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MINIMALLY PROCESS ON CUT PEELED CHAYOTE

MINIMALLY PROCESS PADA LABU SIAM KUPAS POTONG

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ABSTRAK

Labu siam adalah salah satu sayuran yang dapat diolah menjadi berbagai macam masakan. Jika labu siam dikupas akan meninggalkan getah yang lengket ditangan dan tidak mudah dihilangkan walau sudah dicuci berulangkali dengan menggunakan sabun. Rumah Sayur Cisarua Bandung Barat memasarkan produk labu siam kupas potong. Labu siam kupas potong cepat mengalami penurunan mutu yang ditandai dengan berubahnya warna menjadi kecoklatan (browning enzimatis). Untuk itu, dilakukan penelitian dengan tujuan mendapatkan rancangan minimally process pada labu siam kupas potong. Rancangan perlakuan yang diujikan yaitu perlakuan kimia, dengan perendaman dalam larutan asam sitrat (0,5; 1; 1,5%) dan larutan natrium metabisulfit (500, 750, 1000 ppm), perlakuan fisik dengan blansir (10, 20, 30 detik), serta perlakuan kombinasi gabungan perlakuan kimia dan fisik. Rancangan minimally process yang terpilih yaitu perendaman dalam natrium metabisulfit 500 ppm selama 15 menit dan residu sulfit tidak terdeteksi. Labu siam kupas potong dengan perlakuan tersebut bertahan kesegarannya hingga hari keempat penyimpanan.

Kata kunci: labu siam kupas potong, minimally process, natrium metabisulfit

ABSTRACT

Chayote is a vegetable that can be processed into various kinds of dishes. If you peel chayote, it will leave a sticky sap on your hands that is not easy to remove even if you wash it repeatedly with soap. Rumah Sayur Cisarua, Bandung Barat markets cut peeled chayote products. Cut peeled chayote quickly experiences a decline in quality, characterized by the color changing to brownish (enzymatic browning). For this reason, research was carried out with the aim of obtaining a minimally process design for cut peeled chayote. The treatment design tested was chemical treatment, by immersion in citric acid solution (0.5; 1.0; 1.5%) and sodium metabisulfite solution (500, 750, 1000 ppm), physical treatment by blanching (10, 20, 30 seconds), as well as a combination of chemical and physical treatments. The minimally process design chosen was soaking in 500 ppm sodium metabisulfite for 15 minutes and sulfite residue was not detected. Cut peeled chayote with this treatment remains fresh until the fourth day of storage.

Keywords: minimally process, sodium metabisulfite, cut peeled chayote

INTRODUCTION

Indonesia has a climate suitable for growing various horticultural plants, one of which is the chayote. Chayote contains nutrients such as sodium, iron, potassium, phosphorus, calcium, fats, proteins, carbohydrates, and a high water content. Vitamins found in chayote are vitamin A, vitamin B, and vitamin C. Chayote also contains alkaloids, flavonoids, saponins, terpenoids (Fadliya *et al.*, 2018), and tannins (Chaniago, 2019).

Cut peeled chayote rapidly deteriorates in quality, indicated by a color change to brown due to enzymatic browning reaction. Enzymatic browning occurs as a result of oxidation reactions on phenolic compounds catalyzed by polyphenol oxidase (PPO) or peroxidase (POD) enzymes. This process happens when plant tissues are cut, peeled, or subjected to mechanical damage (Arsa, 2016). PPO enzymes, with the help of oxygen, convert polyphenols into quinones, causing fruits and vegetables to turn brown. Meanwhile, POD enzymes produce quinones with the presence of hydrogen peroxide. Besides catalyzing phenolic reactions with peroxide, POD enzymes can also catalyze the formation of brown pigments from quinone compounds. PPO and POD enzymes are widely distributed in plant tissues (Pardede, 2017).

Minimally process is a series of treatments applied to fresh fruits/vegetables, defined as processing activities including washing, sorting, cleaning, peeling, cutting, and others that do not affect the quality properties of the fresh material, especially its nutritional content (Shewfelt *et al.*, 1987). Minimally process on cut peeled chayote aims to inhibit enzymatic browning reactions and can be done in three ways: chemical treatment, physical treatment, and a combination of chemical and physical treatments. Chemical treatments using chemicals can inhibit the formation of brown pigments in peeled and cut products. Another

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function of chemicals in peeled and cut products is as reducing agents. The mechanism of action of reducing agents is to reduce quinones back to phenolic compounds. Browning prevention can occur as long as reducing agents are available. If reducing compounds are depleted, quinone polymerization reactions will take place, forming brown pigments. This occurs because reducing compounds have been irreversibly oxidized (Pardede, 2017). One of the chemical that can act as a reducing agent is sodium metabisulfite. Sodium metabisulfite at 500 ppm can inhibit browning processes in pears for up to 8 days (Akolo and Azis, 2017). Sodium metabisulfite at a concentration of 750 ppm can inhibit browning in potato flour (Setyaningsih, 2010) and corn starch (Doddy and Darmajana, 2011). Another chemical that can be used to slow down the deterioration of quality is sodium chloride (NaCl) or table salt. NaCl can disrupt protein stability, especially enzymes, thereby disrupting the activity of the enzymes (Fardiaz *et al.*, 1988 in Riandi, 2007).

Another method to prevent enzymatic browning in peeled and cut products is by using a physical treatment called blanching. Blanching is a preliminary process carried out on fruits and vegetables at temperatures below 100°C for a short period of time (Safrina and Supriadi, 2019). Blanching aims to deactivate enzymes in fruits and vegetables. Enzymes have a protein structure that easily deteriorates when exposed to heat, causing them to lose their original characteristics. Similarly, the PPO enzyme found in chayote becomes inactive when subjected to heat treatment. Blanching can be done through methods such as hot water blanching, steam blanching, and a recently developed method using a microwave (Pardede, 2017). In addition to chemical and physical treatments, post-harvest handling can also be combined to achieve the best results. Based on Pardede (2017), a combination of chemical and physical treatments is often utilized to achieve optimal outcomes.

This research is part of the Agro-Industrial Design Project aimed at solving issues for its partner, the Sinar Mukti Farmer Group. Therefore, the objective of this study is to develop a minimally process design for cut peeled chayote that can slow down enzymatic browning reactions, thus ensuring the freshness and quality of the product during distribution to consumers. Furthermore, this design should be applicable to the Rumah Sayur Cisarua Farmer Group in West Bandung.

MATERIAL AND METHOD

Equipments and Materials

The equipment used in this research includes plastic containers, knives, measuring cups, scales, thermometers, stoves, strainers, cool boxes, sealers, showcases, and tools for testing sulfite residues such as round-bottom flasks, heating mantles, Liebig condensers, electric stirrers, and a 10 ml burette.

The materials used include local chayote weighing 350-500 g per fruit, sodium metabisulfite, citric acid, salt, water, ice cubes, plastic packaging, plastic gloves, and a mask. Chemical materials used for sulfite residue testing include water, 2% starch indicator, 1% KI solution, 16% HCl solution, and 0.01 N I_2 solution. The sulfite residue testing procedure complies with SNI 01-2894-1992.

Methodology

The design of minimally process on cut peeled chayote was carried out using an engineering design approach. The result is a process design prototype that aligns with the availability of human resources and the needs of partners.

Ideation Phase: Determining the Minimally Process on Cut Peeled Chayote

During the ideation phase, the testing of chemicals to be used, namely citric acid at concentrations of 0.5%, 1.0%, and 1.5%; and sodium metabisulfite at concentrations of 500, 750, and 1000 ppm, while the physical treatment involved blanching for 10, 20, and 30 seconds. Samples were evaluated based on visual observation and partner acceptance. Chemical treatments were assessed based on color and taste parameters, while physical treatments were evaluated based on color and texture parameters. The treatment design is illustrated in Figure 1.

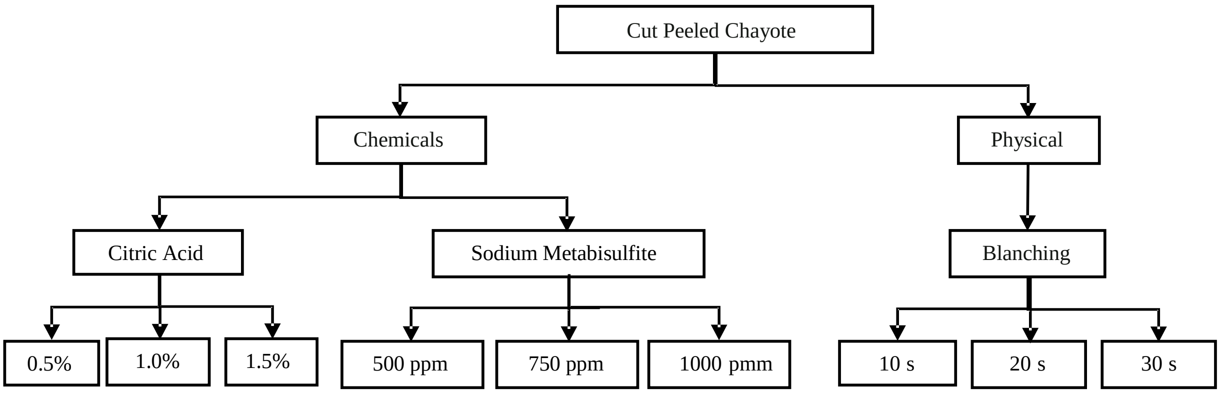

Figure 1. Minimally process treatments design for cut peeled chayote

Prototype Development Phase

In this phase, the selected treatments from the ideation phase were further developed and compared with treatments used by partners. The minimally process treatments tested included selected chemical and physical treatments, as well as their combinations; the treatment used by partners (soaking in a 4% salt solution for 1 minute); and no treatment. The treatment design in this phase is illustrated in Figure 2.

Each treatment sample was tested three times with a weight of 200 grams per sample in plastic packaging. The storage scheme was planned by considering the real distribution conditions and consumer storage. The cut peeled chayote was distributed to consumers at night (estimated at room temperature 20-25°C) with a distribution time of 5 hours, while consumer storage was at a low temperature (estimated at 5-8°C) until the test sample was deemed unfit. The test samples were evaluated based on partner acceptance by visually observing the color of the cut peeled chayote during storage.

Prototype Validation Phase

In this phase, a cost calculation of the selected minimally process treatment was conducted and compared with the treatment currently used by the partners. The cost calculation was based on the required raw materials and labor involved in processing 400 kg of cut peeled chayote (daily capacity).

RESULTS AND DISCUSSION

Minimally Process on Cut Peeled Chayote

Minimally process on cut peeled chayote was implemented to inhibit the occurrence of enzymatic browning reactions. Visual observation of the test samples was conducted by partners after 2 days of storage. The acceptance parameters tested by partners for chemical treatments were color and taste. In the treatment where cut peeled chayote was soaked in citric acid solution, the color of all test samples was accepted by the partners; however, the treatment imparted a sour taste to the chayote, leading to its rejection by the partners for all citric acid soaking treatments.

In the treatment where chayote was soaked in sodium metabisulfite solution, it was observed that the higher the concentration added, the paler the color of the chayote became. According to Angkasa (2015), an increase in sodium metabisulfite concentration results in a paler white product color. Additionally, it was suspected that higher concentrations of sodium metabisulfite could cause the surface of the chayote to dry out more. The sodium metabisulfite soaking treatment did not affect the taste of the chayote. The soaking treatment in 500 ppm sodium metabisulfite solution was accepted by the partners. The observation results of the soaking treatments in citric acid and sodium metabisulfite solutions can be seen in Figure 3.

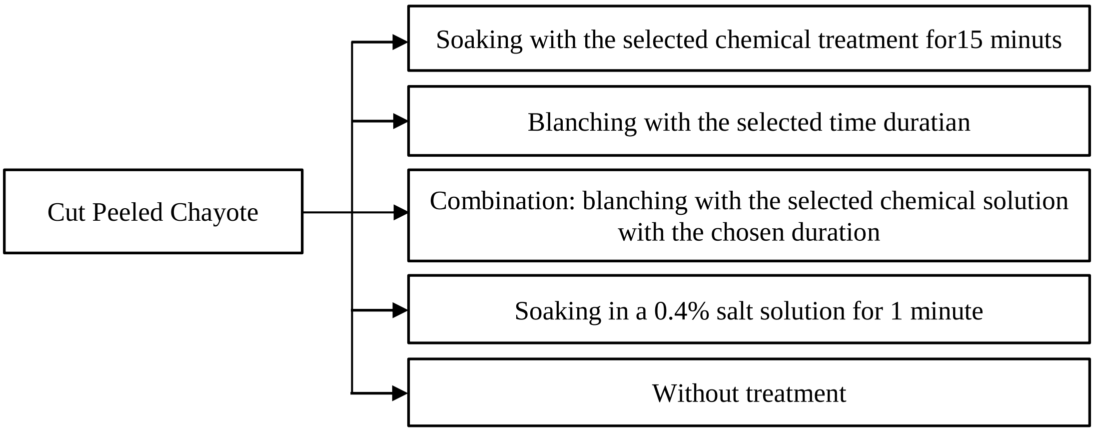

Figure 2. Development design of minimally process treatments for cut peeled chayote

0.5% 1.0% 1.5% 500 ppm 750 ppm 1000 ppm

Soaking in citric acid solution Soaking in sodium metabisulfite

Figure 3. Observation results of minimally process on cut peeled chayote with chemical treatment

The acceptance parameters tested by the partners for physical treatments involving blanching were color and texture. On day 0 of observation, the cut peeled chayote that was blanched for 10, 20, and 30 seconds was still accepted by the partners, as it retained a fresh green color and did not show any texture changes. On the second day of storage, the cut peeled chayote blanched for 10 seconds remained acceptable to the partners, whereas those blanched for 20 and 30 seconds exhibited a soft texture and a paler color. The texture of the cut peeled chayote became softer with longer blanching times. Heating causes damage to the fruit tissue (Laswatin, 2020). This tissue damage results in the fruit becoming soft (Lospiani *et al.,* 2017). The observation results for the physical treatments on cut peeled chayote can be seen in Figure 4.

10 s 20 s 30 s

Blanching Duration

Figure 4. Observation results of minimally process on cut peeled chayote with physical treatment

Prototype Development

Based on the results of the selected chemical and physical treatments, namely soaking in a 500 ppm sodium metabisulfite solution for 15 minutes and blanching for 10 seconds, the following treatments were developed:

1. Soaking in a 500 ppm sodium metabisulfite solution for 15 minutes.
2. Blanching for 10 seconds.
3. Blanching in a 500 ppm sodium metabisulfite solution for 10 seconds.
4. Soaking in a 0.4% salt solution for 1 minute.
5. No treatment.

The treatments were also developed under storage conditions that closely resemble the real conditions managed by partners, such as storing the cut peeled chayote during distribution to consumers (conducted at night at room temperature close to 20-25°C, estimated for 5 hours) and storing at the consumer's end at a low temperature of 5-8°C until the cut peeled chayote becomes unfit.

Acceptance testing was conducted by daily observations until the samples were no longer accepted by the partners. The observation results of the cut peeled chayote based on the sample acceptance by partners can be seen in Table 1.

The untreated cut peeled chayote experienced a decline in quality after the initial 5 hours of storage at room temperature. This quality degradation was marked by the browning of the chayote. Therefore, the untreated samples were not accepted by the partners. According to Pardede (2017), the enzyme PPO, with the aid of oxygen, converts polyphenols into quinones, which causes the browning of fruits and vegetables. Meanwhile, other treatments were still accepted by the partners. This indicates that chemical, physical, combination treatments, and soaking in salt solution can prevent browning during the delivery process. The observation results of the untreated cut peeled chayote can be seen in Figure 5.

Table 1. Observation results of the cut peeled chayote based on the sample acceptance by partners

Treatment	Observastion Result																	
	H0+5 Hour			H1			H2			H3			H4			H5		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Soaking in 500 ppm sodium metabisulfite solution for 15 minutes (chemical treatment)	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	TD	TD	TD
Blanching in water for 10 seconds (physical treatment)	D	D	D	D	D	D	D	D	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD
Blanching in 500 ppm sodium metabisulfite solution for 10 seconds (combination treatment)	D	D	D	D	D	D	D	D	D	D	TD	D	TD	TD	TD	TD	TD	TD
Soaking in 0.4% salt solution for 1 minute	D	D	D	D	D	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD
Without treatment	TD	D	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD

Note: D = Accepted; TD = Not Accepted

In Table 1, the observation results show that the cut peeled chayote treated with chemical, physical, and combination methods were still accepted by the partners on the first day (H1) of storage. The soaking treatment in a 0.4% salt solution was accepted for test samples of iteration 1 and 2, while iteration 3 was not accepted by the partners due to browning on the first day (H1) of storage. Therefore, overall, the test samples treated by soaking in a 0.4% salt solution were deemed unacceptable by the partners. The effectiveness of salt in inhibiting browning is lower compared to sodium metabisulfite. According to Azis (2016), soaking treatment in sodium metabisulfite solution is more effective in preventing browning compared to soaking treatment in NaCl or salt solution. The observation results of the cut peeled chayote soaked in a salt solution can be seen in Figure 6.

On the second day (H2) of storage, the cut peeled chayote treated with chemical and combined chemical and physical treatments were still accepted by the partners. The physical treatment of blanching for 10 seconds was accepted for test samples of iteration 1 and 2, while iteration 3 was not accepted by the partners due to the chayote becoming pale, experiencing browning, and producing water. The presence of water indicates tissue damage in the cut peeled chayote that underwent the heating process. Additionally, tissue damage also caused the color of the chayote to become pale. All test samples with the 10-second blanching treatment were deemed unacceptable by the partners. The observation results of the minimally process on cut peeled chayote with the 10-second blanching treatment can be seen in Figure 7.

The observation results of the cut peeled chayote on the third day (H3) of storage indicate that the combined treatment of blanching with a 500 ppm sodium metabisulfite solution for 10 seconds was accepted for test samples of iteration 1 and 3, while iteration 2 was not accepted by the partners due to browning. Therefore, all test samples with the combination treatment were deemed unacceptable by the partners. The observation results of the minimally process on peeled chayote with the combination treatment can be seen in Figure 8.

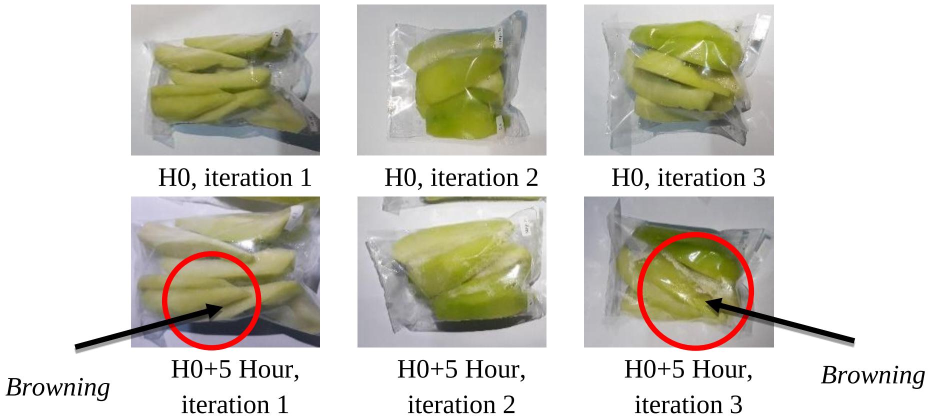

Figure 5. Observation results of untreated cut peeled chayote

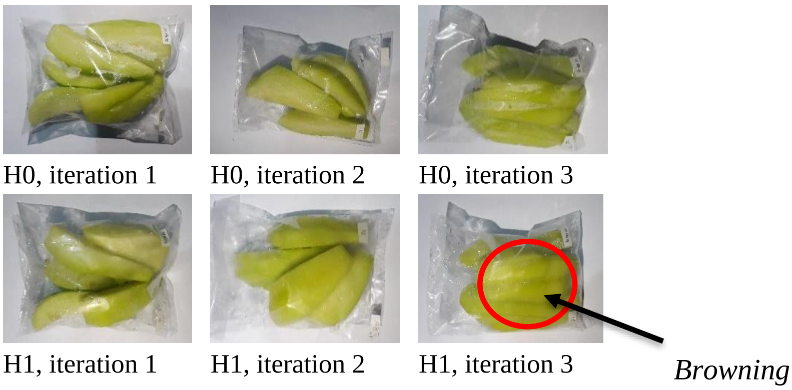

Figure 6. Observation results of minimally process on cut peeled chayote with soaking in a 0.4% salt solution treatment

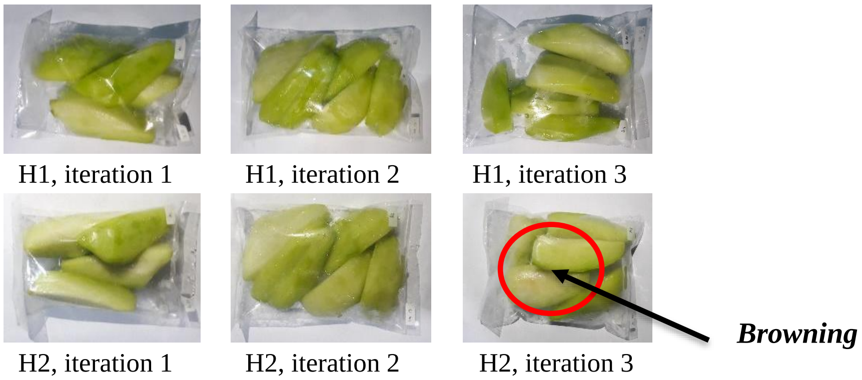

Figure 7. Observational outcomes of minimally process on cut peeled chayote subjected to a 10-second blanching treatment

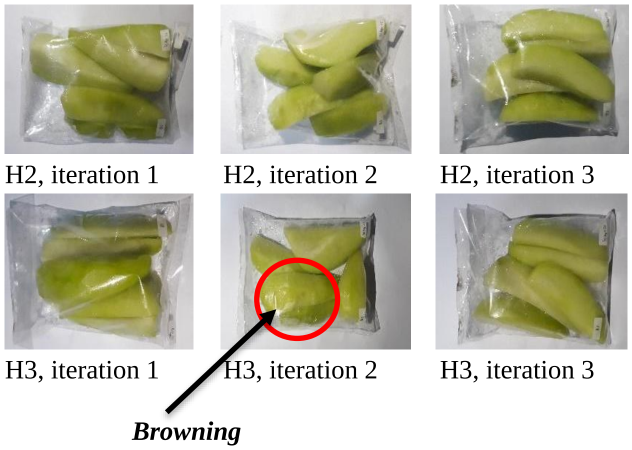

Figure 8. Observational results of minimally process on cut peeled chayote with combination treatment

The observation results of the cut peeled chayote on the third (H3) and fourth (H4) day of storage show that the chemical treatment was still accepted by the partners. This acceptance was based on the color of the chayote, which did not undergo browning, and the texture which did not become soft. The soaking treatment in the sodium metabisulfite solution did not produce water in the packaging and tended to keep the samples dry. This is consistent with Hehmaning *et al*. (2013) in Angkasa (2015), who stated that sodium metabisulfite causes cells within the tissue to become porous, thereby accelerating the drying process. The observation results of the minimally process on cut peeled chayote with the chemical treatment could last up to the fourth day (H4) of storage (Figure 9).

The soaking treatment in a 500 ppm sodium metabisulfite solution for 15 minutes is the selected minimally process treatment. This treatment is suspected to leave sulfite residues on the cut peeled chayote. According to Rosanti (2016), consuming food high in sulfite content can cause digestive disorders and endanger health. The residual sulfite limit according to BPOM regulations (2013) for fresh whole fruits is 30 mg/kg. The sulfite residue test refers to SNI 01-2894-1992.

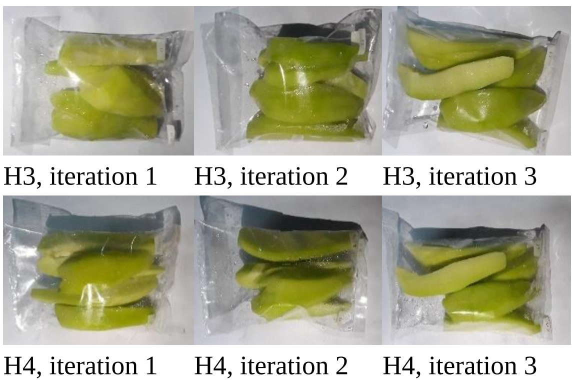

Figure 9. Observation results of minimally process on cut peeled chayote with 500 ppm sodium metabisulfite soaking treatment

The results of the sulfite residue test showed that sulfite residues were not detected, or the residual sulfite content was very low, in the cut peeled chayote. The undetected sulfite residue is suspected to be due to the evaporation of sulfite compounds from the surface of the chayote. According to Cahyadi (2006) in Anggarini *et al.* (2014), sulfite compounds have essential oil properties, meaning they are easily volatile, so the residual sulfite concentration will not exceed the given sulfite concentration. Additionally, the undetected sulfite residue is suspected to be due to the low concentration of sodium metabisulfite and relatively short soaking time, resulting in minimal absorption into the tissue. Based on these test results, the cut peeled chayote soaked in 500 ppm sodium metabisulfite is safe for consumption.

Prototype Validation

The validation of the minimally process prototype on cut peeled chayote with soaking in a 500 ppm sodium metabisulfite solution was conducted at Rumah Sayur Cisarua with the partners. The aspects validated included the comparison of the amount of 500 ppm sodium metabisulfite solution to the cut peeled chayote and the costs needed to apply the selected minimally process treatment. The experiment results showed that the water-to-material ratio for soaking chayote was 2:1. According to the partners, this ratio was inefficient due to the relatively large amounts of water and sodium metabisulfite used. The partners proposed that the amount of water used for the soaking process should just cover the surface of the chayote. Therefore, the water-to-material ratio was recalculated with the partners directly.

A 60-liter capacity container box was used in the production process of cut peeled chayote. Calculations were conducted by weighing 10 kg of cut peeled chayote and placing it into the container box. Water was then added until all of the chayote was submerged. The results showed that 10 liters of water were required to soak 10 kg of cut peeled chayote. This indicates a 1:1 water-to-material ratio, meaning that a container box can be used to soak 30 kg of cut peeled chayote with 30 liters of water.

The cost calculation for the selected minimally process treatment is based on production capacity according to consumer demand. Currently, consumer demand is 400 kg of cut peeled chayote per order. Using a water-to-material ratio of 1:1, 400 liters of water are needed for the production of 400 kg of cut peeled chayote. The water required for peeling, washing, and cutting processes is 430 liters, making the total water requirement 830 liters.

Figure 10. Soaking cot peeled chayote in sodium metabisulfite solution with a water-to-material ratio of 1:1

The selected minimally process treatment requires 0.2 kg of sodium metabisulfite to make a 500 ppm solution. Because sodium metabisulfite powder easily disperses in the air and has a strong odor, workers must wear masks during production. The production time is 424 minutes. Meanwhile, the minimally process method currently used by the partners uses a 0.4% salt solution (requiring 1.6 kg of salt) with a production time of 410 minutes. The selected treatment adds 14 minutes (0.23 hours) to the production time, necessitating additional labor costs (labor wages for the production process are Rp 9,375.00 per hour). The costs required for the selected minimally process treatment and the treatment currently used by the partners are presented in Tables 2 and 3.

Table 2. Costs required for sodium metabisulfite treatment

No.	Element	Quantity	Unit	Price per Unit (Rp)	Totol Price per Unit (Rp)
1	Sodium metabisulfit	0.2	kg	18,000.00	3,600.00
2	Masker	1	pcs	2,000.00	2,000.00
3	Labor	5	Person	2,188.00	10,938.00
The required cost for 400 kg of cut peeled chayote					16,538.00
The required cost for 1 kg of cut peeled chayote					41.00

Table 3. Cost required for salt solution treatment

No.	Element	Quantity	Unit	Price per Unit (Rp)	Totol Price per Unit (Rp)
1	Garam	1.6	kg	10,000.00	16,000.00
The required cost for 400 kg of cut peeled chayote					16,000.00
The required cost for 1 kg of cut peeled chayote					40.00

Based on Tables 2 and 3, soaking in a 500 ppm sodium metabisulfite solution does not incur significant additional costs. However, this treatment can extend the shelf life of cut peeled chayote up to 4 days of storage.

CONCLUSIONS AND RECOMMENDATION

Conclusions

Minimally process on chayote involves peeling, cutting, soaking, and packaging. The treatment with soaking in a 500 ppm sodium metabisulfite solution for 15 minutes can maintain the quality and freshness of cut peeled chayote up to the fourth day of storage at 5-8°C. Sulfite residues were either undetected or very low, making the cut peeled chayote safe for consumption. The sulfite residue limit according to BPOM regulations (2013) for fresh whole fruits is 30 mg/kg.

Recommendation

It is expected for further research to conduct browning prevention testing on cut peeled chayote by using sodium metabisulfite solution with a concentration of less than 500 ppm.

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