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Impact of enzymatic treatment on total carotene and sensory evaluation of various vegetable juices

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Abstract
This study was aimed to compare Total Carotene, Colour changes and Sensory evaluation of seven different Vegetable juices (Carrot, beet root, Pumpkin, Cucumber, Tomato, Ivy Gourd and Bottle Gourd) which were prepared both in conventional pressing & liquefied enzymatic treatment (Pectinase). Both liquefied enzyme treated and Non enzyme treated vegetable juices were evaluated for colour & appearance, Flavor, Mouth feel and overall Acceptability. Obtained results were compared. Observed Total carotene and Sensory parameters scores were significantly high in liquefied enzymatic treated juices when compared to Non-Enzymatic Vegetable Juices.

Keywords: Total carotene, enzyme treatment, pectinase, sensory evaluation and vegetable juices

1. Introduction
India's share in world production is about 9.3% in vegetables. India is 2nd largest producer of vegetables after China. Vegetables are perishable in nature and more than 20–25% of fruits and vegetables are spoiled before utilization. Despite being the world's second largest producer vegetables, in India only 1.5 percent of the total fruits and vegetables produced are processed. High Acidity, bitterness and astringency are the factors which are limiting the utilization of Fruit and Vegetables. Most of the vegetable juices losing their color stability after extraction as it contain convertible chemical compounds. Natural juices are valued for their refreshing, nutritional value, pleasant flavor, and medicinal properties. Though Vegetables like bitter gourd, Ivy gourd having astringency and bitter taste; Tomato, bottle gourd, carrot, Cucumber, beet root, basil and bitter gourd, which are having excellent source of nutrients can be used for juice blending to get acceptable highly nutritious juice blend, which is a natural health drink and also serve as an appetizer. (RajuLal Bhardwaj & Shruti Pandey., 2011) [13].
Now days, diabetes is the major health problem in all over the world. Part of regular healthy diet and other activities to protect from long-term damage to the nerves, eyes and major arteries, by focusing on natural diets i.e. like vegetable products which are rich in dietary fibre, vitamins, minerals and antioxidants etc. will promote the health of diabetes people due to their multivalent action as balanced diet as well as functional foods (Mohammad Asif., 2011) [11].
Vegetables are good sources of dietary fibre and which lowers the risk of cardiovascular disease and obesity. Vegetables are rich in Phytochemicals, which are function as anti-oxidant, phytoestrogens and anti-inflammatory through their protective mechanisms (Slavin, J. L., & Lloyd, B., 2012) [18].
Vegetables contribute supplements like nutrients, minerals, proteins, dietary fibre, fats and plays vital role. Vegetables are major source for Vitamin B complex & Vitamin C. Minimum five servings of vegetables were recommended by USFDA's Food guide pyramid. Vegetables provides both nutrition and colour, texture and flavor. Most of the vegetables are plays vital role in human health due to presence of carotenoids, flavonoids, phenolics, chlorophylls and anthocyanins; which are anti-oxidant in the prevention of carcinogenic health problems (Nirmal K. Sinha, 2011; Andersen and Jordheim 2006).
Carrot and Pumpkin are rich in β-Carotene, Antioxidant, anti-inflammatory perspectives, inhibits arthritis and prostate cancer, improves skin tone, carrot especially effective in diabetes mellitus, lowers cholesterol, and reduces colon cancer. Cucumber is rich in Antioxidants, carotenoids, and Vitamins and which are Antioxidant potential, improves the skin tone. Tomatoes are rich in Lycopene which are Potent antioxidants, lowers cholesterol/glucose, anticancer potential (Nirmal K. Sinha, 2011). Beet roots are rich in phenolic compounds, betalains consisting of red violet colored betacyanins and yellow colored betaxanthins and the

Concentration 300-600mg/Kg of betanin, whereas isobetanin, betanidin, and betaxanthins were present at lower concentrations (Kanner *et al*. 2001) [9]. A 100 g of edible portion of the bottle gourd contains ascorbic acid 12.0 mg, potassium 87.0 mg, calcium 12.0 mg, phosphorus 37.0 mg and niacin 0.3 mg (Rumeza *et al*., 2006; Sawate *et al*., 2009) [16, 17]. In the treatment of acidity, indigestion, ulcers, pectoral cough and in other bronchial disorders bottle gourd is used. (Deore *et al*., 2009) [5].

Ivy gourd is rich in β-carotene and also a good source of fibre, protein and a moderate source of calcium and can consume by all age groups hence it is being selected for several studies in Thailand. (Xu *et al*., 2003) [20].

1.1 Health Functions of Vegetable Juice

Fruits and vegetables are found to be protective against the risks of arthritis, cardiovascular diseases (CVD), cancers and chronic inflammation (Chen *et al*. 2006) due to the presence of carotenoids, Vitamin E, vitamin C, minerals and Fiber (Roy *et al*. 2007) [15].

Deep colored vegetables juices supplementation demonstrated immunomodulatory potential via the regulation of Th1/Th2 cytokine secretions, especially Th1 cytokines (Lin and Tang 2008). Vegetable juice also play an important role in delaying the onset of Alzheimer's disease, particularly among those who are at high risk for the disease (Dai *et al*. 2006) [4].

2. Material and methods

2.1 Materials

2.1.1 Chemicals

All chemicals and reagents used in the experiments were of analytical grade and purchased Mostly from SD Fine, India and SRL private Limited, India.

2.1.2 Selection of raw materials

Carrot, Beet root, Pumpkin (yellow skin), Tomato, Ivy gourd, Cucumber and Bottle gourd procured from single vendor for uniqueness in the local market of Mysore.

2.2 Unit operations involved in juice extraction:

Unit operations such as Sorting, Cleaning, Peeling, slicing, puree preparation-Enzyme treatment, filtration, pasteurization and packaging were carried out in the present research. The unit operations are briefly explained in the following sections;

2.2.1 Sorting and Cleaning

- Procured high grade raw materials and sorted out for uniformity in raw material based on visual inspection (color, size and ripening).
- Carrots were selected in uniform Orange color with medium size.
- Beet roots were selected in uniform dark color with medium size.
- Bottle gourds were selected with medium size and tender seeds.
- Tomatoes were selected with reddish color medium sized.
- Ivy gourds were selected in medium size, which were unripened one.
- Cucumbers were selected in medium size and without bitter taste,
- Pumpkins were selected in yellow colored pomace one with medium size.

All vegetables were washed properly under potable running tap water and allowed drain the excess water after washing.

2.2.2 Peeling & **Seed removing**: Peeling of carrot, beet root, bottle gourd, Ivy gourd and cucumber was done to remove unwanted skin on vegetables with the help of knife and hand peeler and seeds of tomatoes, pumpkin and bottle gourd were removed with the help of knife.

2.2.3 Blanching: Blanching of Carrots, beet root and tomatoes were done to improve tenderness of vegetable and inactivation of enzymes in boiling water for 1min.

2.2.4 Chopping: Blanched vegetables and remaining vegetables were chopped to easy pulp in the home level grinder (Ultra Choice Plus).

2.2.5 Enzyme treatment, Puree preparation & Incubation: Chopped vegetables were taken into home scale mixer of the common type (Ultra Choice + RX, 1000 watts) for puree preparation. Liquefied Enzyme was added before puree preparation starts. To improve the yield of juice, while puree preparation all the vegetables were treated with different percentages of liquefied Pectinase enzyme, but finally optimized with 2% liquefied Pectinase treatment for carrot & 1% for remaining all vegetables based on the juice yield calculation. Enzyme treated puree kept for incubation at room temperature for min 2 hours to get enhanced juice. Pectinase will active at the temperature around 40 ^{0}C and that required temperature will be attained while grinding to make puree.

Prepared puree was kept for incubation at room temperature for 2 hours in closed vessel.

In case of Non-enzyme treated juices, puree was prepared without adding liquefied Enzyme.

2.2.6 Filtration: Filtration was done using muslin cloth to remove the residual pomace material in the enzyme treated juice.

2.2.7 Pasteurization & Storage: The filtered juice was stored under freezing condition (-18 ^{0}C) after inactivation of enzyme at 70 ^{0}C for 5 min.

2.3 Total Carotene (mg/100mL) (Ranganna, 1999) [14]: 10 mL of the juice was taken and was extracted with acetone till the color of the sample turned white and filtered using wad of cotton. The filtrate was transferred to a separating funnel and 10-15 mL of petroleum ether was added along with 10 mL of water. It was mixed well and then allowed to stand for few minutes. The bottom layer was separated. Then add some amount of water and the procedure was repeated 2-3 times. The top layer was collected and the volume was recorded and then its OD was noted at 452 nm in a UV Visible Spectrophotometer (UV-1601, Shimadzu, Japan). Total carotene was measured by following formula and expressed in terms of mg/100mL.

$$\text{Total carotene (µg/100mL)} = \left(\frac{3.857 * OD\ at\ 452\ nm * volume\ made\ up * dil}{weight\ of\ the\ sample}\right) \times 100$$

2.4 Sensory Evaluation:

The Vegetable Juices were subjected to sensory evaluation for its Color & appearance, Flavor, Mouth feel and Overall Acceptability for selecting the best among the various formulation of the product. Sensory analyses of the different formulations of beverages were evaluated for sensory quality and acceptance of the product for consumption. The acceptance was determined by a Semi trained panelist on 9

point HEDONIC scale, 1-9 scale numerical values were assigned to each point on the scale where 1 indicates dis like extremely and 9 indicates like extremely.
Score cards were provided to judges to evaluate the product on a 9 point Hedonic scale. Sensory evaluation of both the Enzyme Treated (ET) and Non-Enzyme treated vegetable juices were done by semi trained panel members in the morning and in the afternoon in appropriate rooms. All the samples were coded properly and juices were served in 50mL cups and also offered cracker pieces in a cup to have in-between each sample, to keep the saliva and the taste buds in their natural state and thereby to prepare them for the next tasting. An average scores of ten judgments was determined for each Vegetable juices. Nine points were awarded as like extremely-9, like very much-8, like moderately-7, like slightly-6, neither like nor dislike-5, dislike slightly-4, dislike moderately-3, dislike very much-2 and dislike extremely-1 (Gandhi and Taimini, 2009) [8].

3. Results and Discussion

Now a days, consumer demand for fresh ready-to-use products, which has led to increase in minimally processed vegetables and fruits, as this minimally processed products combine freshness and convenience (Yamada H, 1996) [19]. In juice processing, the enzyme treatment of fruit & vegetable pulp is a general practice. Generally enzymatic treatment is being done with cellulase, hemicellulases and pectinases and in the combination also. Enzymes hydrolyze protopectins and which is leading to the release of cell wall contents, which have been envisioned to be composed of cellulose fibres embedded in an amorphous mixture of polysaccharides and glucoproteins (El-Zoghbi M *et al*., 1992 and Borowska J, 2000) [7, 1]. In this work we have studied liquefied Enzyme (Pectinase) treatment effect on Carrot, Beetroot, Pumpkin, Tomato, Bottle Gourd, Ivy Gourd and Cucumber juice extraction. All the obtained results were presented in mean values along with their standard deviation.

3.1 Change in Total Carotene

Results of Total Carotene of both enzyme treated (ET) and Non Enzyme Treated (NET) were presented in Table 1 and expressed in micro grams.

Table 1: Total Carotene of Vegetable Juices (µg/ 100 mL)

Vegetable Juices	NET	ET
Carrot	739±2.94	891.20±2.83
Beet Root	45±0.82	56.36±1.39
Pumpkin	825±1.63	997.26±2.74
Cucumber	9.93±0.09	11.95±1.09
Tomato	159±2.16	169.48±0.00
Ivy gourd	427.67±2.05	487.27±1.16
Bottle Gourd	56.67±1.25	61.61±2.43

Total Carotene of all enzyme treated vegetable juices were significantly high when compared to non-enzyme treated vegetable juices and shown graphically in figure 1.

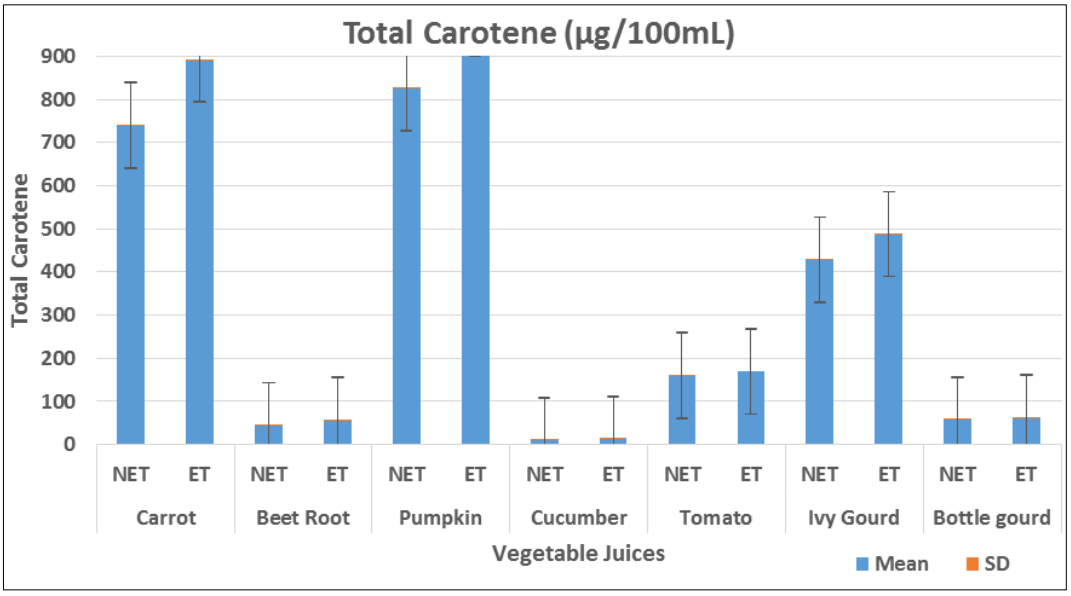

Fig 1: Total Carotene of vegetable Juices

Total carotene content of Non enzyme treated Carrot, Beet root, Pumpkin, Cucumber, Tomato, Ivy Gourd and Bottle gourd juices was 739±2.94, 45±0.82, 825±1.63, 9.93±0.09, 159±2.16, 427.67±2.05 and 56.67±1.25 µg/ 100 mL respectively. Whereas Carotene content of Enzyme Treated Carrot, Beet root, Pumpkin, Cucumber, Tomato, Ivy Gourd and Bottle gourd juices was 891.20±2.83, 56.36±1.39, 997.26±2.74, 11.95±1.09, 169.48±0.00, 487.27±1.16 and 61.61±2.43 respectively. The increase of carotene content in Enzyme treated vegetable juices due to enzymes action on the cell wall components and hydrolyzes polysaccharides which leads breakage of texture and releases bounded bioactive components, which results in higher extraction yields of bioactives (Chandini *et al*., 2011; Puri *et al*., 2012) [2, 12].

3.2 Effect of Enzyme Treatment on Sensory Evaluation:

The sensory scores for Both Enzyme Treated (ET) and Non Enzyme Treated (NET) Vegetable juices were carried out on the basis of attributes of colour and appearance, flavour, mouth feel and overall acceptability. The results were compared for both Enzyme Treated and Non Enzyme treated Vegetable Juices for sensory attributes. The sensory scores of both Enzyme Treated (ET) and Non Enzyme Treated (NET) Vegetable juices were presented in Table 2 and the results were expressed in mean values along with their standard deviations.

Table 2: Sensory score of Vegetable Juices (Mean Values ± S.D)

Juices	Color & Appearance		Flavor		Mouth feel		Overall Acceptability	
	NET	ET	NET	ET	NET	ET	NET	ET
carrot	7.33±0.58	8.5±0.1	7.33±0.1	7.87±0.33	6.33±0.58	6.67±0.58	6±0.2	6.33±0.1
Beet Root	8.67±0.58	8.67±0.33	7.67±0.2	7.67±0.2	6.33±0.58	6.33±0.58	6.67±0.1	6.67±0.1
Pumpkin	8.33±0.58	8.67±0.58	6.67±0.58	6.67±0.58	5±0.5	5.33±0.33	5.33±0.2	5.67±0.58
Tomato	7.5±0.1	8±0.2	7.67±0.33	7.67±0.33	6.33±0.58	6.33±0.58	6.33±0.1	6.67±0.1
Bottle gourd	5±0.5	5.33±0.58	5.33±0.58	5.33±0.58	4.33±0.5	4.67±0.5	4.33±0.58	4.67±0.58
Ivy gourd	5±0.5	5.5±0.33	5±0.58	5±0.58	4.33±0.58	4.67±0.58	4.67±0.58	4.67±0.58
Cucumber	6±0.58	6.33±0.33	8.33±0.1	8.33±0.1	8±0.1	8±0.1	7.33±0.1	7.67±0.1

3.2.1 Carrot Juice Sensory Evaluation: The results of both Enzyme Treated (ET) and Non Enzyme treated Carrot juices were evaluated for color and appearance, flavor, mouth feel and Overall Acceptability. The sensory scores were presented in Table 2 and the comparison of results were graphically represented in figure 2. Compared to Non Enzyme treated carrot juice, enzyme treated carrot juice was shown significantly high scores.

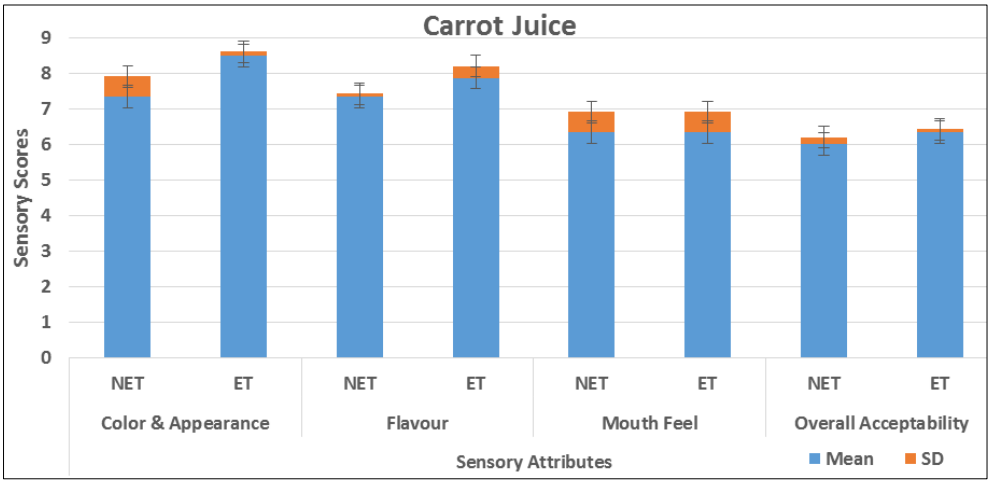

Fig 2: Carrot Juice (ET & NET) Sensory evaluation.

3.2.2 Beet Root Juice Sensory Evaluation: The results of both Enzyme Treated (ET) and Non Enzyme treated Beet root juices were evaluated for color and appearance, flavor, mouth feel and Overall Acceptability. The sensory scores were presented in Table 2 and the comparison of results were graphically represented in figure 3. Sensory panelists were given same sensory scores to both enzyme treated and Non enzyme treated beet root juices, this might be high intensity color and earthy flavor.

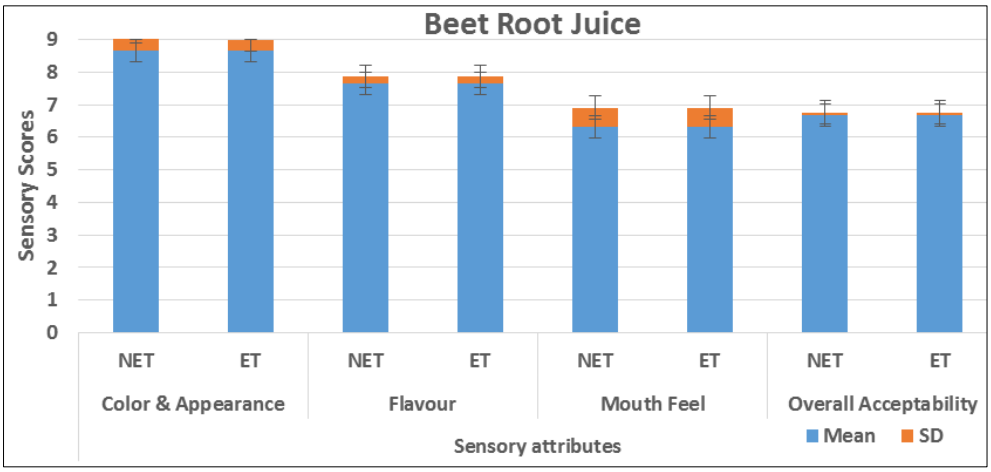

Fig 3: Beet Root Juice (ET & NET) Sensory evaluation.

3.2.3 Pumpkin Juice: The results of both Enzyme Treated (ET) and Non Enzyme treated Pumpkin juices were evaluated for color and appearance, flavor, mouth feel and Overall Acceptability. The sensory scores were presented in Table 2 and the comparison of results were graphically represented in Figure 4. Compared to Non Enzyme treated Pumpkin juice, enzyme treated Pumpkin juice was shown significantly high scores except flavor. Flavor sensory score (6.67±0.58) was same for both Enzyme Treated and Non Enzyme Treated Juices.

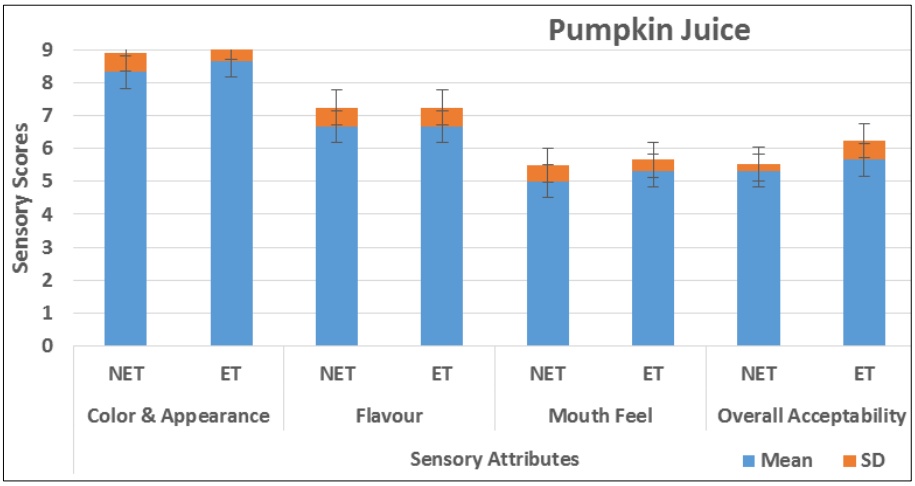

Fig 4: Pumpkin Juice (ET & NET) Sensory Evaluation

3.2.4 Tomato Juice: The results of both Enzyme Treated (ET) and Non Enzyme treated Tomato juices were evaluated for color and appearance, flavor, mouth feel and Overall Acceptability. The sensory scores were presented in Table 2 and the comparison of results were graphically represented in figure 5. Compared to Non Enzyme treated Tomato juice, enzyme treated Tomato juice was shown significantly high scores for Color & Appearance and Overall acceptability. Flavor (7.67±0.33) and mouth feel (6.33±0.58) were shown same sensory scores and might be due to acidic nature of Tomatoes.

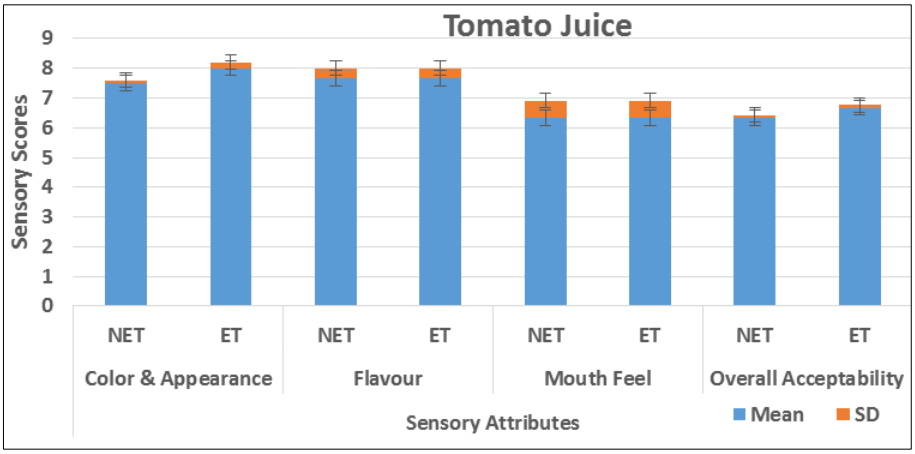

Fig 5: Tomato Juice (ET & NET) Sensory Evaluation

3.2.5 Bottle Gourd Juice: The results of both Enzyme Treated (ET) and Non Enzyme treated Bottle Gourd juices were evaluated for color and appearance, flavor, mouth feel and Overall Acceptability. The sensory scores were presented in Table 2 and the comparison of results were graphically represented in figure 6. Compared to Non Enzyme treated bottle gourd juice, enzyme treated bottle gourd juice was shown significantly high scores except flavor. Flavor (5.33±0.58) was shown same sensory scores and might be due to unique flavor.

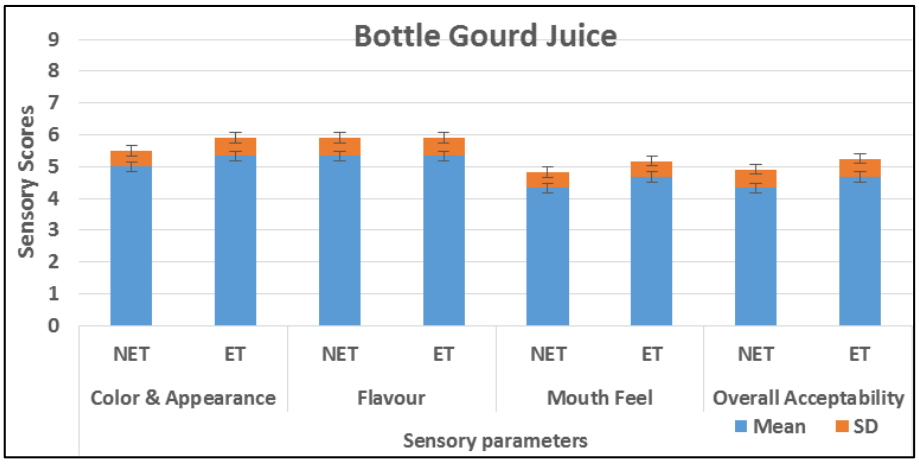

Fig 6: Bottle gourd Juice (ET & NET) Sensory Evaluation

3.2.6 Ivy Gourd Juice: The results of both Enzyme Treated (ET) and Non Enzyme treated Ivy Gourd juices were evaluated for color and appearance, flavor, mouth feel and Overall Acceptability. The sensory scores were presented in Table 2 and the comparison of results were graphically represented in figure 7. Compared to Non Enzyme treated Ivy gourd juice, enzyme treated Ivy gourd juice was shown significantly high scores for mouth feel and Color & Appearance. Flavor (5±0.58) and Overall Acceptability were shown same sensory scores. The significant high values of color and appearance and Overall Acceptability might be due to increase of carotenoid content in Enzyme Treated Ivy Gourd Juice.

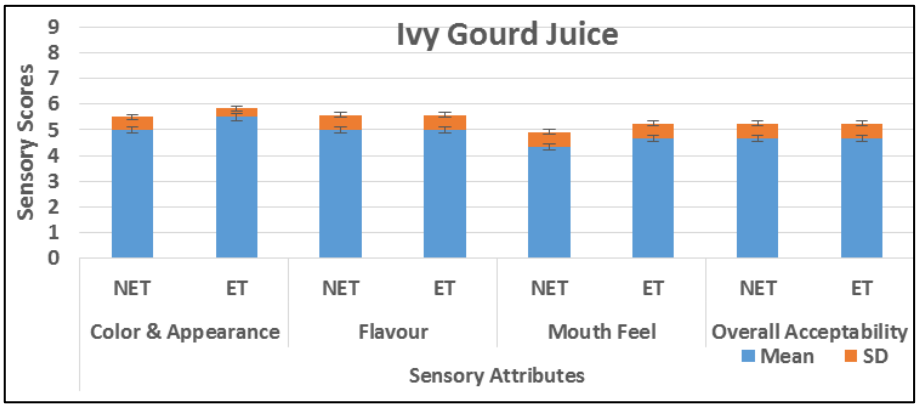

Fig 7: Ivy Gourd Juice (ET & NET) Sensory Evaluation.

3.2.7 Cucumber Juice: The results of both Enzyme Treated (ET) and Non Enzyme treated Cucumber juices were evaluated for color and appearance, flavor, mouth feel and Overall Acceptability. The sensory scores were presented in Table 2 and the comparison of results were graphically represented in figure 8. Compared to Non Enzyme treated Cucumber juice, enzyme treated Cucumber juice was shown significantly high scores for Overall acceptability and Color & Appearance. Flavor (8.33±0.1) and Mouth feel (8±0.1) were shown same sensory scores. The significant high values of color and appearance and Overall Acceptability might be due to effective juice clarification in Enzyme Treated Cucumber Juice.

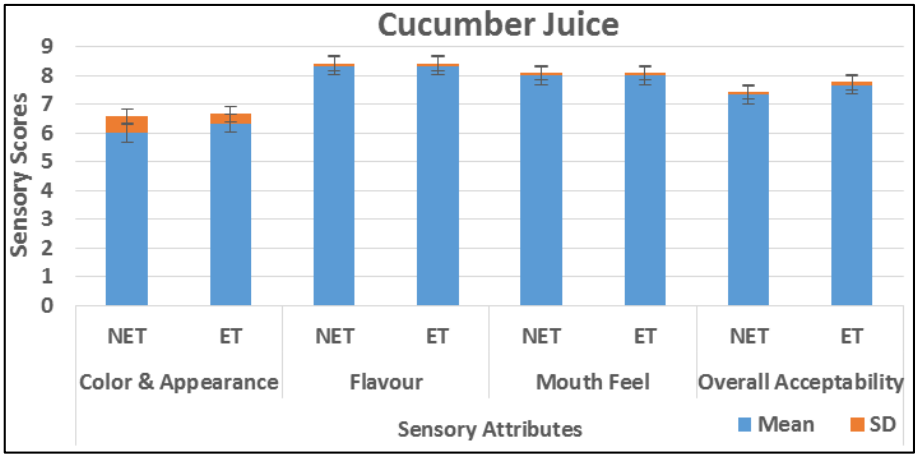

Fig 8: Cucumber Juice (ET & NET) Sensory Evaluation

4. Conclusion

In the present study Total Carotene and Sensory attributes of both Enzyme Treated and Non-Enzyme Treated Vegetable Juices were evaluated. In all enzyme treated Juices, Total Carotene was significantly high due to enzymes action on the cell wall components and hydrolyzes polysaccharides which leads breakage of texture and releases bounded bioactive components, which results in higher extraction yields of bioactives (Chandini *et al*., 2011; Puri *et al*., 2012) [2, 12]. Among all seven vegetables, except Bottle gourd and Ivy Gourd all were shown better sensory scores. Liquefied enzyme (Pectinase) treated Carrot Juice was shown better sensory scores due to increase in total carotene content. Increase in Carotene content contributes color and flavor (De Simon BF *et al*., 1992). Enzyme treated carrot juice was shown high score for color & appearance (8.5±0.1). Due to high intense color and earthy flavor beetroot has shown same sensory scores for both Enzyme Treated and Non Enzyme Treated Juice. Enzyme Treated Pumpkin was shown better score for color (8.67±0.58) and overall acceptability (5.67±0.58). Enzyme Treated Tomato also shown better scores for color (8±0.2) and overall acceptability (6.67±0.1). Enzyme Treated Bottle gourd was shown better sensory scores (color- 5.33±0.58, Mouth feel- 4.67±0.5 and Overall Acceptability- 4.67±0.58) when compared to Non Enzyme Treated Juice. Enzyme treated Ivy Gourd was shown better sensory scores (Color-5.5±0.33 & Mouth feel- 4.67±0.58), when compared to non-enzyme treated Ivy gourd juice and this might be due to increase total carotene content as explained for carrot juice. Enzyme Treated Cucumber was shown better sensory scores compared to Non Enzyme treated juice. Among all Vegetables carotene content rich and deep

colored vegetable juices were shown better sensory scores when compared to other vegetables. Compared to Non Enzyme treated vegetable Juices, the liquefied enzyme treated vegetable juices sensory scores were high and significant in carrot, tomato and cucumber but whereas not that much significant in other vegetable juices.

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