Food Research 5 (2) : 164 - 172 (April 2)
Journal homepage: http://www.myfoodresearch.com

FOOD RESEARCH

FULL PAPER

Physicochemical properties and sensory characteristics of ciku fruit (*Manilkara zapota*) pastilles

[1]Hashim, N.H., [1]Mohd Zin, Z., [1]Zamri, A.I., [2,3]Rusli, N.D., [4]Smedley, K.L. and [1,*]Zainol, M.K.

[1]*Faculty of Fisheries and Food Science, Universiti Malaysia Terengganu, 21030, Kuala Nerus, Terengganu*
[2]*Faculty of Agro-Based Industry, Universiti Malaysia Kelantan, Jeli Campus, 17600 Jeli, Kelantan, Malaysia*
[3]*Institute of Food Security and Sustainable Agriculture, Universiti Malaysia Kelantan, Jeli Campus, 17600 Jeli, Kelantan, Malaysia*
[4]*Stratford School, Stratford-upon-Avon, Warwickshire, CV37 9DH, United Kingdom*

Article history:
Received: 14 September 2020
Received in revised form: 18 October 2020
Accepted: 17 December 2020
Available Online: 14 March 2021

Keywords:
Antioxidant activity,
Pastille,
Ciku fruit,
Physicochemical properties

DOI:
https://doi.org/10.26656/fr.2017.5(2).510

Abstract

Ciku fruit *(Manilkara zapota),* also known as sapodilla is an exotic tropical fruit commonly eaten by Malaysians but not as popular as durians, rambutans, and bananas. Due to the short period of storage of ripened ciku fruits, making or converting it to a new end product such as pastille may promote the utilization and promote this tropical climate fruit and provide a wide range of products. Therefore, the purpose of this study was to develop ciku pastille and determine the physicochemical properties and sensory characteristics of ciku pastilles. A total of six formulations of ciku pastille were developed based on the different amounts of ciku purée (10%, 12%, 14%, 16%, 18% and 20% of ciku purée) added. The pastilles were analysed for their texture profile analysis (TPA), water activity (A_w), total soluble solids (TSS), colour analysis, pH, moisture content, ash, fibre and antioxidative activity. Results showed that formulation F (20% ciku purée) illustrated the highest value for moisture (18.59%), ash (2.43%), fibre (2.65%) and scavenging activity (36.58%). The production of this product is highly likely to be commercialised as no synthetic preservatives and artificial colouring were used. The ciku pastille was successfully developed with brownish-orange colour, round-shaped with a diameter of 1.0-1.2 cm, weighing approximately 1.2-1.5 g. Formulation B (12% ciku purée) has 62.7º Brix with pH 4.3, which had an acidic aftertaste and a water activity of 0.54. For colour analysis, L* value (59.76), a* value (23.71) and b* value (34.33) brought the brownish-orange colour for ciku pastille. Formulation B (12% ciku purée) was highly accepted by the panellists and retained its good texture and colour after being kept in the chiller for 2 months at below 18°C. The analysis, therefore, revealed that the physicochemical properties of the ciku pastille produced were enhanced and found to be rich in antioxidants and accepted by the panellists. Ciku fruit may consequently be a possible natural ingredient for pastille production, thus promoting its use in the food sector.

1. Introduction

Fruits play a significant role in human health by providing protection from exposure to high levels of free radicals and helping in the digestive system (Prior and Cao, 2000). They also provide a variety of antioxidants like vitamin C, polyphenols and carotenoids (Tungmunnithum *et al*., 2018). Little is known about the nutritional value of tropical fruits, especially the more exotic species (Mahatanatawee, 2011). According to the Third National Agricultural Policy (1998-2010), ciku is one of fifteen types of fruit identified for the development of the food industries, yet it has not been fully exploited (Aw, 2000). Ciku has been identified by the Ministry of Agriculture in Malaysia to be promoted under the programme for the development of its fruit industry (Bakar and Abdul Karim, 1994).

In general, an increasing trend has been observed over the last ten years on the use of Plant Genetic

*Corresponding author.
Email: *mkhairi@umt.edu.my*

Resources for Food and Agriculture (PGRFA) in Malaysia's crop improvement research including improvement of ciku fruits through selecting superior genotypes from the existing indigenous landrace (Nordin *et al.,* 2007). Even though ciku fruits are not as popular as other climacteric fruits, their potential in the food industry should not be denied. The rapid softening of fruits mainly results from the high activity of several oxidative enzymes and the release of ethylene (Arjona *et al.,* 1992; Bhutia *et al.,* 2011). Rapid ripening is characterized by a significant increase in the products of respiration and ethylene which makes it very difficult to conserve and market this fruit (Raja and Shanmugasundaram, 2019). Due to the short storage time of ripened ciku fruits, one of the alternative methods for retaining its use and nutrients is by making or converting it to a new end product (Benichou *et al*., 2018) such as pastille. Developing ciku fruit pastilles that maximizes the use of ciku fruits is required to promote this tropical climate fruit and provide a variety of healthy food products.

Gott (1985) cited the fact that pastilles are products made by reducing sugar to the desired state and then kneaded through the interaction of sugar syrup and colloidal materials. It is characterized as softer than gums but not as soft as jellies. Since people have now realized the importance of consuming natural food, they are keen to find the food that is processed but retains its nutrients. One of the processed food products that have high nutrients is pastilles. The research on pastille production using local fruit is hoped to produce healthier candy-like products containing natural fruit instead of high sugar, artificial colour and flavour and other food additives that could have long-term adverse effects on the human body. In addition, the study has good potential in increasing the variety of natural products on the market. It will also provide additional nutritional benefits to the consumer without losing the physical properties of the pastille which is gummy in texture. Therefore, the objective of this study was to produce pastilles containing ciku fruits and determine the physicochemical as well as the sensory acceptability of the product.

2. Materials and methods

2.1 Materials

Ciku fruits were obtained from Pasir Puteh, Kelantan, Malaysia. The fruits were blended in a mechanical food processor after undergoing washing, peeling and blanching processes. Ciku purée was packed in polyethylene plastics, sealed and stored at -21ºC. The frozen ciku purée was thawed at 4ºC for the production of ciku pastille. Generally, the major materials used to produce ciku pastille were ciku purée, glucose syrup, sorbitol and gelatine. The coating starch of pastille was made up of corn flour. Six formulations and one control were prepared based on the ratios of each different formulation (Table 1).

Table 1. Ingredients in ciku pastille formulation

Ingredients	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)
Ciku purée	10	12	14	16	18	20
Gelatine	15	13	11	9	7	5
Sorbitol	20	20	20	20	20	20
Glucose syrup	30	30	30	30	30	30
Gum Arabic	14	14	14	14	14	14
Water	7	7	7	7	7	7
Corn flour	3	3	3	3	3	3
Citric acid	1	1	1	1	1	1
Total (%)	100	100	100	100	100	100
Yields	200 g	200 g	200 g	200 g	200 g	200 g
Brix Value	62.5°	62.7°	63.6°	61.1°	67.3°	63.6°

2.2 Development of ciku pastilles

Ripe ciku fruits were rinsed to remove debris or impurities prior to washing with tap water and then simmering for 5 mins. To make ciku pastilles, the Gum Arabic solution was prepared by diluting the powder in water at a ratio of 1:70. Sorbitol and Glucose were heated to 120°C and cooled down to 75°C, before the addition of Gum Arabic solution and cornflour into the mixture of sorbitol and glucose syrup. Gelatine was dissolved with warm water (less than 50°C) before being added to the previous mixture and ciku purée was added. The mixture was then cooked for 10 mins while the Brix value was set at 60°Brix. Citric acid was then added to the cooled mixture (60°C). Finally, the mixtures were shaped into round shapes using a squeezer. At a temperature of 45°C, the formed pastilles were dried in an electric dehydrator for 4 hrs (Zainol *et al*., 2019).

2.3 Chemical analysis

The moisture, ash, fat, fibre and crude protein content of the ciku pastille were determined according to AOAC International (2007) standard procedures. All analyses were carried out in triplicate.

2.3.1 Antioxidant capacity using 2, 2-diphenyl-2-picrylhydrazyl hydrate (DPPH) assay

Approximately 0.1 mM solution of DPPH in methanol was prepared by dissolving 1.9 mg DPPH reagent in 100 mL methanol. The mixture was allowed to react by incubation in the dark (Malik *et al*. 2017). An aliquot of 4 mL from this solution was added to 10 mL of diluted extracts (50 mg sample in 100 mL distilled water), 10 mL of distilled water (control) and 10 mL of standard ascorbic acid, α-tocopherol and butylated hydroxyl toluene (BHT). All the prepared mixture was then left to incubate in the dark at room temperature for 60 min. The absorbance was then measured at 517 nm using UV-Vis spectrophotometer.

2.3.2 Determination of calorie content

The pastilles samples were dried overnight in the oven to remove all the moisture presents in them. Standards were measured before the samples to calibrate the bomb calorimeter. Approximately 1 g of sample was weighed after the drying and put in the specific pan. Precisely 2 L water was placed in the bucket inside the bomb bucket calorimeter's well. Ten centimetres of wire was placed in the slot. The bomb calorimeter was closed and the oxygen was pumped into the system to allow the combustion. The bomb was inserted into the bucket, the system was set and the machine was started. After the pre-fire, fire and post-fire session, the wire left was measured as the calorie content (Azuan *et al*., 2020).

2.4 Physical analysis

2.4.1 pH

The ciku pastilles were prepared by finely blending and homogenising approximately 5 g of ciku pastilles with 20 mL of distilled water. Prior to analysis, the pH meter was calibrated with standard buffer solutions of pH 7.0 and pH 4.0. The sample was placed in a beaker with a sufficient amount to cover the tip to get the most accurate reading. The pH was recorded and the electrode was removed from the sample. Distilled water was used to rinse the pH meter and blotted with a paper tissue. The probe was then kept in the buffer solution with pH 7.

2.4.2 Total soluble solid (TSS) analysis

Brix value was determined to check evaporation and concentration in order to assess the firmness of the products. It is based on the principle that light entering a prism has a unique characteristic. This feature is represented by a value on a scale in units known as ° Brix. Homogenated ciku purée was filtered through Whatman no.1 filter paper and a digital refractometer was used to evaluate the filtered content.

2.4.3 Colour profile analysis

Minolta Chroma Meter CR 300 (Japan) was used to determine the colour of ciku pastille. The instrument was calibrated using a white calibration plate before the process began. Ciku pastilles were minced and placed in the measuring plate until they covered the whole plate, prior to the data reading process. This action was taken to avoid error when taking the reading (Wan Mohamad Din *et al*., 2020).

2.4.4 Water activity analysis

The free moisture or water activity (a_w) is the water available to support microbiological growth in the food. Two grams of the sample was ground into small pieces, put in a disposable cup and put in the sample compartment of the water activity metre and analysed. An infrared beam focused in a tiny mirror determined the dew point and then the data was extracted the water activity value was recorded (Zhang *et al*., 2015).

2.4.5 Texture analysis

The analysis was conducted using a TA.XT.Plus texture analyzer (Stable Microsystems, UK) to determine the hardness, springiness, cohesiveness, gumminess, chewiness and resilience of ciku pastilles based on the mechanical characteristics where the material was subjected to a controlled force from a deformation curve of response. The sample was placed centrally under the 3 -point bend rig probe until the probe came into contact with the sample. Then, the deformation curves were recorded (Azuan *et al*., 2020).

2.4.6 Sensory analysis

The sensory evaluation session was performed based on a 7-point hedonic scale (higher score indicates better quality attributes (1, dislike very much and 7, like very much)) (Hasmadi *et al*., 2018). The colour, texture, taste, and overall acceptance of the ciku pastilles were evaluated. All the attributes were independently evaluated by fifty untrained panellists based on their likeness. The sample was packed and coded with a 3-digit code. The mean score for each attribute was reported.

2.5 Statistical analysis

All the results from chemical analysis, physical analysis and sensory evaluation were analyzed using ANOVA and Fisher's multiple range tests the significant difference ($p<0.05$) data were further analysed and $p<0.05$ were regarded as significant. The data were analysed using Minitab 14 software and all data obtained were presented at mean±standard deviation (Zainol *et al*., 2018).

3. Results and discussion

3.1 Development of ciku pastilles

Ciku pastille (*M. zapota*) was successfully developed with a round-shaped at a diameter of 1.0-1.2 cm, weighing approximately 1.2-1.5 g (Figure 1). Inconsistent diameter and weight were caused by

eISSN: 2550-2166

manually spreading the cornflour which acts as the pastille moulding on dehydrator trays and manually making holes into the flour. Azuan and co-workers (2020) have suggested that the rise in the plant product would ultimately increase the size of the product produced. This may happen as the purée interferes with the other ingredients in the formulations of the study.

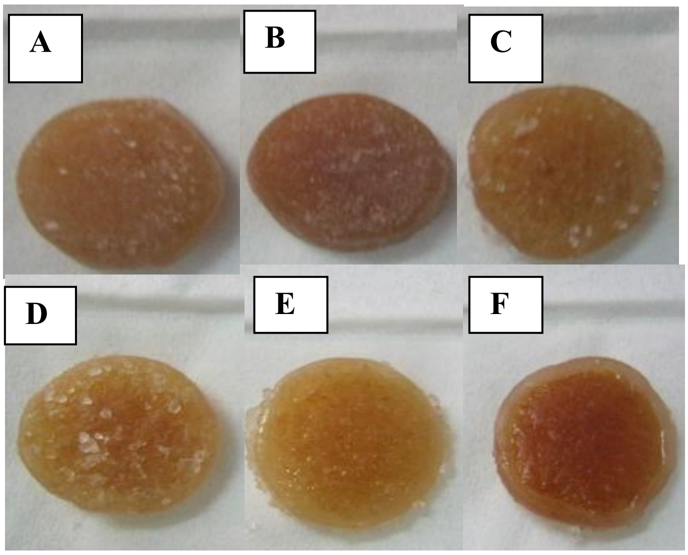

Figure 1. Formulations of ciku pastille: A) 10% ciku purée, b) 12% ciku purée, c) 14% ciku purée, d) 16% ciku purée, e) 18% ciku purée, f) 20% ciku purée

3.2 Chemical analysis

3.2.1 Moisture content

In terms of food quality, the content of moisture in a food sample especially pastilles are essential, as it affects food freshness, durability and deterioration resistance. Lees and Jackson (1973) recorded that a wide class of confectionery products are gums, jellies and pastilles that can be produced with many interesting variations. Table 2 shows that the level of moisture for all ciku pastille formulations did not exceed 20%. If the percentage of moisture is higher than 20%, the shelf life of pastille may be shortened. Formulation F (20% ciku purée) has the highest moisture content among six formulations which is 18.59% and was significantly different (P<0.05) compared with the other formulations. This is probably due to the high amount of percentage ciku purée used which was 20% since the moisture content for raw ciku fruit was 70.07% (Ahmed *et al*., 2011). The safe moisture content of a pastille product ranges from 12% to 18% (Razak, 2013). All formulations are within the safe range of moisture content due to the use of sorbitol which protects the pastille against loss of moisture content.

3.2.2 Ash content

Formulation F (20% ciku purée) showed significantly the highest (P<0.05) ash content (2.42%) among the six formulations, compared to the lowest ash content in Formulation A (1.77%). The data show that the higher percentage of ciku purée used in the formulation of the pastille, the higher the ash content. Ash is composed of accumulated minerals after undergoing high-temperature burning (more than 500°C) in a muffle furnace. The date is consistent with the USDA National Nutrient Database (2013) which reported that raw ciku fruit consists of 19.9 g of carbohydrates, 0.44 g of protein, 1.1 g of total fat and 5.3 g of dietary fibre.

3.2.3 Crude fibre content

Formulation F (20% ciku purée) (2.65%) has significantly the highest (P<0.05) fibre content among six formulations while the lowest fibre content was found in Formulation A (0.43%). The higher the ciku purée incorporated in the pastille formulation, the higher the fibre content. There were 14% dietary fibre from 100 g fresh ciku (USDA, 2013). Since formulation F used 20% of ciku purée, the fibre content obtained seemed reasonable. In contrast, Prasetyowati *et al*. (2014) pointed out the fact that the fibre content of the pastille samples was not significantly affected by the formulation used, but used a combination of wortel carrot and gum arabic instead of ciku purée and gelatine.

3.2.4 Antioxidant activity using 2, 2-diphenyl-2-picrylhydrazyl hydrate (DPPH)

The DPPH radical scavenging activities of ciku

Table 2. Chemical analysis of ciku pastille

	A (10% ciku purée)	B (12% ciku purée)	C (14% ciku purée)	D (16% ciku purée)	E (18% ciku purée)	F (20% ciku purée)
Chemical analysis						
Moisture content (%)	12.30 ± 0.01^{b}	12.55 ± 2.00^{b}	12.58 ± 0.56^{b}	14.24 ± 0.38^{ab}	14.58 ± 1.83^{ab}	18.59 ± 1.79^{a}
Ash content (%)	1.77 ± 0.08^{c}	1.88 ± 0.16^{bc}	1.82 ± 0.03^{c}	2.11 ± 0.06^{b}	2.26 ± 0.08^{ab}	2.42 ± 0.04^{a}
Fibre content (%)	0.43 ± 0.07^{e}	0.91 ± 0.05^{d}	1.38 ± 0.04^{c}	1.81 ± 0.10^{b}	2.35 ± 0.011^{a}	2.65 ± 0.19^{a}
DPPH Scavenging activity	12.97 ± 0.29^{e}	16.11 ± 0.91^{de}	18.31 ± 1.45^{d}	25.09 ± 2.18^{c}	29.07 ± 0.28^{b}	36.58 ± 1.56^{a}
water activity	0.46 ± 0.04^{c}	0.54 ± 0.03^{c}	0.64 ± 0.03^{b}	0.70 ± 0.01^{b}	0.78 ± 0.01^{ab}	0.81 ± 0.01^{a}

Values are expressed as mean±SD of triplicates (n = 3). Values with different superscript within the row are significantly different (p<0.05).

purée are shown in Table 2. DPPH analysis was used since it is a stable free radical and accepts an electron or hydrogen radical to become a stable diamagnetic molecule (Peksel *et al*., 2013). The analysis to evaluate the amount of antioxidant retained in the ciku pastille was carried out by checking its scavenging activity. Formulation F (20% ciku purée) exhibited significantly (P<0.05) the highest scavenging activity (36.58%) among six formulations produced, which was comparable to BHT (the positive standard) used (31.7%). Although the reference antioxidant reading is lower than formulation F pastille reading, the comparison is still reliable. The higher the scavenging activity, the better the product retained antioxidant content. Similarly, Concha-Meyer *et al*. (2016) reported the addition of strawberry and kiwi to improve antioxidant activity in fruit leather. As a consequence, the increase in DPPH scavenging activity can be attributed to phenolic content that improved the antioxidant ciku purée.

3.2.5 Water activity

Water activity represents the energy status of water in the food system through the provision of valuable information on microbial spoilage, chemical stability and physical stability (Hansson *et al*., 2001). Most foods with a water activity value above 0.95 will provide sufficient moisture to support the growth of bacteria, yeasts and mould. The water activity of foods must be controlled to 0.85 or less in the finished product. Table 2 shows that all samples of ciku pastille had water activity values lesser than 0.85. Formulation F (20% ciku purée) shows the highest water activity value of 0.81±0.01 and is significantly different from formulations A, B, C and D (p<0.05). Results showed that the moisture content increased with increased levels of ciku purée in formulations, while the water activity decreased by increasing gelatine concentration. The data is in line with the study by Azimi *et al*. (2019), who cited the increase in water activity in mulberry pastille as the amount of mulberry in pastille formulations was increased. According to Decagon Devices Inc. (2009), moisture content and water activity are related and a clear understanding of two parameters relationship which is referred to as moisture sorption isotherm that is complex and unique to each food product type.

3.3 Physical analysis

3.3.1 Total soluble solid (TSS)

The total soluble solids (TSS) or °Brix value is used to check the evaporation and concentration to evaluate the firmness of the final products and the sweetness and texture of the final product (Table 2). The data showed somewhat similar readings from 60.5 to 67.3°Brix of the total soluble solid obtained from all formulations. The equal amount used for sweetener which was 60 g for glucose syrup and 40 g for sorbitol in all ciku pastille formulations was the reasons why the values did not display not much difference.

3.3.2 Colour analysis

The effects of ciku purée incorporation in the gelatine-based pastille on the colour change are shown in Table 3. Food colour influenced the tipping point moment when many consumers were determining whether to choose a specific food product or not. Addition of ciku purée significantly affected (p<0.05) L* (lightness/darkness), a* (redness/greenness) and b* (yellowness/blueness) values of the ciku pastille. As the amount of ciku purée was increased (from 10% to 20 % ciku purée), the values for a* and b* also increase except L value. L values of ciku pastille decreased from 63.25±0.08 to 44.69±0.27 (an indicator of the tendency towards lightness) but a* increased from 24.51±1.13 (an indicator of the tendency towards redness) and b* increased from 34.33±1.117 to 41.15±0.88 (an indicator of the tendency towards yellowness). The data reveals that all formulations of ciku pastille possessed the same colour which was brownish-orange. This could be due to the combination of ciku purée and gelatine that gives out an attractive colour.

3.3.3 Texture profile analysis

The complexity of eating or even the chewing phase makes high demands on a texture measuring tool. One would ideally want to make measurements of structure, displacement and force on the subject. The texture is a complex property, determined by the structure, shape,

Table 3. The effects of the ciku purée on the colour profile of pastille

Parameter	A (10% ciku purée)	B (12% ciku purée)	C (14% ciku purée)	D (16% ciku purée)	E (18% ciku purée)	F (20% ciku purée)
L*	63.25±0.08^{a}	59.76±0.54^{b}	55.77±1.42^{c}	54.83±1.21^{c}	46.91±1.36^{d}	44.69± 0.27^{d}
a*	24.51±1.13^{d}	23.71±1.16^{d}	28.62±1.11^{c}	35.91±1.88^{b}	38.94±0.27^{b}	43.47±1.55^{a}
b*	34.33±1.12^{b}	34.25±1.86^{b}	35.79±1.39^{b}	37.45±0.820^{ab}	38.07±1.18^{ab}	41.15±0.88^{a}
Colour	Brownish orange					

Values are expressed as mean±SD of triplicates (n = 3). Values with different superscript within the row are significantly different (p<0.05).

chemical composition, viscosity and other physical properties of the product (Szczesniak, 2002). Table 4 illustrated the overall results of texture profile analysis for ciku pastilles. As a sensory property, hardness is defined as the force required to compress a substance between molar teeth or between tongue and palate (Butler, 2019). The hardness attribute shows that formulation F (20% ciku purée) possessed significantly the highest (p<0.05) value compared to other formulations. This result is contrary to the results of DeMars and Ziegler (2001), who reported a higher percentage of gelatine incorporated with pectin as being harder than a low percentage of gelatine gels incorporating pectin. Poppe (1995), reported that the presence of pectin may 'shorten' a gelatine network. For the result of springiness, there were no significant differences among the formulations (p>0.05) because the amount of gelatine being used in each formulation is 15% and below so that it can be considered as a low amount of gelatine. The presence of pectin in ciku purée is also one of the reasons why the results were not significantly affected. Table 4 also shows that formulations A (10% ciku purée) and B (12% ciku purée) exhibited a high cohesiveness value, but no significant differences were observed between formulations (p>0.05) since all the pastille had the same structure after being compressed and flattened by the moving probe. Formulation B (12% ciku purée) had the highest value of gumminess and was significantly different from formulation C (14% ciku purée), D (16% ciku purée), E (18% ciku purée) and F (20% ciku purée). On the other hand, chewiness is defined as the length of time required to masticate the sample at a constant rate of force application to reduce it to a consistency suitable for swallowing (Szczesniak, 2002). Table 4 also reveals that formulation C has the highest chewiness value (6661.5±132.7 g mm) significantly different compared with formulation A (10% ciku purée), E (18% ciku purée) and F (20% ciku purée). Resilience is a measurement of how a sample recovers from deformation in relation to speed and force derived (Szczesniak, 2002). Formulation C (14% ciku purée) has the highest resilience value (0.48±0.01) and is significantly different from other formulations.

3.4 Sensory evaluation

Table 5 reveals the results for sensory evaluation of ciku pastilles among fifty untrained panellists. Four attributes were evaluated namely colour, texture, taste and overall acceptance. These attributes were the basic sensory techniques that could aid the research on the nutritional or functional benefits of natural products. It is also important to highlight and refine the sensory properties of products in an attempt to ultimately appeal to consumers: no matter how healthy and nutritious a food is, if it does not appeal to its intended end-user, it is unlikely to succeed in today's market (Civille and Oftedal, 2012).

In colour attribute, all formulations were not significantly different, as the highest formulation E (18% ciku purée) (5.82±1.68) while the lowest acceptance was

Table 4. Texture profile analysis of ciku pastille

Attributes	A (10% ciku purée)	B (12% ciku purée)	C (14% ciku purée)	D (16% ciku purée)	E (18% ciku purée)	F (20% ciku purée)
Hardness (g)	7149±605^{d}	6270±770^{d}	7884±470^{cd}	9192±638^{c}	11449±653^{b}	14127±354^{a}
Springiness (mm)	0.91±0.02^{a}	0.90±0.03^{a}	0.97±0.15^{a}	0.98±0.29^{a}	0.59±0.03^{a}	0.63±0.02^{a}
Cohesiveness(g)	0.88±0.03^{a}	0.88±0.01^{a}	0.81±0.02^{a}	0.72±0.03^{a}	0.63±0.06^{ab}	0.51±0.83^{b}
Gumminess (g)	9891±140^{a}	10362±539^{a}	6273±274^{b}	5520±697^{bc}	4503±707^{bc}	3543±466^{c}
Chewiness (g mm)	4986.6±141^{b}	5685.7±481^{ab}	6661.5±132^{a}	5583.9±261^{a}	2550.1±332^{c}	1921.5±666^{c}
Resilience	0.44±0.03^{a}	0.41±0.06^{a}	0.48±0.00^{a}	0.46±0.05^{a}	0.27±0.00^{b}	0.27±0.04^{b}

Values are expressed as mean±SD of triplicates (n = 3). Values with different superscript within the row are significantly different (p<0.05).

Table 5. The acceptability scores of sensory attributes of ciku pastille

	A (10% ciku purée)	B (12% ciku purée)	C (14% ciku purée)	D (16% ciku purée)	E (18% ciku purée)	F (20% ciku purée)
Colour	5.62±1.73^{a}	5.66±1.74^{a}	5.24±1.81^{a}	5.48±1.86^{a}	5.82±1.68^{a}	5.46±1.86^{a}
Texture	5.62±1.94^{a}	6.86±1.74^{a}	4.58±1.79^{b}	4.54±1.77^{b}	5.48±1.84^{ab}	5.00±2.02^{ab}
Taste	5.18±2.09^{ab}	5.74±1.77^{a}	4.9±1.76^{b}	4.51±1.71^{b}	5.44±1.76^{ab}	5.26±1.79^{ab}
Overall acceptance	5.62±1.60^{a}	5.82±1.79^{a}	4.22±1.69^{b}	4.54±1.86^{b}	5.70±1.48^{a}	5.08±1.81^{ab}

Values are expressed as mean±SD of triplicates (n = 3). Values with different superscript within the row are significantly different (p<0.05).

eISSN: 2550-2166

observed in formulation C (14 % ciku purée) (5.24±1.81). The differences between the highest value and the lowest value are still comparable. The L*, a* and b* obtained by the colourimeter also depicted no differences in colour, which is brownish-orange for all formulations. Since the gelatine is yellowish-orange in colour and the ciku purée is dark brown, the brownish-orange is the colour of the ciku pastille.

The texture attributes for ciku pastille should be not too chewy and not too gummy as most of the panellists rated highly for formulation B (12% pure) that used 13% gelatine (6.86±1.74) and did not like formulation D (16% purée) that used 9% gelatine (4.54±1.77). These findings suggested that panellists prefer to choose the half quantity of gelatine used in pastilles. When a high amount of gelatine is used, the texture of the pastilles becomes too chewy, and when very little gelatine is used, it becomes less chewy. Texture has long been regarded as a second-rank sensory feature of food products. The texture is a sensory feature and constitutes a complex of parameters connected with rheological properties (Bourne and Szczesniak-Surmacka, 2003).

The taste of ciku pastille is important as it is an indicator of repeat purchase if the taste is unacceptable, this product cannot be commercialized. Table 5 also shows that formulation B (12% ciku purée) has the highest taste acceptance (5.74±1.77), while the lowest taste acceptance was observed in formulation D (16% ciku purée) (4.5±1.71). Overall acceptance for ciku pastilles is presented in Table 5, which depicted that formulation B (12% ciku purée) exhibited the best overall acceptance (5.82 ±1.79), while conversely, formulation C (14% ciku purée) received the lowest score in terms of overall acceptance (4.22±1.69).

4. Conclusion

Ciku pastilles were successfully developed with a brownish-orange colour, round-shaped with a diameter of 1,0-1,2 cm and a weight of approximately 1,2-1,5 g. Formulation B (12% ciku purée) has 62.7º Brix with pH 4.3 with an acidic aftertaste and water activity was 0.54. In the colour analysis, L* value was 59.76, a* value was 23.71 and b* value was 34.33 which brought the brownish-orange colour for ciku pastille. The total soluble solids for all formulations were not less than 60º Brix and did not exceed 68ºBrix. Formulation F showed the highest value in those four analyses since it has the highest amount of ciku purée (20% ciku purée). Sensory evaluation showed that in terms of texture, taste and overall acceptance among untrained panellists, pastille from formulation B (12% ciku purée) was most acceptable. Results show that the highest acceptance in the overall quality of the pastilles due to the addition of approximately 12% ciku purée. Therefore, ciku fruit could be a potential natural ingredient for the production of pastilles, thereby encouraging its use in the food industry.

Conflict of interest

The authors declare that there is no conflict of interest in conducting this study.

Acknowledgments

This research was funded by the UMT short-term grant (Research Incentive Grants/GGP(UMT/RMIC/2-2/2/25/6(73). The authors would like to thank the Faculty of Fisheries and Food Sciences (FPSM) as well as UMT Research and Field Service Centre for the facilities to conduct this study.

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