

Chemical characteristics of papaya for specific product requirements

(Ciri-ciri kimia betik untuk keperluan produk khas)

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Key words: chemical characteristics, papaya, jam, sauces, fruit rolls, candied fruit bits

Abstrak

Keperluan produk khas daripada betik (*Carica papaya* L.) kv. Eksotika II dan kv. Subang (yang berisi merah) yang diproses menjadi jem, sos, gegulung dan halwa telah dikaji. Kaedah pemprosesan MARDI digunakan. Analisis kimia dijalankan pada betik segar dan produknya. Kandungan lembapan betik segar tinggi (84–88%) manakala produknya boleh dibahagi kepada produk berlembapan sederhana (sos 50–57%) dan berlembapan pertengahan (jem 19–24%, halwa 12–19% dan gegulung 9–12%). Kandungan gula dalam betik segar berjulat antara 9% dan 12%, dan lebih tinggi dalam produk betik (halwa 62–71%, jem 68–75% dan gegulung 78–80%). Kandungan lemak (0.06–2.02%) dalam betik dan produknya rendah. Kandungan mikrobiologi tidak dapat dikesani dan aras logam rendah (tidak dapat dikesani sehingga 1.96 mg/100 g). Hasil daripada kajian disimpan dalam pengkalan data untuk digunakan sebagai garis panduan tentuan bagi betik dan produknya.

Abstract

The specific product requirements of papaya (*Carica papaya* L.) cv. Eksotika II and cv. Subang (a red-fleshed variety) processed into jam, fruit sauces, fruit roll and candied fruit bits were investigated. The standard processing methods established by MARDI were used. Chemical analyses of the raw papaya and its products were carried out. The moisture content in raw ripe papaya was high (84–88%), whilst its products could be divided into medium moisture products (fruit sauces 50–57%) and intermediate moisture products (jam 19–24%, candied fruit bits 12–19% and rolls 9–12%). Sugar content in raw papaya ranged from 9% to 12% and the content was higher in the papaya products (candied fruit bits 62–71%, jam 68–75% and rolls 78–80%). Fat content was low in papaya and its products (0.06–2.02%). Microbial counts were not detectable and total metal contents were present at low levels (not detectable to 1.96 mg/100 g). These results were stored in a database as guideline characteristics for specifications of papaya and its products.

Introduction

Papaya (*Carica papaya* L.) is one of the 16 priority fruits identified in the program for the development of the fruit industry in

Malaysia (Abu Bakar et al. 1989). The fruit is cultivated mainly for fresh consumption with a small proportion being used to produce fruit cocktails, chilli sauce, filler,

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cakes and pickles. With the development of cv. Eksotika Malaysia, a special red-fleshed dessert variety with a high sugar content, firm texture and convenient fruit size, the total cultivated area has increased from 535 ha in 1982 to 2 549 ha in 1991. It is expected to reach 4 000 ha by the year 2000. Exports of the Malaysian papaya have risen from 23 693 t in 1988 to 50 980 t in 1991 (Anon. 1991, 1994). Further increase is expected from the demand for Eksotika papaya as new market potentials are exploited. The establishment of postharvest handling practices for the quality control of papaya enables it to be stored for 3–4 weeks under a controlled atmosphere condition of 15 °C and relative humidity of 85–90% (Abdullah 1985; Mohd. Salleh and Zaipun 1993).

To boost the image of Malaysian fruits overseas, the Federal Agricultural and Marketing Authority (FAMA) is making an effort to set up export standards for local fruits, starting with carambola and Eksotika papaya (Anon. 1992). Thus, it is necessary to establish specifications for agricultural raw materials intended for specific end uses, and to control the desired quality of the final products in accordance with good manufacturing practice.

This project is aimed at compiling such information for MARDI's Nutrimea product range. Thus far, work on the properties of banana, carambola and their products has been carried out (Chin et al. 1996a, 1996b). In this paper, the chemical properties of papaya and its products are looked into.

Materials and methods

Acquisition of samples

The samples analysed, i.e. the types of fruit and their degree of ripeness as well as their various processed products, were acquired according to recommendations and standard methods of processing already established through research in MARDI. Three lots of each sample were obtained over the year to take into account seasonal variations.

Analyses were carried out in triplicates on fresh fruit and their products.

Papaya for jam and fruit sauces

Firm and fully ripe red-fleshed papaya (cv. Subang) was purchased from local market. The fruit were washed, peeled, sliced, deseeded and pureed in a bowl chopper (Faridah and Rokiah 1994) for processing into jam and sauces.

- **Jam**

The puree was processed into jam of 35% fruit content with the addition of sugar, water, pectin, citric acid and colouring according to the MARDI standard procedure (Anon. 1987).

- **Sauces**

The papaya puree was made into three sauces, i.e. thick, dessert and creamy sauces, according to the procedure established by Faridah and Rokiah (1993). Sugar was added to the papaya puree together with other thickening ingredients. The mixture was boiled to achieve a desired consistency.

Fruit rolls

Fully ripe but firm Eksotika II fruit of colour index 4–5 (Lam 1991) were obtained and made into fruit rolls (Che Rahani, Z., MARDI, Johor Bahru, pers. comm. 1993).

Candied fruit bits

Whole unblemished Eksotika II fruit of maturity index 3 (Lam 1991) were obtained from the MARDI orchards and processed into candied fruit bits according to the MARDI standard procedure (Anon. 1986a).

Analysis

The samples were analysed, where applicable, for pH, total soluble solids/Brix, gel strength, Hunterlab colour (Minolta CR-200 with standard reference plate used: D65). Proximate analysis was carried out for moisture, fat, ash, protein, crude fibre, carbohydrate (by difference), total titratable

acidity, total and reducing sugars, pectin, insoluble solids as well as metal contents (copper, iron, lead, tin and arsenic). Microbiological analysis for total plate count, yeasts and moulds, osmophiles and water activity was conducted. Standard methods of analysis as described in the analyses of banana and its products (Chin et al. 1996a) were used.

Results and discussion

Analysis results showing the range and mean values for the various parameters

recorded for papaya and its products are given in *Table 1* to *Table 5*.

From the data obtained, it can be seen that the moisture content varies according to the varieties as well as fruit maturity. Moisture content was high in fresh raw papaya. Raw Subang papaya had 85–90% (*Table 1* and *Table 2*), raw ripe Eksotika II papaya of maturity index 4–5 had 87–88% (*Table 4*) while raw firm papaya of maturity index 3 had 84–85% (*Table 5*). The papaya products, on the other hand, could be divided into medium moisture products (50–57%) as in fruit sauces and intermediate

Table 1. Guideline specifications data for raw Subang papaya and papaya jam

| | Raw papaya | | | Jam | | |
|-----------------------------------|-------------|-------|------|-------------|-------|------|
| | Range | Mean | SD | Range | Mean | SD |
| Physical | | | | | | |
| pH | 5.0–5.7 | 5.25 | 0.32 | 2.8–3.0 | 2.88 | 0.06 |
| Brix | 8–12 | 10.3 | 1.70 | 66–67 | 66.43 | 0.42 |
| Gel strength (g/cm ²) | | | | 20.24–29.20 | 24.72 | 3.66 |
| Colour | | | | | | |
| <i>L</i> | | | | 30.25–36.76 | 33.40 | 2.66 |
| <i>a</i> | | | | 8.83–9.30 | 9.02 | 0.20 |
| <i>b</i> | | | | 9.73–15.40 | 12.22 | 2.37 |
| Proximate composition | | | | | | |
| Moisture (%) | 88.79–90.11 | 89.54 | 0.55 | 18.97–24.05 | 21.55 | 2.07 |
| Fat (%) | 0.09–1.16 | 0.65 | 0.44 | 0.06–0.16 | 0.10 | 0.04 |
| Protein (%) | 0.81–1.12 | 1.00 | 0.14 | 0.63–1.08 | 0.87 | 0.20 |
| Crude fibre (%) | 4.23–6.70 | 5.47 | 1.01 | 0.24–0.77 | 0.50 | 0.22 |
| Ash (%) | 0.45–0.58 | 0.51 | 0.05 | 0.19–0.26 | 0.23 | 0.03 |
| CHO by difference (%) | 1.34–4.28 | 2.75 | 1.20 | 74.16–79.07 | 76.70 | 2.01 |
| Total acidity (% citric acid) | 0.14–0.19 | 0.16 | 0.02 | 0.75–0.83 | 0.80 | 0.04 |
| Total sugars (%) | 9.23–10.60 | 9.75 | 0.61 | 68.42–75.43 | 72.84 | 3.14 |
| Reducing sugars (%) | 7.50–9.13 | 8.48 | 0.70 | 29.54–32.20 | 31.11 | 1.14 |
| Pectin (%) | 0.15–0.66 | 0.43 | 0.21 | 0.16–0.37 | 0.27 | 0.09 |
| Insoluble solids (%) | 0.72–0.94 | 0.82 | 0.09 | 0.26–0.40 | 0.32 | 0.06 |
| Metal content | | | | | | |
| Cu (mg/100 g) | 0.02–0.04 | 0.03 | 0.01 | 0.01–0.04 | 0.02 | 0.01 |
| Fe (mg/100 g) | 0.29–0.43 | 0.35 | 0.06 | 0.04–0.20 | 0.14 | 0.07 |
| Pb (ppm) | 0.08–0.12 | 0.10* | 0.02 | 0.02–0.10 | 0.06* | 0.04 |
| Sn (ppm) | nd* | – | – | nd* | – | – |
| As (ppm) | 0.04–0.07 | 0.06* | 0.02 | 0.02–0.06 | 0.04* | 0.02 |
| Microbial analysis | | | | | | |
| Total plate count | | | | nd | | |
| Yeasts and moulds | | | | nd | | |
| Osmophiles | | | | nd | | |

*on 2 samples

nd = not detectable

Table 2. Guideline specifications data for raw Subang papaya and dessert sauce

| | Raw papaya | | | Dessert sauce | | |
|-------------------------------|-------------|-------|------|---------------|-------|------|
| | Range | Mean | SD | Range | Mean | SD |
| Physical | | | | | | |
| pH | 4.4–4.5 | 4.47 | 0.05 | 2.7–3.1 | 2.97 | 0.33 |
| Brix | 13–17 | 15.2 | 2.00 | 42–47 | 45.3 | 2.04 |
| Proximate composition | | | | | | |
| Moisture (%) | 85.34–87.52 | 86.69 | 0.96 | 50.19–52.73 | 51.50 | 1.04 |
| Fat (%) | 0.13–0.25 | 0.18 | 0.05 | 0.46–0.88 | 0.63 | 0.18 |
| Protein (%) | 1.00–1.25 | 1.21 | 0.18 | 0.40–0.49 | 0.44 | 0.04 |
| Crude fibre (%) | 0.76–0.95 | 0.87 | 0.41 | 0.62–0.74 | 0.70 | 0.05 |
| Ash (%) | 1.02–1.11 | 1.05 | 0.04 | 0.92–0.99 | 0.96 | 0.03 |
| CHO by difference (%) | 9.79–11.24 | 10.29 | 0.67 | 44.49–47.32 | 45.47 | 1.17 |
| Total acidity (% citric acid) | 0.76–0.94 | 0.83 | 0.08 | 2.01–2.14 | 2.06 | 0.06 |
| Reducing sugars (%) | 0.13–0.16 | 0.15 | 0.01 | 0.11–0.24 | 0.16 | 0.06 |

Table 3. Guideline specifications data for thick and creamy papaya sauces

| | Thick sauce | | | Creamy sauce | | |
|-------------------------------|-------------|-------|------|--------------|-------|------|
| | Range | Mean | SD | Range | Mean | SD |
| Physical | | | | | | |
| pH | 3.0–3.4 | 3.27 | 0.19 | 2.1–2.4 | 2.23 | 0.12 |
| Brix | 42–44 | 42.7 | 0.84 | 39–42 | 40.7 | 1.06 |
| Proximate composition | | | | | | |
| Moisture (%) | 50.68–56.61 | 53.76 | 2.43 | 54.68–57.16 | 55.96 | 1.01 |
| Fat (%) | 0.47–0.68 | 0.56 | 0.09 | 1.25–2.02 | 1.52 | 0.36 |
| Protein (%) | 0.50–0.53 | 0.51 | 0.02 | 0.74–0.86 | 0.81 | 0.06 |
| Crude fibre (%) | 0.32–0.38 | 0.36 | 0.03 | 1.02–1.08 | 1.05 | 0.02 |
| Ash (%) | 2.82–3.08 | 2.97 | 0.11 | 2.35–2.47 | 2.42 | 0.05 |
| CHO by difference (%) | 39.05–45.02 | 41.81 | 2.26 | 37.26–39.65 | 38.20 | 1.04 |
| Total acidity (% acetic acid) | 1.63–2.18 | 1.88 | 0.23 | 1.78–2.03 | 1.91 | 0.10 |
| Reducing sugars (%) | 0.10–0.19 | 0.14 | 0.04 | 0.13–0.16 | 0.15 | 0.01 |

moisture products as in jam (19–24%), candied fruit bits (12–19%) and rolls (9–12%).

Sugar content in raw papaya ranged from 9% to 12%. However, it was much higher in the papaya products, especially in candied fruit bits (62–71%), jam (68–75%) and rolls (78–80%), depending on the amount of sugar used for preservation and the moisture content of the end product. In fruit sauces, the addition of sugar resulted in a controlled Brix of 42–47 for dessert sauce, 42–44 for thick sauce and 39–42 for creamy sauce.

Fat content was generally low in papaya and its products (0.06–2.02%).

However, it was notably higher in creamy sauce as margarine was used.

Microbial counts were not detectable in the products. Total metal contents were present at low levels (not detectable to 1.96 mg/100 g). The presence of lead (0.1 ppm) in raw papaya and products may be due to its uptake from the ground as well as lead-containing utensils used in the processing of products. The differences in copper and iron contents in raw papaya and its products may be the result of the processing parameters where it is lower in jam, and higher in fruit rolls and dehydrated candied fruit bits.

Table 4. Guideline specifications data for raw Eksotika papaya and papaya rolls

| | Raw Eksotika papaya | | | Papaya rolls | | |
|-------------------------------|---------------------|-------|------|------------------------|-------|------|
| | Range | Mean | SD | Range | Mean | SD |
| Physical | | | | | | |
| pH | 4.9–5.4 | 5.17 | 0.21 | 3.6–4.4 | 4.0 | 0.33 |
| Brix | 10–13 | 11.3 | 1.25 | 86–88 | 86.7 | 0.94 |
| Water activity | | | | 0.54–0.58 (24.5 °C) | 0.56 | 0.02 |
| Proximate composition | | | | | | |
| Moisture (%) | 86.71–87.50 | 87.11 | 0.32 | 8.89–11.83 | 10.59 | 1.24 |
| Fat (%) | 0.43–1.68 | 1.04 | 0.51 | 0.25–0.94 | 0.51 | 0.30 |
| Protein (%) | 1.00–1.10 | 1.04 | 0.04 | 1.88–2.08 | 1.96 | 0.09 |
| Crude fibre (%) | 3.63–4.17 | 3.97 | 0.24 | 1.19–1.44 | 1.34 | 0.11 |
| Ash (%) | 0.43–0.57 | 0.52 | 0.06 | 1.07–2.14 | 1.61 | 0.44 |
| CHO by difference (%) | 4.93–7.18 | 6.27 | 0.97 | 82.79–85.14 | 83.88 | 0.97 |
| Total acidity (% citric acid) | 0.11–0.19 | 0.15 | 0.03 | 1.41–1.60 | 1.51 | 0.08 |
| Total sugars (%) | 8.79–9.33 | 9.14 | 0.25 | 78.02–80.46 | 79.61 | 1.12 |
| Reducing sugars (%) | 8.05–9.29 | 8.54 | 0.54 | 3.43–4.35 | 3.97 | 0.39 |
| Pectin (%) | 0.17–0.62 | 0.47 | 0.21 | 1.38–1.59 | 1.51 | 0.09 |
| Insoluble solids (%) | 0.85–1.04 | 0.95 | 0.08 | 2.08–2.35 | 2.24 | 0.12 |
| Metal contents | | | | | | |
| Cu (mg/100 g) | 0.04–0.06 | 0.05* | 0.01 | 0.15–0.19 | 0.17* | 0.02 |
| Fe (mg/100 g) | 0.30–0.36 | 0.33* | 0.04 | 0.92–1.03 | 0.98* | 0.06 |

*on 2 samples

Colour of the papaya jam, as measured by Hunterlab colour measurements (*L*, *a* and *b*), was deep yellowish red.

Comparisons of data from this study with available data for the raw papaya and its products are shown in *Table 6* to *Table 8*.

The analytical data for raw papaya (*Table 6*) differed slightly from those obtained by various workers (Duckworth 1966; Purseglove 1968; Chan 1983; Anon. 1986b; Tee et al. 1988). However, there were differences in other results such as total acidity, pectin and iron contents. These differences may be attributed to different starting materials as well as processing conditions of these products.

Data obtained for papaya jam, candied fruit bits and papaya rolls differed slightly from those published data as seen in *Table 7*. However, results obtained for the fruit sauces differed from the available data, especially for Brix and total acidity (*Table 8*).

Conclusion

Chemical characteristics of papaya and some specific products have been determined.

They may be used as guideline characteristics to establish specifications for these materials. However, the data for papaya products obtained in this study may be applied for specifications of products derived only from the standard MARDI processes and may be different if other processes and raw materials are used.

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Table 5. Guideline specifications data for raw Eksotika papaya and candied fruit bits

| | Raw Eksotika papaya | | | Fruit bits (A) | | | Fruit bits (B) | | |
|---|---------------------|-------|------|------------------------|-------|------|------------------------|--------|------|
| | Range | Mean | SD | Range | Mean | SD | Range | Mean | SD |
| Physical | | | | | | | | | |
| pH | 4.9–5.3 | 5.03 | 0.16 | 3.7–3.8 | 3.77 | 0.05 | 3.7–4.0 | 3.85 | 0.11 |
| Brix | 13–15 | 13.9 | 0.82 | 69–81 | 74.1 | 4.92 | 73–76 | 74.7 | 1.25 |
| Water activity | | | | 0.69–0.74 (24.3 °C) | 0.72 | 0.02 | 0.63–0.77 (24.6 °C) | 0.69 | 0.06 |
| Proximate composition | | | | | | | | | |
| Moisture (%) | 83.76–85.37 | 84.82 | 0.75 | 11.57–18.97 | 16.22 | 3.31 | 11.92–19.20 | 16.07 | 3.06 |
| Fat (%) | 1.03–1.38 | 1.15 | 0.16 | 0.06–0.19 | 0.11 | 0.06 | 0.07–0.12 | 0.09 | 0.02 |
| Protein (%) | 0.90–0.98 | 0.95 | 0.04 | 0.78–0.81 | 0.79 | 0.01 | 0.74–1.00 | 0.84 | 0.12 |
| Crude fibre (%) | 3.65–4.98 | 4.30 | 0.54 | 0.80–1.77 | 1.36 | 0.41 | 0.88–1.40 | 1.16 | 0.21 |
| Ash (%) | 0.52–0.61 | 0.56 | 0.04 | 0.37–0.41 | 0.38 | 0.02 | 0.36–0.45 | 0.41 | 0.04 |
| CHO by difference (%) | 7.83–8.38 | 8.18 | 0.25 | 78.19–86.36 | 81.13 | 3.71 | 78.18–85.89 | 81.43 | 3.26 |
| Total acidity (% citric acid) | 0.18–0.70 | 0.38 | 0.23 | 0.43–0.49 | 0.47 | 0.03 | 0.46–0.55 | 0.50 | 0.04 |
| Total sugars (%) | 10.23–12.26 | 11.57 | 0.95 | 61.59–71.02 | 66.08 | 3.86 | 65.93–70.70 | 67.93 | 2.02 |
| Reducing sugars (%) | 9.59–10.41 | 9.94 | 0.35 | 6.99–8.23 | 7.45 | 0.56 | 7.34–9.43 | 8.14 | 0.92 |
| Pectin (%) | 0.25–0.69 | 0.47 | 0.18 | 0.16–0.27 | 0.22 | 0.05 | 0.17–0.33 | 0.25 | 0.07 |
| Insoluble solids (%) | 1.08–1.37 | 1.18 | 0.13 | 2.66–4.11 | 3.20 | 0.65 | 2.54–4.96 | 3.36 | 1.13 |
| Metal contents | | | | | | | | | |
| Cu (mg/100 g) | 0.02–0.08 | 0.05 | 0.02 | 0.01–0.05 | 0.03 | 0.02 | 0.01–0.06 | 0.04 | 0.02 |
| Fe (mg/100 g) | 0.30–0.76 | 0.55 | 0.19 | 0.45–1.96 | 0.96 | 0.17 | 0.64–0.68 | 0.66 | 0.02 |
| Pb (ppm) | 0.08* | | | | | | 0.12–0.17 | 0.15** | 0.03 |
| Sn (ppm) | nd* | | | | | | nd** | | |
| As (ppm) | 0.09* | | | | | | 0.01–0.04 | 0.03** | 0.02 |
| Fruit bits (A) with glycerol and sugar | | | | | | | | | |
| Fruit bits (B) with sugar only | | | | | | | | | |
| *on 1 sample | | | | | | | | | |
| **on 2 samples | | | | | | | | | |
| nd = not detectable | | | | | | | | | |

Table 6. Data for raw papaya from various sources

| | Eksotika | | Solo | Other varieties | | | | |
|-------------------------------|----------|------|------|-----------------|------|----------|------|------|
| | S1 | S6 | S3 | S1 | S2 | S4 | S5 | S6 |
| Physical | | | | | | | | |
| pH | 5.1 | | | 4.9 | 5.4 | | | |
| Brix | 13 | | 13 | 13 | 11 | | | |
| Proximate composition | | | | | | | | |
| Moisture (%) | 86.1 | 84.4 | 86.8 | 88.1 | 87.0 | 85–94 | 88.0 | 90.7 |
| Fat (%) | 1.3 | 0.1 | 0.1 | 0.4 | | 0.1–0.3 | 0.1 | 0.1 |
| Protein (%) | 1.1 | 1.0 | 0.4 | 1.0 | | 0.3–1.3 | 0.5 | 1.5 |
| Crude fibre (%) | 4.1 | 0.5 | 0.6 | 3.3 | | 0.5–2.7 | 0.7 | 0.5 |
| Ash (%) | 0.5 | 0.5 | 0.6 | 0.8 | | 0.1–1.2 | 0.6 | 0.1 |
| CHO by difference (%) | 6.9 | 13.5 | | 6.4 | | | | 7.1 |
| Total acidity (% citric acid) | 0.3 | | 0.1 | 0.5 | | | 0.1 | |
| Total sugars (%) | 10.3 | | | 9.8 | | 5.9–11.1 | 10.0 | |
| Pectin (%) | 0.5 | | | 0.4 | 1.0 | | | |
| Metal content | | | | | | | | |
| Fe (mg/100 g) | 0.4 | 0.6 | 0.2 | 0.4 | | 0.5–2.2 | | 0.7 |

S1 = this study

S2 = Anon. (1986b)

S3 = Chan (1983)

S4 = Duckworth (1966)

S5 = Purseglove (1968)

S6 = Tee et al. (1988)

Table 7. Data for papaya jam, candied papaya bits and papaya rolls from various sources

| | Jam | | Fruit bits (A) | | Fruit bits (B) | | Fruit bits | Rolls | |
|------------------------------|------|------|----------------|------|----------------|------|------------|-------|------|
| | S1 | S2 | S1 | S3 | S1 | S3 | S2 | S1 | S4 |
| Physical | | | | | | | | | |
| Water activity | | | | | | | | 0.56 | 0.51 |
| Proximate composition | | | | | | | | | |
| Moisture (%) | 21.6 | 26.7 | 16.2 | 17.0 | 11.8 | 12.0 | 16.1 | 10.6 | 12.5 |
| Fat (%) | 0.1 | 0.1 | 0.1 | | 0.6 | | 0.1 | | |
| Protein (%) | 0.9 | 0 | 0.8 | | 1.0 | | 0.8 | | |
| Crude fibre (%) | 0.5 | 0.5 | 1.4 | | 0.7 | | 1.2 | | |
| Ash (%) | 0.2 | 0.2 | 0.4 | | 0.3 | | 0.4 | | |
| CHO by difference (%) | 76.7 | 72.5 | 81.1 | | 85.6 | | 81.4 | | |
| Metal content | | | | | | | | | |
| Fe (mg/100 g) | 0.1 | 0.8 | 1.0 | | 1.6 | | 0.7 | | |

Fruit bits (A) with glycerol and sugar

Fruit bits (B) with sugar only

S1 = this study

S2 = Tee et al. (1988)

S3 = Jainuddin A., MARDI, Serdang, pers. comm. (1994)

S4 = Chan (1983)

Table 8. Data for papaya sauces from various sources

| | Thick sauce | | | Dessert sauce | | | Creamy sauce | |
|-------------------------------|-------------|------|-----|---------------|------|-----|--------------|-----|
| | S1 | S2 | S3 | S1 | S2 | S4 | S1 | S2 |
| Physical | | | | | | | | |
| pH | 3.3 | 3.6 | 3.4 | 3.0 | 2.7 | 2.8 | 2.2 | 2.8 |
| Brix | 43 | 40 | 44 | 45 | 44 | 44 | 41 | 38 |
| Proximate composition | | | | | | | | |
| Total acidity (% acetic acid) | 1.9 | 0.9 | 0.9 | 1.8 | 0.9 | 0.9 | 1.9 | 0.9 |
| Moisture (%) | 53.8 | 59.7 | | 51.5 | 56.3 | | | |
| Fat (%) | | | | 0.6 | 1.6 | | | |
| Ash (%) | 3.0 | 2.7 | | 1.0 | 1.0 | | | |

S1 = this study

S2 = Faridah, A. A., MARDI, Serdang, pers. comm. (1994)

S3 = Faridah and Rokiah (1993)

S4 = Faridah, A. A., MARDI, Serdang, pers. comm. (1993)

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