Conference Paper

The Effects of Sugar, Blanching, and Pasteurization on the Antioxidant Properties of Pineapple Juice

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Abstract.

This study aimed to improve the quality of pineapple juice by increasing its durability and antioxidant properties. A factorial design with four test factors, namely, the level of ripeness of pineapple, sugar composition, duration of blanching, and pasteurization was used. The results showed that the use of ripe pineapple as an ingredient of pineapple juice had better responses than raw pineapple. The sugar composition had a negative response to the antioxidant property of pineapple juice, both measured on day 0 and day 7. The duration of blanching was proven to have a positive effect on increasing antioxidant activity both on day 0 and day 14. Pasteurization had a negative response when measured on day 0, and a positive response on day 14. Producing pineapple juice in accordance with the results has been proven to have greater durability and antioxidant properties.

Keywords: blanching, pasteurization, pineapple juice, response surface methodology

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1. INTRODUCTION

Subang is one of the districts in West Java as the main producer of pineapple commodities. In 2015, Subang was able to produce 136,567 tons of pineapple [1]. Meanwhile, in 2020, pineapple production from Subang increased to 187,448.2 tons and placed in second ranks in the fruit production sector after papaya [2]. Five sub-districts produce pineapple in the Subang district, including Serangpanjang, Jalancagak, Ciater, Cisalak, Kasomalang, and Cijambe.

Kebun Indonesia Berdaya (KIB) is one of the centers for pineapple fruit producers located in the Cijambe District. KIB has 10 hectares of land area and is capable of producing approximately 2 tons of pineapple per month. Of the total pineapple produced, not entirely absorbed by the market due to its below-average size. To increase its economic value, the pineapple is then processed by KIB into pineapple juice.

Pineapple juice was only carried out through simple steps, namely washing, peeling, cooking at high temperatures, filtering, and then packaging Because of this non-standardized production process, the pineapple juice produced was only able to last for 2 days if stored at room temperature and would last for 1 week if stored at cold temperatures (in the refrigerator). The types of damage that occurred include the occurrence of fermentation so that large amounts of carbon dioxide gas were produced, the sedimentation, and the changed in colors. The short shelf life of pineapple juice

made it difficult for the product to be distributed outside the Subang area. So it is necessary to make efforts to improve the quality of pineapple juice.

The damage of pineapple juice products was usually caused by the activity of enzymes and microbes [3]. The presence of the enzyme bromelain, which is a type of protease enzyme, is capable of denaturing the protein. the enzyme is more active along with the pineapple ripening process [4]. In addition, large amounts of sugar addition can trigger fermentation caused by microbes such as bacteria or yeast. Therefore, the addition of large amounts of sugar to pineapple juice was usually carried out in wine production to induce fermentation [5]. The fermentation was marked by the production of large amounts of carbon dioxide gas.

Pineapple (Ananas comosus) is a type of plant from the Bromeliaceae which is known to have strong antioxidant activity. The strong antioxidant activity was not only resulted from fruit but also skin waste [6]. This antioxidant activity was produced by the existence of polyphenolic compounds, flavonoids, anthocyanins, vitamin C, tocopherols, carotenoids, and various other antioxidant compounds [7]. In addition, pineapple is also known to be rich in the content of the protease enzyme, namely bromelain which is known to have several pharmacological properties including inhibiting the growth of leukemia cancer cells [8], against oral cancer cells [9], and also as an anti-inflammatory in rhinosinusitis conditions [10].

The improvement efforts of the quality of pineapple juice, are carried out by improving all stages of production and optimizing the best factors at each stage made. The factorial randomized design method has been widely applied to various processes such as maintenance, production, and so on to find the best strategy to produce the best product. In this study, each stage was optimized and evaluated to find the best parameters so that the pineapple juice produced has better durability and strong antioxidant activity.

This study aims to find the best strategy for pineapple juice production stages to produce pineapple juice products that are durable and have the best antioxidant activity.

2. METHODS

2.1. Materials

Pineapple was obtained from the Indonesian Berdaya Garden, then the pineapple was processed by washing it thoroughly using a brush and running water and then separated it from the skin. The 2, 2 -diphenyl-1-picrylhydrazyl (DPPH) [SIGMA] was used as a free radical in the assay of antioxidant activity.

2.2. Random Factorial Design

This study was designed using a factorial design with four different parameters, namely the maturity level of the pineapple, the duration of blanching, the composition of added sugar, and the duration of pasteurization. Each test parameter was made into 2 differentiating factors. There were two types of pineapple material used in the experiment namely two types, namely raw pineapple and ripe pineapple. The blanching duration time was set amount 2 parameters, namely 5 minutes and 10 minutes The sugar composition was set at 20% and 40%, while the pasteurization duration was set at 30 minutes and 60 minutes. The research design is designed as shown in Table 1

TABLE 1: Factorial design for all test parameters of pineapple juice production.

No	Pineapple Ripening Level	Blanching (minutes)	Sugar Concentration (%)	Pasteurization (minutes)
1	raw	5	20	30
2	raw	5	40	60
3	raw	10	40	30
4	raw	10	20	60
5	riped	5	40	30
6	riped	5	20	60
7	riped	10	20	30
8	riped	10	40	60

2.3. Blanching

The clean pineapples were then cut lengthwise and then blanched with hot water at 90 ^{O}C with the time duration set in table 1. The pineapples were then drained.

2.4. Juice Production and Pasteurization

The pineapple pieces were then blended to obtain pineapple juice. The pineapple juice was then allowed to stand and then filtered until there was no more sediment. The pineapple juice was then added with sugar in the proportions as set out in the table. Furthermore, the pineapple juice was pasteurized at a temperature of 90 OC with a predetermined duration as shown in table 1. The pasteurized pineapple juice was then cooled to form a precipitate and supernatant. The precipitate was separated and the supernatant was packed into bottles for further sealing with a special plastic seal. Pineapple juice was then stored in the refrigerator with a temperature between 5-10 ^{o}C.

2.5. Antioxidant Analysis by DPPH method

The antioxidant activity of each pineapple juice was determined using a method similar to that done by Maulana et al [11].

2.6. Data Analysis

Each treatment was measured its antioxidant activity using the DPPH method, that was on day 0 and storage after day 14, then the % inhibition of pineapple juice on DPPH was calculated by the following formula:

$$\%inhibition = \frac{ABlanko - ASample}{ABlanko} x100\% \quad (1)$$

Each data obtained was then analyzed using the response surface methodology by comparing the effect of each factor, namely blanching - sugar composition, blanching - pasteurization, and sugar composition - pasteurization. The significance of each DPPH test result was also analyzed using one-way analysis of variance (ANOVA) using MS software Office Excel 2016.

3. RESULT AND DISCUSSION

3.1. Effects of Using Raw and Ripe Pineapples

The use of ripe pineapple and raw pineapple as the main ingredients of pineapple juice has an impact on the antioxidant activity of the pineapple juice produced. Fig.

1 shows that ripe pineapple (pineapple juice 5-8) produced better antioxidant activity than raw pineapple (pineapple juice 1 - 4). According to the research of Domínguez et al, during the ripening process of pineapple fruit, the activity of the enzyme phenylalanine ammonia-lyase (PAL) increased [12]. PAL is a key enzyme involved in the biosynthesis of flavonoids, coumarins, and other polyphenolic compounds [13]. The activity of the PAL enzyme made the ripe pineapples richer in polyphenols than unripe pineapples. The high content of polyphenolic in pineapple is highly correlated with the antioxidant activity produced [14]. Polyphenolic compounds produced from pineapple fruit are very strong types of antioxidants that make pineapple fruit a fruit that is recommended for antioxidant therapy [15]. In a ripe pineapple, the carotenoid content is also increased [16]. The presence of polyphenolic content, carotenoids, and other antioxidant compounds, makes pineapple juice produced from ripe pineapples contain high antioxidant activity.

Pineapple juice (with raw pineapple ingredients) was experienced an antioxidant activity decrease of 10.82% after being stored for 14 days and The pineapple juice (made from ripe pineapple) was experienced an antioxidant activity decreased by 22.78%. Data analysis of antioxidant activity on day 0 and day 14 can be seen in Fig. 1.

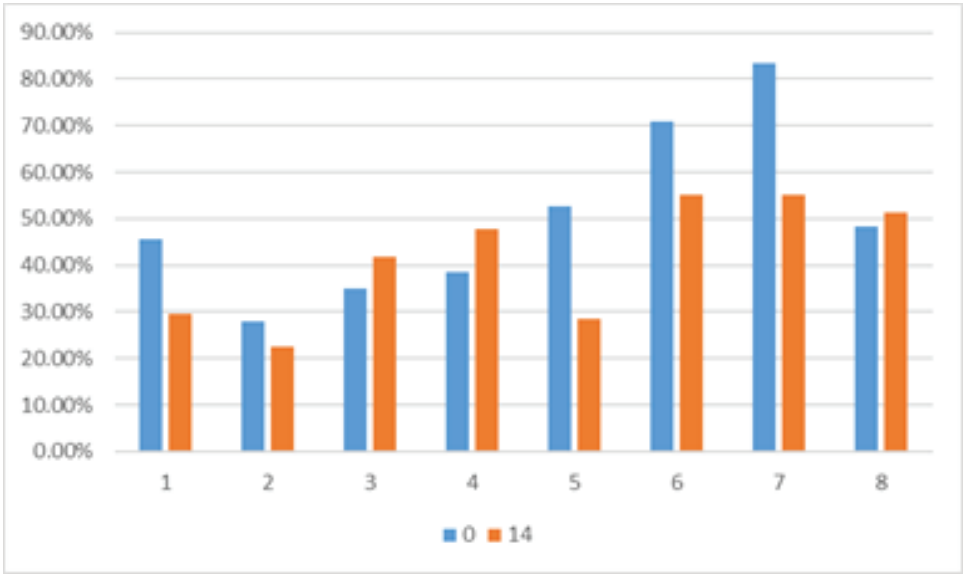

Figure 1: Diagram of the antioxidant activity of pineapple juice measured on days 0 and 14 post-production.

Although it experienced a decrease in antioxidant activity after being stored for 14 days, the antioxidant power of pineapple juice using ripe pineapple was still above pineapple juice using raw materials. In pineapple 3, 4, and 8, the antioxidant activity of pineapple juice after being stored for 14 days increased. There was the same factor that confirmed from that three pineapple juice, namely blanching for 10 minutes. The blanching factor has a close relationship with the increase in the antioxidant activity of pineapple juice. For more details, we will see based on the results of the study of the

response of surface blanching and its combination with other factors on the antioxidant activity of pineapple juice.

3.2. Effect of Sugar and Pasteurization on y Response (Antioxidant Activity)

Sugar and pasteurization have been shown to affect the antioxidant activity of the pineapple juice produced. This can be seen in Fig. 2.

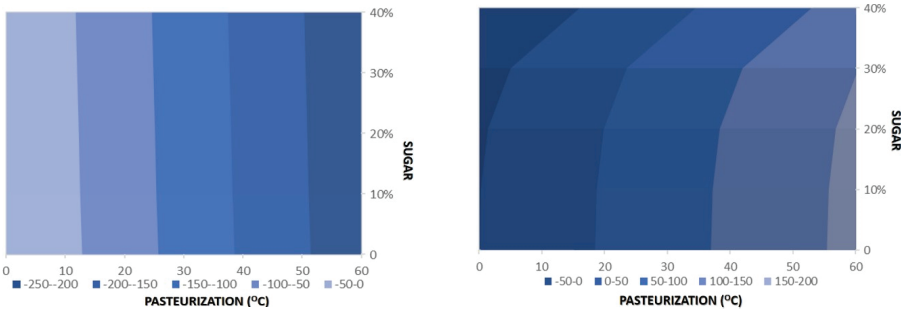

Figure 2: Graph of the effect of sugar composition and pasteurization duration on the antioxidant activity of pineapple juice
(a) day-0 and (b) day-14.

When the pasteurization factor is removed (0), the higher the sugar content added to the pineapple juice, the lower the antioxidant response both on day 0 testing and after 14 days of storage. This indicates that the higher the sugar content, the lower the antioxidant activity of pineapple juice. In contrast to sugar, pasteurization has a unique impact on the antioxidant activity of pineapple juice. the longer pasteurization was carried out, the antioxidant activity would decrease (Figure 2a). On the other hand, pasteurization was able to maintain the antioxidant activity of pineapple juice when stored for 14 days (Figure 2b). Pasteurization is known to harm the stability of several antioxidant compounds in pineapple juice such as vitamin C, beta-carotene, and several other antioxidant compounds. The destruction of these

compounds can reduce the potential antioxidant activity of the pineapple juice produced. But on the other hand, pasteurization is also able to inhibit microbial growth, inactivate enzymes to maintain the antioxidant activity of the pineapple juice produced.

The combination of the amount of added sugar and pasteurization provided a unique response to the antioxidant activity of pineapple juice. The combination of sugar and pasteurization both reduced the antioxidant activity of the pineapple juice produced (Fig. 2a), but even though the presence of sugar produced a negative response, the

duration of pasteurization was able to improve the response of the sugar, where on the 14th day of testing (Fig. 2b), the combination of the two gave a positive response.

3.3. Effect of Sugar and Blanching on Antioxidant Activity

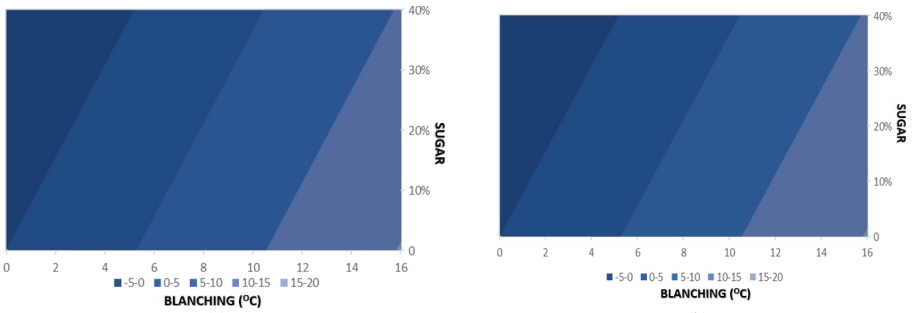

Figure 3: Graph of the effect of sugar concentration and duration of blanching on the antioxidant activity of pineapple juice.

Blanching is the process of soaking ingredients (usually vegetables or fruit) in hot water at a quick time [17]. The blanching temperature is usually set between 90 – 100 ^{O}C with a fast duration [18]. Blanching can cause damage to cell tissue so that cells die and inactivate enzymes so that the decay process does not occur. In Fig. 3a, blanching had a positive effect on the resulting response although it was small. The longer the duration of blanching, the better the antioxidant activity of pineapple juice. Blanching was also able to improve the negative impact caused by the addition of sugar in pineapple juice. In addition, blanching was also able to maintain the antioxidant activity of pineapple juice up to 14 days of storage (Fig. 3b).

The blanching process was thought to be able to increase the levels of anthocyanin compounds in pineapple juice [19]. This made blanching able to give a positive response to the antioxidant activity of pineapple juice. Blanching was known to be able to reduce the total neutral sugars of the arabinogalactan group such as galactose, rhamnose, and glucuronic acid [20]. The decrease in the amount of natural sugar from pineapple was thought to be able to reduce fermentation activity to maintain the antioxidant activity of pineapple juice.

Although blanching gave a positive response to the increase in antioxidant activity of pineapple juice, the duration of blanching still had to be limited. The long duration of Blanching could reduce the amount of thermolabile antioxidant compounds such as anthocyanins and several other polyphenolic compounds [21]. According to the results of research by Nurhuda et al., [22] blanching for 5 minutes reduced total anthocyanins.

3.4. Effect of Pasteurization and Blanching on Antioxidant Activity

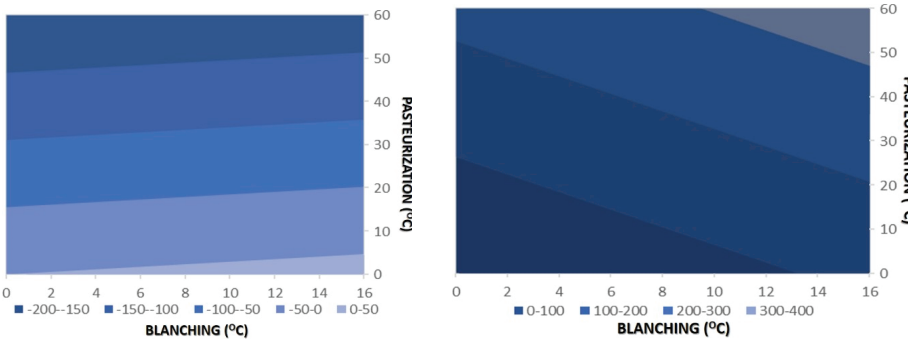

Figure 4: Graph of the effect of sugar concentration and duration of blanching on the antioxidant activity of pineapple juice.

As previously explained, the duration of pasteurization could reduce the antioxidant activity of pineapple juice. According to Fig. 4, blanching had a positive effect in improving the negative response given by the pasteurization process (Fig. 4a). Blanching duration was also able to maintain the antioxidant activity of pineapple juice after 14 days of storage (Fig. 4b). Even the combination of blanching and pasteurization provided a synergistic effect in maintaining the antioxidant activity of pineapple juice. Blanching could reduce the neutral sugar content in pineapples, while pasteurization could kill bacteria. Both of these activities provide a good synergistic effect in that they were able to maintain the antioxidant activity of pineapple juice.

4. CONCLUSION

Ripe pineapple was known to produce pineapple juice with a stronger antioxidant activity effect than raw pineapple. The amount of added sugar turned out to give a negative response to the antioxidant activity of pineapple juice, both measured on day 0 and day 14. This showed that in the manufacture of pineapple juice, sugar should be added as little as possible. The duration of blanching was proven to have a positive effect on increasing antioxidant activity both on day 0 and day 14 of the test. Pasteurization gave a unique response, where the pasteurization process gave a negative response to the antioxidant activity of pineapple juice which was measured on day 0, but pasteurization also produced a positive response that was able to maintain the antioxidant activity of pineapple juice when measured on day 14. The making process of pineapple juice according to the optimization results had been proven to have longer durability and had good antioxidant activity.

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5. CONFLICT OF INTEREST

The author declared that there is no conflict of interest in this research. the data completely could be published by the author

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