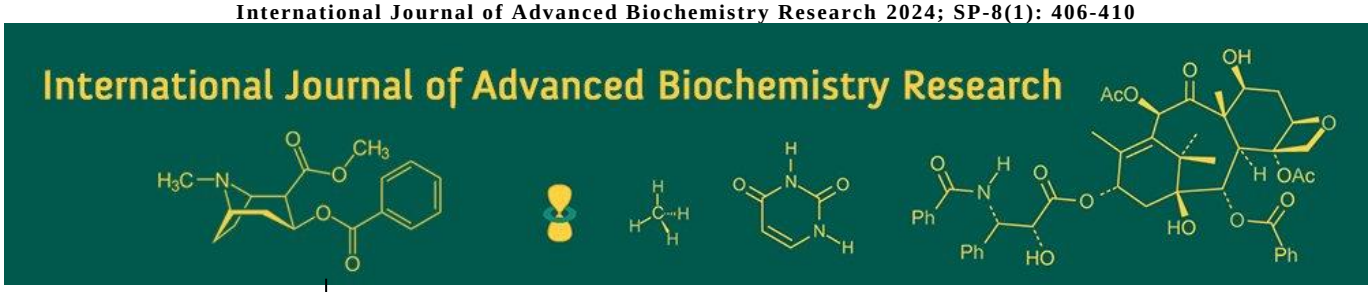


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# Studies on the preparation of lime-blended beet syrup

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**Abstract**
An experiment named "Studies on preparation of lime-blended beet syrup" was conducted out in the Postharvest Technology Laboratory, Horticulture Section, College of Agriculture, Nagpur, in 2022, to investigate the various lime-blended beet syrup recipes and their storability, to evaluate the chemical changes and sensory attributes of lime blended beet syrup under ambient storage conditions, and to determine the best mix of beet pulp and lime juice for the creation of blended beet syrup. The experiment was carried out in a Factorial Completely Randomized Design (FCRD) with two factors, factor A consisting of three levels of pulp *viz*., P1 (25% pulp), P2 (30% pulp), and P3 (35% pulp), and factor B consisting of four levels of lime juice concentrations *viz*. L1 - 0%, L2 - 2%, L3 - 4%, and L4 - 6% with twelve treatment combinations and replicated three times. According to the data, the TSS, total sugars, reducing sugars, and pH content of lime blended beet syrup gradually increased over a 120-day storage period. However, as storage time increased, the acidity, non-reducing sugars, and ascorbic acid concentration of lime-blended beet syrup dropped. The treatment P2L3 (30% pulp: 4% lime juice) had the smallest change in TSS, acidity, reducing sugars, non-reducing sugars, total sugars, ascorbic acid, and pH, while the treatment P1L4 (25% pulp: 6% lime juice) had the most change. Furthermore, as the storage duration progressed, the colour, taste, flavour, and overall acceptability evaluations dropped. When compared to the others, the lime-blended beet syrup with 30% pulp and 4% lime juice received a higher score. As a result, the treatment combination of 30% pulp content and 4% lime juice concentration was discovered to be the best for the creation of lime-blended beet syrup.

**Keywords:** Beetroot, lime, pulp, blended and syrup

## 1. Introduction
Beetroot (*Beta vulgaris* L.) is a member of the Chenopodiaceae family with a bright crimson colour. Due to its therapeutic, nutraceutical, high economic return, and suitability for marginal areas it is commercially grown in some primary states namely Haryana, Uttar Pradesh, Himachal Pradesh, West Bengal, and Maharashtra are the states involved. It comes in a variety of colours, with bulb colours ranging from yellow to dark crimson, and it is classified botanically as an alkaline herbaceous biennial, with an alkaline nature. As beetroot juice is high in iron content it helps in blood circulation, boosts the immune system, and protects the liver and the bile duct. Beetroot syrup is rich in folic acid, some minerals and vitamins which help in lowering blood pressure and along with that it also interacts with cholesterol, preventing its absorption into the blood. It is also helpful in the assimilation of food proteins because of its high antioxidant properties. Betacianines participate actively in the synthesis of choline, which promotes the activity of liver cells and inhibits cancer cell proliferation, preventing the emergence of malignant tumours. The most studied betacyanin is a betanin pigment known as Beetroot Red. It is one of the ten most powerful vegetables in terms of antioxidant qualities. It is high in minerals, nutrients, and vitamins, but it also contains unique phytoconstituents with therapeutic characteristics. Antioxidants, antidepressants, antimicrobials, antifungals, antiinflammatory agents, and diuretics are some of the medicinal uses of this plant's parts The highest nitrates and sugar contents boost the energy in athletes (Yadav *et al*., 2016) [17]. Beetroot's sugar is sucrose, unlike other fruits, with only a small amount of glucose and fructose. Unlike other fruits, the sugar in beetroot is sucrose, with only a little of glucose and fructose. Sports beverages with a low fructose and a high sucrose concentration are chosen due to the fructose influence on human exercise capacity.

Lime (*Citrus aurantifolia*) is grown almost in every home garden and belongs to the Rutaceae family. Lime juice is high in vitamin C, which is responsible for a variety of health benefits, including reduced body heat, increased appetite, and improved digestion, and drinking lime juice with salt decreases stomach pain. The lime is extensively grown in almost all parts of tropical and subtropical regions. The flowering and fruiting take place throughout the year. The world's largest producer of acid lime is India. Lime is an acidic fruit that contains a significant quantity of dietary fiber, vitamin C, phenolic components, and flavonoids. Citrus is thought to have potential health-promoting characteristics. Lime juice contains citric acid, which acts as a natural preservative in foods. Lime has many health benefits such as weight loss, skin care, good digestion, relief from constipation, eye care, and treatment of scurvy, piles, peptic ulcer, respiratory disorders, gout, gums, urinary disorders, etc. (Hariharan and Mahendran, 2016) [7].

Beetroot has enormous potential in processed form since it has a high water content when it is fresh, which makes deterioration happen more quickly. There is not much research being done in the area on beet that has been processed. Thus, for the creation and preservation of beetroot-processed products such as beet syrup, lime-infused beet syrup, ready-to-serve squash beverages, and so on, a scientific method is required. Due to their health and nutritional benefits, syrup beverages are becoming increasingly popular throughout the country. The market price falls because of the increase in production, seasonal glut in the market and perishability. Thus, to minimize losses, a scientific approach has been taken to prepare and preserve lime-blend beet syrup.

## 2. Materials and Methods

An investigation entitled "Studies on preparation of lime blended beet syrup" was carried out at the Postharvest Technology Laboratory, Horticulture Section, College of Agriculture, Nagpur during the academic year 2021–2022. A Factorial Completely Randomized Design experiment was conducted with 12 treatments in three replications: P1L1 (25% pulp + 0% lime juice), P1L2 (25% pulp + 2% lime juice), P1L3 (25% pulp + 4% lime juice), P1L4 (25% pulp + 6% lime juice), P2L1 (30% pulp + 0% lime juice), P2L2 (30% pulp + 2% lime juice). P2L3 (35% pulp + 4% lime juice), P2L4 (35% pulp + 6% lime juice), P3L1 (35% pulp + 0% lime juice), P3L2 (35% pulp + 2% lime juice), P3L3 (35% pulp + 4% lime juice), P3L4 (35% pulp + 6% lime juice), P3L4 (35% pulp + 6% lime juice). Some of the characteristics to evaluate include total soluble salts, titrable acidity, total sugars, reducing sugars, non-reducing sugars, ascorbic acid, pH, microbial count, color, taste, flavor, general acceptability, and benefit-cost ratio.

**2.1 Preparation of Preparation of lime blended beet syrup:** At first, well-matured beet fruit and lime are selected. Then washing and sorting are done. Then remove the peel and cut it into small pieces. Then smash it into a blender to get pulp. Take the required quantity of water into a stainless steel utensil for preparation of syrup then add sugar to maintain 65° Brix TSS. Then boil it for 10 minutes. Then add pulp of beet in hot sugar syrup. Squeeze the lime juice and blend it with beet juice as per the treatment. Then add sodium benzoate at the rate of 300 ppm. Then fill it in the bottle of 100 ml and store it in ambient condition.

## 3. Results and Discussion

### 3.1 Chemical Qualities Parameters

#### 3.1.1 Total soluble solids (ºBrix)

Total soluble solids significantly vary between different concentrations. A significant minimum increase (2.92 ºB) at the 120th day in total soluble solids of lime blended beet syrup was recorded in treatment P2 30% pulp i.e. from 65.04 to 67.96 ºB in Table 1. Due to different concentrations of lime juice, the minimum increase (2.71 ºB) in total soluble solids was recorded in treatment L3 (4.0% lime juice) i.e. from 65.03 to 67.74 ºBin Table 2. Interaction data revealed that a significantly significant minimum increase in total soluble solids (2.63 ºB) i.e. from 65.03 to 67.66 ºB in lime blended beet syrup were recorded in treatment combination with P2L3 30% pulp and 4.0% lime juice in table 3. Hydrolysis of polysaccharides such as starch, cellulose, and 37 pectin compounds may result in an increase in total soluble solids. The results mentioned above are in accordance with the findings of Reddy and Chikkasubbanna (2009) [13] in aonla syrup.

#### 3.1.2 Titrable acidity

In general, the titratable acidity of lime blended beet syrup was gradually decreased in all the pulp levels. A significant minimum decrease (0.41%) i.e. from 1.59 to 1.18% in titratable acidity of lime blended beet syrup was found to be superior at the 120th day of storage in treatment P2 (30% pulp) in Table 1. Due to different concentrations of lime juice minimum decrease in titratable acidity (0.31%) i.e. from 1.51 to 1.20% was recorded with the treatment L3 (4.0% lime juice) in Table 2. Interaction data revealed that a significant minimum decrease (0.29%) i.e. from 1.49 to 1.20% in titratable acidity of lime blended beet syrup was recorded with treatment combination P2L3 (30% pulp and 4.0% lime juice in Table 3. The hydrolysis of polysaccharides and nonreducing sugars, when acid is used to convert them into hexose sugars (reducing sugars), may be responsible for the decrease in titratable acidity of lime-blend beet syrup. The downward trend could also be a result of chemical interactions between the chemical constituents of juice which are influenced by temperature influencing enzymatic action (Palaniswamy and Muthukrishanan, 1974) [10]. The results mentioned above correspond with the findings of various research workers. Kannan and Thirumaran (2002) [9] analysed that the decrease in acidity of jamun products may be a result of partial hydrolysis of complex carbohydrates into simple sugar.

#### 3.1.3 Total sugar

A significant minimum increase (3.30%) i.e. from 58.11 to 61.41% in total sugars up to 120 days of storage was observed in treatment P2 (30% pulp) in Table 1. Due to different levels of lime juice concentration significant minimum increase in total sugars (2.13%) i.e. from 54.89 to 57.02% of lime blended beet syrup was found in treatment L3 (4.0% lime juice) in Table 2. Interaction data revealed that the minimum increase (2.01%) i.e. from 53.73 to 55.74% in total sugars of lime blended beet syrup was recorded in treatment combination P2L3 (30% pulp and 4.0% lime juice) in Table 3. The rise in total sugars of lime-blended beet syrup during storage was most likely driven by the conversion of starch into simple sugar. This could be due to the hydrolysis of polysaccharides like pectin and starch into reducing sugars. The results indicated above are

consistent with the findings of other researchers. According to Reddy and Chikkasubbanna (2009) [13], aonla syrup total sugars increased during storage.

### 3.1.4 Reducing sugars

A significant minimum increase (8.62%) i.e. from 21.23 to 29.85% in reducing sugars up to 120 days of storage was observed in treatment P2 (30% pulp) in Table 1. Due to different concentrations of lime juice significant minimum increase in reducing sugars (8.80) i.e. from 21.38 to 30.18% in lime blended beet syrup was recorded in treatment L3 (4.0% lime juice) in Table 2. Interaction data revealed that a significant minimum increase (8.00%) from 21.60 to 29.60% of lime blended beet syrup was recorded with treatment combination P2L3 (30% pulp and 4.0% lime juice) in Table 3. The gradual loss of moisture and hydrolysis of polysaccharides into sugars may have caused an increase in the reduction of sugars in lime-blended beet syrup during storage. In 1987, Bawa and Saini [1] examined the physio-chemical and organoleptic characteristics of bottled carrot juice and found that the reduced sugar content was increased. Reddy and Chikkasubanna (2009) [13] observed a significant increase in the reduction of sugars in aonla syrup while it was stored.

### 3.1.5 Non-reducing sugars

A significant minimum decrease (5.33%) i.e. from 36.88 to 31.55% in non-reducing sugars up to 120 days of storage was observed in treatment P2 (30% pulp) in Table 1. Among the lime juice levels treatment significant minimum decrease in nonreducing sugars was found in treatment L1 (0%) with 5.35% i.e. from 37.75 to 32.40% was recorded in Table 2. According to interaction data, a significant minimum decrease in non-reducing sugars (5.19%) i.e. from 35.94 to 30.75% of lime blended beet syrup was found in treatment combination Non-reducing sugars in lime-blended beet syrup may decrease due to the inversion of non-reducing sugars into reducing sugars during storage. The results indicated above are consistent with the findings of other researchers. Reddy and Chikksubbanna (2009) [13] reported that considerable decline in non-reducing sugars during the storage period of amla syrup. Jadhao (2012) [8] reported that the nonreducing sugars of Aonla beverages decreased throughout the storage period.

### 3.1.6 Ascorbic acid (mg/100 ml syrup)

A significant minimum decrease (3.88) i.e. from 7.02 to 3.14 mg/100 ml of lime blended beet syrup in ascorbic acid during 120 days of storage was observed in treatment P2 (30% pulp) in Table 1. Due to different levels of lime juice significant minimum decrease in ascorbic acid (3.23mg) of lime blended beet syrup i.e. from (6.27 to 3.04 mg/100 ml) in ascorbic acid was recorded in treatment L3 (4.0% lime juice) was observed in table 2. According to interaction data significant minimum decrease in ascorbic acid of lime blended beet syrup was recorded in treatment combination P2L3 (25% pulp content and 4.0% lime juice) and the minimum decrease (from 6.27 to 3.15 mg/100 ml) in ascorbic acid was (3.12mg) was recorded in table 3. Because ascorbic acid is sensitive to oxygen, light, and heat, and was rapidly oxidized in the presence of oxygen by both enzymatic and non-enzymatic catalysts, the ascorbic acid content of lime-blend beet syrup decreased during storage. The above-mentioned findings are consistent with those of other researchers. Das (2009) [2] reported that the jamun product ascorbic acid content decreased steadily throughout the storage period and ranged from 12.21 to 10.20 mg/100 ml in RTS.

### 3.1.7 pH

Significant minimum increase (0.99) i.e. from 6.40 to 7.39 in pH during 120 days of storage was recorded in treatment P2 (30% pulp) in Table 1. Due to different levels of lime juice concentration significant minimum increase in pH (0.98) i.e. from 6.40 to 7.38 in lime blended beet syrup was recorded in treatment L3 (4.0% lime juice) in Table 2. According to interaction data, a significant minimum increase (0.74) i.e. from 6.40 to 7.17 in pH of lime blended beet syrup was recorded in treatment combination P2L3 (30% pulp and 4.0% lime juice) in Table 3. According to the results above, the pH of lime-blended beet syrup decreased gradually during storage. The above-mentioned result is consistent with the findings of other researchers. Reddy and Chikkasubbanna (2009) [13] revealed that the pH of amla syrup was decreased during the storage period. Jadhao (2012) [8] observed an increase in pH throughout the storability investigation for lime-blend-only drinks.

### 3.2 Microbial count

During the 120-day storage period, there were no microbiological growths. Microbial deterioration was not seen in the lime-blended beet syrup. Due to osmosis, high sugar concentrations may have lower water activity, reducing the availability of free water for microbial growth and multiplication. The fermentation of lime-blended beet syrup received no unfavorable comments from the organoleptic evaluation panel, and all treatments were safe to ingest. The above-mentioned conclusion is consistent with previous studies' findings. Reddy and Chikkasubbanna (2008) [18] observed microbial load over the storage term of 90 days on lime-blended squash.

### 3.3 The impact of storage time on the sensory quality characteristics of lime blended beet syrup.

### 3.3.1 Colour score

Table 4 shows that a minimal decrease in colour score (0.19), i.e. from 8.85 to 8.66, was found in treatment combination P2L3 (30% pulp and 4.0% lime juice) based on interaction data. Based on the foregoing findings, it was discovered that the colour of lime-blended beet syrup gradually faded during storage due to differences in pulp level, lime juice concentration, and treatment combinations. Ghorai and Khurdiya (1998) [6] discovered that storage temperature had a substantial effect on juice colour. Gaikwad (2011) [4] reported that guava syrup and RTS were acceptable up to 180 days and 56 days, respectively in sensory qualities except ambient storage had the highest score of colour irrespective of storage periods.

### 3.3.2 Taste score

Table 4 reveals that the treatment combination P2L3 (30% pulp and 4.0% lime juice) had a minor decrease in taste score (0.26), from 9.41 to 9.15. The taste of lime-blended beet syrup gradually degraded after storage, according to the findings. The decrease in taste score of lime blended beet syrup during storage could be attributed to a number of factors impacting product storage stability, one of which is temperature. The above findings are in line with what other

research scientists have found. Pattar *et al*. (2013) [11] reported that the tamarind syrup retained its taste for up to 3 months of storage at room temperature. Shaheen *et al*. (2015) [15] reported that the taste of pineapple and papaya blended karonda juice decreased during the storage period.

### 3.3.3 Flavour

In general, the flavor score of lime blended beet syrup dropped throughout time (0 to 120 days). Table 4 shows a minimum decline in flavor score (0.20), i.e. from 8.82 to 8.62, in treatment combination P2L3 (30% pulp and 4.0% lime juice). The above-mentioned findings are consistent with the findings of other researchers. According to Prasad and Mali (2000) [12], the flavour of the pomegranate squash was maintained better at low temperatures, and all squash samples were organoleptically acceptable at low temperatures for a year. Sahoo *et al*. (2014) [14] revealed that the flavour of guava syrup decreased with the advancement of the storage period. A study by Totad *et al*., (2014) [16] found that sapota mixed with jack fruit, avocado syrup with 50% juice, 50% citric acid, and 70% Brix was acceptable with a good flavour and organoleptic quality.

**3.3.4 Overall acceptability:** During a 120-day storage period, the overall acceptability score of lime-blended beet syrup declined. Table 4 demonstrates that the treatment combination P2L3 (30% pulp and 4.0% lime juice) had the smallest drop in overall acceptability (0.21), i.e. from 8.89 to 8.68. The findings presented above are congruent with those of other studies. Reddy and According to Chikkasubbanna (2008) [18] 73, the interaction effect of pulp and total soluble solids influenced the overall acceptability of lime-blended aonla squash. Ghanekar and Jain (2014) [5] blended custard apples with papaya and reported that the RTS prepared with 100% custard apple pulp scored the highest organoleptic score (7.0).

**3.4 Benefit-cost ratio:** According to the results in Tables 1 and 2, the treatment combination P2L3 (30% pulp and 4.0% lime juice) had the highest benefit-cost ratio (3.56).

**Table 1:** The effect of varied pulp levels on the quality characteristics of blended beet syrup.

| Treatments | TSS (ºB) after 120 days | Titrable acidity (%) after 120 days | Total sugars (%) after 120 days | Reducing sugars (%) after 120 days | Non-reducing sugars (%) after 120 days | Ascorbic acid (mg/100ml) | pH |
|---|---|---|---|---|---|---|---|
| P1 - 25% pulp | 68.28 | 1.17 | 60.02 | 31.86 | 28.16 | 3.05 | 7.44 |
| P2 - 30% pulp | 67.96 | 1.18 | 61.41 | 29.85 | 31.55 | 3.14 | 7.39 |
| P3 - 35% pulp | 67.99 | 1.16 | 59.98 | 31.05 | 28.92 | 3.22 | 7.41 |
| 'F' test | Significant | Significant | Significant | Significant | Significant | Significant | Significant |
| SE(m) ± | 0.015 | 0.005 | 0.03 | 0.13 | 0.14 | 0.007 | 0.007 |
| CD at 5% | 0.043 | 0.016 | 0.10 | 0.38 | 0.40 | 0.021 | 0.020 |

**Table 2:** The effect of various quantities of lime juice on the quality parameters of blended beet syrup.

| Treatments | TSS (ºB) after 120 days | Titrable acidity (%) after 120 days | Total sugars (%) after 120 days | Reducing sugars (%) after 120 days | Non-reducing sugars (%) after 120 days | Ascorbic acid (mg/100ml) | pH |
|---|---|---|---|---|---|---|---|
| L1 - 0% | 68.05 | 1.18 | 63.38 | 30.98 | 32.40 | 3.14 | 7.47 |
| L2 - 2.0% | 68.10 | 1.14 | 61.97 | 31.04 | 30.93 | 3.18 | 7.38 |
| L3 - 4.0% | 67.74 | 1.20 | 57.02 | 30.18 | 26.84 | 3.04 | 7.16 |
| L4 - 6.0% | 68.40 | 1.15 | 59.50 | 31.48 | 28.02 | 3.17 | 7.63 |
| 'F' test | Significant | Significant | Significant | Significant | Significant | Significant | Significant |
| SE(m) ± | 0.017 | 0.006 | 0.04 | 0.15 | 0.16 | 0.08 | 0.008 |
| CD at 5% | 0.050 | 0.018 | 0.11 | 0.44 | 0.46 | 0.024 | 0.023 |

**Table 3:** The interaction effect of varied amounts of pulp and lime juice concentrations on blended beet syrup quality factors.

| Treatments Interaction (PxL) | TSS (ºB) after 120 days | Titrable acidity (%) after 120 days | Total sugars (%) after 120 days | Reducing sugars (%) after 120 days | Non-reducing sugars (%) after 120 days | Ascorbic acid (mg/100ml) | pH |
|---|---|---|---|---|---|---|---|
| P1L1 | 67.99 | 1.21 | 64.15 | 31.04 | 33.11 | 3.09 | 7.30 |
| P1L2 | 68.48 | 1.14 | 60.75 | 32.66 | 28.09 | 3.09 | 7.67 |
| P1L3 | 67.85 | 1.19 | 58.00 | 30.77 | 27.23 | 2.99 | 7.10 |
| P1L4 | 68.79 | 1.12 | 57.18 | 32.95 | 24.23 | 3.05 | 7.68 |
| P2L1 | 68.04 | 1.17 | 63.61 | 30.26 | 33.35 | 3.11 | 7.52 |
| P2L2 | 67.89 | 1.19 | 62.81 | 30.12 | 32.69 | 3.18 | 7.25 |
| P2L3 | 67.66 | 1.20 | 55.74 | 29.60 | 26.14 | 3.15 | 7.17 |
| P2L4 | 68.25 | 1.16 | 63.47 | 29.44 | 34.03 | 3.18 | 7.62 |
| P3L1 | 68.12 | 1.17 | 62.39 | 31.64 | 30.75 | 3.23 | 7.58 |
| P3L2 | 67.93 | 1.18 | 62.34 | 30.34 | 32.00 | 3.26 | 7.26 |
| P3L3 | 67.73 | 1.22 | 57.31 | 30.18 | 27.14 | 3.09 | 7.20 |
| P3L4 | 68.17 | 1.16 | 57.85 | 32.04 | 25.81 | 3.29 | 7.60 |
| 'F' test | Sig. | Sig. | Sig. | Sig | Sig. | Sig. | Sig |
| SE(m) ± | 0.030 | 0.011 | 0.07 | 0.26 | 0.27 | 0.014 | 0.013 |
| CD at 5% | 0.087 | 0.032 | 0.20 | 0.75 | 0.79 | 0.041 | 0.039 |

**Table 4:** The influence of varying amounts of pulp and lime juice concentrations on sensory quality indices and the benefit-cost ratio of blended beet syrup.

| Treatments Interaction (PxL) | Colour score after 120 days | Taste score after 120 days | Flavour after 120 days | Overall acceptability after 120 days | Benefit-cost ratio |
|---|---|---|---|---|---|
| P1L1 | 7.55 | 7.54 | 7.82 | 7.62 | 2.76 |
| P1L2 | 7.81 | 8.01 | 8.01 | 7.99 | 2.67 |
| P1L3 | 7.95 | 8.08 | 8.22 | 8.11 | 2.60 |
| P1L4 | 7.52 | 7.16 | 7.61 | 7.59 | 2.52 |
| P2L1 | 7.63 | 7.32 | 7.78 | 7.62 | 3.02 |
| P2L2 | 8.41 | 8.72 | 8.18 | 8.38 | 2.93 |
| P2L3 | 8.66 | 9.15 | 8.62 | 8.68 | 3.56 |
| P2L4 | 8.30 | 8.41 | 8.22 | 8.16 | 3.46 |
| P3L1 | 7.64 | 7.18 | 7.74 | 7.71 | 2.93 |
| P3L2 | 8.14 | 8.31 | 8.01 | 8.27 | 2.84 |
| P3L3 | 8.57 | 8.73 | 8.55 | 8.35 | 3.46 |
| P3L4 | 7.99 | 8.15 | 7.99 | 7.95 | 3.36 |

## 4. Conclusion

In terms of qualitative parameters such as TSS, titratable acidity, total sugars, reducing sugars, non-reducing sugars, ascorbic acid, and pH, the current study titled "Studies on the preparation of lime blended beet syrup" concluded that the lime blended beet syrup prepared from 30% pulp and 4.0% lime juice was superior to all other treatments. Similarly, in lime-blended beet syrup prepared from 30% pulp and 4.0% lime juice, the smallest changes in TSS, titratable acidity, total sugars, reducing sugars, nonreducing sugars, ascorbic acid, and pH were found. The lime blended beet syrup, created with 30% pulp and 4.0% lime juice, also obtained the highest sensory quality score for colour, taste, flavour, and overall acceptability, with a rating of 'like greatly'. The lime-blended beet syrup, which was prepared with 30% pulp and 4.0% lime juice, also had the highest benefit-to-cost ratio.

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