Systematic study of the effect of conventional and non-conventional processing on vitamins in fruit juices

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1. Introduction

Fruit juices are a good source of water-soluble vitamins; therefore, vitamin retention in these products is a critical quality attribute [1]. Non-conventional processing technologies are believed to ensure better vitamin retention than conventional thermal treatment (TT) due to short treatment time and low operating temperatures [2]. Recent review studies, however, demonstrate that the knowledge on the topic is fragmentary[3]. To ensure fair and reliable characterization of the effects of different preservation technologies on the quality of fruit juices, it is essential to perform a comparison under comparable conditions.

2. Methodology

2.1.B vitamin analysis

Table 1. The table summarizes the HPLC parameters for the developed vitamin B method.

Column	Agilent EC-C18 Poroshell (3.0 mm x 150 mm, 2.7 µm)
Column Temperature	20 °C
Injection Volume	5 µL
Eluents	**A:** 0.1 % Formic acid in 4.5 mM of Ammonium Formate buffer in water* **B:** 0.1 % Formic acid in 4.5 mM of Ammonium Formate buffer in Methanol*
Ion Source Temperature	500 °C
Ionising Voltage	3500 V

Table 2. The table shows MS-related parameters for the respective vitamins along with their retention time.

Q1	Q3	Analyte	Retention time (min)
265.0	122.0	Thiamine B1	2.6
124.0	78.1	Nicotinic acid B3-A	3.9
123.2	80.0	Nicotinamide B3-M	5.5
170.0	152.2	Pyridoxine B6	6.1
220.1	202.1	Pantothenic Acid B5	11.4
678.4	147.1	Cyanocobalamin B12	11.9
442.1	295.2	Folic acid B9	12.4
245.1	227.1	Biotin B7	12.6
377.1	243.0	Riboflavin B2	12.7

2.2.Vitamin C analysis

Table 3. The table shows a summary of the HPLC parameters for the developed vitamin C method.

Column	SeQuant®ZIC-HILIC (2.1 × 100 mm, 3.5 µm)
Column Temperature	5 °C
Injection Volume	0.5 µL
Ion Source Temperature	350 °C
Ionization Voltage	-4500 V
Flow rate	0.3 mL/min

Table 4. The table shows the MS-related parameters for the respective vitamins, along with their retention time. AA: ascorbic acid, DHA: dehydroascorbic acid

Analyte	Retention time (min)	Q 1 (m/z)	Q 3 (m/z)	DP (V)	CE (V)	CXP (V)
AA	5.25	175	115*	-60	-15	-9
			87	-60	-24	-9
			71	-60	-15	-9
DHA	2.97	173	113*	-115	-14	-11
			99	-115	-12	-13
			71	-115	-22	-29

2.3.Comparison of technologies

Table 5. The summary of processing conditions for the processing technologies corresponding to 5 log reduction of reference microbe.

Processing technique	Processing parameters
Conventional thermal processing (TT)	Temperature: 72 °C Holding time: 117 s
High pressure processing (HP)	Pressure: 600 MPa Holding time: 5 min
Pulse electric field (PF)	Field strength: 20 kV/cm Specific Energy: 100 kJ/Kg Treatment time: 109 µs
Ohmic heating (OH)	Temperature: 72 °C Holding time: 117 s

Pilot-scale equipment was used to undertake processing. The processing conditions were validated using a surrogate matrix for the 5-log reduction condition at the pilot scale. The surrogate matrix was a sugar solution with water, and soluble solids and titratable acidity were adjusted to 12° and 5 g/kg. Strawberry nectar was used as a model matrix. The strawberry nectar was prepared after blending 40 % strawberry puree with water. Sucrose and citric acid were added to adjust the soluble solids and titratable acidity to 12° and 5 g/kg, respectively.

3. Results

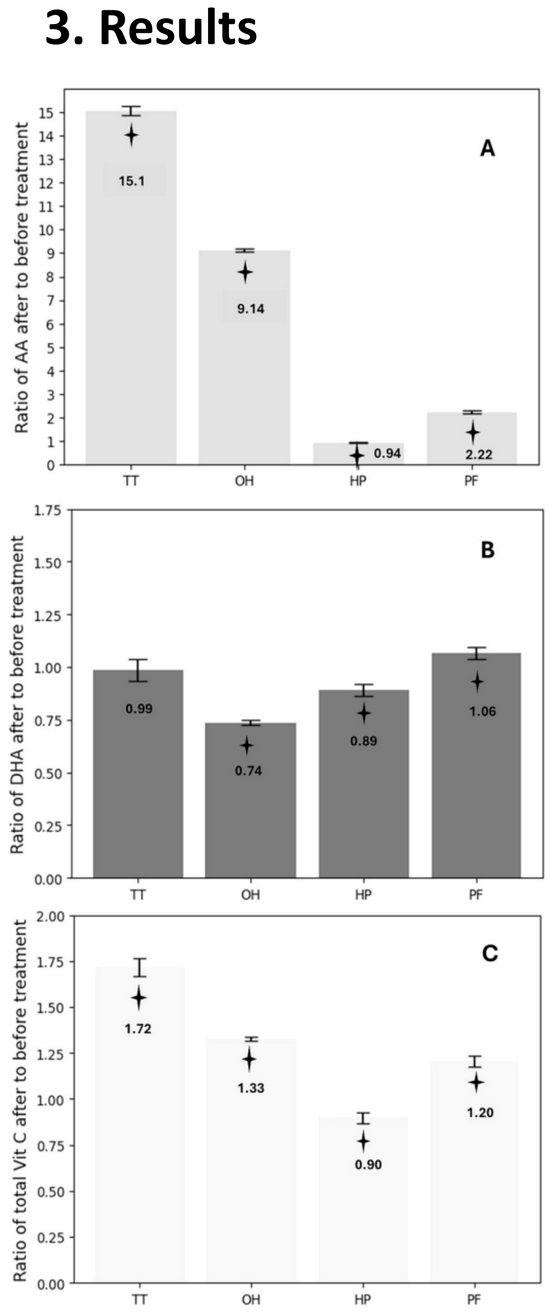

Figure 1. Change in the content of AA (A), DHA (B), and total vitamin C content (C). The star symbol shows a significant difference in the content between treated and untreated nectar ($p < 0.05$). AA: ascorbic acid, DHA: dehydroascorbic acid

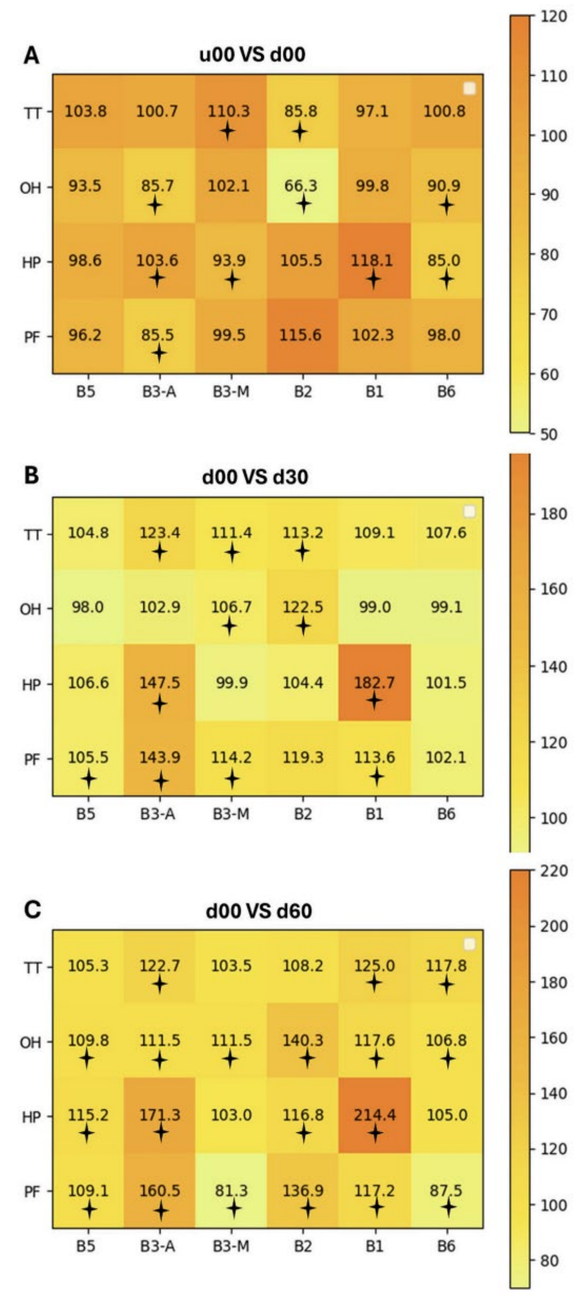

Figure 2. Change in the content of B vitamins after treatment (A) and after storage of treated strawberry nectar at 4 °C for 30 days (B) and 60 days (C). The change is reported as % retention. The star symbol indicates the statistical significance

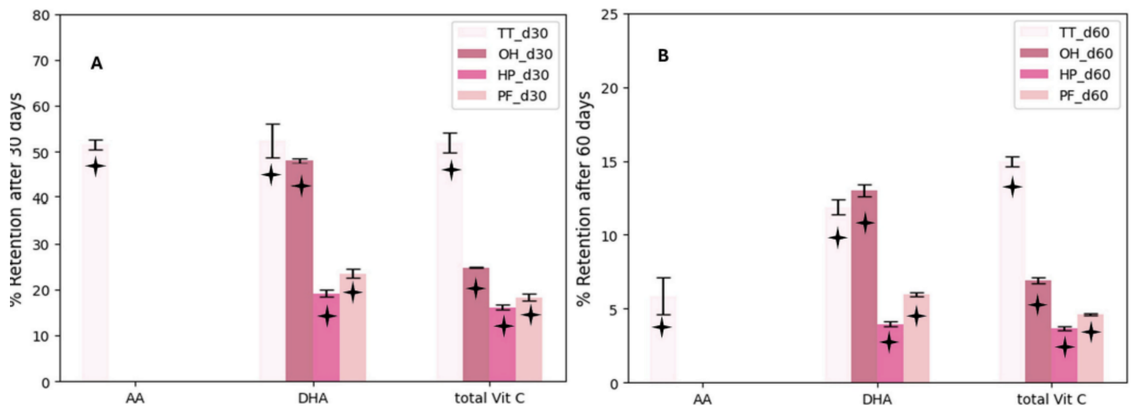

Figure 3. Change in the content of ascorbic acid (AA), dehydroascorbic acid (DHA), and total vitamin C content (AA+DHA) in treated strawberry after 30 days (A) and 60 days (B) of storage at 4 °C. The star symbol shows a significant decrease in the content of analytes in the treated samples ($p < 0.05$).

4. Conclusion

- This study concludes simple and accurate multi-vitamin analysis methods for water-soluble vitamins. The methods can facilitate fast and accurate B vitamin routine analysis in fruit juices.
- TT, OH, and PF resulted in a significant increase in AA content.
- TT-treated nectar had best retention of vitamin C after treatment and during storage.
- The B vitamins remained largely unchanged after processing
- B vitamin content in treated nectars significantly increased during storage

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