MICROWAVE BLANCHING OF VEGETABLES. A REVIEW

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Abstract: The paper presents the influences of microwaves on vegetables blanching. Microwave blanching is a processing technology that has as primary purpose the inactivation of the tissular enzymes in vegetables. In the paper we presented the enzymes inactivation in mushrooms, spinach, peppers, carrots, green been pods. Also, the vitamins, especially ascorbic acid retention at vegetables microwaves blanching were presented. Microwave–water blanching technique is very important because it ensure the preservation of the vegetables by surface microbial inactivation. Finally, microwave blanching is a good method of blanching because inactivates the vegetables enzymes quicker than in conventional blanching, as an overall process, and keeps the nutritive and sensorial values of vegetables.

Key words: enzymes, ascorbic acid, microbiota, antioxidants.

Introduction

Conventional blanching is a heat treatment having as purpose the inactivation of enzymes, expelling air trapped in the intracellular regions of vegetables, the reduction of superficial microbiota number.

The principal purpose of blanching is the enzyme inactivation. The most important enzymes that determine the nutritive loss (the quality loss) from vegetables are: polyphenol oxydase, polygalacturonase, lipoxygenase, chlorophyllase [7]. The most important thermoresistant enzymes in vegetables are: catalase and peroxidase. Conventional blanching can be done with steam and hot water. If the vegetables are not properly blanched, at storage can occur unwanted sensory and nutritional transformations.

Microwaves technology can be appealing to be used to vegetables blanching, but it have some issues that need to be considered. The most important is the penetration ability of microwaves. Their frequencies are in the range from 0.3 GHz up to 300 GHz and the wavelength is between 1m and 1mm [15]. Commercial microwaves use the 2.45 GHz band according to international conventions and the wavelength is 12.23 cm. This frequency is used to avoid interference with telecommunication and cellular phone frequencies, being a reserved frequency. Only that we are interested in penetration depth of the microwaves in vegetables, and this is smaller, being of 1 to 2 cm at 2.45 GHz [11]. So, the energy distribution in vegetables can vary. Besides the 2.45 GHz frequency, the 0.915 GHz frequency can be applied for food processing. At 0.915 GHz the wavelength is higher than that at 2.45 GHz and the penetration depth is also higher.

Using the pulsed microwave heating can improve the temperature uniformity of vegetables. Also, it seems that we cannot use the microwaves blanching alone, but in combination with conventional blanching processing using steam or hot water [10].

The influence of microwaves blanching on vegetables

There are many effects of the microwaves on various vegetables, due to the purposes mentioned above. Although the microwave blanching is defined as a non–thermal process, its effect on the foods is thermal, being equivalent with the conventional blanching. Therefore microwave blanching influence the sensorial proprieties of vegetables, the vitamins content, the texture, the microbiota etc.

The influence on enzymes

In case of enzymes inactivation in mushrooms, Devece *et al.*, 1999, compared microwaves blanching, conventional blanching and the combination of heat treatments. Polyphenoloxidase is the primary enzyme responsible for mushroom (*Agaricus bisporus)* browning. The conclusion of the study was that the combined microwave and hot–water bath treatment has achieved complete polyphenoloxidase inactivation in a short time. The advantage of microwave blanching of mushrooms over conventional blanching is that of the retention in higher amount of the nutritive value [9].

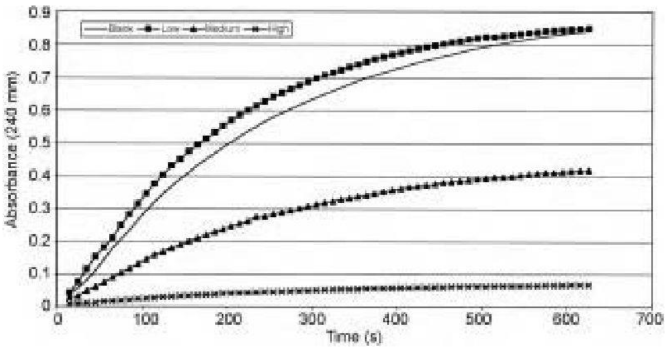

Fig. 1.The activity of mushroom polyphenoloxidase [13]

The samples were previously treated in a microwave oven at specific times, using different potency levels: high = 770 W, medium = 560 W and low = 240 W. According to Shaheen *et al*., 2012, when the blanching temperature is not adequate, the enzymatic deteriorative action on vegetables may prevail or even increase. From figure 1 we can see that, the high power value, the greater enzyme inactivation.

Ramesh *et al*., 2002, studied the blanching effect on peroxidase in spinach, bell peppers and carrots. The temperature was monitored to be around 95°C in the Pyrex container filled with water and vegetables, and blanching was realized by pulsed method of 30 second/pulse. The power used was 900W. The conclusion is that the peroxidase was not fully inactivated in spinach and bell peppers after 190 and 330 seconds, respectively. After 150 seconds of blanching the carrots discs (35 mm diameter and 3 mm thick) the enzyme were fully inactivated.

Dorantes–Alvarez *et al.,* 2011, found that the necessary time to inactivate polyphenoloxidase the peppers (*Capsicum annuum)* with microwaves was 20 s. However, the time required to reach the inactivation temperature of the enzyme (80ºC or higher) was 15 s. Therefore, the real time of enzyme inactivation was of five seconds, a short time blanching because the peppers were processed as paste.

In the case of green beans pods, Ruiz–Ojeda and Peñas, 2013, found that catalase were inactivated after 150 seconds of microwave blanching in water at powers higher than 650 W, peroxidase after 150 seconds at powers higher than 750 W, and L–ascorbate peroxidase was not inactivated even treated at 900 W for 300 seconds. The water temperature at 150 seconds of blanching was over 80°C, increasing with power. In figure 2 is presented the kinetic study of the microwave blanching effect at 750 W on the studied enzymes. The figure highlights the water temperature variation inside the microwave oven.

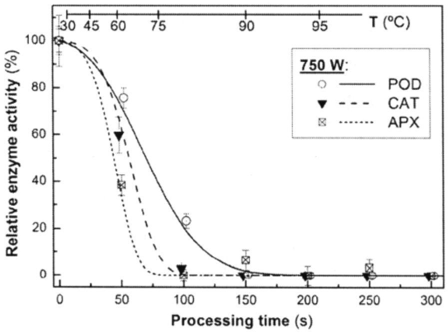

Fig. 2. The microwave blanching kinetic study on the enzymes from green bean pods. POD=peroxidase, CAT=catalase, APX=L–ascorbate peroxidase [12]

The influence on ascorbic acid and other vitamins

Ascorbic acid is a very labile component of vegetables, its presence being influenced by the presence of light, heat and the enzyme ascorbic acid oxidase [3].

In a comparison of vitamin C content in tomatoes, Begum and Brewer found that the content of this vitamin decreased after boiling–water blanching (65% retention), but there was 90% retention after the microwave blanching method. Microwave blanching of tomato pieces (700 W for 4 min.) did not result in a significant reduction (88–91% retention) in vitamin C, while boiling–water blanching only retained 65% [1].

Table 1. Various vitamin retentions in vegetables blanched with microwaves [11]

Vitamin	Product	Blanching conditions	Vitamin retention (%)
Vitamin C	*100 g of* Spinach Carrots Green peas Green beans Broccoli	Radar oven, 3000 mc, for 20 seconds 25 seconds 25 seconds 20 seconds 30 seconds	 100 98 100 100 100
Vitamin C	Broccoli	Domestic, for 2 minutes	79.2
Vitamin C	*300g of* Green beans	Domestic Model 2005, 650 W, 60 seconds, 2450 MHz, with rotation	88.5
Vitamin C β–carotene	*100 g + 150 ml water* Green peas	NE 7900 Panasonic domestic, 700 W, 2450 MHz, 6.5 minutes	88.7 102.3

continuation of ***Table 1***

Vitamin C Carotene	*100g of* Spinach	Litton 520 domestic, 650 W, 95 seconds	310 mg/100 g 25 mg/100 g
Vitamin C	*500 g + 50 ml water* Broccoli Spinach Green beans Carrot	Domestic EX 30 LF AEG, 700 W 7 minutes 7 minutes 7 minutes 7 minutes	 90 70 75 100
Vitamin C	Frozen spinach	Pilot scale, conveyorized tunnel 3990 W, 2450 MHz, 90 seconds	59.1
Vitamin C	Frozen endive	Pilot scale, conveyerized tunnel, 4020 W, 2450 MHz, 90 seconds	84.5
Vitamin C	*50g of* Spinach Bell peppers Carrot	Siemens–Model HF 66020, pulsed 3.2 minutes. 4.8 minutes 2.0 minutes	 68.9 84.7 82.6
Carotene	Carrot	Siemens–Model HF 66020, pulsed 2.0 minutes	56.9

The data presented in table 1 highlights the fact that various microwave blanching conditions protects the vitamin C initial contents from the studied vegetables.

In figure 3 is presented the reduction in vitamin C amount at microwave blanching of green bean pods. The heating of water at 650 W lead to a smaller reduction of the vitamin C amount in green bean pods as compared to 900 W.

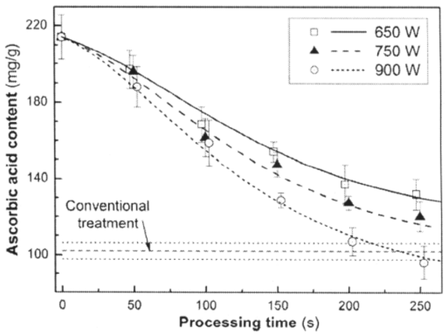

Fig. 3. Ascorbic acid content kinetic study of microwave–blanched green bean pods [12]

The influence on sensorial characteristics of vegetables

The effect of different methods of blanching on the color L, a, b values of various vegetables are shown in Table 2.

Table 2. The color changes in vegetables blanched with microwaves [14]

Vegetable	Blanching	*L*	*a*	*b*
Snow peas	Microwave Microwave blanching in a bag	31.8 31.6	–4.7 –5.1	11.6 12.3
Green beans	Microwave	55.2	–22.7	22.2

continuation of ***Table 2***

Spinach	Microwave	22.4	–6.4	11.6
Broccoli (florets)	Microwave	43.1	–9.5	32.8
	Microwave blanching in a bag	43.9	–8.5	33.1
Asparagus (tips)	Microwave	33.4	–4.9	22.4
	Microwave blanching in a bag	3.02	–2.5	19.1
Asparagus (stem)	Microwave	37.7	–8.1	13.3
	Microwave blanching in a bag	36.8	–7.6	15.6

Begum and Brewer, 2003, studied the sensory quality of snow peas blanched by boiling water, steam, microwave and microwave blanching in heat–sealable bags. No differences occurred in lightness (L) values. Microwave blanched in bag peas were the most green. Between the two microwaves blanching treatment was no significant difference in the b (yellowness) value.

Other influences of microwave blanching on vegetables

Water assisted microwave treatment at 950 W of fresh jalapeno peppers and coriander foliage were found to have an effect against the pathogenic bacterium *Salmonella typhimurium* which resulted in the reduction of 4–5 log cycles of microbial population [4].

In mushrooms, the loss of antioxidant content was minor when treated with a combination of microwave and hot water blanching [5]. Regarding about the antioxidant activity and the free phenol content in microwave blanched peppers paste, Dorantes–Alvarez *et al.*, 2011, found that after 20 seconds the free phenol compounds decreased with 20.8% and the antioxidant activity was enhanced from 29 to 42 μM of trolox/g.

Conclusions

Usually, due to the small penetration of microwaves, the microwave blanching is done in water. The most important factors that influence the microwave blanching in water are: the microwave power, the physical geometry of the vegetables and the thermal proprieties of vegetables. Microwave blanching is a good method of blanching because inactivates the vegetables enzymes quicker than in conventional blanching, as an overall process, and keeps the nutritive and sensorial values of vegetables.

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