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PRESERVING VITAMIN C, ANTIOXIDANT CAPACITY, AND SENSORY ATTRIBUTES OF MINIMALLY PROCESSED FRESH-CUT PINEAPPLE (ANANAS COMOSUS) USING MILD HEAT BLANCHING

[Preservasi Vitamin C, Kapasitas Antioksidan, dan Sensoris Nanas (Ananas comosus) Segar Potong Proses Minimal menggunakan Blansir Suhu Rendah]

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ABSTRACT

Pineapple (Ananas comosus) is a nutrient-rich tropical fruit known for its high content of vitamin C, bromelain enzyme, and phenolic compounds with antioxidant properties, which are prone to degradation during storage. This study investigated the effect of mild heat blanching (40 °C, 50 °C, and 60 °C) on the physicochemical and sensory qualities of blanching-treated fresh-cut pineapple. The blanching process was applied to improve shelf life while preserving key nutritional attributes, particularly vitamin C content, which is sensitive to thermal degradation. Pineapples were pretreated with 0.15% calcium chloride and subjected to blanching for 5 minutes, vacuum-packed, frozen, thawed, and evaluated for antioxidant activity (DPPH method), vitamin C content (iodometry), total soluble solids (TSS), pH, and sensory attributes (hedonic rating). Researchs result showed that blanching at 60 °C significantly preserved vitamin C (865.33 mg/100g) and antioxidant activity (17.39%) compared to using lower temperatures (40 °C, 50 °C), while maintaining acceptable sensory properties. Although blanching reduced TSS and pH compared to fresh pineapple, the treatment at 60 °C achieved the highest preference scores for color, aroma, taste, and texture. The De Garmo effectiveness index identified 60 °C as the optimal blanching temperature, balancing nutritional preservation and consumer acceptability. These findings suggest that controlled blanching at 60 °C is a viable preservation method for fresh-cut pineapple, extending shelf life while maintaining sensory and functional quality.

Keywords: Antioxidant activity, fresh-cut pineapple, mild heat blanching, sensory evaluation, postharvest preservation

ABSTRAK

Nanas (Ananas comosus) merupakan buah tropis kaya nutrisi yang dikenal karena kandungan vitamin C, enzim bromelain, dan senyawa fenoliknya yang memiliki sifat antioksidan selama penyimpanan. Penelitian ini bertujuan untuk mengkaji pengaruh blansir dengan panas ringan (40 °C, 50 °C, dan 60 °C) terhadap sifat fisikokimia dan sensoris nanas segar potong yang diberi perlakuan blansir. Proses blansir diterapkan untuk memperpanjang umur simpan sekaligus mempertahankan atribut nutrisi utama, khususnya kandungan vitamin C yang sensitif terhadap degradasi termal. Nanas diberi pra-perlakuan dengan larutan kalsium klorida 0,15%, kemudian diblansir selama 5 menit, dikemas secara vakum, dibekukan, dicairkan, dan dievaluasi untuk aktivitas antioksidan (metode DPPH), kandungan vitamin C (iodometri), total padatan terlarut (TSS), pH, serta atribut sensoris (skala peringkat hedonik). Hasil penelitian menunjukkan bahwa blansir pada suhu 60 °C secara signifikan mempertahankan kandungan vitamin C (865,33 mg/100 g) dan aktivitas antioksidan (17,39%) dibandingkan dengan perlakuan suhu lebih rendah (40 °C dan 50 °C), sambil tetap menjaga karakteristik sensoris yang dapat diterima. Meskipun perlakuan blansir menyebabkan penurunan nilai TSS dan pH dibandingkan nanas segar, perlakuan pada suhu 60 °C memperoleh skor preferensi tertinggi untuk warna, aroma, rasa, dan tekstur. Indeks efektivitas De Garmo

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mengidentifikasi suhu 60 °C sebagai suhu blansir paling optimal, karena mampu menyeimbangkan antara pelestarian nutrisi dan penerimaan konsumen. Temuan ini menunjukkan bahwa blansir terkontrol pada suhu 60 °C merupakan metode pengawetan yang layak diterapkan untuk nanas segar potong, dengan potensi memperpanjang umur simpan sekaligus mempertahankan kualitas fungsional dan sensoris produk.

Kata Kunci: *Aktivitas antioksidan, blansir suhu rendah, evaluasi sensoris, nanas potong segar, pengawetan pascapanen*

INTRODUCTION

Pineapple (*Ananas comosus*) is one of the most widely consumed tropical fruits, appreciated not only for its sweet-sour flavor but also for its rich nutritional and functional components. Pineapple is a natural source of vitamin C, minerals, and bromelain a proteolytic enzyme complex known for its health-promoting properties (Kinanti et al., 2023). Bromelain and vitamin C components contribute to fruit's antioxidant potential, which plays a critical role in neutralizing free radicals and preventing oxidative cell damage (Aryani et al., 2025).

The rising demand for convenient, ready-to-eat fruit options has led to a significant increase in the popularity of fresh-cut processing (Husnayain et al., 2025). Minimally processed pineapple maintains a significant degree of the original appearance, texture, and flavor of fresh fruit, while simultaneously providing enhanced convenience for consumers. The procedure generally consists of washing, peeling, cutting, and packaging, all conducted under hygienic conditions (Husnayain et al., 2025). Nonetheless, in spite of its benefits, fresh-cut pineapple exhibits a high degree of perishability. Storage, especially in refrigerated conditions, frequently results in negative alterations including tissue softening, discoloration, the development of off-flavors, and nutrient degradation (Chang et al., 2025; Padrón-Mederos et al., 2020).

One approach to overcome this decline in quality is to apply pre-treatment such as blanching. Blanching is a mild heat pre-treatment utilized for fruits and vegetables to inactivate enzymes, decrease microbial load, and preserve product quality during storage. Mild heat blanching, when optimized, enhances cell wall integrity and preserves bioactive compounds (Xiao et al., 2017). Blanching requires careful control, as essential nutrients like vitamin C and bromelain are sensitive to heat. Bromelain demonstrates optimal stability at approximately 60 °C; however, extended exposure to elevated temperatures may result in enzymatic degradation (Wiyati & Tjitraresmi, 2018; Zhang et al., 2020).

In this context, the application of mild heat blanching at designated temperatures (40 °C, 50 °C, and 60 °C) during the fresh-cut pineapple process has the potential to enhance product stability while reducing nutrient loss. Blanching is a method that can be used to inactivate enzymes to prevent oxidation. Blanching is a method that can be used to inactivate enzymes to prevent oxidation. Temperatures from 50 to 80 ◦C seem to be effective when inhibiting PPO activity during washing for many products (Delgado, 2021). Blanching can affect sweetness perception and total soluble solids (TSS), which are linked to glucose and fructose levels as well as pH variations during the ripening process of Fruit. Therefore, this study aimed to investigate the effects of mild heat blanching on the physicochemical and sensory properties of minimally processed fresh-cut pineapple. The study specifically assessed variations in vitamin C content, antioxidant activity, total soluble solids (TSS), pH levels, and overall sensory quality. The anticipated outcomes aim to deliver insights regarding effective preservation strategies that sustain the nutritional and sensory quality of fresh-cut pineapple.

MATERIAL AND METHOD

Materials

Fresh pineapples (*Ananas comosus*) were obtained from a local market in Caruban, East Java, Indonesia and used as raw materials for both sample preparation and sensory evaluation. Food-grade calcium chloride was purchased from CV. Subur Kimia Jaya, while mineral water was sourced from PT Tirta Fresindo Jaya, Indonesia. Reagents used for chemical analyses included DPPH (2,2-diphenyl-1-picrylhydrazyl) solution, 85% methanol, starch solution, and iodine solution (I_2 0.01 N), all supplied by Smart Lab (Indonesia). Distilled water (aquadest) was obtained from Myer, Indonesia.

The tools used for fresh-cut pineapple processing included standard kitchen knives, plastic basins, cutting boards, spoons, and pans. Mass measurements were performed using an analytical balance (Radwag, Poland) and a digital kitchen scale (MTE, China). Blanching was conducted using a gas stove

(Rinnai, Indonesia), and samples were packed using a vacuum sealer (Getra, Indonesia) with 75 µm low-density polyethylene (LDPE) vacuum bags (Cerantic, Indonesia). Processed samples were stored in a freezer unit (GEA, Indonesia) prior to analysis.

Methods

Blancing Procedure

Pineapple cutting and pretreatment were carried out using previous method (Hien et al., 2022). The pretreatment process was carried out using the blanching method according to Hien et al. (2022) with variations in temperature and time to obtain the most optimal bromelain enzyme activity. Pineapples that have been cut were then soaked using a 0.15% $CaCl_2$ solution. Next, the blanching process was carried out by heating the pineapple soak at varying temperatures of 40, 50, and 60 °C and heating times of 5 minutes. The pineapple fruit was then drained and packaged using 75 µm LDPE plastic in a vacuum (90%) and frozen at –20 °C. The thawing process on the sample was carried out slowly (4-5 °C) until the ice was completely melted (around 2 °C) before testing.

Sensory Evaluation

Sensory evaluation was carried out involving 40 untrained panelists. The panelists were asked to carry out a preference rating hedonic test. Four sample groups were evaluated, each assigned a random code: Group 1 – fresh (unprocessed) pineapple; Group 2 – pineapple blanched at 40 °C; Group 3 – pineapple blanched at 50 °C; and Group 4 – pineapple blanched at 60 °C. The sensory data were used to determine differences in preference among the treatments and evaluate the impact of blanching temperature on sensory quality.

Antioxidant Activity, Vitamin C, Soluble Solids and pH Value Analysis

The antioxidant activity of blanched pineapple samples was determined using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method. Vitamin C content was quantified using the iodometric titration method, which measuresascorbic acid concentration based on its reducing properties. Total soluble solids (TSS) were measured using a handheld refractometer with a range of up to 30 °Brix, while pH was determined using a calibrated digital pH meter. All analyses were conducted in triplicate, and the results were expressed as mean ± standard deviation.

Statistical Analysis

The sensory acceptance data from the minimally processed fresh-cut pineapple subjected to blanching treatments were analyzed quantitatively using IBM SPSS Statistics Version 26. A univariate analysis was performed, followed by one-way analysis of variance (ANOVA) at a significance level of $\alpha=0.05$. All analysis was conducted in triplicate. When significant differences were observed, Duncan's multiple range test was conducted for post hoc comparison. The Garmo method was also employed where applicable to further interpret treatment differences.

RESULT AND DISCUSSION

Chemical Analysis of Minimally Processed Fresh-Cut Pineapple

Chemical analyses were conducted on all treatment groups of minimally processed fresh-cut pineapple. The parameters evaluated included antioxidant activity, pH, TSS, and vitamin C content. These analyses were performed to assess the impact of different blanching temperatures (40 °C, 50 °C, and 60 °C) on the nutritional and physicochemical quality of the product. The detailed results of the chemical analyses are presented in Table 1, which summarizes the effects of blanching on the functional and quality attributes of the fresh-cut pineapple samples.

Table 1. Chemical Analysis of The Minimaly Processed Fresh-Cut Pineapple using Mild Heat Blanching

Treatments	Antioxidant Activity (%)	Vitamin C (mg/100g)	pH	TSS (°Brix)
Fresh	23,33 ± 1,73^{d}	928,66 ± 25,8^{c}	4,96 ± 0,03^{e}	12,5 ± 0,28^{c}
40 °C	11,37 ± 1,88^{a}	469,33 ± 29,3^{a}	4,13 ± 0,03^{a}	11,5 ± 0,0^{b}
50 °C	14,81 ± 0,98^{bc}	542,66 ± 14,6^{a}	4,4 ± 0,0^{b}	11,5 ± 0,28^{b}
60 °C	17,39 ± 0,28^{c}	865,33 ± 38,8^{c}	4,76± 0,03^{d}	9,96 ± 0,03^{a}

Antioxidant Activity

As shown in Table 1, a clear trend was observed, where antioxidant activity increased with higher blanching temperatures but remained lower than that of fresh pineapple. The lowest antioxidant activity was recorded in the sample blanched at 40 °C (11.37%), followed by 50 °C (14.81%) and 60 °C (17.39%), while the fresh sample demonstrated the highest antioxidant activity at 23.33%. Although blanching generally led to a reduction in antioxidant activity compared to the fresh control, a progressive increase in antioxidant retention was observed with rising blanching temperatures.

Maulana et al. (2022) reported that extended blanching time can increase the antioxidant activity of pineapple juice, and that blanching treatment is effective in maintaining antioxidant stability over 14 days of storage. This suggests that heat treatment not only reduces enzymatic degradation but may also facilitate the release or stabilization of antioxidant compounds. In some instances, blanching has been shown to increase the concentration of anthocyanins and other phenolic compounds due to enhanced extractability or the breakdown of cellular matrices, which liberates bound antioxidant constituents.

Pineapple is naturally rich in various antioxidant compounds, including ascorbic acid, flavonoids, carotenoids, and phenolic constituents such as quinones, coumarins, and phenolic acids (Nugraheni et al., 2018). While excessive heat can lead to thermal degradation of these compounds (Adi et al., 2023; Anam et al., 2024; Yudhistira et al., 2024), moderate temperatures such as 60 °C can preserve or even enhance antioxidant activity by reducing enzymatic degradation and potentially activating less-reactive antioxidant precursors. Supporting this, Pujimulyani et al. (2010) observed that thermal processing can increase the antioxidant activity of tannin-containing compounds, which may partially explain the higher antioxidant values found in samples treated at 60 °C.

Vitamin C Content

As presented in Table 1, vitamin C content showed statistically significant differences ($p < 0.05$) between fresh pineapple and the blanching treatments at 40 °C and 50 °C, but not with the 60 °C treatment. The lowest vitamin C content was observed in samples blanched at 40 °C (469.33 mg/100 g), followed by 50 °C (542.66 mg/100 g), while the highest levels were recorded in pineapple blanched at 60 °C (865.33 mg/100 g) and the fresh sample (928.66 mg/100 g). This finding suggests that blanching at 60 °C may preserve vitamin C more effectively than lower temperatures. Vitamin C (ascorbic acid) analysis was conducted using the iodometric titration method. The relatively higher vitamin C content observed at 60 °C is hypothesized to result from the inactivation of ascorbate oxidase, an enzyme responsible for vitamin C degradation, which remains active at lower blanching temperatures.

Blanching, and especially HTST blanching, was found to be very effective in the inactivation of ascorbic acid oxidase (AAO) (Giannakourou & Taoukis, 2021). In contrast, blanching at 40 °C and 50 °C likely allowed continued enzymatic oxidation, leading to greater nutrient loss. Moreover, the use of calcium chloride in the pre-treatment may have contributed to vitamin C preservation by reducing respiration rates and slowing oxidative degradation (Eroğul et al., 2024).

Vitamin C, a water-soluble and heat-sensitive compound, functions as a coenzyme and antioxidant in metabolic processes (Salwa et al., 2023; Sernita, 2022). It is highly susceptible to oxidation during food processing, especially when tissue damage occurs, such as through peeling, cutting, or freezing. This is supported by Mieszczakowska-Frąc et al. (2021), who reported that mechanical disruption and prolonged storage reduce ascorbic acid content due to oxidation. Thus, while some loss of vitamin C is inevitable during processing, blanching at 60 °C appears to be a more favorable condition for preserving this essential nutrient in fresh-cut pineapple.

pH Value

The results of the pH analysis, shown in Table 1, indicate that the pH values of all blanched samples were significantly lower than that of fresh pineapple ($p < 0.05$). The pH values ranged from 4.13 (40 °C) to 4.96 (fresh sample), with intermediate values of 4.40 (50 °C) and 4.76 (60 °C). These findings suggest that the blanching process influenced acidity levels, although not drastically. The pH was measured using a calibrated digital pH meter. The observed decrease in pH values among the treated samples may be attributed to changes in organic acid composition during the storage period following blanching.

While blanching is not typically associated with direct acid degradation, it may affect acid solubility or distribution within the tissue, particularly during hot water immersion. However, the relatively modest change in pH values suggests that the blanching treatment primarily influences other physicochemical properties, with only a minor effect on acidity.

Total Soluble Solids

As presented in Table 1, TSS measurements revealed significant differences ($p < 0.05$) between fresh pineapple and all blanching treatments. The TSS values observed were 12.5% in fresh pineapple, 11.5% in both the 40 °C and 50 °C blanching treatments, and the lowest at 9.5% in the 60 °C treatment. These results suggest that both blanching and freezing processes influence the soluble solid content of minimally processed fresh-cut pineapple. TSS analysis was performed using a handheld refractometer and primarily reflects the sugar and carbohydrate content in the product (Bayu et al., 2017). The significant decrease in TSS observed in blanched samples is consistent with prior findings that thermal and freezing treatments can lead to leaching of water-soluble compounds, including simple sugars, organic acids, and minerals. The reduction in TSS at higher blanching temperatures is likely due to increased permeability of plant cell membranes, which facilitates the loss of soluble solutes into the blanching medium (Dewandari et al., 2009).

Notably, the lowest TSS level observed at 60 °C may be attributed to intensified nutrient leaching at elevated temperatures. According to Giannakourou & Taoukis (2021), blanching at temperatures approaching 60 °C can cause substantial losses of soluble solids, including up to 35% of sugars and 40% of minerals and vitamins. These findings highlight the trade-off between enzymatic inactivation and nutrient preservation in heat-treated fresh-cut products.

Sensory Properties

Sensory evaluation of the minimally processed fresh-cut pineapple was carried out using a rating test to assess consumer acceptance. A total of 40 untrained consumer panelists participated in the evaluation, assessing the samples based on four sensory attributes: color, aroma, taste, and texture. A rating scale was employed, where 1 represented the most preferred sample and 4 the least preferred (value 1 is the first order of preference, value 2 is the second order of preference, value 3 is the the third order of preference and value 4 is the fourth or last order of preference).

Color

Based on the data presented in Table 2, the sensory evaluation of color showed a statistically significant difference between the fresh pineapple and the sample blanched at 40 °C ($p < 0.05$), whereas no significant differences were observed between the fresh sample and those blanched at 50 °C and 60 °C. In terms of preference score, fresh pineapple received the highest score (3.47), followed by samples blanched at 50 °C and 60 °C (both scoring 3.12), while the sample blanched at 40 °C received the lowest score (2.32). Color is a critical sensory attribute influencing consumer perception and acceptance, often serving as an initial indicator of product quality and freshness (Adi et al., 2024). The higher score of the 50 °C and 60 °C blanched samples suggests that mild heat treatment at these temperatures effectively preserved the visual appeal of the pineapple. This can be attributed to the partial inactivation of polyphenol oxidase (PPO), an enzyme responsible for enzymatic browning, which remains active at 40 °C but is significantly reduced at higher temperatures. These findings are in line with Hartanti & Sulistyani (2017), who reported that PPO activity decreases substantially above 50 °C, contributing to improved color stability. Additionally, blanching at moderate temperatures may induce desirable color development through the Maillard reaction, particularly due to the presence of natural sugars in pineapple. Liu et al. (2022) reported that mild heat treatment can enhance red or golden hues via non-enzymatic browning reactions, potentially increasing consumer preference. The similarity in preference scores between fresh pineapple and samples blanched at 50 °C and 60 °C suggests that these blanching conditions are optimal for retaining or enhancing the color quality of minimally processed fresh-cut pineapple.

Aroma

As presented in Table 2, pineapple blanched at 50 °C achieved the highest preference score (3.37), followed by blanching at 60 °C (3.15), 40 °C (2.82), and the fresh sample, which received the lowest score (2.47). These findings indicate that mild heat treatment, particularly at 50 °C, may positively influence the aromatic profile of minimally processed fresh-cut pineapple, enhancing consumer acceptance. In this study, the highest preference score for aroma was observed in minimally processed fresh-cut pineapple subjected to blanching at 50 °C. This result suggests that mild heat treatment at 50 °C may enhance the release or retention of desirable volatile compounds while minimizing thermal degradation.

Pineapple's characteristic aroma is attributed to a complex mixture of volatile esters and aldehydes, including ethyl 2-methylbutanoate, ethyl hexanoate, 2,5-dimethyl-4-hydroxy-3(2H)-furanone (DMHF), decanal, ethyl 3-(methylthio) propanoate, ethyl butanoate, and ethyl (E)-3-hexenoate (Wei et al., 2011). The blanching treatment appears to influence the volatile profile by potentially inactivating enzymes responsible for aroma degradation or by enhancing the liberation of bound aromatic precursors.

Taste

As shown in Table 2, among the treatments, pineapple blanched at 50 °C received the highest preference score (3.50), followed by 60 °C (3.32), 40 °C (3.15), and the fresh pineapple, which had the lowest score (2.37). These findings indicate that blanching, particularly at 50 °C, may positively influence the taste perception of minimally processed fresh-cut pineapple. Taste is a critical determinant of consumer preference, assessed primarily through gustatory perception. In this study, blanching at 50 °C was most effective in enhancing the perceived taste quality of the product. This improvement can be attributed to the modulation of pineapple's flavor-active compounds during mild heat treatment. Pineapple is known to contain several volatile compounds that contribute to its flavor profile, including allyl hexanoate, allyl heptanoate, allyl cyclohexanepropionate, and propylene glycol.

Table 2. Sensory Evaluation of Minimally Processed Fresh-Cut using Mild Heat Blancing

Treatments	Parameter			
	Color	Aroma	Taste	Texture
Fresh	$3{,}47\pm1{,}67^{b}$	$2{,}47\pm1{,}60^{a}$	$2{,}37\pm1{,}51^{a}$	$2{,}07\pm1{,}57^{a}$
40 °C	$2{,}32\pm1{,}28^{a}$	$2{,}82\pm1{,}50^{ab}$	$3{,}30\pm1{,}20^{b}$	$3{,}17\pm1{,}27^{b}$
50 °C	$3{,}12\pm1{,}15^{b}$	$3{,}37\pm1{,}14^{b}$	$3{,}50\pm1{,}30^{b}$	$3{,}37\pm1{,}39^{b}$
60 °C	$3{,}12\pm1{,}32^{b}$	$3{,}15\pm1{,}45^{ab}$	$3{,}32\pm1{,}32^{b}$	$3{,}30\pm1{,}15^{b}$

Sweet flavor notes are mainly imparted by compounds such as maltol and furaneol maltol providing a caramel-like, butterscotch flavor, and furaneol contributing a strong, sweet, fruity aroma (Zhu & Yu, 2020). Furthermore, mild heat blanching may enhance flavor through the partial hydrolysis of glycosidic compounds into aglycones and free sugars, thereby increasing sweetness (Pujimulyani et al., 2010). Meanwhile, the typical sourness of pineapple attributed to citric acid may be reduced during blanching due to the leaching of organic acids into the blanching water (Siregar & Hardianta, 2018). This balance of reduced sourness and enhanced sweetness likely contributed to the increased taste preference observed in the 50 °C treatment.

Textures

As shown in Table 2, pineapple blanched at 50 °C achieved the highest preference score for texture (3.37), followed closely by 60 °C (3.30) and 40 °C (3.17), while the fresh sample received the lowest score (2.07). These findings suggest that blanching positively influenced textural attributes, with 50 °C providing the most favorable sensory response among panelists. Texture is a critical property perceived through mechanical stimuli during mastication and is commonly described using terms such as soft, firm, smooth, or crisp. In this study, sensory analysis revealed that the blanching treatment at 50 °C yielded the highest texture preference score among all treatments, indicating that mild heat processing contributed positively to the mouthfeel of fresh-cut pineapple. A significant difference ($p < 0.05$) was observed between the texture preference of the fresh sample and the blanched treatments, with all blanched samples being preferred over the untreated control.

One contributing factor to improved texture in blanched samples is the addition of calcium chloride, which is known to reinforce structural integrity in plant tissues. The texture of fruits and vegetables is largely determined by turgor pressure, cell wall structure, and the composition of the middle lamella, which acts as a cellular adhesive (Maherawati et al., 2022). The cell wall of mature pineapple fruit is primarily composed of a polysaccharidenetwork including cellulose, hemicellulose, pectin, and glycoproteins, and alterations in these components can modify cell wall structure and mechanical propertie (Yao et al., 2025).

Calcium chloride contributes to textural firmness by providing Ca^{2+} ions that cross-link with the carboxyl groups of galacturonic acid in pectin chains, forming calcium pectate complexes. This cross-linking reduces pectin solubility, thereby increasing tissue rigidity and enhancing structural resistance to softening during thermal processing and storage (Christna, 2019). As a result, samples treated with calcium chloride and blanched at 50 °C retained a firmer, more desirable texture that closely resembled that of fresh pineapple, but with improved stability.

Determination the Best Treatment

The determination of the optimal treatment group for the minimally processed fresh-cut pineapple was conducted using the De Garmo Effectiveness Index Method according to Hayati et al. (2020). This multi-criterion decision-making approach was applied to both chemical and sensory parameters, including antioxidant activity, vitamin C content, pH value, TSS, as well as sensory evaluations of color, aroma, taste, and texture.

Based on the weighted effectiveness scores calculated for each parameter, the blanching treatment at 60 °C was identified as the most favorable. This treatment demonstrated superior performance across both nutritional and sensory attributes, indicating its suitability as the optimal processing condition. The detailed characteristics of the 60 °C treatment group were as follows: antioxidant activity of 17.39%, vitamin C content of 865.33 mg/100 g, pH value of 4.76, and TSS of 9.96%. For sensory attributes, this treatment received preference scores of 3.12 for color, 3.15 for aroma, 3.32 for taste, and 3.30 for texture.

These results suggest that blanching at 60 °C offers a balanced approach to preserving both the functional properties (e.g., antioxidant and vitamin C retention) and the sensory quality of fresh-cut pineapple.

CONCLUSION

Blanching at 60 °C significantly preserved vitamin C (865.33 mg/100g) and antioxidant activity (17.39%) compared to using lower temperatures (40 °C, 50 °C), while maintaining acceptable sensory properties. Although blanching reduced TSS and pH compared to fresh pineapple, the treatment at 60 °C achieved the highest preference scores for color, aroma, taste, and texture. The De Garmo effectiveness index identified 60 °C as the optimal blanching temperature, balancing nutritional preservation and consumer acceptability. These results indicate that mild heat blanching at 60 °C represents a promising pre-treatment strategy for minimally processed fresh-cut pineapple, supporting shelf-life extension while maintaining functional and sensory quality. Further studies on long-term storage stability are recommended to facilitate industrial-scale application and quality assurance.

CONFLICT OF INTEREST

There is no conflict of interest.

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