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Physico-chemical, nutritional and organoleptic properties of coated Gandul pineapple developed with different coatings

(Ciri fiziko-kimia, zat pemakanan dan nilai rasa nanas Gandul bersalut yang dihasilkan dengan berlainan bahan salut)

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Key words: pineapple, physico-chemical properties, nutritional properties, organoleptic properties, processing, coatings

Abstrak

Nanas varieti Gandul telah diproses menggunakan kaedah salut dan sejuk beku bagi menghasilkan produk nanas bersalut sejuk beku. Prestasi empat jenis bahan salut serta kesan pemprosesan terhadap ciri fiziko-kimia, zat pemakanan dan nilai rasa produk telah dikaji. Adunan tepung dan bahan salut menyumbang pada kandungan lemak produk bersalut sejuk beku. Produk yang bersalut reroti mengandungi karbohidrat dan nilai tenaga yang tertinggi antara produk-produk bersalut sejuk beku yang dihasilkan. Produk yang bersalut oatbran, wheatgerm dan wheatbran mengandungi vitamin B1, vitamin B2, vitamin C, kalsium, kalium, ferum dan jumlah serat dietari yang lebih tinggi daripada produk yang bersalut reroti. Dari aspek kesihatan, nanas bersalut oatbran, wheatgerm dan wheatbran mempunyai nilai pemakanan yang lebih daripada nanas bersalut reroti.

Abstract

Pineapple variety, Gandul was processed using coating and freezing methods in the development of frozen coated pineapple products. The performance of four types of coatings as well as the effect of processing on the physico-chemical, nutritional and organoleptic properties were studied. The batter and coating materials contributed to the fat content in the frozen coated products. Among the frozen coated products developed, breadcrumb-coated product had the highest carbohydrate and energy values. Oatbran, wheatgerm and wheatbran-coated products had higher values of vitamin B1, vitamin B2, vitamin C, calcium, potassium, iron and total dietary fibre compared to breadcrumb-coated product. This indicated that oatbran, wheatgerm and wheatbran-coated pineapple offer healthier benefits than breadcrumb-coated pineapple.

Introduction

A pineapple-based product was developed with the aim of diversifying the use of fruits in processed products. It was also intended to provide more variety of fruit products to consumers of all age groups, especially as fruits and vegetables are able to provide many essential vitamins and minerals and

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are rich in fibre (Tee and Khatijah 2001). The nutritional advantage of fruits and vegetables is that they offer a high concentration of nutrients but low calories and fat.

A joint study of the Harvard School of Public Health and WHO reported that the top causes of death in 1990 was due to heart disease and stroke. Their study postulated that by 2020 the top causes of death would also be due to heart disease, stroke and other non-communicable diseases, including cancer (Choong 1999). Previous studies (Negri et al. 1991; Huang et al. 1994) have demonstrated that greater fruit and vegetable consumption is associated with reduced risk of some types of cancer. Thus the development of fruit-based products would benefit the population as it would help to increase the intake of fruits in the diet. This is especially important as Malaysian children's food intake had been reported to be low in fruits and vegetables (Zanariah et al. 1986, 1993). The Malaysian Food-based Dietary Guidelines under the National Plan of Action on Nutrition has also recommended an increase in fruit and vegetable consumption for all Malaysians above two years of age (Zanariah 1999).

Preliminary work was conducted with easily available pineapple varieties such as Sarawak, Moris and Gandul in the development of frozen coated pineapple. Gandul is currently the most widely grown variety used for canning in Malaysia while Sarawak and Moris are for fresh consumption. It was found that the Gandul variety was more suited for mechanisation operations due to its uniform shape, which is an important criterion in the selection of materials for processing. The other two varieties can also be used for making coated fruit but recovery rate was lower upon mechanical deskinning. Hence, Gandul was chosen as the base material for this study. Different types of coating material were used to diversify the products as well as to study the effect on the nutritional composition of the product. Different methods of cooking the product namely baking and frying were also compared.

The main objective of the study was to determine the performance of different coatings and the effect of processing stages on the physico-chemical and nutritional properties of coated pineapple products. The study was also to evaluate the organoleptic acceptability of the developed products.

Materials and methods

Gandul pineapples of maturity index 1 were obtained from a farm in Pontian, Johor. The fruit crown and peduncle were removed and the length, width and circumference of the fruit were measured using a ruler and a string. The weight was measured using a digital weighing scale.

The skin and eyes of the fruits were removed manually. The fruits were then cut into rings of approximately 1 cm thickness along the length of the fruit. The rings were further cut into wedges of approximately 10 g each. The wedges were blanched for 2 min, soaked in 30° Brix syrup overnight, drained, battered with a mixture of flour and water (ratio 1:1.15), and then coated with either commercial breadcrumbs, oatbran, wheatgerm or unprocessed wheatbran. Oatbran, wheatbran and wheatgerm were used as coating materials due to their nutritional benefits (Kent 1980; Bond 1981; Storch et al. 1984; Sosuliki and Wu 1988; Andersen et al. 1991; Klont 1999).

The products were then packed in high density polyethylene bags, sealed and blast frozen to -18 °C. The products were either fried at 190 °C for 2 min in palm olein or baked at 150 °C for 30 min in a convectional oven for evaluation. These cooking parameters were established in earlier preliminary work.

The fresh pineapple as well as the blanched and soaked pineapple were homogenised into puree. The pH and total soluble solids were determined using an Orion pH meter and Atago hand held refractometer respectively.

Determination of colour was carried out on the four types of coating material as well as the fresh and processed Gandul pineapple. Colour was measured using a Chroma meter CR300 (Minolta Camera Co.) based on the CIE 1976 L*a*b* colour system. The equipment was calibrated using a white tile for the Y, x, y values of 92.5, 0.3134 and 0.3194 respectively. For fresh pineapple, 15 fruits were cut in half longitudinally. Colour readings were obtained for the top, middle and bottom sections of the flesh for each of the 15 fruits and the results averaged. For the processed pineapples, colour determination was conducted on the 15 pieces of wedges for each type of coating material.

Samples were taken and analysed for moisture, protein, crude fibre, fat, ash, vitamins B1, B2, C, calcium, potassium, iron, total dietary fibre and carotene. Moisture, ash, fat, calcium, potassium and iron were determined by AOAC methods (1990). Total dietary fibre was analysed by an accredited company Applied Chemie Consultancy (M) Sdn. Bhd. according to the method by AOAC (1993). Crude fibre was determined using Tecator (1978) method, protein by Tecator (1987) method while vitamins B1, B2 and carotene by Tee et al. (1996) methods. Vitamin C was determined by FAO (1986) method. Each analysis was carried out in duplicate on one batch of sample. Carbohydrate was calculated by subtracting the values of moisture, protein, crude fibre, fat and ash, from 100. Energy values were calculated from protein, fat and carbohydrate results by multiplying the values by Atwater's factors 4, 9 and 4 respectively.

For data analyses of the above, the SAS (Statistical Analysis System) programme release 8.01 was used (SAS Institute Inc. 2000). The values obtained were tested using the t-test.

Organoleptic evaluation was carried out on the products after 2 days of storage. Two separate evaluations were carried out:

a) to compare baked against fried breadcrumb-coated pineapple
b) to compare the baked products made with the four types of coatings

The products were either fried at 190 °C for 2 min in palm olein or baked at 150 °C for 30 min in a convectional oven. The quality attributes assessed by 25 taste panelists were colour, texture, taste and overall acceptability. A nine point hedonic rating scale ranging from 1 (dislike extremely) to 9 (like extremely) was used (Larmond 1977). The mean score of each quality attribute was used as a measure of product acceptance. A two-way analysis of variance (ANOVA) was conducted for all quality attributes of the samples to determine the significant difference between the treatments. The sources of variation shown to be significant by ANOVA were further tested using least significant difference test to estimate which means were statistically different.

Results and discussion

Physical characteristics of fresh Gandul pineapple are as follows: length 17.44 ± 0.86 cm, width 12.54 ± 0.63 cm, circumference 40.54 ± 1.27 cm and weight 1.60 ± 0.17 kg, based on 25 fruits. Gandul variety has a fairly uniform circumference over the whole fruit length as compared to other varieties such as Sarawak, Moris and Pernambuco which are tapered fruits, making them unsuitable for processing with machines as the recovery rate is low. Abd. Shukor et al. (1998) also reported that the Gandul variety is recommended for processing and is currently the most widely grown pineapple variety for canning in Malaysia.

The composition of Gandul pineapple was almost similar to that reported by Tee et al. (1988) i.e. 87.8% moisture, 0.5 g protein, 0.1 g fat, 0.6 g fibre, 0.4 g ash, 10.6 g carbohydrate and 45 kcal energy per 100 g edible portion *(Table 1)*. There was a significant difference in moisture content between fresh Gandul and blanched Gandul but not in protein, crude fibre, fat and ash

Table 1. Proximate analysis of fresh, blanched and coated Gandul pineapple

Sample/treatment	Moisture (%)	Protein (%)	Crude fibre (%)	Fat (%)	Ash (%)	Carbo-hydrate (%)	Energy (kcal/ 100 g)
Fresh Gandul	89.18 ± 0.07a	0.53 ± 0.03f	0.75 ± 0.08de	0.06 ± 0e	0.24 ± 0.03f	9.24h	40i
Blanched Gandul	87.27 ± 0.10b	0.59 ± 0.01f	0.58 ± 0.02e	0.05 ± 0e	0.25 ± 0.01f	11.26h	48h
Frozen Gandul with breadcrumb coating (BC)	64.03 ± 0.10e	3.04 ± 0.06d	0.54 ± 0.01e	0.56 ± 0.01d	0.54 ± 0.03e	31.29e	142e
Frozen Gandul with oatbran coating (OB)	65.49 ± 0.13d	3.03 ± 0.03d	1.07 ± 0.08bc	1.23 ± 0.04c	0.69 ± 0.01d	28.49f	137f
Frozen Gandul with wheatgerm coating (WG)	65.94 ± 0.08d	6.04 ± 0.03b	1.16 ± 0.17b	1.65 ± 0.04b	1.06 ± 0.01b	24.14g	136f
Frozen Gandul with unprocessed wheatbran coating (WB)	72.29 ± 0.03c	2.11 ± 0.07e	1.41 ± 0.16a	0.31 ± 0.06de	0.81 ± 0.02c	23.07g	104g
Fried BC	58.43 ± 0.09f	3.12 ± 0.66d	0.90 ± 0.01cd	7.96 ± 0.50 a	0.57 ± 0.01e	29.02f	200a
Baked BC	57.00 ± 0.66g	3.36 ± 0.35d	1.01 ± 0.07bc	0.18 ± 0e	0.76 ± 0.02c	37.69b	166c
Baked OB	50.63 ± 0.01i	4.55 ± 0.29c	0.72 ± 0de	1.06 ± 0.12c	0.81 ± 0.04c	42.23a	197a
Baked WG	53.49 ± 0.07h	8.27 ± 0.42a	1.55 ± 0.04a	1.88 ± 0.11b	1.46 ± 0.10a	33.35d	183b
Baked WB	59.69 ± 0.32f	3.53 ± 0.69d	1.61 ± 0a	0.05 ± 0.01e	1.08 ± 0.02b	34.77c	151d

Means in the same column followed by the same letter are not significantly different ($p < 0.05$)

contents. This indicated that the short blanching process was a mild heat treatment that caused only a loss in moisture from the pineapple wedges.

Upon blanching and soaking of the pineapple in syrup, the pH of the pineapple wedges did not change very much compared to the fresh Gandul. However, the total soluble solids increased significantly due to the exchange of the higher concentration of sugar molecules in the syrup with water in the fruit cells during the soaking process *(Table 2)*. This increase in total soluble solids indicated an increase in sweetness of the pineapple wedges.

Frozen oatbran-coated Gandul had the lightest colour compared to fresh Gandul while the wheatgerm-coated had the darkest colour. This was reflected by the L* values obtained *(Table 3)*. Frozen Gandul coated with breadcrumb was more red and more yellow than the other samples, and this was reflected by the a* and b* values respectively. The colour of the coated pineapple depends on the original colour of the coatings. This can be seen from the L*a*b* values for the different types of coating which are nearly the same as the values for the different coated fruits *(Table 4)*.

Table 2. pH and total soluble solids of fresh and semi-processed Gandul pineapple

	Fresh pineapple	Blanched and soaked pineapple
pH	3.44 ± 0.14a	3.32 ± 0.06a
Total soluble solids (Brix)	10.5 ± 0.58b	19.38 ± 0.48a

Mean of 4 batches consisting of 3 fruits per batch. Means in the same row followed by the same letter are not significantly different (p <0.05)

Table 3. Colour of fresh and processed Gandul pineapple

	L* (lightness)	a* (chromaticity coordinate)	b* (chromaticity coordinate)
Fresh Gandul flesh[1]	71.97 ± 2.41b	−4.15 ± 0.30d	+26.41 ± 2.10b
Frozen Gandul with breadcrumb coating[2]	70.55 ± 3.30b	+10.35 ± 1.12a	+36.15 ± 3.75a
Frozen Gandul with oatbran coating[2]	77.76 ± 1.87a	n +1.99 ± 0.27c	+16.13 ± 1.51e
Frozen Gandul with wheatgerm coating[2]	61.44 ± 2.09d	+5.75 ± 0.68b	+23.30 ± 2.56c
Frozen Gandul with unprocessed wheatbran coating[2]	65.91 ± 2.95c	+5.76 ± 0.67b	+21.41 ± 1.66d

[1]Mean of 45 readings conducted on 15 fruits
[2]Mean of 15 pieces
Means in the same column followed by the same letter are not significantly different (p <0.05)

Table 4 . Colour of different types of coating used for processing of Gandul pineapple

Coating	L* (lightness)	a* (chromaticity coordinate)	b* (chromaticity coordinate)
Breadcrumb	67.06 ± 1.28	+11.56 ± 0.34	+42.90 ± 0.54
Oatbran	76.79 ± 0.87	+2.72 ± 0.28	+19.77 ± 1.65
Wheatgerm	62.17 ± 0.64	+4.52 ± 0.31	+25.83 ± 0.65
Wheatbran	70.61 ± 0.58	+5.30 ± 0.23	+22.52 ± 0.84

Mean of 15 samples

Frozen coated pineapple

Moisture content for the four frozen coated products ranged between 64.03% and 72.29% *(Table 1)*. This is significantly lower than the moisture content of both the fresh and blanched Gandul. The lower moisture content was due to the contributory effect of subsequent processes following blanching namely soaking, coating and freezing. It was also probably due to the migration of water molecules out of the fruit cells when the pineapple wedges were soaked in syrup and also partly due to the coating process whereby drier coating material was added to the product. The soaking process was to improve the taste of the product.

Fat contents of frozen coated pineapple ranged between 0.31–1.65% which were significantly higher than the fresh or blanched Gandul. This indicated that the batter and coating materials contributed to the fat content in the frozen coated products. Compared to uncooked beef burger patty (15.8%) (Tee et al. 1997) or commercial uncooked chicken nuggets (30.4%) (Chuah 1998), the fat contents of these frozen coated products were much lower. Hence, frozen coated pineapple products could be healthier alternatives to beef patties or chicken nuggets as snacks. Among the frozen coated products, wheatgerm-coated product had the highest protein content while the breadcrumb-coated product had the highest carbohydrate and energy values.

Oatbran, wheatgerm and wheatbran-coated pineapple products had higher values of vitamin B1, vitamin B2, vitamin C, calcium, potassium, iron and total dietary fibre compared to breadcrumb-coated pineapple indicating that those products offer healthier benefits than breadcrumb-coated pineapple *(Table 5)*. The wheatgerm-coated product had the highest levels of vitamin B2, vitamin C, potassium, iron and carotene.

All the four products are high fibre products (containing more than 6% total dietary fibre) based on the definition of Codex Alimentarius draft table of conditions

Table 5. Vitamin, mineral and total dietary fibre contents of frozen Gandul pineapple coated with different coatings

Coating	Vit. B1	Vit. B2	Vit. C	Calcium	Potassium	Iron	Total dietary fibre (%)	Carotene (µg/ 100 g)
	(mg/100 g)							
Bread crumb	0.03 ± 0d	0.03 ± 0d	1.00 ± 0.10 b	5.76 ± 0.10d	89.70 ± 5.30d	0.44 ± 0.02d	8.74 ± 0.20d	29.89 ± 0.18c
Oatbran	0.12 ± 0a	0.04 ± 0c	1.74 ± 0.02 a	9.55 ± 0.10c	130.95 ± 0.20c	0.90 ± 0.02c	13.23 ± 0.50c	20.17 ± 0.03d
Wheatgerm	0.10 ± 0b	0.15 ± 0a	1.87 ± 0.13 a	10.52 ± 0.02b	263.42 ± 3.21a	1.54 ± 0.1a	16.47 ± 0.30b	50.14 ± 0.42a
Wheatbran	0.04 ± 0c	0.05 ± 0b	1.04 ± 0.13 b	11.27 ± 0.04a	179.85 ± 1.27b	1.04 ± 0b	31.29 ± 0.22a	30.22 ± 0.12b

Means in the same column followed by the same letter are not significantly different (p <0.05)

for dietary fibre content for the term "high fibre" (Codex Alimentarius Commission 2001). Wheatbran-coated product had the highest total dietary fibre content of 31.3%. These products can help to increase dietary fibre intake in the diet and contribute to the general health as fibre functions in aiding the passage of food through the body and ensuring the efficient elimination of natural waste (Bond 1981). Fibre has also been associated in epidemiological studies with a reduction in risk in most dietary problems including cancer, coronary disease, diabetes and obesity such that it is now generally accepted as a marker for a healthy diet (Klont 1999, 2000).

Cooked coated pineapple

Fried breadcrumb-coated fruit had significantly higher fat content than baked breadcrumb-coated fruit *(Table 1)*. This was due to the oil being absorbed by the product during frying. As a result, the energy value of the fried breadcrumb-coated pineapple was also the highest among the products. Nevertheless, the fat content of the fried product (8.0%) was still considerably lower when compared to fried commercial chicken nuggets (34% fat) and fried low fat chicken nuggets (23.6–24.5% fat) which were reported by Chuah (1998). Baked coated pineapple contained between 0.1–1.9% fat. Among the baked samples, wheatbran-coated pineapple had the lowest energy value of 151 kcal/100 g.

All the developed products were acceptable to the sensory panelists with mean scores for all attributes being greater than 6 *(Tables 6* and *7)*. Fried breadcrumb-coated pineapple was significantly different from baked breadcrumb-coated pineapple in terms of colour, texture, taste and overall acceptability *(Table 6)*. The panelists gave higher scores to the fried product. Baked breadcrumb, wheatbran and wheatgerm-coated products obtained significantly higher overall acceptability scores compared to oatbran-coated products.

Table 6. Average scores for colour, texture, taste and overall acceptability of fried and baked breadcrumb-coated pineapple

Characteristic	Fried breadcrumb-coated	Baked breadcrumb-coated
Colour	7.80 ± 0.64a	7.18 ± 0.75b
Texture	6.70 ± 0.87a	6.40 ± 0.98b
Taste	6.98 ± 0.60a	6.48 ± 0.74b
Overall acceptability	7.14 ± 0.53a	6.64 ± 0.47b

Means in the same row with the same letter are not significantly different (p <0.05)

Conclusion

The pineapple coated products are convenient healthy snacks being high in dietary fibre and provide most of the vitamins and minerals. They are healthy alternatives to meat-based nuggets and an alternative way to introduce more fruits into the diet especially for children. Baked coated pineapple has lower fat content and as such is suitable as healthy snacks for the family.

Table 7. Average scores for colour, texture, taste and overall acceptability of baked coated pineapple made with different coatings

Characteristic	Wheatgerm	Breadcrumb	Wheatbran	Oatbran
Colour	7.28 ± 0.63b	8.14 ± 0.49a	8.24 ± 0.44a	6.92 ± 0.79c
Texture	6.16 ± 0.80a	6.18 ± 0.66a	6.20 ± 0.82a	6.30 ± 0.82a
Taste	6.80 ± 0.78a	6.70 ± 0.72ab	6.54 ± 0.73ab	6.48 ± 0.70b
Overall acceptability	6.78 ± 0.54a	6.88 ± 0.42a	6.82 ± 0.45a	6.48 ± 0.51b

Means in the same row with the same letter are not significantly different (p <0.05)

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