Mehta *et al*., (2005) in Galgal peel candy. Rani and Bhatia (1985) reported more loss in moisture content in pear candy from 20.1-12.9% at high storage temperature for 24

weeks. After 270 days of storage, the moisture content decreased from an initial range 16.5 to 17.2 per cent to a final of 14.7 to 15.4 percent in flavored candy of four aonla cultivator. (Nayak *et al*., 2011).

4.3.2 Total soluble solids

The data regarding differentiation in TSS of candy as influenced by storage period is presented in Table 5. TSS gradually increase in storage period. The mean score of TSS was found to significantly increase from 69.20ºbrix to 72.86ºBrix. The maximum increase in TSS was found in the candy prepared in Trial 3, it may be might be due to conversion of polysaccharides into sugars during hydrolysis or due to reduction in moisture content of product with storage.

Table 4.4. TSS (ºBrix) content of aonla candy as influenced by storage period.

Treatments			Storage	
	0	10	30	60
T 1	70.33	71.44	72.50	74.58
T 2	69.12	70.12	72.58	72.78
T 3	68.88	69.11	70.55	71.85
T 4	68.50	69.05	70.32	72.88
Mean	69.20	69.93	71.48	72.86
S.E±	0.02	0.01	0.02	0.01
CD AT 5%	0.06	0.02	0.07	0.02

However, at 0 days storage period the TSS reported in trial 1 was 70.33ºbrix which got increased to 74.58ºbrix by 60th days. The TSS reported in trial 2 at 10 days were 70.12ºbrix which got increased to 72.78ºbrix during storage. The appropriate or desirable variation in TSS was obtained in trial 3 i.e, from 68.88ºbrix to 71.85ºbrix by 60th days.

Increase in TSS with storage was also found to be reported by Tandon *et al*.,(2003); Tripathi *et al*., (1988); Nayak *et al*.,(2011) in flavored aonla candy; Manivasagan *et al*.,(2006) in karonda candy and Rani and Bhatia(1985) in pear candy from 74º to 79ºbrix at ambient condition during storage of 3 months.

4.3.3Acidity

The data regarding effect of storage period on titratable acidity of banana candy during storage is presented in Table 6. The acidity of banana candy decreased significantly in all trial during storage period from 0.51 to 0.62 percent. The higher reduction in acidity was recorded in candy prepared in trial 1 and trial 2. Pectic acid has been reported to increase the acidity in fruit products; hence decrease of pectic substance into soluble solids might have contributed towards decrease in acidity of banana and several other fruit products. The other major reason the acidity in candy is due to the presence of ginger and pineapple in it.

The higher reduction in acidity was recorded in trial 1 and trial 2. The reduction in acidity in trial 1 ranging from 0.76% to 0.68% and candy in trial 2 reported variation in acidity from 0.75% to 0.66% which is due to decrease in temperature. In trial 3as there is least variation in the acidity that will help to maintain quality of candy, so at 0 days acidity was 0.68% and 0.60% at 60 days.

Table 4.5. Effect of storage period on titratable acidity(%) of banana candy during storage.

Treatments			Storage	
	0	10	30	60
Trial 1	0.76	0.73	0.71	0.68
Trial 2	0.75	0.72	0.69	0.66
Trial 3	0.68	0.64	0.62	0.60
Trial 4	0.64	0.62	0.61	0.59
Mean	0.51	0.67	0.65	0.62
S.E ±	0.01	0.03	0.01	0.02
CD at 5%	0.02	0.10	0.05	0.07

Tripathi *et al*., (1988) reported decrease in acidity with storage as there are least number of hydrogen bonds. The reduction in acidity from 0.17 to 0.07 percent during storage in pear candy was observed when stored at room temperature (Rani and Bhatia, 1985). Decrease in acidity with storage were also reported in aonla candy (Tripathi *et al*., 1988); in apple candy(Sharma *et al*.,1988) and in citrus peel candy (Mehta and Baja, 1984).

4.3.4 Reducing sugar

The data pertaining to effect of storage period on reducing sugars of aonla candy is presented in Table 7. There was a significant increase in reducing sugars during storage period of 60 days. The mean values of reducing sugars were found to be increase from 24.91% to26.43%percent. The candy obtained in trial 4 exhibited higher increase in reducing sugars. Increase in reducing sugars might be due to conversion of sucrose to reducing sugar.

Table 4.6. Effect of storage period on reducing sugars(%) of banana candy during storage

Treatments			Storage	
	0	10	30	60
Trial 1	25.63	25.98	26.10	26.55
Trial 2	25.00	25.45	25.73	25.99
Trial 3	24.78	24.98	25.12	25.95
Trial 4	24.25	25.33	26.14	27.25
Mean	24.91	25.43	25.77	26.43
S.E±	0.01	0.02	0.02	0.11
CD at 5%	0.02	0.06	0.09	0.32

The trial 1 recorded 26.55 percent reducing sugars of candy 60 days storage followed by trial 2 reported 25.99% reducing sugar by 60 days of storage. Trial 3 shows variation of reducing sugar in candy from day 0 to day 60 from 24.78% to 25.95% reducing sugar. The reducing sugar content increases in banana candy due to conversion of sucrose to reducing sugar.

Jain *et al*.(1983) revealed an increase in reducing sugars from 35.50 to 41.80 percent after 6 months storage of aonla candy. Similar results were found in aonla preserve and aonla candy(Tripathi *et al*., 1988); in flavored aonla candy (Nayak *et al*., 2011) and for ber candy (Gupta *et al*., 1980).

4.3.5 Non reducing sugars

The variations in non-reducing sugars of banana candy during storage are presented in table 8. The non-reducing sugars were found to decrease gradually during storage period as there is reducing agents. The mean values of reducing sugars are found to be significantly decreases from 31.87 to 29.96percent. The candy obtained in trial 1 and trial 2 exhibited higher decrease in non-reducing sugars. Candy in trial 1 at 0 days shows 32.45% non-reducing sugar which decreases to 29.65%. Whereas the candy in trial 2 reported 31.75% of non-reducing sugar at 10 days with a variation of 30.85% non-reducing sugar at 60^{th} day.

Table 4.7. Variations in non-reducing sugars(%) of banana candy during storage.

Treatments	Storage			
	0	10	30	60
Trial 1	32.45	31.02	30.85	29.65
Trial 2	32.00	31.75	31.15	30.85
Trial3	31.95	31.22	30.65	30.12
Trial 4	31.11	30.02	29.75	29.23
Mean	31.87	31.00	30.6	29.96
S.E±	0.01	0.01	0.02	0.02
CD at 5%	0.02	0.03	0.09	0.10

Freshly prepared ber candy contained 51.10 percent non reducing sugars which decreased to 37.90 percent on storage at room temperature for one year (Gupta *et al*., 1980). The non-reducing sugars content showed a continuous fall from 34.40 to 31.50 percent during storage of aonla preserve for 6 months at room temperature(Jain *et al*., 1988).

4.3.6 Total sugars

The changes in total sugar content of banana candy during storage are presented in table 9. There was gradual increase in total sugars content of banana candy during storage. The mean value of total sugars was found to significantly increase from 59.62 to 60.29 percent. The candies prepared in trial 3 exhibited higher increase in total sugars during storage. Increase in total sugar might be due to decrease in moisture content during storage. The trial 1recorded

60.45 percent total sugar at 30 days storage which was at an average with trial 2 (59.95%), trial 3(59.65%) and trial 4(59.25%).

Table 4.8. Changes in total sugars(%) of banana candy during storage

Treatments	Storage			
	0	30	60	90
Trial 1	60.35	60.45	60.75	60.89
Trial 2	59.75	59.95	60.05	60.45
Trial 3	59.35	59.65	59.85	60.09
Trial 4	59.05	59.25	59.45	59.75
Mean	59.62	59.82	60.02	60.29
S.E±	0.01	0.25	0.03	0.02
CD at 5%	0.03	0.80	0.10	0.08

Total sugars content of aonla candy were reported to increase from 65.50-67.00 percent during storage for 135 days at room temperature(Tripathi *et al*., 1988). Similar results were reported in ber candy(Gupta *et al*., 1980), pear candy(Rani and Bhatia, 1985), flavored aonla candy(Nayak *et al*., 2011) and apple candy (Sharma *et al*., 1998).

4.3.7 Ascorbic acid

The data on ascorbic acid(mg/100g) content of banana candy as influenced by storage period is presented in table 10. Ascorbic acid was found to decrease gradually during storage. The mean rate of reduction in ascorbic acid was from 113.71 to 113.00mg/100g of banana candy. Reduction in ascorbic acid could be due to oxidation by trapped oxygen in jars which results in formation of dehydro-ascorbic acid.

Table 4.9. Ascorbic acid(mg/100g) content of banana candy as influenced by storage period.

Treatments	Storage			
	0	10	30	60
Trial 1	115.02	114.85	114.25	114.01
Trial 2	114.11	114.02	113.95	113.35
Trial 3	113.68	113.35	113.15	113.00
Trial 4	112.05	112.00	111.85	111.65
Mean	113.71	113.55	113.3	113.00
S.E±	0.01	0.03	0.01	0.04
CD at 5%	0.03	0.02	0.02	0.10

The ascorbic acid reported to be 115.02mg/100g at 0 days in trial 1 which got decreased to 114.01mg/100g, followed by trial 2 with ascorbic acid content 114.11mg/100g at 0 days which reported to be 113.35mg/100g by 60th day. Trial 3 shows least variation in ascorbic acid content

from 113.68mg/100g to 113.00mg/100g, which shows appropriate range of ascorbic acid content.

Agarwal and Chopra (2004) reported that ascorbic acid loses were 83.86,83.11,56.58 and 34.72 percent respectively with shreds, candy, jam and squash. Loss in ascorbic acid content was also observed in aonla preserve, Tripathi *et al*., (1988) in aonla products; Rani and Bhatia (1985) in pear candy and Nayak *et al*., (2011) in flavored candy.

4.4 Microbial Quality of Banana Candy

The microbiological study for standard plate count of banana candy was carried out initially and after 60 days storage. The data regarding changes in microbial count of banana candy during storage are presented in table 11. The data indicates that there was increase in mean microbial count from 1 x 10^3 to 6 x 10^3 cfu/g. The microbial count rapidly increased during storage at ambient temperature (15ºC to 24ºC). The increase might be due to available favorable temperature and media for bacterial growth during storage. The least increase in microbial count was recorded for trial 3 samples due to favorable conditions provided for growth such as room temperature, medium of growth etc. The values of cfu/g observed in trial 3 were quite low and the products were found to be microbiologically safe.

Table 4.10. Microbial Count of Banana Candy

Treatments	Standard Plate Count(-x 10^3 cfu/g)	
	0 day	60 days
Trial 1	1	5
Trial 2	1	4
Trial 3	-	3
Trial 4	-	4

Johar and Anand (1958) have studied the nature of spoilage in aonla preserve while Subbarao and Johar(1958) had isolated the spoilage organisms from murabbas and reported the inhibitory effect or least spoilage is due to high acidity and sugar content in such products. Mehta et al., (2005) reported that microbial load of galgal peel candy was found to be very low. The initial bacteria count was in the range of 2.14-2.30(as $\log_{10}$ cfu) in untreated product where as it was 1.07-1.17 (as $\log_{10}$ cfu) in treated product of both varieties.

4.5 Changes in sensory parameters of candy during storage

4.5.1 Color and Appearance

The data on changes in color and appearance of banana candy during storage are presented in table 12. The data indicate that the score of the color and appearance decreased significantly during storage. It decreased gradually from 7.15 to6.25as storage period was exhibited. The

color deterioration was found more in trial 1 and trial 2. This might be due to higher rate of mallard's reaction occurred in trial 1 and trial 2. The color changes from golden yellow to brown which result in decreased score. Candies prepared in trial 3 maintained better color up to 60 days during storage.

Table 4.11. Changes in color and appearance of banana candy during storage.

Treatments	Storage			
	0	10	30	60
Trial 1	7.00	6.55	6.24	6.12
Trial 2	6.78	6.67	6.33	6.33
Trial 3	8.00	7.67	7.50	7.33
Trial 4	6.67	6.00	5.67	5.17
Mean	7.15	6.71	6.37	6.25
S.E±	0.50	0.31	0.25	0.15
CD at 5%	1.59	0.96	0.76	0.59

The lowest color and appearance score were recorded in trial4(6.67%) at 0 days which was at an average with trial2(6.78%), trial1(7.00%) was at an average with trial 3(8.00%). The candies in trial 1 recorded sensory score 6.55% at 10 days storage which got reduced to 6.33%. Followed by the candies in trial 2 recorded 6.78% to 6.33% by 60th days of storage. Whereas trial 3 shows 8.00% of sensory score which is getting changed to 7.33% by 60th day of storage, which is highly acceptable.

It is reported that the color score decreased gradually during storage in aonla candy (Gupta et al., 1980), pear candy (Rani and Bhatia.,1985) and citron peel candy (Baber et al.,2013). The results obtained were similar to the reports available in the literature.

4.5.2 Flavor

The data regarding flavor score of banana candy as influenced by storage are presented in table 13. The data indicate that the flavor score decreases significantly and continuously from 7.05 to 5.21. Variation in score in all types of candies was very less and least significant. The trial 1 shows flavor score as 6.67 at 0 day which is getting changed to 6.97 by 60th days of storage. The highest score was reported in trial 1 i.e. 6.33 at 0 days whereas by 60th days of storage it getting reduced to 6.45. Trial 3 shows least change in variation of flavor score from day 0 to day 60 i.e. from 7.89 to 7.00, which is acceptable as compared to the other candies.

Table 4.12. Flavor score of banana candy as influenced by storage

Treatments	Storage			
	0	10	30	60
Trial 1	6.67	6.33	6.00	6.97
Trial 2	6.33	6.00	6.27	6.45
Trial 3	7.89	7.17	7.13	7.00
Trial 4	6.33	6.00	5.33	5.00
Mean	7.05	6.62	6.16	5.21
S.E ±	0.30	0.39	0.26	0.41
CD at 5%	0.92	1.20	0.81	1.26

Loss of flavor with advancement of storage period is reported in aonla candy by Tripathi *etal*., (1988), ber candy (Kaikadi, 1994), pear candy (Rani and Bhatia, 1985) and citron peel candy (Baber *et al*., 2013). The results obtained are similar to the reports available in literature.

4.5.3 Texture

The data regarding texture score of banana candy as influenced by storage are presented in table 14. The data indicate that there was significantly decrease in texture score from 6.72 to 5.63. The decrease in score might be due to hardening effect resulting from loss of moisture during storage. The candies obtained in trial 2 were found to deteriorate in texture quite extensively and become harder than other candies. Candies prepared in trial 3 were found superior in texture during storage up to 60 days ranging from 7.77 to 6.52, showing texture mostly acceptable by everyone. The lowest texture score was reported in trial 4 i.e. 5.89 which is getting variations till 5.02 texture.

Table 4.13. Texture score of banana candy as influenced by storage.

Treatments	Storage			
	0	10	30	60
Trial 1	6.77	6.22	5.11	5.65
Trial 2	6.83	6.40	6.01	5.64
Trial 3	7.77	7.20	6.80	6.52
Trial 4	5.89	5.65	5.10	5.02
Mean	6.72	6.36	6.00	5.63
S.E±	0.30	0.39	0.26	0.41
CD at 5%	0.92	1.20	0.81	1.26

The decrease in texture score with advancement of storage has been reported for aonla candy (Tripathi *et al*., 1988); ber candy (Kaikadi, 1994), pear candy (Rani and Bhatia, 1985) and

citron peel candy (Baber *et al*., 2013). The results obtained are similar to the reports available in literature.

4.5.4 Taste

Data on changes in taste score of banana candy during storage are presented in table 15. The data revealed that the score for taste decreased significantly during storage. It decreased continuously from 6.33 to 5.7. The taste deterioration was observed more in candies prepared in trial 2 and trial 4. The candy prepared in trial 3 exhibited good taste during storage.

Table 4.14. Changes in taste of banana candy during storage.

Treatments	Storage			
	0	10	30	60
Trial 1	6.65	6.30	6.80	6.70
Trial 2	6.40	6.30	6.00	6.00
Trial 3	7.65	7.55	6.75	6.60
Trial 4	5.50	5.30	5.30	5.00
Mean	6.33	6.16	5.96	5.7
S.E±	0.40	0.34	0.25	0.22
CD at 5%	1.24	1.05	0.76	0.66

Trial 1 shows taste score 6.65 at 0 day which is showing variable to 6.70 by 60th days of storage. Followed by trial 2 reporting taste score of 6.40 at 0 day showing variation to 6.00 by 60th days of storage. Candy made in trial 3 showed acceptable results as showing a taste score of 7.65 at 0 days to 6.60 at 60th days of storage, as it is liked by most of the individual doing sensory analysis.

The taste score is reported to decrease during storage period in aonla candy by Tripathi *et al*.,(1988); ber candy (Kaikadi,1994) and pear candy (Rani and Bhatia, 1985). The results obtained are similar to the reports available in the literature.

4.5.5 Overall acceptability

Data on overall acceptability score of banana candy as influenced by storage are presented in table 16. There was significant decrease overall acceptabilityscore from 6.48 to 5.85 during storage. The candies prepared in trial 3 were more acceptable than other candies. The lowest score was recorded in trial 4(4.40) at 0 days storage which was at an average with trial 1(6.99). And the highest overall acceptability score was recorded in trial 3(7.30) which was at par with trial 2(6.60) as well as trial 1(6.85) was at par with trial 4(6.00) at 10 days storage.

However, these two trials were at par with each other. At 30 days storage, the lowest score was recorded in trial 4(5.65) which at average with trial 3(6.00) and trial 2(6.30) was at par with

trial 1(7.00). The lowest acceptability score was recorded in trial 4(5.12) was at an average with trial2(6.00) which was at an average with trial 1(6.70) at 60 days storage.

Table 4.15. Overall acceptability score of banana candy as influenced by storage.

Treatments	Storage			
	0	10	30	60
Trial 1	6.99	6.85	6.55	6.70
Trial 2	7.00	6.60	6.30	6.00
Trial 3	7.77	7.30	7.00	7.20
Trial 4	4.40	6.00	5.65	5.12
Mean	6.48	6.55	6.23	5.85
S.E±	0.51	0.39	0.12	0.34
CD at 5%	1.57	1.20	0.38	1.05

The overall acceptability of candy was reported to decrease with advancement of storage in pear candy(Rani and Bhatia, 1985); aonla candy (Tripathi *et al*., 1988); ber candy(Kaikadi, 1994), aonla candy (Patil, 2000) and citron peel candy(Baber et al., 2013). The observed candy decrease in acceptability of candy is consistent with the observations recorded earlier by various workers.

The candy prepared in trial 3 were mostly accepted by everyone from all other candies and it was also most durable quality wise as it was having high acidity and honey content in it, exhibiting favorable color and texture was also good. The optimized candy with its constituents is shown in table 17.

Table 4.16. Optimized candy with its constituents

Banana pulp	**50 g**
Pineapple	**150 g**
Ginger	**5 g**
Pectin	**3 g**
Honey	**150 g**
Salt	**0.5 g**
Color and appearance	**8.00**
Texture	**7.77**
Flavor	**7.65**
Overall acceptance	**7.77**
Desirability	**0.80**

As the candy made in trial 3 having excess of honey in it, shows least spoilage till 60 days and it also had good texture, flavor, taste etc. So, candy made in trial 3 is most acceptable.

Cost estimation of banana candy is shown in given Table 4.17.

Table 4.17 Calculation of cost ofdeveloped banana candy

Ingredients	Quantity of ingredients taken (g)	Rate Rs. / kg	Total cost for banana candy (Rs.)
Banana	50 g	Rs. 30	1.5
Pineapple	150 g	Rs. 70	10.5
Ginger	5 g	Rs. 40	0.2
Honey	150 g	Rs. 300	45
Salt	1 g	Rs.20	0.02
Pectin	3 g	Rs.1500	4.5
Water	50 ml	Rs. 20	1
Sub-total	400		*62.72

***100g material of candy is equivalent to 10 candy. So, the cost of one candy is 1.57.**

The cost of 400g of candy mix. (material) equal to Rs.62.72. Therefore, the cost of optimized developed banana candy is Rs. 1.57/candy. It is calculated that the cost of developed functional banana candy is less than market candy.

SUMMARY AND CONCLUSION

The present investigation was carried out to develop the banana candy using pineapple, ginger. The banana candy was then optimized using different trials, which evaluates individual and interactive effects of independent variables. As, per sensory evaluation by 9-point hedonic scale. The present product thus was evaluated for its storage stability.

The results of the present investigation are summarized below:

1. Banana candy was prepared using pineapple pulp, ginger, @ 3% of citric acid. 1% salt along with honey was also added based on sensory evaluation.
2. Banana candy was prepared using pineapple pulp (73%), banana pulp (24.39%), ginger paste (2.4%), salt (0.24%), pectin (1.46) and honey (73.17%), on the basis of all these constituents the storage stability of candy was evaluated using different trials method.
3. In banana candy, the moisture, reducing sugar, non-reducing sugar, total soluble solids were 19.25%, 24.78%, 31.95%, 68.88% receptively. While, total sugars, titratable acidity, and ascorbic acid contents were as found to be 59.35%, 0.68%, 113.68mg/100g respectively.
4. During storage maximum loss in moisture was obtained in trial 2 (19.85-18.75%), minimum loss in moisture was obtained in trial 1 (20.00-19.25%).
5. During storage the maximum gain in reducing sugar was obtained in candy made in trial 4 (24.91 to 27.25 percent), minimum gain in reducing sugar was obtained in candy made in trial 2 (25.00-25.99 percent) stored at ambient temperature (15^0C to 24^0C). Simultaneously, the maximum loss in non-reducing sugar was obtained in trial 1(32.45-29.65 percent) and minimum loss was reported in trial 31.95-30.12 percent)

6. During storage maximum gain of total soluble solid was recorded in trial 4 (68.50-72.88^{0}brix), whereas minimum gain was obtained in trial 3 (68.88-71.85^{0}brix).
7. During storage (2 months) of banana candy, the maximum loss in acidity was reported in trial 2 (0.75-0.66%) whereas minimum loss was obtained in trial 4 (0.64-0.59). Similarly, the maximum loss in ascorbic acid was reported in trial 1

(115.02-114.01 percent) and minimum loss reported in trial 3 (113.68-113.00 percent).

8. The maximum gain in total sugar in banana candy was observed in trial 4 (59.05-59.75 percent) and minimum gain is reported in trial 3 (59.35-60.09).
9. During storage, no total plate count (TPC) was detected in all the samples of banana candy till two months of storage and thereafter increased significantly ($p \leq 0.01$). The maximum TPC was observed in candy made in trial 1 (05cfu/g) at 60^{th} day of storage. Whereas the minimum total plate count was observed in candy made in trial 3 (03cfu/g) even at 60^{th} day of storage at ambient temperature (15^0C-24^0C).
10. The cost of production of banana candy was Rs. 62.72 for 100g candies respectively. So, cost of one banana candy was about Rs. 1.27.

It is concluded that banana candy prepared by using pineapple, ginger along with 73.17% of honey with 0.24% of salt and 3% of pectin acid is beneficial for people of all age group. Banana candy shows shelf life more than 2 months. The acceptable candy made in trial 3 showed shelf life of more than two months as it had excess of honey in it due to honey act as preservative, which helped it to be consumed for longer period of time.

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APPENDIX

Appendix: Score Card for Sensory Evaluation

Name of the Sample: Banana Candy

9 POINT HEDONIC SCALE

Sample	Color	Texture	Flavor	Chewiness	Overall Acceptability

Parameters	Scale
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**

Name of the Judge

Signature

Date

Appendix I: Score Card for Sensory Evaluation

Name of the Sample: Banana Candy

9 POINT HEDONIC SCALE

Sample	Color	Texture	Flavor	Chewiness	Overall Acceptability
1	**6**	**8**	**7**	**7**	**7**
2	**7**	**7**	**7**	**6**	**7**
3	**8**	**8**	**8**	**7**	**8**
4	**7**	**7**	**7**	**7**	**7**

Parameters	Scale
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**

Name of the Judge: Nidhi Tomar

Date: 12.03.2020

Appendix II: Score Card for Sensory Evaluation

Name of the Sample: Banana Candy

9 POINT HEDONIC SCALE

Sample	Color	Texture	Flavor	Chewiness	Overall Acceptability
1	**7**	**8**	**7**	**8**	**8**
2	**6**	**7**	**7**	**8**	**7**
3	**8**	**7**	**8**	**7**	**8**
4	**7**	**6**	**7**	**7**	**7**

Parameters	Scale
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**

Name of the Judge: Jyoti Chaudhary

Date: 13.03.2020

Appendix III: Score Card for Sensory Evaluation

Name of the Sample: Banana Candy

9 POINT HEDONIC SCALE

Sample	Color	Texture	Flavor	Chewiness	Overall Acceptability
1	**7**	**8**	**7**	**7**	**7**
2	**7**	**6**	**8**	**7**	**7**
3	**9**	**8**	**9**	**8**	**9**
4	**8**	**7**	**7**	**6**	**7**

Parameters	Scale
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**

Name of the Judge: Garima Gautam

Date: 13.03.2020

Appendix IV: Score Card for Sensory Evaluation

Name of the Sample: Banana Candy

9 POINT HEDONIC SCALE

Sample	Color	Texture	Flavor	Chewiness	Overall Acceptability
1	**7**	**8**	**7**	**6**	**7**
2	**6**	**7**	**6**	**7**	**7**
3	**7**	**8**	**7**	**8**	**8**
4	**8**	**7**	**7**	**7**	**7**

Parameters	Scale
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**

Name of the Judge: Ajeet Kumar

Date: 14.03.2020

Appendix V: Score Card for Sensory Evaluation

Name of the Sample: Banana Candy

9 POINT HEDONIC SCALE

Sample	Color	Texture	Flavor	Chewiness	Overall Acceptability
1	**7**	**6**	**7**	**7**	**7**
2	**7**	**7**	**8**	**7**	**7**
3	**8**	**9**	**8**	**8**	**8**
4	**7**	**7**	**7**	**7**	**7**

Parameters	Scale
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**

Name of the Judge: Ananya

Date: 14.03.2020