

## **Comparative acceptability and stability of toffee made from powdered and fresh juice of *Morinda citrifolia***

(Perbandingan penerimaan dan kestabilan tofi yang dibuat daripada serbuk dan jus segar mengkudu)

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Keywords: *mengkudu* toffee, water activity, sensory evaluation, free fatty acids, packaging

### **Abstract**

Toffee, a hard-boiled candy, was enriched with 5% *mengkudu* juice or *mengkudu* powder. Organoleptic, chemical and microbiological qualities of *mengkudu* toffees in twist-wrapped metallised film and plain cellophane were evaluated for 6 months duration. The *mengkudu* juice toffee (MJT) was preferred over the *mengkudu* powder toffee (MPT) especially for attributes such as overall acceptability, aroma and texture. The overall acceptability of MJT was higher and significantly different at second month ( $p < 0.01$ ) and third month ( $p < 0.05$ ) compared to MPT. Similarly, aroma of MJT was slightly preferred over MPT throughout storage period, which was significantly different at the fifth month ( $p < 0.05$ ). Texture for freshly prepared MJT as well as samples stored for two months was found to be significantly preferred over MPT, and the difference was significant at  $p < 0.01$  and  $p < 0.05$ , respectively. The product acceptability was reduced with the storage period due to increase in water activity. Free fatty acid of the MJT and MPT products was below 0.5–1.5% (calculated as oleic acid). Microbiological evaluation showed that freshly prepared and stored samples were safe for consumption. Plain cellophane or metallised materials showed no significant differences in retaining toffee sensory attributes.

### **Introduction**

*Morinda citrifolia*, locally known as *mengkudu*, is traditionally used by Tahitian in treating inflammation, headache, fever, arthritis, sore gums, gingivitis, toothache, respiratory disorder, sore throat with cough, infections (bacterial, fungal, viral, helminthes), tuberculosis, diarrhea, gastric ulcer, indigestion, diabetes, high blood pressure, childbirth and menstrual cramps (McClatchey 2002). Heinicke (1985) made claims on *mengkudu* fruits which contain active ingredients such as xeronine and

proxeronine. Production of xeronine is promoted by *mengkudu* juice. Xeronine can regenerate cells for anti-aging, reduce mental depression, blood vessel problems (atherosclerosis), drug addiction, senility and analgesia. Recent scientific studies include the use of *mengkudu* in the treatment of cancer, immunology, virology and others.

More recent studies showed that an aqueous extract of *mengkudu* fruit exhibited hypolipidemic effect by reducing certain lipids component in the plasma and liver of normal and streptozotocin-induced diabetic

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rats at certain dosage (Hadijah et al. 2008). *Morinda citrifolia* citrus-flavoured drink has been developed using Response Surface Methodology (RSM) (Saniah and Hasimah 2008), whereby the addition of citrus juice had the most pronounced effect on the degree of liking for all sensory attributes investigated for *mengkudu* drink.

*Mengkudu* toffee is prepared from ingredients such as sugar, glucose syrup, condensed milk, hydrogenated palm kernel oil (HPKO), butter, salt, lecithin, water and *mengkudu* powder. Fats such as HPKO and butter play an important role in perception of taste and texture of toffee and their absence would make toffee more difficult to prepare and consume. Hydrogenated vegetable fats are normally used. These fats melt at body temperature and solidify during storage (Brown 1993).

Storage study of herbal toffee is to determine that the original quality of the toffee is maintained to a certain period under certain conditions. Plain cellophane and metallised film, both are twist-wrap materials, provide moderate protection as the overlap is not sealed. The twist-wrap materials provide an attractive appearance especially if coloured films are used, and the “twists” are useful to give padding and bulk in a loose carton pack. A twist wrapped sweet is easily unwrapped just by pulling at each twist (Minifie 1982).

Consumers want a product that can retain freshness, aroma and flavour for as long as possible. Moisture loss, spoilage because of microorganism, enzymatic changes, and oxidation can all affect the shelf life of a product (Byrd 2001). Ideally, storage condition should have a humidity level of 15% or less, but this condition could not be achieved except in the desert. Moisture is not good for stored edibles, thus it needs to be minimized as much as possible. This can be achieved by several methods such as to keep the storage location air-conditioned throughout the year and to package the goods in storage containers

impervious to moisture and to deal with the moisture trapped inside.

The general assumption is that when a given toffee’s taste, appearance or texture begin to take on noticeable changes, it has reached the end of its best marketable shelf life and should be removed from the shelf. The toffee is no longer edible. It is losing its chemical and microbiological qualities and should be replaced with a fresher stock. Oxidation, a chemical chain reaction that occurs in unsaturated compounds like fats and oils (Byrd 2001), is one of the reasons for the toffee to lose its chemical qualities.

Thus, the objective of the study was to determine the exact storage duration of the herbal toffee twist wrapped in materials such as metallised film and plain cellophane through sensory, microbiological, water activity as well as free fatty acid evaluations.

## **Materials and methods**

### ***Sample preparation***

Toffees were prepared according to the following formula: sugar (25.1%), glucose syrup (20.1%), condensed milk (25.1%), hydrogenated palm kernel oil (HPKO) (14.5%), butter (9.7%), salt (0.5%), lecithin (0.3%) and water (4.8%). *Mengkudu* juice and *mengkudu* powder were incorporated into the toffee each at 5% of the total weight. *Mengkudu* powder used was purchased from Chemical Engineering Pilot Plant (CEPP), UTM Johor whereas *mengkudu* juice was obtained from local supplier.

Processing of the toffee involved mixing, cooking, cooling, tempering, rolling, cutting and wrapping. Toffee incorporated with *mengkudu* juice (MJT) was prepared by blending and homogenizing it with sugar, glucose, condensed milk, HPKO, salt, lecithin and water for 1 min. The mixture was cooked until temperature 110 °C before adding the butter. Cooking was continued to 124 °C or until the soluble solids reached 92 °Brix with constant stirring throughout the process. Lastly, the sugar mass was poured onto an oiled marble slab, cooled,

kneaded, tempered, cut and wrapped.

For toffee mixed with *mengkudu* powder (MPT), the mixture was mixed vigorously with concentrated sugar mass using Waring blender equipped with hot water circulation.

The prepared toffees (MJT and MPT) were twist wrapped in materials such as plain cellophane (C) and metallised film (M) and they (MJT-C, MPT-C, MJT-M and MPT-M) were stored in plastic bottle for 6 months.

### ***Training of panellists***

The 30 selected panellists were familiarized with the taste of toffee with and without *mengkudu*. They were given toffees of different concentration levels of 0, 5 and 10% *mengkudu*. The ranking tests were carried out in two sessions. A total of 18 panellists that managed to rank the correct samples were selected as panellists in this study.

### ***Sensory evaluation***

Sensory evaluation was carried out using the hedonic rating test to analyse the aroma, colour, taste, texture and overall acceptability. The panellists were given four samples (MJT-C, MPT-C, MJT-M and MPT-M) with a sensory evaluation sheet. Assessments of the stored *mengkudu* toffees were carried out at 0, 1, 2, 3, 4, 5 and 6 months whereby the freshly prepared toffee was indicated as "0". A hedonic 9-point rating scale was used with 1 = dislike extremely, 5 = neither like nor dislike and 9 = like extremely. In this evaluation, all products were generally regarded as acceptable if the evaluation scores were more than 5.

### ***Microbiological analysis***

Duplicate samples (about 10 g) for the 2 x 2 treatment combination of ingredients and packaging types were taken at 0, 1, 2, 3, 4, 5 and 6 months and analysed separately. Samples were placed in a sterile stomacher bag and homogenized with 90 ml Ringer's solution in a laboratory blender (Seward

Stomacher 400). From the homogenate, serial dilutions were prepared in Ringer's solution, and each dilution was poured onto duplicate plates. Total microbial counts were determined by pour plate methods using standard plate count agar. Yeast and mould counts were determined by the same method using potato dextrose agar. Total coliform and *Escherichia coli* in the homogenate were estimated by a pour plate method using violet red bile agar (AOAC 1990). All plates were incubated at 37 °C for 48 h.

### ***Determination of water activity***

The water activity of samples was determined using Novasina Water Activity Meter according to manufacturer's instruction. Samples were mashed and placed into three individual containers which were put into three separate chambers and allowed to equilibrate for 25–30 min. Values were taken after constant readings were obtained.

### ***Determination of free fatty acid***

Free fatty acid (FFA) of the stored sample was determined according to the method of Pearson (1976). Analyses were done in three replicates.

### ***Experimental design***

Two types of *mengkudu* ingredients (*mengkudu* juice and *mengkudu* powder) and two types of packages (metallised film and plain cellophane) with a total of four treatment combinations were studied. In sensory evaluation study, all the four samples were randomly assigned to each of the 18 selected trained panellists to evaluate sensory attributes such as aroma, colour, taste, texture and overall acceptability throughout the storage duration (6 months). Analyses of samples were conducted at monthly intervals (0, 1, 2, 3, 4, 5 and 6 months). To determine the water activity and free fatty acids, the stored samples were laid out in completely randomized design (CRD) with three replications. The data gathered were analysed statistically using

analysis of variance (ANOVA) for the main and interaction effects of the treatments. The differences between means were compared using LSD as outlined by Steel and Torrie (1960).

## Results and discussion

### *Interaction between mengkudu ingredients and packaging materials*

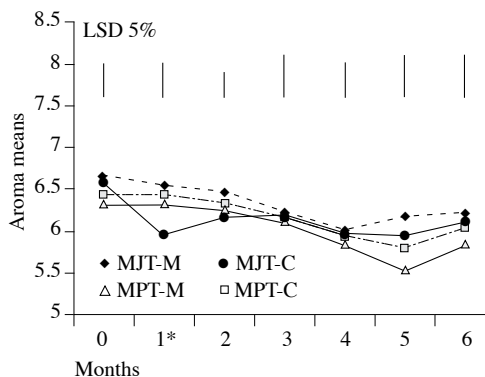
There was an interaction between the *mengkudu* ingredients and packaging materials used for the aroma attribute which only occurred at first month of storage (significantly at  $p < 0.05$ ) as shown in *Figure 1*. The MJT-C received fewer score in aroma as compared to MJT-M, MPT-M and MPT-C. It could be due to the cellophane material which is a fairly good water vapour barrier but not a good odour barrier as compared to metallised film (Minifie 1982).

However, there was no interaction between the *mengkudu* ingredients and packaging materials observed for the other attributes which included colour, taste, texture and overall acceptance. Since there was no interaction, discussion on sensory evaluation would only focus on effect of storage on *mengkudu* ingredients irrespective of the types of packaging materials used.

### *Sensory evaluation*

It was shown that there was an interaction between *mengkudu* ingredients used with the organoleptic qualities of toffee evaluated during the 6 months storage duration. With the exception of colour, the other organoleptic attributes evaluated were significantly affected by the different *mengkudu* ingredients used.

*Mengkudu*, either in the form of powder or juice, can be used as raw material in making *mengkudu* toffee. However, it was found that *mengkudu* juice performed significantly better ( $p < 0.05$ ) than *mengkudu* powder in retaining the *mengkudu* aroma in toffee especially during the fifth month of storage (*Figure 2*). *Mengkudu* juice was added at the stage of cooking to dissolve



\*Significantly different at 5% level

MJT-M = *Mengkudu* juice toffee – Metallised Film

MJT-C = *Mengkudu* juice toffee – Cellophane

MPT-M = *Mengkudu* powder toffee – Metallised Film

MPT-C = *Mengkudu* powder toffee – Cellophane

*Figure 1. Effect of selected packaging materials on aroma of stored mengkudu toffees*

sugar solids whereas *mengkudu* powder was incorporated at the last stage of processing so as to minimize the loss of aroma and active components in the products. Further loss of aroma in MJT and MPT during storage was probably due to the packaging materials and method of packing used (*Figure 2*).

There were no significant changes in colour for MJT and MPT samples during storage (*Figure 2*). The MJT has uniform brown colour whereas the MPT has fine brown particles of *mengkudu* powder distributed uniformly throughout the product.

In terms of taste, MJT was preferred than MPT throughout the 6 months storage period (*Figure 2*). Storage time affected the taste of both MJT and MPT. MJT taste was significantly better ( $p < 0.05$ ) than MPT especially at the second and fifth months of storage. Addition of *mengkudu* powder into hot cooked sugar mass caused a great deal of flash-off. Rapid temperature changes could evaporate the volatile components that resulted in loss of some *mengkudu* flavour.

Preference for texture of stored MJT and MPT decreased with storage (*Figure 2*). Texture of MJT was significantly higher

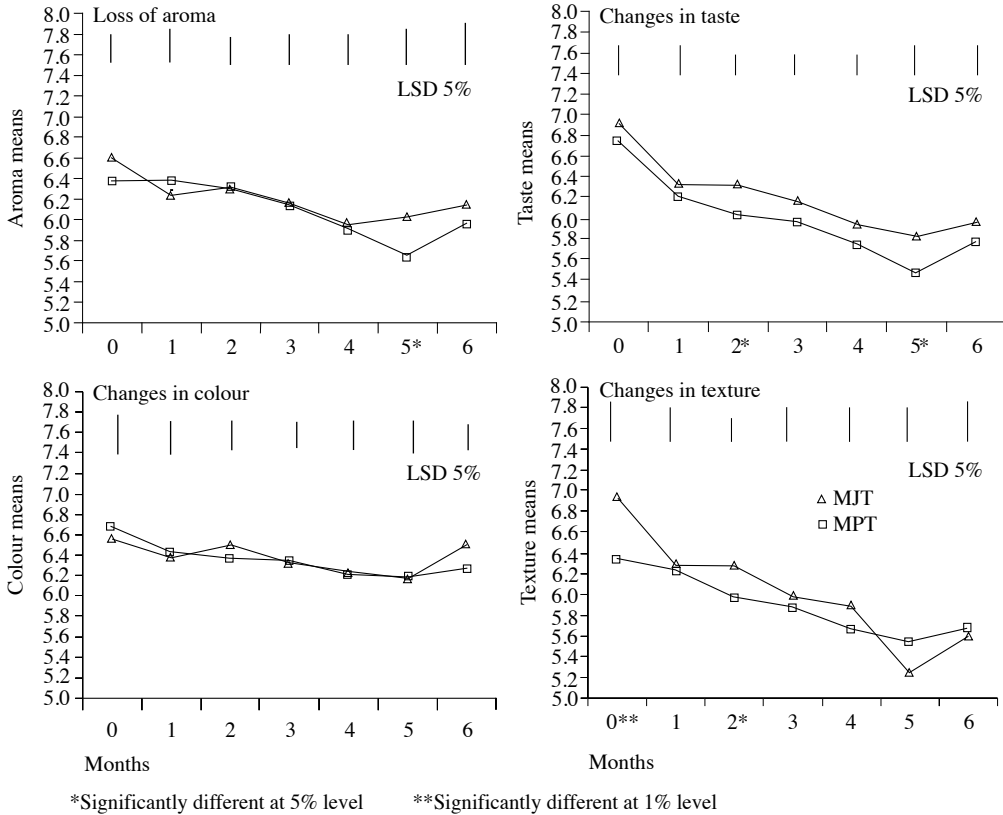


Figure 2. Loss of aroma and changes in colour, taste and texture of *mengkudu* toffees during storage

( $p < 0.01$ ) compared to MPT immediately after processing. The texture was better compared to MPT up to the fourth month of storage, after which the texture of MJT dropped rapidly. Incorporation of *mengkudu* powder in toffee (MPT) caused the product to lose its texture faster than MJT. The presence of powder can change the texture of toffee, making it usually more ‘short’ and sandy. It was observed that MPT had lost some of the flavour and elasticity when herb powder was used. One solution of retaining elasticity in candy is to use liquid herb extract or essential oil. Losing of flavour and elasticity probably explained why overall acceptability for MJT containing *mengkudu* juice was better than MPT.

Overall acceptability of both MJT and MPT reduced with storage time (Figure 3). However, preference for MJT was better

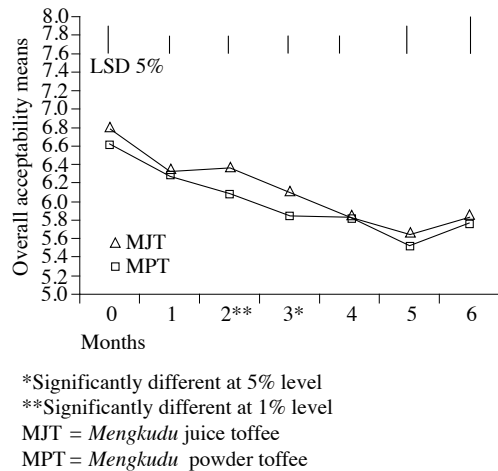


Figure 3. Overall acceptability of storage *mengkudu* toffees

compared to MPT throughout the storage period especially at the second and third month which was significantly different at  $p < 0.01$  and  $p < 0.05$  respectively.

**Water activity**

Generally, the water activity ( $A_w$ ) increased with the storage period for all the treatments (Table 1). Initial water activities of MJT was a bit higher compared to MPT. However the differences were insignificant. It was observed in the first and second month, MJT-C, MJT-M, MPT-C and MPT-M showed substantial increase in  $A_w$  and differences among them were significant at  $p < 0.01$  and  $p < 0.05$  respectively. After the third month, MPT and MJT packed in either cellophane or metallized film showed no significant difference ( $p > 0.05$ ) in  $A_w$ .

Cellophane material was rated as a better material for storing toffee, especially for toffee made of *mengkudu* powder. However, its performance was not significantly different ( $p > 0.05$ ) from metallized film after the third month and beyond.  $A_w$  of any product, if higher than 0.49, usually requires better packaging materials such as high water barrier materials. The water activity recorded for 6 months storage was too low for bacteria growth; however  $A_w$  of 0.6 and above can encourage the growth of some moulds and yeasts (Karel et al. 1975). The salt contained in the *mengkudu* toffees would have some influence on lowering the  $A_w$ , and tends to create conditions hostile to microbial growth (Groves 1988).

**Free fatty acids**

Free fatty acid (FFA) values (as % oleic acid) in *mengkudu* toffees during storage ranged from 0.159–0.2805 (Figure 4). With most oils, acidity begins to be noticeable to the palate when FFA is about 0.5–1.5% (Egan et al. 1981). Within 6 months storage, the products still showed satisfactory results in terms of free fatty acid contents which was below the limit mentioned.

The presence of FFA during storage was due to fat containing ingredients used in the product (14.5% vegetable fat). The fatty acids are susceptible to breakdown and contribute to lipid oxidation and also the development of rancid flavours during storage (Smith et al. 1986). To reduce this problem, the use of packages that are highly impermeable to oxygen and lightproof is required (Heiss 1970). Plain cellophane film provides very little protection against water vapour and moderate protection for oxygen gas transmission (Minifie 1982). Fat containing confection will also react with moisture to produce fatty acids and the degradation of products.

**Microbiological evaluation**

The microbiological evaluation results of stored toffees for 6 months duration were within tolerable level ( $< 1.0 \times 10^6$ ) and this indicated that the products were safe for consumption. Both toffees showed satisfactory microbiological quality. There was no significant difference ( $p > 0.05$ ) among the treatments conducted for

Table 1. Change in water activities ( $A_w$ ) of *mengkudu* toffees during 6 months storage

Treatment	0	1	2	3	4	5	6
MJT-C	0.409a	0.599a	0.609a	0.568a	0.617a	0.630a	0.619a
MJT-M	0.409a	0.583ab	0.602ab	0.601a	0.614a	0.630a	0.615a
MPT-C	0.388a	0.548b	0.545c	0.609a	0.578a	0.582a	0.589a
MPT-M	0.388a	0.472c	0.567bc	0.578a	0.582a	0.619a	0.589a
Significant levels	ns	**	*	ns	ns	ns	ns

Means bearing the same letter within the same column are not significantly different at 5% level

\*\*Significantly different at 1% level; \*Significantly different at 5% level

ns = Not significantly different

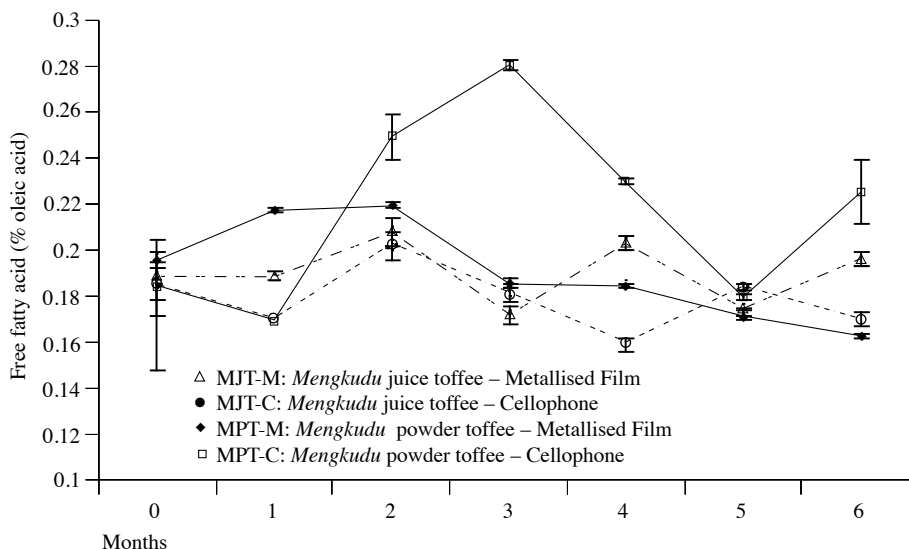


Figure 4. Free fatty acid contents of stored mengkudu toffees

microbial counts during the 6 months storage.

### Conclusion

The effect of storage time on the sensory quality and water activity of stored *mengkudu* juice toffee and *mengkudu* powder toffee was observed throughout the 6 months study. The acceptability of the products reduced with storage time. *Mengkudu* juice performed better than *mengkudu* powder in retaining aroma, taste, texture and overall acceptability of product during the 6 months storage. Cellophane material was rated as a better material for storing toffee made of *mengkudu* powder up to 3 months; however its performance was not significantly different from metallized film after the third month and beyond. Both *mengkudu* juice toffee and *mengkudu* powder toffee twist wrapped in metallized film as well as plain cellophane showed satisfactory microbiological quality throughout the 6 months study. Using either cellophane or metallized film, the best storage time recommended is 6 months for both *mengkudu* powder and juice incorporated toffees.

### References

- AOAC (1990). *Official methods of analysis*, 15th ed. Arlington: Association of Official Analytical Chemists
- Brown, S. (1993). Caramel and toffee cooking. *Confectionery Manufacturing Magazine* July/August, p. 36–43
- Byrd, S.J. (2001). Using antioxidants to increase shelf life of food products. *Cereal Food World* (46)2: 48–53
- Egan, H., Kirk, R.S. and Sawyer, R. (1981). *Pearson's chemical analysis of foods*, 8th Edition, p. 533–535. UK: Longman Scientific & Technical
- Groves, R. (1988). Controlling moisture in confectionery. *Candy Industry* August, p. 58
- Hadijah, H., Ayub, M.Y., Zaridah, H. and Normah, A. (2008). Hypolipidemic activity of an aqueous extract of *Morinda citrifolia* fruit in normal and streptozotocin-induced diabetic rats. *J. Trop. Agric. and Fd. Sc.* 36(1): 77–85
- Heinicke, R.M. (1985). The pharmacologically active ingredient of noni. *Pacific Tropical Botanical Garden Bulletin* 15: 10–14
- Heiss, R. (1970). Influence of packaging on the shelf life of the foodstuffs. In: *Principles of food packaging*. Munich: FAO of the United Nations
- Karel, M., Fennema, O.R. and Lund, D. B. (1975). Water activity and food preservation. In: *Principles of food science. Part II. Physical principles of food preservation*, (Oven, R. Fennema, ed.), p. 237–261. New York and Basel: Marcel Dekker Inc.

- McClatchey, W. (2002). From Polynesian healers to health food stores: Changing perspectives, of *Morinda citrifolia* (Rubiaceae). *Intergrative cancer therapies* 1(2): 110–120
- Minifie, B.W. (1982). *Chocolate, cocoa and confectionery: Science and technology*, 2nd Edition. p. 548–598. Westport, Connecticut: AVI Publishing Company Inc.
- Pearson, D. (1976). *General method in the chemical analysis of food*. London: Longman Group Ltd.
- Saniah, K. and Hasimah, H.A. (2008). Development of *Morinda citrifolia* citrus-flavoured drink using Response Surface Methodology (RSM). *J. Trop. Agric. and Fd. Sc.* 36(1): 87–97
- SAS Inst. (1985). *SAS User's Guide: Statistics*, Version 5. Cary, North Carolina: SAS Institute Inc.
- Smith, J.P., Ooraikul, B., Koersen, W.J., Jackson, E.D. and Lawrence, R.A. (1986). Novel approach to oxygen control in modified atmosphere packaging of bakery products. In: *Principles and applications of modified atmosphere packaging of food*. London: Blackie Academic & Professional
- Steel, R.G.D and Torrie, J.H. (1960). *Principle and procedures of statistics*. New York: McGraw Hill

### **Abstrak**

Tofi, sejenis kandi didihkan keras, telah diperkaya dengan 5% jus mengkudu atau serbuk mengkudu. Penilaian kualiti organoleptik, kimia dan mikrobiologi bagi tofi mengkudu di dalam bahan bungkus pintal balut (*twist-wrap metallised film*) dan selofan telah dijalankan selama 6 bulan. Tofi jus mengkudu (MJT) lebih disukai daripada tofi serbuk mengkudu (MPT) terutama untuk sifat penerimaan keseluruhan, aroma dan tekstur. Jika dibandingkan dengan MPT, ternyata penerimaan keseluruhan bagi MJT adalah lebih baik dan nyata berbeza pada bulan kedua ( $p < 0.01$ ) dan bulan ketiga ( $p < 0.05$ ). Dari segi penerimaan, aroma MJT adalah lebih baik daripada MPT sepanjang tempoh penyimpanan dengan perbezaan yang nyata ditunjukkan pada bulan kelima ( $p < 0.05$ ). Tekstur MJT lebih digemari terutama bagi sampel yang baru diproses dan sampel bulan kedua dengan masing-masing nyata berbeza pada  $p < 0.01$  dan  $p < 0.05$ . Penerimaan produk menurun dengan tempoh simpanan, akibat daripada kenaikan keaktifan air. Kandungan asid lemak bebas untuk MJT dan MPT adalah memuaskan iaitu kurang daripada 0.5–1.5% (dikira sebagai asid oleik). Penilaian mikrob bagi sampel yang baru diproses dan disimpan menunjukkan produk tersebut selamat untuk dimakan. Bahan pembungkus selofan biasa atau *metallised film* tidak menunjukkan perbezaan yang nyata dalam mengekalkan sifat cita rasa tofi herba ini.