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RESEARCH ARTICLE

DEVELOPMENT OF QUALITY SENSING SYSTEM OF MINIMALLY PROCESSED POMEGRANATE ARILS

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ABSTRACT

Pomegranate is suggested by nutritionists in the diet for weight reduction and cholesterol controlling programs. Regular inclusion of fruits in the diets boosts immunity, improves circulation, and offers protection from cancers. It is also good source of many vital B-complex groups of vitamins such as pantothenic acid (Vitamin B-5), folates, pyridoxine and vitamin K, and minerals like calcium, copper, potassium, and manganese (Rudrappa, 2009). The quality changes of pomegranate samples kept at different temperatures namely 0, 5 and 10^0 C are determined with the help of different experiments. The methods of measuring different data, instruments used and various tests are described.

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INTRODUCTION

Pomegranate (Punica granatum) fruit is one of the most popular, nutritionally rich fruit with unique taste, flavor and good for health. Pomegranate is grown in tropical and subtropical regions of the world. Along with the tropical fruits such as mango, it too has novel qualities of functional foods. Botanically, it is a small size fruit-bearing deciduous tree belonging within the *Lythraceae* family, of genus: *Punica*. The fruit is thought to originate in the Sub-Himalayan range of North India. The acreage and production of pomegranate at world level is estimated that approximately 1,439.1 thousand tons of pomegranate are produced (FAO 2012 -13). Out of this, 849.1 thousand tons are produced in India, while around 120 thousand tons each is produced in Spain and Iran, rest of the quantity 350 thousand tons is produced in Afghanistan, Pakistan, Egypt, Jordan, Tunisia, Lebanon, Israel, Chile, Peru, USA, etc. The total area under cultivation of pomegranate in India is 107.00 thousand ha and production is around 743.00 thousands tons. Maharashtra is the leading producer of pomegranate followed by Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu. Ganesh, Bhagwa, Ruby, Arakta and Mridula are the different varieties of pomegranates produced in Maharashtra (Agriculture Statistics, 2014). Pomegranate tree grows to about five and eight meters tall. Completely grown-up tree bears numerous spherical, bright red, purple, or orange-yellow colored fruits depending on the cultivar types. Each fruit measures about 6-10 cm in diameter and weighs about 200 gm. Its tough outer skin (rind) features leathery texture. The edible part of the pomegranate fruit (50%) consists of 40% arils and 10% seeds. Arils contain 85% water, 10% total sugars, mainly fructose and glucose, and 1.5% pectin, organic acid such as ascorbic acid, citric acid, and malic acid, and bioactive compounds such as phenolics and flavonoids, principally anthocyanins. Interior of the fruit is separated by white, thin, spongy, membranous, bitter tissue into discreet compartments. Such sections, packed as sacs, filled with tiny edible sweet, juicy, pink pulp encasing around a single, angular, soft or hard seed. The fruit is moderate in calories; 100 g provides 83 calories, slightly more than that in the apples. Similarly 100g of fruit contains 1.67 g of protein, 1.17 g of fat, 18.7 g of carbohydrates and 4g of dietary fibre. It contains no cholesterol or saturated fats. It is a good source of soluble and insoluble dietary fibers, providing about 4 g per 100 g (about 12% of RDA), which aid in smooth digestion and bowel movements (Rudrappa, 2009). The pomegranate shelf life varies from 10-12 days. It depends on various factors like respiration rate, transpiration rate, physical damage, temperature, relative humidity, ethylene production and atmospheric composition. Minimally processing the pomegranate arils in modified atmospheric packaging will help a lot in increasing the shelf

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life. Even studies say that freeze drying is the best process to extend the shelf life of pomegranate arils. Hence, the present study is undertaken to study the quality changes of minimally processed pomegranate arils stored in modified atmospheric pellets, packaged with coextruded films, at three different temperatures namely 0, 5 and 10 ^{0}C in order to extend the shelf life.

Hence, keeping the above facts in view, the research work is formulated to be done on following objectives:

1. To determine the atmospheric changes of minimally packed pomegranate arils.
2. To determine the physical and chemical properties of minimally processed pomegranate arils.

MATERIALS AND METHODS

The methods of measuring different data, instruments used and various tests are also described. The quality changes of pomegranate samples kept at different temperatures namely 0, 5 and 10^0 C are determined with the help of different experiments.

1. Colour Values using Hunter Colorimeter: Colour measurement was carried out using a Hunter Colorimeter model D25 optical sensor (Hunter Associates Labs, Reston, VA,USA) on the basis of three variables, namely, L, a and b. The 'L' value signifies the lightness (100 for white and 0 for black), the 'a' value represents greenness and redness (-80 for green and 100 for red), while the 'b' value signifies change from blueness to yellowness (-80 for blue and 70 for yellow). The instrument was calibrated against standard black as well as white references tiles. Each reading was replicated four times and the average values were used in the analysis. Colour measurement of pomegranate arils were carried out by placing the sample below the lens of Hunter colorimeter. The Hunter Lab colours scale may be used on any object whose colour may be measured.

2. Total Soluble Solids: Sugars are the major soluble solid in fruit juice. Other soluble materials include organic and amino acid, soluble pectin, etc. soluble solid concentration (SSC%, brix) can be determined in a small sample of fruit juice using a hand held refractometer, this refractometer measures the refractive index, which indicate how much a light beam is bent when it passes through the fruit juice.Temperature of juice is very important factor in the accuracy of reading.

3. pH of pomegranate arils at different temperatures : A **pH Meter** is an electronic device used for measuring the pH which is either the concentration of Hydrogen ions in an aqueous solution or the activity of the Hydrogen ions in an aqueous solution. The pH will indicate if the solution is acidic or basic, but is not a measure of acidity or alkalinity.

4. Headspace Gas Analyser for measuring the respiration rate of fruits : For the most advanced features in headspace gas analysis, the Gas space Advance offers automatic calibration, diagnostics and control which ensure that the instrument is always performing to its highest degree of accuracy - essential for HACCP compliance. This carbon dioxide (CO_2), oxygen (O_2) and nitrogen (N_2) headspace analyzer provides consistently reliable results and simplicity in operation allowing to maximize production efficient.

5. Determination of Polyphenol: This method is used for the determination of total phenols using Folins Ciocalteu reagent was adapted from Shahidi and Naczk (1995). A diluted extract (0.5 ml of 1:10, v/v) or phenolic standard was mixed with Folin ciocalteu reagent (5 ml, 1:10 diluted with nanopure water) aqueous Na2 Co3 (4ml, 1M) Solutions were heated in a 45^0 C water bath for 15 min and the total phenols were dtermined colorimetrically at 765nm the total phenols were determined colorimetrically at 765nm wavelength with the help of absorbence values observed from spectrophotometer.

RESULTS AND DISCUSSION

The different results obtained in the experiments done on minimally processed pomegranate arils which were stored at three different temperatures namely at 0, 5 and 10 °C are described in this segment.

Observations

Colour Readings of pomegranate arils at 0^0C

		1	2	3	4	5	6	7	8	9
		2nd day	4th day	7th day	9th day	11th day	14 th day	16 th day	18 th day	21th day
P1	L	37.49	39.33	36.89	39	27.76	35.32	34.89	28.73	33.64
	a	28.65	30.67	32.5	30.29	30.31	34.26	31.39	39.49	35.62
	b	11.18	9.58	9.76	10.7	15.53	10.21	9.7	9.48	7.29
	z	6.63	7.91	6.73	7.43	2.73	5.97	5.92	3.83	5.68
P2	L	38.2	41.48	37.3	38.33	26.86	35.98	38.95	39.54	34.78
	a	29.77	26.14	30.03	29	31	30.98	30.66	26.03	34.51
	b	11.54	9.11	9.39	11.35	18.93	9.63	8.81	10.15	6.97
	z	6.85	9.17	7.01	6.99	2.06	6.37	7.9	7.84	6.40
P3	L	37.86	38.26	36.4	40.67	36.03	33.14	32.61	32.36	30.37
	a	28.39	27.26	29.69	27.88	30.13	30.64	35.14	36.14	35.20
	b	10.3	27.67	12.44	10.24	12.33	8.46	8.44	10.78	8.38
	z	7.03	8.5	5.88	8.38	5.81	5.49	5.31	4.76	4.48
P4	L	41.58	42.73	35.61	35.38	35.82	32.84	38.54	21.23	27.79
	a	27.24	25.73	31.08	33.21	29.69	32.62	28.79	41.15	38.15
	b	11.26	9.98	10.19	10.68	12.16	8.56	8.84	13.63	8.03
	z	8.53	9.51	6.07	5.91	5.75	5.38	7.72	1.61	3.71

Colour readings of pomegranate arils at 5^0C

		2nd day	4th day	7th day	9th day	11th day	14 th day	16 th day	18 th day	21th day
P1	L	38.16	35.88	34.91	36.02	36.05	36.92	34.1	29.72	32.12
	a	27.87	28.12	29.15	28.15	30.93	25.46	25.28	32.08	32.71
	b	14.81	14.91	15.09	15.38	17.43	13.53	15.22	18.05	17.23
	z	6.03	5.19	4.8	5.17	4.78	5.9	4.54	2.84	3.51
P2	L	34.73	32.3	35.91	28.14	31.91	30.35	34.82	35.48	32.71
	a	28.8	33.38	28.35	33.37	31.37	33.52	29.22	26.92	30.42
	b	15.36	15.94	15.89	17.61	17.66	17.71	15.24	15.98	15.69
	z	4.66	3.8	4.99	2.51	3.42	2.97	4.76	4.85	3.96
P3	L	35.02	33.17	34.69	31.67	32.84	32.84	32.06	30.19	28.77
	a	28.97	33.33	32.65	32.57	33.68	33.68	32.54	33.21	33.2
	b	14.8	15.93	16.49	17.35	17.73	17.73	17.87	18.43	16.75
	z	4.87	4.08	4.43	3.41	3.65	3.65	3.45	2.92	2.68

Colour readings of pomegranate arils at 10 ^{0}C

		2nd day	4th day	7th day	9th day	11th day	14 th day	16 th day	18 th day	21th day
P1	L	35.32	38.04	33.52	31.46	33.12	32.16	32.87	31.43	29.81
	a	32.43	26.74	32.63	31.89	32.57	32.13	32.42	34.34	35.85
	b	15.45	14.36	17.36	16.77	17.6	17.5	18.09	16.25	17.89
	z	4.85	6.14	3.9	3.45	3.78	3.51	3.63	3.51	2.77
P2	L	31.87	34.62	33.51	33.25	32.04	30.58	33.01	32.87	27.45
	a	30.56	30.4	32.88	30.93	31.04	31.71	30.22	30.02	37.98
	b	14.96	15.29	16.29	17.13	18.16	18.54	17.6	13.97	19.94
	z	3.82	4.65	4.13	3.9	3.38	2.93	3.77	4.41	2.01
P3	L	31.72	34.52	30.44	33.02	33.73	32.83	28.91	32.67	29.1
	a	28.47	28.08	35.06	27.25	31.69	31.68	34.01	29.98	30.14
	b	12.81	14.7	16.19	12.89	18.45	18.45	17.53	15.02	17.35
	z	4.17	4.75	3.25	4.62	3.86	3.59	2.69	4.07	2.72
P4	L	33.07	35.57	30.82	30	31.73	29.19	30.81	31.88	30.29
	a	34.5	30.35	34.31	33.4	34.65	32.14	33.29	30.85	31.49
	b	17.4	16.61	18.05	18.19	20.15	17.68	16.73	13.64	17.37
	z	3.75	4.72	3.07	2.86	2.99	2.73	3.26	4.12	2.99

Total Soluble solids in pomegranate juice made from arils at different temperatures

Temp. of Sample	2nd day	4th day	7th day	9th day	11th day	14th day	16th day	18th day	20th day
0 ^{0}C	15	15.86	14.77	15	14.1	14.6	14.4	15.2	16
5 ^{0} C	15.6	14.533	15	14.5	14.2	14.5	14.3	14.9	15.1
10 ^{0} C	15	15.233	16.2	15.6	14.6	15.7	14.7	15	15.8

pH Values of pomegranate arils at different temperatures

Temp. of Sample	2nd day	4th day	7th day	9th day	11th day	14 th day	16 th day	18 th day	20 th day
0 ^{0}C		3.72	3.9	3.72	3.59	3.58	3.59	3.58	3.59
5 ^{0} C		3.49	3.72	3.49	3.31	3.38	3.37	3.35	3.54
10 ^{0} C		3.52	4	3.39	3.29	3.37	3.36	3.55	3.37

Head space Gas Analyser readings of packed pomegranate arils

Temp. of Sample		0th Day	2nd day	4th day	7th day	9th day	11th day	14th day	16 th day	18 th day	20th day
0 ^{0}C	O_2	15.6	18.3	15.2	14.7	16.7	14.9	16	14.6	15.1	13.6
	CO_2	12.4	10.5	20.5	11.8	12.1	24.6	13.5	26.4	23.5	30.2
	N_2	72	71.2	64.3	73.5	71.2	60.5	70.5	59	61.4	56.2
5 ^{0} C	O_2	13.8	16.5	11.1	6.34	4.56	4.09	1.61	1.99	0.445	1.14
	CO_2	21.5	12	21.1	20.61	29.4	26.8	37.5	26.9	25	29.5
	N_2	64.7	71.5	67.8	73.1	66	69.1	60.9	71.1	74.6	69.4
10 ^{0} C	O_2	13.7		9.98	9.49	15.1	17.8	1.83	20.88	5.05	18.9
	CO_2	22.7		25.7	15.1	7.8	5.4	29.2	1.99	36.2	3.9
	N_2	63.6		64.3	75.4	77.1	76.8	69	77.3	58.7	77.2

Titre values of Acidity

Day	0 ^{0}C			5 ^{0}C			10 ^{0}C		
	1	2	3	1	2	3	1	2	3
7th day	0.8	0.8	0.8	0.85	0.75	0.75	0.9	0.9	0.8
9th day	0.7	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
11th day	0.6	0.6	0.6	0.7	0.7	0.7	0.85	0.8	0.85
14th day	0.7	0.7	0.7	0.75	0.8	0.8	0.9	0.8	0.8
16th day	0.7	0.7	0.75	0.8	0.8	0.8	0.8	0.8	0.9
18th day	0.6	0.7	0.6	0.65	0.65	0.65	0.8	0.8	0.8
20th day	0.7	0.7	0.7	0.8	0.8	0.8	0.85	0.9	0.9

Absorbence Values

Day	0 ^{0}C		5 ^{0}C		10 ^{0}C	
	1	2	1	2	1	2
9th day	1.254	1.239	1.47	1.489	1.411	1.447
11th day	1.495	1.479	1.334	1.478	1.293	1.351
14th day	1.392	1.549	1.472	1.46	1.495	1.404
16th day	1.277	1.25	1.439	1.421	1.555	1.53
18th day	1.323	1.321	1.358	1.402	1.471	1.468

Total soluble solids

The total soluble solids in the 5°C sample were initially high but decreased to 15.2 brix after 19th day. The total soluble solids in 0 and 10°C samples were 15º brix initially and increased to 16 and 15.8° brix respectively. Among the three samples, the sample stored at 5°C noted less TSS values with some fluctuations. All the samples noted a significant decrease on the 11th day of storage and gradually increased later. There was a significant increase in pH in all three samples on 7th day of storage. The pH of sample stored at 0°C was found to be high on most of the days except on the 7th day. The pH of sample stored at 10°C was found to be high on that day. No significant changes in pH were observed for the sample stored at 0°C after the 11th day of storage. The colour changes of the three pomegranate arils samples stored at different temperatures were analysed with the help of hunter colorimeter and the changes in l, a, b, z values were noted. The 'L' value signifies the lightness (100 for white and 0 for black), the 'a' value represents greenness and redness (-80 for green and 100 for red), while the 'b' value signifies change from blueness to yellowness (-80 for blue and 70 for yellow). The changes in ' l ' values represent that the sample's darkness decreased on the second day but regained again to the end of the experiment. The changes in 'a' values indicate the sample turns red to the end of the experiment. 'b' value indicates that the sample is in the light yellow zone in the blue-yellow range. The changes in ' l ' values represent that the sample's darkness decreased from 35 to 30 in the hunter calorimeter scale. The changes in 'a' values indicate the sample turns red to the end of the experiment. 'b' value indicates that the yellowness of the sample increased in the blue-yellow range. The concentration of nitrogen gas decreased from 70 to 56.2 % in the sample stored at 0°C. The CO_2 concentration increased at the final day to 30%. No drastic changes were observed in concentration of O_2 gas during the storage period. There was a gradual increase in the CO_2 concentration which implies that the break down of energy reserves like proteins, carbohydrates into simpler molecules is high at this temperature. However, the concentration of N_2 decreased from 58 to 56.2% in sample packed at 0°C. An unpredictable order of changes were observed in the concentrations of O_2 and CO_2 gases. N_2 concentration also suddenly decreased on 18th day and again rose on 20th day.

Conclusion

The samples noted a significant decrease on the 11th day of storage and gradually increased later. No significant changes in pH were observed for the sample stored at 0°C after the 11th day of storage. The concentration of N_2 decreased from 72 to 58% in sample packed at 0 °C. An unpredictable order of changes were observed in the concentrations of O_2 and CO_2 gases. N_2 concentration also suddenly decreased on 18th day and again rose on 20th day.

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