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Optimization of Blanching Process for Bottle Gourds

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ABSTRACT

Experiments were carried out to study the effects of water blanching on the quality of bottle gourds over a temperature range of 85–100 ^{0}C. Bottle gourd slices with thickness 5, 10 and 15 mm were selected for the blanching treatments. These blanching treatments were evaluated with respect to the inactivation time of peroxidase (POD) and the process was optimized on the basis of maximum retention of vitamins and nutrients, and minimum loss in yield of extracted juice. The most effective water blanching treatment was 3.67 min at 100 ^{0}C in 5 mm slices thickness. At this time–temperature-slices thickness combination, PODs were completely inactivated and the yield, ascorbic acid contents, pH and TSS of bottle gourds juice were found to be 69.40 %, 7.25 mg/100 ml. 6.32 and 3.67 ^{0}Brix respectively. The thermal inactivation of POD in fruits and vegetables using various enzyme inactivation processes available in the literature was critically studied. The time-temperature-slices thickness combination during hot water blanching provided a good description of the inactivation of POD in bottle gourds over the temperature range of 85–100 ^{0}C and slices thicknesses of 5-15 mm.

Introduction

Bottle gourd (*Langenaria siceraria*) fruit is one of the important cucurbitaceous vegetable and a potential source of natural antioxidants [1]. Bottle gourds are known for their contents viz. vitamin B complex and choline along with fair quantum of vitamin C and appreciable amount of nutrients and minerals [2-6]. Bottle gourd contains cucurbitacins, polyphenols and two sterols namely; campesterol and sitosterol [7]. Bottle gourd is well known for their immunomodulatory, hepatoprotective, antioxidant, anti-stress, adaptogenic, analgesic, anti-inflammatory, cardio protective, cardio tonic, antihyperlipidemic, diuretic, aphrodisiac, alternative purgative, antidote to certain poisons and cooling properties [8-11]. Enzymes commonly found to have deteriorative effects in bottle gourd are peroxides (PODs) and poliphenoloxidases (PPOs) [12]. There is an empirical relationship between residual POD activity and the development of off-flavors and off-odors in foods. POD is considered the most heat stable enzyme and it can be used in the design of thermal processes; if inactivated, all other enzyme systems are usually inactivated [13-15].

Blanching is extremely necessary for inhibition of enzyme action before processing of fruits and vegetables and useful in determining the process parameters at different time-temperature combinations with maximum quality retention [16,17]. Along with the inactivation of enzymes, blanching expels trapped air in the intracellular regions and also leads to some unfavorable factors like loss of nutritional quality [18]. In-adequate blanching process may result in regeneration of the enzyme [13]. In order to minimize deteriorative reactions, fruits and vegetables are blanched to inactivate the targeted enzymes either in hot water, steam or selected chemical solutions [15].

Hot water blanching usually results in a more uniform treatment, allowing processing at lower temperatures ranging typically from 85 to 100 ^{0}C [19-21]. Inactivation of POD is usually used to indicate the adequacy of blanching. Therefore, the objective of this work was to determine the optimum blanching conditions for the bottle gourds which will give the most desirable product from the quality standpoint with the least harm to the vitamins and nutrients, and higher juice yield along with POD inactivation.

Materials and Methods

Blanching Process

Fresh bottle gourds (cv. ABG-1) were procured from the Horticultural Farm, Anand Agricultural University, Anand. The bottle gourds were cleaned and washed with running tap water to remove surface adhering extraneous material, contaminations and other microbial load. The bottle gourds were cut 20 mm from the top and 15 mm from the bottom and sliced in 5, 10 and 15 mm using a stainless steel slicer machine (Sumeet). These slices were blanched in water bath having stainless steel body with temperature control range between 0-110 °C (Electro equipment, New Delhi, India). The slices samples were drawn continuously from the water bath each at 0.5 min interval at 85, 90, 95 and 100 ^{0}C to carry out POD inactivation test. The slices to water ratio was maintained 1:7 w/v during water blanching. These slices thickness were selected to study the effect of water blanching on POD enzyme inactivation, yield and nutrient (ascorbic acid) contents of bottle gourd juice after the blanching process. All the experiments were done in triplicate immediately after blanching and average as well as statistically analyzed values were used in the analysis.

Chemicals

Guaiacol (99%) and ascorbic acid standard (99%) were procured from SD Fine Chemicals Mumbai, India; hydrogen peroxide (30%) and sodium bicarbonate (99.5%) from Merck, Mumbai, India and metaphosphoric acid (60%) and sodium salt (98%) from Loba Chemie, Mumbai, India. For all assays, de-ionized distilled water was used.

Peroxidase (POD) Test

Approximate 100g blanched slices were taken out in petri plates continuously from the water bath at every 0.5 min interval unto 60 min and frequently subjected it in deep freezer to stop further heat transfer activity or cooking. Treated slices were subjected into bag mixture (Interscience, France) for 5 min to

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crush. Fine crushed sample was filtered by muslin cloth and was taken in a test tube. Chemical solutions for the POD test were prepared as described by Ranganna [22]. Prepared solutions were poured into the test tube and the contents were thoroughly mixed. Brown-reddish colour change within a few min in sample indicated a high POD activity while weak pink color indicated an incomplete POD inactivation. If there was no color development in sample after 15 min, the reaction was negative and the POD enzymes were considered inactivated.

Juice Yield

Blanched bottle gourd slices were subjected to single pass juice extraction using centrifugal electrical juicer (Rama udyog, Jaipur, India). The yield was measured by the amount of juice extracted from a sample of 1.25 kg blanched slices. Extracted juice was passed through a muslin cloth and percent juice recovery was estimated on the basis of juice weighed [23].

Ascorbic Acid Content

The ascorbic acid content of extracted juice was determined by visual titration method using 2, 6-dichlorophenol-indophenol as described by Ranganna [22].

Juice pH

Extracted juice pH was determined by using digital pH meter (Systronics India Limited, Ahmadabad, India**).** The pH meter was standardized before analysis with distilled water having pH 7.0 and standard buffer solution having 4.0 and 9.1 pH.

Juice Total Soluble Solids (TSS)

The total soluble solids of extracted juice were estimated using pocket hand refractometer-PAL-1(ERMA, Japan) having measuring range 0- 53 ^{0}Brix.

Statistical analysis

The data obtained during the experiments were analyzed by BASIC statistical software using 2-factors 4 and 3-levels CRD with three replications.

Results and Discussion

Optimization of the Blanching Process

Effect of averaged data on various parameters during water blanching

Hot water blanching was carried out for inactivation of POD enzymes in bottle gourd because steam blanching resulted in non-uniformity in the enzyme inactivation. The inactivation time of POD during steam blanching was found consistently higher than hot water blanching [15].

Effect of hot water blanching on POD inactivation time

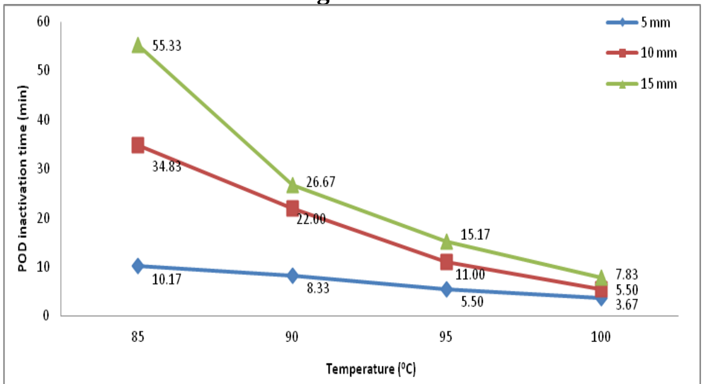

Fig. 1 POD inactivation time of bottle gourd slices during hot water blanching

The inactivation time of POD in bottle gourd slices at selected temperatures during hot water blanching is shown in Fig.1. The POD inactivation time was observed higher in 15 mm slices as compare to 5 and 10 mm at corresponding blanching temperature. Minimum POD inactivation time was 3.67, 5.50 and 7.83 min at 100 °C in slices 5, 10 and 15 mm respectively during blanching. Decreasing patterns of POD inactivation time were noticed across the slices as blanching temperature increased from 85-100 °C. Most effective water blanching was at 100 °C in 5 mm bottle gourd slices where POD inactivation time found to be 3.67 min. Calabrese et al. [12] reported 3 min POD inactivation (residual POD activity < 1 %) time of bottle gourd slices during water blanching at boiling point. Liao et al. [24] reported POD inactivation occurs in 2 min at 95–100°C during hot water blanching of carrot slices. Shivhare et al. [15] and Jan et al. [25] reported POD inactivation occurs in 5 min at 95°C during hot water blanching of carrot slices and acid blanching of carrots respectively. At specific blanching temperature, POD inactivation time was decreased when slices surface area increased might be due to fast penetration of temperature at the centers. Muftugil [19] supported the result conducting experiment on POD enzyme inactivation of some vegetables.

Effect of hot water blanching on juice yield

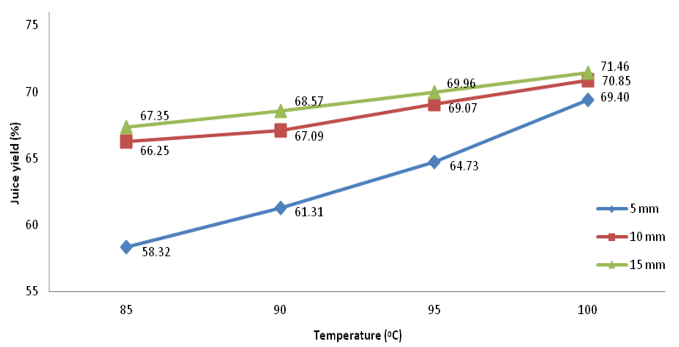

Fig. 2 Effect on juice yield of POD inacivated bottle gourd slices

Extracted juice yield was found to be 69.40, 70.85 and 71.46% at 100 °C and 58.32, 66.25 and 67.35% at 85 °C in 5, 10 and 15 mm slices respectively (Fig. 2). A positive correlation was observed between slices thickness and extracted juice corresponding to the blanching temperature. However, higher variations in juice yields were at 85 °C and contracted at 100 °C across all slices thickness. Un-blanched bottle gourd juice yield was 74.49 % which was slightly higher than obtained juice yield i.e., 71.46 % in 15 mm slices after blanching. Jain and Khurdiya [23] contradicted result standardizing the juice extraction process of blanching aonla (*Emblica officinalis* Gaertn.). Shivhare et al. [15] supported result optimizing blanching process for carrots. Minimum decreased in juice yield (4.06 %) at 100 °C in 15 mm slices during blanching might be due to the leaching loss and softening of the texture of the bottle gourd slices thus makes juice extraction difficult [26]. Extracted juice yield was higher during high-short blanches as compared with low-long blanches. Most effective juice yield was obtained to be 69.40 % at 100 °C in 5 mm bottle gourd slices for 3.67 min POD inactivation time.

Effect of hot water blanching on juice ascorbic acid

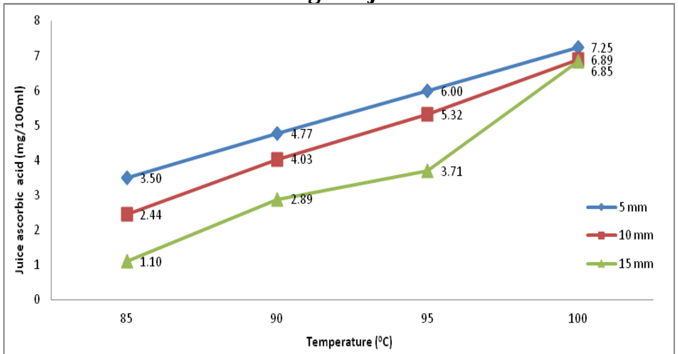

Fig. 3 Effect on juice ascorbic acid conntent of POD inactivated bottle gourd slices

Ascorbic acid content in the juice extracted from bottle gourd slices at selected temperatures is shown in Fig. 3. Wide variation of ascorbic acid present in the juice was observed at 85 °C as compared to the 100 °C across slices. Maximum ascorbic acid content was 7.25 mg/100 ml at 100 °C for 3.67 min POD inactivation time in 5 mm slices. The ascorbic acid content of un-blanched bottle gourds juice was 11.79 mg/100 ml and was decreased to 38.50 % after the minimal blanching at 100 °C in 5 mm thick slices. An inverse relationship was noticed between slices thickness and ascorbic acid content of juice at specific blanching temperature. After blanching, thick slices possess longer time to cool off than thin one and this thermal lag causing extra heat exposed in 15 mm slices which may be a reason of reduction in ascorbic acid content of juice as it is heat labile. Amin et al. [27] supported result recommending minimal blanching for not more than 5 min at 98 ^{0}C to prevent the major loss of antioxidant activity and the pro-oxidant activity of vegetable components. Decreased in juice ascorbic acid content in blanched slices might be due to the leaching loss at lower temperature and higher expose time in blanching process. Sawate et al. [5] reported similar result when blanching of bottle gourd shreds in hot water for preparing bottle gourd powder. The ascorbic acid losses during blanching were rapid and extensive at certain intermediate temperatures where the heating was inadequate for enzyme inactivation but sufficient to cause thermal maceration of the slices. Result revealed that prolonging the blanching time increased the ascorbic acid losses more than the elevation of the blanching temperatures. An increase in the temperature of blanches usually resulted in little accentuation of the ascorbic acid losses than the prolonging blanching.

Effect of hot water blanching on juice pH

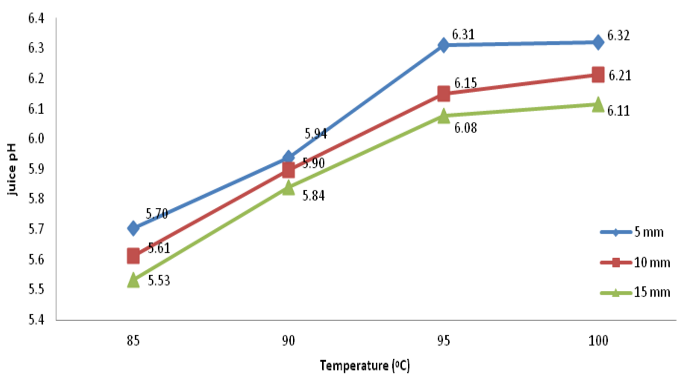

Fig. 4 Effect on juice pH of POD inactivated bottle gourd slices

The pH of POD inactivated bottle gourd slices juice at selected temperatures is shown in Fig. 4. Maximum pH observed was 6.32 at 100 °C in 5 mm bottle gourd slices. Juice pH was highly dependent on slices thickness and temperature during water blanching. An inverse relationship was observed between slice thickness and extracted juice pH at corresponding blanching temperature. pH variations were 3.07 % at 85 °C and 3.43 % at 100 °C between 5 and 15 mm slices during blanching. The pH of un-blanched bottle gourd juice was 5.53 and increased to 14.28 % at 100 °C in 5 mm thick slices after blanching, might be due to adhering of blanching water owing to have more surface area.

Effect of hot water blanching on juice TSS

TSS in juice was increased with increase in blanching temperature. Variations in TSS observed were lower at 85 °C and approximately its double at 100 °C across all slices while blanching (Fig. 5). Maximum and minimum TSS were 3.90 and 2.87 at 100 °C in 15 mm and at 85 °C in 5 mm thick slices respectively. However, the TSS of un-blanched bottle gourd juice were 4.27 and decreased to 8.66 % after blanching at 100 °C in 15 mm thick slices, might be due to direct variation of imbibitions of the blanching water.

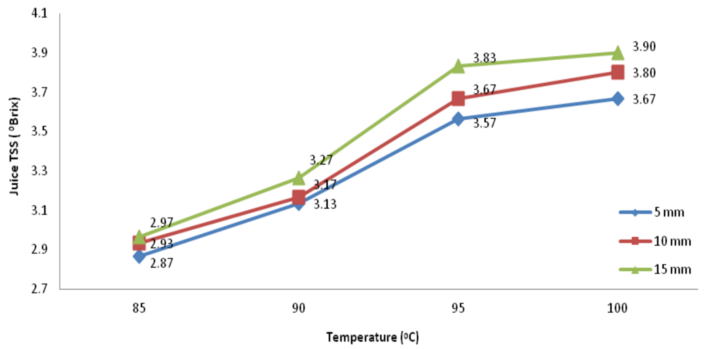

Fig. 5 Effect on juice TSS of POD inactivated bottle gourd slices

The extent of loss of TSS from the bottle gourd slices varied with different blanching conditions. TSS changes during blanching indicated a progressive loss of solids and simultaneously increased imbibitions of water. Prolonged blanching increased the removal of solids as exemplified by the change in sugar content.

Effect of statistically mean analyzed data on various parameters during water blanching

The individual effect on various parameters during water blanching is discussed earlier. The data obtained are almost in agreement with the data reported by earlier researchers. However, the statistically mean analyzed data showing effect of varying temperature and bottle gourd slices thickness on various parameters during water blanching are presented in table 1.

Table 1. Statistically mean analyzed data showing effect of varying temperature and bottle gourd slices thickness on various parameters during water blanching

Treatment	Inactivation time (min)	Juice yield (%)	Juice ascorbic acid (mg/100ml)	Juice pH	Juice TSS (°Brix)
Blanching temperature of water (T)					
T_1	33.4778	63.9700	2.3456	5.6167	2.9222
T_2	19.0556	65.6556	3.8956	5.8900	3.1778
T_3	10.5556	67.9211	5.0067	6.1789	3.6889
T_4	5.6667	70.5722	6.9944	6.2156	3.7889
SEm ±	0.167	0.257	0.086	0.006	0.019
CD (P=0.05)	0.488	0.750	0.250	0.019	0.056
Bottle gourd slices thickness (TH)					
TH_1	6.9583	63.4400	5.3758	6.0667	3.3000
TH_2	18.3333	68.3142	4.6717	5.9683	3.3917
TH_3	26.2750	69.3350	3.6342	5.8908	3.4917
SEm ±	0.145	0.223	0.074	0.006	0.017
CD (P=0.05)	0.422	0.650	0.217	0.016	0.049
Interaction (T x TH)					
SEm ±	0.289	0.445	0.149	0.011	0.033
CD (P=0.05)	0.844	1.300	0.434	0.032	NS
CV, %	2.92	1.15	5.64	1.15	1.7

T_1= 85°C, T_2= 90°C, T_3= 95°C and T_4= 100°C
TH_1= 5 mm, TH_2= 10 mm and TH_3= 15 mm

POD inactivation time

The POD inactivation time of bottle gourd slices was decreased remarkably as the temperature (T) increased, which indicated the highly significant effect of temperature (P<0.05). The inverse trend was noticed in slices thickness (TH). The interaction (TxTH) was found to be significant which indicated the non-compensating effect of increase in temperature and slices thickness simultaneously (Table 1).

Juice yield

The juice yield was increased linearly with increase in temperature and non-linearly with slices thickness during blanching. The analyzed data reported highly significant effect of both the factors at 5 % level of probability.

Juice ascorbic acid

A positive correlation was found between ascorbic acid content of juice and blanching temperature due to decrease in POD inactivation time of slices. Juice ascorbic acid content was decreased with increase in slices thickness. The result and their interaction (TxTH) were highly significant at 5 % level of significance.

Juice pH

The juice pH was increased remarkably with increase in blanching temperature (T) indicated the active acidity in the juice was decreased and reverse trend was noticed in slices thickness (TH). The interaction of both the parameters was found to be significant, which indicated that the effect of temperature (T) and slices thickness (TH) are dependent.

Juice TSS

The increase in temperature (T) and slices thickness (TH) significantly increased the juice TSS. However, their interaction was found to be non-significant, which indicated the compensating effect of increasing in the temperature (T) and slices thickness (TH) simultaneously.

Conclusions

Blanching is an important unit operation prior to processing of fruits and vegetables for juicing, canning, dehydration, drying, freezing, IQF and storage accompanied by initial microbial load reduction. Blanching of bottle gourds is extremely necessary for inactivation of POD enzyme for extraction of bottle gourd juice for further processing to improve the product quality and shelf life. Water blanching was considered based on the POD inactivation time of bottle gourd slices and the process was optimized on the basis of maximum retention of vitamins and nutrients, and minimum loss in yield of juice. The best water blanching treatment was found at 100 °C for 3.67 min in 5 mm bottle gourd slices based on selected process parameters. At this temperature-time-slices thickness combination, POD enzymes were inactivated and 7.25 mg/100 ml ascorbic acid, 69.40 % yield, 6.32 pH and 3.67 °Brix TSS of bottle gourd juice were obtained. The inactivation time indicates the destructive effect of heat on the affected POD enzymes. The processors will enable to modulate their process according to different time–temperature-slices thickness combinations for large scale industrial production.

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