

Effect of Varying Degree of Debittered and Non-debittered Kinnow Serum Clarified by Different Methods on Quality of Concentrate

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Effect of varying degree of debittered and non-debittered kinnow serum clarified by different methods on quality of concentrate reveals that concentration up to 72 °B is obtained successfully. The reconstituted juice from concentrate, prepared from enzymatically clarified serum, is better in quality than the reconstituted juice prepared from serum clarified by centrifugation. Concentrate prepared from debittered serum is found to be superior in quality than that prepared from nondebittered serum which obviously results in better quality juice.

Introduction

Kinnow cultivation has assumed importance because it has many superior characteristics like heavy bearing, better adaptability, good fruit quality, compatability to withstand wind and hail storms and is frost resistant. It has also received popularity among North Indian citrus growers and a large acreage is being brought under its cultivation, particularly in Punjab, Haryana, and Himachal Pradesh^{1,2}. Despite the large potential for production the technology to preserve citrus fruits and their products is still not of much use. During heat processing, kinnow juice becomes bitter and thus poses a great hinderance on its commercial utilization for processing into juice or preservation in the form of concentrate. In Florida, USA, a resinous material Amberlite XAD-16 has been successfully used on pilot scale for debittering of citrus juices. However, in India, neither this nor any other method is in commercial use. Thus, the juice was debittered before concentration. For debittering of citrus juices with adsorptive resins, clarification of juice is a must, prior to debittering. Clarification of juice enables the commercial evaporators to produce concentrate of higher TSS (because of reduced viscosity) which has added advantage of reduced costs of transportation, storage, container, and handling over low Brix concentrate. Besides, concentrate also allows utilization of entire crop and makes round the year

availability of fruit juice. Keeping in view the aforementioned problem of development of bitterness in juice while converting kinnow fruit into juice or concentrate the present investigations were carried out to observe the effect of varying degree of concentrations on quality of concentrate prepared from debittered and non-debittered kinnow serum clarified by centrifugation and pectinolytic enzyme treatment.

Materials and Methods

Kinnow fruits were procured from a orchard at Dhaulakuan situated above 500 m above sea level in the Sirmour district of Himachal Pradesh. The fruits were harvested at optimum maturity which were ascertained on the basis of different physico-chemical characteristics of the fruits viz., fruit size, peel colour, weight, TSS, sugars, and titratable acidity. The sound and healthy fruits were used for juice extraction within a week after harvesting. The juice was extracted using screw type juice extractor. The SO₂ preserved juice was clarified by different methods of centrifugation and pectinolytic enzyme treatment. The clarification of juice by centrifugation was done at 2000 rpm for 20 min. The pectinolytic enzyme was procured from Triton Chemicals, Mysore. Regarding its activity nothing is yet known. However, P5000 has been mentioned on the product label. The serum clarified by centrifugation and enzyme treatment was divided into two lots. One lot was kept as such, i.e., nondebittered and the second lot was

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debittered using adsorbent Amberlite XAD-16. The serum was passed through a bed of adsorbent Amberlite XAD-16 in a column at a flow rate of 160 mL/min with holding time of 1.45 min and 10 L of serum was collected in one lot, followed by regeneration of XAD-16, using 2.0 per cent NaOH. Regeneration was done after each lot of 10 L. Eight such lots of 10 L. each were collected and the serum from all the lots was mixed. The reduction in the bittering components limonin and naringin in this 80 L of serum was to an extent of 85.3 and 41.5 per cent, respectively. The debittered and non-debittered serum was concentrated to varying degrees of TSS viz., 42, 52, 62, and 72°B. The concentration was done under vacuum (27 to 28" Hg at 50 to 60°C in a glass apparatus. The concentrate of different -4-Brix from serum clarified enzymatically and by centrifugation followed by concentration as such and after debittering was evaluated for different quality characteristics viz., sugars, titratable acidity, pH, ascorbic acid, browning, pectin, and relative viscosity. The concentrate was reconstituted to original TSS and to this pulp, at the rate of 15 per cent was added. Then the juice was blended with sugar to 16°B and orange essence was also added at the rate of 0.02 per cent. The reconstituted juice was also evaluated for tintometer colour units and sensory quality.

Sugars were estimated by Lane and Eynon's volumetric method, whereas titratable acidity was estimated as citric acid using titration method³. The pH was determined with the help of Eltop pH Meter 3030. For the determination of ascorbic acid the method³ using 2,6-dichlorophenol-indophenol dye was used. Browning was determined by the method described earlier⁴, whereas, pectin content was determined by Carre and Hayne's method as calcium pectate⁵. Relative viscosity of concentrate was measured in terms of its flow rate to that of tap water. Higher the flow rate, lower is the viscosity. Relative viscosity was measured with the help of an Ostwald Viscometer and expressed as the ratio of the time taken by concentrate to flow through a defined distance in an Ostwald Viscometer to that of time taken by tap water to flow through the same distance. The Tintometer colour units of reconstituted juice were measured in a Lovibond Tintometer, using 1 in cell, whereas sensory evaluation of juice was carried out with composite scoring for each attribute, i.e., colour, flavour, body, sugar-acid blend, and extent of debitterness, as per standard procedures⁶ and the scores under each attribute were summed up. The experiment was replicated thrice

and the data were analysed statistically by completely randomised design (CRD)⁷. The experiment was conducted in 1993-94 and 1994-95, respectively (Table 1). The similarity of the data of 2 y further adds to its reliability/validity.

Results and Discussion

A perusal of the data given in Table 1 reveals that all the sugars viz., total, reducing and non-reducing and titratable acidity increased significantly, pH decreased with the increase in the concentration of serum during both the years of study. Similarly, serum clarified by pectinolytic enzyme resulted in concentrate having insignificantly higher sugars and titratable acidity than the serum clarified by centrifugation. Concentrate from non-debittered serum had higher concentration though insignificant in sugars and titratable acidity than that in concentrate from debittered serum. The results were in agreement with earlier findings^{4,8-12}. The higher sugars and titratable acidity and lower pH of concentrate from serum clarified by pectinolytic enzyme is attributable to the extraction of more solids and acids into the juice or serum by the pectinolytic enzyme, as has been reported earlier^{11,13-15}. However, the lower titratable acidity of the concentrate from debittered serum is attributable to the adsorption of acids by the adsorbent Amberlite XAD-16, reported earlier^{16,17}.

Data regarding ascorbic acid, pectin, relative viscosity, and browning are presented in Table 2. This reveals that the values for these parameters increased significantly with the increased concentration of serum during both the years of investigation. The ascorbic acid content was recorded higher, whereas pectin, relative viscosity, and browning had lower values in the concentrate from serum clarified using pectinolytic enzyme than the serum clarified by centrifugation. These parameters were insignificantly affected by the serum type, i.e., debittered or nondebittered. However, ascorbic acid content was higher, whereas pectin, relative viscosity, and browning were lower in the concentrate from debittered serum than that of concentrate from non-debittered serum. The results are in conformity with the findings of earlier workers^{4,8-12}. The lower pectin content and relative viscosity of the concentrate from debittered serum than that from non-debittered serum could be ascribed to the adsorption of pulp if somewhat was left behind in the serum during the debittering, using XAD-16 adsorbent.

Table 1 — Changes in sugars, titratable acidity and pH during concentration of kinnow serum in 1993-94 and 1994-95

Treat ment no.	Detail of treatments		TSS (°B)	Total sugars (per cent)		Reducing sugars (per cent)		Non-reducing sugars (per cent)		Titratable acidity (per cent CA)		pH	
	Mode of clarification	Debittered or nondebittered		1993-94	1994-95	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95
T ₁	Enzyme	Debittered	72	56.63	57.10	43.52	44.25	12.46	12.20	7.21	7.23	3.57	3.52
T ₂	Centrifugation	Debittered	72	55.97	56.60	43.25	43.94	12.08	12.03	7.04	7.03	4.12	4.01
T ₃	Enzyme	Debittered	62	49.19	50.09	38.00	39.05	10.62	10.49	6.07	6.06	3.69	4.00
T ₄	Centrifugation	Debittered	62	48.92	49.64	37.81	38.91	10.55	10.20	6.02	6.04	4.14	4.09
T ₅	Enzyme	Debittered	52	42.50	43.73	33.46	34.63	8.59	8.26	4.92	4.93	3.85	4.12
T ₆	Centrifugation	Debittered	52	41.73	42.85	32.30	34.42	8.96	8.02	4.79	4.91	4.15	4.17
T ₇	Enzyme	Debittered	42	34.95	35.23	27.70	28.05	6.88	6.82	3.77	3.82	4.02	4.14
T ₈	Centrifugation	Debittered	42	34.18	34.93	26.49	27.56	7.30	7.01	3.60	3.76	4.16	4.21
T ₉	Enzyme	N-Debittered	72	57.44	57.99	43.96	44.66	12.80	12.66	7.23	7.26	3.56	3.51
T ₁₀	Centrifugation	N-Debittered	72	57.12	57.65	43.85	44.59	12.61	12.40	7.09	7.15	4.03	3.99
T ₁₁	Enzyme	N-Debittered	62	49.74	50.67	38.62	38.66	10.56	10.77	6.11	6.08	3.68	3.96
T ₁₂	Centrifugation	N-Debittered	62	49.48	50.43	38.10	39.11	10.82	10.75	6.08	6.05	4.06	4.08
T ₁₃	Enzyme	N-Debittered	52	42.41	43.40	34.46	34.39	7.24	8.56	4.93	4.97	3.82	4.09
T ₁₄	Centrifugation	N-Debittered	52	42.05	43.33	34.06	34.20	7.59	8.67	4.81	4.92	4.10	4.12
T ₁₅	Enzyme	N-Debittered	42	34.95	35.36	27.50	28.10	7.08	6.92	3.79	3.85	4.00	4.10
T ₁₆	Centrifugation	N-Debittered	42	34.82	35.45	27.63	27.62	6.83	7.44	3.61	3.79	4.14	4.18
C D (0.05)				1.28	1.76	1.45	1.35	1.70	1.18	0.10	0.15	0.10	0.11

N-Debittered = Nondebittered

Table 2 — Changes in ascorbic acid and pectin contents, relative viscosity and browning during concentration of kinnow serum in 1993-94 and 1994-95

Treat- ment no.	Detail of treatments		(°B)	Ascorbic acid (mg/100g)		Pectin (Calcium pectate) (per cent)		Relative viscosity		Browning (O.D. at 440nm)	
	Clarification	Nondebittered		1993-94	1994-95	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95
T ₁	Enzyme	Debittered	72	134.94	124.89	0.18	0.17	21.60	22.00	0.301	0.301
T ₂	Centrifugation	Debittered	72	134.69	124.83	0.21	0.22	22.20	22.30	0.311	0.312
T ₃	Enzyme	Debittered	62	114.33	108.09	0.15	0.14	3.65	3.69	0.260	0.259
T ₄	Centrifugation	Debittered	62	112.46	106.66	0.17	0.18	3.76	3.79	0.269	0.268
T ₅	Enzyme	Debittered	52	99.12	90.23	0.12	0.13	1.76	1.78	0.209	0.205
T ₆	Centrifugation	Debittered	52	97.13	89.21	0.14	0.16	1.88	1.90	0.220	0.213
T ₇	Enzyme	Debittered	42	79.35	72.60	0.09	0.08	1.43	1.46	0.133	0.128
T ₈	Centrifugation	Debittered	42	78.78	71.37	0.11	0.11	1.46	1.46	0.135	0.134
T ₉	Enzyme	N-Debittered	72	133.75	124.74	0.20	0.22	21.90	22.30	0.306	0.306
T ₁₀	Centrifugation	N-Debittered	72	133.10	124.32	0.21	0.23	22.60	22.80	0.315	0.321
T ₁₁	Enzyme	N-Debittered	62	112.80	107.55	0.17	0.16	3.82	3.71	0.268	0.267
T ₁₂	Centrifugation	N-Debittered	62	110.88	106.12	0.18	0.17	3.84	3.76	0.277	0.276
T ₁₃	Enzyme	N-Debittered	52	97.33	89.62	0.14	0.15	1.81	1.81	0.225	0.215
T ₁₄	Centrifugation	N-Debittered	52	96.33	88.58	0.16	0.18	1.93	1.93	0.232	0.226
T ₁₅	Enzyme	N-Debittered	42	78.35	71.82	0.10	0.10	1.45	1.48	0.141	0.136
T ₁₆	Centrifugation	N-Debittered	42	78.15	70.64	0.12	0.12	1.49	1.51	0.143	0.138
C D _(0.05)				3.14	2.25	0.02	0.02	0.46	0.55	0.024	0.033

N-Debittered = Nonbettered

Table 3—Effect of concentration of kinnow serum on tintometer colour units and sensory evaluation score of reconstituted juice during 1993-94 and 1994-95

Treatment no.	Detail of treatments		Tintometer colour units				Sensory evaluation				
	Mode of clarification	Debittered or nondebittered	TSS (°B)	1993-94 Yellow	1993-94 Red	1994-95 Yellow	1994-95 Red	Mean Yellow	Mean Red	score (100)	
T ₁	Enzyme	Debittered	72	10.0	3.0	10.0	3.0	10.0	3.0	71.0	70.0
T ₂	Centrifugation	Debittered	72	10.0	3.0	10.0	3.3	10.0	3.1	70.0	69.0
T ₃	Enzyme	Debittered	62	10.1	3.0	10.0	2.0	10.0	2.5	72.0	71.0
T ₄	Centrifugation	Debittered	62	10.5	3.0	10.7	3.0	10.6	3.0	71.0	70.0
T ₅	Enzyme	Debittered	52	10.9	3.0	11.1	3.0	11.0	3.0	72.0	71.0
T ₆	Centrifugation	Debittered	52	11.2	3.0	10.2	3.0	10.7	3.0	70.0	71.0
T ₇	Enzyme	Debittered	42	10.2	2.0	10.2	2.0	10.2	2.0	72.0	71.0
T ₈	Centrifugation	Debittered	42	10.2	2.0	10.1	2.0	10.1	2.0	71.0	71.0
T ₉	Enzyme	N-Debittered	72	10.1	3.0	10.0	3.0	10.0	3.0	63.0	63.0
T ₁₀	Centrifugation	N-Debittered	72	10.2	3.0	10.2	2.7	10.2	2.8	62.0	62.0
T ₁₁	Enzyme	N-Debittered	62	10.2	3.0	10.3	3.0	10.2	3.0	64.0	64.0
T ₁₂	Centrifugation	N-Debittered	62	10.7	3.0	10.9	3.0	10.8	3.0	63.0	63.0
T ₁₃	Enzyme	N-Debittered	52	10.9	3.0	11.1	3.0	11.0	3.0	64.0	64.0
T ₁₄	Centrifugation	N-Debittered	52	11.2	3.0	11.4	3.0	11.3	3.0	62.0	63.0
T ₁₅	Enzyme	N-Debittered	42	10.2	2.0	11.3	2.0	10.7	2.0	64.0	65.0
T ₁₆	Centrifugation	N-Debittered	42	10.1	2.0	11.2	2.0	10.1	2.0	63.0	64.0
C D										1.5	1.4

N-Debittered = Nondebittered

The data pertaining to the colour and sensory evaluation score of reconstituted juice presented in Table 3 reveal that red colour units were lower in the concentrate of lowest °B which increased with the enhanced concentration. In the concentrate of 42°B, yellow colour units were recorded lower corresponding to lowest red colour units. With increase in concentration from 42°B to 52°B, the yellow colour units were recorded higher as the units for red colour were increased and thereafter with the increase in concentration from 52°B to 72°B the yellow colour units decreased and the red colour units remained unchanged during both the years of study. These results were attributed to the increased browning with the increased concentration of serum. Increased browning with the increased concentration of fruit juice has also been reported earlier^{4,11,12}

The data given in Table 3 further reveal that the sensory score of the juice from the concentrate of maximum TSS, i.e., 72°B from the serum clarified enzymatically and debittered was at par with the score recorded by the juices from other concentrates of debittered serum under treatments, during both the years of study. Score for sensory evaluation was significantly higher in the juice from the concentrate prepared from debittered serum than that prepared from non-debittered serum, during both the years of investigation. The higher score for sensory quality recorded in the juice from the concentrate prepared from debittered serum than that prepared from non-debittered serum is attributed to the lower degree of bitterness of serum and less browning of the concentrate prepared from the debittered serum. The results that the reconstituted juice from concentrate of pectinolytic enzyme clarified serum recorded higher score than that clarified by centrifugation are comparable to the earlier findings¹² in which superior quality ready-

to-serve juice was prepared from pectinase clarified pear juice concentrate.

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