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Effect of Different Drying Methods on the Nutritional Quality of Carica Papaya Leaf during Shelf Life

J.Saritha[1*], Kavitha Waghray[2]

[1] Food Technology, University College of Technology, Osmania University, Hyderabad, Telangana, India.

[2] Dean, Food Technology & Nutrition, Loyola Academy, Old Alwal, Secunderabad, Telangana, India..

Email- [1] sarithajukuri83@gmail.com

ABSTRACT:

Background: Papaya leaves are botanically classified as Carica papaya, they are actually beneficial for health. Papaya leaves have several vitamins and minerals in significant amounts, it is low in calories. The leaves have been researched for its medicinal uses. The leaves also contain active components such as papain, chymopapain, ascorbic acid, flavonoids, cyanogenic glucosides that increase the total antioxidant power in blood and reduce lipid peroxidation level. Papaya leaves also contain vitamins and minerals (calcium, potassium, iron). The study was aimed to achieve 2 objectives, the suitable drying method without affecting the nutritional quality of the product and nutrient content in the dried product.

Methods: The study was conducted in three drying methods to compare the results and come out with the best and most suitable drying method. The studied drying methods are (a) Traditional drying method i.e., tray drying, (b) Microwave drying, © Microwave Vacuum drying. These drying techniques were conducted on Carica papaya leaves, were analyzed nutritionally and the shelf life studies have been conducted.

Results: The experimental results showed that the best nutrition retention in Carica papaya leaves operated by Microwave Vacuum Drying at 500mmHg Vacuum pressure and 40% (360Watts) microwave power level and Nutrient contents are Calcium: 879.35±10 mg per 100g, Vitamin C: 60 ± 5 mg per 100g, Iron:24.337 ±3 mg per 100g, Potassium 45.716 mg ± 5 mg and β Carotene: 279.884±10 µg per 100g, by ANOVA it is concluded that Iron, Potassium and β carotene found significant Pvalue is $P \leq 0.05$, Vitamin C and Calcium found insignificant $P \geq 0.05$.

Keywords: Carica Papaya leaves, Tray Drying, Microwave Drying, Microwave Vacuum Drying, Papaya leaves nutrition, Drying methods.

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INTRODUCTION:

Carica papaya belongs to the family of Caricaceae and many species from Caricaceae have been used as a remedy for different diseases (Alabi et al., 2012) . It is a herbaceous succulent plant with self supporting stems. The leaves increase appetite, improve digestion and can be used as an additive to tenderize meat as well (Aravind et al., 2013). Carica papaya leaf was compared to few other plants for its efficacy on malaria treatment (Avwioro, 2010). In comparison to other medicinal plants, Carica papaya leaves had a comparatively higher composition of tannins, terpenoids and phenolic acids (Fasola and Iyamah, 2014). Other than malaria, papaya leaves were used for the curing of dengue.

Papaya is a powerhouse of nutrients and it is available throughout the year. It is a rich source of powerful antioxidants (Vitamin C), minerals (Iron, Potassium and Calcium), and fiber. Papaya leaves have several Vitamins and Minerals in significant amounts, it is low in Calories,and has an enzyme that is useful in tenderizing meat and for treatment of indigestion (Herbst S, 2001). The leaves have been researched for its medicinal uses and has been documented in literature for its use by natives of various parts of the world for its anti-inflammatory, antitumour, anti-diabetic effects among others. Recently the haemostatic property and beneficial effects of Carica Papaya leaves in curing dengue infected patients has been reported (Ahmad, Fazal, Ayaz et al., 2011).

The leaves also contain active components such as papain, chymopapain, cystain, ascorbic acid, flavonoids, cynogenic glycosides that increases the antioxidant power in blood and reduce lipid preoxidation level (Seigler, Pauli, Nahrstedt et al., 2002).

In many agricultural countries, large quantities of food products are dried to improve shelf life, reduce packaging costs, lower shipping weights, enhance appearance, encapsulate original flavour and maintain nutritional value. In this regard, the goals of drying process research in the food industry may be classified in three groups as follows:

(a) Economic considerations,

(b) Environmental concerns and

(c) Product quality aspects.

Though the primary objective of food drying is preservation, depending on the drying mechanisms, the raw material may end up a completely different material with significant variation in product quality (Chou and Chua, 2001).

Drying is an energy intensive operation of some industrial significance. In most industrialized countries, the energy used in drying accounts for 7-15% of the nation`s industrial energy, often with relatively low thermal efficiencies ranging from 25% to 50% (Chua, Mujumdar, Hawalder, Chou, Ho, 2001) (Dincer, 1998). The most important aspect of drying technology is the mathematical modelling of the drying processes and equipment. Its purpose is to allow

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design engineers to choose the most suitable operating conditions and then size the drying equipment and drying chamber accordingly to meet desired operating conditions. The principle of modelling is based on having a set of mathematical equations that can adequately characterize the system. In particular, the solution of these equations must allow prediction of the process parameters as a function of time at any point in the dryer based only on the initial conditions (Hawalder, Chou and Chua, 1997) (Strumillo and Kudra,1986).

In recent years, the drying behaviour of different products has been studied by many investigators. Some products studied are as follows: Sultana Grape (Yaldiz, Ertekin and Uzun, 2001), Banana (Quriroz, Nebra, 2001), Apricot (Togrul, Pehlivan, 2002), Seedless Grape, Fig, Green pea, Tomato and Onion (El-Sebaii, Aboul-Enein, Ramadan, EI-Gohary, 2002), Pistachio (Midilli, Kucuk, 2003), Potato slice (Akpinar, Midilli, Bicer, 2003), Pumpkin slice (Akpinar, Midilli and Bicer, 2003). There are, however, few works on the drying process of Carica papaya leaves in the literature (Yagcioglu, Degirmencioglu, Cagatay, 1999).

The papaya leaves have many bioactive compounds and these compounds can deteriorate fast, when they remain in their original form. Powdered products have longer shelf life and are easier to handle, since actual form and size are reduced to a greater extent. Bioactive compounds are easily affected by the processing methods, therefore, there is a need for the minimization of processing loss, the effect of a specific drying method on the preservation of raw quality cannot be predicted, as it is dependent on the type of chemical compounds present and the type of plant. Therefore, this research was carried out to study the effect of different drying methods on the nutritional properties and shelf-life properties of papaya leaf powder.

Drying is an ancient technique for the preservation of fruits and vegetables. It stops the biochemical changes in perishable plant materials by reducing the moisture content of the material. Tray drying and Microwave drying are common drying methods for fresh plant materials. In addition, the advancement in science and technology resulted in improved drying methods for better quality of dried products, such as Microwave Vacuum drying. Conventional drying can reduce the moisture content of fresh fruits and vegetables but has the risk of quality degradation and takes long drying times. In order to prevent significant quality degradation, microwave vacuum drying is introduced to replace the conventional drying.

MATERIALS AND METHODS:

The Carica Papaya leaves were brought from a local market and were washed in a jet of water. These leaves were surface dried in air so that the water goes off. Then the leaves were used for drying (Period of work: April 2020 to March 2022, University College of Technology, Osmania University).

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The drying was conducted in three drying methods namely Tray Drying (50°C,60°C,70°C at constant air velocity of 1m/s); Microwave Drying (180 W, 270W, 360W); Microwave Vacuum Drying (Vacuum pressures of 400mmHg, 500mmHg, 600mmHg).

The dried leaves were powdered, sieved and used for further nutritional analysis. The nutritional analysis was performed by following the AOAC methods.

Statistical analysis:

Data were analyzed statistically using the statistical software R (windows version 2.13.1). All results were measures triplicate. Results were expressed as mean values with standard deviation (±SD). DMRT (Duncan Multiple Range Test) was performed to evaluate the significance of difference between mean values at p level of 5%.

RESULTS AND DISCUSSION:

The results of the analysis have been given along with mean by ANOVA technique in the form of tables and graphs. The relation is given between the nutritional parameter and the period of shelf life of the sample.

Table 1 : Nutrient analysis of Fresh Carica Papaya leaves 100g:

Moisture %	Vitamin C mg/100g	Calcium mg /100g	Iron mg /100g	Potassium mg/100g	Total Carotenoids mg/100g
79%	68.59	976.32	13.27	65.38	286.4

Table 2 : Shelf life analysis of Vitamin C in mg per 100g +/- Standard deviation :

Sample	0th day (Result±SD)	45th day (Result±SD)	90th day (Result±SD)	135th day (Result±SD)	180th day (Result±SD)
TD @ 50°C	51.9230±7.43	47.5895±4.93	44.2356±4.36	40.2159±2.36	37.8569±2.65
60°C	43.75±0.57	41.2356±1.07	38.2354±1.64	34.5687±3.64	31.5468±4.35
70°C	39.1304±5.57	36.5684±6.07	33.2568±6.64	30.2365±7.64	27.5648±8.35
MWD @ 360W/g	30±14.57	27.5648±15.07	24.5697±15.64	21.4568±13.64	19.5468±16.35
270W/g	58.6956±14.43	55.2648±12.93	52.0321±10.36	50.2365±12.36	48.6548±13.65
180W/g	50±5.43	47.2564±4.93	44.2135±4.36	42.1569±4.36	40.5649±4.65
MWVD @ 400mmHg @ 360W/g	42.8571±2.57	40.2315±2.07	38.5648±1.64	36.5648±1.64	33.5468±2.35
270W/g	45.652±1.43	43.2156±0.93	42.5689±2.36	40.2568±2.36	38.5467±2.65

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180W/g	36±8.57	33.9845±8.07	31.2658±8.64	30.2156±7.64	28.4567±7.35
MWVD @ 500mmHg @ 360W/g	60±15.43	58.0213±15.93	56.0213±16.36	54.1568±16.36	52.1548±16.65
270W/g	42±2.57	40.2156±2.07	39.2354±0.64	38.5648±0.36	37.9546±2.65
180W/g	54.5454±9.43	52.1564±9.93	50.1236±10.36	48.5684±10.36	45.6849±10.65
MWVD @ 600mmHg @ 360W/g	29.4117±15.57	27.5468±15.07	25.3698±14.64	22.5648±15.64	20.1564±15.35
270W/g	40.9090±3.57	39.1235±3.07	37.5648±2.64	33.4578±4.64	30.1546±5.35
180W/g	52.1739±7.43	50.2135±7.93	48.1236±8.36	45.8795±8.36	44.5684±8.65
Mean	**44.57**	**42.07**	**39.64**	**37.64**	**35.35**

Table 3: Shelf life analysis of Calcium in mg per 100g +/- Standard deviation value:

Sample	0th day	45th day	90th day	135th day	180th day
TD @ 50°C	852.45±127.14	823.65±131.47	794.51±134.47	768.52±128.6	725.68±122.97
60°C	766.32±41.14	735.68±43.47	706.23±46.47	677.41±37.6	542.58±61.03
70°C	652.45±72.86	624.58±68.53	592.31±67.53	569.63±69.4	524.56±79.03
MWD @ 360W/g	568.55±156.86	516.84±175.53	485.23±174.53	452.58±187.4	421.25±182.03
270W/g	675.78±48.86	625.46±67.53	578.23±81.53	544.56±95.4	512.46±91.03
180W/g	648.32±76.86	594.58±98.53	542.31±117.53	513.69±125.4	484.56±119.03
MWVD @ 400mmHg @ 360W/g	633.34±91.86	602.35±90.53	576.21±83.53	542.31±97.4	514.56±89.03
270W/g	648.92±75.86	614.57±78.53	548.58±111.53	551.47±88.4	522.13±81.03
180W/g	611.09±113.86	584.57±108.53	552.46±107.53	524.86±114.4	4932.65±110.03
MWVD @ 500mmHg @ 360W/g	879.35±154.14	859.89±167.57	825.78±166.47	815.28±175.6	798.25±194.97
270W/g	840.23±115.14	831.25±138.47	825.47±165.47	819.87±180.6	810.12±206.97
180W/g	868.11±143.14	845.67±153.47	824.56±164.47	812.64±172.6	802.56±198.97
MWVD @ 600mmHg @ 360W/g	555.45±169.86	514.56±178.53	485.67±173.53	472.56±167.4	422.56±181.03
270W/g	823.45±98.14	792.35±99.47	765.21±105.47	749.89±110.6	724.58±120.97

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180W/g	853.32±128.14	825.48±132.47	794.56±134.47	778.97±139.6	752.56±148.97
Mean	**724.86**	**692.53**	**659.53**	**639.40**	**603.03**

Table 4: Shelf life analysis of Iron in mg per 100g +/- Standard deviation value:

Sample	0th day (Result±SD)	45th day (Result±SD)	90th day (Result±SD)	135th day (Result±SD)	180th day (Result±SD)
TD @ 50°C	18.167±2.93	9.167±5.53	6.327±6.2	5.234±5.46	3.215±5.73
60°C	25.579±4.07	12.484±2.33	9.284±3.2	8.452±2.46	6.587±2.73
70°C	19.263±1.93	9.263±5.33	7.632±4.2	5.264±5.46	3.258±5.73
MWD @ 360W/g	21.453±0.07	13.453±1.33	11.245±1.2	10.123±0.46	9.523±0.27
270W/g	20.285±0.93	12.205±2.33	10.256±2.2	9.899±0.46	7.568±1.73
180W/g	23.534±2.07	15.534±0.67	12.587±0.2	10.258±0.46	8.562±0.73
MWVD @ 400mmHg @ 360W/g	19.518±1.93	14.518±0.33	11.256±1.2	10.589±0.46	9.854±1.27
270Wg	23.023±2.07	17.736±3.67	15.468±2.8	14.586±3.54	13.256±4.27
180W/g	21.088±0.07	16.088±1.67	14.897±2.8	13.589±2.54	11.546±2.27
MWVD @ 500mmHg @ 360W/g	24.337±3.07	20.337±5.67	18.564±5.8	16.258±5.54	12.156±3.27
270W/g	22.585±1.07	18.585±3.67	16.984±4.8	13.567±2.54	12.989±4.27
180W/g	20.723±0.07	16.226±1.67	14.568±1.8	11.258±0.54	10.123±1.27
MWVD @ 600mmHg @ 360W/g	22.147±1.07	17.109±2.67	15.012±2.8	12.545±1.54	9.878±1.27
270W/g	17.875±2.93	12.875±1.33	11.654±1.2	10.254±0.46	8.575±0.73
180W/g	17.912±2.93	12.912±1.33	11.089±1.2	9.875±0.46	7.895±0.73
Mean	**20.93**	**14.33**	**12.20**	**10.46**	**8.73**

Table 5 : Shelf life analysis of Potassium in mg per 100g +/- Standard deviation value:

Sample	0th day (Result±SD)	45th day (Result±SD)	90th day (Result±SD)	135th day (Result±SD)	180th day (Result±SD)
TD @ 50°C	58.925±17.34	52.648±16.2	42.564±10.2	25.486±1.26	8.545±12.73
60°C	52.898±11.34	45.023±8.2	39.854±8.2	33.564±6.74	28.754±8.27
70°C	33.348±8.66	27.458±9.8	21.548±10.8	15.879±10.26	9.752±10.73
MWD @ 360W/g	32.779±8.66	26.589±10.8	20.534±11.8	14.589±12.26	8.426±12.73
270W/g	60.289±18.34	54.948±18.2	48.56±16.2	42.546±15.74	36.849±16.27

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180W/g	48.424±6.34	42.568±5.2	36.245±4.2	30.654±4.74	24.523±3.27
MWVD @ 400mmHg @ 360W/g	14.717±27.66	11.589±25.8	8.542±23.8	5.321±21.26	2.156±18.73
270W/g	42.753±1.34	39.501±2.2	33.254±1.2	30.246±3.74	24.535±3.27
180W/g	35.043±6.66	32.546±4.8	29.756±1.8	26.545±0.26	22.564±1.27
MWVD @ 500mmHg @ 360W/g	45.716±4.34	40.568±3.2	35.684±4.2	30.215±3.74	25.123±4.27
270W/g	20.45±21.66	16.545±20.8	11.256±20.8	6.235±20.26	2.564±18.73
180W/g	48.861±7.34	43.025±6.2	38.752±7.2	33.256±6.74	28.456±7.27
MWVD @ 600mmHg @ 360W/g	49.125±7.34	46.533±9.2	43.568±11.2	40.256±13.74	37.895±17.27
270W/g	26.757±14.66	23.654±12.8	20.256±11.8	17.856±8.26	14.562±6.73
180W/g	56.193±14.34	53.546±16.2	50.264±18.2	45.264±18.74	40.235±19.27
Mean	**41.66**	**36.80**	**31.80**	**26.26**	**20.73**

Table 5 : Shelf life analysis of β Carotene in µg per 100g +/- Standard deviation value :

Sample	0th day (Result±SD)	45th day (Result±SD)	90th day (Result±SD)	135th day (Result±SD)	180th day (Result±SD)
TD @ 50°C	243.748±19.67	151.221±35.33	127.187±32.2	104.003±25.13	81.831±25.06
60°C	190.819±33.33	157.612±28.33	135.765±23.2	112.666±16.13	89.474±18.06
70°C	162.727±61.33	141.081±45.33	117.836±41.2	97.125±32.13	65.355±42.06
MWD @ 360W/g	142.279±82.33	109.837±76.33	79.095±80.2	50.919±78.13	32.890±74.06
270W/g	262.333±37.67	219.953±33.67	189.938±30.8	143.338±13.87	96.483±11.06
180W/g	252.449±27.67	220.610±34.67	189.497±29.8	143.717±14.87	97.125±10.06
MWVD @ 400mmHg @ 360W/g	230.162±5.67	166.676±19.33	112.704±46.2	58.624±70.13	45.579±62.06
270W/g	243.778±19.67	169.744±16.33	119.459±40.2	63.879±65.13	50.726±56.06
180W/g	222.217±2.33	174.234±12.33	127.882±31.2	70.772±58.13	56.143±51.06
MWVD @ 500mmHg @ 360W/g	279.884±55.67	259.242±72.67	248.516±88.88	225.927±96.87	220.741±113.94
270W/g	240.054±15.67	233.500±46.67	231.931±71.8	231.754±102.87	224.101±116.94
180W/g	268.717±44.67	235.618±49.67	219.922±60.8	213.754±83.87	205.162±97.94

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MWVD @ 600mmHg @ 360W/g	108.253±116.33	87.743±98.33	63.802±95.2	40.687±88.13	25.162±82.06
270W/g	248.423±23.67	226.004±39.67	205.162±45.8	182.132±52.87	150.3709±42.94
180W/g	269.714±45.67	241.530±54.67	220.602±61.8	196.738±67.87	166.676±59.94
Mean	**224.33**	**186.33**	**159.20**	**129.13**	**107.06**

The results of nutritional analysis using ANOVA are given in the form of tables as follows:

Table 6 : Vitamin C

Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F Crit**
Between Groups	732.5714	4	183.1429	1.941338	0.114098	2.51304
Within Groups	6132	65	94.33846			
Total	6864.571	69				

Table 7 : Calcium

Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F Crit**
Between Groups	132852.2	4	33213.05	1.886523	0.122424	2.502656
Within Groups	1232380	70	17605.42			
Total	1365232	74				

Table 8 : Iron

Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F Crit**
Between Groups	1341.333	4	335.3333	36.83054	1.489E-16	2.502656
Within Groups	637.3333	70	9.104762			
Total	1978.667	74				

Table 9 : Potassium

Source of Variation	**SS**	**df**	**MS**	**F**	**P-Value**	**F Crit**
Between Groups	4122.587	4	1030.647	5.939838	0.000357	2.502656
Within Groups	12146	70	173.5146			
Total	16268.59	74				

Table 10 : β- Carotene

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Source of Variation	SS	df	MS	F	P-Value	F Crit
Between Groups	128702.9	4	32175.71	8.97446	6.56E-06	2.502656
Within Groups	250967.7	70	3585.253			
Total	379670.6	74				

The nutritional changes in the sample with the time interpreted in graphical representation as follows:

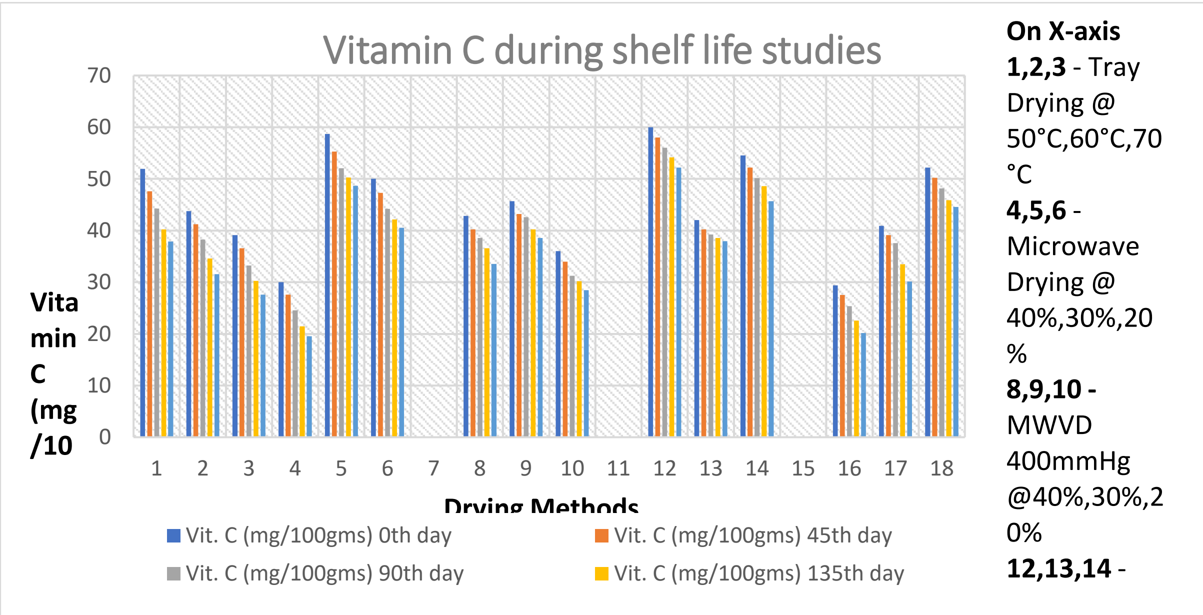

Chart 1.Changes in the Vitamin C content in the sample along with the shelf life

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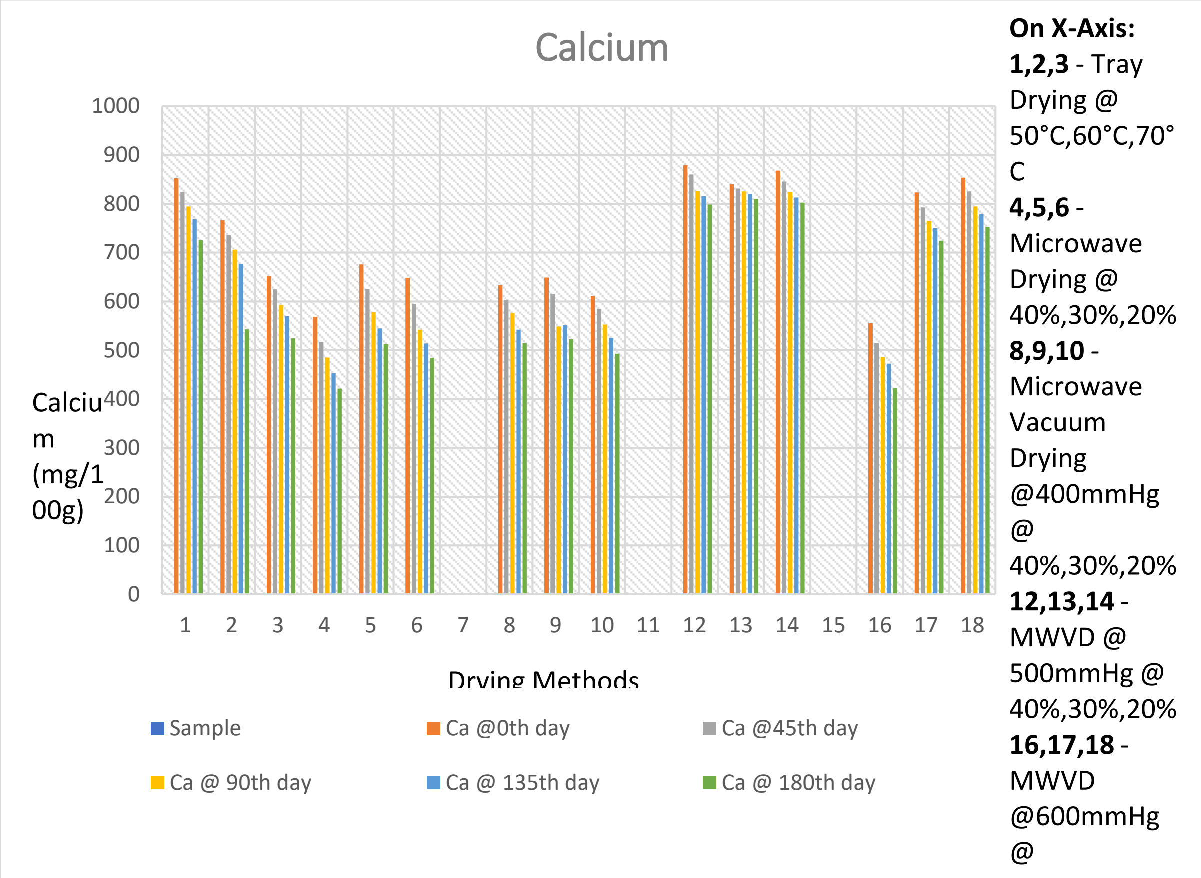

Chart 2. Changes in Calcium composition in the sample with the shelf life

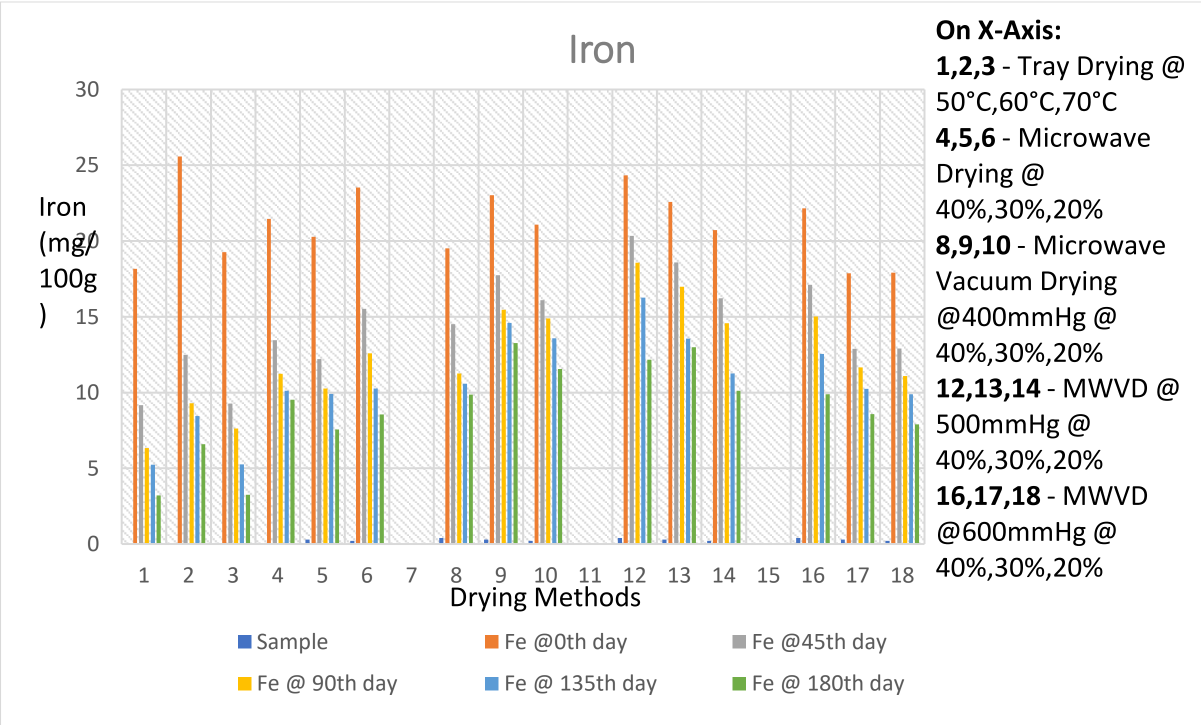

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Chart 3.Changes in Iron composition in the sample with the shelf life

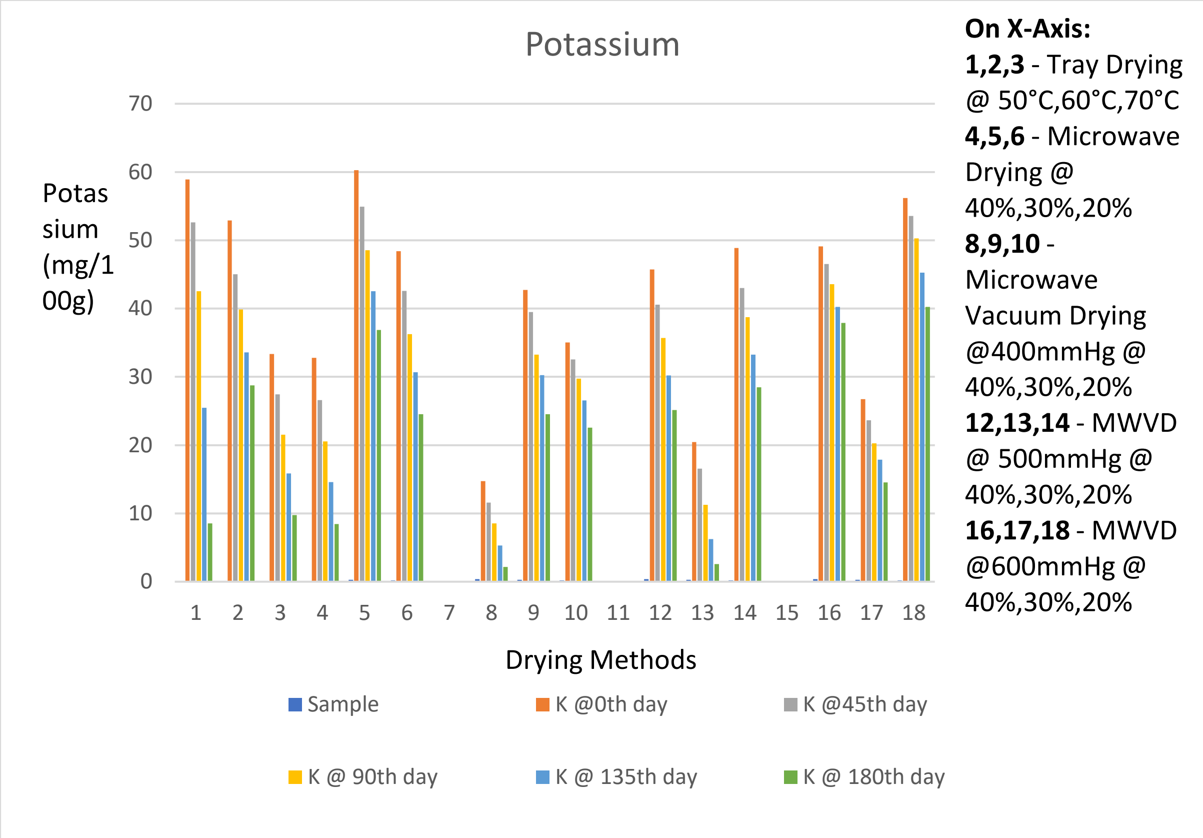

Chart 4.Changes in Potassium composition in the sample with the shelf life

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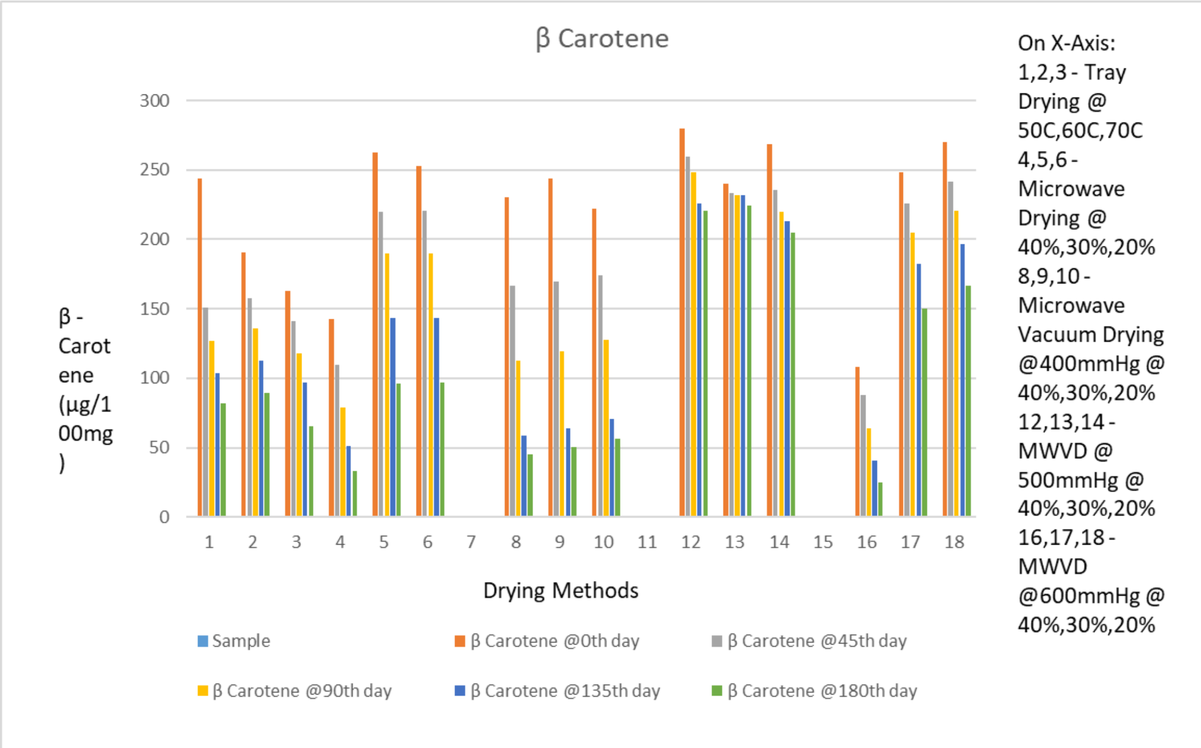

Chart 5.Changes in β Carotene composition in the sample with the shelf life

From the above graphs, it has been said that the study has come out with very drastic changes in the nutritional composition of the Carica papaya leaves powder; it varied with temperature and time of drying. It can also be observed from the graphs that the nutritional changes are bit less in Microwave vacuum drying methods whereas in Tray drying the change is more comparatively.

CONCLUSION:

From the study it can be concluded that the sample operated in Microwave Vacuum drying at 500mmHg Vacuum pressure and 40% (360W) has given the best nutritional results (Nutrients found are: Calcium: 879.35±10 mg per 100g, Vitamin C: 60 ± 5 mg per 100g, Iron:24.337 ±3 mg per 100g, Potassium 45.716 mg ± 5 mg and β Carotene: 279.884±10 µg per 100g, by ANOVA it is concluded that Iron, Potassium and β carotene found significant P≤0.05, Vitamin C and Calcium found insignificant P≥0.05) when compared with other drying methods. The overall nutritional composition loss observed is less in Microwave vacuum drying when compared with the fresh Carica papaya leaf nutrients, in other drying methods like Tray drying, microwave drying nutritional loss is very high.

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