IJFANS
International Journal of Food And Nutritional Sciences

Volume 7, Issue 4, October 2018, www.ijfans.com e-ISSN: 2320-7876

INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

IMPACT FACTOR ~ 1.021

Official Journal of IIFANS

IJFANS International Journal of Food and Nutritional Science

e-ISSN 2320 -7876 www.ijfans.com
Vol. 7, No. 4, October 2018

Research Paper ***Open Access***

EFFECT OF THERMAL EXTRACTION METHODS ON PHYSICO-CHEMICAL CHARACTERISTICS OF FRUIT JUICES

Vishva Priya S[1]* and Lakshmy Priya S[2]

*Corresponding Author: Luxmi Gautam, ✉ vish.priya075@gmail.com

Received on: 18th April, 2018 Accepted on: 14th August, 2018

The experimental research was conducted to analyse the physico-chemical characteristics of fruit juices of pomegranate, watermelon and orange juice extracted by blending (C) and partial heat treatment such as thermal osmotic extraction (TE1), simmering method (TE2) and steaming processing (TE3) and also were analysed for the effectiveness in juice yield, extraction efficiency of methods used for extraction. The process of juice extraction was carried out at low temperature (60-70 ºC) at varied time period. Extraction by partial heat treatment initiates the preservation of juice and increased its storage quality. The analytical results of the processed juice were compared with the control (blended). The pH and titratable acidity results of thermally extracted fruit juices showed effectiveness on reduction of microbial load, whereas total soluble solids was compared with percentage of reducing sugar and total sugars. Colour intensity and tint were analysed and observed to be increased during storage period and turbidity was examined for the same. In this study, the extracted fruit juice samples were also analysed for sensorial acceptance and observed for the differences among their colour, flavour, odour and taste using quantitative descriptive analysis with semi trained panellist.

Keywords: Thermal extraction, Fruit juices, Physico-chemical, Efficiency, Yield

INTRODUCTION

India is said to be second largest in production of fruits and vegetable and it also shares global exports of fresh fruits and processed fruit products at higher grade comparable to other countries worldwide. The development of horticulture crop they contribute about 30% of product share in agricultural sector which is increasing by 3.9%-4.6% per.

Fruits and Vegetables significantly constitute greater part of nutrients for human consumption. Processing of any perishable products are essential for improving their end use and acceptance over the period of time. Fruits are processed specifically to expand on their quality and end use (Aked, 2002). The quality of processed fruit product depends on their processing that they are subjected to. Processing of fruits and vegetable subsequently improve condition of fruits and vegetable end product, may possibly have positive and negative influence on stability of various nutrients like antioxidant, phytochemicals (Aaby, 2007). Thermal treatment has been back bone for food processing and technologies, especially to preserve food and in means of developing texture flavour and colour (Richardson, 2001). Thermal treatments has both advantage and disadvantage among processed fruit juices on textural, colour, flavour, taste and appearance of fruits and there might be leaching of water soluble compounds which alters the phytochemicals present in them. As phytochemicals are not available separately as single compound but they are

[1] M.Sc. Food Technology and Management, School of Food Science, M.O.P. Vaishnav College for Women, Chennai 600034, Tamil Nadu, India.

[2] Assistant Professor, School of Food Science, M.O.P. Vaishnav College for Women, Chennai 600034, Tamil Nadu, India.

always bounded to other compound thus during heat treatment they are readily extracted in to the medium used during treatment. Therefore resulted in increased amount of extractability in medium during heat treatment of fruits (Howard, 1999). Process of heating also encourage the diffusion process of cellular fluid, containing phytochemicals from the plant cell to the water medium (Leong, 2012).

Quality of any processed fruits juice principle get deteriorates due to method of processing acquired for the end product, which determines the main objective to maintain fresh quality as long as possible to keep reliable shelf life

OBJECTIVES

General Objectives

- To extract thermally treated and consumer acceptable naturally flavoured fruit juices.
- To provide convenient thermal conventional method for extraction of fruit juices.

Specific Objectives

- To analyse the physico-chemical characteristic of the control and thermally extracted fruit juice.
- To compare storage stability of the control and thermally extracted fruit juice.
- To evaluate organoleptic property of control and thermally extracted fruit juice.

Thus the research on “Effect of Thermal Extraction Methods on Physico Chemical Characteristic of Fruit Juices” aims to study the effectiveness of different thermal extraction techniques in production of fruit juices.

MATERIALS AND METHODS

Procurement of Ingredients

Fresh, sound fruits of pomegranate, watermelon and oranges and sugar were purchased from local market in Chennai.

Preparation of Samples

The sample extraction methods were standardised for all the 3 samples for extraction of fruit juices.

- Control
- Thermal Osmotic Extraction (TE1)
- Simmering Method (TE2)
- Steaming Process (TE4)

Figure 1: Preparation of Fruit Juice-Control

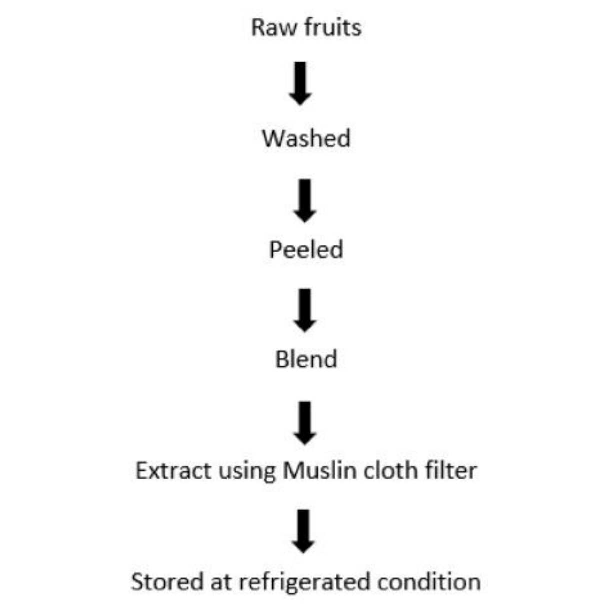


Figure 2: Preparation of Fruit Juice-TE1

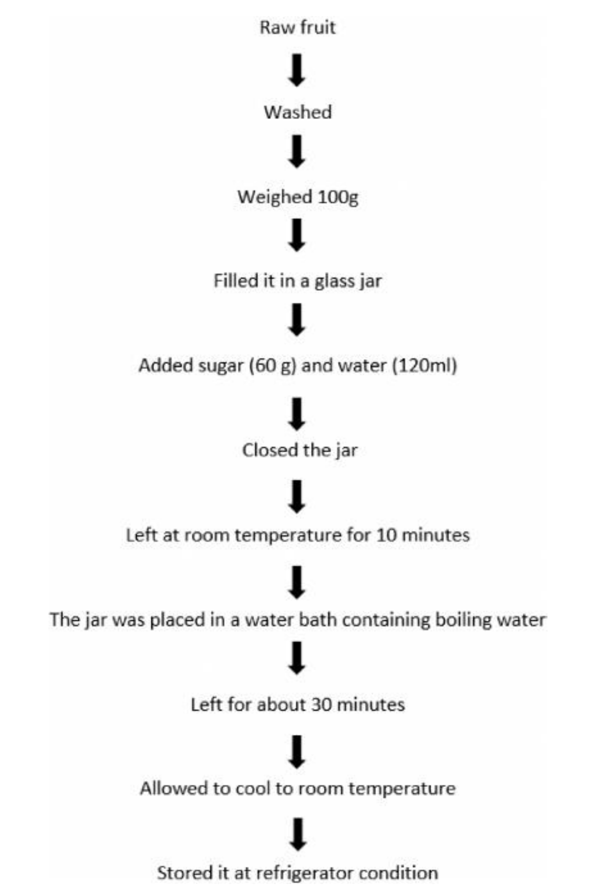


Figure 3: Preparation of Fruit Juice-TE2

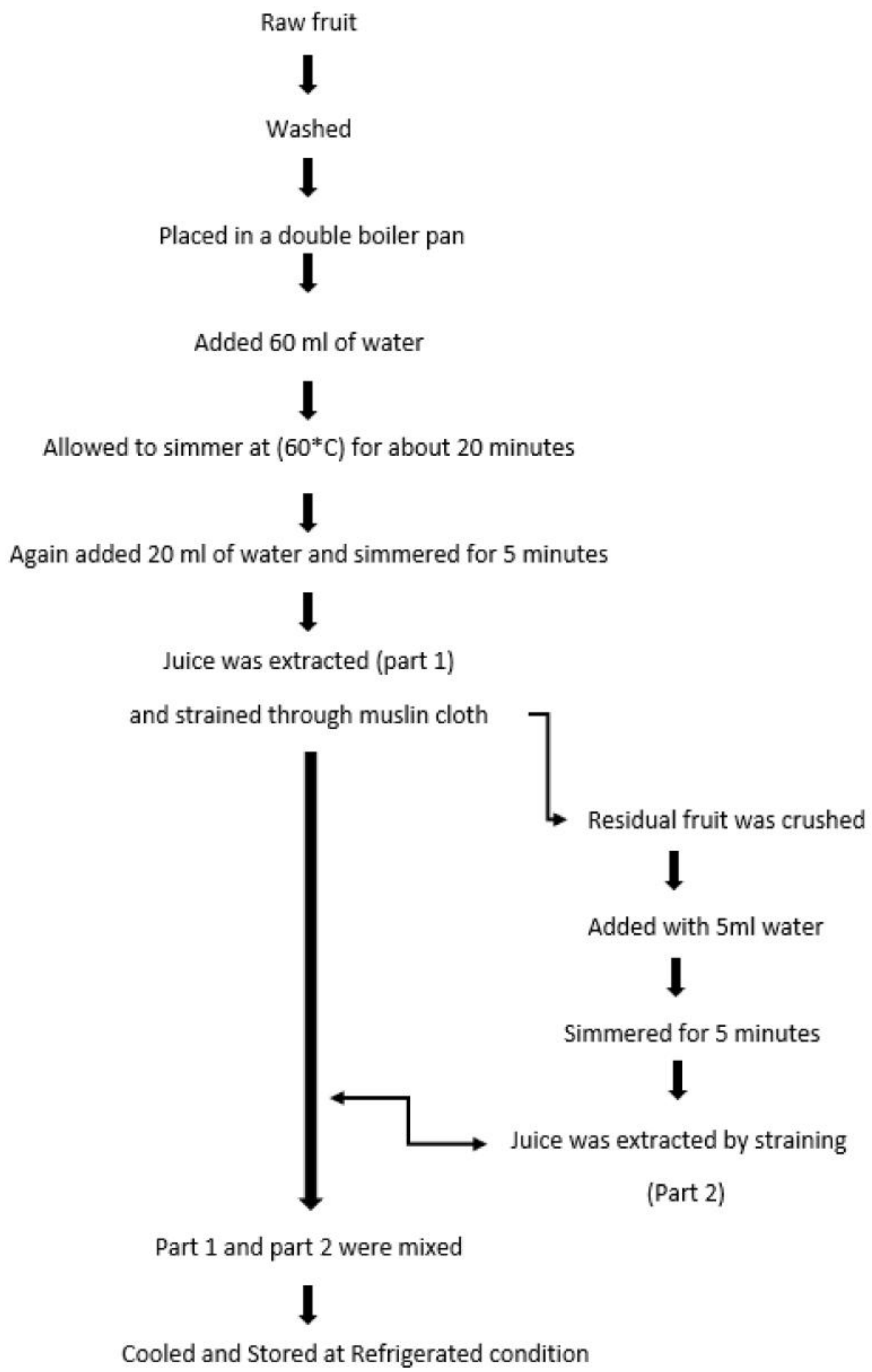


Figure 4: Preparation of Fruit Juice-TE4

Raw fruit

↓

Washed

↓

Water was added at the bottom of the steamer

↓

A clean empty vessel was placed over the water for collection of the extracted juice

↓

A perforated container filled with the fruits was placed over the empty vessel

↓

The steamer was closed with a lid

↓

Heated for about 1 hour at low flame

↓

The juice was extracted in empty vessel after 1 hour

↓

Cooled at room temperature

↓

Stored at refrigerator condition

Figure 5: Pomegranate Fruit Juices

Figure 6: Watermelon Fruit Juices

Figure 7: Orange Fruit Juices

Extraction Analysis (Rosnah Shamsudin, 2015)

Juice Yield

The percentage of juice yield is the amount of juice extracted from the amount of pulp taken for extraction of the juice.

$$Juice\ yield\ \% = \frac{Weight\ of\ juice}{weight\ of\ pulp} \times 100$$

Extrcation Efficiency

The percentage of extraction efficiency of the method used for extraction is determined from total amount juice extracted and the amount of residual waste.

$$Extraction\ efficiency\ \% = \frac{Weight\ of\ the\ juice\ extracted}{weight\ of\ the\ juice\ extracted + weight\ of\ the\ residual\ waste} \times 100$$

Physio-Chemical Analysis

The pH of the fruit juice samples was measured with a glass-electrode digital pH meter and titratable acidity of the samples were analysed against alkali (0.1 N sodium hydroxide), the results were expressed in terms of tartaric acid. The total soluble solids content was determined using a digital refractometer and reducing and total sugars were also analysed for the same fruit samples. The vitamin C content of the fruit juice samples were analysed using 2, 6 indophenol dye and the colour intensity, tint and turbidity were analysed using spectrophotometric methods.

Microbial Analysis

The microbial analysis were done using total plate count which was analysed for 1st day and 10th day of the sample fruit juice samples.

Organoleptic Analysis (Lee, 2006)

A sensorial quality analysis were conducted with 10 semi-trained panellist of fruit juices extracted using thermal treatment. Experiment was conducted using quantitative descriptive analysis to assess the quality of thermally extracted fruit juice. The samples were randomly coded and placed before panellist. Sensorial attributes were evaluated for colour, flavour, taste and odour of the sample in terms of scale 0-10, where 0 cm indicates negative attribute and 10 cm indicates positive attribute

RESULTS AND DISCUSSION

Extraction Analysis

Juice Yield and Extraction Efficiency

The extraction analysis on juice yield/extraction efficiency of pomegranate fruit juice revealed that TE1 (146%)/(100%) and TE2 (163%)/(88.34%) samples showed greater yield compared to other extraction methods. The thermal osmotic extraction method TE1 samples showed greater extraction efficiency on thermal treatment compared to other extraction methods. Similarly, results were showed on juice yield and extraction efficiency of thermally extracted watermelon fruit juices TE1 (147.5%)/(100%) and TE2 (112%)/(88.88%) and orange fruit juices TE1 (148%)/(100%) and TE2 (122.5%)/(90.07%).

This shows that thermal osmotic extraction and simmering method of extraction resulted in a higher rate of juice yield and extraction efficiency for all the three fruits.

Table 1: Juice Yield and Extraction Efficiency

Juice Yield				
Sample	**C**	**TE1**	**TE2**	**TE3**
Pomegranate	54.5	146	163	51
Watermelon	82	147.5	112	59
Orange	69.5	148	122.5	59.5
Extraction Efficiency				
Samples	**C**	**TE1**	**TE2**	**TE3**
Pomegranate	78.4	100	88.34	51
Watermelon	93.18	100	88.88	65.92
Orange	82.73	100	90.07	65.02

Physico-Chemical Characteristic Analysis of Extracted Fruit Juices

pH

The physico-chemical properties- pH of all the three fruit juices evealed that TE3 sample showed lesser pH than other extraction methods. It was observed that there was significant ($p<0.05$) change in pH between extraction methods in all the three fruit juices. There was increase in pH for Control, TE1, TE2, and TE3 samples on storage.

Titratable Acidity

The titratable acidity of the pomegranate fruit juice for TE3 sample seems to be higher compared to control, TE1 and TE2 samples. Similarly, observational results were observed for watermelon fruit juices and orange fruit juices on thermal treatment.

Figure 8: Percentage of Juice Yield

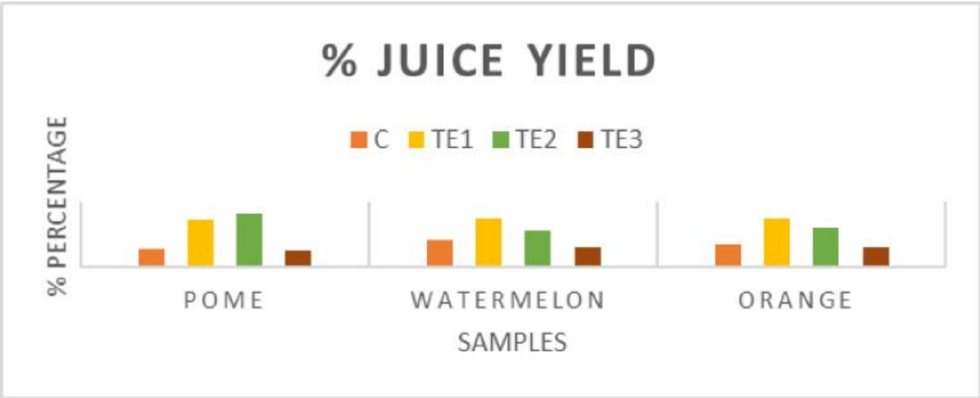


Figure 9: Percentage of Extraction Efficiency

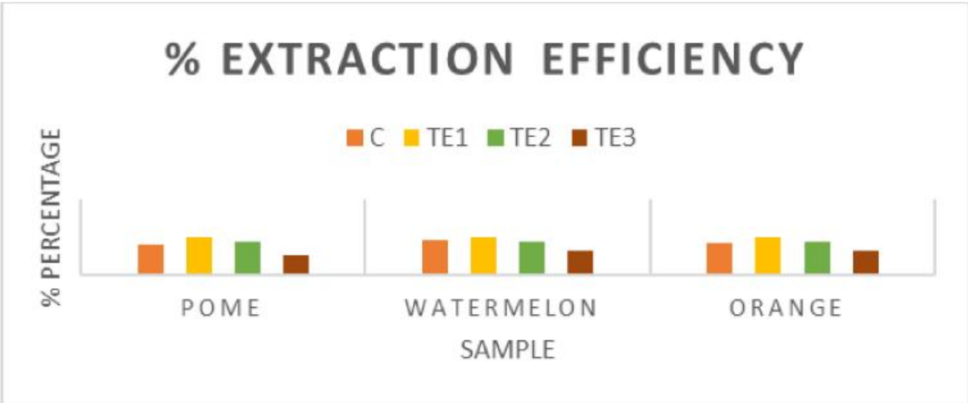
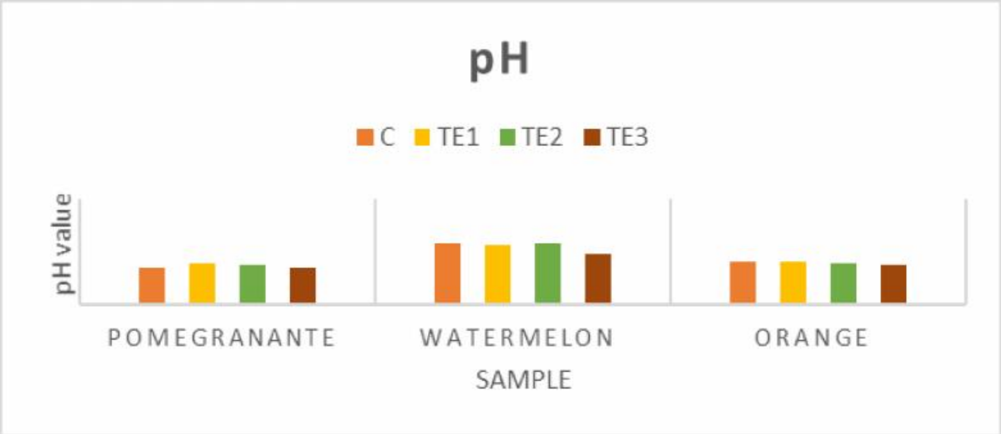


Table 2: pH

	Sample	C	TE1	TE2	TE3
Day 1	Pomegranate	3.460± 0.015	3.973±0.012	3.836± 0.012	3.47±0.06
	Watermelon	5.823±0.006	5.646±0.012	5.810±0.010	4.77±0.02
	Orange	4.103±0.099	4.133±0.012	3.943±0.042	3.77±0.040
Day 10	Sample	C	TE1	TE2	TE3
	Pomegranate	4.126±0.005	4.14±0.005	4.1934±0.005	3.236± 0.015
	Watermelon	6.013±0.005	5.86±0.005	5.92±0.005	4.74±0.156
	Orange	4.13±0.011	4.26±0.015	4.04±0.005	3.453±0.015

Figure 10: pH of Extracted Fruit Juices



There is increase in titratable acidity of fruit juices with decrease in pH of the samples. Hence, It was observed that there was significant ($p<0.05$) change in titratable acidity between extraction methods in all the three fruit juices. There was significant increase of titratable acidity for control TE1, TE2 and TE3 samples on storage period.

Table 3: Titratable Acidity

	Samples	C	TE1	TE2	TE3
Day 1	Pomegranate	0.56±0.138	0.34±0.124	0.51±0.128	1.04±0.07
	Watermelon	0.42±0.073	0.34±0.074	0.29±0.074	1.75±0.075
	Orange	2.71±0.092	2.09±0.071	2.69±0.256	3.74±0.500
Day 10	Samples	C	TE1	TE2	TE3
	Pomegranate	0.86±0.256	0.42±0.073	0.55±0.195	1.57±0.073
	Watermelon	0.59±0.073	0.42±0.073	0.34±0.073	1.83±0.073
	Orange	2.98±0.073	2.17±0.221	2.77±0.266	4.05±0.073

Figure 11: Titratable Acidity of Extracted Fruit Juices

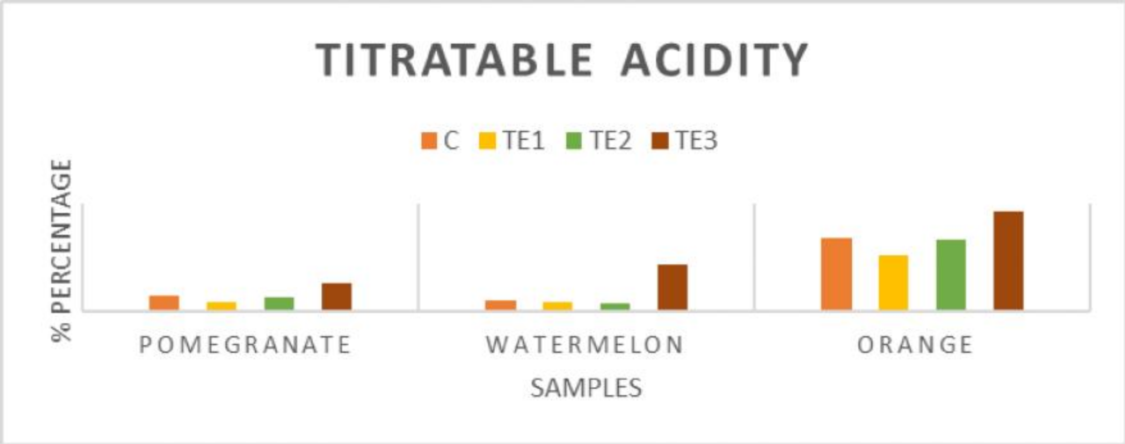
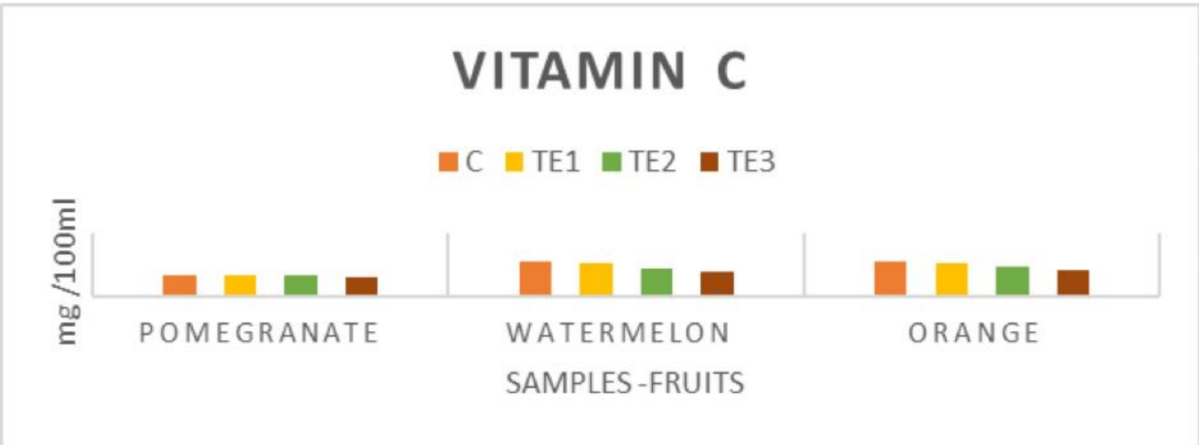


Table 4: Vitamin C

	Samples	C	TE1	TE2	TE3
Day 1	Pomegranate	33.06±0.416	33.3±0.100	32.09±1.83	31.02±1.965
	Watermelon	54.3±1.9	52.93±2.339	43.13±3.23	37.68±1.922
	Orange	54.49±1.28	52.17±1.82	47.9±2.26	39.82±3.94
Day 10	**Samples**	**C**	**TE1**	**TE2**	**TE3**
	Pomegranate	27.71±0.649	27.96±1.114	25.99±1.795	26±1.795
	Watermelon	46.73±1.619	44.17±2.22	33.54±2.32	31.72±2.431
	Orange	50.01±1.179	49.92±1.162	46.81±2.082	38.85±2.653

Figure 12: Vitamin C of Extracted Fruit Juices



Vitamin C

Thermally extracted fruit juices of all three fruits showed negligible difference in vitamin C content. Hence, there is no significant ($p>0.05$) difference observed between extracted fruit juices. But on comparing vitamin C content between storage periods, there was noticeable decrease in vitamin C content in all the three thermally extracted fruit juices on the 10th day.

Total Soluble Solids

The total soluble solids of the pomegranate fruit juice TE1 (sweetened), TE2 and TE3 (unsweetened) samples showed higher brix value than control. Also, similar results were concluded for thermally extracted watermelon fruit juices and orange fruit juices which revealed that on thermal extraction there was increase in total soluble solids.

It was observed that there was no significant ($p>0.05$) difference observed in brix value between extraction methods in all the three fruit juices. But showed trivial increase in brix value during storage period.

Reducing Sugar and Total Sugars

The reducing sugar and total sugar of the all the three fruit juices on thermal extraction methods revealed that TE1 (sweetened), TE2 and TE3 (unsweetened) samples showed higher percentage for reducing sugar and total sugar compared to control.

It was observed that there was no significant ($p>0.05$) difference observed in sugar content between extraction methods in all the three fruit juices. But showed minimal increase in sugar content during storage period.

Table 5: Total Soluble Solids

	Samples	C	TE1	TE2	TE3
Day 1	Pomegranate	9.5±0.152	26.6±1.52	8.6±0.057	11.73±0.057
	Watermelon	7.8±0.115	17.5±0.057	5.8±0.1	9.2±0.057
	Orange	6.5±0.1	19.40.057	5.1±0.057	8.5±0.057
Day 10	Samples	C	TE1	TE2	TE3
	Pomegranate	10.4±0.057	28.8±0.152	8.6±0.057	11.6±0.057
	Watermelon	8.5±0.057	17.4±0.1	5.8±0.057	9.1±0.115
	Orange	6.9±0.057	20.3±0.763	5.4±0.057	8.6±0.057

Figure 13: Total Soluble Solids of Extracted Fruit Juices

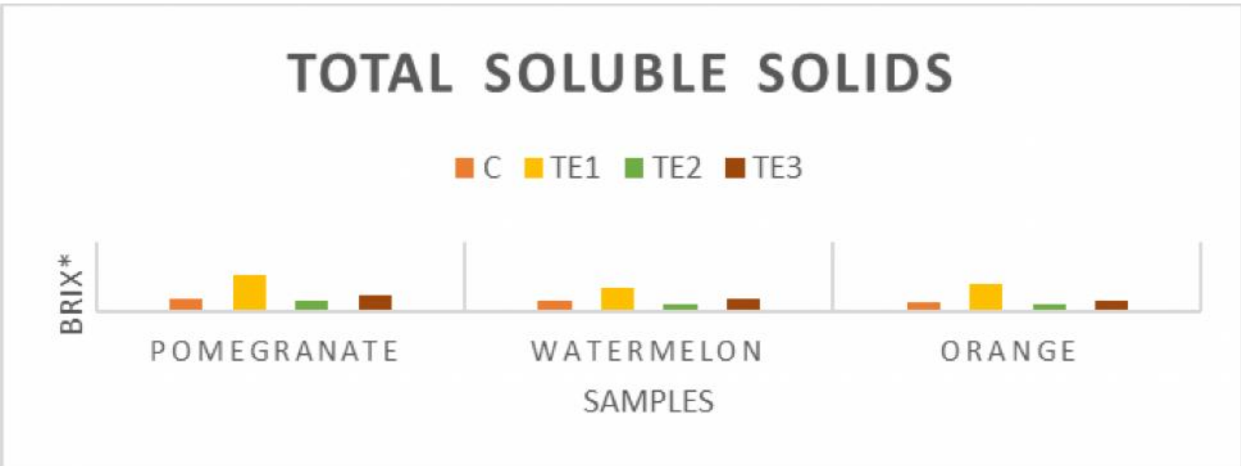


Table 6: Reducing Sugar

	Sample	C	TE1	TE2	TE3
Day 1	Pomegranate	2.586±0.055	26.95±4.76	1.461±0.017	2.993±0.162
	Watermelon	4.906±0.193	10.463±1.677	2.255±0.114	4.642±0.302
	Orange	2.867±0.159	9.457±1.696	2.26±0.076	2.562±0.216
Day 10	**Samples**	**C**	**TE1**	**TE2**	**TE3**
	Pomegranate	2.622±0.015	30.09±2.009	1.458±0.004	2.964±0.040
	Watermelon	4.96±0.057	10.133±1.393	2.296±0.181	4.573±0.048
	Orange	2.876±0.117	9.637±1.502	2.267±0.081	2.553±0.221

Figure 14: Reducing Sugar of Extracted Fruit Juices

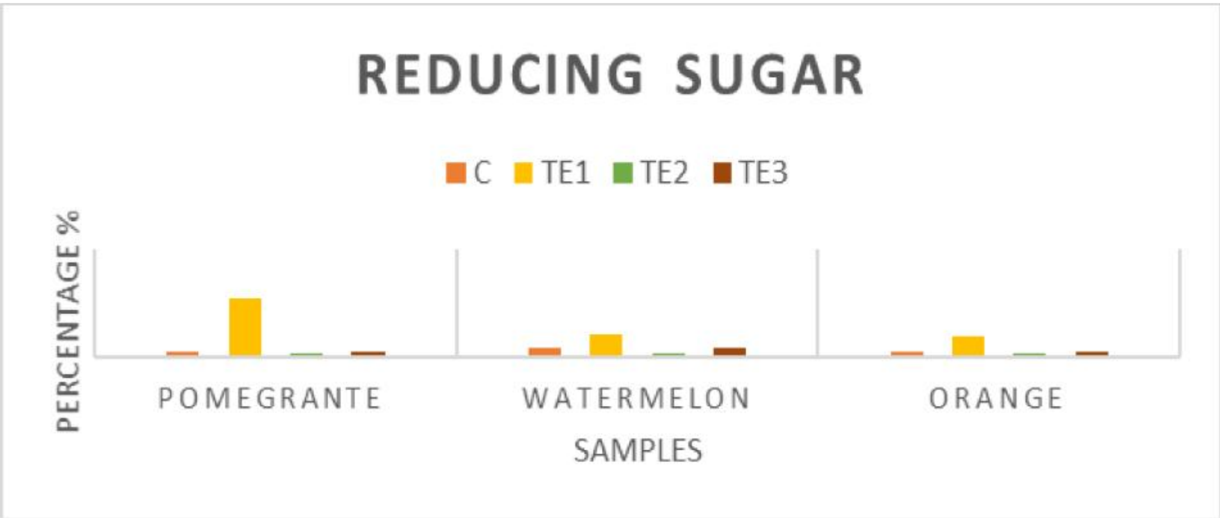
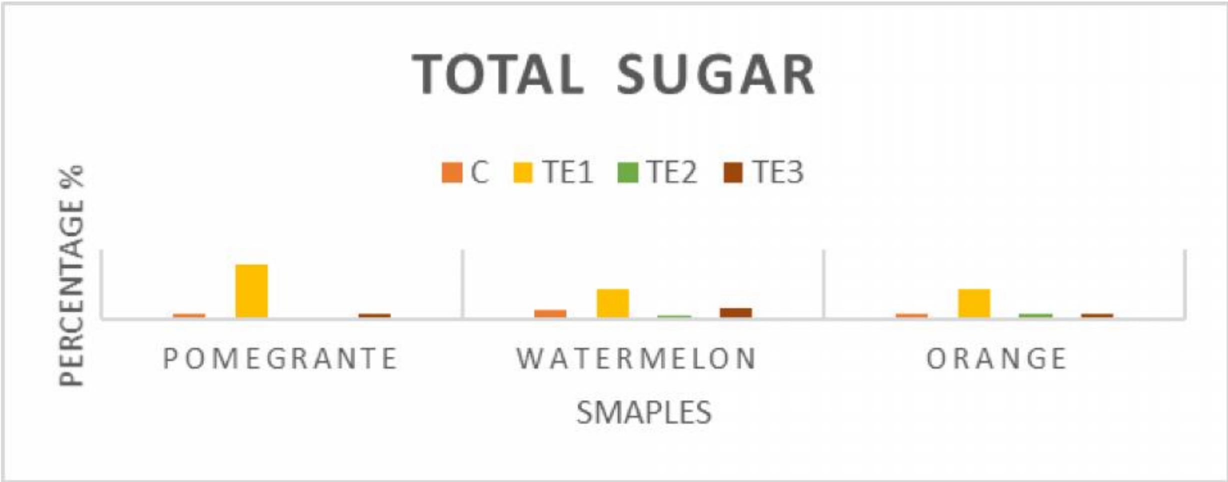


Table 7: Total Sugars

	Sample	C	TE1	TE2	TE3
Day 1	Pomegranate	3.55±0.278	39.118±2.828	1.67±0.028	4.301±0.256
	Watermelon	5.99±0.203	21.11±2.823	2.113±1.114	7.42±1.341
	Orange	4.28±0.280	21.44±0.962	3.54±0.038	3.521±0.051
Day 10	**Sample**	**C**	**TE1**	**TE2**	**TE3**
	Pomegranate	3.88±0.033	40.65±0.434	1.911±0.372	4.24±0.070
	Watermelon	6.088±0.085	15.64±2.029	2.677±0.035	6.216±0.086
	Orange	4.059±0.044	19.33±1.557	3.047±0.216	3.28±0.030

Figure 15: Total Sugars of Extracted Fruit Juices



Colour Intensity

The colour intensity of pomegranate fruit juice for control and TE3 samples were higher, whereas TE1 and TE2 samples showed reduced colour concentration.

Watermelon fruit juices revealed that for control the colour intensity was higher whereas TE1, TE2 and TE3 samples showed reduced colour intensity.

The colour intensity of orange fruit juice for control was higher whereas TE1, TE2 and TE3 samples showed reduced colour concentration.

There was no significant ($p>0.05$) difference observed in colour intensity between all the three fruit juices on thermal extraction methods. But there was significant increase in colour intensity during storage period in all the three fruit juices acquired.

Tint Ratio

The tint ratio of all the three fruit juices revealed that control and TE3 was observed to be higher than other thermal extraction methods.

It was observed that there was no significant ($p>0.05$) difference in tint ratio for all the three fruit juices on thermal extraction. There was noticeable change observed in tint ratio during storage period in all the three fruits.

Turbidity

The pomegranate fruit juice for control showed higher turbidity, whereas TE3 sample showed lesser turbidity than other thermal extraction methods.

The turbidity of watermelon fruit juice for control showed higher individual particles, whereas TE1 and TE3

Table 8: Colour Intensity

	Samples	C	TE1	TE2	TE3
Day 1	Pomegranate	5.531	2.105	2.924	4.793
	Watermelon	5.311	0.887	2.448	2.537
	Orange	4.722	0.911	3.247	4.125
Day 10	Samples	C	TE1	TE2	TE3
	Pomegranate	5.662	2.421	4.532	5.258
	Watermelon	5.504	3.672	3.666	3.506
	Orange	4.65	3.093	3.926	2.052

Figure 16: Colour Intensity of Extracted Fruit Juices

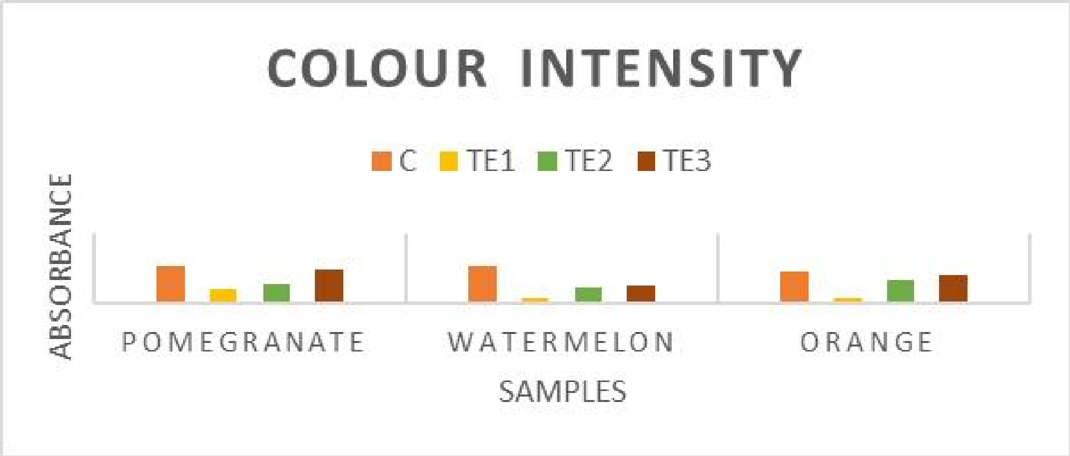


Table 9: Tint Ratio

	Sample	C	TE1	TE2	TE3
Day 1	Pomegranate	0.8393	0.9821	0.7526	1.059
	Watermelon	0.9001	1.077	1.279	1.247
	Orange	1.062	1.7859	1.301	1.586
Day 10	**Sample**	**C**	**TE1**	**TE2**	**TE3**
	Pomegranate	0.8283	0.562	0.8836	0.8718
	Watermelon	0.8544	0.9521	1.003	1.0137
	Orange	1	0.992	1.0608	1.242

Figure 17: Tint of Extracted Fruit Juices

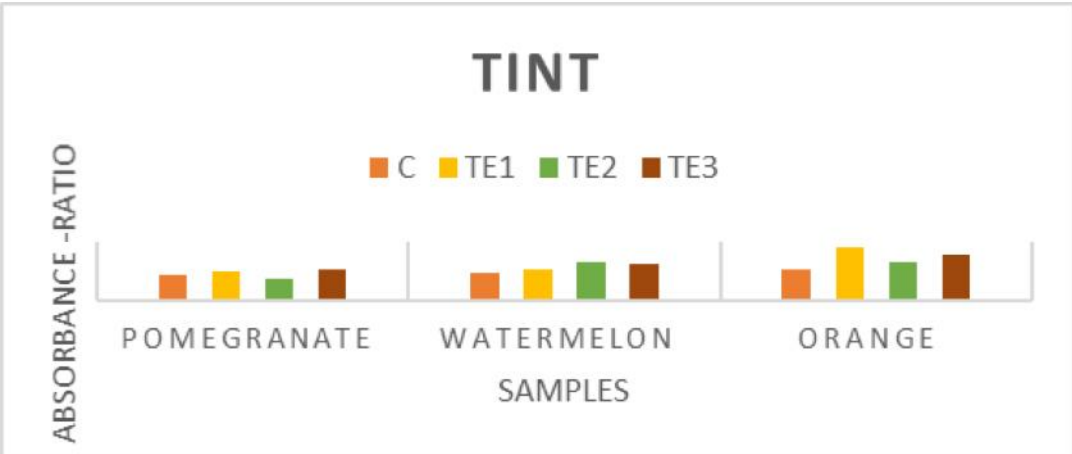
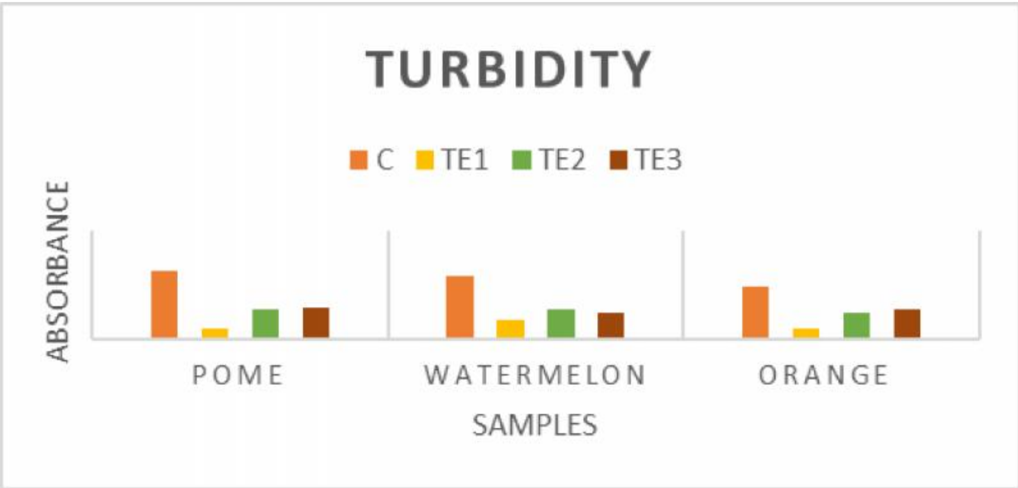


Table 10: Turbidity

	Sample	C	TE1	TE2	TE3
Day 1	Pomegranate	2.519	0.342	1.088	1.156
	Watermelon	2.299	0.695	1.079	0.924
	Orange	1.938	0.351	0.931	1.069
Day 10	**Samples**	**C**	**TE1**	**TE2**	**TE3**
	Pomegranate	2.414	0.476	1.887	1.777
	Watermelon	2.292	1.597	1.313	1.388
	Orange	1.915	1.272	1.514	0.551

Figure 18: Turbidity of Extracted Fruit Juices



samples showed lesser turbidity than other thermal extraction methods.

Higher turbidity for orange fruit juice were observed in control, whereas TE1 and TE2 samples showed lesser turbidity than other thermal extraction methods.

There was no significant ($p>0.05$) difference observed in all the three fruit juices on thermal extraction, whereas significant increase in turbidity was observed during storage period in all the three fruit juices.

Microbial Analysis

Total Plate Count

The microbial load for all the three thermally extracted fruit juices revealed that TE1, TE2 and TE3 samples showed lesser colony formation, whereas Control showed higher colony formation. This showed the effective preservation of thermal methods on extracting fruit juices.

It was observed that there was no significant ($p>0.05$) difference between all the three fruit juices on thermal extraction. But on storage period there was noticeable increase in colony formation in all the three fruit juices.

Organoleptic Analysis

Pomegranate Fruit Juice

The organoleptic properties for pomegranate fruit juice showed that Control and TE1 samples was greatly accepted in terms of colour, flavour, odour and taste whereas TE2 and TE3 samples was soundly accepted only for colour among the semi trained panellist.

Table 11: Total Plate Count

	Samples	C	TE1	TE2	TE3
Day 1	Pomegranate	29×10^{-5}	4×10^{-5}	3×10^{-5}	1×10^{-5}
	Watermelon	30×10^{-5}	12×10^{-5}	3×10^{-5}	2×10^{-5}
	Orange	26×10^{-5}	21×10^{-5}	8×10^{-5}	3×10^{-5}
Day 10	**Samples**	**C**	**TE1**	**TE2**	**TE3**
	Pomegranate	36×10^{-5}	3×10^{-5}	2×10^{-5}	2×10^{-5}
	Watermelon	52×10^{-5}	18×10^{-5}	6×10^{-5}	4×10^{-5}
	Orange	41×10^{-5}	32×10^{-5}	11×10^{-5}	5×10^{-5}

Table 12: Pomegranate Fruit Juice

Samples	Colour	Flavour	Odour	Taste
C	5	8.09	2.1	9.09
TE1	4.7	9	3.45	9.27
TE2	9.2	5.6	7.09	5
TE3	9.5	3.5	7	6.18

Table 13: Watermelon Fruit Juice

Samples	Colour	Flavour	Odour	Taste
C	9.6	9.1	2.9	9.3
TE1	9.4	9.3	4.6	9.3
TE2	5.9	6.6	7.4	9.2
TE3	3.7	4.5	7.5	3.4

Watermelon Fruit Juice

The organoleptic properties for watermelon fruit juice showed that Control and TE1 was greatly accepted in terms of the sensorial attribute whereas, TE2 and TE3 were fairly accepted in terms of colour and flavour among the panellists.

Orange Fruit Juice

The organoleptic properties for orange fruit juice showed that Control was greatly accepted in terms of all the sensorial attributes whereas, TE1 was reasonably accepted only for flavour and taste, TE2 and TE3 were fairly accepted

Figure 19: Sensory Analysis of Pomegranate Fruit Juices

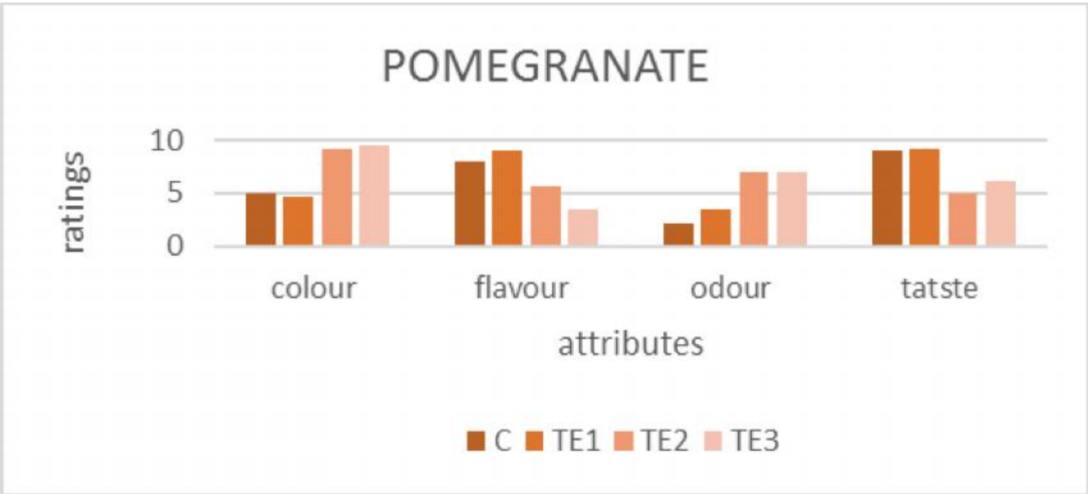


Figure 20: Sensory Analysis of Watermelon Fruit Juices

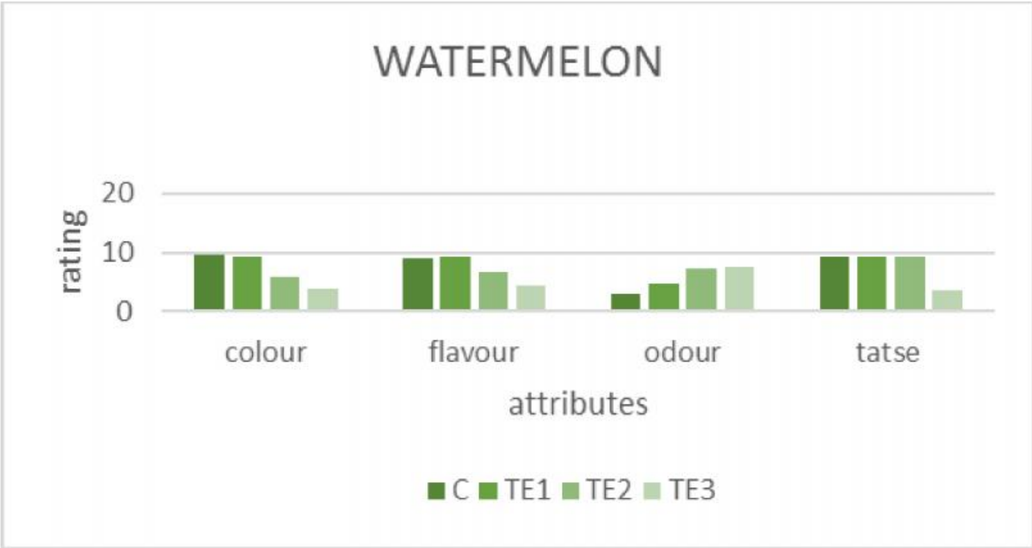


Figure 21: Sensory Analysis of Orange Fruit Juices

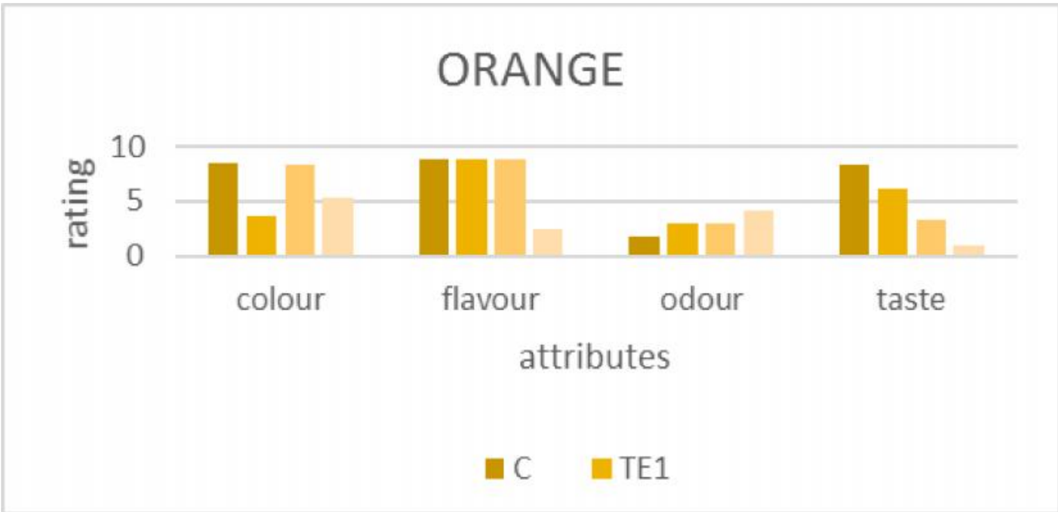


Table 14: Orange Fruit Juice

Sample	Colour	Flavour	Odour	Taste
C	8.5	8.8	1.8	8.4
TE1	3.7	8.8	3	6.1
TE2	8.3	8.8	2.9	3.3
TE3	5.3	2.5	4.2	0.9

in terms of colour and flavour among the semi trained panellist.

There was no significant ($p>0.05$) difference observed between attributes of thermally extracted fruit juices.

CONCLUSION

The study on effect of thermal extraction methods on physico-chemical characteristics of fruit juices, the study revealed that thermally extracted fruit juices have minimal impact on the physico-chemical characteristics of total soluble solids, reducing and total sugars, vitamin C, colour intensity, tint and turbidity, but had significant change in pH, Titratable acidity, and microbial load of thermally extracted fruit juices. During storage period of 10 days, the physico-chemical and microbial properties of the extracted fruit juices of all the three fruits differed significantly.

Thus from the study it could be summarised that thermal methods of fruit juice extraction could be effective in terms of juice yield, extraction efficiency and preservation of fruit juices. Overall acceptability of these fruit juices were good in terms of colour, flavour, odour and taste.

REFERENCES

- Aaby K W R (2007), "Polyphenol Composition and Antioxidant Activity in Strawberry Purees: Impact of Achene Level and Storage", *Journal of Agricultural Food Chemistry,* Vol. 55, No. 13, pp. 5156-5166.
- Arancibia-Avila P and J-A-G-I N (2012), "The Influence of Different Time Durations of Thermal Processing on Berries Quality", *Food Control*, Vol. 26, pp. 587-593.
- Aurélie Cendres A and F-F B (2011), "An Innovative Process for Extraction of Fruit Juice Using Microwave Heating", *Lwt-Food Science and Technology*,| pp. 1035-1041.
- Ayala-Zavala J F and S-A W (2005 and 2007), "Methyl Jasmonate in Conjunction with Ethanol Treatment Increases Antioxidant Capacity, Volatile Compounds and Postharvest Life of Strawberry Fruit", *Eur Food Res Technol*, Vol. 221, No. 6, pp. 731-738.
- Balla C F J (2006), *Minimally Processed Fruits and Fruit Products and their Microbiological Safety, Food Processing*.
- Bliss R (2002), "Watermelon Shows its Lycopene Stripes", Retrieved from USDA Department of Agriculture, https://www.ars.usda.gov/news-events/news/research-news/2002/watermelon-shows-its-lycopene-stripes/ (accessed on June 4, 2009).
- Bothaina M, Youssef A and A-S (2002), "Combined Effect of Steaming and Gamma Irradiation on the Quality of Mango Pulp Stored at Refrigerated Temperature", *Food Research International*, pp. 1-13.
- Bridle T (1997), "Anthocyaninas Natural Food Colourant-Selected Food Ascpects", *Food Chemistry,* Vol. 58, pp. 103-109.
- Bung P (2013), "Indian Fruit Processing Industry: Import and Export Analysis", pp. 72-86, *A Journal of M P Birla*, Institute of Management, Associate Bharatiya Vidya Bhavan, Bangalore.
- Burri J B C (2009), "Food Processing and Nutritional Aspects", in Stadle R H and Lineback D R (Eds.), *Process-Induced Food Toxicants: Occurrence, Formation, Mitigation, and Health Risks*, Wiley, Hoboken.
- Butterfield H M (1963), "History of Subtropical Fruits and Nuts", *Agricultural Experimental Station*, University of Califonia.
- D M (2001), "Uses and Nutritional Composition", *Internatinal Food Research Journal*, Retrived July 8, 2009.
- Deepika Chandra M K (2017), "Development and Quality Analysis of Watermelon Blend with Bitter Gourdginger Juice During Storage", *International Journal of Chemical Studies*, pp. 1420-1424.
- Dike O and Ukuku D J (2017), "Appearance and Overall Acceptability of Fresh-Cut Cantaloupe Pieces from Whole Melon Treated with Wet Steam Process", *Lwt-Food Science and Technology*.
- Facciola S C (1990), *A Source Book of Edible Plants*, pp. 166-167, Kampong Publications.
- Francis F (1995), "Quality as Influence by Colour", *Food Quality and Preferences*, Vol. 6, No. 3, pp. 149-155.
- Gadallah M G E I (2012), "Effect of Different Heating Methods on Quality Charachteristic of Pomegranate Juice Concentrate", *Egypt Journal of Food Science*, Vol. 40, pp. 1-14.
- Ghosh R P (2011), "Effect of Thermal Treatment on Ascorbic Acid Content of Pomegranate Juice", *Indian Journal of Biotechnology*, pp. 309-311.
- Grajek W O A (2010), "The Influence of Food Processing and Home Cooking on the Antioxidant Stability in Foods", in C E Smith (Ed.), *J Functional Food Product Development*, Blackwell, Ames.
- Harry M A B (1963), "History of Subtropical Fruits and Nuts in California", *Agricultural Experiment Station*, University of California.

- Howard La W A (1999), "Beta-Carotene and Ascorbic Acid Retention in Fresh and Processed Vegetables", *Journal of Food Science*, Vol. 64, No. 5, pp. 929-936.
- Hrs Heat Exchangers (August 17, 2016), Retrieved from Thermal Treatment in Food Industry-Hrs Heat Exchangers Ltd., https://www.hrs-heatexchangers.com/resource/thermal-treatment-food-industry/
- Ijah U J J and H A (2015), "Microbiological and Some Sensory Attributes of Watermelon Juice and Watermelon-Orange Juice Mix", *Journal of Food Resources Science*, pp. 49-61.
- Ingrid Aguilo-Aguayo R and S-F-B (2010), "Colour and Viscosity of Watermelon Juice Treated by High Intensity Plused Electric Fields or Heat", *Innovative Food Science and Emerging Technology*, pp. 299-305.
- J D and D (1986), "Preservative Systems in Foods, Antioxidants and Antimicrobial Agents", *Journal of Science-Food Agriculture*, Vol. 93, pp. 94-136.
- Julitta Borowaka M K (2003), "Effect of Hydrothermal Processing on Carrot Carotenoids Changes and Interaction with Dietry Fibers", *Food Nahrung*, pp. 46-48.
- Kano Y (2006), "Effect of Heating Fruit on Cell Size and Sugar Accumulation in Melon Fruit", *Horiculture Science*, pp. 1431-1434.
- Lara Alexander A and B D (2017), "Modifying the Sensory Profile of Green Honeybush (*Cyclopia Maculata*) Herbal Tea Through Steam Treatment", *Lwt - Food Science and Technology*, pp. 49-57.
- Lee S Y (1997), "Effects of Brix, Processing Techniques and Storage Temperature on the Quality of Carambola Fruit Cordials", *Food Chemistry*, Vol. 59, pp. 27-32.
- Lee W C and S H (2006), "Optimizing Condition for Hotwater Extraction of Banana Juice Using Response Surface Methodology", *Journal of Food Engineering*, Vol. 75, pp. 473-479.
- Leong S Y and O I (2012), "Effects of Processing on Anthocyanins, Carotenoids and Vitamin C in Summer Fruits and Vegetables", *Food Chemistry*, Vol. 133, pp. 1577-1587.
- Maja Strbac M S (2010), "Consumption and Industrial Demand for Fruit Juicand Concntrate", *EU*, pp. 589-597.
- Mar Villamiel M D (1998), "Assessment of the Thermal Treatment of Orange Juice During Continuous Microwave and Conventional Heating", *Journal of Science Food and Agricultutral*, pp. 196-200.
- Morton J F (1987), "Fruits of Warm Climate", pp. 352-355, Creative Resource System, Inc.
- Mukesh Yadav S J (2009), "Biological and Medicinal Properties of Grapes and Their Bioactive Constituents: An Update", *Journal of Medicinal Food*, Vol. 12, No. 3, pp. 473-484.
- Pengo-Kong Wong S Y (2003), "Optimization of Hot Water Extraction of Roselle Juice Using Response Surface Methodology: A Comparitive Study with Other Extraction Methods", *Journal of the Science of Food and Agriculture*, Vol. 83, pp. 1273-1278.
- Popenoe W (1920), *Manual of Tropical and Subtropical Fruits*, Facsimile of the Edition, Hafner Press.
- Richardson P (April 24, 2001), *Thermal Technologies in Food Processing*, Woodhead Publishing.
- S R (2001), *Hand Book of Analysis and Quality for Fruits and Vegetable Products*, 2nd Edition, Tata Mcgraw-Hill, New Delhi, India.
- Sheiraz A I and Bittar S P-I (2013), "An Innovative Grape Juice Enriched in Polyphenols by Microwave-Assisted Extraction", *Food Chemistry*, pp. 3268-3272.
- Shellhammer T H U (2001), "High Pressure Processing of Orange Juice: Combination Treatment and Shelf Life Study", *Journal of Food Engineering and Physical Properties*, pp. 332-336.
- Sin H N S Y (2006), "Optimization of Hot Water Extraction for Sapodilla Juice Using Response Surface Methodology", *Journal of Food Engineering*, Vol. 74, pp. 352-358.
- Tiwari U and C E (2013), "Factors Influencing Levels of Phytochemicals in Selected Fruit and Vegetables During Pre-and Post-Harvest Food Processing Operations", *Food Resarch Internatinal*, Vol. 50, pp. 497-506.
- Vinayak V and Kedage J C (January 2007), "A Study of Antioxidant Properties of Some Varieties of Grapes (*Vitis Vinifera L.*)", *Critical Reviews in Food Science and Nutrition*, pp. 175-185.

IJFANS

International Journal of Food
And Nutritional Sciences