

Pilot Scale Debittering of Kinnow Juice Using Adsorbent Amberlite XAD-16

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Use of adsorbent Amberlite XAD-16 packed in glass column was standardized to debitter the kinnow juice. The XAD-16 was regenerated after each lot by washing with 2.0 per cent sodium hydroxide solution. The reduction in limonin and naringin contents in the first lot (0-10 L) was to an extent of 98.3 and 88.5 per cent, respectively, which decreased with its repeated use and the reduction of limonin and naringin in the eighth lot (70-80L) of serum was 68.2 and 17.7 per cent, respectively. The debittered serum was then reconstituted and the juice having 15 per cent pulp, 0.015 per cent orange essence blended to 16 °B TSS was prepared.

Introduction

Kinnow (*Citrus nobilis* x *Citrus deliciosa*) owing to its wider adaptability, higher yield, and quality attributes has assumed importance among North Indian citrus growers and a large acreage is being brought under its cultivation, particularly in Punjab, Haryana, Rajasthan, and Himachal Pradesh¹. Though the fresh fruits are quite delicious but they cannot be stored for longer duration. It is also well known that the processing of fruits results in the development of bitterness in the juice and this sort of taste is not liked by the consumers, particularly in India, which makes it difficult to prepare and market kinnow juice and its products. Thus the bitterness of kinnow juice is one of the serious hinderance in its processing. However, if this problem is overcome, then the saying "Breakfast without orange juice is like a day without sunshine" may hold true *per se* in our country as the juice will be made available round the year and the surplus fruit will also be utilized which will make kinnow cultivation to survive in the future. Several techniques, most of them based on adsorptive method of removal of bitterness causing compounds viz., limonin and naringin have been tried and some of them were successful for this purpose. However, among the different adsorbents, Amberlite XAD has been found to be most successful. Selective removal of bitter compounds from citrus juices by using Amberlite XAD-4 has already been reported^{2,3}. Limonin content of orange juice, treated with Amberlite XAD-16 resin, decreased to 9 mg/L from 23

mg/L, however, its reduction to an extent of 93 per cent has also been reported in orange juice⁴. On the other hand, 100 per cent removal of limonin from the sour orange juice, treated with XAD-16, has also been reported⁵. In another study, limonin and naringin reduction in grape fruit juice and treated with XAD-16 was recorded to an extent of 90 to 97 and 55-58 per cent, respectively⁶. However, in kinnow juice, treated with XAD-16 the reduction of limonin and naringin to an extent of 85.71 and 65.32 per cent, respectively, has been reported⁷.

The present investigations were, therefore, undertaken with a view to debitter the juice on pilot scale (9.6L/h) and to process it to overcome the problem of bitterness and make the juice available round the year.

Materials and Methods

Optimally matured kinnow fruits were procured from Dhaulakuan, situated at an elevation of 500 m above sea level in the Sirmour district of Himachal Pradesh, during 1993-94 and 1994-95. The fruits after their transportation to Department of Postharvest Technology were analysed for different physico-chemical characteristics. The juice was then extracted by using screw type juice extractor and preserved with sulphur dioxide at the rate of 700 ppm before clarification by pectinolytic enzyme. The preserved juice was treated with 0.8 per cent pectinolytic enzyme at 40±1°C for 4h and the treated juice was kept overnight for sedimentation. The pectinolytic enzyme (pectinase)

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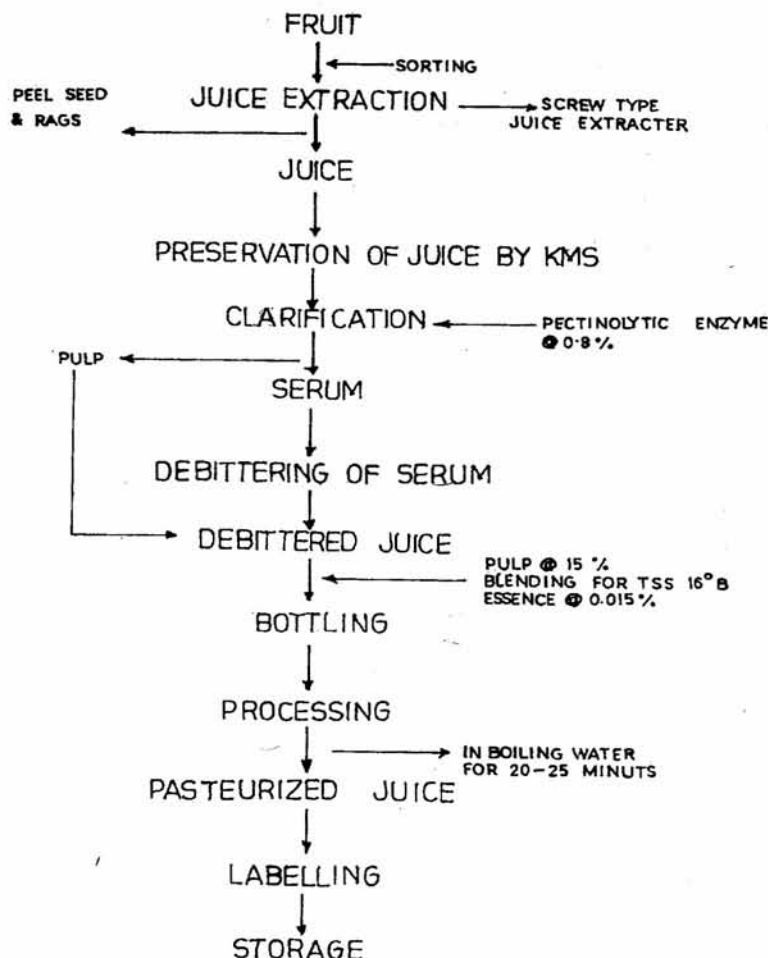


Figure 1—Unit operations in debittering of kinnow juice on pilot scale

which is a mixture of pectinmethylesterase (PME) and polygalacturonase (PG) was procured from Triton chemicals, Mysore, Karnatka (India). Regarding its activity, nothing much is known, except that P 5000 has been written on the product label. The supernatant (serum) was collected by siphoning off it for debittering purpose. The serum was passed through glass column, packed with 120 g Amberlite XAD-16 at a flow rate of 160 mL/min. The serum was collected in eight lots of 10 L each. After collecting each lot the adsorbent was washed with 2.0 per cent NaOH, followed by washing with tap water to make it NaOH-free. The pulp, serum, and debittered serum from each lot were analysed for the limonin and naringin contents. The debittered serum was then reconstituted into juice having 15 per cent pulp level and 0.015 per cent orange essence and varying total soluble solids levels.

The unit operations of debittering kinnow juice are shown in Figure 1. The juice was then analysed for sensory quality. Limonin content was estimated by method reported by Vaks and Lifshitz⁸ and naringin content by the method of Davis⁹. Sensory evaluation for different attributes was done by composite scoring method¹⁰.

Results and Discussion

The data regarding the contents of bitter compounds in serum and pulp and their contents and reduction in the serum debittered by using adsorbent Amberlite XAD-16 are given in Table 1.

The data show that the serum had lower limonin and naringin contents compared with the pulp. The contents and reduction of limonin and naringin were

Table 1—Limonin and naringin contents and their reduction in XAD-16 debittered kinnow serum during 1993-94 and 1994-95

Lot in l	Limonin						Naringin					
	Content(ug/mL)			Reduction(per cent)			Content(ug/mL)			Reduction per cent		
	1993-94	1994-95	Mean	1993-94	1994-95	Mean	1993-94	1994-95	Mean	1993-94	1994-95	Mean
1st (0-10)	3.2	2.9	3.0	98.3	98.4	98.3	42.4	34.5	38.5	87.5	89.5	88.5
2nd (10-20)	6.6	6.7	6.6	96.5	96.3	96.4	125.2	119.7	122.4	63.2	63.5	63.3
3rd (20-30)	15.3	14.8	15.0	92.0	91.8	91.9	175.8	167.3	171.5	48.3	49.0	48.6
4th (30-40)	21.4	20.0	20.7	88.8	88.9	88.8	221.3	215.4	218.3	35.0	34.4	34.7
5th (40-50)	28.9	26.6	27.7	84.8	85.3	85.0	235.4	229.3	232.3	30.8	30.1	30.4
6th (50-60)	39.4	38.0	38.7	79.3	78.9	79.1	250.1	245.6	247.8	26.5	25.2	25.8
7th (60-70)	48.4	46.5	47.6	74.4	74.2	74.3	265.1	256.2	260.6	22.1	22.0	22.0
8th (70-80)	59.6	58.3	58.9	68.7	67.7	68.2	278.4	271.9	275.1	18.2	17.2	17.7
Serum	190.4	180.5	185.4	—	—	—	340.7	328.3	334.5	—	—	—
Pulp	215.4	200.8	208.1	—	—	—	368.5	353.5	361.0	—	—	—

Table 2—Effect of varying levels of Total Soluble Solids (TSS) on sensory evaluation score of reconstituted juice during 1993-94 and 1994-95

TSS (°B)	Colour		Flavour		Body		Taste (Acid-sugar blend)		Extent of debitterness		Total	
	(20)		(20)		(20)		(20)		(20)		(100)	
	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95
15	15.5	15.3	14.3	14.0	14.8	14.7	14.5	15.0	14.0	13.0	73.3	72.0
16	15.2	15.0	15.0	15.0	15.0	14.8	14.8	15.0	14.8	14.1	74.8	74.0
17	15.0	15.0	14.5	14.7	14.7	14.8	14.8	14.7	15.2	14.3	74.2	73.4
18	15.0	15.0	14.7	14.9	14.3	14.5	14.5	14.0	15.4	14.7	74.5	73.3
CD _(0.05)	NS	NS	0.4	0.5	NS	NS	NS	0.5	0.9	0.6	NS	NS

almost similar during both the years of study and the mean reduction in limonin and naringin contents in first lot (0 to 10 L) of debittered serum was 98.3 and 88.5 per cent, respectively. The reduction in limonin and naringin contents by the repeated use of XAD-16 decreased to 85.0 and 30.4 per cent, respectively, in the fifth lot (40 to 50 L) of debittered serum. Table 1 further shows that the efficiency of adsorbent Amberlite XAD-16 for reduction of limonin and naringin further decreased in the eighth lot (70 to 80 L) of debittered serum and the mean limonin and naringin reduction was 68.2 and 17.7 per cent, respectively. Reduction of bittering compounds by the use of XAD-16 has also been reported in citrus juices⁴⁻⁶ and in kinnow juice⁷. The decrease in efficiency of XAD-16 on its repeated use to debitter the citrus juices has also been reported⁶. The reduction in bitter principles

of XAD-16 treated juice could be attributed to the adsorption of these compounds on the specific sites on the adsorbent¹¹.

The data regarding the sensory evaluation and score for different quality attributes are given in Table 2. The data reveal that there were insignificant differences for colour and body among the juices having different TSS (°B) during both the years of study. Score for flavour was recorded highest in the juice having 16°B TSS during both the years of study. Score for taste was recorded to be highest in the juice having 16 and 17°B TSS during 1993-94 and in the juice having TSS of 15 and 16 °B during 1994-95. The score for extent of bitterness was highest in the juice having 18°B TSS during both the years of the study. Total score for sensory evaluation was observed to be highest, though insignificant in the

juice having TSS of 16°B during both the years of study.

Conclusion

On the basis of these results, it is concluded that adsorbent Amberlite XAD-16 can be successfully used for debittering of kinnow juice on pilot scale. The debittered serum was reconstituted into juice by adding 15 per cent pulp and 0.015 per cent orange essence. The juice blended to 16 °B was judged to be of maximum acceptability.

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