EFFECTS OF FRUIT BAGGINGS AS PREHARVEST TREATMENTS ON THE FRUIT QUALITY OF PINEAPPLE 'MD-2'

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Higlight
Preharvest method of bagging and enhancement of pineapple fruit quality.

Abstract
The demand for fresh pineapple fruit is currently highest for the MD2 pineapple variety. Continuous efforts are made to enhance the quality of MD2 pineapples, including the fruit skin color, flesh color, sweetness, and minimizing sunburn damage. Bagging is one of the pre-harvest methods that can be employed for this purpose. This research aims to find suitable bagging materials that meet the industry's criteria and assess the severity of sunburn in each bagging treatment. A completely randomized design was used in this study, with six different bagging materials and pineapples aged 80 Days After Forcing (DAF). The bagging materials used were the control, blue Polyethylene (PE) bag, white PE bag, black paranet bag, paper bag, and the existing cap-shaped bagging technique using recycled paper from banana bagging, as utilized by PT. Great Giant Pineapple. Each treatment involved 120 pineapple samples harvested at 140 DAF. MD2 pineapples without bagging were found to provide the best results according to PT. Great Giant Pineapple's criteria, with green skin color (1.35%) and uniform yellow flesh (85.62%).

Keywords
Pineapple; bagging; polyethylene; paper; black shade net.

Introduction

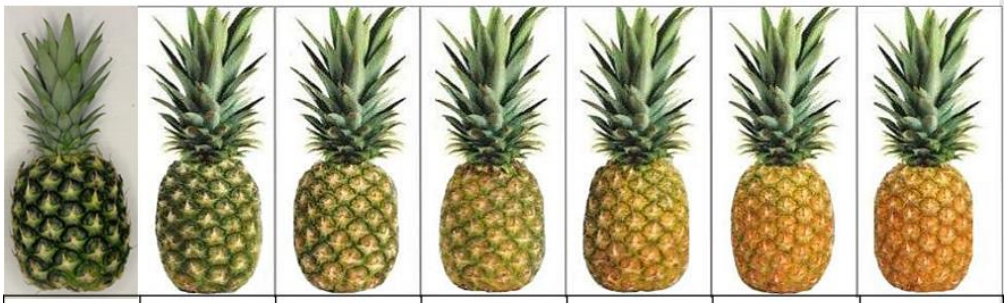
Pineapple (Ananas comosus L. Merr.) is a leading fruit commodity with the highest export volume in Indonesia. Exported pineapples are typically harvested to meet consumer demand. To obtain perfectly ripe pineapples, farmers usually manually select them. The harvest maturity index is based on the degree of skin color development [1]. The widely traded cultivar for fresh fruit is the MD2 pineapple cultivar. The MD2 pineapple cultivar is the most popular globally, accounting for 50%-55% of the world market, mainly due to its excellent taste, sweetness, appealing golden flesh, golden skin color, maturity, and perfect cylindrical shape. MD2 pineapples are more resistant to internal browning but are vulnerable to fruitlet core rot and more sensitive to Phytophthora than Smooth Cayenne [2]. Some challenges in pineapple cultivation include a decrease in fruit quality and aesthetic value due to injuries such as sunburn, mechanical damage during transportation from the field to the factory and packing facilities, and during storage. This happens because MD2 pineapples have thin and less dense physical characteristics [3].

Several protective measures against sun exposure include shading [4], the application of liquid sunshield films [5], plant protection application [6], and fruit bagging [7–10]. Compared to shading nets and the application of liquid sunshield films and plant protectants, fruit bagging has many advantages due to its relatively low cost and fewer negative effects. This not only protects the fruits but also influences fruit growth and quality, as is commonly used in other fruits [11,12]. Bagging treatment is done during the fruit growth stage with the aim

of protecting the fruit from pathogen and insect attacks, as well as improving the fruit's appearance and physicochemical properties [13]. The use of bagging materials has been proven to reduce sunburn rates in some fruit commodities [11]. The fresh pineapple marketing industry, such as PT. Great Giant Pineapple, continues to improve the quality of pineapples to meet market demands. The desired industry appearance criteria are MD2 pineapples with green outer skin and uniformly yellow flesh. This research aims to find suitable bagging materials that meet these industry criteria.

Methods

The research was conducted at the Research and Development Postharvest Laboratory of PT. Great Giant Pineapple (PG4), located at Jl. Taman Nasional Way Kambas Raja Basa Lama I, Labuhan Ratu District, East Lampung, Indonesia. The study was conducted over a period of 70 days before pineapple fruit harvest, from September to November 2022, in area 406Q1. Observations were made on the 1st day after treatment and at the time of harvest. This research utilized a Completely Randomized Design with 6 treatments (bagging materials) and five replications, with four fruit samples in each observation for each treatment. Each treatment involved 120 pineapple fruit samples harvested at 140 DAF (Days After Forcing). The bagging materials consisted of blue Polyethylene (PE) bags, white PE bags, black paranet bags, paper bags, and existing cap-shaped bagging techniques using recycled paper from banana bagging, as used by PT. Great Giant Pineapple. Observations were made on the skin color presentation, flesh color, and soluble solids content using an Atago hand refractometer. Observations of external pineapple fruit ripeness were conducted qualitatively by assessing the percentage of yellow color on the pineapple skin surface according to the guidelines for determining the percentage of shell color in Figure 1.



0	1	2	3	4	5	6
0%	> 0 – 10%	>10 – 20%	> 20 – 35%	>35 – 50%	> 50 – 75%	>75 –100%

Figure 1. Guidelines for determining the percentage of shell color in MD2 pineapples. *Source: PT. Great Giant Pineapple*.

The observation of flesh color was also carried out qualitatively. Observations were conducted by cutting the pineapple fruit into two vertical halves and then measuring the flesh color using a ruler from the bottom to the top of the fruit. Measurement was done by comparing the length of the yellow color with the length of the pineapple fruit, which is the length of the yellow-colored part of the pineapple fruit divided by the length of the pineapple fruit, multiplied by 100%. Data were processed by comparing the means with a 95% confidence interval (α=0.05) for each treatment group and post hoc tested using the Tukey test. The data table is presented along with letter notations to indicate their significance. Statistical data were processed using the Minitab 19 program.

Results and discussion

The occurrence of sunburn is a complex process, closely related to climate, varieties, fruit development stage, tree vitality, fruit growth position, and soil conditions [14]. In this study, the bagging treatment on pineapple fruits did not significantly impact the percentage of sunburn as observed in this research. No instances of sunburn were found in any of the bagging treatment samples, as presented in Table 1.

These results are attributed to the fact that the planting was conducted during the wet season with low environmental temperatures and high rainfall, as shown in Figure 1.

The determination of the wet season is based on the statement from the Ministry of Agriculture of the Republic of Indonesia, which indicates that the suitable rainfall for pineapple cultivation in Indonesia ranges from 1200-4000 mm per year or 3-10 mm per day, depending on the location and the pineapple varieties being cultivated.

During the period of this study, the recorded rainfall could reach up to 52.80 mm in a single day. With high rainfall, air humidity also increases, with the highest humidity reaching 94.13%, and the lowest at 71.01%. Pineapples prefer a humidity of 70% for their growth [13]. The environmental temperatures during September to November 2022 ranged from a maximum of 28.40°C to a minimum of 24.71°C, with an average of 26.72°C. These temperatures fall within the normal range for pineapple growth, which typically ranges from 22-32°C [14]. Sunburn commonly occurs during the summer with temperatures exceeding 32°C [15]. In well-lit environments during the day, the irradiance reaching the Earth's surface is 1,000 W/m² [6], whereas in this study, the highest solar radiation reached only 220.53 W/m².

From the temperature measurements of MD2 pineapple fruit's surface in the morning, noon, and afternoon, there were no significant temperature differences among the treatments. However, the bagging treatment per treatment provided significant temperature values, as shown in Table 2.

Table 1. The Influence of Different Bagging Treatments on Sunburn Incidence in MD2 Pineapples. *Source: Own.*

Treatment	**Sunburn (%)**
No bagging	0
Blue PE bag	0
White PE bag	0
Black shade net	0
Paper bag	0
Bagging existing	0

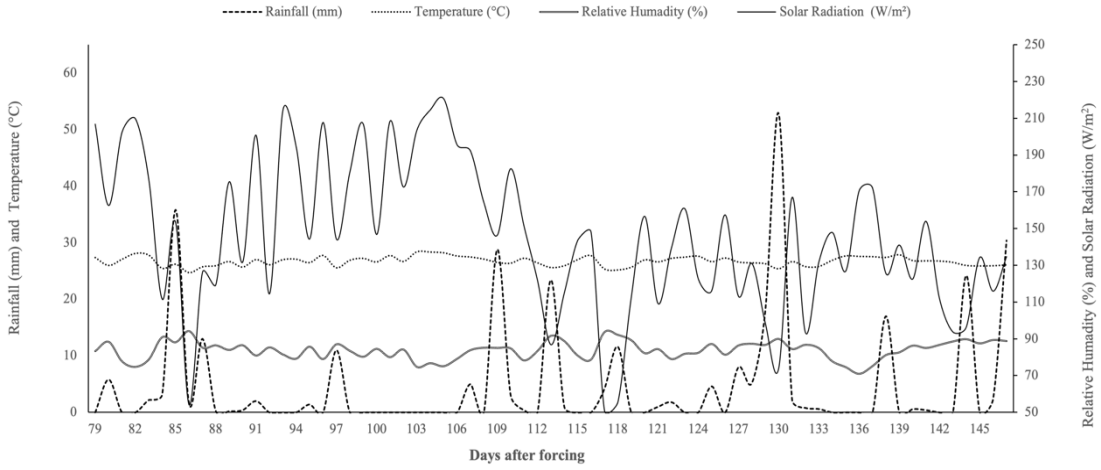


Figure 1. Weather data accumulated based on the Automatic Weather Station (AWS). Source: Own.

Table 2. The lowest temperature was recorded for the unbagged fruit, which was 30.57°C in the morning, 32.80°C at noon, and 33.3°C in the afternoon. *Source: Own.*

Treatment	**Shell temperature (°C)**			**Bagging Temperature (°C)**		
	9:00 AM	12:00 PM	03:00 PM	9:00 AM	12:00 PM	03:00 PM
No bagging	29,08 a	35,09 a	33,77 a	30,57 c	32,80 d	33,33 c
Blue PE bag	28,64 a	35,11 a	33,63 a	32,43 b	33,0 cd	35,33 bc
White PE bag	28,38 a	34,97 a	33,73 a	33,40 a	33,2 c	37,23 b
Black shade net	28,39 a	34,62 a	33,42 a	33,70 a	33,8 b	39,60 a
Paper bag	28,23 a	34,52 a	33,42 a	33,80 a	34,2 a	39,63 a
Bagging existing	28,24 a	34,33 a	33,43 a	33,90 a	34,3 a	39,70 a

[1]Lowercase letters indicate statistically significant differences by Tukey (p≤0.05).

The fruit temperature can increase due to direct sunlight exposure, and the exposed part of the fruit can exceed 50°C if the environmental temperature approaches 30°C [16]. In this experiment, the pineapple fruit's skin did not reach those temperatures because it had a lower environmental temperature than previously recommended

(average of 26.72°C). This statement supports the absence of sunburn in this study due to the lower environmental temperature. Bagging leads to microclimatic changes around the fruit [17], and in this study, the use of bagging was able to increase the bagging temperature. The air temperature inside the bag will be higher, up to 5 degrees higher on bright summer days [18].

Bagging fruit affects the external ripeness level of pineapple fruit (shell color). The highest shell color was obtained in the blue PE bag treatment, at 9.20% of yellow pineapple skin, and the lowest was found in unbagged fruit, at 1.35% of yellow pineapple skin. Bagging did not affect the flesh color of pineapple fruit, as all bagging treatments showed statistically insignificant results, as presented in Table 3.

Table 3. The effect of bagging material treatments onthe skin color (shell color) and flesh color of MD2 pineapple clones(%). *Source: Own.*

Treatment	Shell color (%)	Flesh color (%)
No bagging	1,35 b	85,62 a
Blue PE bag	9,20 a	88,63 a
White PE bag	4,75 ab	75,51 a
Black shade net	4,00 ab	81,77 a
Paper bag	7,55 ab	80,75 a
Bagging existing	2,15 ab	86,45 a

[1]Lowercase letters indicate statistically significant differences by Tukey (p≤0.05).

Bagging can enhance the color of the fruit skin [19]. In this study, the blue PE bag had a more yellow skin color compared to other bagging materials. This is because the blue wavelength can transmit the appropriate energy to the fruit, resulting in a more evenly bright fruit color. This is in line with the research by [20], which concluded that the blue wavelength (around 440-480 nm) is important for photosynthesis in cultivated plants.

Impact

The harvesting of MD2 pineapples is based on their external ripeness level. Pineapples that were bagged before harvesting showed a significantly higher external ripeness level compared to unbagged pineapples. This indicates that the use of bagging can accelerate the shelf life of pineapple fruit. The industry desires pineapples with a long shelf life for sale. Therefore, using bagging during the rainy season can be economically detrimental to the industry.

Conclusions

No instances of sunburn were found in any of the bagging treatments. This is because the planting was conducted during the rainy season. Unbagged pineapples had green skin with uniformly yellow flesh, which aligns with the preferences of PT. Great Giant Pineapple. Consequently, during the rainy season, there is no need to use bagging for pineapple cultivation.

Conflict of interest

There are no conflicts to declare.

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