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EFFECT OF PROCESSING AND STORAGE ON THE DEVELOPMENT OF BITTERNESS IN THE ORANGE JUICE

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Abstract. The effect of three methods of extraction, and pasteurization and storage on the limonin content of the juice from Valencia orange was determined. The limonin content of the fresh juice was observed to range between 2–3 p.p.m. and to increase to a level of 11–13 p.p.m. after pasteurization. There was little change in this constituent during storage. It appeared that most of the limonin had been formed from its non-bitter precursor (limonate A—ring lactone) during pasteurization. Changes in the ascorbic acid content, total titratable acidity, and pH of the juice during processing and storage was also determined.

Citrus fruits are an important commercial crop in Pakistan. They are consumed mainly as fresh fruit but a substantial amount of the crop is also preserved in the form of squash, canned juice and ready-to-drink beverages. These products have not been readily accepted by the consumer primarily due to the development of bitterness. Bitterness is incorporated into these products from rag, peel and seeds of the fruits in the form of limonate A—ring lactone (precursor of the bitter principle, limonin).[1] The extent of limonin bitterness depends upon the variety of orange,[2] rootstock,[3–5] methods of extraction[6] and stage of maturity.[7,8] In Pakistan juice is generally extracted by three different methods, i.e. reamer-head, pressure type and screw type extractors.

The present study was undertaken to determine the effect of method of extraction, pasteurization and storage on the development of bitterness in Valencia orange juice.

Materials and Methods

Valencia oranges were taken at full maturity. The juice was extracted by the following three methods:

a. Juice was extracted from halved oranges with the help of a reamer in which the cut fruit was kept pressed against the reamer-head by hand until all the juice had been extracted.

b. Juice was extracted in a pressure-type extractor which consisted of a convex screen fixed on a stand. Halved fruits were placed on this screen (cut side facing the screen) one by one and pressure was applied on the fruit by an inverted cup with the help of a lever.

c. Oranges were peeled and sections separated. These sections were fed into a meat mincer-type screw-press extractor fitted with a screen. The juice flowed through the screen while the rag was extruded through the mincer head.

Each lot of juice was strained through a pulper and pasteurized in a steam kettle at 195°F. The juice was then filled into No. 2 plain tin cans and stored. The fresh juice was analysed for various chemical constituents just after extraction (and again) after pasteurization, and the canned juice was analysed after 1, 15, 30, 45 and 60 days of storage at ambient temperature (25–30°C).

Ascorbic acid was determined by the method recommended by the A.O.A.C.[10] using 2,6-dichlorophenol indophenol. Total titratable acidity was also determined by the same method, and juice pH was determined with a Pye 70-model pH-meter.

Total soluble solids were determined with an Abbe refractometer and the results were expressed as per cent by weight of soluble solids.

The juice samples were also scored and tested for bitterness and degree of acceptance.

Results and Discussion

The data on the limonin content of Valencia orange juice are given in Table 1, The development time of chromatograms in acetic acid–acetone–benzene–hexane (3:10:22:65) was observed to be 2 hr as compared to 1 hr as reported by Chandler.[9] The *Rf* value of limonin spot was observed to be 0.66 and four spots of limonoids were detected within a range of 0.06–0.25 in *Rf* value as compared to 0.1–0.55 reported by Chandler.[9]

A comparison of spots for limonoids other than limonin showed that their greatest concentration occurred in the case of juice extracted by pressure type

TABLE 1. EFFECTS OF METHOD OF EXTRACTION, PASTEURIZATION AND STORAGE ON QUALITY FACTORS IN VALENCIA ORANGE JUICE.

Treatments (methods of extraction)	Fresh juice	Pasteurized juice	Storage time (days)				
			1	15	30	45	60
Limonin Content (p.p.m.)							
Reamer	2	12	13	13	12	13	13
Pressure-type extractor	2	11	12	11	12	12	12
Screw-type extractor	3	13	14	14	13	14	14
Ascorbic Acid Content (mg/100 ml)							
Reamer	70.00	67.20	64.50	60.21	56.10	51.40	46.00
Pressure-type extractor	71.00	68.80	66.67	62.51	57.30	52.21	47.00
Screw-type extractor	70.00	66.80	64.30	60.06	55.21	51.01	45.45
Titrable Acidity (per cent citric acid)							
Reamer	0.68	0.68	0.72	0.79	0.80	0.80	0.81
Pressure-type extractor	0.70	0.73	0.76	0.84	0.86	0.86	0.86
Screw-type extractor	0.67	0.68	0.72	0.80	0.80	0.81	0.81
pH *Value*							
Reamer	4.25	4.25	4.20	4.18	4.12	4.07	4.02
Pressure-type extractor	4.20	4.20	4.15	4.15	4.10	4.02	3.95
Screw-type extractor	4.25	4.25	4.20	4.18	4.15	4.06	4.00

extractor which also gave juice of slightly lower limonin contents than other methods. The limonin contents of the juice extracted by the screw-type extractor was slightly higher than that of other juices, probably as a result of the crushing of seeds and section coverings during the process.

The limonin content of freshly extracted juice ranged between 2–3 p.p.m. and increased to a range of 11–13 p.p.m. just after pasteurization. There was no consistent increase or decrease in limonin content during storage indicating that most of the precursor had been converted to limonin during pasteurization or immediately after it.

The limonin content of Valencia orange juice observed in these studies was higher than that reported by Scott.[2] The limonin content of Washington Navel orange juice (heated at 70°C for 2 hr) was reported by Wilson and Crutchfield[5] to be in the range 9–18 p.p.m, which was generally higher than observed in these studies.

Organoleptic evaluations showed a nonsignificant effect of the methods of extraction on juice bitterness but the juice was rated as extremely bitter after pasteurization in all cases. Similarly the juice after pasteurization and during storage were rated as unacceptable. These observations correlated with the limonin content of the juice which increased almost four-fold during pasteurization.

There was no significant effect of method of extraction on ascorbic acid content (Table 1). A loss of 3–4 mg ascorbic acid/100 ml occurred during pasteurization and there was a gradual and significant decrease in this constituent during storage. The approximate retention of ascorbic acid after 60 days storage was 66%.

The data on total titrable acidity and pH (Table 1) indicated nonsignificant effects of methods of extraction and pasteurization, however, there was a slight increase in acidity and a corresponding decrease in pH during storage.

The total soluble solids of the freshly extracted juice was observed to be 8.50%; it remained unchanged during pasteurization but increased to 8.57% during storage.

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