Available online at www.sciencedirect.com
ScienceDirect
Postharvest Biology and Technology 42 (2006) 168–175
Postharvest Biology and Technology
www.elsevier.com/locate/postharvbio

Physicochemical, microbial and sensory changes of minimally processed durian (*Durio zibethinus* cv. D24) during storage at 4 and 28 °C

Y.Y. Voon [a], N. Sheikh Abdul Hamid [a,*], G. Rusul [b], A. Osman [a], S.Y. Quek [c]

[a] Department of Food Science, Faculty of Food Science and Technology, Universiti Putra Malaysia, 43400 Serdang, Selangor Darul Ehsan, Malaysia
[b] School of Industrial Technology, Universiti Sains Malaysia, 11800 Pulau Pinang, Malaysia
[c] Department of Food Science, Faculty of Science, The University of Auckland, 11 Private Bag 92019, Auckland 1020, New Zealand

Received 28 February 2006; accepted 24 June 2006

Abstract

The effect of storage temperature on physicochemical, microbial and sensory quality of minimally processed durian (*Durio zibethinus* Murray) was determined at 28 °C for 3 days and 4 °C for 35 days. When held at 28 °C, the pulp retained its colour but softened rapidly after 24 h and became acidic (pH 4.71) after 2 days of storage due to the formation of citric, succinic, acetic and lactic acids. Sucrose decreased concomitantly with increase in glucose and fructose contents during storage. For fruit stored at 4 °C, no noticeable changes in pH occurred. Following 1 week of storage, there was a progressive increase in glucose, fructose and sucrose contents concomitant with the increase in total soluble solids. The firmness increased significantly ($P < 0.05$) at the end of storage. The organic acid content remained constant throughout storage with a minor increase in tartaric acid detected. Titratable acidity of the fruit correlated well with the shift in organic acid profile instead of pH. Sensory evaluation revealed off-odour development on day 14 for fruit stored at 4 °C. The off-flavour increased to an unacceptable point on day 28 of storage. The minimally processed durian fruit could be held at 4 °C for 14 days with acceptable microbiological count and without off-odour development. At ambient temperature, minimally processed durian could only be stored for 1 day after which the pulp became acidified.

Keywords: Durian; Minimally processed; Ambient temperature; Chilled temperature

1. Introduction

Durio zibethinus Murray, commonly known as durian, is one of the most important seasonal fruit in tropical Asia. It is a climacteric fruit (Tongdee et al., 1990; Booncherm and Siriphanich, 1991) belonging to the family Bombacaceae (Martin, 1980). It grows in the warm, wet conditions of the equatorial tropics and is cultivated in Southeast Asia, particularly Malaysia, Indonesia, Thailand, and the Philippines. The durian fruit is a large, heavy fruit covered with inedible thick husk with sharp hexagonal spines, which make peeling a difficult operation for untrained people. As durian ripen, an abscission zone naturally develops along the suture at the middle of each locule that weakens and allows the fruit to be easily opened (Siriphanich, 1994). The fruit normally has five locular units and each locular unit in turn contains 1–5 pulp units. The pulp unit consists of seed, which is completely covered by a creamy, white, yellow or golden yellow aril, the edible portion of the fruit (Nanthachai, 1994).

The advantages of harvesting durian fruit at a mature or ripe stage are often questioned. Unlike in Thailand, where durians are detached from the tree at the mature stage and then allowed to ripen, in Malaysia, Indonesia and the Philippines the fruit are collected after they fall naturally from the tree upon ripening. Durian harvested in this way are believed to have a better aroma and taste compared to those that are plucked from the tree and ripened (Pauziah et al., 1992; Nanthachai, 1994) and are favoured by the local and foreign markets in Hong Kong and Singapore. However, they have a limited shelf life of between 3 and 4 days (Pauziah et al., 1992).

* Corresponding author. Tel.: +60 3 8946 8386; fax: +60 3 8942 3552.
E-mail address: nazimah@putra.upm.edu.my (N.S.A. Hamid).

0925-5214/$ – see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.postharvbio.2006.06.006

Disorders arising from processing can be minimized by the use of sharp cutting tools, enzymatic browning inhibitors, modified atmosphere and low temperatures (Watada and Qi, 1999). Low temperature storage slows down most microbial growth and is effective in reducing enzyme activity as well as reducing respiration and ethylene production rates of minimally processed produce. Reducing the temperature effectively increases the lag phase and the rate of reproduction or generation time of microorganisms.

Durian pulp has lower metabolic activity than the husk. The pulp is less susceptible to chilling injury than the husk, and can be stored at low temperature for longer than the whole fruit (Booncherm and Siriphanich, 1991). Due to these reasons and a high husk to pulp ratio of 2:1, storage of durian pulp instead of the whole fruit is more promising. Matured but unripened whole durian fruit could be stored at 4 °C for only 20 days (Praditdoung, 1986) while the pulp could be stored at 5 °C for up to 8 weeks with slight chilling injury observed after 4 weeks of storage (Booncherm and Siriphanich, 1991). Previous findings showed that durian pulp could be stored at 4 °C for up to 30 days (Salunkhe and Desai, 1984; Praditdoung, 1986), with the main problems encountered being chilling injury at the base of the seed and contamination by fungi. These results have revealed that durian pulp has a longer shelf life than the intact fruit, contrary to most commodities where minimally processed produce has a relatively short shelf life.

For most commodities, the outer layer of peel, skin, or rind and waxy material at the outer surface, which protects the soft inner cells from damage, is usually removed in minimal processing, exposing the fleshy cells (King and Bolin, 1989), rendering the produce highly perishable (Watada and Qi, 1999). Durian fruit, however, possess an additional layer covering the pulp, as well as the husk. The surface of durian pulp is covered with epidermal cells and cuticle (epidermis), which is not easily broken and forms a barrier to microorganisms (Siriphanich, 1994). Fungal growth can occur on the base of the separated pulp where it used to be attached to the fruit axis, but not on the pulp surface itself. This is obviously due to the damaged tissues at the base induced by dehusking, where durian pulp is forcibly taken out from the fruit with a knife when the pulp begins to ripen (Booncherm and Siriphanich, 1991). Such damage could be minimized or prevented when ripe durian is used. This is because when durian fruit ripen, the dehiscence zone along the suture at the middle of each locule weakens and the pulp begins to separate from the fruit axis (Siriphanich, 1994). This enables the fruit to be opened without injuring the husk and with ease of pulp separation from the husk.

Most studies conducted on durian have dealt with whole fruit storage (Suhaila, 1990; Ketsa and Pangkool, 1994; Sriyook et al., 1994; Ketsa and Daengkanit, 1998; Imsabai et al., 2002) and the pulp obtained from mature but unripened durian in storage (Salunkhe and Desai, 1984; Praditdoung, 1986; Booncherm and Siriphanich, 1991). As yet, no information is available on the optimum storage conditions of ripened durian pulp. Hence the aim of this study was to find out if the quality of ripe durian could be sustained long enough at ambient (28 ± 1 °C) and low temperature (4 ± 2 °C) by determination of the physicochemical, microbial and sensory changes that take place during storage.

2. Materials and methods

2.1. Preparation of minimally processed durian

Durian fruit (*D. zibethinus*) cultivars D24 used in this study were obtained from a farm in Bentong, Pahang Darul Makmur, Malaysia (in mid August 2004). Ripened durian fruit that dropped naturally were collected and transported within 2 h on the same morning (30 ± 2 °C) to the laboratory. Fruit were selected for uniformity of size and free of visual defects. The fruit were dehusked (cut open the rind), by cutting along the suture on the back of the locules. Upon cutting, four to six separated fruit arils (350–420 g) were packed together. Care was taken not to break the epidermis of the pulp when removing it from the husk. The pulp was placed on polystyrene trays and over-wrapped with a commercially and widely available low-density polyethylene (LDPE) cling film (20 μm) with an oxygen transmission rate of 4.86×10^{-6} nmol s^{-1} m m^{-2} Pa^{-1} at 25 °C and 75% RH. Dehusking was performed manually in an air-conditioned room (20 °C) using good manufacturing practices. Only pulp with no external injuries (epidermis well-intacted) was selected. Each replicate was composed of pulp from three trays and all data are the mean of three replicates. Samples were stored at 4 ± 2 °C, between 90 and 95% RH and ambient temperature, 28 ± 1 °C (70–85% RH) for 35 and 3 days, respectively. Fruit quality was evaluated initially and on a daily basis for fruit stored at ambient temperature. For fruit stored at 4 °C, analyses were carried out at 7-day intervals.

2.2. Colour

Instrumental colour readings were obtained from a Hunter Lab Colorimeter (Ultrascan Sphere Spectrocolorimeter, Hunter Association Laboratory Inc., Virginia). A representative sample of the pulp was homogenized and placed into a polyethylene bag and sealed. Samples were placed over the specimen port and the colour of pulp measured. L (brightness), a ($+a$ = red, $-a$ = green) and b ($+b$ = yellow, $-b$ = blue) values were recorded.

Colour changes were converted to hue angle $(\theta) = \tan^{-1}(b/a)$ and chroma $= (a^2 + b^2)^{1/2}$. Results were expressed as Hunter L, hue and chroma.

2.3. Texture

Pulp firmness was evaluated using the Instron texture analyzer (Model TA-XT2 Stable Micro Systems Ltd., Surrey, UK). A force of 5 kg was applied at a cross-head speed of