

Jackfruit quality for canning in syrup (Mutu nangka untuk pengetinan dalam sirap)

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Key words: jackfruit quality, harvesting maturity, ripening period, canning

Abstrak

Buah nangka (*Artocarpus heterophyllus* Lam.), jenis NS1, dipetik pada peringkat kematangan 14, 15, 16, dan 17 minggu (dikira dari masa tunas mula dilihat), dan kemudian diperam pada suhu ambien selama 0, 1, 2, 3, 4 dan 5 hari sebelum ditinkan sebagai hirisan dalam sirap. Penilaian citarasa dan analisis telah dijalankan terhadap nangka tersebut sebelum ditinkan, dan yang telah ditinkan selepas 2 minggu, 6 bulan dan 12 bulan.

Keputusan yang telah didapati menunjukkan bahawa buah nangka yang dipetik pada peringkat kematangan 15–16 minggu dan diperam 3 hari sebelum diproses, menghasilkan produk dalam tin yang terbaik, dan boleh disimpan hingga 12 bulan.

Abstract

Jackfruit variety (*Artocarpus heterophyllus* Lam.), NS1 variety, was harvested at 14, 15, 16 and 17 weeks maturity (from the first appearance of the spike), and allowed to ripen at ambient temperature for 0, 1, 2, 3, 4 and 5 days before processing as canned slices in syrup. Sensory evaluation and analysis were carried out on the raw and canned fruit, and on the stored canned fruit after 6 and 12 months storage. The results show that fruit harvested at 15 to 16 weeks maturity and stored for 3 days to ripen, gave optimum quality in the canned product. The processed 'nangka' could be kept up to 12 months without deterioration of quality.

Introduction

In recent years jackfruit (*Artocarpus heterophyllus* Lam., known locally as 'nangka') has been processed as a canned product in Malaysia (Rukayah 1979). The main criteria for selecting a particular variety for canning in syrup are the thickness and texture of flesh (Salehuddin 1985). The Negeri Sembilan variety NS1 was found to have these attributes as well as a splendid colour, aroma and flavour, besides having a good recovery percentage (Sedky 1972).

Fruit which is allowed to ripen on the tree to the 'table ripeness' stage, however, gave a mushy and fibrous texture in the canned product, albiet with excellent flavour and aroma. To obtain a more desirable texture in the canned product the 'nangka' has to develop to the right maturity on the tree and is harvested when it is still hard and unripe. It is then allowed to ripen for development of sweetness and aroma, and processed before it loses its firm crispy texture.

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Indices of fruit maturity at the time of harvesting, and ripening period required before processing, have thus far been very subjective. It was based on the farmer's experience and observations of such visual changes as flattening or spreading of the scales of the skin, yellowing, softening, exudation of a faint fragrance, and even a hollow sound when the fruit is tapped (Hew, S., Semenyih, pers. comm. (1983). A more systematic approach is therefore required.

In this study, the aim is to establish the optimum maturity for harvesting and the ripening period after harvesting of the NS1 'nangka', to obtain the best canned product.

Materials and methods

Maturity studies

Trees of NS1 variety were selected from MARDI orchards in Serdang and from Sendayan in Negeri Sembilan. To determine fruit maturity, individual fruit was tagged at the first appearance of the spike. Tagged fruit were harvested after 14, 15, 16 and 17 weeks from spiking. At the 17th week however, only a few of the tagged fruit were available for harvesting, the others being over-ripe. The harvested fruit (three for each maturity period) were allowed to stand, stem-end down, in a ripening cupboard at room temperature until they ripened. Daily observations were made until the fruit exuded a faint typical aroma of 'nangka'. At the same time the fruit had softened a little and the light green colour of the fruit coat was turning yellow. The ripe fruit of each maturity stage were then withdrawn for sensory evaluation and canning. The canned product was stored for sensory evaluation at 0, 6, and 12 months.

Storage for ripening studies

Fruit of 15 and 16 weeks maturity were stored in the ripening cupboard at ambient temperature. Daily samples (three fruit each) were withdrawn after 1,

2, 3, 4 and 5 days of storage for sensory evaluation, analysis and canning. The canned product was stored for sensory evaluation at 0, 6 and 12 months.

Processing

An impediment in the preparation of 'nangka' slices for canning was the very sticky latex which issued forth when its tough scaly skin was cut. Thus before the cutting and slicing operations, fingers and knife had to be smeared with a protective layer of edible oil. In this way a minimal amount of latex adhered to utensils, etc., which could then be washed off with a detergent. The fruit skin was slit longitudinally to expose a mass of fruitlets or bulbs (flesh and seed) embedded between strands of unformed parthenocarpic fruitlets. The bulbs were sliced off the skin and removed from the unformed fruitlet strands. They were then deseeded and sliced to a suitable size, before washing and processing as an acidified canned food according to the standard method for fruit canning in the Food Technology Division (Salehuddin 1985). The flow chart and parameters of the jackfruit processing is shown in *Figure 1*.

Initial test sample cans were taken after 2 weeks to allow for equilibrium, whilst the remaining cans were stored at ambient conditions for evaluation after 6 months and 12 months storage to determine the shelf life quality of the product.

Sensory evaluation

The sensory qualities of raw and canned 'nangka' and the stored canned products were assessed using a descriptive sensory test. The approach involved the use of a scoring and scaling method (Pangborn 1967). The panel was provided with a verbal scale of brief adjectives describing the intensity or dimension of each attribute under study in a descending or ascending order. A numerical scale was

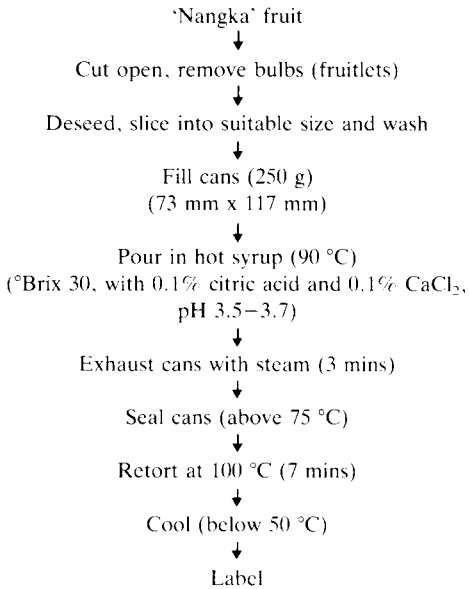


Figure 1. Flow chart of the canning of 'nangka'

assigned to each defined intensity for the purpose of statistical analysis (Daget 1977). The scale was structured at five points each for colour, sweetness, aroma, firmness, flavour and overall acceptability.

Analysis

Raw fruit were analysed during different stages of ripening for the following:

- pH was measured with an Orion Research Digital Ionalyser/501 (U.S.A.).
- °Brix was obtained using an Atago brixmeter (Japan).
- Colour was determined by a Hunterlab colorimeter D25 A-2 (Hunter Associates Laboratory Inc. Virginia, U.S.A.). The colour measured consisted of L = intensity, a = red, and b = yellow.
- Sugar and starch (%) were determined by the Lane and Eynon method (Ruck 1969; A.O.A.C 1970) in which the amount of invert sugar to reduce Fehling's solution to red insoluble cuprous oxide was determined by titration, using methylene blue as indicator. A

sample of 15 g was first extracted with water in the presence of alcohol. The solution was then filtered, the filtrate being used for sugar determination, and then the residue was hydrolysed before being used for starch determination by the same titration method.

- Acidity (% as malic acid) was determined by titrating an aliquot of the water extract with a standard solution of sodium hydroxide to pH 8.1 using the above pH meter (Ruck 1969).

Statistical analysis

The sensory evaluation data were examined for variations between the different storage periods by analysis of variance (ANOVA) calculated separately for each variable using a Hewlett Packard 9133 computer (California, U.S.A.).

Results and discussion

Maturity studies

Changes in the external appearance of the maturing fruit from 14 to 17 weeks after the appearance of the spike were rather gradual. Skin colour was light green to yellow, with fruit of 17 weeks maturity occasionally becoming a full yellow colour and over-ripe for canning as it was too soft but very aromatic. Fruit of 14 weeks maturity were generally small, whilst 15th-week fruit were variable in size. The 16th and 17th-week fruit were consistently larger. The proportion of pointed to flat scales of the skin did not show any sharp demarcation during these maturing periods. Thus harvesting of fruit by external appearance alone would be very dependent on the experience of the farmers.

When sliced open for ripening, fruit of 14 weeks maturity, being smaller, generally gave fruitlets with a relatively thin flesh (but not too thin to be used for canning). By 15 weeks the fruit were better developed and some bulbs were

Table 1. Anova table of significance for sensory evaluation of raw 'nangka' at different stages of maturity

Source of variation	Variable					
	Colour	Sweetness	Aroma	Firmness	Flavour	Overall acceptability
Maturity	ns	*	*	**	ns	ns
Replicate	ns	ns	ns	*	*	ns
Maturity x replicate	ns	ns	ns	*	*	ns

** 1% level of significance

* 5% level of significance

ns not significant

Table 2. Sensory evaluation of canned 'nangka' from fruit of different maturity stages

Weeks	Mean score					
	Colour	Sweetness	Aroma	Firmness	Flavour	Overall acceptability
14	2.86a	2.00a	3.24b	3.35a	3.00b	3.20b
15	2.68a	1.82a	2.78ab	3.20a	2.21a	2.40a
16	2.69a	2.04a	2.65a	3.42a	2.32a	2.45a
17	2.54a	2.57a	2.57a	3.29a	2.30a	2.49a

Scale:	Colour	1=pale yellow	5=dark yellow
	Sweetness	1=very sweet	5=not sweet
	Aroma	1=very strong	5=none
	Firmness	1=very firm	5=soft
	Overall acceptability	1=extremely good	5=extremely poor

Mean values with the same letter are not significantly different at 5% level

Table 3. Sensory evaluation of raw 'nangka' in comparison with stored canned 'nangka' (maturity studies)

	Mean score					
	Colour	Sweetness	Aroma	Firmness	Flavour	Overall acceptability
Raw fruit	2.33a	2.40b	2.51a	1.93a	2.02a	2.05a
Canned fruit stored for						
0 month	2.89a	2.00ab	2.92a	3.62b	2.67b	2.96b
6 months	2.94b	1.40a	2.76a	4.03b	2.47ab	2.81b
12 months	2.62ab	1.92ab	2.05a	3.67b	2.67b	2.72b

Mean values with the same letter are not significantly different at 5% level

For score descriptions see *Table 2*.

thicker, but there was still some degree of uneven thickness. By 16 and 17 weeks the fruit were fully developed and rounded, with fruitlets of thick flesh.

Sensory evaluation of the raw 'nangka' (summarised in *Table 1*) shows that there were significant differences in

firmness, sweetness and aroma between the fruit at different stages of maturity. There was a general trend of increasing sweetness and aroma in the maturing fruit. Firmness was also influenced by significant differences between replicates.

Table 4. Description of raw 'nangka' flesh from fruit harvested at 15 and 16 weeks maturity and stored for ripening

Storage days	Colour	Aroma	Taste	Texture
0	pale yellow	nil	powdery, raw	very hard
1	slight yellow	very slight	raw, slightly sweet	very hard
2	light yellow	faint	slightly sweet, sour	less hard in parts
3	yellow	good	sweet, slightly sour	firm
4	slightly dark yellow	very good	very sweet	softening but still quite firm
5	dark yellow	very good	very sweet, slightly fermented	soft and watery in parts

Since these observations on raw fruit can only give indications for 'table' consumption, it was necessary to process fruit of all stages of maturity to observe their behaviour after processing. Canned 'nangka' from fruit harvested at various stages of maturity were then assessed by the taste panel. The results in *Table 2* show that canned slices from fruit harvested at 14 weeks maturity had less flavour and aroma, and were therefore less acceptable. After 15 weeks there was a significant improvement in flavour, aroma and overall acceptability, which was maintained through to 16 and 17 weeks. Thus 15 to 16 weeks was taken as the optimum maturity period for harvesting, since at 17 weeks fruit were over-ripe in some cases.

On the whole, the canned products from all stages of maturity were always less acceptable when compared with the raw fruit as shown in *Table 3*. The firmness, flavour, and overall acceptability were significantly different. However, the canned products maintained their quality with no significant changes when stored through to 12 months.

Ripening studies

Changes in the external appearance of the ripening fruit after harvesting (observed only on fruit of 15 and 16 weeks maturity) were more marked than in the maturing

fruit: colour and aroma being the main criteria. Initially no aroma at all was detected but by the second day a faint aroma had developed, and the skin colour changed to yellow. By the third day the aroma was distinctly strong and a deeper yellow skin was observed. The increasing aroma and deepening skin colour progressed through to the fifth day when a slight alcoholic aroma was also detected and rust-like patches appeared on the skin.

A descriptive account of the 'nangka' flesh sampled at 0 to 5 days of storage in the ripening cupboard, is given in *Table 4*. Initially the flesh of the unripe fruit (of both 15 and 16 weeks maturity) was pale yellow and very hard, having a powdery raw taste and no aroma. Gradually the colour, aroma and taste began to develop, with a significant change occurring on the third day, thus corroborating the earlier observations of the external appearance of the fruit. This was accompanied by a change from a raw, very hard flesh to a ripe, firm one. On the fourth day, the aroma, taste and colour continued to develop but the fruit began to soften a little, and by the fifth day there was a slight fermented taste in the soft, watery fruit. Thus it would appear that although fourth-day fruit were sweeter and more aromatic than third-day fruit, they would be more suitable for 'table' consumption, whereas the latter fruit were more firm

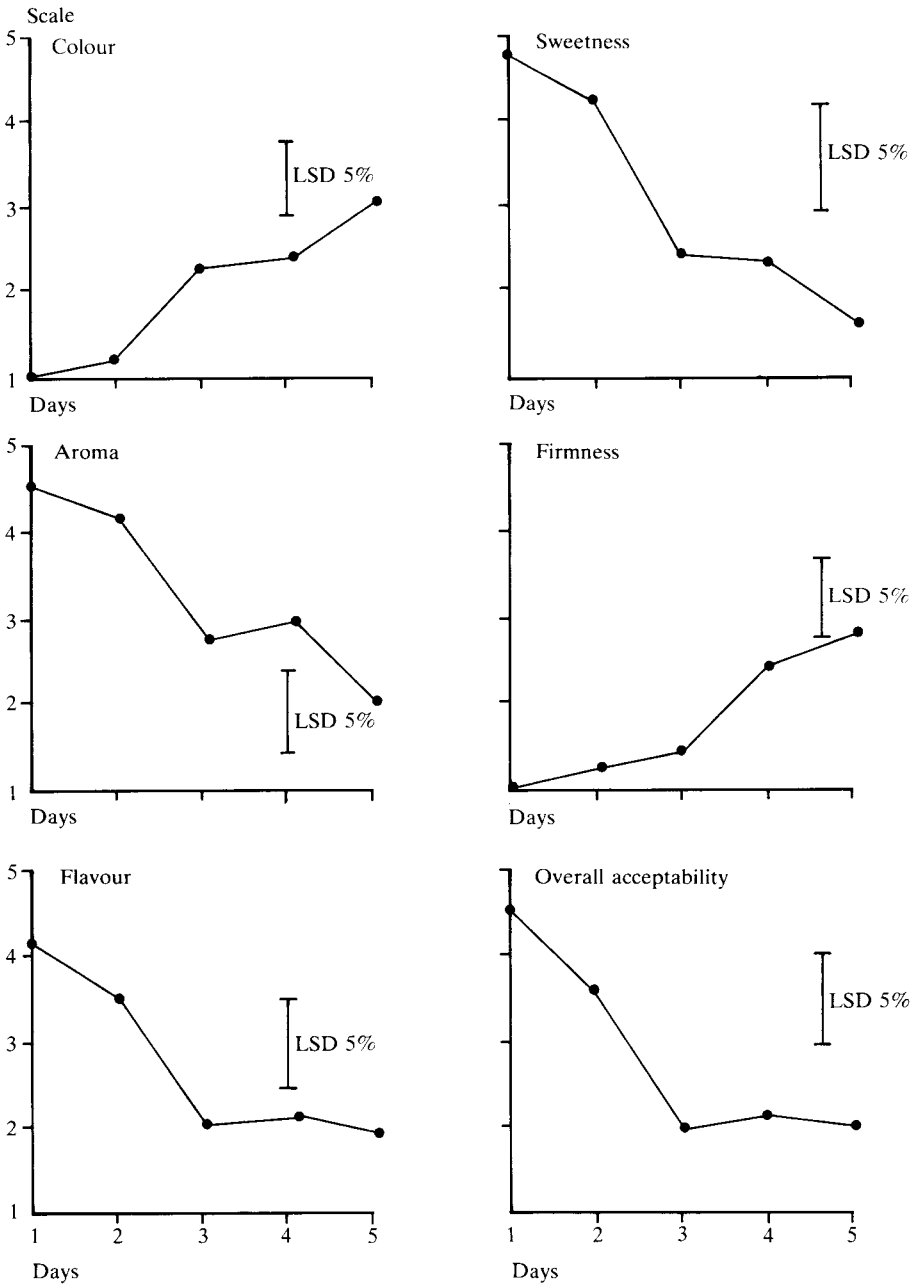


Figure 2. Effect of storage on the sensory evaluation of raw 'nangka' (ripening studies)

and of optimum quality for canning.

The results from sensory evaluation of raw 'nangka', given in Figure 2, confirm that colour, sweetness, aroma, flavour and overall acceptability of the 'nangka'

developed slowly in the first 2 days, and changed significantly to reach optimum levels on the third day. On the fourth day softening of the fruit was observed. No significant differences were noted

Table 5. Analysis of raw 'nangka' harvested after 15 and 16 weeks maturity and stored for ripening

Analysis	Days of storage					
	0	1	2	3	4	5
15 weeks maturity						
pH	6.55	6.01	4.86	5.18	5.53	5.50
°Brix	4.1	6.0	20.0	22.0	20.0	19.0
% sugar	trace	1.65	7.83	10.73	10.34	9.64
% starch	17.06	14.85	7.28	6.03	6.41	7.75
% acidity (as malic acid)	0.12	0.17	0.75	0.61	0.43	0.35
<i>L</i>	+77.1	+77.0	+68.1	+59.3	+59.6	+58.2
<i>a</i>	-2.3	-2.3	+ 2.3	+5.4	+5.1	+5.3
<i>b</i>	+28.3	+28.0	+28.8	+27.0	+27.3	+26.8
16 weeks maturity						
pH	6.51	5.09	5.20	5.08	5.14	5.01
°Brix	1.3	6.0	14.8	21.0	21.0	19.0
% sugar	trace	3.73	7.59	9.19	10.06	10.68
% starch	18.36	14.85	10.37	6.54	7.93	6.25
% acidity (as malic acid)	0.06	0.20	0.26	0.27	0.26	0.17
<i>L</i>	+77.0	+76.9	+72.6	+59.2	+60.7	+51.9
<i>a</i>	-3.1	-2.3	-4.7	+5.3	-0.6	+0.2
<i>b</i>	+28.2	+28.0	+34.0	+27.1	+32.5	+27.4

where *L*, *a* and *b* are Hunterlab parameters for colour

between raw fruit of 15 and 16 weeks maturity. The analysis results on raw 'nangka' (harvested at 15 and 16 weeks maturity) during the process of ripening are shown in Table 5. It is noted that sugar and °Brix levels increased dramatically between the second and third day of storage for fruit of both stages of maturity, and remained so up to the fifth day. At the same time starch decreased markedly on the second and third day, remaining thus up to the fifth day. There were also some increases in acidity, whilst Hunterlab colour for *L* decreased and for *a* increased, showing the deepening of colour. These changes account for the sensory observations when the fruit changed from raw, hard, powdery and light yellow to ripe, firm, sweet, and deep yellow on the third day.

Canned 'nangka' slices from fruit harvested at 16 weeks maturity and ripened at ambient temperature for 3 days were significantly more firm and

acceptable than those from fruit kept for 4 days (Table 6). Those ripened for 2 days or less were not canned since they were still very hard. In the case of fruit harvested at 15 weeks maturity, 2 days ripening was sufficient for some fruit. In this case, sweetness of the canned slices from three-day fruit was better than from those ripened for 2 days. Firmness was significantly better in fruit stored for 2 and 3 days than for 4 days. Aroma increased with ripening storage, 4-day ripening being significantly different from 2-day but not significant from 3-day. Colour and flavour were not significantly different in all cases.

Thus it is clear that fruit of 15 and 16 weeks maturity, stored for 3 days resulted in canned products of optimum quality.

A comparison of the overall sensory evaluation of canned 'nangka' obtained from fruit, harvested at 15 and 16 weeks maturity, kept in the ripening room for 2, 3, and 4 days, and stored over 0, 6 and

Table 6. Sensory evaluation of canned 'nangka' from fruit ripened at ambient temperature for 2, 3, and 4 days (ripening studies)

Days	Mean score					
	Colour	Sweetness	Aroma	Firmness	Flavour	Overall acceptability
15 weeks maturity						
2	2.14a	2.69b	3.40b	2.32a	3.11a	2.90a
3	2.15a	2.19a	2.97ab	2.29a	2.45a	2.48a
4	2.53a	1.83a	2.46a	3.67a	2.31a	2.58a
16 weeks maturity						
3	2.22a	1.99a	2.60a	2.55a	2.28a	2.20a
4	2.13a	1.81a	2.84a	3.60b	2.53a	2.67b

Mean values with the same letter are not significantly different at 5% level
 For score description see Table 2.

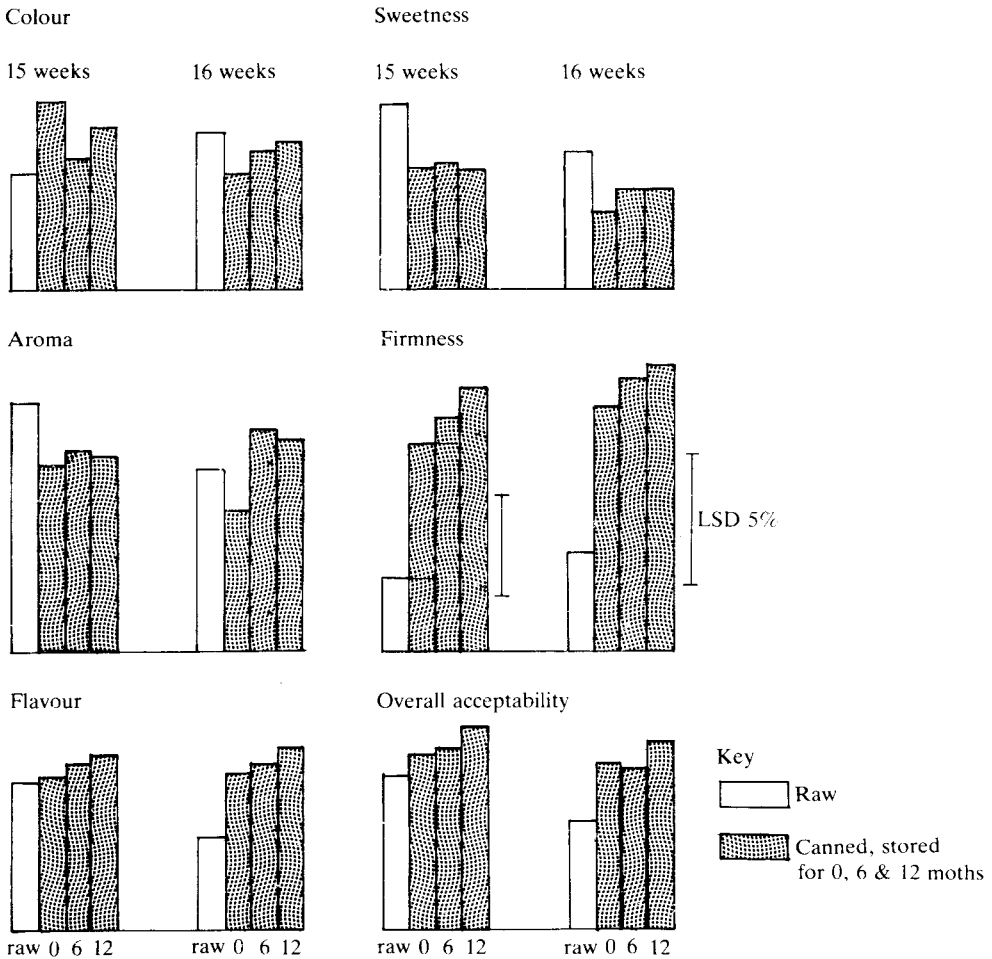


Figure 3. Sensory evaluation of raw 'nangka' in comparison with stored canned 'nangka' (ripening studies)

12 months at ambient temperature, with that of raw 'nangka' is shown in *Figure 3*. The results show that the canned 'nangka' was significantly less firm than raw 'nangka'. However the colour, sweetness, aroma, flavour and overall acceptability of canned 'nangka' were not significantly different from those of raw 'nangka'. There were also no significant changes in the sensory qualities of canned 'nangka' when stored up to 12 months.

Thus, although optimum quality of canned 'nangka' slices was obtained from fruit of 15 to 16 weeks maturity after storing for 3 days, the product was different from raw fruit in firmness.

Conclusion

Optimum quality of canned 'nangka' (NS1) was obtained from fruit harvested at 15 to 16 weeks maturity (after spiking) and stored for ripening at ambient temperature for 3 days before processing. The canned product was kept up to 12 months without loss in quality.

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