EFFECT OF PRE-TREATMENTS ON QUALITY OF MARIAN PLUM (*Bouea macrophylla*) PURÉE

ẢNH HƯỞNG CỦA CÁC BIỆN PHÁP TIỀN XỬ LÝ ĐẾN CHẤT LƯỢNG PURÉE THANH TRÀ (*Bouea macrophylla*)

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ABSTRACT

In this study, marian plums at 50 days after anthesis at Vinh Long province were chosen as main ingredient for purée processing. Influence of blanching to inactivating of browning enzyme and the effect of sucrose and pectin additions on purée were studied. The results showed that blanching condition at 80°C in 3 minutes could inactivate browning enzyme, and maintained marian plum's nutritional values. The cryoprotection effect of added sugar and pectin to purée were noticed. The addition of sucrose to 35°Brix combined with 1.75% pectin have the optimum quality which remained up to 180 days in frozen storage.

Keywords: *Marian plum; Purée; Blanching; Sucrose and Pectin; Cryoprotection.*

TÓM TẮT

Trong phạm vi nghiên cứu, thanh trà ở độ tuổi 50 ngày từ ngày hoa rụng cánh được lựa chọn làm nguồn nguyên liệu chế biến purée. Việc vô hoạt enzyme bằng phương pháp chần và tác dụng của hỗn hợp đường, pectin bổ sung được quan tâm. Kết quả nghiên cứu cho thấy chế độ chần ở nhiệt độ 80°C trong thời gian 3 phút là thích hợp cho quá trình vô hoạt enzyme hóa nâu đồng thời duy trì được giá trị dinh dưỡng của nguyên liệu. Tác dụng chống đông của hỗn hợp sucrose và pectin được nhận thấy, trong đó mẫu bổ sung sucrose đến 35°Brix kết hợp với 1,75% pectin vẫn duy trì chất lượng sau 180 ngày trữ đông.

Từ khóa: *thanh trà; purée; chần; sucrose và pectin; chống đông.*

1. INTRODUCTION

In recent years, marine plum has become a special fruit of Mekong Delta, with beautiful shape, color and featured flavor. Marian plum brings stable income to farmers in Vinh Long, Tien Giang, Kien Giang and An Giang provinces with high annual yield and less labor required. However, marian plum mainly consume in flesh fruit due to the limits of season range and original sour flavor. The impact of transport on damages is significantly. The diversification of product, the process and storage procedure were not studied at a deep level.

Purée, as a semi-finished product, has its advantage that can utilize fruit in unlike quality (overripe, mechanical injured …). With simple procedure easily being carried out, the shelf life can reach up to 6 months or even 2 years at frozen [1-4]. There were two issues which were particularly interested in purée processing. One was the loss of fruit's

featured flavor and the other was the changing of the color due to browning reaction. Therefore, several pretreatment methods on the material were suggested [5]. Blanching can inactive several enzymes that present in fruits, such as polyphenol oxidase (PPO) and peroxidase (PO) - the enzymes that catalyze the browning reaction in fruit and vegetable. Blanching at 60÷90°C or pasteurize at 80÷90°C can inactive PPO, the specific conditions depending on different types of fruit [1,5]. At high temperature, the changing of proto-pectin to pectin also occurred that easily peeling process. Nevertheless, blanching at long time cause several undesirable changes, such as the loss of fruit fluid, the changes in fruit structure, color, and flavor. Adjusting pH below 4, commonly 3÷3,5 [4] or added sucrose to 30÷60% on purée's weight (with the initial Brix at 14÷16%) can also prevent the change in purée's flavor and color, particular in mango purée [3].

The present of large-sized ice molecules in frozen purée influence its rheological stability, thus results in change of an optimal consistency, homogeneous texture and the mouthfeel characteristics which are desirable for purée. The use of cryoprotectants in purée formula were suggested to modify the rheological behavior, melting rate and melting temperature of the frozen purée. At this time, only some sugars and hydrocolloids were studied as cryoprotectants for purée [6-8]. Ricon (2004) suggested that the incorporation of cryoprotectants (carbohydrates with different molecular weights) to mango tissue greatly affected the overall quality of the fruit. Similarly, the glass transition temperature was confirmed to be a function of the composition of the pulp [6]. Conceição (2012) determined that the using of pectin and sucrose mixture in pineapple pulp can improve their rheological properties, thermal properties and stability after freezing and thawing processes [7]. Downey (2002) determined that the effect of each cryoprotectants depending on kind of vegetable. Moreover, quality maintenance or improvement after thawing may be achieved through selection of an appropriate cryoprotectants [8].

2. MATERIALS AND METHODS

2.1 Materials

Marian plum at Binh Minh district, Vinh Long province, Vietnam were marked and collected at 50 days after anthesis. After the branches and leaves were removed, the fruit was washed, drained, and stored at low temperature (12°C) at most 24 hours before the experiments were carried out.

Figure 1. *Marian plum*

The purée was prepared by the following step: (i) Peeling the fruit and removing the seed; (ii) Preliminarily blending the flesh; (iii) Adding additives; (iv) Mixing the mixture until homogeneous; (v) Dividing the mixture into PA package, 500g/sample; (vi) Freezing at -28÷-30°C and kept storage at -18°C [1-4].

2.2 Experimental design

2.2.1 Effect of blanching on material's quality

The experiment was carried out in order to determine the suitable blanching condition that could inactive browning enzymes, maintained marian plum's nutritional values and improved the percent of flesh recovery. The temperature

of water and the time of blanching were chosen as factors. Peroxidase inactivity (indicated the inactivation of browning enzyme), color, vitamin C content and flesh recovery percentage were used to determine the effectiveness of different blanching processes.

2.2.2 Effect of sucrose and pectin addition on marian plum purée quality

This experiment was carried out in order to determine a suitable sucrose and pectin additional ratio. While sucrose addition was adjusted based on the total soluble solids content (TSS) of the processed purée, the addition pectin was calculated based on the total weight of purée. The purée was processed, using the suitable blanching condition (Experiment #1) on material. The changes in color, vitamin C content and moisture content was investigated after 14 days, to determine the suitable sucrose and pectin ratio added.

2.2.3 The changes in psycho-chemical properties of marian plum purée during frozen storage

The suitable blanching condition and sucrose/pectin ratio were used in marian plum purée processing (Experiment #1 and #2). The changes in psycho-chemical properties; included color, moisture content, TSS, TA (total acids) and vitamin C; during frozen storage were investigated, thus determined the shelf-life of purée as a semi-finished product.

2.3 Analytical methods

- Color was measured in L*a*b* color system by a colorimeter (NH300, China).
- Peroxidase activity was detected by immersing the flesh cut in the reaction mixture containing (20 mM) dissolved in 0.1M Na 1acetate buffer pH 6.0, in the presence of 1 mM H_2O_2 as substrates. Peroxidase activity, when present, was visualized or a brown staining under the light microscope [9].
- The recovery percent were calculated based on the weights of the fruit and the flesh obtained, using digital scale, readability 0,002 g (OHAUS, USA).
- For measurement of soluble solids content, a refractometer (Atago Co., Ltd, Japan) was used according to ISO 2173:2003.
- Moisture content was determined by oven-drying method (AOAC Official Method 934.06).
- Content of total acids was determined by potentiometric titration method and was converted to citric acid (AOAC Official Method 942.15).
- Content of vitamin C was determined by 2,6-dichloroindophenol titrimetric method (AOAC Official Method 967.21).

2.4 Statistical analysis

All data were statistically analyzed, the analysis of variance and Duncan's Multiple Range Test was applied to assess the difference between means, processed by Statgraphics Centurion 16.2 (Copyright (C) PP, USA) and Excel 2013 programs. Significance was defined at $p \leq 0.05$. Values are means of three experiments (±SD).

3. RESULTS AND DISCUSSION

3.1 Composition of raw material

Composition of marian plums at 50 days after anthesis were analyzed and showed in Table 1 and Table 2.

Table 1. *Composition of marian plum fruit*

Composition	Amount
Fruit peel (%)	10.43±0.48
Fruit flesh (%)	75.35±1.92
Seed (%)	14.22±1.72

Table 2. *Composition of marian plum flesh*

Composition	Amount
Moisture (%)	86.38±1,59
TSS (°Brix)	13.5±0,6
Total reducing sugar (%)	7.58±0,28
TA (%)	1.43±0,03
Vitamin C (mg%)	50.81±1,46
Pectin (%)	2.34±0,52
pH	2,45±0,21

Marian plum, as fruit in general, had high moisture content, total soluble solid and reducing sugar. These properties made the flesh fruit perishable under microbiological or biochemistry causes [1,11]. The high percent of fruit flesh made a high potential for all processing procedure. Vitamin C, total acid and pectin content presented at high content in fruit flesh were favorable for purée [3-4] and gel-product, such as fruit bar, jam, jelly,… [1].

3.2 Effect of blanching on material's quality

Blanching or heat treatment in general can inactive enzymes, based on heat denaturation of protein. Blanching at suitable temperature and time can also cause proto-pectin changes to pectin which helps the peeling process and increases the flesh recovery percent [1,5,10].

The data in Table 1 indicated that blanching at 70°C for 5 minutes, 80°C for 3 minutes or 90°C for 2 minutes can inactive peroxidase. There were several enzymes present in fruit and vegetable, but peroxidase was the most heat resisted enzyme. The inactivation of peroxidase indicated the inactivation of other enzymes included PPO that mainly cause browning reaction in fruit and vegetable [10-11].

Table 3. *Evaluating the inactivation of peroxidase using guaiacol and H_2O_2 reagent on different blanching conditions*

Temp. (°C)	Time (min)	Peroxiade inactivation	Description
Control		-	Slightlly hard
70	1	-	Slightlly hard
	2	-	Soft
	3	+	Soft
	4	+	Soft
	5	++	Soft, peelable
80	1	-	Slightlly hard
	2	+	Soft
	3	++	Soft, peelable
	4	++	Soft, peelable
	5	++	Soft, peelable
90	1	+	Soft, peelable
	2	+	Soft, peelable
	3	++	Very soft, peelable
	4	++	Very soft, peelable
	5	++	Very soft, peelable

Due to the changing of proto-pectin to pectin, the cell's structure collapsed, made the fruit became softer and the peel processing become easier [10]. But the more the structure of the cell was collapsed, the harder to separate the flesh from the peel, thus resulted in the decreasing of flesh recovery percent. The collapsed of the cell also cause cracking on the peel, result in the loss of fruit fluid and the decreasing in weight and nutrition values [1,5,10]. The highest flesh recovery percent were achieved by blanching at 90°C for 2 minutes, 80°C for 3÷4 minutes or 70 for 5 minutes (Figure 2).

Vitamin C is an important nutrition and used as food additive because of its antioxidant capacity. The degradation of vitamin C could easily occur during

processing and storage; depending upon many factors such as oxygen, heat, light, and in both aerobic and anaerobic pathways. Thus, vitamin C content can be used to evaluate the effects of the procedure or the storage condition to the quality of products [10-11]. During blanching, vitamin C content in marian plum decreased. The higher the temperature, the faster the decreasing (Figure 3).

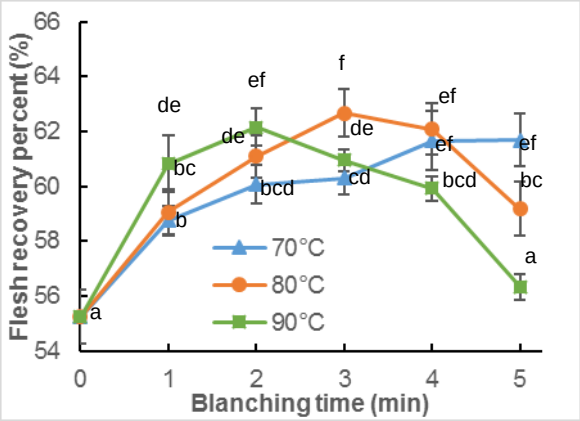

Figure 2. *Effect of blanching on flesh recovery percent*

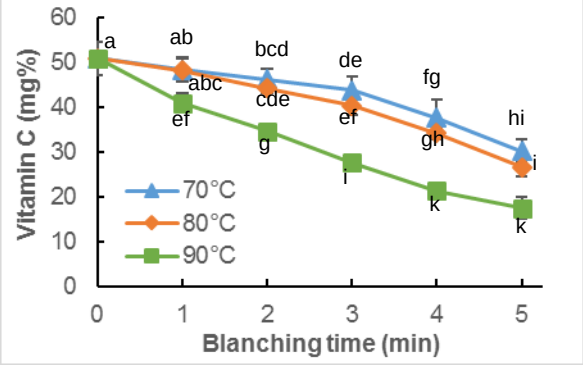

Figure 3. *Effect of blanching on vitamin C content*

Blanching conditions also effect the color of marian plum, specifically at b* value. The decreasing of b* during blanching showed the changes in color from yellow to blue due to the degradation of carotenoid in fruit flesh. Similarly, the degradation of carotenoid occurred faster at the higher temperature [10-11].

Among all the blanching conditions and the recovery percent, only blanching at 80°C for 3 minutes could maintain the fruit's nutrition values and color that made it suitable for purée processing.

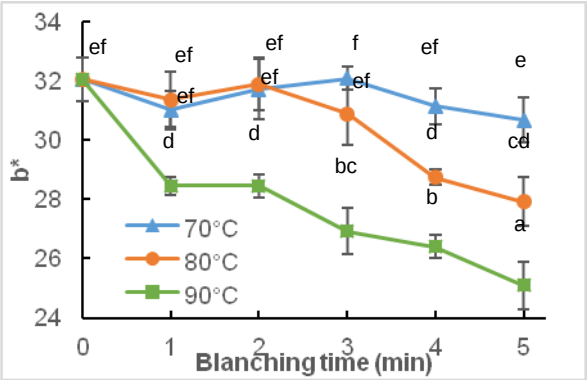

Figure 4. *Effect of blanching on marian plum's color*

3.3 The cryoprotection effect of sucrose and pectin on marian plum purée

After 14 days at frozen, the changes in purée color were noticed in L* and b*, indicated the changes in brightness and in the orange color.

Before freezing, the results showed that the more the sucrose and pectin were added, the brighter the color increased (indicated by L* values). With only the sucrose was added, b* values decreased and was lower than control sample. Added 1% pectin made the b* values higher and the more pectin and sucrose added, the more the b* values increased (Figure 5).

After thawing, the slightly decreasing of L* and b* values were noticed, compared to before freezing. About the brightness, L* values only increased until 1.5% pectin was added, the following increased in pectin content only caused the decreasing in L* values. The same phenomenon was also noticed in b* values (Figure 6).

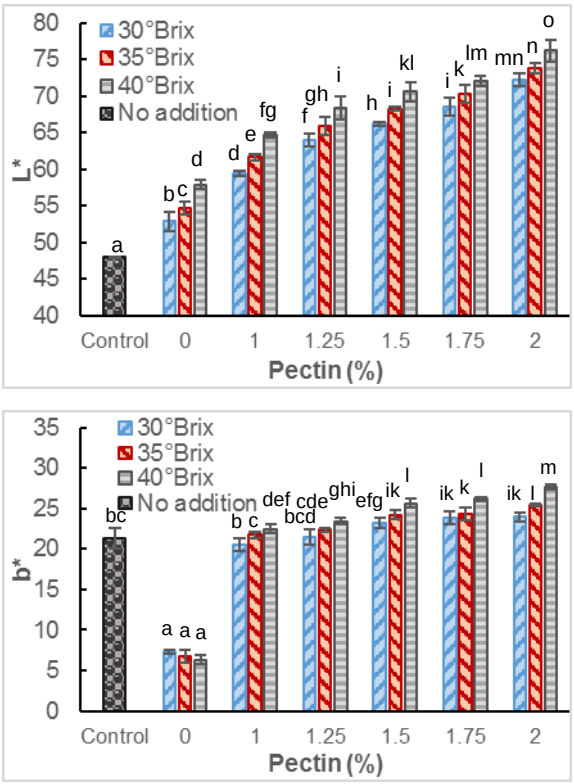

Figure 5. *Effect of sucrose and pectin on purée's color (L* and b*) before freezing*

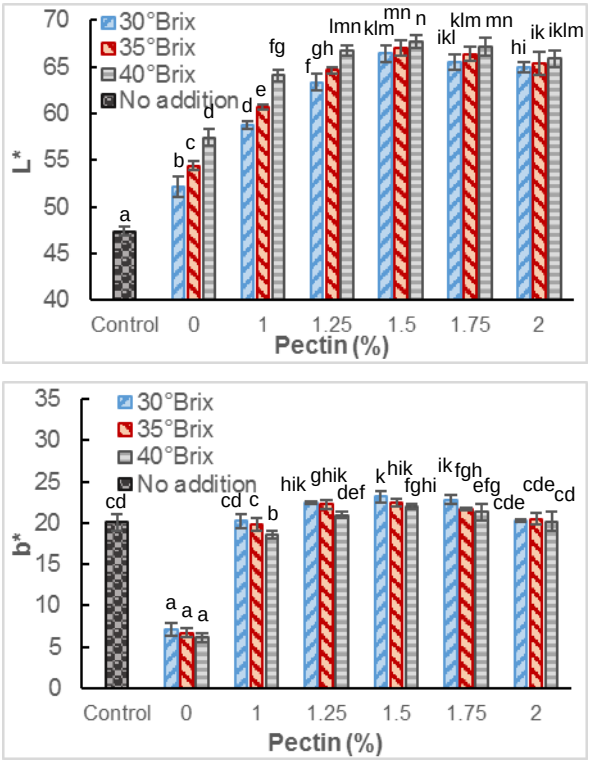

Figure 6. *Effect of sucrose and pectin on purée's color (L* and b*) after thawing*

With only the sucrose was added, the dilution effect was occurred, resulting the increasing in L* and the decreasing in b*. Sucrose, in low pH medium, also acted as browning factor. Plus, the degradation of carotenoid and the other browning reactor (such as vitamin C, polyphenol…), in the environment with rich oxygen, incorporated in as air bubbles when the purée was homogenized. That may be the cause of the decreasing of L* and b* after 14 days, even in frozen condition [10-12]. When pectin was added, pectin particles interact with sucrose particles, and in low pH medium, the gel formation was established [7,10,11]. The gel formation changed the pathway of light, so it was natural for the color changed. But when the gel formation was just established, the more pectin and sucrose added, the more force needed to homogenize the mixture, resulted in the more air bubbles incorporated in the gel formation [12]. Thus, the more sucrose and pectin were used, the higher the L* and lower the b* before freezing. But, during freezing and thawing, the movement of the water also affected other particles, the air also moved, incorporated with each other, created the bigger one, with the difference in Laplace pressure as a gradient, and the big air trended to move out of the gel formation. That phenomenon was similar in ice cream [13], thus resulted in the change of color to toward its original state, when the color depended on the gel structure, and the gel structure depended on pH, sucrose content, pectin content and sucrose/pectin ratio [7,10,11].

Vitamin C in purée could be easily degraded due to the existence of oxygen in the air incorporated in the gel formation, and the other causes, such as light and L-ascorbate oxidase. When the gel formation was established, it trapped ascorbic acid molecules inside, made it harder to interact with other

particles [7,10,11]. Thus, the degradation of ascorbic occurred slower (Figure 7). After 14 days at frozen storage, vitamin C content remained high, up to 95% in 35°Brix-1.75% pectin, 35°Brix-2% pectin, 40°Brix-1.75% pectin, 40°Brix-2% pectin samples.

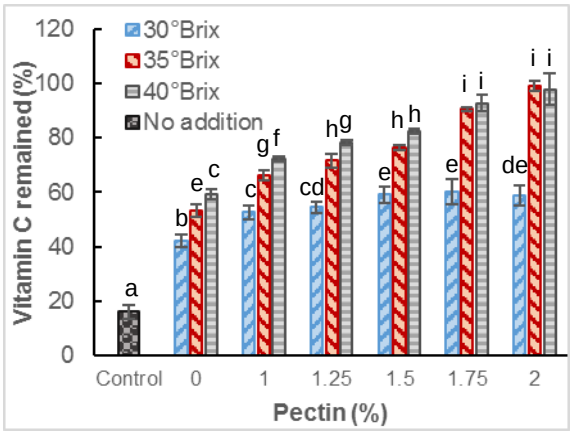

Figure 7. *Effect of sucrose and pectin on vitamin C remained in purée after thawing*

The establishment of gel formation also bounded water molecules, or trapped the water molecules inside, thus decrease the "free water" in the system [7,10,11], resulted in the decreasing of moisture loss (calculated based on moisture content in dry basis) compared to control sample (Figure 8).

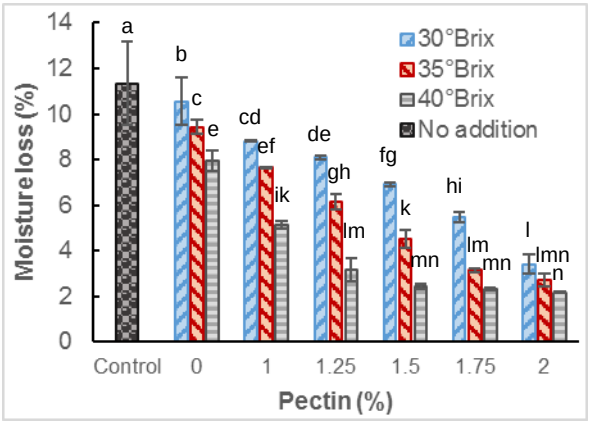

Figure 8. *Effect of sucrose and pectin on moisture loss of purée after thawing*

Basing on the changes in color, vitamin C content and moisture loss, the sample which using 35°Brix and 1.75% pectin as well as 40°Brix combined with 1.75% pectin have better quality than the others, after 14 days at frozen. The sucrose addition to 35°Brix (33.08g/100g fruit flesh) combined with 1.75% pectin were chosen to further investigate the changes in quality during frozen storage.

3.4 The changes in psycho-chemical properties of marian plum's purée during frozen storage

The changes in psycho-chemical of marian plum purée were showed in Table 2. During frozen storage, the changes in quality of marian plum purée was noticed, indicated by the changes in color, vitamin C content and moisture content.

The decreasing in L* and b* values kept on due to the released of the incorporated air, the degradation of carotenoid and the browning reaction. In mashed potato, the increasing of L*/b* ratio was also noticed, during frozen storage [14]. Yet, in red peeper, L* and a* had no significant difference before and after stored [15]. Although the change in color occurred, L* and b* values of the sample were still higher than the control sample before frozen (with L*= 54.76 and b*=6.74).

The moisture content also decreased. The low humidity of the low temperature air (-18±2°C) and the polyamide (PA) package were a favorable condition for moisture loss. The moisture loss was only 7.18% (calculated on dry basis) after 180 days at storage. This may be due to the gel formation that bounded water molecules. The loss of water also caused the insignificant increases of TSS and TA.

Figure 9. *The thawed marian plum purée after 6 months stored at frozen*

The decreasing of vitamin C was also noticed. Vitamin C content remained at 64.69% after 180 days at frozen. In green bean, blanching has a good effect on vitamin C protection. Specifically, unblanched beans lost ≥97% of their vitamin C within 1 month of freezing. After blanching, the beans' vitamin C content reduced by 28%, but limited further decreases in 12 months to 3% at vacuum sealed and 10% at no vacuum [16].

In summary, although there were light changes in physicochemical properties of marian plum purée during frozen storage, the sample still kept at high quality even after 6 months of freezing.

Table 4. *The changes in psycho-chemical of marian plum purée during frozen storage*

Days	Color		Moisture content (%, db)	TSS (%)	TA (%)	Vitamin C (mg%)
	L*	b*				
0	70.74^{a}±1.05	24.30^{a}±0.47	176.11^{a}±0.25	35.0^{a}±0.2	1.09^{a}±0.00	25.82^{a}±0.63
15	66.63^{b}±1.31	21.80^{b}±0.25	170.55^{b}±0.57	35.1^{a}±0.5	1.10^{a}±0.01	24.41^{ab}±0.92
30	59.30^{c}±0.83	18.99^{c}±0.44	167.70^{c}±0.28	35.5^{a}±0.4	1.11^{a}±0.01	23.23^{bc}±0.74
60	57.13^{d}±1.43	17.67^{d}±0.98	165.74^{d}±0.73	35.8^{ab}±0.5	1.13^{b}±0.01	21.98^{cd}±1.05
90	57.45^{cd}±1.72	15.34^{e}±0.67	164.79^{e}±0.83	36.0^{b}±0.3	1.15^{c}±0.01	21.22^{de}±1.21
120	58.56^{cd}±0.42	14.05^{f}±0.34	164.37^{ef}±0.30	35.8^{b}±0.2	1.16^{cd}±0.01	20.06^{e}±1.58
180	59.80^{cd}±1.31	11.20^{g}±0.84	163.68^{f}±0.43	35.8^{b}±0.3	1.17^{d}±0.01	16.70^{f}±0.76

4. CONCLUSSION

The suitable blanching condition could inactivate browning enzyme. However, the quality of the fruit decreased during blanching process. Blanching condition at 80°C in 3 minutes were suggested to inactivate enzyme and maintained material's quality at high level. Added sucrose and pectin effect on purée feature. The sample with sucrose added to 35°Brix combined with pectin at 1.75% remained high quality after 180 days at frozen. However, the stability of marian plum purée for longer shelf life still need to be researched. Marian plum purée can be used as main material for different products such as fruit bar, fruit ice cream or yogurt.

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