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THE EFFECT OF PACKAGING USE ON THE QUALITY OF SALAK PONDOH (*SALACCA EDULIS* REINW.)

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KEYWORDS
Salak pondoh (*Salacca edulis Reinw.*); Low Density Polyethylene (LDPE); carton box

ABSTRACT
The demand for salak pondoh is increasing along with the increase in economic growth and population. Efforts to maintain the quality of salak pondoh fruit are to delay ripeness using various types of packaging and knowing the most effective type of packaging to extend the shelf life of salak fruit. The research aims to determine the effect of using various types of packaging. The research was carried out at the Agricultural Product Processing Technology Laboratorium, Faculty of Agriculture, Swadaya Gunung Jati University. The study design used Complete Randomized Design (RAL) with TK treatment = no packaging, P = Low Density Polyethylene (LDPE) plastic packaging and K = carton box packaging, each treatment was repeated as many times 9 times. The parameters observed were percentage of weight loss, hardness, total dissolved solids and vitamin C levels. The data obtained were analyzed with Analysis of Variance (ANOVA) and if the difference was real continued with the Scott-Knott test at the level of significance of 5%. The results showed that the use of cardboard box packaging material was able to delay the ripeness of salak fruit. Low density polyethylene plastic is a type of packaging that is effective in reducing the weight loss and hardness of salak fruit, and cardboard boxes are a type of packaging that effective in suppressing total dissolved solids and vitamin C levels of salak pondoh fruit (*Salacca edulis* Reinw.).

INTRODUCTION

A horticultural plant with potential for export is snake fruit. Salak production in 2020 increased 78% from the previous year, reaching 1,225,088 tons (Setyanto, 2020). According to Christie and Lestari (2020), salak fruit grows in lowland or highland areas with an average rainfall of 200-400 mm/month. Several regions in Indonesia that produce snake fruit are Java, Bali, South Sulawesi and North Sumatra. Apart from that, salak has many varieties, including sidempuan salak, granulated sugar salak, ivory salak, honey salak, and pondoh salak.

Consumption of snake fruit increases every year, which causes production of snake fruit to increase. This is caused by the very high nutritional content in snake fruit. According to Fitriani, et al. (2022), The composition of salak fruit flesh is as follows: calories 77.0 cal; protein 0.40 g; carbohydrates 20.90 g; calcium 18.00 mg; phosphorus 18.00 mg; iron 4.20 mg; vitamin B 0.04 mg; vitamin C 2.00 mg; and water 78.00 mg. The high carbohydrate and water content makes snake fruit rot more easily, because snake fruit usually only lasts for seven days if stored at room temperature (Rai, et al., 2021). On the other hand, another change that is quite suspicious is the enzymatic change in the color of the fruit flesh. This is because the tannins which give salak its astringent taste, if exposed to air, will turn brown, which is an enzymatic browning reaction (Utami, 2019). Because of this problem, snake fruit must be packaged to prevent spoilage and increase its economic value.

To maintain its quality, snake fruit must be cared for properly because it is a perishable horticultural product. Fresh food storage management is critical, especially in countries experiencing significant climate change. The inability to store food properly will result in increased food waste (Asiah, et al., 2020). Post-harvest handling helps horticultural products maintain their quality by reducing damage caused by mechanical damage, physiological damage, and pathological damage (Murdijati, 2015).

Packaging is one way to handle post-harvest. One method of post-harvest processing that can extend the storage period of agricultural materials or products is packaging. Packaging is intended to help prevent and reduce product damage, protect the food ingredients inside from contamination and other physical disturbances, and place products or processed products in a form that makes transportation, storage and distribution easier (Maulani, 2003). Packaging materials must be non-toxic, suitable for the packaging material, clean and safe to use. Plastic and paper are common packaging for fresh horticultural products. Because of its advantages, namely its smooth, clean surface and light weight (Kalsum, et al., 2017).LDPE plastic has a low density, namely 0.9 g/cm3 (Maulana et al., 2013). The water vapor permeability value of LDPE plastic packaging is 0.501 g/m2hr.mmHg (Pakpahan et al., 2020).

According to research conducted by Djaafar, et al. (2022), it was found that pondoh salak fruit can remain fresh during storage if it is packaged in Low Density Polyethylene (LDPE) plastic bags. By using packaging, the hardness (texture) of the fruit and the color of the Pondoh salak fruit flesh can be maintained during storage. Packaging individual Pondoh salak fruit in LDPE plastic bags makes it possible to maintain the shelf life of the fruit until the thirtieth day with weight loss below 10%, compared to waxing and 5% galangal extract treatment with plastic baskets coated with oil and packaging in perforated cardboard boxes on the third day 00 were not analyzed because all samples were damaged. Therefore, LDPE bags can be used for exporting or long-distance transportation.

According to research conducted by Johansyah, et al. (2014), The use of plastic packaging materials Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), and Polypropylene (PP) affects the percentage of weight loss and color change of tomatoes (*Lycopersicon esculentum*, Mill) during ten days of storage compared to treatment without packaging. This is because LDPE, HDPE and PP plastics have low water vapor permeability. Low water vapor permeability will reduce the rate of entry and exit of water vapor and cause humidity in the packaging to increase. This will reduce the temperature during packaging, thereby suppressing the process of water loss due to transpiration. This study is also supported by research Fauziah, et al. (2016) showed tomatoes packaged in LDPE plastic showed the best reaction to vitamin C, total acid, hardness, and water content. Packaging tomatoes with LDPE plastic at temperatures of 5oC and 10oC also shows the best reaction to organic tomatoes during storage, and can maintain the shelf life of tomatoes.

Efforts to delay the decline in the quality of salak fruit need to be made so that the quality of the fruit is maintained. This research was conducted to determine the effect of using various types of packaging and to find out the type of packaging that is most effective in delaying the ripening of salak fruit so that it can be used to maintain the quality of the fruit so as to extend the shelf life of salak fruit.

RESEARCH METHOD

The research was conducted in the Agricultural Product Processing Technology laboratory, Faculty of Agriculture, Universitas Gunung Jati Swadaya, Cirebon, from 31 July to 7 August 2023.

The tools used are analytical scales to measure fruit weight; refractometer to measure total sugar content; penetrometer to measure fruit ripeness; test tube for reacting two or more chemical solutions; Erlenmeyer flask to be a container for liquid chemicals; beakers as containers for stirring, mixing and heating liquids; mortar pestle to grind the test sample and pipette to transfer the measured volume of liquid.

The materials used are pondoh salak fruit (Salacca edulis Reinw.) obtained from farmers in Cimara Village, Mandirancan District, Kuningan Regency, Low Density Polyethylene (LDPE) plastic packaging, cardboard box packaging weighing 0.045 grams, plastic containers weighing 0.020 gram, Iodine 0.01 N, starch 1%, filtrate and distilled water.

The age of the snake fruit used as a sample is known before the selection (sorting) is carried out based on the uniform size of the snake fruit. How research works is as follows:

a. Snake fruit obtained from farmers is cleaned and then selected based on uniform weight. Weight measurements are carried out using scales;
b. The selected snake fruit does not have physical defects such as damaged fruit skin;
c. The sorted snake fruit is then packaged in different packaging, namely without packaging, Low Density Polyethylene (LDPE) plastic packaging and cardboard box packaging;
d. The packaging of snake fruit in the non-packaging treatment was provided with a fruit net container and in the Low Density Polyethylene (LDPE) plastic treatment it was provided with a plastic container base;
e. Observations of fruit weight were carried out on days 0 to 7, observations of hardness and total soluble solids were carried out on days 0 and 7, and observations of vitamin C were carried out on the 7th day.

(a) (b) (c)

Figure 1. Packaging of salak fruit (a) salak fruit without packaging; (b) snake fruit in LDPE plastic packaging; and (c) snake fruit in cardboard boxes

Research parameters were observed on the physical and chemical properties of snake fruit. Parameters that indicate physical properties include weight loss and hardness, while parameters for chemical properties include total dissolved solids and vitamin C content.

a. Weight Loss Percentage

Fruit weight was obtained by weighing the snake fruit before and after treatment for 7 days. The weight data obtained then calculates the percentage of weight loss based on the following formula:

$$\text{Susut bobot} = \frac{W_0 - W_1}{W_0} \times 100\%$$

Information:
W0 = weight of fruit before storage
W1 = weight of fruit after storage
(Widodo et al., 2019)

b. Violence

The hardness of the snake fruit was measured using a penetrometer based on the level of resistance of the snake fruit to the penetrometer piercing tool. Measurements were carried out on snake fruit by attaching a penetrometer to the middle of the snake fruit with the penetrometer positioned perpendicular to the surface of the snake fruit. Fruit hardness is indicated by the number on the penetrometer. The working principle of a penetrometer is to measure the puncture depth of the penetrometer needle per certain load weight in a certain time (mm/g/s). The unit of measurement for fruit hardness is expressed in kg and the compressive strength value is expressed in kg/cm2 (Nasrudin, 2019). Observations were carried out twice, namely before treatment and after treatment on the 7th day. The hardness value of the snake fruit will be visible on the digital tool.

c. Total Dissolved Solids

Total dissolved solids were measured using a refractometer. Measurements are made by taking the flesh from the middle. The total sugar content value is obtained by crushing the salak fruit flesh and then dripping the fruit juice onto the glass object on the refractometer so that the total sugar content value will be read directly on the tool screen in Brix units (Lestari, et al., 2017).

d. Vitamin C levels

Vitamin C levels were analyzed using the titration method according to Ngginak et al. (2019). The steps are as follows: 50 g of fruit pulp is mashed then distilled water is added until it reaches 100 ml. 15 ml of filtrate was put into an Erlenmeyer flask, and added with 2 ml of starch indicator. The mixture was titrated with a standard 0.01 N iodine solution until the color changed to blue. Vitamin C levels are calculated using the formula:

$$\text{Vit. C} = \frac{(I \times 0{,}88 \times Fp \times 100)}{W_s}$$

Information:
Vit. C = vitamin C level (mg g^{-1})
I = volume of iodine (ml)
0.88 = 1 ml of 0.01 N iodine is equivalent to 0.88 mg of vitamin C
Fp = dilution factor
Ws = sample weight

This research was carried out using a Completely Randomized Design (CRD) where the treatments were unpackaged snake fruit (TK), snake fruit packed in Low Density Polyethylene (LDPE) plastic (P) and snake fruit packed in cardboard boxes (K). Each treatment was repeated nine times.

The data obtained were tabulated and analyzed using SPSS 19 software with the One Way Analysis of Variances (ANOVA) method and continued to test real differences using the Scott-Knott method at a significance level of 5%.

RESULTS AND DISCUSSION

The results of observing the percentage of weight loss, hardness, total sugar content and vitamin C content of salak fruit (*Salacca edulis* Reinw.) are presented in table 1.

Table 1. Results of analysis of the percentage of weight loss, hardness, total dissolved solids and vitamin C content of salak fruit (*Salacca edulis* Reinw.) treated with different types of packaging during 7 days of storage

Treatment	Weight Loss Percentage (g)	Hardness (kg cm-2)		Total Dissolved Solids (oBrix)		Vitamin C level (mg g-1)
		Beginning	End	Beginning	End	
Kindergarten	0.84c	4.74a	3.77a	20a	21.87b	1.80b
P	0.17a	4.75a	3.99b	20a	20.43a	1.57a
K	0.63b	4.79a	4.01b	20a	22.03b	2.27c

Note: numbers followed by the same letter in the same column do not show significant differences based on the Scott-Knott test at the 5% confidence level. TK: Snake fruit without packaging, P: LDPE plastic packaging, K: cardboard box packaging.

The results of the ANOVA test with a confidence level of 5% showed that the use of several types of packaging in packaging salak fruit had significant differences in the percentage of weight loss, hardness, total soluble solids and vitamin C content of salak fruit. The Scott-Knott further test with a confidence level of 5% showed that treatment P (LDPE plastic packaging) was significantly different from K (cardboard box packaging) and TK (no packaging). This shows that the use of LDPE plastic is able to reduce weight reduction compared to salak fruit packaged in cardboard boxes (K) and without packaging (TK).

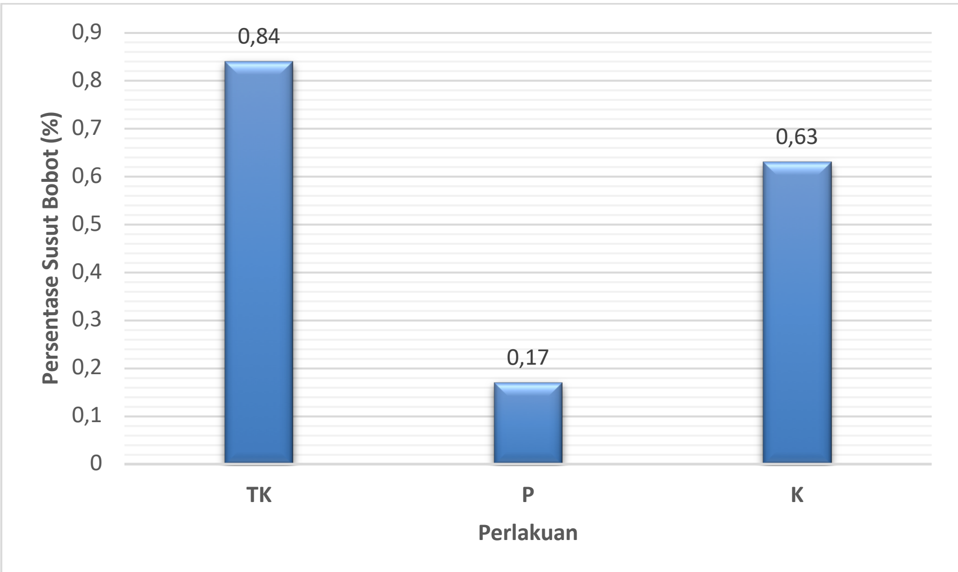

Figure 2. Histogram of percentage weight loss of salak fruit (Salacca edulis Reinw.) with different packaging treatments

Figure 2 shows that snake fruit treated with P had the lowest percentage of weight loss (0.17%) compared to K (0.63%) and TK (0.84%). The properties of LDPE plastic are that it has a low density (0.9 g/cm3) and water vapor permeability is0.501 g/m2hr.mmHg. Low permeability will reduce the rate of entry and exit of water vapor. Low water vapor permeability will increase the humidity in the packaging. This will reduce the temperature during packaging, thereby suppressing the process of water loss due to transpiration. Water vapor will move directly to a low concentration through the pores on the surface of the fruit, if the concentration of water vapor during packaging is high it will reduce evaporation by the salak fruit.

According to Rochman (2007) Plastic film provides protection against water loss in the fruit, so that the packaged fruit still looks fresh. The packaging process will result in atmospheric modifications where the CO2 concentration will be higher than O2. The principle of respiration in products after harvest is the production of CO2, H2O and energy by taking O2 from the environment. Modify the atmosphere according to Kader and Moris (1977) will slow down the fruit ripening process, reduce the rate of ethylene production, slow down rot and suppress various changes associated with ripening. Modification of the atmosphere will cause the respiration process to be hampered, thereby reducing substrate loss and water loss. Subhan (2008)stated that one of the causes of the decrease in fruit weight is the process of transpiration, Rohmana (2000) explained that the reduction in fruit weight is influenced by the loss of food reserves due to the respiration process.

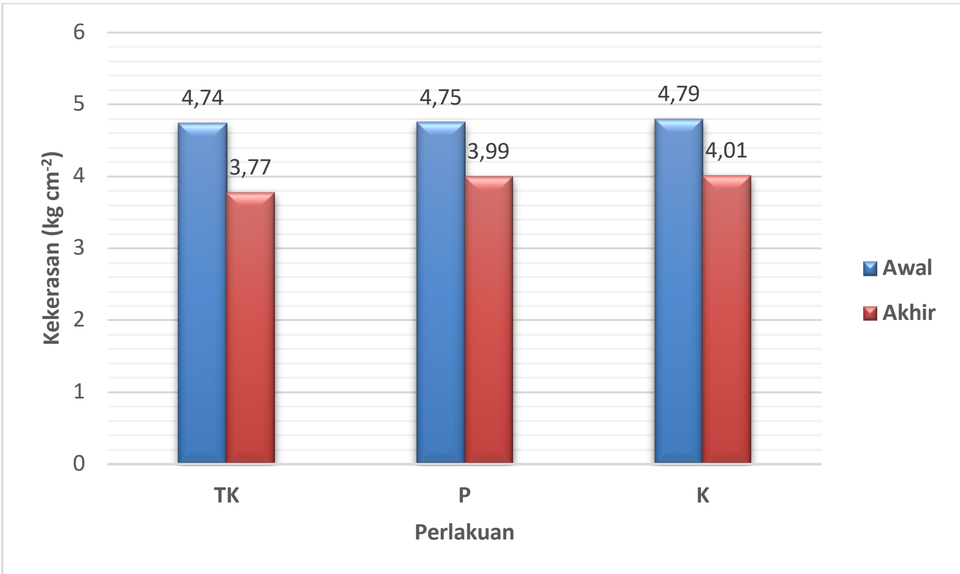

Figure 3. Histogram of changes in hardness of snake fruit (Salacca edulis Reinw.) with different packaging treatments

Changes in the hardness of snake fruit in Figure 2 show that treatment K (4.01 kg cm-2) had the highest hardness compared to treatments P (3.99 kg cm-2) and TK (3.77 kg cm-2). Treatment types of cardboard boxes and LDPE plastic did not trigger changes in hardness, so they did not show significant differences in each treatment, but were significantly different from the treatment without packaging. It is suspected that salak fruit in the 7 days storage period has not had a real influence on the level of hardness. The TK treatment showed the lowest change in hardness compared to K and P. LDPE plastic has other properties, namely low water vapor permeability (0.501 g/m2hr.mmHg) and low density (0.9 g/cm3), which will reduce the interaction of O2 and other gases which affect the respiration rate.

This decrease in hardness value occurs due to the degradation of water-insoluble pectin (protopectin) and turning it into water-soluble pectin. This results in a decrease in cell wall cohesion which binds one cell wall to another cell wall (Kismaryanti, 2007). Spencer (1965) in Johansyah, et al. (2014)stated that the decrease in hardness in tomatoes occurs due to depolymerization of carbohydrates and pectin substances that make up cell walls so that it will weaken the cell walls and cohesive bonds between cells and cell viscosity decreases as a result of which the texture of the tomato becomes soft, Rohmana (2000) explained that the fruit flesh becomes soft due to the degradation of pectin and hemicellulose. During the ripening and storage process of fruit, some of the water-insoluble protopectin turns into water-soluble pectin, thereby reducing the cohesive power of the cell walls that bind the cells to one another as a result, the hardness of the fruit will decrease and the fruit will become soft (Syaefullah, 2008).

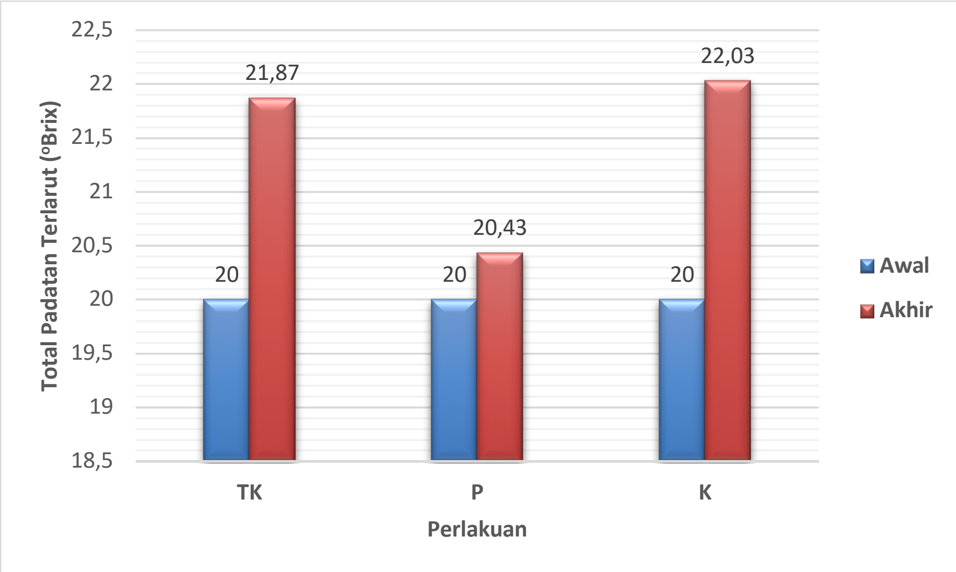

Figure 4. Histogram of changes in total soluble solids of salak fruit (Salacca edulis Reinw.) with different packaging treatments

Figure 4 shows that snake fruit treated with K had the highest total dissolved solids (22.03 oBrix) compared to TK (21.87 oBrix) and P (20.43 oBrix). The results of measuring total dissolved solids showed that there was no real difference in treatments K and TK, but significantly different from treatment P. It is suspected that the 7 day storage period did not provide a real change in the total dissolved solids of salak fruit. The use of LDPE plastic shows the lowest reduction in total dissolved solids. LDPE plastic is a type of plastic derived from semi-crystalline polymers which has no effect on respiration rate. The results of this analysis are not in accordance with the theory put forward by Sjaifullah (1996) that the sugar content in fruit will increase along with the ripening process and decrease with the length of fruit storage. The decrease in total sugar content is thought to be because the respiration process requires total sugar as a substrate, so that this sugar content is used as a respiration substrate rather than stored in the form of simple sugar. The decrease in sugar content during ripening corresponds to Babarinsa and Ige (2012) that tomatoes when harvested are at three stages of maturity, namely unripe (5.6%), semi-ripe (3.9%) and fully ripe (3.2%).

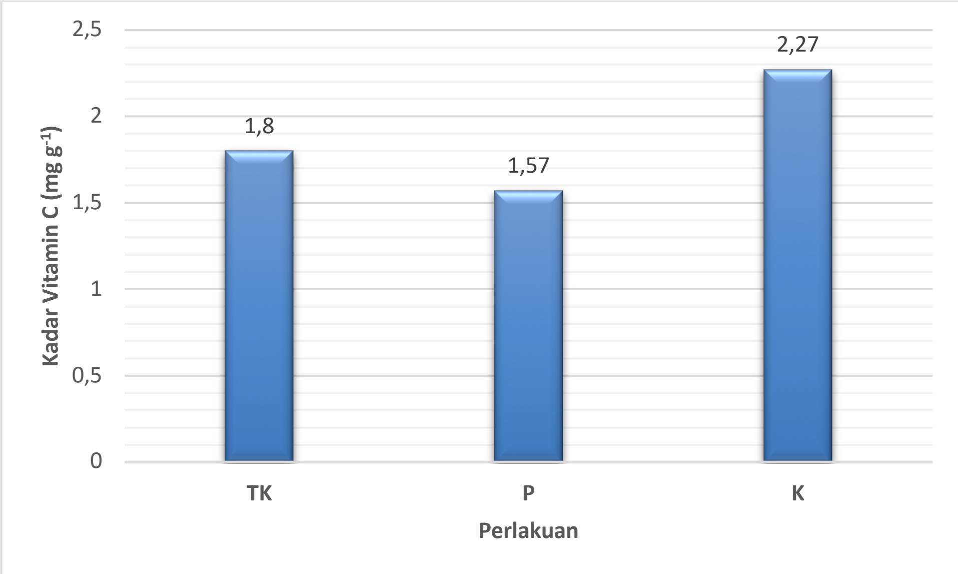

Figure 5. Histogram of changes in vitamin C levels of salak fruit (Salacca edulis Reinw.) with different packaging treatments

Figure 5 shows that snake fruit treated with K had the highest levels of vitamin C (2.27 mg g-1) compared to TK (1.8 mg g-1) and P (1.57 mg g-1). The results of measuring vitamin C levels showed significant differences in each treatment, the highest decrease in vitamin C levels occurred in the P treatment which was caused by damage to the LDPE plastic due to the hardness of the snake fruit skin, making it easier for oxygen to enter the packaging. This causes vitamin C to be easily degraded by temperature, light and surrounding air so that vitamin C levels are reduced. The decrease in vitamin C levels is caused by the activity of the ascorbate oxidase enzyme (Kartasapoetra, 1989). This study is also supported by research Trenggono, et al. (1990) which states that storing fruit in conditions that cause wilting will reduce the vitamin C content quickly due to respiration and oxidation processes.

CONCLUSION

Based on the results of study are; (1) the use of Low Density Polyethylene (LDPE) plastic packaging materials and cardboard box packaging affects the percentage of weight loss and hardness of snake fruit (*Salacca edulis* Reinw.), and (2) the use of Low Density Polyethylene (LDPE) plastic is effective in reducing the percentage of weight loss and the use of cardboard boxes is effective in reducing the total dissolved solids and vitamin C levels of snake fruit (*Salacca edulis* Reinw.).

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