

UltraSound-Steam Treatment Process for Quality change during Frozen storage of Vegetables

Regina Basumatary, Dr. Ali R Taherian, Neelakanth Lamani, Husain Dhariwala, Ali Asgar Rampurwala, Maheshwor Bastakoti, Dr. Hosahalli S. Ramaswamy

McGill University (Macdonald Campus),
Department of Food Science and Agricultural Chemistry, Sainte-Anne-de-Bellevue, Canada
Email: regina.basumatary@mail.mcgill.ca; hosahalli.ramaswamy@mcgill.ca

Abstract:

This study is aimed at demonstrating the effectiveness of combination heating of ultrasound to enhance heat transfer from steam and steam/air mixtures for enzyme inactivation of vegetables for blanching prior to freezing and storage and quality retention of the frozen vegetables during storage. Enzyme inactivation studies using different blanching methods were conducted on fresh vegetables such as green pepper, zucchini and broccoli using a custom pilot scale equipment and quality analysis of the frozen vegetables during storage was determined. Results on the efficiency of enzyme inactivation and quality retention of the vegetable are presented.

Introduction:

Blanching is a mild heat treatment given to inactivate oxidative enzymes in vegetables prior to canning, freezing or drying. Hot-water and steam blanching are commonly used for enzyme inactivation; hot-water treatment generally results in nutrient leaching, and steam blanching can take relatively longer time in the presence of entrapped air. Adding ultrasound waves to steam has the potential to reduce the influence of entrapped air and rapid expulsion of tissue air thereby enhance the heat transfer and rapid enzyme inactivation.

Objective:

In this work, the ultrasound-assisted steam and steam-air blanching process was evaluated and compared with hot water blanching for influence on physicochemical and mechanical properties of green pepper, zucchini and broccoli. The main objectives were:

- To establish the blanching treatment schedule for fresh vegetables using ultrasound-steam and steam/air process for enzyme inactivation in different vegetables and compare with conventional hot water treatment.
- Develop kinetic models to characterize enzyme inactivation
- To compare US blanching with conventional blanching for frozen storage of vegetables.

Methodology:



Fig.1. Vegetables cut in specific dimensions



Fig.2. Blanching treatment (30-300s)

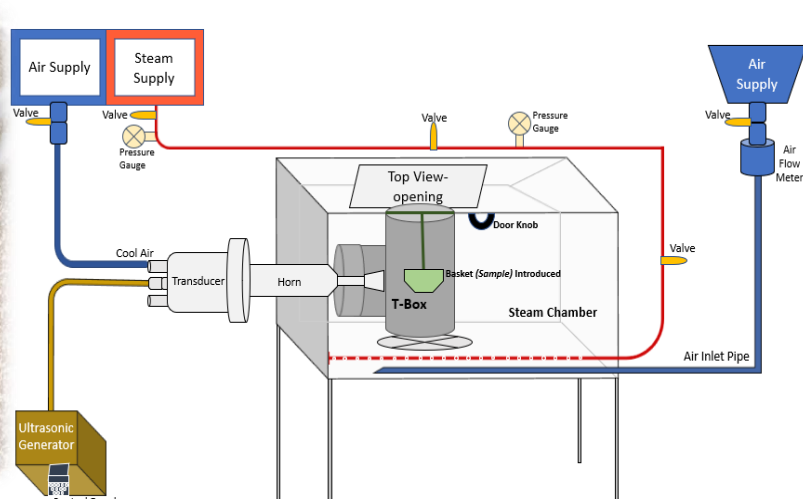


Fig.3. Schematic diagram of US-steam treatment chamber

Quality Analysis : Color, Texture & Ascorbic Acid Content

Enzyme Inactivation

Kinetic Data Analysis and Blanching Time Determination:

$$\log\left(\frac{N}{N_0}\right) = -\frac{t}{D}$$

where N= enzyme activity (change in optical density/min),

t = time (min),

N₀ = initial enzyme activity.

D is the decimal reduction time (D-value is time needed to reduce 90% of the activity). The D value can be obtained as the negative reciprocal of linear regression slope of log (N/N₀) versus time (min).

$$D = -(1/\text{slope})$$

Blanching Time: Time taken to achieve 95% inactivation of peroxidase (calculated as 1.5D).

Establish blanching time for different vegetables

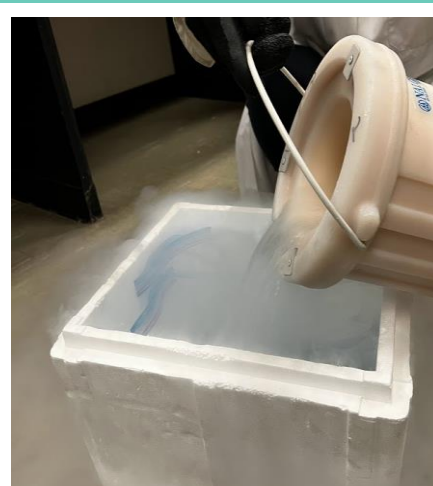
Freezing and Storage Studies

All vegetables cut in specific dimensions

Steam & Steam-Ultrasound blanching (Fig.3) with absence and presence of added air (25%air/75% Steam); Hot water blanching (90°C); Treatment time : Based on enzyme inactivation studies

Immediately cooled in ice cold water

Frozen using liquid nitrogen and stored at -20°C for storage studies and quality analysis



Liquid Nitrogen Freezing

Results and Discussion:

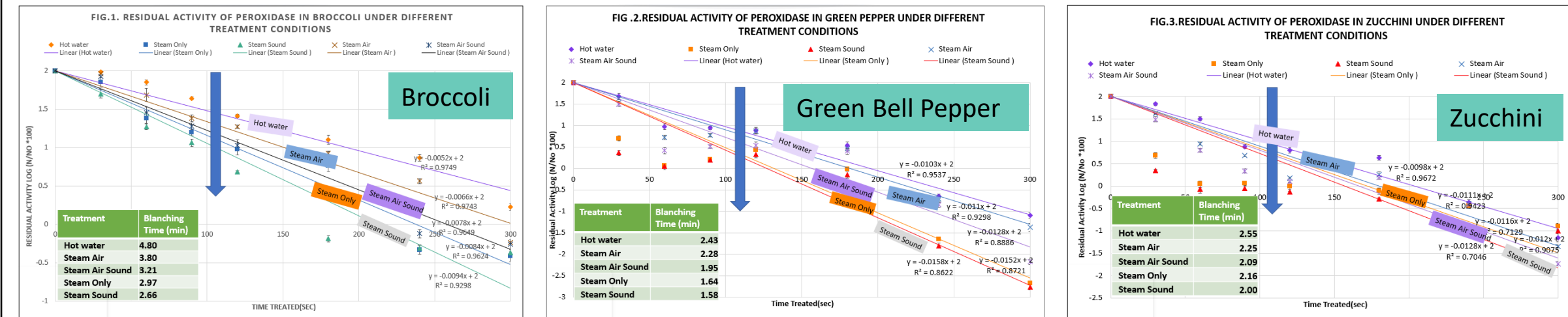


Table.1. Peroxidase Activity D value for vegetables under different treatment conditions

Treatments	D values (min)					
	Broccoli	R ²	Green Bell Pepper	R ²	Zucchini	R ²
Hot water	3.20	0.97	1.62	0.95	1.70	0.96
Steam Only	1.98	0.92	1.09	0.86	1.44	0.71
Steam Sound	1.77	0.96	1.05	0.87	1.33	0.70
Steam Air	2.53	0.97	1.52	0.92	1.50	0.94
Steam Air Sound	2.14	0.96	1.30	0.88	1.39	0.90

Fig. 1-3 shows the residual activity of enzyme in different vegetables under different treatment conditions. The blanching time was calculated based on the D values (shown in Table 1) obtained from this graphs. The figures show that highest enzyme inactivation was achieved when vegetables were subjected to combined steam and ultrasound blanching both in presence or absence of air compared to hot water blanching.

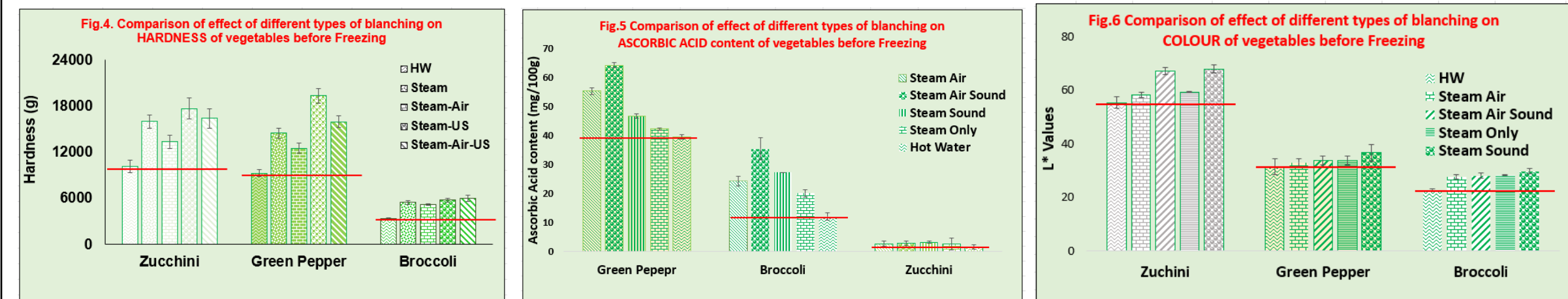


Fig. 4-6 shows the effect of different blanching techniques on the quality parameters of different vegetables. The texture (hardness), color (L* values representing brightness) and ascorbic acid content retention of the vegetables were maximum when vegetables were subjected to combined steam and ultrasound blanching both in presence or absence of air compared to hot water blanching. The red line represents that hot water blanching had least retention of quality in all the vegetables

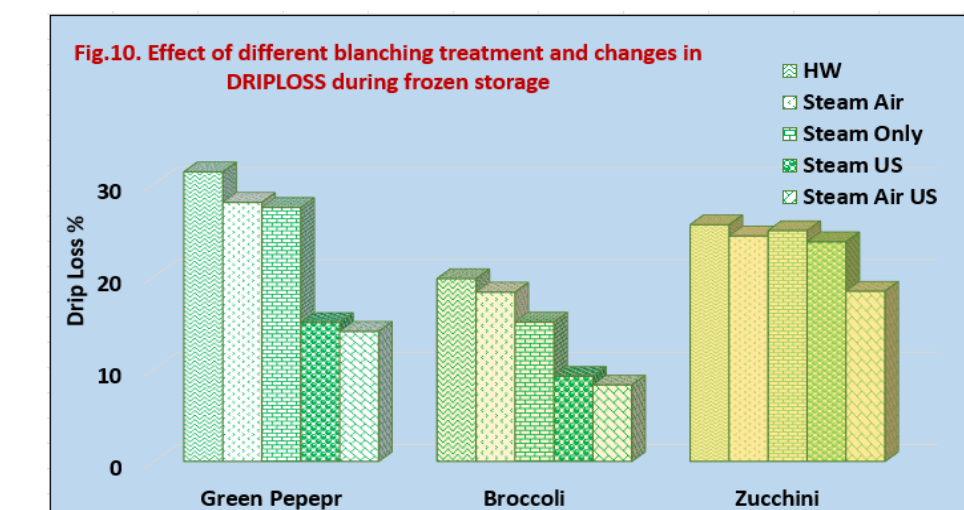
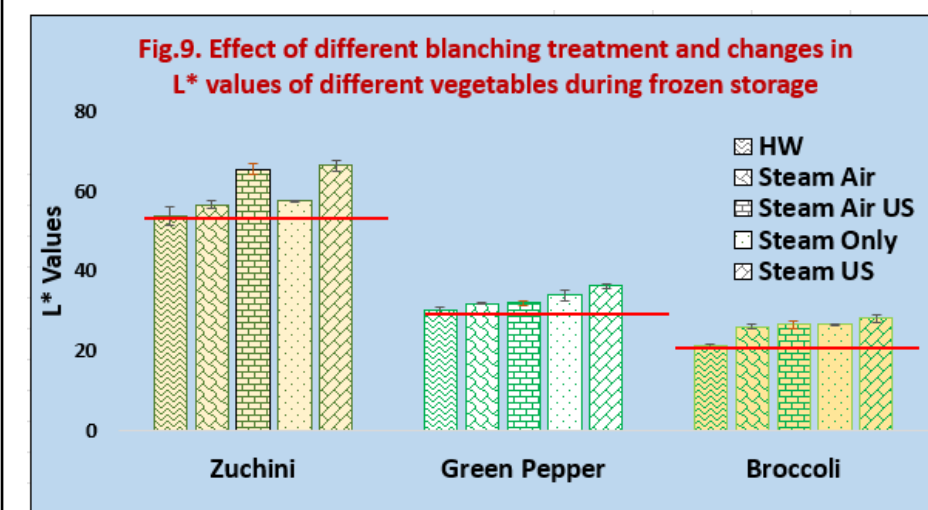
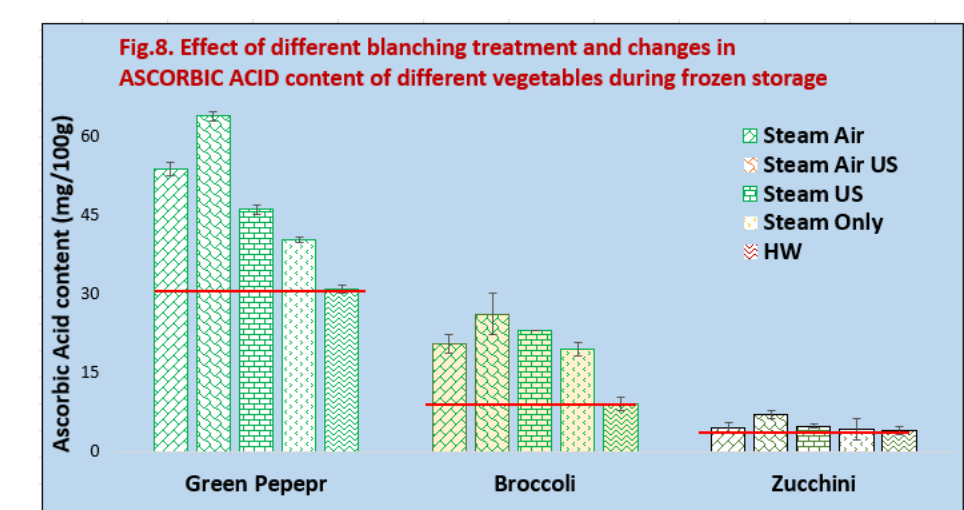
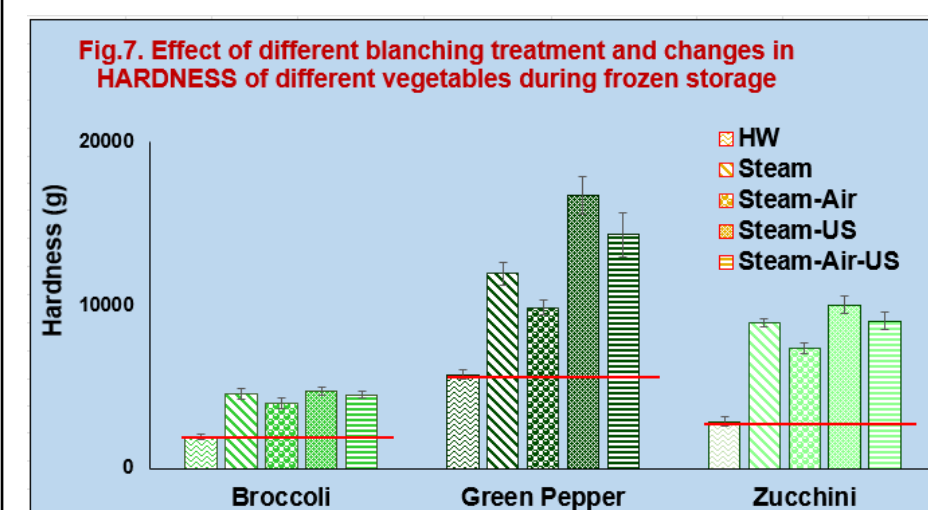


Fig. 7-10 shows how different quality parameters: hardness, ascorbic acid content, color and drip loss of different vegetables changes due to different blanching techniques during frozen storage. The drip loss was found to be highest in hot water blanching in case of all the three vegetables.

Conclusions:

Studies on broccoli, zucchini and green bell pepper showed that enzyme inactivation was achieved faster when blanched with combined ultrasound steam and ultrasound steam/air medium as compared to steam or steam-air and hot water blanching without ultrasound. Ultrasound-assisted blanching showed superior quality for all the tested vegetables in terms of color, texture and ascorbic acid content retention. The highest quality losses were associated with hot water blanching. Presence of air in steam-ultrasound blanching provided some protection against texture loss for broccoli. Ultrasound assisted steam blanching, in the absence of air, caused a smaller amount texture loss for green bell pepper and zucchini. Ultrasound-steam blanching can be successfully implemented for effective blanching with reduced treatment time to achieve enzyme inactivation of vegetables prior to freezing. Retention/Increase in important product quality parameters like color, texture and ascorbic acid content were evident when compared with conventional blanching. The results are potentially useful in food processing industry (canning, drying, freezing) for better quality retention and process turn over as effective blanching treatment for frozen vegetables

References:

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