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Effect of processing on physico-chemical characteristics and acceptance of breaded banana

(Kesan pemprosesan terhadap ciri-ciri fiziko-kimia dan penerimaan pisang bersalut)

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Key words: processing, physico-chemical properties, acceptance, breaded banana

Abstract

Breaded banana (*Musa* sp.*)* was prepared from cultivars Nangka by battering pre-treated fruit pieces with batter containing wheat flour, corn flour, seasonings and water before breading and blast freezing. The products need to be kept frozen at –18 °C. The products can be either fried at 170 °C for 3 min in palm olein oil or baked at 120 °C for 15 min in a conventional oven immediately after taking from freezer prior to consumption. Assessment of chemical composition of fruits was done on fresh fruit, blanched, frozen, baked and fried breaded banana. The chemical composition of the breaded bananas differed at different stages of processing. The major component of breaded banana was carbohydrate. The chemical composition of the fried breaded such as protein showed that some values of the component have changed due to high oil temperature. Fried breaded banana had relatively lower moisture and higher fat content compared to frozen breaded banana.

Introduction

Breaded food products have long been popular consumer items. Coating seafood, poultry, red meat and vegetable products with a batter and/or breading before cooking is a common practice of homemakers, food processors and commercial food establishments. Recently, the relative importance of coatings has shifted from the homemaker to use in restaurant and fast-food outlets. That change is reflected in 1978 figures, which showed Americans spent more than 20 billion dollars at franchised chicken restaurants, twice as much as was spent 5 years previously (Anon. 1979). The importance of batters and breading for poultry has also increased due to the increased popularity in fried chicken.

Breaded fruits are another portion of battered and breaded foods. Breaded fruits may be battered, crumbed or both; when frozen in ready-to-cook form, they offer a convenience food widely valued by the consumer. Previous studies by Zainun (2000) and Hasimah et al. (2002) have shown that breaded fruits are highly acceptable and their taste and texture were as original as fresh fruits.

This coating-freezing technology can be used to produce a new type of healthy frozen banana products made with real banana cuts, thus providing the taste and texture of the original banana. The products packed in high density polyethylene or aluminium laminate bags can be kept at least for one year at –20 °C (Zainun 2004).

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Consumption of breaded banana is a novel way to increase consumption of fruits in daily diet especially for children. The frozen products are convenient, ready-to-cook and easily prepared. Busy housewives can prepare the products in a short time regardless of fruit season. It offers a healthy choice for consumers as an alternative to meat or poultry-based nuggets.

Banana is also high in dietary fibre. Increased intake of dietary fibre has been recommended to protect against high blood pressure, bowel disease, obesity, stroke and diet-related cancers. Thus, the consumption of fruit-based products would benefit the population as it would help to increase the intake of fruits in diet.

Preliminary studies indicated that the product developed has its own unique banana taste and flavour and is comparable to banana fritters which were prepared traditionally (Zainun 1999). Thus, this study was to investigate the effects of processing on the physico-chemical characteristics, microbiological qualities and acceptance of breaded banana made from Nangka variety.

Materials and methods

Preparation of batter

Batters were prepared by dry blending 35.2% flour mixture (wheat and corn) and 0.8% seasonings for 5 min in a Hobart N-50 mixer with a paddle mixing attachment. The optimum amount of water was added to the preblended dry ingredients and mixed for 30 sec in a Hobart N-50 with a whisk attachment at first speed. Bowl sides were scrapped down, and the batter was mixed for an additional 1 min on second speed. The batter temperature was kept at room temperature.

Production of breaded banana

Firm ripe bananas of variety Nangka were purchased from a plantation in Beranang, Selangor. Bananas were cut from comb, washed and steam blanched for 20 min. The blanched bananas were cooled, peeled and cut vertically across the length of the fruits into halves. The banana pieces were battered with a mixture of flour and water (ratio 1:1.18) and then coated with breadcrumbs.

The breaded products were then blast frozen to –18 °C and packed in high density polyethylene bags until evaluation. Each pack contained 250 g of breaded bananas. The frozen products were divided into 2 lots: (i) fried at 170 °C for 3 min in palm olein oil and (ii) baked in a conventional oven at 120 °C for 15 min for evaluation. These frying and baking parameters were established in earlier preliminary work (Zainun and Hasimah 1997).

Physico-chemical characteristics

Physical characteristics of each fruit measured were fruit weight, fruit length, fruit circumference and fruit pulp colour. A digital balance was used to measure fruit weight. The yield percentage of edible portion of fruits, the pulp to peel ratio, the average weight of fruit pulp before and after battering and breading (B/B) and the percentage coating pick-up B/B mix were recorded. Each measurement was carried out in duplicate on two batches of samples for 15 fruits.

The amount of batter and breadcrumb adhering to a banana piece was considered battering and breading pick-up. This was measured by: (a) weighing a towel-dried, blanched banana piece, (b) dipping the banana piece into a fully mixed batter, (c) allowing the banana piece to drain for 5 sec, (d) coated the banana piece with breadcrumbs, and then (e) weighing the coated and breaded banana piece. Final values were reported as percentages of battering and breading pick-up.

Total soluble solids and pH

The fresh banana was homogenized into puree. The total soluble solids (TSS) and pH were determined using Atago hand held refractometer and an Orion pH meter respectively.

Colour intensity
Fruit flesh colour was measured using Chroma meter CR300 (Minolta Camera Co.). Fruit flesh surface was measured individually and recorded in terms of coordinates L*, a* b* (CIE L* a* b* system), where L* indicates lightness or darkness, a* indicates chromaticity on a green to red colour space and b* indicates chromaticity on a blue to yellow colour space. For fresh banana, colour readings were obtained for the top, middle and bottom sections of the banana fruit flesh for each of the 15 fruits. For the frozen and fried breaded bananas, colour determination was conducted on the 10 pieces of fruits cut coated surface. The average mean values of L* a* b* for each fruit were recorded and the results averaged.

Chemical analysis
Chemical analysis was carried out on the fresh banana, frozen and fried breaded fruits. Samples were taken and analysed for moisture, protein, fat and ash using AOAC method (AOAC 1990) while crude fibre was analysed using Tecator method (Tecator 1978). Total sugars were determined by extraction of homogenate sample with 80% warm ethanol according to AOAC method (AOAC 1995). The amount of sugars was analysed by titrating the extract with boiling Fehlings solution (Ranganna 1977). Result was expressed as percentage of total sugar (as invert sugar). Each analysis was carried out in duplicate on one batch of samples for fresh fruit, blanched, frozen, baked and fried breaded bananas.

Carbohydrate was determined by means of difference. Energy values were calculated from protein, fat and carbohydrate results by multiplying the values by Atwater's factors 4, 9 and 4 respectively. Statistical analysis was used to determine significant difference between treatments or sample means. Data were analysed using Duncan Multiple Range Test (DMRT). The values obtained were tested using the t-test.

Microbiological analysis
Mirobiological was carried out in duplicate on frozen breaded banana using standard methods recommended by ICMSF (1978). The tests carried out included total viable counts (cfu/g), yeast and moulds counts (cfu/g), coliform (MPN/g), *Salmonella* in 25 g and *Staphlococcus aureus* in 0.1 g sample.

Sensory evaluation
The samples were assessed for colour, flavour, texture, taste and overall acceptability by a 25-member taste panel using a 9-point hedonic rating scale, where 1= dislike extremely and 9 = like extremely. The products were presented to the panellists after frying to golden yellow colour in refined palm oil at 170 °C for 3 min. The sensory data was subjected to two way analysis of variance (Larmond 1977) and the difference between the means was analysed by DMRT.

Results and discussion
Physico-chemical quality of fresh banana
The size and weight of banana fruit varies from one variety to another. The physico-chemical characteristics of fresh Nangka banana used in this study were:

Weight: 142.82 ± 0.95 g
Length: 17.00 ± 0.76 cm
Cicumference: 11.50 ± 0.54 cm
Edible portion: 63.98 ± 0.25%
Pulp: peel: 63.98 : 36.02
TSS: 23.00 ± 0.38 °Brix
pH: 4.30 ± 0.08

The percentage recovery of edible portion of Nangka banana is significantly high compared to Abu banana due to its thinner skin (Zainun 2003). This is indicated by its high pulp to peel ratio. Higher ratio indicates the skin is thinner while lower ratio means peel takes a larger proportion of the weight, i.e. the skin is thick.

The percentage pick-up of batter breading mix of Nangka banana was significantly higher than Gading banana

but the percentage was lower than observed in Abu banana (Zainun 2004). Due to its intermediate surface area, the percentage pick-up of batter breading mix of breaded Nangka banana was approximately 21.5%. The recovery of frozen breaded Nangka bananas was 72.7% (based on weight of fresh banana) for manual methods of battering and breading whereas with mechanized battering and breading operations, recovery was 77.9% (double coating).

This cooking variety banana was found suitable for processing into breaded banana as well as bulk processing and handling due to its thick skin and firm texture compared to dessert varieties such as Berangan, Raja and Mas which are usually eaten fresh. The dessert banana can also be used for making breaded banana, but the finished product is inferior in quality. This was due to their texture being less firm and oilier after frying. Apart from that, they easily get bruised during transportation and handling.

The TSS of the fruit was moderately high (23 ± 0.38 °Brix). This value coincides with moderately high total sugar content of the banana fruit (17.9%) (*Table 1*). The result revealed that the TSS content and the total sugar content of the fresh banana were significantly correlated. The composition of fresh Nangka banana was almost similar to that reported by Tee et al. (1997). Generally, it can be observed that fresh banana contained low amount of moisture content as to pineapple (87.8%), soursop (82.0%) and rambutan (84.7%) (Tee et al. 1997). As a result, the fruit pulp was not watery although it is quite sweet.

Effect of processing on the physico-chemical characteristics of breaded bananas

There was a significant difference in moisture content between fresh Nangka and blanched Nangka banana (*Table 1*). However, there were no significant effect of protein, fat, crude fibre and ash content after blanching treatment. This indicated that the short steam blanching was a mild heat treatment that only caused an increase in moisture content of the banana cuts. The increase in moisture content of blanched Nangka probably due to the migration of water molecules from the steam into the fruit cells.

Upon freezing, there was no significant change in terms of moisture content in breaded banana as compared to the fresh Nangka. This is expected in frozen breaded fruit because breadings protected the inner part of the products during freezing especially from freezer dehydration due to high air velocities. Conversely, breadings have an insulating effect on the products since they have lower thermal conductivities than those fruits.

The amount of fat in frozen breaded banana was 0.07%, which was significantly higher than those obtained in fresh and

Table 1. Chemical composition of fresh banana and breaded banana before and after frying

Chemical composition	Fresh banana	Blanched banana	Breaded banana		
			Frozen	Fried	Baked
Moisture (%)	67.55 ± 0.13b	71.47 ± 0.04c	69.85 ± 0.30c	66.33 ± 0.08b	64.54 ± 0.18a
Protein (%)	2.32 ± 0.04a	2.38 ± 0.05a	2.37 ± 0.06a	2.22 ± 0.01a	2.31 ± 0.10a
Total fat (%)	0.02 ± 0.01a	0.04 ± 0.03a	0.07 ± 0.01a	7.91 ± 0.00c	0.13 ± 0.06ba
Ash (%)	1.16 ± 0.01a	0.95 ± 0.01a	1.61 ± 0.02b	1.77 ± 0.16b	2.17 ± 0.13c
Crude fibre (%)	0.58 ± 0.00b	0.51 ± 0.01b	0.43 ± 0.00a	0.54 ± 0.10a	0.74 ± 0.12c
Total sugars (%)	17.92 ± 0.17c	12.10 ± 0.02b	9.52 ± 0.34a	9.77 ± 0.16a	11.55 ± 0.18b
Total carbohydrate (%)	28.95 ± 0.01d	25.46 ± 0.04b	26.40 ± 0.03b	21.77 ± 0.46a	30.85 ± 0.23d
Energy (kcal/100 g)	125.26 ± 0.13b	111.72 ± 0.29a	115.71 ± 0.38a	167.15 ± 1.86d	133.81 ± 1.24c

Means in the same row followed by the same letter are not significantly at $p < 0.05$

blanched sample. This indicated that the batter and breadcrumbs contributed to the fat content in the frozen breaded bananas.

Frying process resulted in lesser weight loss of breaded banana compared to baking process (*Table 1*). This is due to the absorption of the frying medium into the batter and breadcrumb of the breaded products, which imparts an additional moistness and fattiness to the foods. According to Varela (1988), oil absorption occurs as moisture is removed from the food during frying thus increased fat content in the fried products as indicated by higher fat content as in the case of these breaded bananas. There was significant decrease in moisture content and significant increase in fat content of the breaded Nangka banana. This is considered quite normal in frying process.

Frying involves heat and mass transfer as well as interaction between the food and the frying medium. At the beginning of frying process, the outer surface contains both free and bound water. When the food is exposed to the high temperature of the frying process, moisture initially evaporates and its concentration decreases rapidly. The outer surface becomes dry, creating a crust that is a diffusion barrier. The inner moisture is converted to steam, causing a pressure gradient. The steam finds selective capillaries and channels in the cellular structure and escapes through these pores. As this process progresses, oil may adhere to the food and enter the voids left by the water. The amount of oil uptake has been shown by Rice and Gamble (1989) to be directly proportional to the amount of moisture lost.

The crumb structure and/or the particle size of the breadcrumb also affect the amount of fat absorbed. As a result, fried breaded banana becomes fat-enriched to an extent which depends on the fat content of the raw banana. This fat supplement increases the energy content of the breaded banana. According to Varela (1988), this could assist transport of liposoluble components such as unsaturated fatty acids and possibly liposoluble vitamins.

However, the fat content of the fried breaded Nangka bananas (7.91%) was still considerably lower that banana fritters (14–17%) (Zainun 1999), fried coated cempedak (9.7%) (Zainun 2000), fried breadcrumb coated pineapple (8.0%) (Hasimah et al. 2002), uncooked beef burger patty (15.8%) (Tee et al. 1977), as well as fried commercial chicken nuggets (34%) (Chuah 1998) and fried low fat chicken nuggets (23.6–24.5%) (Chuah 1998). This is because freezing prior to frying can decrease oil uptake in breaded bananas during frying. This result in agreement with Weaver et al. (1975), who found that freezing prior to frying lessen fat uptake in french fries. Since frozen breaded banana contains low fat, it could be taken as alternative snack besides banana fritters, beef patties or chicken nuggets.

Frying process also resulted in a significant change in the protein content of fried breaded bananas. This is because during deep fat frying, heat is transferred from the surrounding oil to the interior of breaded bananas. As a result, several chemical and physical changes occur, including starch gelatinization and protein denaturation.

There was no significant difference in colour between the fresh banana pulp and the frozen breaded banana. They were more yellow than green as indicated by low negative a* value and high positive b* value (*Table 2*). The colour of the breaded banana depends on the original colour of the breadcrumbs which is almost similar with the banana pulp. This can be seen from the L*, a* and b* values of the breadcrumbs. However, frying significantly affected the colour intensity of breaded bananas as observed in L*, a* and b* values. Fried breaded bananas became darker, yellower and redder with frying.

Table 2. Colour of fresh banana, frozen and fried breaded banana

Products	L* (lightness)	a* (chromaticity coordinate)	b* (chromaticity coordinate
Fresh banana flesh	74.87 ± 2.72a	–0.35 ± 0.72a	+29.63 ± 0.55a
Frozen breaded banana	62.66 ± 2.54b	–2.32 ± 1.35b	+23.90 ± 3.83b
Fried breaded banana	52.54 ± 1.68c	–4.24 ± 0.48c	+26.79 ± 2.75c

Mean of 15 pieces
Means in the same column followed by the same letter are not significantly different at $p < 0.05$

Table 3. Sensory evaluation score of breaded banana

Sensory attribute	Fried	Baked
Colour	7.20 ± 0.87a	6.80 ± 0.95b
Flavour	7.10 ± 0.64a	6.86 ± 0.73b
Texture	7.35 ± 0.46a	6.95 ± 0.76b
Taste	7.20 ± 0.60a	6.74 ± 0.56b
Overall acceptability	7.30 ± 0.58a	6.94 ± 0.62b

Mean scores of 25 taste panellists
Means in the same row with the same letter are not significantly different at $p < 0.05$

Effect of processing on microbiological quality of breaded banana

Microbiological studies indicated that the five groups of microorganism studied were very low or not detected at all from the samples analysed. This indicated that the products were microbiologically acceptable. Levels of *coliform* are often used for monitoring the sanitary conditions under which food is processed. Coliform was not detected in the breaded bananas stored at –18 °C. Absence of coliform in samples indicated that the product was processed hygienically.

The breaded bananas were analysed for the presence of *Salmonella* sp. both before and after frozen. This food-borne pathogen was not isolated from any of the frozen and unfrozen breaded banana tested. This null result does not suggest, however, that these breaded bananas are completely pathogen free, but it does indicate that the prevalence of these pathogens in these breaded banana samples is very low (<0.8%).

Breaded and battered bananas themselves do not pose health hazard problems. It is how these breaded products are treated during processing, storage, distribution, sale, cooking and consumption that determines the safety of these food items

Effect of processing on sensory quality of breaded banana

Breaded bananas were analysed for sensory qualities after frying and baking by the panel members for colour, flavour, texture, taste and overall quality. Panellists showed a significant liking for the colour, texture, flavour, taste and overall acceptance of fried breaded bananas compared to baked breaded bananas (*Table 3*). Their golden yellow colour, firm texture and pleasant banana taste had attracted the attention of the panel members. This could be due to the heat transferred from oil into the fruits caused crust formation which was responsible for colour and flavour development during the frying process.

Crust is the most palatable characteristics of fried food. According to Dagerskog (1977), when most of the

water on the surface and inside the food has evaporated, the surface temperature rises to that of the frying medium which, owing to a series of Maillard-type reactions, makes the outsides of the food turn golden brown and form a crust. This coincides with the findings of Rosana et al. (1995) who suggested that formation of crust is related to the Maillard reaction, a reaction between reducing sugar and amino acids. The frying medium (oil) also offers special properties including flavour and smoothfeel of the product that improves the overall breaded bananas palatability.

Consumers are looking for food of good appearance and with an attractive odour, texture and flavour. One of the sensory attributes of fried food is crispiness of texture, particularly crispness of surface texture. Frying is the only method of cooking where the heat transfer medium adds to the attractiveness of the product flavour. The lipid material becomes part of the end product. Fat also has a lubricating effect during chewing and swallowing. In addition, fried products are usually best when freshly cooked; frying is a quick, high temperature process which requires little preparation and hence is very acceptable for both consumers and caterers alike.

Conclusion

Fried breaded Nangka bananas have excellent qualities and were found to be as original as banana fritters that were prepared traditionally in terms of colour, taste, texture and flavour. The sensory attributes of importance to breaded banana such as texture, crispiness, flavour and appearance are well accepted.

They are alternative to meat or chicken-based nuggets and alternative way to introduce more fruits into the diet. Development of breaded banana will certainly be a help for local food processors to diversify their lines which in turns provides more choices for the consumers.

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Abstrak

Pisang bersalut (*Musa* sp.) telah disediakan daripada pisang varieti Nangka dengan mencelup kepingan pisang yang telah menjalani proses prarawatan di dalam bater yang mengandungi tepung gandum, tepung jagung, bahan perisa dan air sebelum disalut dengan serdak roti dan disejuk beku. Produk ini disimpan sejuk beku pada suhu –18 °C. Produk ini digoreng di dalam minyak kelapa sawit pada suhu 170 °C selama 3 minit, atau dibakar di dalam ketuhar pada suhu 120 °C selama 15 minit, selepas dikeluarkan terus dari peti sejuk sebelum dihidangkan. Penilaian komposisi kimia dijalankan terhadap buah pisang, pisang celur, pisang bersalut sejuk beku, pisang bersalut bakar dan pisang bersalut bergoreng. Komposisi kimia pisang adalah berbeza pada setiap langkah pemprosesan. Komposisi utama pisang bersalut ialah karbohidrat. Komposisi kimia pisang bersalut bergoreng menunjukkan beberapa komposisi kimia seperti protein telah berubah disebabkan oleh suhu minyak yang tinggi semasa proses penggorengan. Pisang bersalut bergoreng mengandungi kandungan lembapan yang rendah dan kandungan lemak yang tinggi berbanding dengan pisang bersalut sejuk beku.

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