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Preservation and storage of Lemon (*Citrus Limon*) Juice

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Abstract— *Lemon fruits were sorted and washed before extraction of juice. Extracted juice of lemon fruits was treated with potassium metabisulphite, sodium benzoate and thermal processing. Treated and untreated samples of juice were stored at room and refrigeration temperature for 90 days and analyzed for chemical properties at 15 days of interval during storage. Total sugars, reducing sugars and browning of juice increased during storage. On the contrary, tannin content of juice decreased during storage. Storage at refrigeration temperature was found better effective in preservation and keeping quality of juice showing lesser changes in chemical properties of juice during storage than at room temperature. Results suggested that lemon juice after chemical and pasteurisation treatments can be stored safely at room and refrigeration temperature for 90 days.*

Keywords— chemical preservatives, lemon juice, sugar content, tannin, thermal processing.

I. INTRODUCTION

Lemon (*Citrus limon Burm. f.*) is the medicinally important plant and belongs to the family Rutaceae. Lemon is the third most important citrus fruit following orange and mandarin (Perez-Perez et al., 2005). Alkaloids in crude extracts of different parts of lemon plant such as stem, root, leaves and flower have been reported by Kawaii et al. (2000). Fruits of lemon plants are appreciated for their high content of flavonoids, vitamin C, citric acid and minerals. Many consumers around the world prefer lemons as fruit due to exceptional flavour and acidity, and also potential applications of lemons in value-added food products. Lemon juice in the form of beverage is enjoyed by people of all age groups including children and elders due to their refreshing taste and medicinal benefits (Mishra et al., 2015). Depending on the climatic conditions, different varieties of lemons are grown around the world. Baramasi variety of lemon is commonly grown in various agro-climatic zones including sub mountainous tract of Punjab. Winter crop of Baramasi lemon is harvested it the cooler part of the year, in that period consumption of lemon fruits is low. Sensitive of lemon fruits to chilling injury makes it hard to store in the commercial cold stores (Kaur et al., 2014). So, due to sensitive to chilling injury and limited shelf-life of lemon fruit, it becomes important to process the it in the form of juice to reduce the surplus in the market in its peak season of production. Preservation of fruit in the form of juices has turn out to be the business activity of great significance and countries with rich fruit resources with short harvesting season are emphasizing more for established storage to keep up quality of fruits, enhance shelf life and preserve fruit juices for availability in off-season (Franke et al., 2005). Fruits juices are preserved by various methods such as freezing, irradiation, heat processing and addition of chemical preservatives, however it is well known fact that nutritional and sensory quality of juice changes during extraction, preservation treatment and storage. Rabia et al. (2014) and Holeman et al. (2002) reported that thermal processing of citrus juice lowers the ascorbic acid content. Sulfur dioxide acts as an antimicrobial agent and also stabilizes ascorbic acid and it is added in fruit juices in the form of sulfites and metabisulfites of sodium or potassium. Shahnawaz et al. (2013) investigated the effect of sodium-benzoate with different concentrations on orange juice packed in various popular packing materials for different time intervals of storage and found that orange juice with sodium benzoate without the additions of sugar could be useable up to 30 days. The action of sulphur dioxide as an antimicrobial agent as well as a stabilizer of ascorbic acid depends on the pH of the food (El-Ashwah et al., 1981). It is, therefore, significant to assess its effectiveness in a high acid juice such as orange and lemon juice. Keeping all these factors in view, present investigation was carried out to preserve lemon juice by chemical preservatives and heat processing and to study the effects of different preservation treatments and storage temperature on properties of lemon juice during storage.

II. MATERIALS AND METHODS

2.1 Preparation of fruits and juice extraction

Fully matured lemon fruits of Baramasi variety were procured from central fruit farm, Hisar. Lemon fruits were washed thoroughly with water to remove dirt and waste, manually graded for size and shape, only sound fruits were taken for extracting juice. Fruits were cut into halves and juice was extracted by pressing the fruit pieces in manually operated citrus juice machine. The expressed

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juice was passed through single layer of muslin cloth to remove the solids and pulp materials. The filtered juice was filled in sterilized glass bottles with head space 2cm.

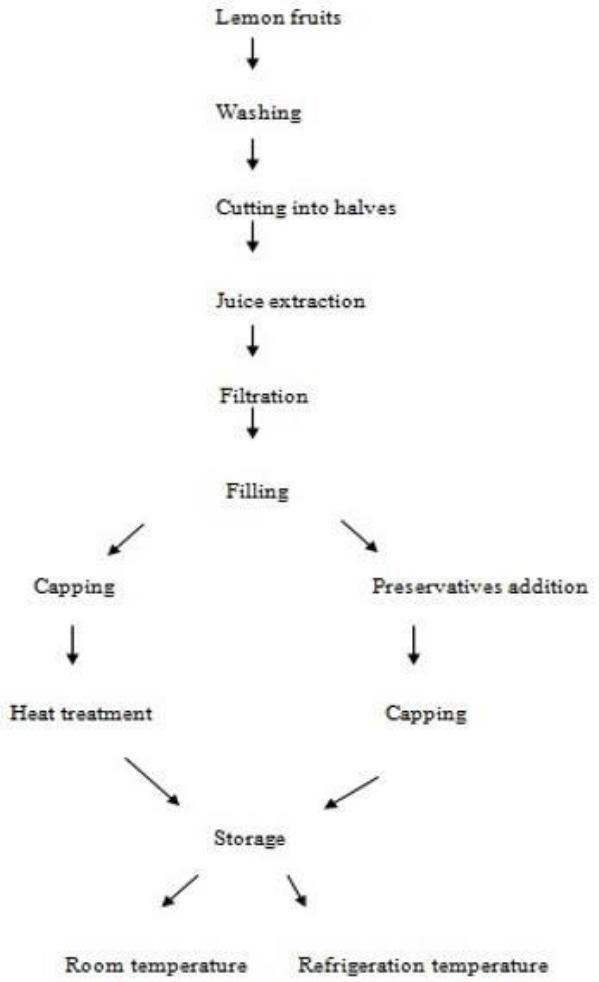

Fig.1: Schematic diagram showing the process of extraction and preservation of juice

2.2 Preservation and storage of juice

Preservation of juice was done by two methods using chemical preservatives and pasteurization as shown in Fig 1. In filtered juice chemical preservatives namely potassium metabisulphite (@ 0.1%) and sodium benzoate (@ 0.1%) were added. Juice in sealed bottles was heat processed for 15 minutes at 80°C in hot water bath and then cooled under running tap water. Untreated juice was taken as control sample. Processed and control juice samples were labelled and stored at two different temperatures (room temperature and refrigeration temperature) for 90 days.

2.3 Chemical analysis

Stored samples of lemon juice were analysed at 15 days interval during storage. Tannin content was determined according to AOAC (1984) method. Non-enzymatic browning was determined using method described by Ranganna (1986). Total sugars and reducing sugars were estimated according to method describe by Hulme and Narain (1931). The data obtained in present investigation was subjected to statistical analysis of variance (ANOVA) techniques using two factorial completely randomized designs (CRD). All the tests were made in triplicate. Chemicals used in the study were of analytical reagent grade obtained from Sigma Chemicals, U.K.

III. RESULTS AND DISCUSSION

Total and reducing sugar contents of control and treated lemon juice samples during storage at room and refrigeration temperatures are presented in Table 1. Total sugars escalated from 1.456g to 1.956g per 100ml during storage. Total sugars were maximum (1.783g per 100ml of juice) in pasteurized juice stored at room temperature and minimum (1.623g per 100ml of juice) in sodium benzoate treated sample stored at refrigeration temperature. The rise in total sugars could be due to hydrolysis of starch to sugars in juice during storage. Such results have already been observed in earlier studies (Shahnawaz, 2013; Barwal and Shrera, 2009) reporting increase in total sugars in lemon juice and orange juice respectively during storage. Reducing sugar increased substantially from 0.587g to 1.002g per 100ml juice in all juice samples during storage period. The escalation in reducing sugars in juice could be due to the gradual inversion of non-reducing sugars during storage. The average reducing sugars content was observed maximum (0.816g per 100ml) in potassium metabisulphite treated samples stored at room temperature and minimum (0.753g per 100ml) was found in sodium benzoate treated samples stored at room temperature. The results were consistent with the findings of other studies (Akhtar et al., 2013) in which a significant increase was noticed in reducing sugars in pomegranate juice during ambient temperature storage.

Table.1: Effects of different treatments and storage on total sugars (g/100ml) and reducing sugars (g/100ml) of lemon juice

Treatment		**Storage period (days)**							
		0	**15**	**30**	**45**	**60**	**75**	**90**	**Mean**
Total sugars	C + RT	1.410	1.380	*	*	*	*	*	
	KMS+ RT	1.480	1.535	1.650	1.720	1.820	1.920	1.960	1.726[b]

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	SB + RT	1.450	1.500	1.550	1.635	1.750	1.835	1.920	1.663^{d}
	P + RT	1.450	1.550	1.705	1.790	1.905	2.020	2.060	1.783^{a}
	C + RFT	1.430	1.520	1.650	1.620	1.790	1.890	2.040	1.706^{c}
	KMS + RFT	1.480	1.500	1.550	1.650	1.690	1.820	1.905	1.656^{d}
	SB + RFT	1.450	1.480	1.520	1.565	1.690	1.805	1.850	1.623^{e}
	P + RFT	1.450	1.520	1.580	1.690	1.820	1.940	2.020	1.717^{b}
	Mean	1.456^{g}	1.515^{f}	1.601^{e}	1.667^{d}	1.781^{c}	1.890^{b}	1.965^{a}	
Reducing sugars	C + RT	0.570	0.500	*	*	*	*	*	
	KMS+ RT	0.570	0.655	0.770	0.825	0.870	0.980	1.040	0.816^{a}
	SB + RT	0.600	0.640	0.700	0.770	0.810	0.890	0.940	0.764^{d}
	P + RT	0.600	0.640	0.720	0.770	0.840	0.960	1.010	0.791^{b}
	C + RFT	0.570	0.670	0.700	0.770	0.810	0.855	1.040	0.774^{c}
	KMS + RFT	0.570	0.670	0.740	0.790	0.840	0.910	1.010	0.790^{b}
	SB + RFT	0.600	0.640	0.685	0.740	0.770	0.855	0.980	0.753^{e}
	P + RFT	0.600	0.640	0.720	0.740	0.770	0.870	0.995	0.762^{d}
	Mean	0.587^{g}	0.651^{f}	0.719^{e}	0.772^{d}	0.816^{c}	0.903^{b}	1.002^{a}	

C = Control; KMS = Potassium metabisulphite; SB = Sodium benzoate; P = Pasteurized; RT = Room temperature; RFT = Refrigeration. Means with the same superscript are not significantly different. * Not recorded due to fermentation

The values of tannin content and optical density of lemon juices during storage are given in Table 2. Tannin content showed a noticeable downtrend from 51.035mg to 31.652mg/100 ml juice during storage. The maximum tannin content (45.305mg/100 ml juice) was noticed in potassium metabisulphite treated juice stored at refrigeration and minimum tannin content (38.179 mg/100 ml juice) was observed in sodium benzoate treated juice stored at room temperature. The reduction in tannins in juice could be attributed to their condensation into brown pigments during storage. These results were in conformity with the finding of Ranote et al. (1992) who reported decrease in tannin content in kinnow-RTS stored at room temperature for 24 weeks. It was perceived from data (Table 2) that the mean optical density value of lemon juice increased from 0.022 to 0.036 during storage. The samples stored at room temperature showed significantly higher mean browning value than the samples stored at refrigeration temperature. Maximum browning (0.042 OD) was noticed in pasteurized sample stored at room temperature while minimum browning (0.022OD) was observed in potassium metabisulphite treated sample stored at refrigeration temperature. Intensification in browning in juice may be attributed to the accumulation of degradation products of sugars, ascorbic acids and proteins during storage. These results are in agreement with earlier studies (Alex et al., 2004) for litchi juice, kinnow natural juice, sweetened juice and squash stored at room and refrigeration temperature.

Table.2: Effects of different treatments and storage on tannin content (mg/100ml) and browning (OD) of lemon juice

Treatment		**Storage period (days)**							
		0	**15**	**30**	**45**	**60**	**75**	**90**	**Mean**
Tannin content	C + RT	49.670	45.285	*	*	*	*	*	
	KMS+ RT	51.305	50.120	47.485	45.865	33.565	32.515	30.570	41.632^{c}
	SB + RT	49.960	46.975	42.020	36.800	33.175	30.385	27.935	38.179^{e}
	P + RT	50.795	49.025	46.395	44.445	37.435	32.005	30.880	41.569^{c}
	C + RFT	51.105	49.365	48.205	46.525	39.710	36.080	33.290	43.469^{b}
	KMS + RFT	52.145	50.985	51.135	49.580	39.545	38.065	35.680	45.305^{a}
	SB + RFT	50.460	48.675	43.115	40.075	35.575	31.470	28.480	39.693^{d}
	P + RFT	51.475	49.755	47.850	46.185	38.125	35.615	34.730	43.391^{b}
	Mean	51.035^{a}	49.271^{b}	46.601^{c}	44.211^{d}	36.733^{e}	33.734^{f}	31.652^{g}	
Non enzymatic	C + RT	0.022	0.034	*	*	*	*	*	
	KMS+ RT	0.022	0.022	0.024	0.036	0.038	0.039	0.041	0.032^{c}

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browning	SB + RT	0.022	0.022	0.024	0.040	0.043	0.045	0.046	0.035^{b}
	P + RT	0.022	0.025	0.028	0.049	0.057	0.057	0.057	0.042^{a}
	C + RFT	0.022	0.022	0.022	0.024	0.026	0.027	0.027	0.024^{f}
	KMS + RFT	0.022	0.022	0.022	0.022	0.022	0.022	0.023	0.022^{g}
	SB + RFT	0.022	0.022	0.023	0.026	0.028	0.029	0.029	0.026^{e}
	P + RFT	0.022	0.022	0.023	0.028	0.029	0.030	0.030	0.026^{d}
	Mean	0.022^{g}	0.022^{f}	0.024^{e}	0.032^{d}	0.035^{c}	0.036^{b}	0.036^{a}	

C = Control; KMS = Potassium metabisulphite; SB = Sodium benzoate; P = Pasteurized; RT = Room temperature; RFT = Refrigeration. Means with the same superscript are not significantly different. * Not recorded due to fermentation.

IV. CONCLUSION

In the present study, it was noticed that chemical properties of lemon juice were affected by different preservation treatments, storage temperature and storage period. Retention of tannin content in juice was the highest in samples preserved with potassium metabisulphite during storage. Sodium benzoate treated samples showed least increase in total and reducing sugars during storage. Visual quality of juice was greatly affected by pasteurization which resulted in highest increase in non-enzymatic browning in juice. Substantial changes in all chemical properties of juice were noticed at room temperature than at refrigeration temperature in all treatments during storage. Tannins and browning of juice in all samples were highly affected by storage temperature showing noticeable changes at room temperature storage as compared to refrigeration temperature storage. Comparatively little effect of storage temperature was observed on total sugars and reducing sugars of juice in all samples. The findings of present investigation suggest that untreated lemon juice cannot be stored for more than a week at room temperature but it can be stored for 90 days at refrigeration temperature. Refrigeration temperature was better than room temperature for storage of untreated and processed lemon juice.

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