A DISSERTATION ON

Valorization of Beetroot Greens into Functional Jelly

SUBMITTED TO THE

DEPARTMENT OF BIOENGINEERING

FACULTY OF ENGINEERING & INFORMATION TECHNOLOGY

INTEGRAL UNIVERSITY, LUCKNOW

IN PARTIAL FULFILMENT

FOR THE

DEGREE OF MASTER OF TECHNOLOGY

IN FOOD TECHNOLOGY

BY

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B.Tech + M.Tech Dual Degree Food Technology (X Semester)

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UNDER THE SUPERVISION OF

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DECLARATION FORM

I, **Juveria Kafeel** , a student of **B.Tech.-M.Tech. Dual Degree Food Technology** (V Year/ X Semester), Integral University have completed my six months dissertation work entitled **" Valorization of Beetroot Greens into Functional Jelly"** successfully from **Integral University, Lucknow** under the able guidance of **Mrs. Poonam Sharma.**

I, hereby, affirm that the work has been done by me in all aspects. I have sincerely prepared this project report and the results reported in this study are genuine and authentic.

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CERTIFICATE

Certificate that Ms **Juveria Kafeel** (Enrollment Number 1800101015) has carried out the research work presented in this thesis entitled **"Valorization of Beetroot Greens into Functional Jelly "** for the award of **B.Tech.-M.Tech. Dual Degree Food Technology** from Integral University, Lucknow under my supervision. The thesis embodies results of original work and studies carried out by the student himself and the contents of the thesis do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution. The dissertation was a compulsory part of her **B.Tech.-M.Tech. Dual Degree Food Technology** degree.

I wish her good luck and bright future.

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This is to certify that **Juveria kafeel ,** a student of **B.Tech. - M.Tech. Dual Degree Food Technology** (V Year / X Semester), Integral University has completed her six-month dissertation work entitled **"Valorization of Beetroot Greens into Functional Jelly "** successfully. She has completed this work from Integral University under the guidance of Mrs. Poonam Sharma, Assistant professor , Department of Bioengineering . The dissertation was a compulsory part of her **B.Tech.-M.Tech. Dual Degree Food Technology** degree.

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TO WHOM IT MAY CONCERN

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I wish her good luck and bright future.

Dr. Alvina Farooqui
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PLACE : Lucknow **Juveria Kafeel**

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ABSTRACT

Beet greens, also known as beetroot tops, were once actually used for medicine, while Ancient Romans believed they were an aphrodisiac. Beet greens are the large green leaves of the beet plant that grow above ground . They are the only part of the plant that is visible. Beet greens are high in Vitamin C, essential for boosting immunity. Vitamin C plays a crucial role in helping improve your immune system and fight off cold and flu viruses. One cup of cooked beet greens contains almost 60% of your daily nutritional value with little to no sugars. The variety of nutritional advantages that beet greens provide make them a great supplement to any balanced diet . These leaves are loaded with important vitamins, minerals, and antioxidants that support a diet that is nutritious and well-balanced. Vitamins A, C, and K are all abundant in beet greens. In our hectic and fast-paced lives, we frequently make poor food choices without realizing the potential health risks. J**elly candies** are popular in all age group because it is soft, sweet and chewy texture and fresh fruits flavor make them more juicy and fresh which are more liked by kids.

The objective of the study was valorization of beetroot (*Beta vulgaris*) greens into functional jelly . The juice of beetgreen was used in the development of the functional jelly .Other ingredients were pectin , citric acid and sugar . A good jelly is firm and should taste fresh and fruity . After the development of jelly various analysis were performed including moisture analysis , ash analysis , shelf life , pH analysis , protein content , and antioxidant property . The jelly can be stored for 18 days under refrigerated and ambient temperature with no addition of any artificial preservative .

CHAPTER 1

INTRODUCTION

The red beet (Beta vulgarisssp. vulgaris L.) is a herbaceous biennial or occasionally, perennial plant upto 120 cm (up to 200 cm in the second year), but cultivated versions are primarily biennial. Fruits and vegetables are excellent sources of nutrients that can help you fight off variety of illnesses, including cancer, diabetes, gastrointestinal disorders, and heart and lung ailments. Because of their extensive and diverse nutritional properties, these crops may assist to improve socioeconomic conditions in the society (Prasad et al., 2018) . In an effort to explore the potential of underutilized foods and their co-products as functional foods, several research have looked into the composition profiles of these foods and their co-products (Pereira et al., 2003), (Almeida et al., 2009) (Boroski et al., 2011).

Beetroot leaves are neglected yet incredibly nutritious vegetable (Biondo P.B.F, Evaluation of beetroot (Beta vulgaris L.) leaves during its developmental stages: a chemical composition study (Ebrahimi, P., Mihaylova et al.,2022) . The iron content of beetgreen is better than that of spinach. It is being assumed that the nutritional composition of beet leaves is similar to the beetroot which is rich in carbohydrates, fibre, protein, and many minerals such as Sodium, Potassium, Calcium as well as Iron (Bakhru, H.K. et al., 1995) . The variety of nutritional advantages that beet greens provide make them a great supplement to any balanced diet. These leaves are loaded with important vitamins, minerals, and antioxidants that support a diet that is nutritious and well-balanced. Vitamins A, C, and K are all abundant in beet greens. Healthy vision, immune system, and skin are supported by vitamin A. Antioxidants like vitamin C help shield cells from harm and strengthen the immune system. Blood clotting and bone health require vitamin K. Fiber is essential for keeping the digestive tract in good shape. Dietary fiber, which also aids in digestion, prevents constipation, and encourages a feeling of fullness, can be helpful for weight management, and beet greens are a rich source of it. Antioxidants are substances that prevent or delay the oxidation of lipids and other molecules by scavenging free radicals (Zheng & Wang et al., 2001). These greens are a rich source of antioxidants like beta-carotene, lutein , and zeaxanthin , which aid in preventing oxidative stress and minimizing the harm done by free radicals. This may thus help to reduce the chance of developing chronic illnesses and age-related problems. The ability of beet greens to support heart health is widely documented. They include potassium, which helps regulate blood pressure, and betaine, a compound that may help lower blood levels of homocysteine, so reducing the risk of cardiovascular diseases. Beet greens are a great option for anyone wanting to limit their calorie intake because they are low in calories while providing a variety of essential nutrient .Since fiber slows down how quickly sugar is absorbed by the digestive tract, beet greens' high fiber content can help control blood sugar levels. Consumption of traditional diets are said to have many beneficial effects such as prevention of some age related degenerative diseases – arteriosclerosis, stroke, etc. Despite these benefits, traditional plant foods are typically under cultivated and underutilized (Kunwar et al., 2006). By using gentle methods and careful monitoring of each stage of the transformation with appropriate control tests, the technology in the food sector should be used to decrease the loss of antioxidants and micronutrients to the lowest possible level. A healthy lifestyle, which includes a balanced diet and physical activity, includes functional foods that contain fruit and vegetable juices or extracts (Blasa , M. Gennari et al., 2010)

In our hectic and fast-paced lives, we frequently make poor food choices without realizing the potential health risks. According to CAC section 2-2, jellies are goods that have been produced to a semisolid gelled form and are manufactured from the juice and/or aqueous extracts of one or more fruits or vegetables .Veggies should be combined with sweetening meals, either with or without water. (Codex Alimentarious commission 296 - 2009) Jellies are made by heating fruit juice and sugar together. A good product is transparent and sturdy enough to keep its shape when turned out of its container yet trembles when moved. When cut , jelly should be soft but still have the cut's angle. (B. Ingham , “Making jams, jellies and fruits preserves” University of Wisconsin- Extension cooperative Extension). It shouldn't have crystallized sugar, be gummy, sticky, or syrupy. The product must be clear , have minimal or no synergy, and not be too rigid or rubbery. Four ingredients are necessary: pectin, acid, 65% sugar, and water for the preparation of jelly. For the quality of the jelly, pectin test and determining the point at which jelly is formed are crucial (Da Silva et al.,2006).

OBJECTIVES OF STUDY

1. To develop jelly from beetroot leaves
2. To study the physical and chemical properties of the developed functional Beetgreen Jelly .

CHAPTER 2

Review of Literature

2.1 Importance of underutilized vegetable leaves

About 600 species constitute the global diversity in vegetable crops but only one fourth is utilized as a major vegetable crop and rest are named as underutilized, underexploited, unconventional, minor, rare vegetables or so on (Pandey et al., 2014). The remainder are referred to as underutilized, under exploited, unusual, minor, rare vegetables, and so forth (Pandey et al., 2014). The leaves of the crop used for its roots only, are thrown away as garbage. One of the greatest challenges faced by our society is the establishment of environmentally friendly methods of managing food waste. These waste items have often been recycled into animal feed or compost (Llorach R., et al. 2003). Numerous studies conducted over the past ten years have revealed that vegetable by-products are potential sources of high-value substances, including fiber, antioxidants, vital fatty acids, and antimicrobials (O'Shea N. et al., 2012). These characteristics have increased the fascination with recovering underutilized vegetable by-products for purposes related to human nutrition or as alternative sources of healthful chemicals. The quest for alternatives to achieve the comprehensive utilization of natural resources along with the development of new food sources constitute a challenge that scientists must address now in order to respond sooner rather than later to this concern growth in global population indicate that there will be serious issues with food availability for future generations (O'Shea N. et al., 2012).

According to (Anal et al., 2017 and Lai et al. 2017), a lot of wastes related to agriculture and the food industry are produced each year. Although they can be employed as sources of nutrients and phytochemicals in food products, these wastes are usually disposed of in the environment, creating ecological issues. (Harrab et al.,2018)

2.2 Beetroot leaves

The young, leafy tops of the beetroot plant are known as beet greens. In fact, beet tops contain more vitamins, minerals, and antioxidants that are beneficial for your health than the taproot, however they are one of the leafy greens with the lowest calorie counts. Even though the top greens of the plant can be collected at any stage of growth and development, they are at their peak when the plant is young and the stems are still fragile and flexible. Beetroot leaves (beetgreens) are sometimes used as an organic fertilizer, animal feed, and traditional medicine (Amnah et al., 2013). Beetroot leaves are rarely consumed as vegetables and are deemed as wastes because of a lack of knowledge or dietary habits (Biondo et al., 2014). Fernandez, Jagus, and Agüero (2017) showed that beetroot leaf and bulb are both valuable sources of nutrients. In addition , the levels of anti-nutrition in beetroot leaves are either equal to or lower than those of some other leafy vegetables, such as spinach (*Spinacia oleracea L*.). Protein, fiber, minerals, vitamins, including calcium, pyridoxine, cyanocobalamin, and rutin, as well as phytochemicals like quercetin, kaempferol, and rutin, as well as plant pigments like chlorophylls, carotenoids, and betalains, are all present in beetroot leaf. These nutrients have antioxidant activity (Agüero, M.V. et al.,2017) . In addition, beetroot leaf is an abundant source of omega-3 fatty acids, including linolenic acid (Biondo et al., 2014; Fernandez et al., 2017; Elaby & Ali, 2018). There are relatively few studies on other beetroot by-products, like leaves, which are thrown away as food waste, in contrast to the significant quantity of research done on beetroot extract and juice. However, research in the literature revealed that this underutilized biomass is a good source of bioactive substances, such as proteins (Akyüz A, Ersus S. et al.,2021), minerals (Asadi SZ, Khan MA et al.,2021) , and many phytochemicals (Goyeneche R, Di Scala K et al.,2020) , with potential biological application . Various parts of beetroot are utilized in traditional Indian medicine for its wide range of therapeutic benefit (Kirtikar KR, Basu BD. et al.,2005) . The leaves are tonic, diuretic, and helpful in treating liver and spleen illnesses as well as paralysis and inflammation (Khare CP et al.,2007) . The great nutritious content of leaves makes them popular as vegetables everywhere. According to reports, these phytochemicals are strong antioxidants and hepatoprotective substances . (Lee, J.H. et al.,2009)

Table 2.2 : United States Department of Agriculture (USDA), 2019

Portion : per 100 gm

NAME	AMOUNT	UNIT
Calcium	117	Mg
Iron	2.57	Mg
Magnesium	70	Mg
Sodium	226	Mg
Potassium	762	Mg
Copper	0.191	Mg
Zinc	0.38	Mg
Vitamin B6	0.106	Mg
Vitamin K	400	µg
Fiber	3.7	Gm
Protein	2.2	Gm
Carbohydrate	4.33	Gm
Energy	22	Kcal
Ash	2.33	Gm
Phosphorus	41	Mg
Beta Carotene	3790	µg
Alpha Carotene	3	µg

2.3 Overview on Jelly

One of the earliest methods of food preservation known to man involves making jams, jellies, and marmalades using fruit, sugar, pectin, and edible acids. This approach facilitates the consumption of fruit during the off season. The market for candies includes a sizable and expanding area for jellies and gummies. They belong to a large class of goods whose properties are significantly influenced by the gelling agent and the ultimate moisture content (DeMars; Ziegler et al., 2001) . With the recent diversification and gentrification of dietary life, not only processed foods made of natural food materials and foods with enhanced functional ingredients are preferred, but also increased interest in the texture of foods, leading to an increase in the consumption of jelly as a dessert food (Son et al., 2005). Jelly is consumed as a popular food by people of all ages, and goods with increased health functioning are being created, along with gel-like foods that can offer a variety of textures. (Choi and Lee, 2014) Jelly is one typical gel-like food , which has water content of 20% and is a favored food of saccharides. Different textures result depending on the sort of gelling agent that may bind water, and different products are likely to be anticipated depending on the production method (Kim et al., 2007). There are four types of jelly: pectin jelly, agar jelly, gelatin jelly, and starch jelly, depending on the gelling agent used. Pectin jelly has a slight chewiness while breaking well, agar jelly has a slight chewiness while breaking better, gelatin jelly has a tough texture and excellent chewability, and starch jelly has a hard structure, so it can satisfy the needs of various consumers. (Lee et al., 2010).

According to Codex Stan-79 (1981) , jam/jelly is a food product with intermediate moisture (semi-solid) that is made by heating fruits with sugar (with or without the inclusion of pectin and acid) to raise the total soluble solids (TSS) content to >65% . The product (jelly) composition, such as sugar, pectin type and concentration, fruit and cultivar, and pH, may increase or retard the loss of bioactive components during processing (Pavuluri Srinivasa Rao et al., 2018). Even during the product storage, these modifications might occur, again depending on the product's composition, the packaging used, the period of time it is kept, and the temperature at which it is kept. Jelly can be made from fruits, especially those that have a shorter shelf life and are bursting with bioactive components . These are ready-to-eat, shelf-stable goods that can be transported anywhere, even into space (by astronauts), and they are commonly consumed, especially by young people. In order to determine the true nutritional value of fruit, it is therefore necessary to evaluate this technology from raw materials through processing and storage (Kaunsar Jabeen Shinwari et al., 2018) .

2.4 Ingredients of Jelly

2.4.1 Pectin

According to Maxwell, Belshaw, Waldron, and Morris (2012) and (Srivastava , Malviya et al., 2011) , pectins are a family of heteropolysaccharides that typically occur in the cell walls of terrestrial plants. The word "pectin," which is derived from the Greek word "pektikos," which means "congealed" , was first used by Henri Bracconot in 1825. He performed the very first studies on pectin and recognized its potential applications.Pectin has multiple applications in the pharmaceutical sector and is widely regarded as a functional food ingredient. Pectin, which is found in abundance in fruits and vegetables, promotes the textural quality of goods manufactured from those ingredients (Wicker et al., 2014). It mainly serves as a gelling agent in jams and jellies and is also known to successfully stabilize fruit juices, acidified milk drinks, high-protein fruit drinks, and meals fortified with antioxidants (Srivastava et al., 2011). According to Maran, Sivakumar, Thirugnanasambandham, and Sridhar (2013), pectin mimics fat in spreads, ice creams, and emulsified meat items.Apple pomace, citrus peels, and sweet potato pulp are a few popular industrial sources of pectin. Currently, pectin is extracted from food waste and agricultural industrial waste. It enables organizations to address the concern of waste collection and makes a variety of source materials for commercial use available. Fruit wastes including papaya peels, kiwifruit pomace, and banana peels (Emaga, Ronkart, Robert, Wathelet, & Paquot, 2008; Yuliarti, Goh, Matia-Merino, Mawson, & Brennan, 2015). Pectic polysaccharide, also referred to as pectin, aids in jellification by maintaining the right concentration of pH and sugar. The organoleptic and physico-chemical characteristics of jam and jelly might vary depending on the amount of added pectin (SIRINE et al., 2022) .When a jellying mixture's pH is increased, the strength of the jelly that results weakens other factors, including the total solids content, stay unchanged. On the other hand, if acid is added, the jelly gets stronger until it reaches a pH where its strength is at its peak , preventing the combination from forming a jelly if the pH is elevated sufficiently (Hinton CL et al.,1940). During ripening, storage, and processing, pectin is most susceptible to enzymatic and non-enzymatic alterations (Van Buren et al.,1979) .

In pure water, pectins are soluble. Pectinic and pectic acid salts with monovalent cations (alkali metals) are often soluble in water while those with di- and trivalent cations are either weakly soluble or insoluble. On mixing with water, dry powdered pectin tends to hydrate quickly and clump (Okunlola et al.,2021). These crumps are made up of semi-dry packets of pectin that are enclosed in an outer covering that is very hydrated. Such crumps slowly dissolve over time. Using pectin with improved dispersibility through special processing during production or dry mixing pectin powder with a water-soluble carrier substance can avoid clump formation (Rolin, 1993; Hercules Incorporated, 1999).

2.4.2 Citric acid

One of the most commonly used organic acids in food, medicine, the chemical industry, and other industries is citric acid, which is a naturally occurring component in plants as well as animals and a intermediate of physiological activity (Barretti et al., 2022). Citric acid is harmless and non-hazardous with a pleasant sour taste, a cooling entry, and no residual taste. It is also exceptionally soluble in water and can be ingested and processed by living things immediately. Citric acid is commonly employed in the food business due to this outstanding quality (Vázquez-Rodrguez , Escalante et al.,2022). The world's largest producer and consumer of an edible organic acid is citric acid. It is extensively utilized in the chemical, pharmaceutical, and food industries (Chavez-Esquivel et al., 2022). The citric acid production is the second-largest fermented product globally, following alcohol. Citric acid has been used in a number of novel fields recently, including nanomedicine, drug delivery, and tissue engineering (Yan et al., 2022), which has brought about in an increase in demand for the product on a global scale that is currently growing at a pace of 5% annually . Citric acid is commonly used for its low toxicity compared to other acidulants, which are mostly employed in the pharmaceutical and food industries

(Pandey et al.,2006). Detergents, cleaning products, personal hygiene products, and other products are a few examples of the other applications for citric acid. Citric acid demand and consumption are increasing by 3.5–4.0% year, and global production has reached 1.4 million tonnes. (C.R. SOCCOL et al., 2006) .

The expert committee of FAO/WHO has designated citric acid as a safe food additive, referring to it as the "first edible sour agent" because it is both versatile and environmentally friendly (GRAS, generally recognized as safe). Citric acid primarily serves to impart a sour flavor to jam and jelly and to regulate pH to the lowest range necessary for pectin gel (Soares et al., 2022).Globally, biological fermentation is used to generate more than 99% of the citric acid consumed. About 99% of all products in the world are produced by fermentation, resulting in it being the most significant industrial manufacturing method (Jin et al., 2021).

CHAPTER 3

Material and Methods

3.1Material Procurement

Beetroot, pectin , citric acid and sugar was collected from the local market . Fresh beet greens were chopped using knife and was further subjected to cleaning by washing it several times with water. Sugar was grinded to powder.

3.2 Material and Glassware

Beetgreen juice , sugar , pectin , citric acid , beakers , petri plates , muslin cloth , conical flask , measuring cylinder ,test tubes , mould .

3.3 Equipments Used

1 . Digital Electronic Balance

For weighing various ingredients of jelly an electronic balance (model : BL P38/6002 of kerro company) was used .

Fig 3.3.1 Digital Balance

2.A pH meter

A pH meter was used to determine the pH of the jelly samples. It is used to determine the hydrogen – ion activity of a solution .

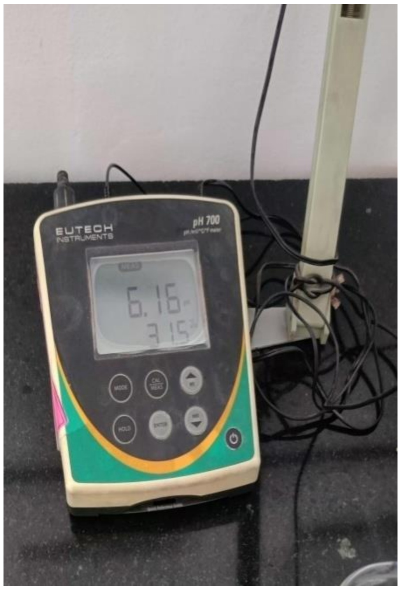


Fig 3.3.2 A pH Meter

3. Hot air oven

It was used for determining the moisture content of the jelly samples . The size of thechamber is 30cm × 30cm × 30cm . It needs 650 watts input power . The chamber is made up of mild steel sheet. Capillary thermostat is used to control the temperature.

Fig 3.3.3 Hot Air Oven

4. Hand sealing machine

It was used to seal the packaging of the products used by using heat.

Fig 3.3.4 Hand Sealing Machine

5. Muffle Furnance

It is used to heat the material at extremely high temperature , isolating it from external factors . It is used for the ash analysis of the samples. The percentage of residue remained after dry oxidation at a certain temperature range (500-600C) is used for estimating the ash content. (Farid R. Abadi et al., 2018)

Fig 3.3.5 Muffle Furnace

6. Spectrophotometer

It is used to measure the photons absorbed while passing through a sample solution . It was used for antioxidant analysis and protein analysis by lowry method .

7.Texture analyzer

It is used to analyze the texture of the sample . It measures the hardness , firmness , chewiness , , cohesiveness , gumminess , adhesiveness.

Fig 3.3.7 Texture analyzer

8. Hot plate

It has a smooth, flat surface composed of a heat-resistant substance. the desired heat level can be set by adjusting the hot plate's temperature using a control knob . During the preparation of media, it aids in dissolution of agar in distilled water.

Fig 3.3.8 Hot Plate

9. Laminar flow

Laminar airflow is a crucial tool in maintaining cleanliness, precision, and safety in settings where a controlled and contaminant-free atmosphere is essential.

Fig 3.3.9 Laminar Flow

10. Incubator

An incubator , is a device or apparatus designed to provide a controed environment for growing living organisms , such as microbes.

Fig 3.3.10 Incubator

11. Autoclave

An autoclave is device used sterilizing glassware . It uses high pressure steam and temperature. Their efficiency is based on the fact that steam under pressure retains a temperature greater than 100°C. The drawback of autoclaves is that they can't be used to autoclave the items that are sensitive to heat, frequent exposure to high heat and humidity can degrade fine cutting tools, especially those made of high-grade carbon steel. (Trenton R.Schoeb DVM et al ., 2015)

Fig 3.3.11 Autoclave

3.4 Methodology for the Development of Jelly

After the procurement of the materials required for the development of jelly , the leaves of beetroot was washed thoroughly with water to remove any kind of dirt or any extraneous element on it . Then the leaves were chopped and grinded in the grinder . Further to obtain fresh and clear juice , strain the grinded leaves paste with the help of a muslin cloth . This strained juice was stored in the refrigerator.

3.4.1 Preparation of Jelly

Weigh all the ingredients (sugar , pectin , citric acid and beetgreen juice) according to the proportion needed for the development of a jelly . Total 4 samples of beetgreen jelly were made with different proportion of ingredients as given in the table below. All the ingredients were mixed in the juice and stirred to a proper consistency . Then the mixture was heated with constant stirring uptill the TSS reached to 65° Brix and desired consistency was obtained . The jelly was poured on a petri plate and was allowed to cool at room temperature . After 3-4 minutes the jelly was set .

SAMPES	JUICE (ml)	SUGAR (gm)	PECTIN (gm)	CITRIC ACID (gm)
1.	100	48.8	2	1
2.	100	48.8	2.5	1.5
3.	100	48.8	3	2
4.	100	48.8	4	0.5

Table 3.4.1 :- Ratios of Ingredients in the jelly samples .

The procedure of making of the jelly is represented in the flowchart given below :

3.4.2 Steps to Extract the Beetgreen Juice :-

Cut the beetroot top

↓

Wash them several times with water to remove the dirt

↓

Chop them into smaller leaves and stem

↓

Grind the chopped beetgreen in the grinder

↓

Strain the grinded beetgreen with the help of a muslin cloth

→

3.4.3 Steps of making Beetgreen jelly :-

Take 100ml of beetgreen juice

↓

Weigh sugar , pectin and citric acid

↓

Add the weighed ingredients in the beetgreen juice and mix it evenly

↓

Heat the mixture with constant stirring uptill the TSS reaches to 65° Brix

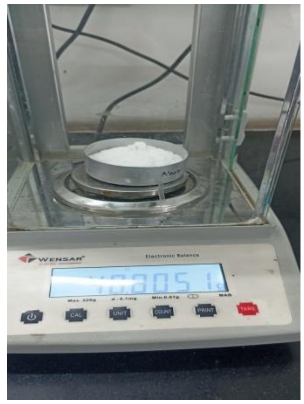
↓

Pour it in a container and let it set at room temperature

↓

Store it in refrigerator


400
300
200
100
500
400
300
200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Electronic Balance

3.5 Evaluation and Analysis

3.5.1 Moisture Content Analysis :-

The amount of water in a food product is measured by its moisture content, which is often stated as a percentage of weight on a wet basis (Mathlouthi et al.,2001) . The objective was to estimate the sample's moisture content. The weight of the sample before drying is compared to its weight after drying . The steps to measure the moisture content of the sample was performed by weighing 2gm of each sample in petri dish . Place the petri dishes in the Hot Air Oven and set the temperature at 135°C for 2 hrs . After 2 hrs of drying remove the samples from the oven and cool it in the dessicator and then weigh the samples .

$$\textbf{Moisture Content (MC)} = \frac{\mathbf{(w - d) \times 100}}{W}$$

Where ,

w = weight of the sample

d = weight of drying

3.5.2 Ash Content Analysis :-

Ash is the inorganic residue of burning organic matter. The reduction in weight that occurs after complete oxidation of the sample at a high temperature (about 500° to 600°C) due to decomposition of organic components is used to calculate the ash content. Due to possible losses from decomposition or interactions between constituents, the ash obtained may not completely match the composition of the mineral components found in the original food. The analysis was performed by taking 2gm of each sample in a crucible . Keep the samples in the muffle furnace at 550° C for 4 hours . After 4 hrs cool the samples to atleast 250° C . Place the samples in the dessicator to cool at temperature and then weigh the samples .

$$\textbf{Ash Content} = \frac{(z - x) \times 100}{y - x}$$

Where,

X = weight of crucible

Y= weight of crucible with sample

Z= crucible weight after ashing

Fig 3.5.2 Ash analysis

3.5.3 pH Analysis

The logarithm of the reciprocal of the hydrogen ion concentration is used to define pH. The analysis was performed by weighing 2gm of each sample and dissolving in 10ml distill water . Dip the electrode in the buffer solution and wait until the indicator shows “ready”. When it shows ready dip the electrode in the sample dissolved in distill water . Wait until the indicator displays the reading. Note down the readings of each sample. For each sample rinse the electrode with distill water.

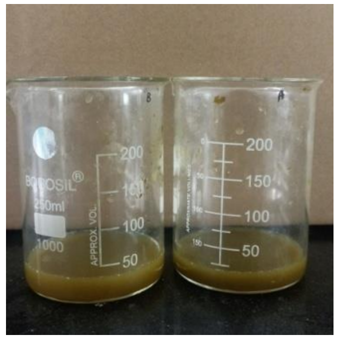


Fig 3.5.3 pH Analysis

3.5.4 Protein Analysis

Using Hartree's approach, the modified Lowry protein measurement was conducted (Hartree et al.,1972).

The extracts were diluted to 1 mL with water for the analysis, and 0.9 mL of solution A (2% sodium carbonate + 50 ml 0.1N NaOH) and soution B (1.56% copper sulphate + 10ml 2.37% sodium potassium tartarate soution) was added .

After cooling the samples to room temperature, 1 mL of solution B was added, and the mixture was allowed to sit for 10 minutes.

Before incubating for 10 min at 50 °C, 3 mL of solution C (mixture of Folin-Ciocalteu phenol reagent and water 1:16 v/v)—was added.

Bovine serum albumin (BSA; 0, 0.0625, 0.125, 0.25, 0.5, and 1 g L-1) was used to create a standard curve. Then take OD at 660 nm. (Khilnani et al.,2018).

Fig 3.5.4 Protein Analysis

3.5.5 Antioxidant Analysis

Antioxidants are substances that, by scavenging free radicals and reducing oxidative stress, can delay, inhibit, or prevent the oxidation of oxidizable materials. Oxidative stress is an unbalanced state where excessive levels of reactive oxygen and/or nitrogen species (ROS/RNS, such as superoxide anion, hydrogen peroxide, hydroxyl radical, and peroxynitrite) surpass endogenous antioxidant capacity, causing oxidation of a variety of biomacromolecules, involving enzymes, proteins, DNA and lipid (Ames et al.,1993) . The analysis was performed by preparing DPPH solution (0.002 gm DPPH + 50m methanol) and extract (2mg sample + 1 ml methanol). For each sample take 1ml extract and 3ml DPPH solution and 3ml methnol in a test tube (SO). For blank , take 1ml distill water , 3ml DPPH solution and 3ml methanol (CO) . Keep both in dark for 30 min. after 30 min take the reading in spectrophotometer at 517 nm .

$$\textbf{Antioxidant} = \frac{(co - so)}{so} \times 100$$

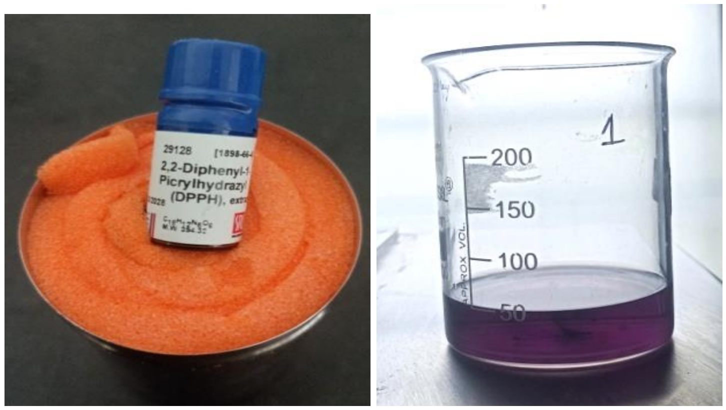


Fig 3.5.5 Antioxidant Analysis

3.5.6 Pectin Analysis by Alcohol Test

This analysis was performed by adding 3 teaspoons of methylated spirit was poured gently in 1 teaspoon of strained juice extract . Then shake it well and allow to stand for few minutes . Pectin-rich juices create a solid mass that resembles jelly.

3.5.7 Texture Analysis

Food texture has been defined by the International Standards Organization (ISO) in their standard vocabulary for sensory analysis as ‘All the rheological and structure (geometrical and surface) attributes of a food product perceptible by means of mechanical, tactile, and where appropriate, visual and auditory receptors’ (ISO, 2008).According to (Wilhelm et al. 2004) , texture characteristics are significant from the perspectives of both quality control and food safety. Texture characteristics include hardness , chewiness , firmness , cohesiveness , gumminess , adhesiveness.

Fig 3.5.7 Texture Analyzer

3.5.8 Shelf Life

Shelf life is the recommended maximum stretch of time for which items or fresh (harvested) produce can be held, during which the defined quality of a specified fraction of the commodities remains acceptable under anticipated (or stipulated) conditions of distribution, storage, and display (Gyesley et al.,1991). Under shelf life moisture content , pH , and titrable acidity is evaluated .

Fig 3.5.8 Shelf Life Estimation

CHAPTER 4

Result and Discussion

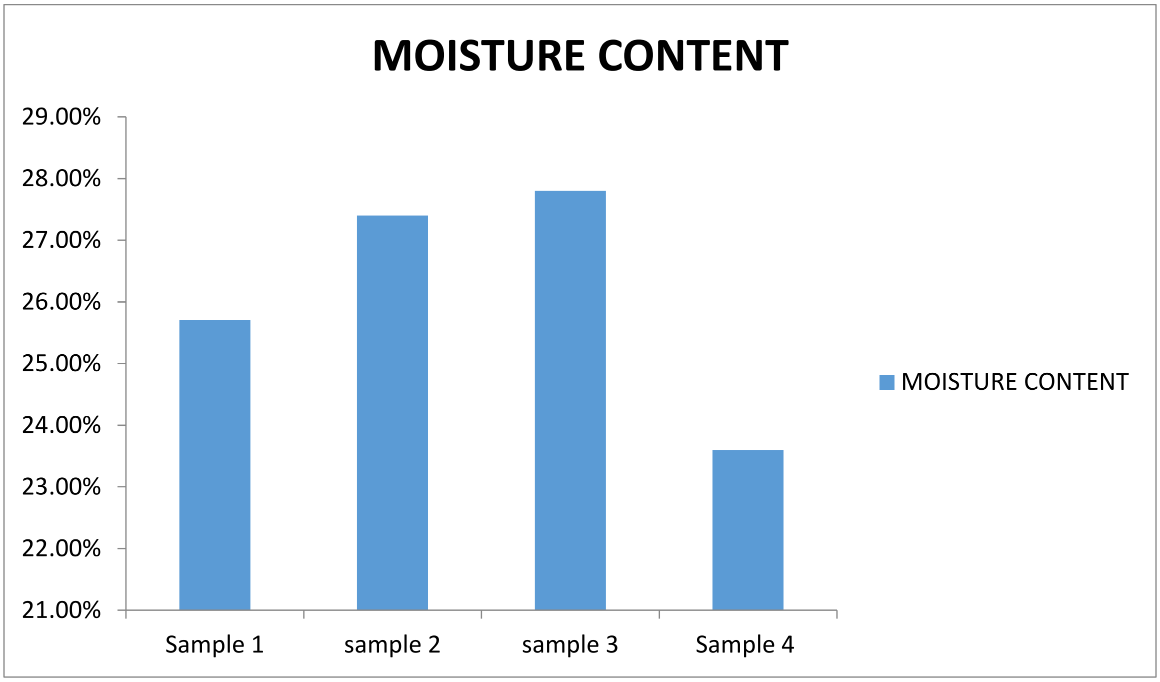
The objective of this work was to utilize the leaves of beetroot which is discarded due to lack of knowledge about its nutritional properties and health benefits. Beetgreens are utilized by using their juice for the development of jelly . Total 4 samples were developed with different compositions . The result is outlined below based on its physical and chemical analysis .

4.1Moisture Content

The moisture content of all the 4 samples were evaluated and are given below in the table . The highest moisture content is observed in sample 3 which was 27.8% . Whereas the moisture content of sample 1 and sample 2 was calculated to be 25.7%m and 27.4% respectively. Sample 4 had the least amount of moisture content , that is 23.6% .

SAMPLE	MOISTURE CONTENT
Sample 1 (2gm pectin & 1gm citric acid)	25.7%
sample 2 (2.5gm pectin & 1.5gm citric acid)	27.4%
Sample 3 (3gm pectin &2gm citric acid)	27.8%
Sample 4 (4gm pectin & 0.5gm citric acid)	23.6%

Table 4.1 Moisture Content



Graph 4.1 : Graphical representation of moisture content

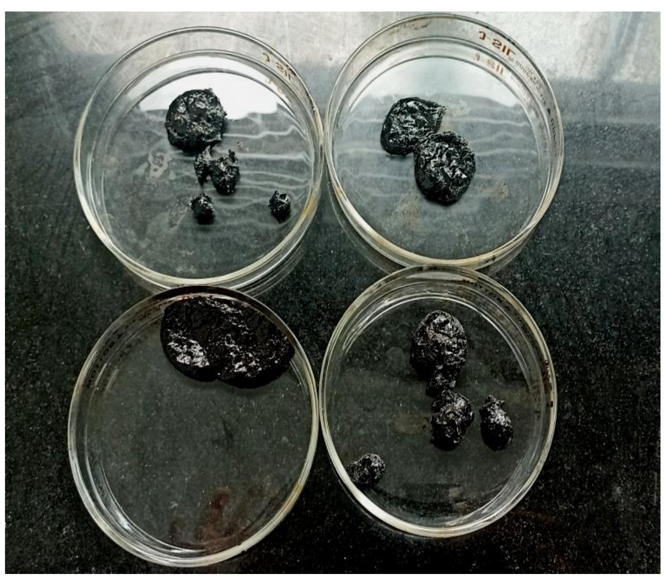


Fig 4.1 Result of Moisture Content

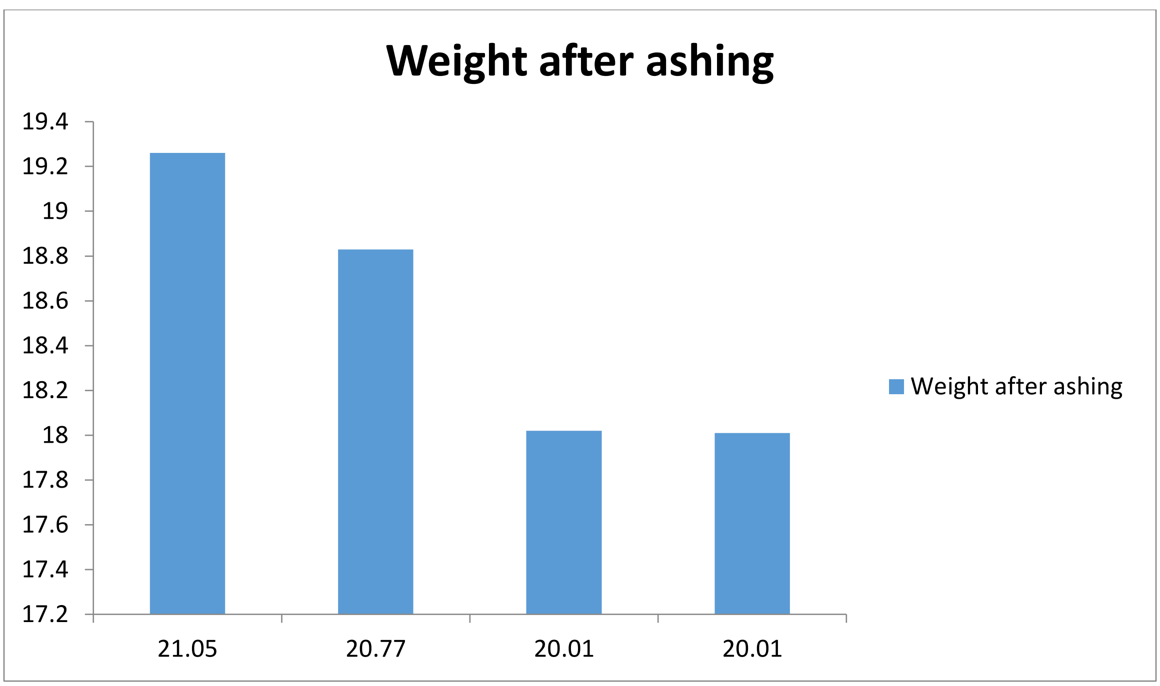
4.2 Ash Content

When organic content in food is completely oxidized or ignited, the inorganic residue left over is referred to as ash. For consistent outcomes, it's imperative to have a fundamental understanding of the traits of the various ashing techniques **(Maurice R. Marshall et al.,2010) .**

The ash content of all the 4 samples were evaluated and are given in the table below .

SAMPLE	WEIGHT OF CRUCIBLE	WEIGHT [CRUCIBLE+SAMPLE]	WEIGHT AFTER ASHING
1	34.75	36.76	32.21
2	18.76	20.77	18.83
3	18.01	20.01	18.02
4	18.01	20.01	18.01

Table 4.2 Ash Content



Graph 4.2 Graphical representation of ash content

Fig 4.2 Result of Ash Content

4.3 Shelf Life analysis

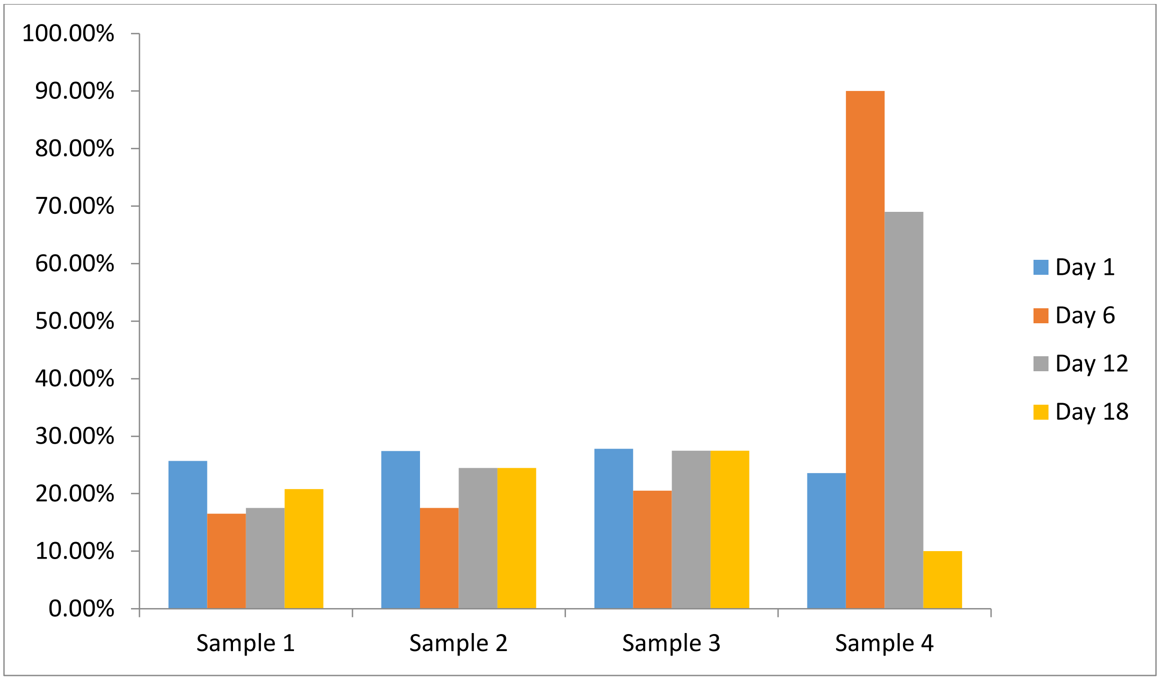
Shelf life is the recommended maximum stretch of time for which items or fresh (harvested) produce can be held, during which the defined quality of a specified fraction of the commodities remains acceptable under anticipated (or stipulated) conditions of distribution, storage, and display (S. W. et al.,1991) . Under shelf life moisture content , pH , and titrable acidity is evaluated .

The shelf life of all 4 samples were evaluated on every 6 days for 1 month and is given below in the table .

4.3.1 Moisture content

	Sample 1	Sample 2	Sample 3	Sample 4
Day 1	25.7%	27.4%	27.8%	23.6%
Day 6	16.5%	17.5%	20.5%	30%
Day 12	17.5%	24.5%	27.5%	69%
Day 18	20.8%	24.5%	27.5%	10%

Table 4.3 : Moisture content for shelf life of beetgreen jelly



Graph 4.3 : Graph of moisture content for shelf life of beetgreen jelly

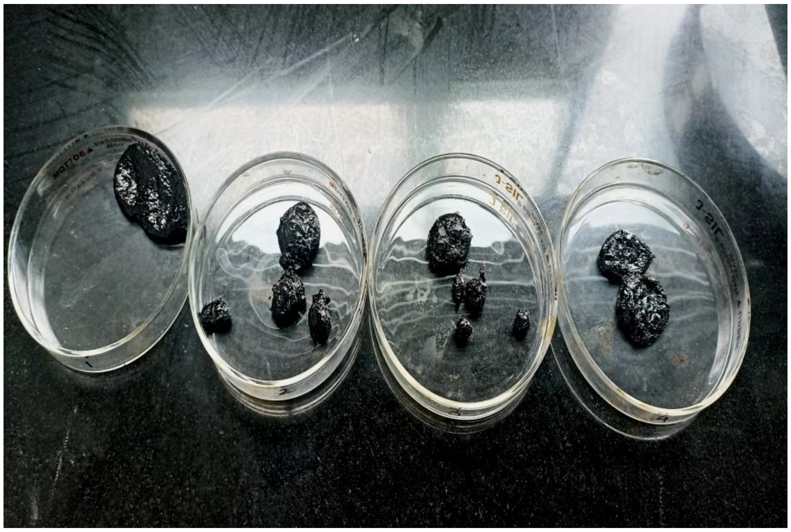


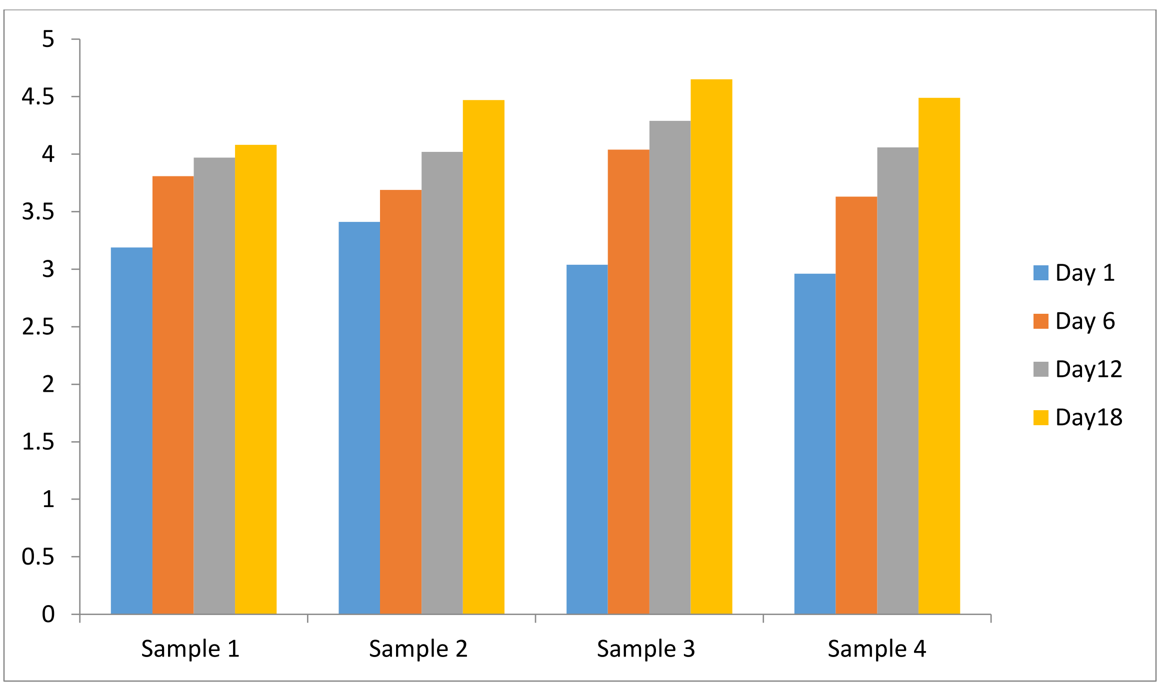
Fig 4.3 Result of Shelf Life (MC)

4.4 pH analysis

The pH of all the 4 samples is recorded in the table below for 18 days . It is observed that the pH has increased with time . The final increase in the pH of sample 1 (4.08) is least whereas sample 4 (4.49) has the highest final increment in the pH .

	Sample 1	**Sample 2**	**Sample 3**	**Sample 4**
Day 1	3.19	3.41	3.04	2.96
Day 6	3.81	3.69	4.04	3.63
Day 12	3.97	4.02	4.29	4.06
Day 18	4.08	4.47	4.65	4.49

Table 4.4 : pH analysis for shelf life of beetgreen jelly



Graph 4.4 : Graphical representation of pH for beetgreen jelly .

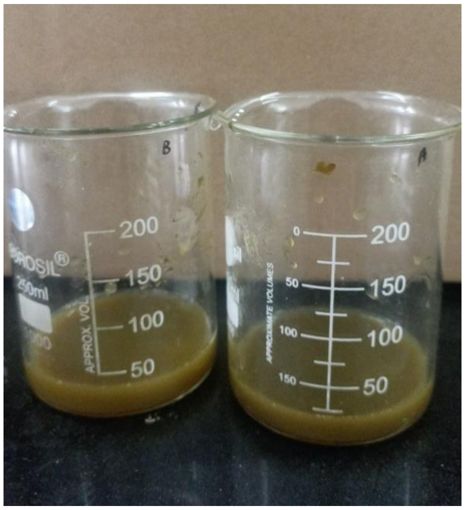


Fig 4.4 Result of shelf life (pH)

4.5 Pectin Analysis

Pectin analysis was performed of the beetgreen juice by alcohol test . After few minutes it was determined that little amount of solid thread like mass deposited in the beaker , which signifies the presences of pectin in the beetgreen juice .

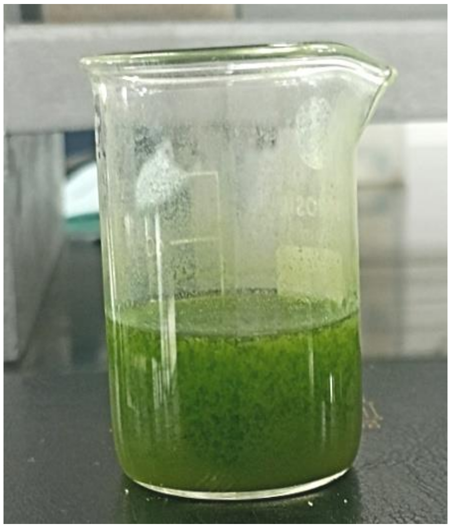


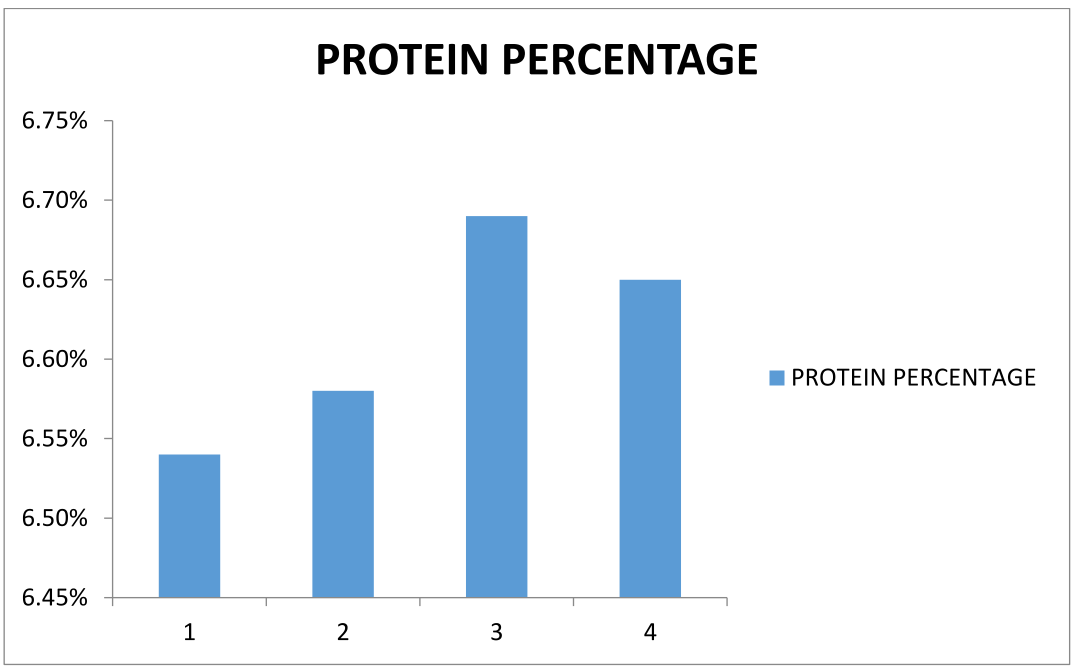
Fig 4.5 Result of Pectin Analysis by Alcohol test

4.6 Protein Analysis

Protein analysis was performed for all the samples. It was observed that sample 3 has highest protein content i.e. 6.69% and sample 1 has least protein content i.e. 6.54%. Protein content of sample 2 and sample 4 are 6.58% and 6.65% respectively.

SAMPLE	PROTEIN PERCENTAGE
1.	6.54%
2.	6.58%
3.	6.69%
4.	6.65%

Table 4.6 Protein estimation



Graph 4.6 Graphical representation of protein

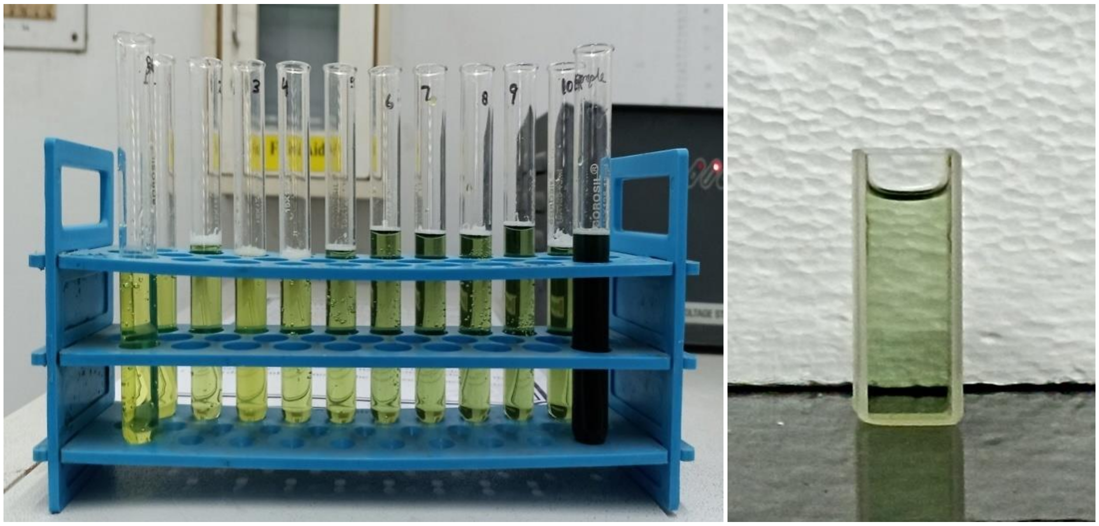


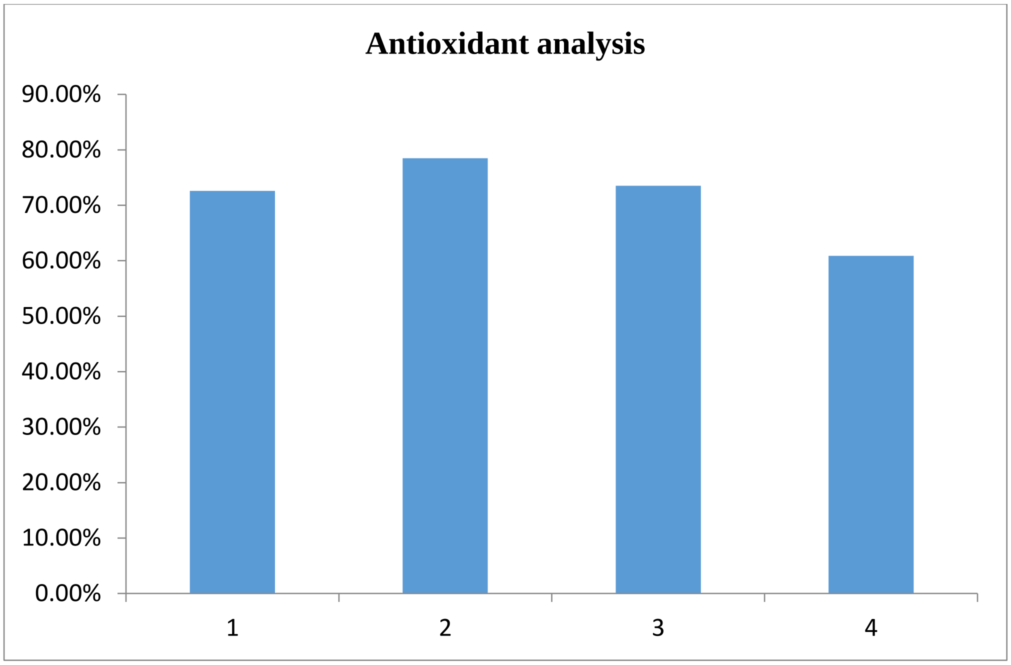
Fig 4.6 Result of Protein Analysis

4.7 Antioxidant analysis

Antioxidant analysis was estimated of all 4 sample , it was observed that sample 2 has highest percentage of antioxidant (78.5%) and sample 4 has least percentage of antioxidant (60.9%).

S. No.	Sample	Antioxidant percentage
1	1	72.6%
2	2	78.5%
3	3	73.5%
4	4	60.9%

Table 4.7 Antioxidant analysis



Graph 4.7 Graphical representation of Antioxidant Analysis

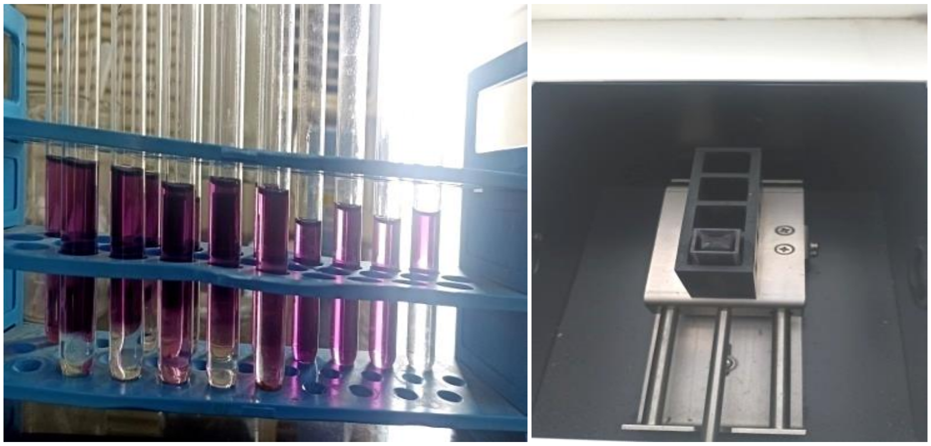
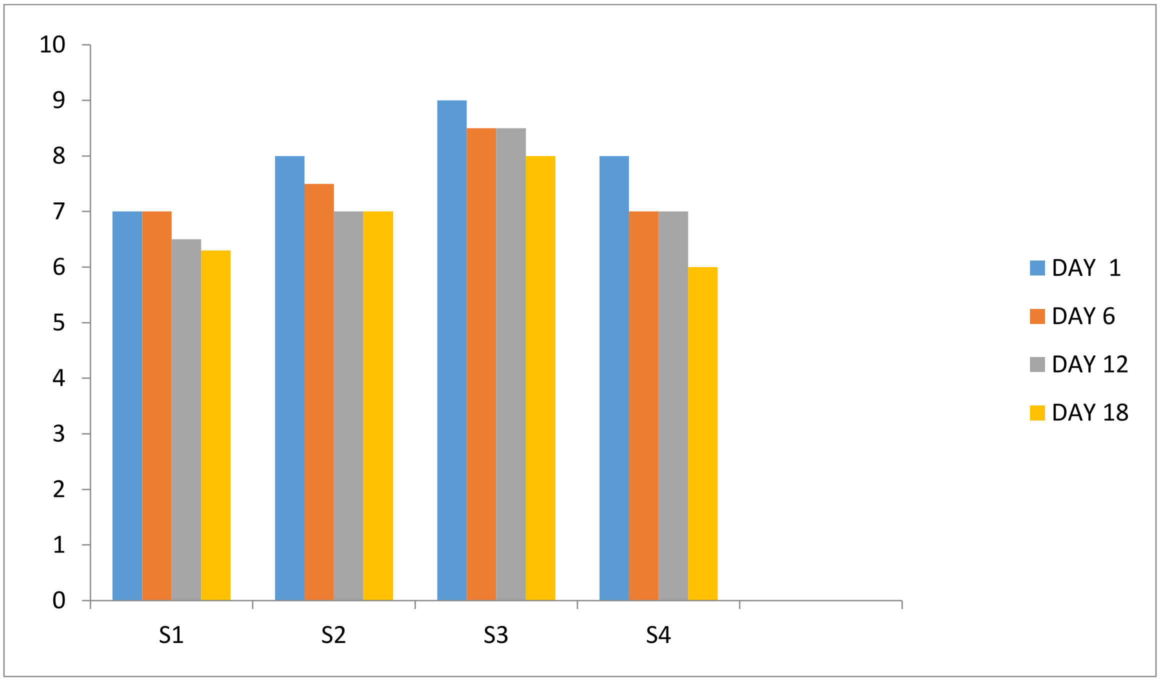


Fig 4.7 Result of Antioxidant Analysis

4.8 SENSORY ANALYSIS

All the 4 samples were rated on the hedonic rating scale by the semi trained panel members and it was observed that S1 had 7, S2 had 8 , S3 had 9 and S4 had 8 rating . It was observed that with the number of days the rating of hedonic scale was decreasing .



Graph 4.8 Graphical representation of sensory analysis

SUMMARY

In this study beetgreen valorized functional jelly was successfully developed. The formulation of the jelly was standardized as 48.8 gm sugar , 3gm pectin and 2 gm citric acid was mixed in 100ml beetgreen juice and heated until it reaches 65° brix . Protein by Lowry method and antioxidant property using DPPH was successfully studied. The jellies were stored in refrigerated and ambient condition without addition of any artificial preservative. Sample 3 has highest protein content i.e. 6.69% and sample 1 has least protein content i.e. 6.54%. Sample 2 has highest percentage of antioxidant (78.5%) and sample 4 has least percentage of antioxidant (60.9%). Ash content was evaluated by Muffle Furnace. Sample 1 has highest ash content (32.21%). For shelf life pH , moisture content and sensory analysis was conducted on every 6^{th} day for 18 days .

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