

## Carambola characteristics for specific product requirements

(Ciri-ciri belimbing untuk keperluan hasilan khusus)

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Key words: characteristics, carambola, jam, jelly, fruit filling, canned slices in syrup

### Abstrak

Belimbing (*Averrhoa carambola* L.) kv. B10 telah diperoleh dan diproses mengikut kaedah pemprosesan yang diwujudkan oleh MARDI menjadi hasilan seperti jem, jeli konfeksionari, inti buah-buahan dan hirisan dalam sirap. Analisis kimia dijalankan terhadap belimbing dan hasilnya. Hasil yang diperoleh disimpan dalam pangkalan data sebagai garis panduan bagi tentuan belimbing dan hasilnya.

### Abstract

Carambola (*Averrhoa carambola* L.) cv. B10 was obtained and processed according to processing methods established by MARDI into products such as jam, confectionery jellies, fruit fillings and canned slices in syrup. Chemical analyses were carried out on the raw carambola as well as its products. Results obtained were stored in database and used as guidelines for specifications of carambola and its products.

### Introduction

The local and overseas demand for fresh tropical fruits as well as their processed products is increasing. Exports of fresh fruits increased from 116 841 t in 1985 to 209 000 t (worth some RM139 million) in 1990. During the same period, exports of processed fruits increased from RM66.4 million to RM85.3 million (Anon. 1992). To meet this increasing demand, 15 priority fruits were promoted by the Malaysian government for the development of its fruit industry. Carambola (*Averrhoa carambola* L.) is one of the priority fruits which is also included in the Food Production Plan (1987) with the aim to replace import and increase export (Abu Bakar et al. 1989).

Various strategies have therefore been put forward for the growth of the carambola

industry. One approach is to encourage and improve the growing of carambola by expansion of areas for the planting, planting improved clones and setting up farmers' organizations in group farming systems or commercial farming. The next step is to expand and strengthen the market for fresh consumption as well as for processed fruits, locally and through export. Further to this, considerable emphasis has to be given to improving backup services such as quality control in postharvest handling, industrial processing, as well as R & D (Izham and Abd. Razak 1992).

The estimated demand for carambola in the year 2000 is 42 220 t, whereas only 14 570 t would be available, giving a deficit of 27 650 t. This is because of the increasing popularity of carambola as a fresh fruit,

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which is high in vitamin C, and as a potential raw material for processing into various products such as jam and jelly (Izham and Abd. Razak 1992; Mohd Nordin and Adinan 1992).

Among the selected cultivars, B2, B10 and B17 are commonly planted. B10 is the most popular cultivar in Petaling and Serdang because of its large sweet juicy fruit and good returns. B17 has recently gained momentum for the future, being very much sought after for its sweeter fruit and low fibre content (Abd. Rahman and Johari 1992).

To boost the image of Malaysian fruits overseas, Federal Agricultural and Marketing Authority (FAMA) is making an effort to set up export standards for local fruits, starting with carambola and Eksotika papaya, to be followed by the other selected fruits (Anon. 1992). Following from this, it will also be 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 practices. This project is thus aimed at compiling such information for the Nutrima product range of MARDI. Work on the properties of banana and its products has already been carried out (Chin et al. 1996). In this paper, the properties of carambola and its products are looked into.

## **Materials and methods**

### ***Acquisition of samples***

All the samples analysed, i.e. the types of fruit and their degree of ripeness, as well as their various processed products, were acquired and processed according to recommendations and the 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. Chemical analyses were carried out on the raw fruit and its products.

### ***Jam and jelly confectionery***

Carambola fruit (cv. B10) of colour maturity index 4 (75–100% yellow) (Anon. 1989), being the most suitable for the processing of these products as recommended by Mohd. Nordin and Adinan (1992) as well as Sharifah Samsiah and Latifah (1993), were purchased from local markets. The fruit were sorted, washed, trimmed and deseeded, then steamed and pureed in a bowl chopper.

The puree was processed into jam of 35% fruit content with the addition of sugar, water, pectin, citric acid and colouring according to the standard procedure in MARDI (Anon. 1987a, 1987b, 1988).

For the production of jelly, the puree was expressed to obtain the juice which was then gradually mixed with a solution of pectin, sodium citrate and sugar, and boiled for 1 min. Glucose syrup and sugar were then added and the solution boiled to 108 °C until the soluble solids content reached 78 °Brix. Acid and flavouring were mixed in and the hot solution poured into prepared cornflour moulds to set for 12–24 h. Upon removal from the moulds, the jelly was steamed lightly to wet the surface and then dredged in castor sugar, ready for wrapping (Anon. 1986, 1991; Sharifah Samsiah M., MARDI, Serdang, pers. com. 1991).

### ***Fruit filling***

Carambola (cv. B10) of maturity index 6 (Anon. 1989) was used. The fruit were sorted, washed, trimmed, deseeded, steamed and pureed for processing into fruit filling. A mixture of carboxymethyl cellulose (CMC) and sugar was added gradually to the hot puree with constant stirring. This was followed by the addition of salt and glucose, and the mixture was heated to boiling. A slurry of modified starch (Colflo 67, National Laing Ltd., Manchester) was then added gradually to the boiling mixture with constant stirring until it thickened. Lastly, a solution of citric acid was stirred into the mixture which was then brought to the boil again. The fruit mixture was

hot-filled into cans (300x305), sealed and pasteurized in boiling water for 30 min (Che Rahani, Z., MARDI, Johor Bahru, pers. com. 1993).

### ***Fruit slices in syrup***

Whole unblemished carambolas cv. B10 of maturity index 4 (Anon. 1989) were selected, washed, trimmed, deseeded and sliced. The fruit slices were then blanched for 1 min and packed into cans (300x410). The cans were filled with hot syrup (30 °Brix, pH 3.5, 0.1% CaCl<sub>2</sub>). They were then steamed and processed in boiling water for 9 min, cooled and labelled (Anon. 1987b; Mohd. Nordin and Adinan 1992).

### ***Analysis***

The samples were analysed, where applicable, for pH, total soluble solids (TSS), total and reducing sugars, total titratable acidity and metal contaminants such as Cu, Fe, and Zn, microbiological analysis for total plate count, yeasts, moulds and osmophiles. Proximate analysis for moisture, fat, ash, protein, crude fibre, carbohydrate by difference, insoluble solids, Hunterlab colour, gel strength, pectin and water activity was also carried out.

The methods of analysis used were standard methods as described in the analysis of banana and its products (Chin et al. 1996).

### **Results and discussion**

Results of the analysis showing the range of values and means for the various parameters recorded for the carambola and its products are given in *Table 1* and *Table 2*.

From the data obtained, it can be seen that the raw carambola samples were high in moisture content (88–91%) while their products could be divided into high moisture products such as fruit slices in cans (80%) and fruit filling (64–71%), intermediate moisture product such as jam (17–24%), low moisture product such as jelly confectionery (7–8%).

Sugar contents were rather low in raw carambola as shown by TSS values of 7–12 °Brix, but were higher in the products because of added sugar. Thus, jam and jelly confectionery had high sugar contents with values of 67–68 and 80–81 °Brix respectively, as required in their formulations. Depending on the amount of sugar added, fruit filling and fruit slices in cans had somewhat lower values of 32–33 and 17–19 °Brix respectively.

Fat content was generally low in carambola and its products (0.03–1.4%). In jam and jelly confectionery, microbial counts were not detectable, and metal contaminants were present at low levels (0.02–0.8 mg/100 g), well within the acceptable ranges.

Comparison of data from this study with available data for the raw carambola and their products are shown in *Table 3* and *Table 4*. It is noted that pH and TSS of the fruits from other countries differed slightly from those of the Malaysian carambola of both maturity indices 4 and 6 (Wagner et al. 1975; Hou et al. 1978; Neog and Mohan 1991). Total titratable acidity also differed with those values reported by Hou et al. (1978) as well as Neog and Mohan (1991). Vitamin C content showed similar values for local varieties (Bagar 1980; Tee et al. 1988), but differed in other work (Wagner et al. 1975; Neog and Mohan 1991).

Data for the products of carambola were less comprehensive and sometimes not available. *Table 4* shows results obtained by other researchers (Anon. 1986; Zainun 1992; Sharifah Samsiah and Latifah 1993) who used similar formulations for these products. Data for other such products were not available elsewhere.

### **Conclusion**

Chemical characteristics of carambola cultivar B10 and some specific products have been determined. They may be used as guideline characteristics for the establishment of specifications for these materials. However, the data obtained in this

Table 1. Guideline specifications data for carambola, carambola jam and jelly

	Carambola (maturity index 4)			Jam			Jelly		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
pH	4.10–4.20	4.17	0.05	2.70–2.80	2.77	0.05	3.70–3.80	3.73	0.05
Total soluble solids (°Brix)	7.00–9.00	7.83	0.62	67.00–68.00	67.57	0.26	80.00–81.00	80.33	0.24
Total titratable acidity (% as oxalic acid)	0.17–1.57	1.07	0.64	0.41–0.59	0.50	0.08	0.68–0.77	0.72	0.04
Total sugars (%)	7.38–7.74	7.56	0.15	63.95–71.15	66.50	3.29	66.91–78.81	71.81	5.08
Reducing sugars (%)	4.62–4.75	4.69	0.05	21.60–27.54	24.16	2.49	17.77–18.62	18.05	0.40
Pectin (%)	0.04–0.10	0.07	0.03	0.39–0.50	0.44	0.05	1.18–1.68	1.44	0.20
Proximate analysis									
Moisture (%)	87.88–89.76	89.05	0.83	17.16–23.75	20.76	2.72	7.32–8.42	7.87	0.45
Fat (%)	0.07–1.37	0.73	0.53	0.08–0.12	0.10	0.02	0.03–0.05	0.04	0.01
Protein (%)	0.22–0.24	0.23	0.01	0.11–0.13	0.12	0.01	0.11–0.11	0.11	0
Crude fibre (%)	4.03–5.33	4.79	0.55	0.35–0.50	0.42	0.06	0.06–0.16	0.10	0.04
Ash (%)	0.38–0.88	0.60	0.21	0.10–0.14	0.12	0.02	0.38–0.51	0.44	0.05
CHO by difference (%)	3.33–6.75	4.60	1.53	75.56–82.08	78.48	2.71	90.94–92.06	91.44	0.46
Insoluble solids (%)	1.76–2.05	1.90	0.12	0.57–0.64	0.61	0.03	0.33–0.66	0.45	0.15
Metal contaminant									
Cu (mg/100 g)	0.02–0.22	0.12	0.08	0.03–0.33	0.13	0.14	0.05–0.08	0.06	0.01
Fe (mg/100 g)	0.20–0.35	0.28	0.06	0.20–0.60	0.35	0.18	0.65–0.80	0.70	0.07
Zn (mg/100 g)	0.27–0.42	0.37	0.07	0.18–0.45	0.27	0.12	0.19–0.22	0.20	0.01
Microbial analysis									
Total plate count				nd			nd		
Moulds and yeasts				nd			nd		
Osmophiles				nd			nd		
Gel strength (g/cm <sup>2</sup> )				33.70–38.3	36.80	2.15			
Colour <i>L</i>				+28.30 to +32.9	+31.23	2.05	+58.2 to +59.9	+59.07	0.71
<i>a</i>				+0.53 to +2.64	+1.56	0.86	–0.3 to –0.4	–0.33	0.04
<i>b</i>				+3.25 to +5.79	+4.40	1.05	+14.3 to +16.1	+15.35	0.74
Water activity at 26.8 °C							0.66–0.67	0.67	0

Table 2. Guideline specifications data for canned carambola slices, carambola and carambola fruit filling

	Canned slices			Carambola (maturity index 6)			Fruit filling		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
pH	3.30–4.10	3.70	0.33	3.70–3.80	3.77	0.05	3.30–3.50	3.43	0.09
Total soluble solids (°Brix)	17.00–19.00	17.67	0.94	7.00–12.00	9.33	2.05	32.00–33.00	32.67	0.47
Total titratable acidity (% as oxalic acid)	0.49–1.39	0.94	0.37	0.56–1.96	0.26	0.57	1.88–3.29	2.69	0.59
Reducing sugars (%)	7.58–9.26	8.42	0.69	8.57–12.32	10.53	1.54	10.67–19.05	14.86	3.42
Proximate analysis									
Moisture (%)	80.19–80.44	80.32	0.10	90.71–90.78	90.75	0.03	64.44–71.32	67.88	2.81
Fat (%)	0.13–0.16	0.15	0.01	0.25–0.29	0.27	0.02	0.08–0.19	0.14	0.05
Protein (%)	0.30–0.46	0.38	0.07	0.68–0.85	0.75	0.07	0.30–0.64	0.47	0.14
Crude fibre (%)	2.17–3.12	2.65	0.39	0.46–0.90	0.62	0.20	0.28–0.40	0.34	0.05
Ash (%)	0.20–0.24	0.22	0.02	0.35–0.73	0.58	0.17	0.37–1.25	0.81	0.36
CHO by difference (%)	15.58–17.01	16.29	0.58	6.55–7.63	7.13	0.44	26.20–34.53	30.36	3.40
Vitamin C (mg/100 g)				20.47–26.90	23.63	2.63			

study may be applied for specification of products processed based on the MARDI standard formulations and may be different if other processes and raw materials are used.

### Acknowledgements

The authors wish to thank Dr Noraini Mohd. Khalid, Ms Sharifah Samsiah Mohamad, Ms Che Rahani Zakaria for providing the various carambola products. Thanks are also due to Mr Nushirwan Zainuddin, Mr Misli Sulaiman, Ms Ku Hasnah Ku Abdullah, Ms Zainun Ismail, Mr Bahari Ismail for technical assistance, Mr A.W. Ahmad and Mr A. L. Karim for ICP-AES analysis.

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Table 3. Data for raw carambola of maturity index 4 (S1) and 6 (S2) from eight sources

	S1	S2	S3	S4	S5	S6	S7	S8
pH	4.2	3.8		3.8	3.3		3.3	
Total soluble solids (°Brix)	7.8	9.3		9.5	8.3	8.3	8.0	
Total titratable acidity (% as oxalic acid)	1.07					0.22	0.58	
Total sugars (%)	7.56						10.85	
Reducing sugars (%)	4.69	10.53					6.25	
Proximate analysis								
Moisture (%)	89.1	90.8	92.0			91.1		
Fat (%)	0.7	0.2	0.1					
Protein (%)	0.2	0.8	0.7					
Crude fibre (%)	4.8	0.6	1.8					
Ash (%)	0.6	0.6	0.4			0.3		
CHO by difference (%)	4.6	7.0	5.0					
Metallic contaminant								
Fe (mg/100 g)	0.28		0.3					
Vitamin C (mg/100 g)		23.6	25.8		35.5		13.8	25.0

S1 = this study

S2 = this study

S3 = Tee et al. (1988)

S4 = Abd.Raman and Johari (1992)

S5 = Wagner et al. (1975)

S6 = Hou et al. (1978)

S7 = Neog and Mohan (1991)

S8 = Bagar (1980)

Table 4. Data for carambola jelly and jam from four sources

	Jelly			Jam	
	S1	S2	S3	S1	S4
pH	3.7	3.2–3.6	3.5	2.8	3.1
Total soluble solids (°Brix)	80.0	78.0–79.0	78.0	67.6	68.0
Pectin (%)	1.44	1.5			
Total titratable acidity (% as oxalic acid)				0.50	0.31
Total sugars (%)				66.50	45.50
Proximate analysis					
Moisture (%)				20.76	26.95
Fat (%)				0.10	0.02
Protein (%)				0.12	1.46
Crude fibre (%)				0.42	0.53
Ash (%)				0.12	0.12
CHO by difference (%)				78.48	70.92

S1 = this study

S2 = Sharifah Samsiah and Latifah (1993)

S3 = Anon. (1986)

S4 = Zainun (1992)

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