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NUTRITIONAL QUALITY OF THERMALLY PROCESSED FRUITS AND VEGETABLES

Pushpa Chethan Kumar[1] , Ranjitha, K[2] and Ranjitha, J[3]

ICAR-Indian Institute of Horticultural Research, Hesaraghatta Lake Post, Bengaluru

**Corresponding author email: pushpa.chethan@icar.gov.in*

ABSTRACT

Processing fruits and vegetables are necessary for preserving, producing a value-added product, and reducing the post-harvest losses in fruits and vegetables. The application of thermal processing has led to many products benefiting both producers and consumers. Owing to the impact of high temperature treatment on nutritional and sensory properties of food, many novel non-thermal processing techniques have been developed. However, even thermal processing has some beneficial effects as it enhances the bio-accessibility of some of the bioactive compounds existing in fruits and vegetables. Hence, both thermal and non-thermal processed products impact the overall availability of nutrients to the consumers.

INTRODUCTION

Processing of fruit and vegetables mainly depend on the application of heat. Even today, the most common method for processing food is the application of heat. It is required to reduce the enzyme activity, reduce the moisture content, and remove the microbial load. However, thermal processing leads to changes in foods' chemical, physical, sensory, and nutritional quality. Although thermal processing aims to reduce food spoilage by microorganisms, it results in undesirable modifications in sensory attributes, nutrients content, and bioactive compounds in many conditions. Besides being well established, scientific studies have shown the impact of thermal processing of fruits and vegetables on their nutritional quality; still, the high-temperature application remains the most efficient way of processing. However, to overcome this deprivation of nutrients, fortification of processed foods has also been attempted and successfully demonstrated.

IMPACT OF THERMAL PROCESSING ON NUTRITIONAL QUALITY

Many studies have shown that heat treatment can enhance or degrade the nutrients present in food during processing (Table 1). The bioavailability of lycopene was enhanced due to thermal processing. The lycopene bio-accessibility was increased from 5.1 to 9.2 and 9.7 mg/kg at 60 and 90 °C blanchings, respectively, followed by boiling (Svelander *et al.*, 2010). Smoothie prepared from carrot juice-papaya-mango combination showed a better liberation and micellarization of carotenoids than an unprocessed raw smoothie. Upon mild

Table 1: Effect of thermal processing on nutrients present in fruits and vegetables

Product	**Treatment**	**Bioactive compound**	**Per cent change on dry weight basis**	**Reference**
Apple	Vacuum drying	Vitamin C	1.35	Joshi *et al.*, 2011
		Total phenols	9.31	
Starfruit	Freeze-drying	β-carotene	15.75	Shofian *et al.*, 2011
Mango			26.21	
Papaya			8.23	
Muskmelon			2.96	
Watermelon			43	
Starfruit	Freeze-drying	Ascorbic acid	6.41	Shofian *et al.*, 2011
Mango			0.23	
Papaya			1.62	
Muskmelon			22.76	
Watermelon			36	
Apricot	Canning	β-carotene	17.72	Adkison *et al.*, 2018
		Ascorbic acid	34	
		Phenols	47.70	
Jackfruit	Hot-air drying	Carotenoids	50	Saxena *et al.*, 2012
Guava	Freeze drying	β-carotene	26.27	Leiton-Ramirez *et al.*, 2020
		Lycopene	39	
		Ascorbic acid	62.12	
	Refractance window drying	β-carotene	4.26	
		Lycopene	29.57	
		Ascorbic acid	69.56	

(90 °C, 20 s), intensive heat treatment (120 °C, 20 s), and ultrasound treatment (60 °C, 20 min), β-cryptoxanthin liberation was found in the range of 3%, 10.3%, and 9%, respectively. However, mild heat treatment showed 34.2% liberation of β-carotene, but significantly higher micellarization was found in

intensive heat treatment for β-cryptoxanthin and β –carotene compared to the unprocessed raw smoothie (Buniowska *et al*., 2019).

Moisture content often changes during processing, especially in thermal processing such as drying and storage. Removal of moisture to the extent of 5-15 % in fruits, vegetables, and green leafy vegetables resulted in the high value of bioactive compounds present per unit weight compared to fresh samples (Kumar *et al.,* 2020). As drying of fruit and vegetables enables easy transportation and preservation of commodities, the dried fruits and vegetables can be used as an ingredient without much being devoid of bioactive compounds. The thermal treatment enhances the bio-accessibility of carotenes and reduces the antinutritional compounds present in vegetables, including phytic acid, tannic acid, and oxalic acid. Conventional and microwave heat treatment in vegetables showed a significant reduction of these antinutritional compounds.

Similarly, amla, known for vitamin C content, cannot be consumed more as fresh due to high astringency, but processing amla into osmotically dehydrated segments can provide consumers about 20-25% of the required vitamin C per day without any astringency. In addition, the consumption of amla products rich in ascorbic acid and other iron-rich foods enhances iron absorption in our body. Moreover, many processed products are fortified with micronutrients which acts as a suitable vehicle for targeted and market-driven fortification.

Furthermore, freeze-drying of fruit and vegetables showed increased content of ascorbic acid. Freeze drying of carrot, muskmelon and peach for 48–72 hours resulted in less than or equal to a 3-fold increase in the content of ascorbic acid.

RECENT PROCESSING TECHNOLOGIES TO REDUCE THE NUTRIENT LOSS

Demand for high-quality foods by consumers with high nutrient content has led to the development of many new technologies in the food industry to preserve nutrients and prevent microbial spoilage. Novel thermal and non-thermal processing techniques such as ohmic heating, dielectric heating/microwave heating/radio frequency heating, pulsed electric field, ozone processing, ultrasound and high hydrostatic pressure processing may be used alone or in combination with other processing methods. Processing of foods using non-thermal technologies resulted in minimal or no changes in flavour, colour, and essential nutrients. Yildiz *et al*. (2009) Showed that the total phenolic contents of pomegranate juice did not alter much when ohmic heat was applied. High retention of lycopene and antioxidant activity was observed in watermelon juice when the high-intensity pulsed electric field was set up at electric field strength of 35 kV/cm for 50 µs at 200 Hz (Oms-Oliu *et al*., 2009). High-pressure processing (600 MPa, 40 °C, 4 min) of fresh Navel orange juice resulted in better retention of the antioxidant activity compared to thermally pasteurized (80 °C, 60 s) juice during storage (Polydera *et al*., 2005). Thus, the new non-thermal technologies can retain the nutrients present in fruit and vegetables during processing. At the industrial level, applying these technologies is a challenge as it involves standardization of process for product and the cost involved.

CONCLUSION

Thermal processing is a well-accepted processing method for value addition and food preservation. Even though thermal processing leads to some degradation of nutrients and bioactive compounds in fruits and vegetables, some of them have shown to be more bio-accessible than their fresh counterparts. Changes in the nutritional quality of foods processed using high temperatures have led to novel non-thermal techniques. The application of non-thermal processing techniques resulted in the retention of nutrients in the product with appreciable sensory parameters and shelf life.

REFERENCES

Adkison, E.C., Biasi, W.B., Bikoba, V., Holstege, D.M and Mitcham. E. J. 2018. Effect of canning and freezing on the nutritional content of apricots. *Journal food Science* 83(6): 1757-1761.

Barret, D.M. 2007. Maximizing the Nutritional Value of Fruits & Vegetables. *Food Technology Magazine*. April 1, 2007

Buniowska, M., Arrigoni, E., Znamirowska, A., Blesa, J, Frígola, A and Esteve, M. J. 2019. Liberation and Micellarization of Carotenoids from Different Smoothies after Thermal and Ultrasound Treatments. *Foods* 8(10): 492

Joshi, A.P.K., Rupasinghe, H.P.V and Khanizadeh. S. 2011. Impact of drying processes on bioactive phenolics, vitamin c and antioxidant capacity of red-fleshed apple slices. *Journal of Food Processing and Preservation* 35 (4): 453-457

Kumar, P.C., Sethuraman, B., Azeez, S and Kozhummal, R. 2020. Effect of drying methods and storage on bioactive compounds of *Moringa oliefera* leaf powder. *International Journal of Chemical Studies* 8(4): 1406-1410. DOI: 10.22271/chemi.2020.v8.i4m.9795

Leiton-Ramirez, Y.M., Ayala-Aponte, A and Ochoa-Martinez, C. 2020. Physicochemical Properties of Guava Snacks as Affected by Drying Technology. *Processes* 8(1): 106. https://doi.org/10.3390/pr8010106

Leong, S.Y and Oey, I. 2012. Effects of processing on anthocyanins, carotenoids and vitamin C in summer fruits and vegetables. *Food Chemistry* 133:1577–1587.

Oms-Oliu, G., Odriozola-Serrano, I., Soliva-Fortuny, R and Martín-Belloso, O. 2009. Effects of high-intensity pulsed electric field processing conditions on lycopene, vitamin C and antioxidant capacity of watermelon juice. *Food Chemistry* 115:1312-1319

Polydera, A.C., Stoforos, N.G and Taoukis. PS 2005. Effect of high hydrostatic pressure treatment on post processing antioxidant activity of fresh Navel orange juice. *Food Chemistry* 91(**3**): 495-503.

Saxena, A., Maity, T., Raju, P.S and Bawa, A.S. 2012. Degradation Kinetics of Colour and Total Carotenoids in Jackfruit (*Artocarpus heterophyllus*) Bulb Slices During Hot Air Drying. *Food and Bioprocess Technology* **5**: 672–679

Shofian, et al. 2011. Effect of Freeze-Drying on the Antioxidant Compounds and Antioxidant Activity of Selected Tropical Fruits. *International Journal Molecular Sciences* 12(**7**): 4678-4692

Svelander, C.A., Tiback, E.A., Ahrne, L.M., Langton, MIBC, Svanberg, U.S.O., Alminger, M.A.G. Processing of tomato: Impact on *in vitro* bioaccessibility of lycopene and textural properties. *Journal Food Science Agriculture* **90**:1665-1672.

Yildiz, H., Bozkurt, H. and Icier, F.İ.L.İ.Z., 2009. Ohmic and conventional heating of pomegranate juice: effects on rheology, color, and total phenolics. *Food Science and Technology International*, 15(**5**):503-512.

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