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COMPARATIVE STUDY ON EXTRACTION OF CONCENTRATE FROM RAISINS AND ITS APPLICATION IN JELLY

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ABSTRACT

This study compared sugar concentrates extraction methods from raisins: solvent extraction (water at 1:1 and 1:2 ratios, 60°C for 2 hours) and enzyme-assisted extraction (pectinase at 10–50 ppm, 0.25–0.75% levels, 50°C for 4 hours). Thomson Seedless raisins at a 1:1 ratio yielded 70% the most sugar with solvent extraction, while enzyme-assisted extraction at 0.75% enzyme concentration and 50 ppm was more effective, enhancing sugar yield 82%, clarity, and aroma by breaking down pectin. Jelly made from enzyme-extracted sugar was clearer, had better texture, and was preferred in sensory evaluations. The T_2 jelly sample stood out for its superior sensory qualities, and its shelf life was extended due to the antimicrobial and antioxidant properties of raisins, highlighting their potential as a natural, healthier sweetener alternative.

1. INTRODUCTION

Consuming added sugar provides empty calories that lack essential vitamins and minerals, potentially displacing healthier foods in our diets, while also affecting hormones and the brain in ways that directly contribute to weight gain and obesity.(L Poe 2018) Excessive sugar consumption promotes the development of cardiovascular disease (CVD) and type 2 diabetes (T2DM), both directly by impacting metabolic health and indirectly by contributing to risk factors like obesity.(L Poe 2018) Cardiovascular disease and type 2 diabetes are major chronic conditions contributing to global morbidity and mortality. These diseases are often linked to preventable risk factors, including high blood pressure, elevated glucose levels, high lipid levels, physical inactivity, sedentary lifestyles, and obesity. Early onset of these risk factors in childhood raises the likelihood of developing chronic diseases in adulthood. Sugar-sweetened beverages, as significant sources of excess calories, have been increasingly recognized for their role in the development of these conditions, warranting a systematic review.(Stevens et al. 2014)

Grapes are a vital fruit crop in India, renowned for producing some of the world's finest raisins with exceptional productivity levels. Raisins, the second most significant product derived from grapes, are made by drying seedless varieties like Thompson Seedless, reducing their moisture content to about 15 percent. These dried seedless grapes are known as raisins or Kismish, while dried seeded grapes are referred to as Monukkas.(Mandal and Thakur 2015) Raisins are nutrient-dense, offering a good source of natural sugars, dietary fiber, vitamins (especially B vitamins), minerals like potassium and iron, and antioxidants.(Maki and Yasin 2023)

In India, raisins are primarily produced in the Sangli, Solapur, and Nashik districts of Maharashtra, as well as in the Vijayapura and Bagalkot districts of Karnataka. The varieties used for raisin production include Thompson Seedless and its clonal selections (such as Tas-A-Ganesh, Sonaka, Manik Chaman), along with Sharad Seedless and its clonal selections (like Krishna Seedless, Sarita Seedless, Nanasaheb Purple Seedless).(Somkuwar et al. 2020)

The process of extraction is known to be a separation technique that helps in removing a soluble substance from one solvent into another. Comparatively, it stands out as more favorable than other processes like evaporation and distilling when confronted with extreme heat.(Todd 2014) The extraction of monosaccharides, sucrose, and raffinose oligosaccharides from plant materials is influenced by solvent type and temperature.(Johansen et al. 1996) In comparison to 80% ethanol, using 62.5% aqueous methanol as a solvent gives better extraction of fructose, glucose and sucrose from onion bulbs with higher yields in shorter times and lower temperatures.(Davis et al. 2007) The food industry and agro-forest waste, such as flavonoids, phenolic acids, and lignins among others are effectively extracted by DESs while algae provide proteins, carbohydrates, and lipids. Additionally, vegetable oils and dietary fibers contain other phenolic compounds, dietary fibers, and non-carbohydrate materials.(Jablonský et al. 2018) The extraction yields of antioxidants greatly differ depending on the solvents that are used. The PCA analysis shows that there is a great contrast between extracts derived from mixtures of organic solvents and water as well as those from pure organic solvents.(Boeing et al. 2014)

Supercritical liquid extraction, ultrasound-assisted extraction, and enzyme-assisted extraction can be classified as recent physiological systems that provide benefits like minimizing solvent use and therefore reduced extraction periods. Usually, there are larger extracts using these processes compared to conventional ones.(Alexandre et al. 2018) Enzyme-assisted extraction is a process that involves the hydrolysis of plant cell walls with enzymes so that their internal components can be released. The enzyme adheres to the cell wall, promoting more contact and breaking down bonds leading to an easy release of active constituents.(Nadar, Rao, and Rathod 2018) The quality of date palm juice improved significantly under optimal pectinase-assisted extraction conditions: 60 IU/100 g pectinase at 60°C for 120 minutes. These settings enhanced both the physicochemical properties and antioxidant capacity of the juice.(Tuntiteeraboon, Jafari, and Assatarakul 2021)
The fruit juice production via enzyme mediated degradation is dependent on a variety of aspects including the type of enzyme used, conditions for incubation and usage of a

combination of enzymes like amylases, pectinases and cellulases. This article examines how these enzymes enhance yield, clarity and biochemical properties of juices.

The fruit juice production via enzyme mediated degradation is dependent on a variety of aspects including the type of enzyme used, conditions for incubation and usage of a combination of enzymes like amylases, pectinases and cellulases. This article examines how these enzymes enhance yield, clarity and biochemical properties of juices.(Sharma, Patel, and Sharma 2014) In the industry breaking down pectin in plant cell walls using enzymes such as pectinases from several microorganisms is actually very critical. Those pectinases can be grouped according to how they act upon the pectin, and some of the factors that affect them include pH, temperature, enzyme type and concentration. Their biochemical structure and function are thoroughly documented for use in commercial applications.(Sharma, Rathore, and Sharma 2013) Pectinases needed for breaking down pectins come in different forms including methyl esterases, polygalacturonases and lyases. Effectiveness increases with other enzyme combination and microbial commercial production.(Sudeep et al. 2020) To obtain a juice that is both more transparent and has a higher yield, the enzyme-assisted breakdown of pectin in fruit is performed, thus prompting the exploration for omega spectrums with effects in industry. So far, due to the rapid advancements in gene sequencing and protein engineering, it has been possible to generate pectinases at lower cost which can be applied during the preparation of functional foods as well as in human nutrition purposes.(Khan, Nakkeeran, and Umesh-Kumar 2013)

Raisin juice concentrate is a concentrated aqueous extract of dry raisins, treated to partially remove dissolved acids. It serves as a natural sweetener in the form of dark brown syrup, containing approximately 70% w/w invert sugar and around 2% w/w proteins. Additionally, it is rich in trace elements such as potassium, sodium, phosphorus, magnesium, and calcium, as well as vitamins, particularly C, B3, and A.(Papadakis, Gardeli, and Tzia 2006) The chemical properties of grape juice primarily vary based on the grape varieties, environmental conditions, and processing methods. Typically, the chemical composition of grape juice includes a Brix value of 28.85%, protein content of 0.69%, fiber content of 1.10%, and fat content of 0.82%. The average pH is 4.25, and the total soluble solids are around 65.58.(Hawsar S.Husseina 2023) Raisin concentrates are effective alternatives to sorbitol and other sugar alcohols, offering a "natural" formulation. They also function as natural preservatives in yeast-leavened baked goods. In addition to their preservative qualities, these concentrates provide natural color, enhance dough strength, improve flavor, add sweetness, and retain moisture, making them versatile, multi-purpose ingredients for various food applications.(Zahra Sheikholeslami1 2015)

Jelly is a semi-stable meals product with intermediate moisture, made by using cooking fruits with sugar. This procedure, which might also or may not contain introduced pectin and acid, goals to boom the entire soluble solids (TSS) content to extra than 65%.(Shinwari and Rao 2018) Fiber-enriched jellies are not designed to supply the whole endorsed day by day consumption of dietary fiber (approximately 30 g/day), but alternatively to help meet this requirement. As in line with the Argentine Food Code, a meals product must incorporate as a minimum three g of dietary fiber consistent with a hundred g to be classified as a "source of fiber."(Figueroa and Genovese 2019) Jelly candy is a confectionery item characterised with the aid of its gentle and chewy texture, executed via the usage of a gelling agent like pectin. The present-day trend in promoting a wholesome weight loss program involves developing new confectionery products with decreased sugar content, moving them from the "danger" category to a group of more healthy meals alternatives.(Perfilova et al. 2018)

Watermelon (*Citrullus lanatus*) is a colourful, amazing fruit packed with nutrients and phytochemicals recognized for their health blessings. It is a great source of vitamins B, C, and E, together with essential minerals like phosphorus, magnesium, calcium, and iron. Epidemiological research has proven that watermelon includes antioxidants with anti-inflammatory and antihypertensive houses and offers protective consequences against carbon tetrachloride-precipitated toxicity. (Maoto, Beswa, and Jideani 2019) Watermelons may be round, oval, or elongated, normally weighing between 1.5 and 15 kg. The rind varies from light to dark inexperienced, regularly with striped patterns. While the flesh of watermelons may be white, inexperienced, yellow, orange, or crimson, clients tend to partner the first-class satisfactory with deep crimson, red, or excessive yellow flesh, alongside a candy taste and ideal texture.(Kyriacou et al. 2018). Watermelon is a seasonal fruit that frequently reports surplus production, that's frequently underutilized. Additionally, watermelon is rich in antioxidants, especially the phytochemical lycopene, which performs a good-sized role in decreasing oxidative stress. This has been related to a decreased risk of coronary coronary heart sickness.(Rubio-Arraez et al. 2018)

Beetroot (*Beta vulgaris*) is diagnosed as health selling food due to presence of important components such as nutrients, minerals, phenolics, carotenoids, nitrate, ascorbic acids and betalains that promote health.(Chhikara et al. 2019) Beet is a biennial plant recognized for its thick, fleshy roots, normally cultivated in early spring. As a dicotyledonous herb with tuberous root shares, it ranks some of the top ten greens for antioxidant houses. Rich in minerals, nutrients, and nutrients, beet additionally contains unique phytoconstituents with numerous medicinal blessings. It is used for its antioxidant, antidepressant, antimicrobial, antifungal, anti-inflammatory, diuretic, expectorant, and carminative houses. Additionally, beet is an herbal strength booster for athletes due to its high nitrate and sugar content material.(Kale et al. 2018) Beetroot is a key supply of herbal crimson pigment, known as betalains. This pigment is broadly used inside the food enterprise as an additive in merchandise inclusive of gelatins, confectioneries, baked goods, cakes, dairy merchandise, candies, jellybeans, non-alcoholic liquids, and juices. (Trishitman, Negi, and Rastogi 2021) Red colorants derived from veggies, consisting of beetroot (*Beta vulgaris L.*) and radish (*Raphanus sativus L.*) extracts or concentrates, are considered the handiest choice for accomplishing the preferred coloring outcomes in diverse programs. (Fernández-López et al. 2023) Red colorants derived from greens, together with beetroot and radish extracts or concentrates, are considered the simplest alternative for accomplishing the favored coloring consequences in various applications.(Fernández-López et al. 2023)

Life is affected at every stage by excessive sugar intake. In addition, it is known that high sugar intake increases the risk of several non-communicable diseases like obesity, diabetes and heart problems.(Feldens et al. 2022) The use of sucralose, low-methoxyl pectin, and maltodextrin to create sugar-free jelly. (Khouryieh, Aramouni, and Herald 2005)

This study demonstrated that a healthier jelly candy for children can be made by using natural ingredients instead of synthetic flavorings and colorings, offering a better alternative to conventional jelly products on the market. (Mutlu, Tontul, and Erbaş 2018) While substituting sugar in jelly to reduce their energy content, it is necessary to pay close attention to the impact of sucrose and glucose on gelation and texture building. (Riedel, Böhme, and Rohm 2015) Despite raisins' high sugar content, research suggest they may provide fitness blessings due to their phytochemical profile. Intervention research show ability effective results on cardiovascular health, diabetes, and oral health, mainly with quick-term consumption of approximately 70 g/day. (Restani et al. 2016)

2. MATERIALS AND METHODOLOGY

2.1 To prepare the Raisin Concentrate

The experiment was conducted in the laboratory of the Department of Food Science and Technology at Post Graduate D.Y. Patil Agriculture Technical University, Talsande, Kolhapur, during the years 2022-2024. Watermelon was sourced from the local market, and the primary ingredients used for product preparation included sugar, raisins, pectin, and various other chemicals, all of which were obtained from the laboratory store.

2.1.A. Materials

There are various types of raisins produced in the Maharashtra region. In which Thomson seedless variety was selected. Distilled water is used for all the procedures.

2.1.B. Raisin Concentrate extraction using solvent extraction:

In this work the raisins are firstly washed then dried and weighed. After weighing the raisins were grind with the ratio of 1:1 and 1:2. The raisins were ground for the better absorption. Then the extraction temperature was kept at (60, 70 and 80°C). The extraction time kept for 2 hrs and for the extraction-controlled temperature bath were used. Then the extract is filtrate using the centrifuge for better clarification of the concentrate. Then by this process the extract is ready for the concentrate. The extract is then boiled at 80°C till the 70° Brix. (Peiman Ariaii 2009)

2.1.C. Raisin Concentrate extraction using pectinase enzymes:

Additionally, the extraction process was performed again at the selected ratio (1/3 Raisins/Water) with the combination of enzymes added. The samples were blended with a hand blender, followed addition of pectinase at concentrations of 0.25, 0.50, and 075% (v/w) were added, and the pH was brought to 4.8 ± 0.2 before the enzyme was added. getting ready. Every sample was put in a temperature control hot plate for four hours, 50°C. Subsequently, the mixture was passed through a muslin cloth using a big impurities and insoluble materials with a manual press.(Gamal A El Sharnouby 2014)

2.1.D. Apparatus and Procedure

Production of the Raisin is illustrated in the following flow chart.

Flow Chart:

Dried Raisins

↓

Grading

↓

Weighing

↓

Blending

↓

Extracting (2 hrs)

↓

Separate Supernatant

↓

Centrifuged (4000 rpm for 20 mins)

↓

Rotary Evaporate (till 70° Brix)

↓

Storage

Fig1: The standard flow chart for the raisin concentrates extraction.

After the preparation of the concentrate microbial experiments were take like Total Plate Count and chemical tests like ph, acidity, reducing sugar, ash and moisture.

a. Physicochemical Test

The physicochemical characteristics of the concentrate were assessed, including the determination of reducing sugars and acidity, along with an analysis of crude fiber. The crude fiber content was determined using standard analytical procedures to provide insights into the fiber composition of the concentrate. for moisture content by FSSAI 03.005:2022 and total ash by FSSAI 03.010:2022. To determine crude protein and crude fat, the FSSAI applied methods were FSSAI 03.016:2022 and FSSAI 03.039:2022, respectively. Carbohydrates and energy values were calculated by the methodology of Gopalan C., et al., NIN, ICMR, 1996. Crude fiber content was determined by the procedure described in FSSAI 03.017:2022. Total sugars and total reducing sugars were estimated in terms of FCL/SOP/14.1 and FCL/SOP/14.2, respectively. Mineral content, like calcium, iron, and potassium, was analyzed according to the procedure of FCL/SOP/2.0. Each of these tests was performed to establish accurate and dependable results regarding the nutritional profile of the sample.(FSSAI 2022)

b. Microbial Test

Total Plate Count (TPC) is a method used to estimate the number of viable microorganisms in a sample. To prepare for TPC, a sample is diluted in a sterile diluent, then plated on agar medium. After incubation, colonies are counted. (FSSAI 2016)

2.2 To prepare Jelly using Raisin Concentrate
2.2.A. Preparation of Watermelon Juice

We bought ripe watermelon from the Kolhapur local markets. To prepare watermelon juice for jelly, start by way of cutting a ripe watermelon into small chunks. Blend the chunks in a blender until clean, then stress the mixture via an exceptional sieve or muslin to get rid of any seeds and pulp, yielding clean juice.

2.2.B. Preparation of Beetroot Juice

To prepare beetroot juice, start by way of washing and peeling sparkling beetroots to take away any dirt or impurities. Cut the beetroots into small chunks and location them in a blender or juicer. Blend or juice the beetroots till clean. For a thinner consistency, pressure the mixture through a satisfactory mesh sieve or muslin to do away with the pulp, leaving simplest the clear juice.

2.2.C. Extract Recovery

The entire extract was gathered and measured using a measuring cylinder in a glass jar. The percentage recovery has been determined and expressed against the total amount of materials consumed.

2.2.D. Chemical Analysis

The sample was analyzed using different standardized methods to determine the nutritive composition: for moisture content by FSSAI 03.005:2022 and total ash by FSSAI 03.010:2022. To determine crude protein and crude fat, the FSSAI applied methods were FSSAI 03.016:2022 and FSSAI 03.039:2022, respectively. Carbohydrates and energy values were calculated by the methodology of Gopalan C., et al., NIN, ICMR, 1996. Crude fiber content was determined by the procedure described in FSSAI 03.017:2022. Total sugars and total reducing sugars were estimated in terms of FCL/SOP/14.1 and FCL/SOP/14.2, respectively. Mineral content, like calcium, iron, and potassium, was analyzed according to the procedure of FCL/SOP/2.0. Each of these tests was performed to establish accurate and dependable results regarding the nutritional profile of the sample.(FSSAI 2022) (. Mr.P.V.Parthasarathy et. al 1999)

Table 1 Optimization of the watermelon jelly

Sr. No	Sample No.	Extracted Sugar (ml)	Watermelon (ml)	Beetroot (ml)	Agar (g)
1.	T_1	25	70	4	1
2.	T_2	30	65	4	1
3.	T_3	35	60	4	1

2.2.E. Optimization of Jelly

Jelly from Watermelon processed with various treatments was coded as: Jelly T_1, T_2, and T_3. The optimization of various Watermelon jelly is shown in Table 1.

2.2.F. Methods of Jelly preparation

The transparent fruit extract was added to a stainless-steel pan and brought to a boil. Next, Agar is activated with the necessary quantity of in a stainless-steel pot. Fruit extract was combined with the sugar or extracted sugar, and the combination was cooked. Following the addition of agar, the boiling process was continued until the TSS approached 65 °Brix.

2.2.G. Recognizing the jelly's final point

A sheet test was used to determine the end point when the mass had thickened enough in consistency. Sheet test: Using a spoon, a tiny amount of jelly was removed after boiling. Then allowed to drop should the product come off as a sheet or flakes rather than moving in a steady stream, was regarded as the jelly's terminus.

2.2.H. Moulding the Jelly

The jelly mixture is poured into moulds while still hot, ensuring it fills each mould completely. The moulds are then left undisturbed to cool and set, allowing the jelly to solidify into the desired shape.

2.2.I. Sensory Evaluation

The nine-point hedonic scale is a method used in sensory evaluation to measure how an awful lot individuals like or dislike a particular product. Respondents price the product on a scale from 1 to 9, in which 1 represents "dislike extremely" and nine signifies "like extremely." This scale allows quantify subjective choices and provides a clean photograph of ordinary product acceptability. For instance, if a raisin sugar jelly sample gets a high rating of 8 or 9, it suggests strong desire and superb sensory attributes most of the evaluators. The evaluation based on Appearance, Flavour, Texture, Taste and Overall Acceptability.(STONE and SIDEL 1985)

2.2.J. Microbial Analysis

Microbial analysis using the entire plate count (TPC) technique includes figuring out the number of possible microorganisms in a Jelly. This is accomplished via diluting the pattern, plating it on an agar medium, and then incubating it to allow colonies to form. The quantity of colonies is counted, and from this, the whole variety of microorganisms within the sample is estimated. This technique is commonly used to evaluate the microbial best and safety of food merchandise, which include the ability shelf existence and infection degrees.(FSSAI 2016)

Flow Chart:

Watermelon

↓

Extracting Juice

↓

Adding Beetroot Juice

↓

Adding Raisins Concentrate

↓

Adding Agar

↓

Boiling (68°Brix)

↓

Moulding

↓

Keep at room temperature

↓

Demoulding

↓

Storage

Fig 2: Flow chart of the Watermelon jelly incorporating with raisin concentrate

3. RESULT AND DISCUSSIONS

3.1. Rasin Concentrate

In this observe, diverse system parameters had been evaluated on two raisin varieties, Thomson Seedless and Sonnaka, from the Maharashtra place. The parameters blanketed solvent ranges (ratios of 1:1 and 1:2), three extraction temperatures (60°C, 70°C, and 80°C), and extraction temperature (70, 80 and 90°C).

3.1.A. Effect of Extraction of Raisin Concentrate Using Solvent Extraction

For the study comparing the sugar extraction efficiency of Thomson Seedless raisins using two different water-to-raisin ratios (1:1 and 1:2), it was found that the extraction efficiency was higher in 1:1 ratio at 95% as compared to 92% in 1:2 ratio. The Total Soluble Solids (TSS) after extraction were also higher for the 1:1 ratio at 36°Brix against 25°Brix for the 1:2 ratio. After evaporation, extraction yield decreased from 70% to 65% respectively indicating that higher sugar content from raisins can be obtained more efficiently using a 1:1 ratio.

Raisin Varieties	**Thomson Seedless**		**Sonakka**	
Ratio (R/W)	1:1	1:2	1:1	1:2
Extraction Yeild After Extraction	95%	92%	93%	90%
TSS After Extraction (°brix)	36	25	33	23
Extraction Yeild After Evaporation (%)	70%	65%	68%	60%
TSS (°brix)	70			

Table 2 Effect of Extraction of Raisin Concentrate Using Solvent Extraction

3.1.B. Effect of Extraction of Raisin Concentrate Using Enzyme Assisted Extraction

The extraction yields were between 88% and 96%. This was as a result of the extraction procedure which used different enzyme concentrations (0.25%, 0.5%, and 0.75%) at a constant ratio of 1:3 (raisin to water). Higher enzyme concentrations led to an increase in Total Soluble Solids (TSS) measured in °Brix and ranging from 37°Brix to 45°Brix. The extraction yields after evaporation ranged from 65% to 82%, where highest yields (when using 0.75%) matched the highest enzyme concentration.

PPM Concentration	**10**			**30**			**50**		
Enzyme Concentration (%)	**0.25**	**0.5**	**0.75**	**0.25**	**0.5**	**0.75**	**0.25**	**0.5**	**0.75**
Ratio (R/W)	1:3	1:3	1:3	1:3	1:3	1:3	1:3	1:3	1:3
Extraction Yield After Extraction (%)	88	91	92	90	91	92	92	94	96
TSS After Extraction (°brix)	37	38	39	38	39	40	39	42	45
Extraction Yield After Evaporation (%)	65	68	69	70	72	75	78	79	82
TSS after Evaporation (°brix)	70								

Table 3 Effect of Extraction of Raisin Concentrate Using Enzyme Assisted Extraction

3.1.C. Influence of Solvent Ratio, Extraction, and Concentration Temperature at the Percentage of Reducing Sugars

Distinct differences can be observed in the percentage of reducing sugars obtained from raisins when comparing the influence of the solvent ratio, extraction, and concentration temperature.

In solvent extraction with a 1:1 water-to-raisin ratio, the percent of reducing sugars obtained is higher than that in a 1:2 ratio. This extraction efficiency is improved at this ratio but is strongly dependent on time and temperature; moderate temperatures around 60°C give optimal results. The presence of impurities that are poorly removed during the process affect the clarity of the sugar solution.

On the other hand, enzyme-assisted extraction with pectinase greatly increases reducing sugar yields, especially at higher enzyme concentrations (for example, 50 ppm) and temperatures (around 50°C). This not only increases the amount of reducing sugar produced but also makes for clearer and more transparent solvent thus favored where clarity and purity is essential.

Enzyme-assisted method is more viable for breaking down cell walls in raisins thereby releasing sugars better than solvent extraction method does.

3.1.D. Interaction Effect of Raisin/Water Ratio and Extraction Temperature on Production Yield and Sugar Recovery of Solvent Extraction

The impact of solvent and enzyme-assisted extraction on production yield and sugar recovery are different with regard to interaction effects of water/raisin ratio and extraction temperature. In solvent extraction method, increase in extraction temperature and ratio of water to raisin resulted in increase in the efficiency of concentrate production. The best sugar recovery was at 80°C using 1:2 raisin ratio, where maximum sugar yield was obtained but overall, there was no significant change in sugar recovery across various ratios and temperatures. In addition, high temperatures together with water to raisin ratios made concentrate darker and lighter when low values were used.

On the other hand, enzyme assisted extraction achieved more efficient sugar recovery than solvent extraction especially for lower temperatures. Also, it was observed that lower ratios of water to raisin made enzymatic processes even more efficient particularly those involving pectinase hence higher amounts of sucrose achieved without higher heating levels. This method also ensured clearer and more transparent concentrates with little color intensity which is good for other purposes. Although solvent extraction method heavily leans on temperature and water ratio; enzymes-based approaches yield better results by lowest dependence on them.

3.1.E Impact of Concentration Temperature on Aroma Retention Coefficient (RC) of Solvent Extraction

The temperature of concentration plays a significant part in the morning of aromatic atoms in solvent extraction. High concentration temperatures usually lead to low Aroma Retention Coefficient values since many smelly compounds evaporate or decomposes during the process because they are very volatile and sensitive to heat leading to decreased RC hence less aroma is retained in final concentrate. For instance, increase in concentration temperature reduces RC leading to an odourless product. This can be seen especially with respect to solvent extraction where temperature is used as driving force for removing excess water from the solution thus resulting in aroma loss.

Enzymatic extraction, on the other hand, tends to have higher Aroma Retention Coefficients even when subjected at high temperatures unlike in other methods like solvent extraction that require elevated amounts of heat energy for concentrating matter because it would be destroying some aromatic related chemicals. The reason being that these enzymes serve more effectively during cleavage thus liberating sugars and other elements contained within cells more easily than relying on heat alone. Consequently, enzyme-assisted extraction achieves effective concentration under lower temperatures which retain a lot of aromatic substances. Consequently, this is why enzymes are preferred over all methods especially when aroma preservation is highly prioritized because enzyme-assisted extractions often exhibit a higher RC compared to other forms of extracting processes.

3.1.F. Chemical Analysis

3.1.F.a. Chemical analysis of the Raisins concentrate by Solvent Extraction

The data presented is an examination of a food sample with an emphasis on different nutritional factors. The sample has a total ash content of 1.0% and a moisture content of 37.9%. Crude protein makes up 0.5% of the total, but crude fat and crude fiber are both less than 0.1%, which is below detectable limits. The sample has a 60.6% carbohydrate content, which adds to its 244.4 kcal/100 grams energy value. 57.9% of the sample is made up of total sugars, of which

21.2% are total reducing sugars. A calcium concentration of 13,440 mg per 100 grams highlights the mineral content, while iron is present at undetectable quantities (less than 0.1 mg per 100 grams). There contains 190 mg of potassium in every 100 grams. For these assessments, a variety of sandard test protocols were used, such as those from the Indian Council of Medical Research (ICMR)-affiliated National Institute of Nutrition (NIN), the Food Safety and Standards Authority of India (FSSAI, 2011).

3.1.F.b. Chemical analysis of the Raisins concentrate by Enzyme Assisted Extraction

The data provides a food sample's nutritional analysis, paying particular emphasis to the sample's moisture and nutrient content. The sample comprises 1.5% of total ash and 41.1% of moisture content. Crude protein is reported as 0.2%, whereas crude fat and crude fiber are less than 0.1%, which is below detectable limits. With 57.2% of the weight in carbohydrates, there are 229.6 kcal of energy per 100 grams. 52.1% of the sample's total sugars come from total reducing sugars, which make up 36.7% of this amount. According to mineral analysis, there is less than 0.1 mg of iron per 100 grams, and there is 6060 mg of calcium per 100 grams. There contains 180 mg of potassium in every 100 grams. The findings were acquired through the use of protocols under the auspices of the Indian Council of Medical Research (ICMR) and the National Institute of Nutrition (NIN), as well as standardized test procedures from the Food Safety and Standards Authority of India (FSSAI, 2011).

Parameter	**Using Solvent Extraction**	**Using Enzyme Assisted Extraction**
Moisture %	37.9	41.1
Total Ash %	1.0	1.5
Total Energy Kcal/100g	244.4	229.6
Crude Fat %	0.1	0.1
Crude Protein %	0.5	0.2
Carbohydrates %	60.6	57.2
Crude Fiber %	0.1	0.1
Total Sugars %	57.9	52.1
Total Reducing Sugars %	21.2	36.7
Calcium (Ca) mg/100g	13440	6060
Potassium (K) mg/100g	190	180

Table 4 Chemical Analysis of Rasin Concentrate

3.2. Jelly

3.2.A Standardization of the Jelly

In the development of the jelly formulations, four samples were prepared, including a control sample (T_0) and three experimental samples (T_1, T_2, and T_3). The control sample (T_0) consisted of 70% watermelon, 4% beetroot, 25% added sugar, and 1% agar, with no raisin concentrate. In the experimental formulations, the added sugar was completely replaced by raisin concentrate. Sample T_1 included 70% watermelon, 4% beetroot, 1% agar, and 25% raisin concentrate. Sample T_2 contained 65% watermelon, 4% beetroot, 1% agar, and 30% raisin concentrate. Finally, Sample T_3 was formulated with 60% watermelon, 4% beetroot, 1% agar, and 35% raisin concentrate.

3.2.B. Sensory Evaluation of Jelly

The sensory assessment of the jelly was carried out by adding extracted sugar, looking at aspects such as color, taste, odor, and overall acceptability. The assessment tool of choice is the nine-point hedonic scale. The control sample for the sensory evaluation was added sugar jelly. Table No. 2 shows that the T_2 sample received a high score for the acceptance of the sensory evaluation.

The sensory evaluation was done using 9point hedonic scale of watermelon jelly with beetroot using different sweetening agents revealed varied results across the samples. The control sample (T_0), which contained added sugar, received a moderate score of 6.5 for appearance, 7.5 for flavor and texture, and 8 for taste, resulting in an overall acceptability score of 7.5. Sample T_1, which might have used a different concentration of raisin concentrates, achieved a higher score of 7 for appearance but slightly lower flavor at 6.5, while maintaining a texture score of 7.5. It excelled in taste with a score of 8.5, leading to an overall acceptability equal to T0 at 7.5

Sample T_2, however, outperformed the others in almost every aspect, with the highest scores across all criteria. It achieved 8.5 in appearance and texture, 8 in flavor, and 9 in taste, reflecting an overall acceptability of 8.5. This suggests that T_2's formulation was most favored among the samples. Lastly, sample T_3 scored similarly to T_0, with a notable difference only in appearance and flavor, both rated at 6.5, but matched T_0 in texture, taste, and overall acceptability at 7.5. This indicates that while alternative sweetening methods, like raisin concentrate, can compete closely with traditional sugar, the formulation in T_0 was particularly successful in enhancing the sensory qualities of the jelly.

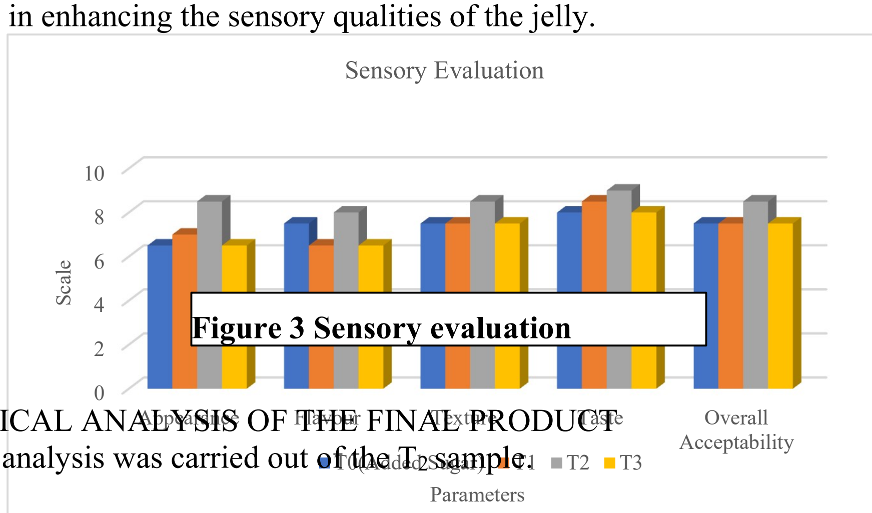

Figure 3 Sensory evaluation

3.2.C. CHEMICAL ANALYSIS OF THE FINAL PRODUCT

The chemical analysis was carried out of the T_2 sample.

Parameter	**T_2**
Moisture %	39.9
Total Ash %	2.1
Total Energy Kcal/100g	232.5
Crude Fat %	0.1
Crude Protein %	2.6
Carbohydrates %	55.3

Crude Fiber %	0.1
Total Sugars %	56.7
Total Reducing Sugars %	49.3
Calcium (Ca) mg/100g	1330
Potassium (K) mg/100g	790

Table 5

Chemical Analysis of Jelly

The T2 sample has a moisture content material of 39.9% and a total ash content of 2.1%. It gives a total energy of 232. 5 kcal consistent with one hundred grams. The sample consists of 0.1% crude fats and 2.6% crude protein, with carbohydrates making up 55.3% of its composition. Crude fiber is minimum at 0.1%, even as general sugars account for 56.7%, and overall reducing sugars make up 49.3%. Additionally, the T_2 pattern is rich in calcium, providing 1330 mg according to a hundred grams, and carries 790 mg of potassium in keeping with a hundred grams.

4. CONCLUSION

Raisin concentrate is a very effective natural sweetener, such as dietary fiber, antioxidants, calcium, potassium, magnesium, and B vitamins, offering a nutrient-rich alternative to synthetic sugar, which lacks fiber, minerals, and vitamins. This paper presents solvent and enzyme-assisted extraction methods aimed at maximizing sugar yield, clarity, and aroma retention in raisin concentrates. Solvent extraction at 1:1 water-raisin ratio and 60°C gave excellent content of sugar and TSS but could affect the aroma when the temperature was increased. On the other hand, enzyme-assisted extraction with pectinase provided better clarity as well as aroma and sugar yields at lower temperatures, thus making it more suitable for applications where purity and subtle flavor are required.

The chemical analysis indicates that both methods of extraction are effective in producing concentrates with high content of sugars and minerals. The solvent extractions have a higher calcium content while the enzyme extractions have a slightly higher reducing sugar content. Concentrates from raisins provide natural sweetness, color, and moisture-retaining properties along with preservative characteristics, making these concentrates suitable for various applications in baking, confections, and dairy products to improve flavor profiles, shelf life, and nutritional value.

A jelly was also prepared in the study from natural raw materials watermelon, beetroot, and raisin concentrate. Sample T_2, which was preferred due to its organoleptic properties and balanced nutritional composition, pointed out the possibility of healthier jellies with natural sweeteners and colorants. Research emphasizes selective ingredient procurement and manufacturing to satisfy consumer desires and nutritional objectives hence permitting further products with better health benefits.

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