The Effect of Pre-cooling and Cold Storage on the Shelf Life of Betel Fruit (Piper Betel)

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Abstract. Betel nut (Piper betel) is a fruit that is widely consumed by people in Papua which is combined with lime and areca nut in the tradition of eating areca nut. However, this Betel fruit is quickly damaged and rotten. The purpose of this study was to increase the shelf life and maintain the quality of betel fruit by combining pre-cooling and cold storage methods with pre-cooling time of 30, 60 and 90 min and cold storage time of 5, 10 and 15 days. Water content, ash content, protein content, fat content, and organoleptic tests were all performed. The best treatment to increase the shelf life of piper betel based on Bayesian Method is soaking time 90 min and storage time 10 days.

Keywords: Pre-cooling · Cold storage · Betel fruit · Piper betel

1 Introduction

Betel fruit (Piper betel) is a fruit that is widely consumed by people in Papua and is combined with lime and areca nut in the tradition of eating areca nut. However, this betel fruit is quickly damaged and rotten. Damage to betel fruit can occur physically, mechanically, and chemically during transportation and storage. The economic potential for betel fruit is particularly promising in Papua, Indonesia, although they are still marketed traditionally.

Isolation and identification of chemical content of essential oils in three types of betel plants have been carried out. From these results, it was found that the main content of betel nut essential oil was 12.36% eugenol, 9.55% isocaryophyllene and 8.09% -selinene [1]. In general, the betel leaf is only used for herbal medicine and the manufacture of essential oils. Furthermore, because betel leaf includes an active component from the phenyl propanoic family of the eugenol chavicol group that has been demonstrated to have high antibacterial effects, it is also utilized as an antifungal agent for storage of agricultural products [2].

To increase the economic value of betel fruit, proper post-harvest handling is needed so that the betel fruit becomes more durable and to maintain the quality of the betel. Storage of betel fruit is generally still limited to cold storage in the refrigerator. However,

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prior to cold storage, it is necessary to reduce the initial temperature/field heat. This increase in heat is due to sudden respiration because the commodity is under stress at the beginning of harvesting. Precooling technology has been widely developed to increase the shelf life of agricultural products. Pre-cooling was first introduced by Powell and colleagues at the US Department of Agriculture in 1904. Since then, pre-cooling has been characterized in a variety of ways, including the removal of field heat from freshly harvested products to slow metabolism and prevent spoiling prior to transit or storage, direct reduction of commodity land heat after harvest, and quick temperature reduction [3].

Pre-cooling of horticultural products is the most important postharvest technology for retaining desirable, fresh, and marketable produce. This technique can remove field heat from fresh agricultural products before storage and transportation, slowing metabolism and reducing spoilage [4]. Pre-cooling rapidly reduces the temperature of freshly harvested produce and is done immediately after harvest to reduce spoilage. Room cooling, forced air cooling, hydro cooling, ice cooling, and vacuum cooling are the five main methods of pre-cooling fresh produce [5].

The technology of pre-cooling, packaging and cold storage when combined can maintain the quality of agricultural products. The aimed of this study is to increase the shelf life of betel fruit by using ice cooling and hydro cooling methods. Because water in direct contact with the produce has a higher heat removal capacity than air, this method of pre-cooling is faster than forced air cooling. Ice can be used to chill the water if it is available. Because contact with the produce is good and ice has a higher heat removal capacity than water, ice cooling is faster than hydrocooling. Ice can also keep the product cool for a long time [5].

Temperature is well-known to be the most important environmental factor influencing the rate of deterioration of freshly harvested produce. The amount of heat generated by the produce is affected by temperature; the higher the temperature, the faster the rate of creation. The rapid pre-cooling process to the lowest permissible temperature is thus the most critical stage for fresh food, especially for foods with naturally high respiration rates. Rapid pre-cooling improves nutrition element freshness and preservation, improves coldness, and prevents chilling injury [6].

2 Methods

This research uses ice cooling and hydro cooling methods. The tools used in this study were refrigerators, thermometers, and digital scales. The materials used are fresh betel fruit, water, ice cubes, Styrofoam box, tray, and polyethylene packaging film. After harvesting, the betel fruit is cleaned, and put into a Styrofoam box measuring 75 × 43 × 40 cm with a thickness of 3 cm. Pre-cooling was carried out using 20 L of water and ice and 10 kg of ice (with a temperature range of 0–1.5 °C) for 30 min, 60 min and 90 min. Furthermore, for pre-cooling with water, namely by soaking the betel fruit in 20 L of water for 30 min and removing it. After pre-cooling, the sample was drained, weighed 100 g and packed in a Styrofoam tray and polyethylene plastic. Cold storage is carried out at a temperature of 5–10 ºC in the refrigerator. The analysis was carried out on days 5, 10, and 15. Water content, ash content, fat content, protein content, and organoleptic tests were all performed.

The research was carried out utilizing analysis of variance in a three-replication factorial totally randomized design model. The treatment factors given were pre-cooling time (L) and storage time (W). The pre-cooling time treatment levels were 30 min (L1), 60 min (L2) and 90 min (L3) and the storage time levels were 5 days (W1), 10 days (W2) and 15 days (W3). Thus, there were 9 (nine) treatment combinations and 3 replications, for a total of 27 experimental units. The obtained data were tested using the F test at the 5% level. If the treatment has a significant effect, the Duncan Multiple Range Test (DMRT) will be performed.

3 Results and Discussion

3.1 Moisture Content

Moisture content is one of the most critical factors in determining food product durability, and it is linked to microbial activity during storage. Products with a high water content are more susceptible to harm because they might serve as a breeding ground for germs. Long-term stability is better for products with a low water content.

Moisture is a measurement of a food product's total water content, which is usually expressed as a percentage by weight on a wet basis. Although the moisture sorption isotherm relates water activity to moisture content at a particular temperature and humidity, this relationship is complicated and specific to the food product [7].

In this study, the water content of Betel fruit ranged from 77.06%–80.41%, the water content value was still in the control water content range, namely 77.4%–80.69%. The interaction between pre-cooling time and storage duration had a significant effect on the water content of betel fruit, according to the results of analysis of variance. The pre-cooling treatment for 60 min and storage for 5 days yielded the maximum water content of 80.41%, while the pre-cooling treatment for 60 min and storage for 15 days yielded the lowest water content. This demonstrates that the lower the water content, the longer the storage time.

From the results of Duncan's further test in Table 1, it shows that 90 min of pre-cooling with 15 days of storage did not have a significant effect on changes in water content. This is due to the decreased respiration rate along with the length of storage and the low temperature of the storage room.

3.2 Ash Content

The combustion of organic materials produces ash, which is an inorganic waste. The ash content of a substance can be used to determine its mineral content. The amount of ash in a material influences its purity. The lower the purity level, the higher the ash concentration. The inorganic residue left over from the burning of organic stuff is referred to as ash. The amount and content of ash in a food product is determined by the type of food that was ignited and the ashing process used [8].

According to the test results, the ash content of the betel nut is between 1.51% and 2.10%. A combination of 15 days of storage and 90 min of pre-cooling yielded

Table 1. Duncan advanced test results moisture content

Treatment	Average
L1W1	79,40 efg
L2W1	80,41 fgh
L3W1	77,86 abcd
L1W2	79,33 cdef
L2W2	77,53 ab
L3W2	77,80 abc
L1W3	78,77 bcde
L2W3	77,06 a
L3W3	80,11 efgh

Note: Within a column, values followed by the same alphabets are not substantially different at a 95% confidence level.

Table 2. Duncan advanced test results ash level

Treatment	Average
L1W1	1,83 bcde
L2W1	1,79 abc
L3W1	1,84 bcdef
L1W2	1,83 bcde
L2W2	1,82 bcd
L3W2	1,65 ab
L1W3	1,97 cdefg
L2W3	2,10 defg
L3W3	1,51 a

Note: Within a column, values followed by the same alphabets are not substantially different at a 95% confidence level.

the lowest ash content, whereas a combination of 10 days of storage and 90 min of pre-cooling yielded the highest ash level. From the results of the diversity test, the interaction between the two factors provides a significant difference.

Duncan's further test findings in Table 2 reveal that the pre-cooling time factor to the ash content, as well as the storage time of 5 and 10 days, have no significant differences. The significant difference in ash content was shown in the 15-day storage period where the ash content decreased.

Table 3. Duncan advanced test results fat level

Treatment	Average
L1W1	2,29 cdefgh
L2W1	1,66 abcde
L3W1	1,67 abcdef
L1W2	1,54 abcd
L2W2	2,49 cdefgh
L3W2	1,77 abcdefg
L1W3	1,45 abc
L2W3	0,70 a
L3W3	0,95 ab

Note: Within a column, values followed by the same alphabets are not substantially different at a 95% confidence level.

3.3 Fat Content

Lipids' physical and chemical properties are mostly governed by the fatty acids that make up their composition. Aliphatic and monocarboxylic fatty acids are commonly found in foods. They can have four to 26 carbons and can be saturated or unsaturated to variable degrees [9]. From the results of testing betel fruit, the lowest result was 2.86% and the highest was 7.47%. The lowest betel fat content was found in the pre-cooling treatment of 90 min and storage time of 15 days. The results of the diversity analysis revealed that there was no significant difference between the interactions of the two components, but the pre-cooling time factor did, therefore Duncan's additional test was performed.

Duncan's follow-up test revealed that while the storage time factor had no effect on fat content, the pre-cooling time factor had a substantial influence on betel fruit fat content. As seen in Table 3, the fat content reduced even more as the pre-cooling duration increased.

3.4 Protein Content

Heat, pH, chemicals, mechanics, and other factors can produce denaturation. Proteins make up about 1% of the fresh bulk of most fruit and vegetable tissues [10].

In this study, the protein content of betel fruit ranged from 24.44% to 46.8%. The treatment's protein content was higher than the control's protein content. This is because the betel nut with pre-cooling treatment did not experience denaturation. The results of the diversity test revealed that the interaction between the two parameters had no significant differences (Table 4).

Table 4. Duncan advanced test results protein level

Treatment	Average
L1W1	11,20 ^{abc}
L2W1	9,82 ^{a}
L3W1	10,63 ^{ab}
L1W2	15,72 ^{fgh}
L2W2	12,16 ^{abcd}
L3W2	13,87 ^{defgh}
L1W3	13,81 ^{defg}
L2W3	13,1 ^{bcdef}
L3W3	12,42 ^{bcde}

Note: Within a column, values followed by the same alphabets are not substantially different at a 95% confidence level.

Duncan's follow-up test verified that there was no significant difference in protein levels between pre-cooling and storage duration in betel fruit.

3.5 Organoleptic Test

The color observed in this study is the level of green color of betel fruit because in general the color of betel fruit is green which then relatively changes color to brown. This color change occurs due to the browning reaction. This reaction occurs because of an enzymatic reaction that forms melamine compounds. Aroma is an added value to a product, by smelling the aroma one can recognize the deliciousness of a product. The texture of the betel fruit can be tested by feeling or touching it. Texture is one aspect of the assessment in the appearance of the product.

From the results of the weighting of organoleptic tests using the Bayes method, it was found that the highest level of preference was found in the L3W2 sample (storage time 15 days; soaking time 10 min) and the lowest level of preference was in the L2W3 sample (10 days storage time; soaking time 15 min) (Table 5).

When viewed from the graph, the most preferred color by the panelists was in the L3W2 sample (6.96), the preferred aroma was L3W1 (6.88), and the most preferred texture was in the L2W1 sample (7.6). The level of choice among the panelists did not differ significantly on storage days 5, 10, or 15 (Fig. 1).

Table 5. Bayesian weighting determines the best method

Treatment	Total	Rank
L1W1	20,28	6
L1W2	20,72	4
L1W3	19,40	7
L2W1	20,80	3
L2W2	20,88	2
L2W3	18,92	9
L3W1	20,64	5
L3W2	21,40	1
L3W3	19,36	8

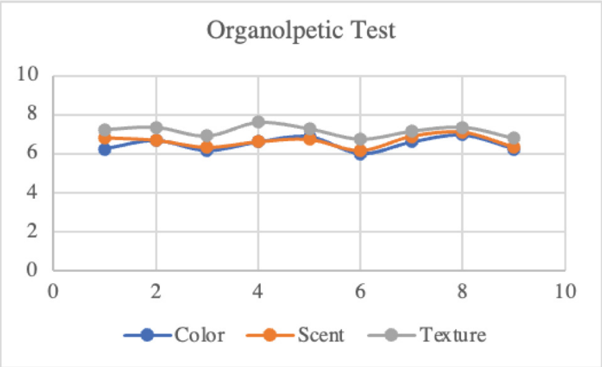

Fig. 1. Graph of organoleptic tests.

4 Conclusion

Pre-cooling paired with cold storage can increase the shelf life of betel fruit without lowering the amount of compounds in the fruit. According to the Bayesian Method, soaking for 90 min and storing for 10 days is the optimal treatment for extending the shelf life of piper betel.

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