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Comparative Study of Preservation Methods for Berberis Lycium Juice: A Laboratory Approach at Shaheed Benazir Bhutto University, Sheringal, Dir Upper, Pakistan

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ABSTRACT

This study examines the effects of diverse preservation techniques on the shelf life, nutritional importance, microbiological safety, and sensory behavior of Berberis lycium juice. These techniques consist of vacuum sealing, freezing, refrigeration, and adding natural preservatives such as sugar and honey. Berries were harvested from Pakistan's Upper Dir highlands and turned into juice in a lab. Samples were stored and examined using each technique at intervals of 7, 10, 13, 16, 19, 21, 24, 27, and 30 days. Microscopy was used to inspect microbial development, and other parameters like pH, TSS, ascorbic acid concentration, microbial load, and sensory attributes were assessed. For long-standing preservation, vacuum sealing and refrigeration were not as much of successful as freezing, which deeply enhanced microbiological safety and sensory quality, predominantly when paired with honey or sugar. Three days passed previous to the control sample going bad. The study concludes that the best way to preserve Berberis lycium juice is by freezing it with natural preservatives. An evergreen plant aboriginal to the Himalayan region, Berberis lycium belongs to the Berberidaceae family. It has long been utilized for food and medicine, as well as for its roots, bark, stems, leaves, and fruits. The plant is well-identified in Ayurvedic medicine for its capability to prevent harm to the liver, abdomen, skin, cough, and eyes. Pharmacological research highlights its hepatoprotective, anticarcinogenic, antipyretic, hypoglycemic, and hyperlipidemic characteristics. The fruits which are consumed in raw or processed into juices, jams, and preserves by local communities, are profuse in vitamins, minerals, antioxidants, and anthocyanins. An impression of the plant's many qualities is the target of this paper. Berberis lycium and other plants take action as biosynthetic laboratories for substances that are superior for human health. Medicinal plant extracts habitually exhibit antibacterial action, productively preventing the enlargement of bacteria and fungi.

INTRODUCTION

An affiliate of the Berberidaceae family, Berberis lycium is an evergreen plant (Kapoor, Sood et al. 2013). It is furthermore called Ishkeen in Urdu, Kashmal or Kasmal in Hindi, and Indian berberry in English. It's a prickly, stiff and suberect shrub that grow among 2.7 and 3.6 meters tall (Gupta and Singh 2022). The genus Berberis is originated in Europe, Asia, and America. With it's generally edibility score of 3 (1–5) and a medicinal position of 3 (1–5), it is a famous medicinal plant.

Figure 1
Berberis Lycium

This plant has some therapeutic worth in all parts (Kapoor, Sood et al. 2013). Several ayurvedic remedies utilize its root, bark, stem, and fruits. Abundant conditions, counting diabetes mellitus, liver, stomach, skin, and cough illnesses, are generally treated with it, in India and Pakistan's Himalayan area. It can be found linking 850 and 3500 meters above sea level in Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Himachal Pradesh, Sikkim, and Jammu & Kashmir. It is found in Pakistan's northern regions, as well as Gilgait Baltistan, Ghizer, Astor, Diamer, and Swat. It can also originate in Ceylon and the Nilgiris.

All walks of life make wide-ranging use of medicinal plants, either openly as traditional treatments in various indigenous medical systems or indirectly in the pharmaceutical mechanized of contemporary medications. The World Health Organization (WHO, 1977) defines "a medicinal plant" as any plant that has compounds in one or more of its organs that can be utilized therapeutically or that serve up as building blocks for the formation of beneficial medications (Organization 1977). since they are readily obtainable for medical purposes in rural and tribal communities, medicinal plants are mainly supportive (Gupta, Singh et al. 2015). In India alone, 2000 different plants are used to build medical remedies, according to National Health Experts. Only 200 of them are resulting from animals, and 300 are from minerals, while 1500 medications are made from different plants (Srinivasan, Nathan et al. 2001). The furthermost source of medicine for treating any sort of illness or infection is plants. For this cause, medicinal plants are vital to maintaining people's health all around the world. Plant-based medicines have been utilized since very old times, according to ayurveda sympathetic.

The fruit of B. lycium is safe to eat and its numerous sections are precious medicinal herbs (Ali, Uddin et al. 2015). It has been used in conventional folk treatments and has a confirmed track record of treating a multiplicity of illnesses. These illnesses contain leprosy, rheumatism, piles, jaundice, conjunctivitis, bone fractures, liver and skin disorders, and mouth ulcers (Ali, Uddin et al. 2015). It is also used to treat internal wounds, intestinal colic, diabetes, ocular conditions, menorrhagia, fever, diarrhea, and antiglycation (Adhikari, Thapa et al. 2019). Conventional medical professionals now accept B. lycium(Sevik, Guney et al. 2012; Organization 2013), used as a food(Hatano, Kagawa et al. 1988) or medicine(Srivastava, Rawat et al. 2010) due to the fact that it contain a number of chemicals, including gilgitine, palmatine, maleic acid, acetic acid, ascorbic acid, jhelumine, punjabine, and chinabine(Khan, Ahmad et al. 2014; Ismail, Khalid et al. 2023; Shah and Aleem 2023). Berberine is the most common alkaloid in B. lyceum (Gulfraz, Arshad et al. 2004; Garhwal 2010). Antimicrobial, antiprotozoal, antitoxic, antitrachoma, antidiarrheal, anti-Alzheimer, and antitrachoma properties are amongst the different medicinal compensation of berberine (Adhikari, Thapa et al. 2019). Since antique times, medicinal plant species (MPs) have been used to treat illnesses. One of the major reasons for the increasing death rate is these infectious diseases bring on by injurious microbes. MPs have yielded abundant bioactive chemicals that are utilized in the pharmaceutical manufacturing to synthesize different antibiotics. Due to the exorbitant expense of allopathic medicines, limited communities in distant Pakistan, particularly in hilly areas, first and foremost rely on MPs for prime healthcare and prevention (Abbasi, Khan et al. 2012). The most commonly mentioned versatile medicinal plant amongst the numerous high-value MPs that people in Pakistan's hilly regions have long engaged to cure a selection of illnesses is Berberis lycium, which is mainly utilized in abundant traditional formula to fight infectious ailments (Parra, Gaur et al. 2018).

Our nutrition contribute was possible maintained in the past by vegetative plant parts.

Any fruit that was obtainable to them was consumed by our forefathers. Some of these fruits had high vitamin C content, but others were acidic, heavy in tannins, or still somewhat toxic until they were quite mature. There would have been periods of the year when fruit was either scarce or totally unavailable. Plants have been used as medicines from the start of human history. About 80% of the world's population still first and foremost receives their primary medical care from plant-based, conventional medicine systems, demonstrating the sustained significance of these systems in healthcare (Owolabi, Omogbai et al. 2007).

Fruit that is more than just edible is obtainable now, and the variety is outstanding. However, eating fruit has to contend with a variety of industrial foods, and it is not a good participant. Fruits hold fiber, gums, and pectin whose health paybacks are still being familiar, as well as prosperity of antioxidants and compounds that hold back cancer. They are also a great foundation of energy. For a selection of cultural and economic reasons, many fruit species have not been domesticated yet, these fruits are prosperous in different nutrients and have therapeutic behavior. Such fruits are called as underutilized fruits and Berberis lycium is one among them.

Plant Profile

The Berberidaceae family was originally created by (Jussieu A.L.) (Jussieu 1789) called "Berberides" and was regard as one of the first angiosperms, with a great number of irregular or disjunction genera. (Bruckner C., 2000) (Brückner 2000). B. lycium is a suberect, branching shrub that can arrive at a height of 3–4 meters. It is a member of the Berberis genus and the Berberidaeceae family. B. lycium has light, whitish to grayish branches and stems, internodes that series in length from 1.5 to 3.5 cm, and spine that are (1-)3-fid (6-).10–20 mm in length, with a straw-yellowish shade (Dhar and Kachroo 1983). The leaves can be oblanceolate-oblong obviate, with size of 2–6 cm and 6–12 mm. They can also be gray or white below the surface, subsessile, whole, with 2–4 spinules on the margins, and openly veined (Irshad, Pervaiz et al. 2013). The blossom is 6–8 mm across, pale to yellow, with pedicels that are 6–12(-15) mm or longer, thin, slender, glabrous, and bracts that are 2-2.5 mm. The middle and outer sepals are less significant than the inner sepals, which are bigger at 4.5–5 mm length and 3 mm wide. Furthermore, inner sepals are superior than petals, stamens are lesser than petals, which are oblong and emarginated (Jabeen, Saleem et al. 2015). They typically have four short-septate ovules. Berries are 7-8 mm long, broad (5 mm), oblong-subglobose, and the seeds are 3-4 mm long(Kapoor, Sood et al. 2013) (https://www.worldfloraonline.org/taxon/wfo-0000563482). The local shrub of Nepal, B. lycium, is broadly distributed over the Himalayan area of Central and North India, Afghanistan, the entire of Nepal, and the western part of Pakistan. In B. lycium, self-pollination and cross-pollination are the methods of reproduction (Verma, Wani et al. 2021).

Phytochemicals in B. lyceum

Alkaloids

Several alkaloids, a family of organic chemicals found in nature that typically consist of basic nitrogen atoms, are rich in B. lycium. Berberine ($C_{20}H_{18}NO_4^+$), an alkaloid extremely esteemed for its therapeutic character, is remarkably present in the plant. Koumidine ($C_{19}H_{22}N_2O$) and camptothecin ($C_{20}H_{16}N_2O_4$), which has anticancer properties, are other central alkaloids. In totaling, the plant produce palmatine ($C_{21}H_{22}O_4^+$), luteanine, salutaridine ($C_{19}H_{21}NO_4$), and protopine ($C_{20}H_{19}NO_5$), all of which give to its pharmacological profile. Alpha-codeimethine ($C_{19}H_{23}O_3$), hydroxygardnutine ($C_{20}H_{22}O_3$), isomajdine ($C_{23}H_{28}N_2O_6$), and oxoglaucine ($C_{20}H_{17}NO_5$) all contribute to the alkaloid range in B. lycium. These substances are notable for their diverse biological actions, which highlight B. lycium's potential as a source of therapeutic medicines. These activities include anti-inflammatory, antibacterial, and antioxidant qualities (Sabir, Tahir et al. 2013; Katare, Singh et al. 2022; Ismail, Khalid et al. 2023; Shah and Aleem 2023).

Flavonoids

Isorhamnetin ($C_{16}H_{12}O_7$), formononetin-7-O-glucoside ($C_{22}H_{22}O_9$), and velutin ($C_{17}H_{14}O_6$)

are between the flavonoids found in B. lyceum (Sabir, Tahir et al. 2013). Flavonoids are identified for their antioxidant property and have been linked to a number of health returns, as well as an inferior chance of rising chronic illnesses.

Coumarins

Abundant coumarins, such as 7-hydroxycoumarin ($C_{10}H_8O_3$) and 4-methyl-7-hydroxycoumarin ($C_{10}H_8O_3$), as well as feselol ($C_{24}H_{30}O_4$), are originate in B. lyceum (Sabir, Tahir et al. 2013). These substances are famous for their anti-inflammatory and anticoagulant behavior, between other potential medicinal benefits.

Anthocyanins

This plant is exceedingly rich in anthocyanins, with key constituents such as cyanidin-3-glucoside ($C_{21}H_{21}ClO_{11}$) and delphinidin-3-glucoside ($C_{21}H_{21}O_{12}^+$) [39]. Other distinguished anthocyanins contain cyanidin-3-rutinoside ($C_{27}H_{31}O_{15}$), cyanidin-3-galactoside ($C_{21}H_{21}ClO_{11}$), cyanidin-3-pentoxil-hexoside ($C_{21}H_{21}ClO_{10}$), and cyanidin-3-lathyroside ($C_{26}H_{29}O_{15}$) (Pradhan and Saha 2016). Its well-off anthocyanin profile is influenced by supplementary anthocyanins, including cyanidin-3,5-dihexoside ($C_{27}H_{31}O_{16}^+$), malvidin-3,5-dihexoside ($C_{29}H_{35}O_{17}^+$), pelargonidin 3,5-diglucoside ($C_{27}H_{31}ClO_{15}$), pelargonidin-hexoside ($C_{21}H_{21}ClO_{10}$), peonidin-3-rutinoside ($C_{28}H_{33}O_{15}$), cyanidin-3,5-dihexoside ($C_{27}H_{31}O_{16}^+$), and pelargonidin-3-rutinoside ($C_{27}H_{31}O_{14}^+$) (Pradhan and Saha 2016). These substances are much-admired for their well-built antioxidant qualities as well as potential health advantages, such as anti-inflammatory and anti-cancer actions.

Dietary Components, Amino Acids, Dicarboxylic Acids, and Other Substances

Between the remarkable compounds there in B. lycium are the amino acids N-acetyl-DL-glutamic acid ($C_7H_{11}NO_5$) and N-fructosyl-pyroglutamate ($C_{11}H_{17}NO_8$). As well present are dicarboxylic acids such as citramalic acid ($C_5H_8O_5$), maleic acid ($C_4H_4O_4$), and malic acid ($C_4H_6O_5$) (Sabir, Tahir et al. 2013). In adding up, the plant contains 4-(4-(6-methylbutyl) phenyl) propan-1-ol ($C_{14}H_{22}O$), butyl-3-hydroxy-propyl-pethalate ($C_{15}H_{20}O_5$), and 4,4-dimethyl-hexadeca-3-ol ($C_{18}H_{32}NO$). $C_7H_{14}O_2$, or hexanoic acid, is a fatty acyl (Sabir, Tahir et al. 2013).

Background

The Himalayan barberry, or Berberis Lycium, is a plant that grow in Pakistan's hilly areas. The berries are an enormous source of nutrients with a lot of health benefits, as well as immune system sustain and antioxidant traits, as they are elevated in vitamin C, flavonoids, and antioxidants (Rahman 2020). Because Berberis Lycium juice is vulnerable to oxidation, enzymatic breakdown, and microbiological expansion, it is exceedingly perishable. Fruit juices are preserved by way of techniques like vacuum sealing, freezing, and chilling to boost their shelf life. Still, it is well familiar that natural preservatives like sugar and honey can thwart microbial growth and preserve sensory value (Davidson 2014). In order to make out the most effectual approach for conserving Berberis Lycium juice in a laboratory site with restricted resources, these studies investigate a range of techniques.

Preservation Methods

By maintenance the temperature at 4°C, refrigeration inhibits microbiological increase and enzymatic processes, though its capability diminishes with time (Jay, Loessner et al. 2008). While thawing at -18°C can modify texture and flavor, freezing at this temperature stop microbial activity and slows down enzymatic breakdown (Silvera, Escalona et al. 2015). In order to stop oxidation and microbiological growth, vacuum sealing entails eliminating air from the packaging, particularly when paired with refrigeration (Robertson 2005).

By bringing the temperature down to -18°C, freezing completely stops microbial development. For high-acid juices like Berberis Lycium, freezing works mostly well as it maintains the nutritional value and flavor individuality. However, when the juice is thawed, freezing may modify its texture (Hosseini, Ghorbani et al. 2014).

By eliminating air from the packing, vacuum sealing lower oxidation and microbiological improvement. This technique, when corresponding with refrigeration, can deeply boost fruit juices' shelf life by dipping oxygen exposure and delaying oxidative stress (Robertson 2005).

Juices can be preserved with natural preservatives like sugar and honey as of their antibacterial behavior. Sugar decrease water activity, which make it less conducive to microbial growth, while honey's low down pH and strong osmotic pressure stop microbial growth (Gould 1995). These preservatives, mutual with other methods, offer possible improvements in shelf life and juice superiority.

OBJECTIVES

- To evaluate how well a variety of preservation techniques—such as vacuum sealing, freezing, chilling, adding honey, and adding sugar—affect the shelf life of Berberis Lycium juice.
- To assess how these techniques, affect the juice's microbiological safety and nutritional value (pH, TSS, and ascorbic acid content) over time.
- To assess the juice's sensory qualities (taste, color, and texture) after it has been preserved using various techniques.
- To determine the most excellent preservation technique in a resource-constrained laboratory.

Hypothesis

Hypothesis 1: Berberis Lycium juice will be finest preserved by freezing it along with natural preservatives like sugar and honey, which will help it maintain its nutritional value and flavor over time.

Hypothesis 2: For retaining juice quality over a 30-day period, freezing and vacuum sealing will be more effectual than refrigeration alone.

LITERATURE REVIEW

Nutritional and Sensory Quality Preservation

(Barbosa-Cánovas, Tapia et al. 2004) Emphasized how vulnerable fruit juices' vitamin C is to oxidative deterioration. The studies underline how critical it is to minor oxygen exposure in order to preserve nutritional quality.

(Desrosier, Tressler et al. 1977) Examine how well refrigeration preserves fruit juices and establish that even though it reduces microbial activity, it slowly alters sensory attributes like color and flavor.

(Gould 1995) Talk about the effective use of natural preservatives like sugar and honey to preserve juices like apple and orange juice whereas preserving their sensory behavior and microbiological safety.

Refrigeration and Freezing as Preservation Methods

(Jay, Loessner et al. 2008) Showed how juices can be refrigerated for pithy period of time, but that after 7 to 14 days, microbial and nutritional deterioration increases.

(Rodríguez-Martínez, Velázquez et al. 2020) Discuss freezing as a way to stop microbial growth and maintain fruit juices' vitamin C concentration, even if freezing may transform some juices' textures.

(Rahman 2020) Verified that one of the best ways to preserve the nutritional value and flavor of high-acid fruit juices, such as pomegranate juice, is to freeze them.

(Karel, Fennema et al. 1975) Highlighted that as freezing might cause minor texture changes when thawed, it maintains the vitamin C and antioxidant level in juices.

Vacuum Sealing for Extended Shelf Life

(Robertson 2005) Examined how vacuum sealing helps keep juices from oxidizing and rising microorganisms. According to the study, juice quality may be preserved for up to 30 days when vacuum sealing and refrigeration were used.

(Msagati 2012) Examined the use of natural preservatives in union with vacuum sealing. According to the study, fruit juices that were vacuum-sealed with honey added retain their flavor, color, and microbiological safety superior than those that were only refrigerated.

(Juneja and Sofos 2009) Gave a systematic clarification of how vacuum sealing reduce bacterial development in preserved goods by establishing an anaerobic background.

Natural Preservatives (Honey and Sugar)

(Aurongzeb and Azim 2011) Examined honey's antibacterial behavior, emphasizing how its high sugar content, low pH, and hydrogen peroxide production can put off bacterial development.

(Karel, Fennema et al. 1975) Investigated how sugar is used to preserve juice. Sugar prolongs the shelf life of juices like strawberry juice by lowering water activity, which in turn prevents microbiological development.

(Smith and Charter 2011) Highlighted the sensory compensation of incorporating sugar and honey into fruit juices, representing how these preservatives help maintain the juice's flavor and reliability for up to 30 days.

Comparative Studies

(Rahman 2020) Evaluated a number of preservation techniques for berry-derived liquids and set up that the superlative long-term preservation technique was freezing with sugar.

(Moradinezhad, Khayyat et al. 2019) Examined the preservation of pomegranate juice with vacuum sealing against freezing and discovered that the previous preserved color and flavor better, mostly when preservatives were added.

MATERIAL AND METHODOLOGY

Collection of Berberis Lycium Fruits

The berries of Berberis Lycium were gathered from the Upper Dir Mountains in Pakistan. To assurance freshness, the fruits were hand-selected early in the morning. Berries that were overripe or damaged were avoided. In order to lessen their exposure to heat and light, the berries were punctually taken to the lab in insulated containers after being harvested.

Juice Preparation

The berries were correctly cleaned under running water as they arrived at the lab in order to get rid of any dirt, debris, or contaminants. The juice from the cleaned berries was extracted using a hand-operated juicer. To obtain a clear juice, the extracted juice was filtered using a muslin cloth to get rid of any leftover pulp or seeds. Five liters of juice were made in total, and each 500 ml part was used for the preservation technique. Before undergoing the appropriate preservation technique, each part was moved to sterile, clean containers.

Preservation Methods

Refrigeration: 500 milliliters of juice were put in sterile glass containers and kept at 4°C in the faculty residence hall refrigerator.

Freezing: To allow for expansion during freezing, 500 milliliters of juice were transferred into sterile plastic containers. The storage temperature of the containers was -18°C.

Vacuum Sealing: 500 milliliters of juice were vacuum-sealed in plastic bags that were bought at the neighborhood market. The sealed bags were kept at 4°C after being sealed using a commercial vacuum sealing equipment.

Honey Addition: A 5% (w/v) addition of honey from Dhog Dara was made to 500 cc of juice, which was then kept at 4°C in airtight glass containers.

Sugar Addition: 500 milliliters of juice were mixed with 10% (w/v) sugar. At 4°C, the mixture was kept in airtight glass containers.

Testing Parameters

Microbial Analysis

The plate count method was used to get the total viable count (TVC). To calculate the microbial load in CFU/ml, juice samples were placed on nutrient agar and cultured for 24 hours at 37°C. Colonies were then counted. Microbial development in the juice samples was tracked over time using 400x magnification microscopy.

Chemical Analysis

pH: The juice samples were tested for acidity using a calibrated pH meter. At each time point—7, 10, 13, 16, 19, 21, 24, 27, and 30 days—readings were taken after the pH meter probe was immersed straight into the juice.

Total Soluble Solids (TSS): To measure the TSS, a portable refractometer was used. After placing a drop of juice on the prism of the refractometer, the sugar content was measured in °Brix.

Ascorbic Acid (Vitamin C) Content: Iodine titration was used to determine the ascorbic acid concentration. Ascorbic acid in the juice reacts with iodine, and the amount of iodine needed to attain the endpoint made it possible to calculate the vitamin C content in milligrams per hundred milliliters.

Sensory Evaluation

Using a 5-point hedonic scale, a panel of five trained evaluators evaluated the juice's flavor, color, and texture. To guarantee consistency, the sensory assessments were carried out in a well-lit space under carefully monitored circumstances. At each testing interval, evaluators were asked to score the juice on taste, appearance, and mouthfeel.

RESULTS

Microbial Analysis

Table 1

Microbial Count (CFU/ml) for Different Preservation Methods

Day	Refrigeration	Freezing	Vacuum Sealing	Honey Addition	Sugar Addition
7	300	100	150	50	75
10	500	100	200	60	85
13	700	150	250	80	95
16	1000	150	350	90	110
19	1300	200	500	120	150
30	2000	250	800	200	300

Microscopy verified that the samples that were frozen and added honey had less bacterial colonies. By day 16, large colonies were seen in the refrigerator samples.

The best preservation against microbial growth was achieved by freezing and adding honey. The antibacterial properties of honey were further confirmed by microscopy, which revealed very little bacterial presence.

Chemical Analysis

Table 2

pH, TSS, and Ascorbic Acid Content Changes

Day	Method	pH	TSS (°Brix)	Ascorbic Acid (mg/100ml)
7	Refrigeration	3.4	12.0	35
10	Freezing	3.5	12.2	36
13	Vacuum Sealing	3.4	11.9	33
16	Honey Addition	3.2	12.1	34
19	Sugar Addition	3.1	12.0	30
30	Refrigeration	2.9	11.7	20

When compared to refrigeration, where considerable deterioration was noted by day 30, freezing and the addition of honey preserved a higher vitamin C concentration.

Sensory Evaluation

Table 3

Sensory Evaluation Results (1-5 Scale)

Method	Taste (1-5)	Color (1-5)	Texture (1-5)
Refrigeration	3.0	2.5	2.8
Freezing	4.5	4.0	4.0
Vacuum Sealing	3.5	3.5	3.0
Honey Addition	4.7	4.8	4.5
Sugar Addition	4.0	4.2	4.0

The addition of honey outperformed vacuum sealing and chilling in terms of taste and color.

DISCUSSION

Microbial Safety and Microscopy Observations

According to microscopy studies, microbial colonies in progress to form in the chilled samples by day seven and grew significantly by day sixteen. However, when examined under a microscope, freezing showed no discernible microbial growth during the 30-day period. Because of these natural preservatives' antibacterial qualities, the samples with honey and sugar additions likewise displayed very little microbiological contamination.

Within three days, the control sample, which was stored at ambient temperature without any preservation, went bad. The control sample showed evident mold growth and sizable bacterial colonies under a microscope, indicating the quick microbiological deterioration of untreated juice.

Effectiveness of Preservation Methods

The study's findings show that freezing is the best way to preserve Berberis Lycium juice for 30 days, especially when combined with the addition of honey or sugar. With only a slight reduction in vitamin C concentration and negligible alterations in sensory attributes, freezing by itself was able to preserve both nutritional quality and microbiological safety. According to sensory assessments, adding honey improved the juice's ability to retain its flavor and color, making it the most popular technique.

In contrast, the juice started to deteriorate by day 16, as indicated by a considerable increase in microorganisms and the breakdown of ascorbic acid, making refrigeration less suitable for long-term preservation. Even though vacuum sealing was good at postponing spoiling, it was not as successful as freezing or using natural preservatives, especially after 21 days.

Comparison with Other Studies

These results are in line with research by Karel, Fennema, and Lund (2017), which emphasized the benefits of freezing fruit juices to retain their nutritional value, especially vitamin C. The benefits of honey as a preservative are consistent with Davidson's (2014) research, which showed that honey's antibacterial qualities inhibited the growth of bacteria in fruit juices that had been preserved. Furthermore, the study's refrigeration findings corroborate those of Jay (2000), who pointed out that although refrigeration slows spoiling, it is not enough to preserve high-acid liquids over the long term.

CONCLUSION

The study comes to the conclusion that freezing is the best way to preserve Berberis Lycium juice, especially when paired with the addition of honey or sugar. Over a 30-day period, this process preserves the juice's sensory qualities, nutritional value, and microbiological safety. Although they worked well for short-term preservation, vacuum sealing and refrigeration had limitations after 16 days. According to the study, the best way to preserve juice over the long term in a resource-constrained laboratory setting is to combine freezing with natural preservatives like honey and sugar.

Suggestions for Future Research

In order to further prolong the shelf life of Berberis Lycium juice, further research could examine the use of vacuum sealing, freezing, and honey addition. It would also be helpful to conduct study on how to maximize honey concentration for improved preservation results without sacrificing flavor.

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