

## STORAGE BEHAVIOUR OF SWEET ORANGE JUICE CONCENTRATE

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The techniques of juice concentration has been shown to effect the quality of the concentrate. Frozen orange juice concentrate samples were found richer in aroma and maintained better colour, taste and flavour when stored at 0°F., than those kept at 32°F., for a period of six months. The frozen concentrates apparently showed no symptoms of gelation and clarification during storage at low temperatures.

The storage period had a significant effect on the retention of ascorbic acid content of frozen and sugared concentrate. The length of storage period and temperatures had insignificant effect on other chemical constituents of the concentrates.

42° Brix sugared concentrates stored at 0°F., maintained good organoleptic properties. The sugared concentrate samples were found to clarify immediately on dilution. These concentrate samples were found less stable towards loss of ascorbic acid and aroma compared to frozen concentrates.

### INTRODUCTION

Concentration of citrus juices at very low temperatures conserves the natural Fruit flavour more than other processes [1]. Heiss and Schachingar [2] reported that flavour preservation in fruit juices with freeze concentration was better than Vacuum concentration. Therefore, high flavour retention by freezing process makes it possible to use as a blending base in fruit juice industries. The manufacture of sweetened citrus juices concentrates also have a better flavour, stability and may be used as a "bottler's base" for the preparation of drinks and cordials.

The storage temperatures and storage period had a definite effect on various chemical constituents and organoleptic qualities of the concentrates. Roy [3] reported that in Frozen Citrus concentrates held at 0°F., for 6 months, losses of ascorbic acid were only 0.2 percent. He further stated that ascorbic acid in frozen concentrate was more stable than single strength juices. It has also been reported that orange juices when stored for five months at different temperatures had significantly lower vitamin-C content than those juices kept for Zero storage period [4]. Curl [5], studying the effect of concentration on the deterioration of pasteurized orange juice, found out that there was very little hydrolysis of sucrose and browning in any sample in a

year at 40°F., but at 60°F., and 80°F., darkening increased with increase in concentration. The gelation and clarification did not occur in the frozen citrus concentrates kept at 0°F. [6] but at higher temperature these changes occurred more quickly [7].

### MATERIALS AND METHODS

Sweet oranges (*Citrus sinensis*), of Valencia late variety largely grown in Peshawar Region were selected for the preparation of juice concentrates by different methods. The variety was obtained from the Horticulture orchard of the University and only the matured fruit was picked. The juice was extracted and pasteurized at 190°F., for one minute [8]. The pasteurized juice was divided into two lots. Lot No. I was utilized for the production of sugared concentrate and Lot No. II was stored at 0°F., for the production of frozen concentrate.

(a) *Concentration of Juice by Addition of Cane-sugar.* The valencia late orange juice sugared concentrate (Lot No. I) was prepared by adopting the technique similar to that described by Burdick [9] and Bissett *et al* [10] with slight modification in the amount of cane-sugar used in the preparation of concentrate. The 42° Brix sugared concentrate was prepared by the addition of dry-sugar to the pasteurized juice with constant stirring. The 42° Brix sugared concentrate was sub divided into two lots. 300 PPM sulphur dioxide was added to one lot to be kept at 32°F and the other lot to be kept at 0°F. was filled in the bottles

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without addition of sulphur-dioxide.

(b) *Concentration of Juice by Freezing Thawing.* The frozen valencia late orange juice was used for the production of valencia late orange juice freeze concentrate (Lot No. II) in accordance with the techniques adopted by Gore [11] with necessary modification according to the available facilities. The frozen juice was thawed crushed and centrifuged in a basket centrifuge @ 3000 R.P.M. and the concentrate was separated. The ice left in the basket centrifuge was collected separately. The separated concentrated juice was collected in a basket and kept again at  $-20^{\circ}\text{F.}$ , for freezing, this process was repeated till a juice concentrate of  $42^{\circ}$  Brix was obtained. The frozen concentrate was also divided into two sub-lots - 300 PPM sulphur-dioxide was added to one lot to be kept at  $32^{\circ}\text{F.}$ , where as the other lot was kept at  $0^{\circ}\text{F.}$ , as such.

The prepared concentrates (both the sugared and freeze concentrates) were filled separately into glass bottles. The filled bottles were stored at two different storage temperatures, i.e.,  $32^{\circ}\text{F.}$ , and  $0^{\circ}\text{F.}$ , for the evaluation of various characteristics at a regular interval of one month for a total duration of six months.

(c) *Nutritional Evaluation.* Moisture content, Brix, acidity, ascorbic acid content, total and reducing sugars determined according to AOAC methods of analysis [12].

Gelation and clarification in the concentrates were visually evaluated according to Olson *et al* [13].

(d) *Evaluation of Organoleptic Properties.* The concentrates were reconstituted to  $12^{\circ}$  Brix and were evaluated by taste-panel of ten judges. The samples were tasted according to a ten point hedonic scale, in which ten indicated extremely liked and one extremely disliked and a mean score of 5.5 was considered liked samples. The characteristics evaluated were, Colour, Taste and Flavour. The average scores of ten judgements for colour, taste and flavour for the reconstituted concentrate samples were compared with each other.

## RESULTS AND DISCUSSION

*Chemical Composition:-* The chemical analysis of fresh, pasteurized juices and the concentrates has been shown in (Table 1). The method of concentration was found to affect the chemical composition of the concentrates. The nutritive value of the freeze concentrate was enhanced considerably while decrease in the Vitamin-C and acid content and increase in the sugar content was recorded. (Table 1).

*Effect of Storage on the Chemical Composition of the Concentrates:* The analysis of variance (Table 3) indicated that the effect of storage temperature on the ascorbic acid content of the concentrates was insignificant [3]. Whereas the significant effect of the storage period on the vitamin-C

content was recorded. The concentrate samples stored for six months had significantly lower ascorbic acid content than the samples kept for zero storage period (Table 2). These results are in agreement with those of Miankhel [4]. The analysis of variance also revealed that the effect of

Table 1. \*Chemical composition of valencia-late orange juice at various stages.

Stages of juice	Total soluble solids %	Total acidity %	Vitamin-C mg/100 ml.	Total sugars	Reducing sugar	pH
Fresh juice.	11.20	1.11	53.10	8.11	4.00	3.4
Pasteurized juice.	12.24	1.14	51.03	8.14	4.13	3.4
Freeze juice concentrate "S <sub>1</sub> .."	42.00	3.10	231.80	24.75	12.50	3.50
Sugared concentrates "S <sub>2</sub> ".	42.00	0.89	40.47	39.68	2.95	3.40

\*Values are result of triplicate analysis.

Table 2. Effect of storage period on vitamin-C content

Months	Mean scores	Mean scores
0	231.30	40.47
1	228.50	39.70
2.	226.90 LSD5 % = 3.08	39.35 LSD5 % = 0.63 LSD1 % = 0.95
3.	226.15	39.10
4.	225.65	39.90
5.	225.45	38.75
6.	225.15	38.56

storage temperatures and length of storage period had no significant effect on the total and reducing sugar content of both the concentrate samples (Tables 4, 5). These results

Table 3. Effect of storage temperature on vitamin-C content.

Freeze juice concentrates "S <sub>1</sub> "		Sugared juice concentrate "S <sub>2</sub> "
Temp.	Mean scores	Mean scores
32°F.	226.36	39.25
0°F.	227.81 N.S.	39.27 N.S.

Table 4. Effect of storage period on the total and reducing sugars contents.

Storage period (months)	Total sugars		Reducing sugars	
	Mean	Scores	Mean	Scores
	For		For	
	"S <sub>1</sub> "	"S <sub>2</sub> "	"S <sub>1</sub> "	"S <sub>2</sub> "
0	24.752	39.682	12.500	2.95
1	24.752	39.682	12.500	2.95
2	24.752	39.682	12.500	2.95
3	24.752	39.619	12.500 N.S.	2.95 N.S.
4	24.752	39.526	12.530	2.96
5	24.752	39.409	12.566	2.98
6	24.702	39.372	12.611	3.00

Table 5. Effect of storage temperature on total and reducing sugars.

Mean scores of				
Temperature F°	Total sugar		Reducing sugars	
	Freeze concentrate (S <sub>1</sub> )	Sugared concentrate (S <sub>2</sub> )	Freeze concentrate (S <sub>1</sub> )	Sugared concentrate (S <sub>2</sub> )
32	24.738 N.S.	39.453 N.S.	12.558 N.S.	2.97 N.S.
0	24.752	39.682	12.500	2.97

seem to support the findings of Curl [5] who, while studying the effect of concentration on the deterioration of pasteurized orange juice, noticed very little hydrolysis of sucrose in any of the juices in one year at 40°F. The effect of storage period and temperatures on other chemical constituents of the concentrate samples was also found to be insignificant. These results are similar to those of Von Loesecke [14] Mainkhel [4] and Donald *et al* [15].

*Effect of Storage on Gelation and Clarification:*- The periodic visual examination of the concentrate samples for gelation and clarification indicated that valencia late orange juice freeze concentrate samples, stores at 0°F., showed no gelation and clarification during six months storage period (Table 6). These results are similar to those of Cotton *et al* [6] and Buboiss and Kew [7]. It was observed that the same concentrate samples stored at 32°F., showed a very slight tendency towards gel formation. The data recorded also revealed that the time and temperatures had no effect on the pulp particles to clarify and settle in the freeze concentrate samples (Table 6). However, the sugared concentrate samples stored at 32°F., and 0°F., (Table 6), were noticed to clarify immediately on dilution [10]. It was further observed that the clarifying effect of the added sugar did not deteriorate quality of the product and retained good flavour.

*Organoleptic Properties:*- The mean score by the ten judges for colour taste and flavour evaluation of 12° Brix

Table 6. Effect of storage temperatures on gelation and clarification in freeze concentrate.

Months	(a) Gelation in "S <sub>1</sub> " at 32°F		(b) Clarification in "S <sub>1</sub> "	
	32°F	0°F	32°F	0°F
	0	None.	None.	None.
1	None.	None.	None.	None.
2	None.	None.	None.	None.
3	None.	None.	None.	None.
4	None.	None.	None.	None.
5	V. slight.	None.	None.	None.
6	V. slight.	None.	None.	None.

- (a) Degree of gelation in concentrate samples after 24 hours at 80°F.  
 (b) Degree of clarification in the reconstituted concentrate samples after 10 minutes holding time.

Table 7. Quality attributes of reconstituted concentrates.

Attributes	No. of judges	"S <sub>1</sub> " Samples at		"S <sub>2</sub> " Samples at	
		30°F	0°F	32°F	0°F
Colour	10	8.60	9.40	6.90	8.80
Taste & flavour	10	8.30	9.10	3.90	5.50

reconstituted valencia late orange juice freeze (S<sub>1</sub>) and sugared concentrate (S<sub>2</sub>) samples has been shown in Table 7 which shows that colour of both the concentrate samples stored at 0°F., and 32°F., was liked by the panel members but the samples stored at 0°F., maintained better colour, as compared to the samples, kept at 32°F. The data also indicated that freeze concentrate samples (S<sub>1</sub>) maintained better colour than samples (S<sub>2</sub>) during six months storage period.

The data further indicated that the taste and flavour of both the samples stored at two different storage temperatures was acceptable to the panel members. The samples stored at 0°F., maintained better taste and flavour than samples kept at 32°F. Since all the samples were scored on ten point hedonic scale in which ten indicated extremely liked and one extremely disliked taste and flavour, a sample getting a mean score of 5.5 was considered to be liked by panel. This revealed that taste and flavour of sample "S<sub>1</sub>" kept at 0°F., and 32°F., and sample "S<sub>2</sub>" kept at 0°F, for six months, liked by the tasters. Whereas the taste and flavour of sample "S<sub>2</sub>" stored at 32°F, for the same storage period was disliked. (due to un-balanced sugar/acid ratio).

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