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Quality evaluation of minimally processed pineapple using two packing systems

(Penilaian mutu nanas yang diproses secara minimum dengan menggunakan dua sistem pembungkusan)

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Key words: minimally processed, chemical changes, gas in package, sensory evaluation

Abstrak

Mutu nanas kultivar Josapine yang diproses secara minimum dan disimpan pada 2 °C telah dikaji dengan menggunakan filem regang dan bekas polipropilina. Mutu nanas dinilai setiap minggu dengan memerhatikan perubahan fizikal, kimia, fisiologi dan penerimaan uji rasa. Bekas polipropilina lebih sesuai digunakan untuk membungkus hirisan nanas. Bekas ini mudah dikendali dan boleh disusun bertingkat-tingkat. Hirisan nanas dalam bekas polipropilina dapat mengekalkan skor yang tinggi dalam penilaian rasa sepanjang 3 minggu penyimpanan. Rasa, bau dan teksturnya masih baik, kehilangan berat rendah (0.1–0.6%), tiada perubahan yang ketara dalam nilai pH dan TTA. Kandungan CO_2 dalam bekas kekal rendah (± 0.1%) dan kandungan O_2 dikekalkan pada ± 20% sepanjang tempoh simpan. Kandungan asid askorbik dan nilai TSS dalam kedua-dua sistem pembungkusan menurun dengan tempoh simpan. Hirisan nanas yang dibungkus dengan filem regang kehilangan bau selepas seminggu dan warna berubah selepas 3 minggu.

Abstract

Quality of minimally prosessed pineapple cv. Josapine stored at 2 °C was evaluated using stretch film and polypropylene container. The samples were evaluated at weekly intervals by observing the physical, chemical, physiological changes and sensory perceptions. The polypropylene container was more suitable to be used for packing minimally processed pineapple as it was easy to handle and stacking was possible. Pineapple slices packed in polypropylene containers maintained high score in the sensory perceptions over the 3-weeks storage period. The flavour, odour and texture were still good, the weight loss was low (0.1–0.6%), and no pronounced changes in the pH and TTA value were observed. The CO_2 in the package remained low (± 0.1%) and O_2 was maintained at ± 20% throughout the storage period. The ascorbic acid and TSS values in both packing systems decreased with duration of storage. Sliced pineapple packed in stretch film lost its aroma after 1 week and became discoloured after 3 weeks.

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Introduction

The market demand for minimally processed fruits and vegetables has increased rapidly, as consumers become more conscious in their food choices but have less time to prepare healthful meals. These minimally processed products though still retain their flavour, aroma and nutrition, are very perishable (Siriphanich 1994). Undesirable physiological changes are the most crucial problems in minimal processing. Loss of cellular integrity at the cut surface of the fruits or vegetables destroys compartmentation of enzymes and substrates. Senescence may accelerate and off flavour may develop as respiration and ethylene production increase near the cut surface. The exudate from the cut surface is also a favourable medium for fungal and bacterial growth (Jacqueline 1995).

Several techniques have been employed to minimize the deleterious effect of minimal processing including low temperature and modified atmosphere packaging (MAP). Temperature is the most important factor governing the storage life. Peeled fruits can tolerate lower temperature than whole fruits. Sliced pineapple of cv. Gandul and N36 discoloured after a week of storage at 10 °C (unpublished data). However, pineapple cv. N36 with the crown still intact could be stored at 10 °C without developing black heart even after 4 weeks of storage (Abdullah et al. 1996). Selection of suitable MAP system for minimally processed products is very important, since the package will create specific atmosphere around the produce. The packing material used should be able to provide enough gas exchange to minimize aerobic respiration and avoid anaerobic respiration. Under these conditions, fruit tissues are kept at minimum metabolic activity without the development of off flavour (Brody 1992; McGlasson 1992).

The market outlet for minimally processed pineapple has expanded from tradisional market at the roadside to sophisticated outlets such as retail chains and food service sector. At present, polyethylene bag is commonly used for packing minimally processed pineapple at the wet market. The size of bag depends on the amount of the cut products. Powrie et al. (1990) have stored pineapple pieces in MAP at 1 °C for up to 4 months. The pineapple slices were packed in Du Pont LP 920 plastic pouches, flushed with a gas mixture of 15–20% oxygen and 3% argon before sealing and immediately cooled to 1 °C. O' Connor-Shaw et al. (1994) reported sliced pineapple packed in polypropylene container stored at 4 °C developed fermented odour after 2 weeks of storage, whereas Faridah et al. (1997) have successfully stored minimally processed pineapple using PVC thermofoam packing at low temperature of 0 °C for 23 days with low risk of microbial count, especially coliform.

The aim of this study was to investigate the suitability of stretch film and polypropylene container with lid for wrapping minimally processed pineapple. Gases in the package in both packing systems were monitored to evaluate the effect of an increase of the atmospheric CO_2 and a depletion of O_2 on the fruit quality.

Materials and methods

Pineapple cv. Josapine at index 3–4 (about 25% of the eyes are yellowish orange – quarter ripe fruit) were obtained from MARDI farm at Pontian, Johor. After harvesting, the fruit were transported to MARDI laboratory at Serdang, Selangor. Fruit were stored at ambient (28 °C) for 24 h. On the following day, the peduncle was trimmed, the calyx was removed and the fruit were dipped in 100 ppm chlorinated water for 10 min. After air drying the skin was peeled off. The fruit were then dipped in chilled water ± 5 °C for 5 min. Following that, the fruit were sliced longitudinally into eight portions. The cut portions were randomly selected for packing in polystyrene tray (12 cm x 12 cm) over wrapped with polyvinylchloride (PVC) stretch film (0.001 mm). Another lot were packed in poplypropylene container with lid (10 cm x 5 cm x 17 cm). Each pack contained five slices of pineapple. Storage study was conducted at 2 °C with 85–90% of relative humidity. The minimally processed pineapple slices were evaluated on weekly basis. During the first experiment, 10 boxes (containing 50 slices) were taken from each packing system, whereas in the second experiment, seven boxes (containing 35 slices) were used as replication.

Physical changes

The weight loss of the pineapple slices in the first and second trials were taken by measuring the difference in the weight before and after storage. Weight loss was reported in percentage. Colour of the sliced pineapple was determined using the colour meter (Chromameter Model 300, Osaka, Japan) by measuring the value of *L* (lightness) and *b* (yellowness).

Chemical changes

The minimally processed fruit were analysed for total titratable acidity by titrating 0.1 *N* NaOH to an end point of pH 8.1. The pH value was determined using an Orion digital pH meter (model SA520) and total soluble solids by a refractometer (model Atago Digital DBX-5). The ascorbic acid content was determined by titrating with 2, 6 dichloro-phenolindophenol (Ranganna 1977). For the chemical analysis, the pineapple slices were blended with a kitchen blender. One package represented a replicate. Eight slices of pineapple were used in each experiment.

Gases in the package

The gases in the package were measured twice a week. The gas samples (O_2 and CO_2) were drawn by a syringe through a septum in the package. One millilitre of the gas sample was injected into a thermal conductivity detector gas chromatograph (varian 1420) fitted with a 1500 mm x 3 mm stainless steel column packed with Porapak R of size 80–100 mesh. The carrier gas was helium at a flow rate of 30 mL/min and the injector temperature was 35 °C. Four replications were used for each experiment.

Sensory evaluation

Descriptive analysis was used for colour, texture, taste, odour and overall acceptability of the minimally processed pineapple. The sensory evaluations were carried out in both experiments by a panel of 10 fixed panelists. The panel was requested to evaluate the fruit for various attributes using a 7-point hedonic scale (1 = very unacceptable, 2 = unacceptable, 3 = moderately unacceptable, 4 = neither good nor bad, 5 = moderately good, 6 = good and 7 = very good). Fruit were served at ambient temperature (25 °C).

Statistical analysis

Analyses of variance and Duncan‘s Multiple Range Test were performed on data (Gomez and Gomez 1984).

Results and discussion

In whole fruit, water in intercellular space is not directly exposed to the atmosphere. However, cutting or peeling a fruit or vegetable exposes interior tissues and drastically increases weight loss (Burton 1982). Water loss in the minimally processed pineapple was significantly affected by the type of packing (p <0.005). Fruit wrapped in stretch film which is highly permeable to water, showed a sharp increase in weight loss (1.6–4.5%) over the 3-week storage period. However for pineapple slices packed in polypropylene container which is less permeable to water, only a gradual increase in weight loss was observed (0.1–0.6%) *(Figure 1).*

Water loss from the minimally processed fruits and vegetables via evaporation reduces sensory quality as it causes wilting and turgor loss (Wills et al. 1989) . This phenomenon was also observed in the sensory attributes of minimally processed pineapple *(Table 1).* Minimally processed pineapple packed in polypropylene container was more preferred as indicated for a higher score given by the various attributes over the 3-week storage period. The lower weight loss possibly had contributed to the sensory acceptance which had influenced the taste attribute. Minimally processed pineapple packed in polypropylene container retained its taste and showed a significantly higher acceptance than those packed in stretch film packing during the 3-week storage *(Table 1)*. The decreasing trend was observed in the taste, texture and odour value. In general, the mean for the overall sensory attributes for sliced pineapple packed in polypropylene container exceeded the value of 5, the average value, indicating the product was well accepted by the panelists *(Table 1)*.

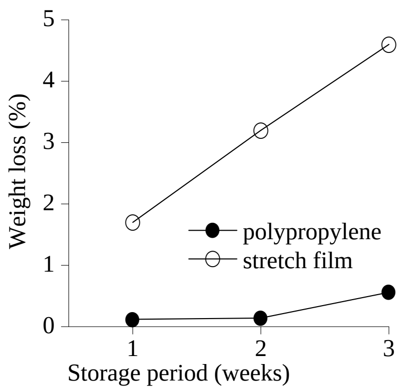

Figure 1. Weight loss of minimally processed pineapple during storage at 2 °C using two packing systems

Minimally processed products are more perishable than the intact products because they have been subjected to severe physical stress, such as peeling, cutting, slicing and removal of protective epidermal cells. As a result, physiological and biochemical changes occurred more drastically (Siriphanich 1994).

There were no significant differences in the total soluble solids (TSS), pH and total titratable acidity (TTA) during the 3 weeks of storage at 2 °C. These were observed in both packing systems *(Table 2)*. The TSS content which is an approximate measurement of the sugar content of a fruit, is a good indicator of fruit sweetness. Besides that, the value can also indicate the available energy remaining in the fruit to carry on respiration and other metabolic functions. The steady decreasing trend in the TSS value of fruit shown in both packing systems indicated that no stress occurred during the 3 weeks of storage at 2 °C *(Table 2)*. The TTA value which is a quantitative measure of the organic acid, decreases with senescence process (Burton 1982). However in this study, the overall TTA value increased after 2 weeks but decreased with prolonged storage *(Table 2)*, probably because the organic acid was being used as a respiratory substrate via the krebs tricarboxylic acid cycle as reported by

Table 1. Changes in the sensory evaluation of minimally processed pineapple in two packing systems during storage at 2 °C for 3 weeks

Duration of storage	Packing system	Colour	Texture	Taste	Odour	Overall acceptability
Day 0	Stretch film	6.3a	6.5a	6.1a	6.1a	6.2a
	Polypropylene	6.3a	6.5a	6.1a	6.1a	6.2a
Week 1	Stretch film	5.6ab	5.4b	5.0bc	4.7c	5.0c
	Polypropylene	5.9ab	5.6b	5.7bc	5.5ab	5.8ab
Week 2	Stretch film	5.4b	5.6ab	5.2ab	4.5c	5.3bc
	Polypropylene	5.6ab	5.8ab	5.8ab	5.0bc	5.7ab
Week 3	Stretch film	5.3b	5.6b	4.7c	4.7bc	4.8c
	Polypropylene	5.7ab	5.2b	5.5ab	5.1bc	5.2bc

Each value is the mean values from 20 panelists. Mean values with the same letters within each column are not significantly different at 5% level according to DMRT

Table 2. Chemical changes in minimally processed pineapple in two packing systems during storage at 2 °C for 3 weeks

Duration of storage	Packing system	TSS (°Brix)	pH	TTA (% citric acid)	Ascorbic acid (mg/100 g flesh)
Day 0	Stretch film	16.10abc	4.03ab	0.52bc	30.20a
	Polypropylene	16.10abc	4.03ab	0.52bc	30.20a
Week 1	Stretch film	16.70a	3.89b	0.56ab	–
	Polypropylene	16.00abc	4.00ab	0.49c	–
Week 2	Stretch film	16.30ab	4.23a	0.59a	16.30b
	Polypropylene	16.10abc	4.08ab	0.58ab	15.43b
Week 3	Stretch film	15.50bc	4.07ab	0.56ab	11.46c
	Polypropylene	15.30c	4.11ab	0.56ab	11.83c

Each value is the mean values from 16 pineapple slices. Mean values with the same letters within each column are not significantly different at 5% level according to DMRT

Table 3. Changes in the *L* and *b* values in the minimally processed pineapple in two packing systems during storage at 2 °C for 3 weeks

Duration of storage	Packing system	*L* value	*b* value
Day 0	Stretch film	76.67a	+41.60a
	Polypropylene	76.67a	+41.60a
Week 1	Stretch film	74.36b	+42.34a
	Polypropylene	74.47b	+39.17a
Week 2	Stretch film	72.28c	+40.80a
	Polypropylene	72.55c	+41.87a
Week 3	Stretch film	71.93c	+38.70a
	Polypropylene	72.45c	+39.07a

Each value is the mean value from 16 pineapple slices. Mean values with the same letters in a column are not significantly different at 5% level according to DMRT

Burton (1982). Ascorbic acid (vitamin C) is a labile essential nutrient in human diet (National Research Council 1989). Retension of ascorbic acid is often measured when evaluating postharvest storage effects on nutrients. A decreasing trend of the ascorbic acid was observed during storage of minimally processed pineapple though no significant difference was observed between the two packing systems at weekly intervals *(Table 2)*.

Colour is the major quality attribute considered to have the most impact on consumer selection of produce. Sliced pineapple packed in stretch film wrapping showed a slight discolouration after the 3 weeks of storage as shown by the decreasing colour score of *L* and *b* values. However, no significant colour change was shown by the fruit in the two packing systems *(Table 3)* which coincided with colour based on the sensory evaluation *(Table 1)*.

Fruits are living tissues that undergo catabolic metabolism and respiration. Respiration rate of minimally processed products increases with temperature (Marita 1996), and the degree of increase differes with commodity. Pineapple which is a non-climacteric fruit, showed a lower range of gases accumulation (CO_2 and O_2) in the package during storage at 2 °C *(Figure 2)*. In durian which is a climacteric fruit, the accumulation of both gases is higher (Latifah et al. 1997). Semi-permeable film is chosen for MAP so that the film permeability and product respiration can

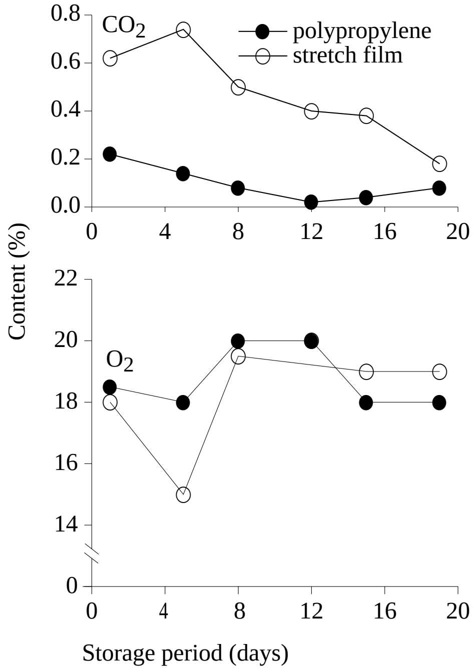

Figure 2. Changes in CO_2 and O_2 of minimally processed pineapple in two packing systems during storage at 2 °C

combine to produce a desirable, steady-state atmosphere within the package (Kader et al. 1989). Polypropylene container which is less permeable to gases and water than the stretch film, showed a lower accumulation of CO_2 in the package (0.02–0.22%) over the 3-week storage period. However, in the stretch film which is more permeable the accumulation of CO_2 was higher (0.62–0.74%) during the early storage period and it decreased to 0.16% at the end of 3 weeks *(Figure 2)*. Similar trend was also observed for minimally processed durian stored at 2 °C (Latifah et al. 1997). The O_2 level in the polypropylene container started to equilibrate from day 8 onwards, whilst the O_2 level in the stretch film packing equilibrated only after day 15. The result thus indicated that the amount of O_2 being used up for the respiration process was quite steady throughout the 3 weeks at 2 °C. Despite the changes in the gas composition (CO_2 and O_2), no abnormal odour or fermentation problem was observed in both packing systems. Thus this indicated that the product was safe to eat and still accepted by the panelists *(Table 1)*.

Conclusion

Polypropylene container with lid can be used for packing minimally processed pineapple. Modification of gases in the package did not result in the development of off flavour, and the product was still acceptable even after 3 weeks of storage at 2 °C. As polypropylene container is easy to handle, packing operation is much faster and stacking is possible. Minimally processed pineapple packed in polypropylene container exhibited better colour, retained the aroma and looked more juicier as the weight loss was lower than the minimally processed pineapple packed using stretch film. Minimally processed pineapple packed using stretch film remained acceptable only up to 2 weeks.

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