The effect of blanching and food additives on the shelf life of kopyor coconut flesh preserved in chiller

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Abstract. Kopyor coconut is a unique coconut native to Indonesia characterized by crumbly flesh and a savory taste. Unlike common coconuts, kopyor coconut undergoes natural mutation, lacking the ability to produce the enzyme α-galactosidase, which results in its distinctive flesh compared to normal coconuts. In nature, kopyor coconuts are rarely found, making them expensive. Kopyor coconuts are distributed as whole fruits, peeled fruits, or repackaged flesh. Kopyor coconut has a shorter shelf life than normal coconut, therefore efforts to extend the shelf life of kopyor coconut flesh are necessary. This study investigated the efficacy of blanching and food additives (potassium sorbate and sugar) in extending the shelf life of kopyor coconut flesh stored under chiller conditions in aluminum pouches. The results showed that the appearance of all treatments remained acceptable until the 6th week. The TSC (Total solid content) results indicated that the blanching-sugar treatment had the lowest values among all treatments. The pH of each treatment did not differ significantly, except for the sugar without blanching treatment, where the pH tended to be lower than other treatments and the control. Based on TPC (Total plate count) result, blanching treatment effectively inhibited microbial growth in kopyor coconut flesh until the 6th week, especially in treatments without food additives. Organoleptic tests on appearance, aroma, taste, and texture showed the highest overall preference for the blanching-sugar treatment.

1 Introduction

Kopyor coconut (*Cocos nucifera* L var. Kopyor) is an indigenous coconut variety from Indonesia, distinguished by its unique flesh. The flesh of the kopyor coconut is crumbly, detached from the shell, and is sweeter and more delicious compared to those of the ordinary coconut. This is because the kopyor coconut lacks of the enzyme α-D galactosidase. Kopyor coconut is resulted from a natural mutation, and the occurrence of kopyor fruits in nature is very low. In the past, kopyor coconuts were only found in some regions of Lampung, Pati,

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Sumenep, Tangerang, and Klaten. Due to the rarity of kopyor coconut, its price is higher than that of ordinary (normal) coconuts.

In vitro embryo rescue technology that Tahardi and the team developed can produce coconut seedlings with >99% kopyor fruits [1,2]. The availability of kopyor coconut seedling-derived embryo rescue has led to a broader distribution of kopyor coconut plantations and an abundance of kopyor coconut fruit. Kopyor coconut can be distributed as whole fruits (peeled or not) or as repacked flesh [3]. The flesh of kopyor coconut is generally packed in clip-on plastic bags and stored in a freezer at -20°C. Packaging involves peeling the kopyor coconut and separating the coconut water and flesh. Before packing, the flesh is drained to reduce water content. The flesh is then packed in clip-on plastic bags, and pressing is done to reduce water content, which is feared to cause microbial contamination. This process turns the texture of kopyor coconut flesh into porridge (kopyor porridge), which diminishes the unique texture of kopyor coconut flesh. Additionally, storage at -20°C creates a dependency on freezer use, thus increasing storage costs. Therefore, a more efficient preservation and storage method is needed.

Microbial attack and enzymatic processes are the primary causes of fruit spoilage during storage. Previous research by Faramitha [3] attributed kopyor coconut flesh spoilage during transportation to microbial contamination. Consequently, preservation efforts should prioritize the elimination or inactivation of microorganisms. Sterilization of food products can be done in two ways: chemically (by adding food additives/preservatives) and physically (through heating, freezing, osmosis, or irradiation).

Potassium sorbate is one of the food preservatives widely used in food, beverage, and pharmaceutical products, which has also been granted GRAS (generally recognized as safe) status [4,5]. However, in Indonesia, the use of potassium sorbate is regulated by the Head of the Food and Drug Supervisory Agency's Regulation Number 36 in 2013 regarding the maximum limit for the use of preservative food additives. Blanching is a commonly used physical sterilization method for food preservation. Blanching is performed by heating food at a boiling or near-boiling temperature for a short period to inhibit or prevent enzyme and microorganism activity in the food. Research conducted by Kartika and Kusumastuti [6] showed that blanching treatment effectively suppressed microorganism growth in chili sauce. Another physical method is osmotic solution immersion, which involves soaking food in a solution with high osmotic pressure; this osmotic pressure helps preserve food by causing microbial cell wall lysis. This method is widely used in canned food/fruit processing, such as in pickles production. Osmotic solutions can be in the form of concentrated salt/sugar. These methods have not yet been applied to preserving kopyor coconut flesh. This research aimed to determine the effect of blanching and food additives on kopyor coconut flesh in aluminium pouch packaging.

2 Materials and Methods

The materials used in this study were kopyor coconuts (aged 11 months post-anthesis) from the Indonesian Oil Palm Research Institute-Bogor Unit, West Java. Kopyor flesh was separated from the shell and drained the water before treatment. The drained coconut flesh was used for treatments, including blanching and non-blanching treatments combined with food additives (FA) such as potassium sorbate and sugar, as shown in Table 1. Blanching treatment was performed by boiling the kopyor coconut flesh at 80-100°C for 10 minutes in a potassium sorbate, sugar, or water solution. Non-blanching treatment was performed by passing a potassium sorbate or sugar solution over the kopyor coconut flesh, which was then drained again. The potassium sorbate and sugar concentration in this study was 25 mg/kg kopyor and 65%, respectively. Potassium sorbate is one of the food preservatives widely used in food, beverage, and pharmaceutical products, regulated by the Indonesian National Agency of Drug and Food Control regulation number 36 of 2013. In this study, 25 mg/kg of potassium sorbate was used, which is within the limits set by the government. Sugar at concentrations of 45-75% is also utilized as an osmotic preservation agent [7,8,9, 10,11]; in this study, 65% was used for *kopyor* coconut where this concentration was used in several fruit preservation such as papaya, peach, pineapple and banana [8].

Table 1. Preservation treatment codes

Blanching/Non-blanching	No FA (1)	Potassium sorbate (2)	Sugar (3)
Non-blanching (A)	A1 (control)	A2	A3
Blanching (B)	B1	B2	B3

No FA= without food additives

The treated kopyor coconut flesh was drained, placed in an aluminum pouch (50 grams/pouch), sealed with a sealer, and stored in a chiller (± 4°C). Observation parameters include the condition of the coconut meat during storage, TSC, pH, microbial count, and preference analysis at 0, 2, 4, and 6 weeks of storage. The number of samples for each treatment was five pouches, resulting in 20 pouches for each treatment (replications). TSC (total solid content) was determined by weighing a 10-gram sample in an oven (105°C) until its weight was constant. The microbial count was determined using the TPC (total plate count) method. TPC on 0 weeks was done one day after treatment. A scoring system determined Preference analysis by organoleptic testing of appearance, aroma, taste, texture, and overall liking.

3 Results and Discussion

3.1 Conditions of kopyor coconut flesh during storage

The conditions of kopyor coconut meat during 6 weeks of storage can be seen in Fig 1. The overall appearance of the flesh was still in good condition. The texture of kopyor coconut flesh still exhibits the unique kopyor characteristic (crumbly).

A1/ Control A2 A3 B1 B2 B3

Fig. 1. The conditions of kopyor coconut flesh during storage at week 0 (top) and week 6 (bottom)

3.2 Total Solid Content (TSC)

The total solid content (TSC) in this study does not show a difference between the control and sorbate treatments, either with or without blanching. Fig. 2 shows that the TSC values are relatively stable over time for each treatment, with the sugar blanching treatment (B3) consistently having the lowest TSC compared to other treatments.

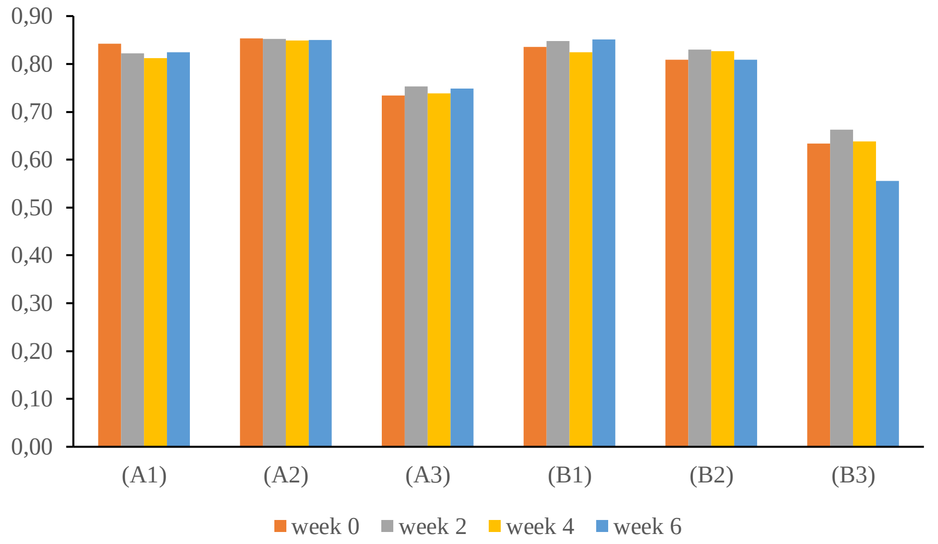

Fig. 2. Total solid content (TSC) of kopyor coconut flesh at 0, 2, 4, and 6 weeks of storage

The treatment of 65% sugar addition acts as an osmotic agent, resulting in a decrease in TSC. The preservation of fruit with osmotic sugar solutions is generally done at concentrations of 40-70% [7, 8]. Osmotic dehydration removes some water and solid density, thereby improving the quality of food products [8]. Kopyor coconut flesh has high water content (up to 77.51%) [12]. The application of sugar as osmotic dehydration agent [11] in coconut kopyor flesh removes some water in the flesh, resulting in the lowest TSC value in all sugar addition treatments.

3.3 pH

The pH for each treatment over time is presented in Table 2. The pH values in each treatment were not significantly different, except for the sugar non-blanching treatment, where the pH tends to be lower compared to other treatments and the control. The pH in this treatment even drops to 5.6 at week 6. In coconuts, pH changes are one of the indicators of changes in food product quality, either due to microbial contamination or enzymatic reactions related to the fruit's harvest age [3, 13, 14]. In this study, kopyor coconut fruits with the same age were used, so the pH change is suspected to be caused by microbial contamination. This is consistent with the research conducted by Faramitha [3], which found that damage to kopyor coconut fruit during distribution was marked by a decrease in pH.

Table 2. pH of kopyor coconut flesh during 0, 2, 4, and 6 weeks of storage

Week	No blanching			Blanching		
	A1/ Control	A2	A3	B1	B2	B3
0	7.13 ± 0.01	7.32 ± 0.01	7.17 ± 0.02	7.66± 0.00	7.63 ± 0.01	7.51 ± 0.01
2	7.19 ± 0.01	7.02 ± 0.01	6.92 ± 0.00	7.47 ± 0.02	7.47 ± 0.01	7.39 ± 0.03
4	7.16 ± 0.03	7.05 ± 0.02	6.57 ± 0.01	7.39 ± 0.01	7.49± 0.02	7.38 ± 0.03
6	7.04 ± 0.01	6.91 ± 0.01	5.61 ± 0.01	6.59 ± 0.02	6.66 ± 0.00	7.35 ± 0.01

3.4 Total Plate Count (TPC)

TPC represents the number of microorganisms in the material. This study observed that even at week 0 (TPC in week 0 was conducted one day after treatment), the control already contained microorganisms, and the number increased over the storage period (Table 3). In typical frozen storage, microbes die during storage. Blanching treatment with no food additives effectively inhibits microbial growth in kopyor coconut flesh. Blanching treatment combined with sugar addition inhibits microbial growth until 4 weeks. Interestingly, the microbial population shows fluctuation in the blanching treatment with the addition of potassium sorbate (B2). Potassium sorbate in liquid form is suspected to undergo degradation during the blanching process. This food additive can undergo transition, evaporation, or degradation during heating [9]. In non-blanching treatments, microbes can be counted even at week 0 of observation. Kopyor coconut flesh is a nutrient source for microbes with pH conditions suitable for neutrophilic microbes (neutral pH, based on Table 2), and blanching treatment without food preservatives has proven effective in preventing microbial growth.

Table 3. TPC of kopyor coconut flesh packaged in an aluminium pouch during 0, 2, 4, and 6 weeks of storage

Code	TPC (log CFU/mL)			
	Week-0	Week-2	Week-4	Week-6
A1	5.74	3.53	6.31	4.89
A2	5.39	6.02	6.09	5.00
A3	6.34	5.23	TNTC	TNTC
B1	0.00	0.00	0.00	0.00
B2	2.31	0.00	2.37	0.00
B3	0.00	0.00	0.00	5.24

TNTC: too numerous to count

The best treatment for preserving kopyor coconut flesh stored in a chiller is blanching without the addition of preservatives. Osmotic dehydration treatment combined with processes like blanching increases the effectiveness of food preservation [11]. In this study, the combination of blanching and osmotic dehydration inhibited microbial growth until the 6th week. Using food additives with too low concentration or unsuitable treatment combinations increases the risk of contamination. Using 65% sugar as an osmotic dehydration preservation agent or 25 mg/kg potassium sorbate was ineffective in controlling microbial contamination, even though these concentrations are commonly used for food preservation [7,8]. Kopyor coconut flesh is high in carbohydrates, vitamins, and minerals, which also serve as a food source for microbes [15,16]. Additionally, kopyor coconut flesh has a high water content [12]. This causes kopyor coconut to deteriorate more quickly and have a shorter shelf life compared to regular coconuts. The short shelf life of coconuts also occurs in coconuts with damaged endosperm flesh character, such as in Makapuno [17].

3.5 Preference test (organoleptic)

The organoleptic test was conducted with a minimum of 20 respondents to provide preference ratings on a scale of 1 to 7 as follows: 1= strongly dislike, 2= dislike, 3= somewhat dislike, 4= neutral, 5= somewhat like, 6= like, and 7= strongly like. The preference test results are presented in Table 4.

Table 4. Preference ratings of coconut kopyor fruit flesh in aluminum pouch packaging stored in the chiller for 0, 2, 4, and 6 weeks of storage.

Character	Code	0 week	2 weeks	4 weeks	6 weeks
Appearance	A1	6.20 a*	6.20 a	5.84 a	5.76 a
	A2	6.16 a	6.08 a	5.64 a	5.44 a
	A3	6.12 a	6.40 a	5.40 a	3.96 b
	B1	5.52 a	6.08 a	5.56 a	5.44 a
	B2	5.64 a	6.00 a	5.76 a	5.44 a
	B3	5.76 a	6.40 a	5.76 a	5.36 a
Aroma	A1	5.76 a	5.40 a	5.24 a	5.32 a
	A2	5.60 a	5.32 a	5.40 a	4.92 ab
	A3	5.84 a	5.84 a	4.40 a	1.20 c
	B1	5.16 a	5.00 a	5.08 a	4.64 b
	B2	5.36 a	5.24 a	5.28 a	5.04 ab
	B3	5.76 a	5.76 a	5.40 a	5.28 a
Taste	A1	5.92 a	5.12 b	5.08 a	4.80 ab
	A2	5.84 a	5.12 b	4.80 a	4.84 ab
	A3	6.00 a	6.24 a	4.32 a	1.16 c
	B1	5.20 ab	536 b	5.04 a	4.92 ab
	B2	4.84 b	5.04 b	4.92 a	4.28 b
	B3	5.72 a	5.76 ab	5.08 a	5.08 a
Texture	A1	5.72 ab	5.6 b	5.60 a	5.36 a
	A2	5.64 ab	5.68 b	5.24 a	4.96 a
	A3	6.16 a	6.32 a	4.96 ab	2.80 c
	B1	4.40 c	4.56 c	4.20 b	4.04 b
	B2	5.40 b	5.56 b	5.20 a	4.96 a
	B3	6.08 a	6.4 a	5.52 a	5.24 a
Overall	A1	5.80 a	5.32 abc	5.48 a	5.24 ab
	A2	5.64 ab	5.36 abc	5.08 a	5.08 ab
	A3	6.04 a	6.08 a	4.60 a	2.00 c
	B1	4.96 c	4.8 c	4.84 a	4.60 b
	B2	5.12 bc	5.16 bc	5.16 a	4.88 ab
	B3	5.68 ab	5.8 ab	5.28 a	5.28 a

* *The number followed by the same letter is not significantly different according to the DMRT test at α 5%*

Based on respondent preference tests, the appearance of kopyor coconut flesh indicated no significant difference in appearance across all treatments and the control from week 0 to week 6, except for treatment A3 (sugar treatment without blanching) in week 6, which was less preferred. Regarding aroma, no preference differences were observed until week 4; differences began to appear in week 6, where treatment A3 was least preferred. This contrasted with B3 (blanched sugar treatment), which was most preferred (similar to the control).

Regarding taste preference, respondents showed varied responses across treatments and times. Only treatment B3 consistently received the highest preference scores in this regard.

Texture preferences mirrored taste preferences, differing across all treatments, with only treatment B3 consistently preferred from week 0 to week 6. By week 6, respondents also preferred other treatments like A1, A2, and B2. Overall, in week 0, A1 (control) was most preferred; however, preferences shifted over storage time. By week 2, respondents favored A3; by week 4, they favored all treatments equally; and by week 6, respondents overall preferred treatment B3 the most, contrasting with A3 (least preferred).

4 Conclusion

Kopyor coconut flesh can be maintained in good condition for up to six weeks across all storage treatments investigated blanching without additives was found to be the most effective preservation method. This treatment preserved the unique texture of kopyor coconut flesh while maintaining constant Total Soluble Solids (TSS) and pH levels and achieving a low Total Plate Count (TPC). It is recommended for kopyor coconut flesh stored in a chiller. However, sensory evaluation indicates that respondents prefer the blanching treatment with sugar addition. Blanching with sugar addition effectively suppresses bacterial growth up to the 4th week, suggesting that storage should be recommended for up to 4 weeks if this technique is used.

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