

Product Development of Kembayau (*Canarium Odontophyllum*) Exotic Fruit Sauce

Mohd. Nazri Abdul Rahman*, Nur Azimah Mohammed Thajudin

Faculty of Food Science & Nutrition, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah

Available online 1 May 2015

Keywords:

Kembayau, Dabai, *Canarium Odontophyllum*, exotic fruit, sauce

✉*Corresponding author:

Mohd. Nazri Bin Abdul Rahman,
Faculty of Food Science &
Nutrition, Universiti Malaysia
Sabah, Jalan UMS, 88400 Kota
Kinabalu, Sabah

Email:

mdnazri@ums.edu.my,
mohdnazri9776@yahoo.com.my

Abstract

Canarium Odontophyllum or known as Kembayau and/or Dabai (*Dacryodes rostrata f. cuspidate*) is an underutilized exotic (indigenous) fruit that can be found in Borneo region particularly Sabah, Sarawak, Brunei and Kalimantan tropical forest. Kembayau is less popular compared to Dabai fruit due to the taste and thickness of flesh. It is rich in minerals, proteins and carbohydrates with milky taste. This study was done to determine the suitability of Kembayau fruit as a sauce. Three formulations, F3, F5 and F8 out of nine were chosen after going through BIB ranking test and F8 then chosen through hedonic test for proximate analysis, microbial storage study and quality sensory. F8 contains 45% Kembayau fruit puree, 30% sucrose, 18% water, 1.53% modified corn starch, 0.1% xanthan gum, 4% margarine, 0.9% salt, 0.4% citric acid and 0.07% sodium benzoate. As result, Kembayau fruit sauce contains 60.43 ± 0.40 moisture, 0.50 ± 0.10 ash, 0.75 ± 0.03 fat, 1.40 ± 0.07 protein, and 0.92 ± 0.02 crude fibre and 35.50 ± 0.04 carbohydrates. Physicochemical shown sample had pH at 3.15 ± 0.10 , 34.00 ± 0.01 °Brix, viscosity at 24.42 ± 0.10 cP and $L^*a^*b^*$ was at 39.75 ± 0.18 , 6.12 ± 0.07 , and 12.42 ± 0.08 respectively. From the view of storage studies, at eight week of storage, sample are contains bacteria and yeast at 3.11×10^2 cfu/ml and 3.55×10^2 respectively at concentration 10^{-1} . Consumer test shows that Kembayau sauce is acceptable among consumers. As conclusion, Kembayau is a potential exotic fruit to be studied for the food product development.

© 2015 UMK Publisher. All rights reserved.

1. Introduction

Canarium odontophyllum or known as Kembayau and/or Dabai (*Dacryodes rostrata f. cuspidate*) among Sabahan, Sarawakian and Bruneian communities respectively sharing similarities in term of colour of the skin [1,2] but both contains high source in minerals (200 mg calcium, 106 mg magnesium and 65 mg of phosphorus), protein, carbohydrate and fat [3,4,5,6]. Dabai fruits are most popular compared to

Kembayau due to the thicker flesh, more milky in taste and delicious. A Kembayau fruit are the last fruit to appear and is an indication that the season for Dabai and other local seasonal fruits are over. Pericarp and mesocarp of Kembayau fruit contains high percentage of carotenoid [7, 8, 9]. Physically, Kembayau fruits have long oval shape approximately 3-4 centimeters and weighing ranges 10-13 grams. Outer skin or pericarp is dark purple in colour with yellow flesh mesocarp, and contains one large seed in the center of the fruit. Research on the food products development

of Kembayau fruit-based is expected to boost the commercial value of *Canarium odontophyllum* as well as will improve the economic incomes of rural communities.

Objectives

1. To determine the suitability and best formulation of Kembayau fruits as fruit sauce.
2. To investigate the physicochemical properties of Kembayau fruit sauce and storage quality parameters.
3. To determine the consumer acceptance and buying potential of Kembayau fruit sauce.

2. Materials and methods

The fruit of *C. odontophyllum* was bought from Donggongon Friday Market, Kolombong Saturday Market and ordered from Balung Plantation, Tawau during the season, starting October to December all the year. The fruits was cleaned, weighed and sorted into good and fresh condition at maturity index of five. The fruit were kept in cold storage at temperature 4 to -4°C until the experiment. On the day of experiment, the fruit were thawed in room temperature for at least 20 to 30 minutes, and the outer skins of the fruits were peel-off manually using knife, and the seed was removed. A clean flesh without skin and seed were weighed before it blended into puree.



Figure 1: Physical appearances of Kembayau fruits with some skin were removed.

Kembayau sauce has been prepared according to fruit sauce preparation [10]. It is involving three steps, puree preparation, sauce making and bottling for storage. To prepare fruit puree, 200g of cleaned Kembayau flesh without seed was finely blended, and boiled into 75ml water with continuously stirring at degree 80 to 100°C .



Figure 2: The flesh of Kembayau fruits before sauce making.

Then, Kembayau sauce has been prepared by addition of 115g crystal sugar, 4.5g table salt and 0.5g xanthan gum into puree. This mixture was boiled and stirred for another 10 minutes. Then, modified corn starch at 7.65g that mix with 30ml water was pour into puree and boiled with rigorously stirring until reach the 35 to 40°Brix .



Figure 3: The colour of Kembayau sauce.

Then, 20g margarine added into the mix as emulsifier, together with 2g of citric acid in 20 ml water, and 0.35g sodium benzoate in 20 ml water. The final mix was heated again until reach 35 to 45°Brix . Finally, Kembayau sauce at temperature 80°C were transferred into clean and sterile glass bottle.

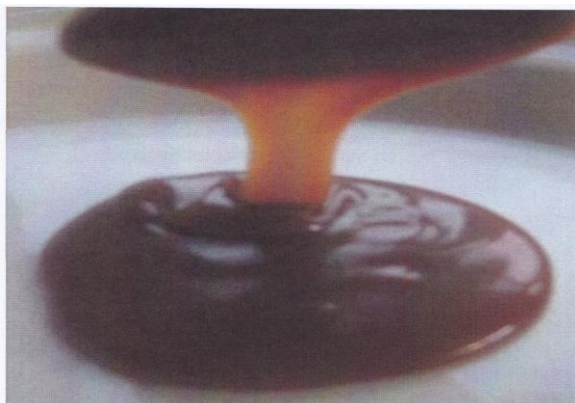


Figure 4: The viscosity of Kembayau sauce in study.

Formulation of Kembayau sauce

Kembayau sauce formulation was adapted from normal fruit sauce [11] and in preparing of béchamel sauce, or also known as ‘white sauce’, [12] with slight modification. This original formulation was to prepare 500g fruit sauce. To have a good formulation for the Kembayau sauce, there are nine formulation prepared with different percentage content of puree, sugar and water.

Balanced Incomplete Block / Ranking test

The purpose of this ranking BIB test is to choose the best three formulations out of nine formulations. This ranking test was assessed by 36 untrained panelist [13], based on overall acceptability, without considering specific attributes. Each sensory panelist only provided with four different formulations (as Table 2 above). These sensory tests were done in three sessions with total 12 panelists per session. This ranking test using number scale, 1 to 4 whereby scale 1 represent the like most, and scale 4 represent the dislike most.

Hedonic test

Hedonic test with seven hedonic scales were used to select the best formulation among three formulations from BIB. It is involving 50 untrained panelist to evaluate attributes of colour, aroma, sweetness, sourness, viscosity, mouthfeel and overall acceptance. Hedonic scale number 1 represent the most dislike, 4 = neither like nor dislike, 7 = the most like. The Kembayau sauce has been served with French fries to dip into sauce and evaluate it.

Table 1: Percentage of ingredients used in Kembayau Sauce

F	Puree	Sugar	Water	Salt	Modified Corn Starch	Xanthan Gum	Citric acid	Margarine	Sodium Benzoate
Faridah (2005)	40	30	23	0.9	1.53	0.1	0.4	4	0.07
F1	35	25	33	0.9	1.53	0.1	0.4	4	0.07
F2	35	30	28	0.9	1.53	0.1	0.4	4	0.07
F3	35	35	23	0.9	1.53	0.1	0.4	4	0.07
F4	40	25	28	0.9	1.53	0.1	0.4	4	0.07
F5	40	30	23	0.9	1.53	0.1	0.4	4	0.07
F6	40	35	18	0.9	1.53	0.1	0.4	4	0.07
F7	45	25	23	0.9	1.53	0.1	0.4	4	0.07
F8	45	30	18	0.9	1.53	0.1	0.4	4	0.07
F9	45	35	13	0.9	1.53	0.1	0.4	4	0.07

Physicochemical properties

The best formulation of Kembayau sauce has been evaluated on physicochemical properties in every two weeks times for at least two months. The parameter includes total soluble solid, pH, acidity, viscosity and colour. Total soluble solid was determined using

refractometer 0 to 40°Brix, viscosity has been determined using Brookfield viscometer, and colour was determined using Hunter Colorimeter.

Proximate analysis

The best formulation of Kembayau sauce has been determine for the proximate composition, includes moisture content, ash, fat, protein, total fiber and carbohydrate [14] for the purpose of nutritional content determination.

Table 2: Design of ranking Balanced Incomplete Block (BIB) used for Kembayau Sauce

Block	Sample			
1	1	4	6	7
2	2	6	8	9
3	1	3	8	9
4	1	2	3	4
5	1	5	7	8
6	4	5	6	9
7	2	3	6	7
8	2	4	5	8
9	3	5	7	9
10	1	2	5	7
11	2	3	5	6
12	3	4	7	9
13	1	2	4	9
14	1	5	6	9
15	1	3	6	8
16	4	6	7	8
17	3	4	5	8
18	2	7	8	9

Storage studies

Microbiological test has been performed in two weeks times for the two months. There are two main types of studies Total Plate Count (TPC) using pour plate techniques and Potato Dextrose Agar (PDA) using spread plate techniques to determine any growth of bacteria and mold and yeast respectively.

Consumer test

A consumer test involved 100 people of public has been done to determine the acceptance of the Kembayau sauce and potential of marketability of the product. A short and simple question's has been asked to consumer, plus their preferences based on attributes colour, aroma, sweetnees, sourness, viscosity, mouthfeel and overall acceptance.

Statistical analysis

All data collected through series of experiments was analyzed using Statistical Package for the Social Science (SPSS). There are involving one way ANOVA test, Tukey test at significant value ($p < 0.05$).

3. Results and Discussion

Ranking test

One-way ANOVA showed no significant differences ($p \geq 0.05$) between all nine formulations of Kembayau fruit sauce on the overall acceptability ($n=36$). Formulation F8, F5 and F3 showed the most accepted formulation with their respective values are 24, 30 and 34 (the lowest score represent the most accepted with score 1=like most; 2=like; 3=dislike; 4=dislike most), without significant differences ($p \geq 0.05$).

Table 3: Total rank sum score ($n=36$) for ranking test on the ninth formulation of Kembayau sauce for the overall acceptance.

Formulation	Total Rank Sum
8	24 ^a
5	30 ^{ab}
3	34 ^{abc}
7	38 ^{bcd}
2	42 ^{bcde}
6	44 ^{cde}
9	46 ^{cde}
4	48 ^{de}
1	54 ^e

^{a-e}: The same superscripts alphabet in the same row indicate no significant difference ($p \geq 0.05$)

Hedonic test

Therefore, formulation F8, F5 and F3 were determined the level of consumer preference ($n=50$), using hedonic test based on the attributes in the Table 4. Hedonic test were assessed by untrained sensory panelist ($n=50$) by Food Science student's using 7-point hedonic scale (1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=neither like nor dislike, 5=like moderately, 6=like very much, 7=like extremely). Hedonic test were run under control condition in the Sensory Evaluation Laboratory, FSMP, UMS to prevent and minimized bias (if occur). Sensory attributes assessed are colour, aroma,

sweetness, sourness, viscousness, mouthfeel and overall acceptability.

Colour attribute of Kembayau sauce showed significance differences ($p \geq 0.05$) between F8 with F5 and F3. The highest score mean of F8 (5.91 ± 0.54) showed that majority of sensory panelist preferred F8 based on colour attribute. The colour of F8, F5, and F3 may affect by the highest Kembayau puree content at 45%, 40%, and 35% that contribute to the lightness to darkness of colour respectively. Based on aroma attribute, once again F8 became as the most selected formulation compared to F5 and F3 with score mean value is 5.33 ± 0.91 , 4.96 ± 0.95 , and 4.40 ± 0.67 respectively.

Table 4: Mean score value of one-way ANOVA ($n=50$) through hedonic test for the three formulations of the best Kembayau fruit sauce

Attribute	F3	F5	F8
Colour	$5.02^b \pm 0.7$	$5.34^b \pm 0.6$	$5.91^a \pm 0.5$
	8	5	4
Aroma	$4.40^b \pm 0.6$	$4.96^a \pm 0.9$	$5.33^a \pm 0.9$
	7	5	1
Sweetness	$4.33^c \pm 1.0$	$5.00^b \pm 0.7$	$5.52^a \pm 0.5$
	9	8	1
Sourness	$4.86^c \pm 0.8$	$5.83^a \pm 0.9$	$5.37^b \pm 1.0$
	8	9	2
Viscousness	$4.54^b \pm 0.9$	$4.87^b \pm 0.8$	$5.42^a \pm 1.0$
	3	8	2
Mouthfeel	$4.31^b \pm 1.1$	$4.74^b \pm 0.7$	$5.65^a \pm 0.9$
	1	2	3
Overall acceptance	$4.72^c \pm 1.0$	$5.35^b \pm 0.7$	$5.96^a \pm 0.9$
	9	9	5

^{a-c}: The same superscripts alphabet in the same row indicate no significant difference ($p \geq 0.05$)

This consistent result appeared in another attributes include sweetness, viscousness, mouthfeel and overall acceptability, except for the sourness attribute. Based on formulation, both F8 and F5 contain 30% of sugar with different percentage of fruit puree. Meanwhile F3 contain a bit higher sugar at 35% but at the lower percentage of fruit puree at 35%. The sweetness attribute has been affected by sugar and puree percentage. In addition, Kembayau fruit that used for preparing puree in this study was at final ripened stage which is contain high sugar in the form of starch [15, 16]. F5 appear as selected formulation for the

sourness attribute (5.83 ± 0.99), that may be result of moderate puree and sugar content at 40% and 30% respectively. In addition, there are fix amount of acid citric added to all Kembayau sauce formulation at 0.4%. Perhaps, this sourness attributes also contributed by the maturity of the Kembayau fruit.

The viscosity of the Kembayau sauce was provided by puree and sugar content, also thickener agent that has been used which is modified cornstarch and xanthan gum. In general, modified cornstarch and xanthan gum used was at constant level in all formulations which is 1.53% and 0.10% respectively. Sugar plays an important role as texturing agent in controlling viscosity of any food products [17]. In addition, the thickness of sauce is mostly influenced by sugar percentage that added into sauce [18] until it reach 35 to 45 °Brix. In another perspective, besides providing sweet taste, sugar also plays an important role in gel formation [19].

Mouthfeel attribute refers to the condition where a sensation of like a layer or coating that left behind in the mouth during or after consumed of specific food or drink [20]. This mouthfeel attribute is contributed by the other attributes such as texture, syneresis, viscosity, sweetness and sourness. Therefore, F8 has been selected as the most preference formulation according to mouthfeel attribute with score mean value is 5.65 ± 0.93 . For the overall acceptability, F8 has been chosen as the most preferable formulation based on the highest mean scores (5.96 ± 0.95) for the most attributes studied. Therefore, F8 has been chosen as the best formulation for the Kembayau fruit sauce.

Physicochemical properties

F8 formulation has undergone further analysis, including physicochemical properties, proximate analysis, microbiological studies and consumer test. Physicochemical properties and microbiological study of Kembayau fruit sauce in the study has been evaluated for every week until up to eight week. During that period, it shows that the total soluble solid (TSS) of Kembayau fruit sauce was increased for 1°Brix. In general, total soluble solid of fresh prepared sauce will increase from 35 to 37°Brix [21]. In comparison, total soluble solid for apple sauce

is around 20.33 ± 0.58 [22]; and the TSS for the tomato sauce is about 33.35 ± 0.14 [23].

The pH value for Kembayau fruit sauce in the study was decreased about 0.05 within eight weeks of storage. The decrease value of pH is correlated with increasing acidity value that commonly due to the present of lactic acid bacteria [24, 25]. Previous report, the range value of pH for sauce is 2.3 to 4.0 [26], therefore the Kembayau fruit sauce in study were meet the pH standard for sauce. In comparison, the pH value for their apple sauce is 3.14 ± 0.03 [22], and the pH value for tomato sauce is 3.48 ± 0.02 [23].

Acidity value of the Kembayau sauce is inverted proportionate with the pH value. Acidity value increase is due to production of acid at low ion at low concentration during the storage. Scientific report stated that, this acidity value is influenced by sodium benzoate that added into product [24, 25]. The

increasing of acidity value may be result from production of acid from polysaccharide degradation and sugar oxidation, or through breakdown of pectin molecule in sauce [27, 28]. In comparison, acidity value of apple sauce is 0.91 ± 0.05 [22], and 1.54 ± 0.03 for tomato sauce [23].

The viscosity of the Kembayau sauce in study was decreased in long period of storage, but in small value from 0.03 - 0.12 centipoise. This is due to low usage of xanthan gum in Kembayau sauce at 0.1%, even it suggested at 0.1 to 0.5%. Syneresis that occurs in sauce will affect to the final viscosity of the sauce product [29]. The standard range of viscosity for the fruit sauce is from 20 - 25 centipoise [26], therefore the Kembayau sauce in the study was meet the viscosity requirement.

Table 5: Physicochemical properties for the triplicate F8 formulation of Kembayau fruit sauce within 8 weeks period with 2 weeks interval for the storage studies

Week	Total Soluble Solid ($^{\circ}$ Brix)	pH	Acidity (%)	Viscosity (cP)	Colour (L*,a*,b*)
0	$34.00^b \pm 0.03$	$3.15^a \pm 0.10$	$1.06^c \pm 0.02$	$24.42^a \pm 0.10$	$39.75^a \pm 0.18$ $6.12^a \pm 0.07$ $12.42^a \pm 0.08$
2	$34.00^b \pm 0.02$	$3.14^a \pm 0.05$	$1.07^c \pm 0.03$	$24.39^b \pm 0.10$	$39.73^a \pm 0.20$ $6.12^a \pm 0.12$ $12.42^a \pm 0.25$
4	$34.50^b \pm 0.01$	$3.12^b \pm 0.05$	$1.10^b \pm 0.02$	$24.35^b \pm 0.15$	$39.73^a \pm 0.10$ $6.09^b \pm 0.10$ $12.40^a \pm 0.17$
6	$35.00^a \pm 0.03$	$3.10^b \pm 0.01$	$1.12^a \pm 0.01$	$24.30^c \pm 0.11$	$39.71^b \pm 0.13$ $6.07^b \pm 0.05$ $12.38^b \pm 0.26$
8	$35.00^a \pm 0.03$	$3.10^b \pm 0.01$	$1.13^a \pm 0.03$	$24.30^c \pm 0.09$	$39.71^b \pm 0.10$ $6.05^b \pm 0.16$ $12.38^b \pm 0.11$

^{a-c}: The same superscripts alphabet in the same column indicate no significant difference ($p > 0.05$)

There is very minimal value of colour (L*, a*, b*) deterioration during storage of Kembayau sauce. The L*=lightness represent scale from 0 to 100, whereby 0=darkness/black hue, and 100=lightness/white hue. Meanwhile, a* and b* represent by negative and positive, whereby -a*=green hue; +a*=red hue; and -b*=blue hue, and +b*=yellow hue. Colour deterioration of Kembayau sauce is due to natural pigment oxidation of fruit puree, and it

happened due to existence or present of oxygen [30]. There are two possibilities of oxidation reaction happened in Kembayau fruit sauce: due to available oxygen (1) during mixing of all raw materials, and (2) during storage. The normal accepted colour for the sauce is in the range of light red to dark brown [32]. Therefore, Kembayau sauce in study can be categorized as having light brown colour and most probably can be accepted by consumer.

Proximate analysis

Proximate composition of F8 Kembayau fruit sauce was done to determine the nutritional value of Kembayau fruit sauce. As shown in table below, Kembayau fruit sauce contain 60.43±0.40 moisture content, 0.50 ± 0.10 ash, 0.75 ± 0.03 fat, 1.40 ± 0.07 protein, 0.92 ± 0.02 crude fiber, and high value of carbohydrate, at 35.50 ± 0.04. In comparison, moisture content for mango sauce is 67.89±0.40 [31], and moisture content of tomato sauce is 66.65±0.14 [23]. Kembayau sauce in study contain ash (0.50±0.10) at bit higher value compared to mango sauce (0.38±0.01) as reported [31], and low value compared to tomato sauce (2.94±0.05) as reported [23]. Kembayau fruits rich with minerals such as calcium, magnesium and phosphorus and high amount of fat [3, 4, 5, 6]. Therefore, Kembayau sauce contain 0.75 ± 0.03 fat, at higher value compared to tomato sauce (0.62±0.01) and low amount compared to mango sauce (0.89±0.02) as reported by [23, 31] respectively. In addition, an inclusion of margarine into Kembayau sauce as emulsifier agent was affected the value of fat content in Kembayau sauce.

Table 6: Proximate values for the triplicate F8 Formulation of Kembayau fruit sauce

Proximate Value (%)	Mean ± S.D
Moisture	60.43 ± 0.40
Ash	0.50 ± 0.10
Fat	0.75 ± 0.03
Protein	1.40 ± 0.07
Crude fiber	0.92 ± 0.02
Carbohydrate	35.50 ± 0.04

Kembayau fruit contain high amount of protein [3, 4, 5, 6], therefore it was affected the high amount of protein content (1.40 ± 0.07) in Kembayau sauce as well. This value is comparable with mango sauce and tomato sauce with protein content at 1.28±0.02 and 1.04±0.03 as reported by [23, 26] respectively. Kembayau sauce is found to have moderate level of crude fiber (0.92 ± 0.02), compared to tomato sauce (0.86±0.04) and mango sauce (1.71±0.01) as reported by [23, 31] respectively. Kembayau fruit contains small and fine fiber [6] that can be seen through naked eye over the Kembayau

flesh. Kembayau fruits also contain very high amount of carbohydrate [6]. Therefore, Kembayau sauce in study shows contains very high amount of carbohydrate at 35.50 ± 0.04, but it might contributed by sugar that added into formulation.

Microbiological studies

Kembayau sauce in study shows the increasing number of bacteria growth, and mold and yeast during eight weeks of storage studies. The product was kept in tight sterile bottle at room temperature (30±2°C) during the study. For the pour plate technique using Total Plate Count (TPC), at dilution of 10⁻¹, the cfu/ml was increased from 1.08 x 10¹ to 3.11 x 10² at week eight of study. At dilution 10⁻² and 10⁻³, the cfu/ml is not detected at the initial and second week, and increased to 2.74 x 10² and 2.25 x 10² respectively. According to Malaysia Food Regulations 1985, Section 342(4) and 343(4), chili and tomato sauce or ketchup should not shows any fermentation sign during and after incubated at temperature 37°C within 15 days, and Howard mold count should not exceed than 50% of the total of field examined [33].

Table 7: Storage studies of F8 formulation of Kembayau fruit sauce

Week	Bacteria (cfu/ml)			Mold & Yeast (cfu/ml)		
	10 ⁻¹	10 ⁻²	10 ⁻³	10 ⁻¹	10 ⁻²	10 ⁻³
0	1.08	NA	NA	1.20	NA	NA
	x			x		
	10 ¹			10 ¹		
2	1.44	1.12	NA	1.79	1.39	1.05
	x	x		x	x	x
	10 ¹	10 ¹		10 ¹	10 ¹	10 ¹
4	2.13	1.72	1.34	2.36	1.89	1.32
	x	x	x	x	x	x
	10 ²	10 ¹	10 ¹	10 ²	10 ²	10 ²
6	2.64	2.17	1.51	2.91	2.58	2.02
	x	x	x	x	x	x
	10 ²	10 ²	10 ²	10 ²	10 ²	10 ²
8	3.11	2.74	2.25	3.55	3.16	2.85
	x	x	x	x	x	x
	10 ²	10 ²	10 ²	10 ²	10 ²	10 ²

NA = non-applicable where the colony growth less than 10 per petri dish.

Meanwhile, for the growth of mold and yeast on the Kembayau sauce, detected using spread plate technique with Potato Dextrose Agar (PDA). It shows that in dilution 10-1, mean value for cfu/ml increased from 1.20×10^1 to 3.55×10^2 . At dilution 10-2 and 10-3, the cfu/ml is not detected at the initial week of study and increased to 3.16×10^2 and 2.85×10^2 respectively. *Aspergillus* and *Penicilium* are those types of fungi that frequently growth on food material contain high amount of carbohydrate [34]. Mold and yeast need acidic medium to promote the sporulation. The range of acidic medium for the mold and yeast sporulation is pH 3 and above [35]. In addition, mold and yeast prefer moist temperature at 10 to 35°C to promote the growth [36]. In general, Kembayau sauce in study considered as safe to consume since the number of cfu/ml is less than 10-100 [37].

The usage of sodium benzoate and citric acid as preservatives of Kembayau sauce in study was not showing any effectiveness in term of bacteria and mold and yeast retardation. This is due to very low amount of sodium benzoate and citric acid has been used, 0.07% (0.35g) and 0.40% (2.00g) respectively. According to Malaysia Food Regulations 1985, in Table Six, Register I, it mentioned that the maximum weight of preservatives that could be used in any of sauce (excludes oyster sauce, fish sauce, soybean sauce, and vegetable or plant protein hydrolysis sauce) as follow: sulphur dioxide $\leq 300\text{mg/kg}$; benzoic acid $\leq 750\text{mg/kg}$; and sorbic acid $\leq 750\text{mg/kg}$ [33]. An ineffectiveness of preservatives it might due to less suitable of preservatives agent to the specific type of sauce [32]. In this case, in example the usage of citric acid could be replaced with benzoic acid.

Theoretically, sodium benzoate is able to retard the growth of bacteria from Bacillaceae, Microceae, Enterobacteriaceae, mold and yeast [39]. The benzoic acids are able to prevent microorganism from using substances that rich with energy for their growth [40]. At the same time, the temperature during storage will affect to the growth of microorganism. Theoretically, microorganism grows faster at temperature 20 to 40°C [36, 40]. Another possibility cause on increasing number of bacteria, and mold and yeast growth in Kembayau sauce product is cross-contamination from utensils-to-product or from

handlers-to-product during handlings and preparation [41].

Consumer preferences

Consumer test or affective test has been performed by 100 people of adult to determine their acceptability of the Kembayau sauce and to determine the potential of marketability of the product. The sensory attributes assessed are colour, aroma, sweetness, sourness, viscosity, mouthfeel and overall acceptance, using five-point hedonic scale [5=like most, 4=like, 3= neither like nor dislike, 2=dislike, 1=dislike most]. An evaluation form with a simple question on their preferences or possibility of buying has been asked to respondents. Every respondent were provided with a small cup of Kembayau sauce (approximately 15 ml each cup), and five sticks of French fries that can be used as medium for sauce evaluation, and evaluation form. Respondents also had given flexibility to provide comments or suggestion regarding the product.

Kembayau sauce in study shows highest hedonic score percentage for attribute of sweetness is 82% (like most 56%, like 26%), followed by colour is 80% (like most 54%, like 26%), sourness is 72% (like most 42%, like 30%), viscosity is 63% (like most 33%, like 30%), and aroma is 53% (like most 25%, like 28%). The sweetness attributes in Kembayau sauce affected by the maturity index of the Kembayau fruit. F8 Kembayau sauces contain 30% sugar and 45% Kembayau fruit puree. Colour attribute play an important role to the overall acceptance of sauce product [26]. Kembayau sauces in study contain 0.4% citric acid that influenced to the sourness attribute. The usage of citric acid contributes to the sour taste of the sauce [42].

In addition, the viscosity of the sauce is contributes by percentage of fruit puree and thickening agents used i.e., modified corn starch and xanthan gum and not only for the purpose to thicken the product but also to prevent from layer separation [43] and syneresis [44]. Kembayau sauce has their own and unique aroma that comes from the original Kembayau fruit puree and is considered as unfamiliar aroma among panelist. Fruit aroma will remain as the sauce aroma but the strength of the aroma is always affected by other ingredient used

and the processing method [45]. In overall, majority of panelist can accept this new product with the total hedonic score percentage 73%: like most (49%), like (24%), neither like nor dislike (22%), dislike (4%), and dislike most (1%).

Some panelist suggests that Kembayau sauce should be eaten with desert such as cake and jelly, or to be used as cooking sauce for their flavour such as in sweet-and-sour fried fish. Based on simple question of buying potential, there are 68% of respondents would prefer to have of this Kembayau sauce if available in the market, followed by 22% who are not sure and 10% do not have interest on this product.

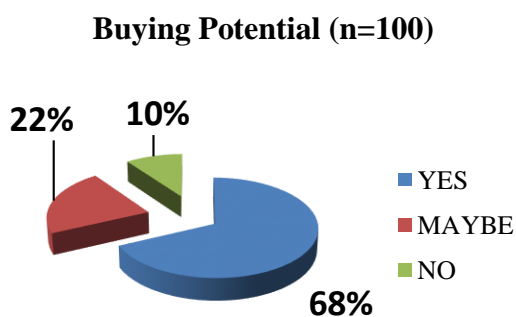


Figure 5: Buying potential of Kembayau exotic sauce through consumer test.

4. Conclusion

As conclusion, Kembayau fruits have shown to have properties and suitability to be used as fruit sauce. The best formulation for the Kembayau fruit sauce contains 45% Kembayau fruit puree, 30% sugar, 18% water, 0.9% salt, 1.53% modified corn starch, 0.1% xanthan gum, 0.4% citric acid, 4% margarine as emulsifier, and 0.07% natrium benzoate. Based on proximate composition, Kembayau sauce contains higher percentage of carbohydrate at 35.50 ± 0.04 , 1.40 ± 0.07 protein, 60.43 ± 0.40 moisture, 0.50 ± 0.10 ashes, 0.75 ± 0.03 fats, and 0.92 ± 0.02 crude fibers. During eight weeks of storage studies at room temperature, Kembayau fruit sauce shows minimally decline of viscosity from 24.42 ± 0.10 at initial storage to 24.30 ± 0.09 , pH value from 3.15 ± 0.10 to 3.10 ± 0.01 , also the lightness and a^* and b^* colour hue, however it does not showing deterioration of the product. For the

total soluble solid (TSS) and acidity it shows minimally increased with 34.00 ± 0.03 to 35.00 ± 0.03 TSS, and 1.06 ± 0.02 to 1.13 ± 0.03 percentage of acidity. Meanwhile, for the microbiological test Kembayau sauce shows increasing number of bacteria growth, and mold and yeast during eight weeks of storage studies, to maximum 3.11×10^2 and 3.55×10^2 in dilution 10-1 for bacteria, and mold and yeast respectively. However it still consider meet Malaysia Food Regulations 1985 for sauce product as mentioned under

Section 342(4) and 343(4), any sauce or ketchup should not shows any fermentation sign during incubation period at temperature 37°C within 15 days, and Howard mold count should not exceed than 50% of the total of field examined [33]. For the consumer acceptance, majority of panelist like Kembayau sauce based on hedonic percentage for the specific attributes of sweetness is 82%, colour is 80%, sourness is 72%, viscosity is 63%, and aroma is 53%. All of these sensory attributes reflects the consumer acceptance of the product, i.e., overall acceptance is 73%. From the total of 100 respondents, there are 68% showing their interest to have this Kembayau fruit sauce if available in the market.

References

- [1] Lau, C.Y. 2009. Development of indigenous fruit crops in Sarawak: A case study on Dabai fruit. In *Proceedings of The National Conference on New Crops and Bio-resources*. Negeri Sembilan.
- [2] Khoo, H.E., Prasad, K.N., Kong, K.W., Chew, L.Y., Azlan, A., Sun, J., Ismail, A. and Idris, S. 2010. A review on underutilized tropical fruits in Malaysia. *Guangxi Agricultural Sciences* 41(7):698-702.
- [3] Kong, K.W., Chew, L.Y., Prasad, K.N., Lau, C.Y., Ismail, A., Jian, S. and Hosseinporsarmadi, B. 2011. Nutritional constituents and antioxidant properties of indigenous kembayau (*Dacryodes rostrata* (Blume) H.J. Lam) fruits. *Food Research International* 44:2332-2338.
- [4] Chew, L.Y., Nagendra Prasad, K., Amin, I., Azrina, A. and Lau, C.Y. 2011. Nutritional composition and antioxidant properties of *Canarium odontophyllum* Miq. (dabai) fruits. *Journal of Food Composition and Analysis* 24: 670-677
- [5] Tee, L.H., Yang, B., Nagendra, K.P., Ramanan, R.N., Sun, J., Chan, E.S., Tey, B.T., Azlan, A., Ismail, A., Lau, C.Y. and Jiang, Y. 2014. Nutritional compositions and bioactivities of *Dacryodes* species: A review. *Food Chemistry* 165:247-255.
- [6] Hoe, V.B. & Siong, H.S. 1999. The nutritional value of indigenous fruits and vegetables in Sarawak. *Asia Pacific Journal of Clinical Nutrition* 8:24-31
- [7] Azrina, A., Nurul Nadiyah, M.N., Zulkhairi, A. & Amin, I. 2009. Physical properties of skin, flesh and kernel of *Canarium*

- odontophyllum fruit. *Journal of Food Agriculture and Environment* 7:55-57
- [8] Azrina, A., Nagendra Prasad, K., Eng Khoo, H., Nurnadia, A.A., Alina, M., Amin, I., and Zulkhairi A. 2010. Comparison of fatty acids, vitamin E and physicochemical properties of *Canarium odontophyllum* Miq. (dabai), olive and palm oils. *Journal of Food Composition and Analysis* 23: 772-776
- [9] Nagendra Prasad, K., Chew, L.Y., Khoo, H.E., Kong, K.W., Azrina, A. and Amin, I. 2010. Antioxidant capacities of peel, pulp, and seed fractions of *Canarium odontophyllum* Miq. fruit. *Journal of Biomedicine and Biotechnology* Article ID 871379, 8 pages doi:10.1155/2010/871379
- [10] Faridah, A.A. and Rashilah, M. 2007. *Buletin Teknologi Makanan*, Bil. 3. Serdang: Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI).
- [11] Faridah, A.A. 2005. *Manual Teknologi Penghasilan Pelbagai Sos*. Serdang: MARDI
- [12] Heyman, B., Depypere, F., Delbaere, C. and Dewettinck, K. 2010. Effects of non-starch hydrocolloids on the physicochemical properties and stability of a commercial béchamel sauce. *Journal of Food Engineering* 99:115-120.
- [13] Cochran, W.G. and Cox, G.M. 1957. *Experimental Designs*, pp. 136-140. New York: John Wiley and Sons.
- [14] AOAC. 1990. *Official Methods of Analysis*, 15th Edition. Washington: Association of Official Analytical Chemists.
- [15] Germain, P. and Linden, G. 1981. *Activites Enzymatiques. Analyse des Constituants Alimentaires*, pp. 211-244. Paris: Tec et Doc Lavoiser.
- [16] Favier, J.C., Ireland, R.J., Lassuc, C. and Feinberg, M. 1993. *Repertoire general des aliments: Table de composition des fruits exotiques*. Paris: Instituto Nacional de Reforma Agraria (INRA).
- [17] McKenna, B.M. 2003. *Texture in Foo: Semi-solid Foods*, Vol. 1. New York: CRC Press.
- [18] Hamdzah, A.R. 1999. Pemprosesan kordial dan jus buah-buahan. *Buletin Teknologi Makanan*, Jilid 10. Serdang: MARDI
- [19] Knecht, R.L. 1990. *Sugar. A User's Guide to Sucrose*. New York: Thomson Publishers.
- [20] Bourne, M.C. 2002. *Food Texture and Viscosity: Concept and Measurement*. 2nd Edition, pp.206-228. New York: Academic Press.
- [21] Akinyele, I.O., Keshunro, O.O. and Akinnano, O.O. 1990. Nutrient losses during and after processing of pineapples and oranges. *Journal of Food Chemistry* 37(4):181-188.
- [22] Katerson, A. and Badrie, N. 2002. Sensory and physicochemical quality of reduced sodium sauces from dwarf golden apples. *Journal of Food Science* 67:3476-3483.
- [23] Sharoba, A.M., Senge, B., El-Mansy, H.A., Bahlol, H.E.I.M. and Blochwitz, R. 2005. Chemical, sensory and rheological properties of some commercial German and Egyptian tomato ketchups. *European Food Resources Technology*. 220:142-151.
- [24] Bajwa, E.E., Naeem, Z., Anjum, J. and Nazir, A. 2003. Development, standardization and storage studies on watermelon-lemon. *Journal of Food Science* 12:21-24.
- [25] Hussain, I., Zeb, A., Shakir, I. and Shah, W.H. 2008. Combined effect of potassium sorbate and sodium benzoate on individual and blended juices of apricot and apple. *Journal of Food Science* 7(1):181-185.
- [26] Faridah, A.A. and Rokiah, B. 1994. Penghasilan sos desert berasaskan buah. *Buletin Teknologi Makanan*. Serdang: Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI).
- [27] Hummel, M. and Okey, R. 1950. Relation of canned tomato products to storage losses of ascorbic acid. *Journal of Food Research* 15:405-414.
- [28] Iqbal, S.A., Yasmin, S., Wadud and Shah, W.H. 2001. Production storage packing and quality evaluation of Guava Nectar. *Journal of Food Science* 11:33-36
- [29] Khadijah, I. and Hamdzah, A.R. 1987. *Food Thickeners*. *Buletin Teknologi Makanan*, Jilid 17. Serdang: Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI).
- [30] Artes, F.C. 2003. *Active packaging and colour control: The case of fruits and vegetables*. *Novel Food Packaging Techniques*. England: Woodhead Publishing Company Ltd.
- [31] Akhtar, S., Riaz, M., Ahmad, A. and Nisar, A. 2009. Physicochemical, microbiological and sensory stability of chemically preserved mango sauce and jam. *Journal of Food Science* 65(2):718-723.
- [32] Claybon, K.T. and Barringer, S.A. 2002. Consumer acceptability of colour in processed tomato products by African-American, Latino and prototypical consumers. *Journal of Food Quality* 25:487-498.
- [33] *Akta Makanan Malaysia 1983 dan Peraturan Makanan 1985*. (Pindaan September 2010). Kuala Lumpur: International Law Book Services.
- [34] Loureiro, V. and Querol, A. 1999. The prevalence and control of spoilage yeasts in foods and beverages. *Trends in Food Science and Technology* 10:355-365.
- [35] Cruess, W.V. and Irish, J.H. 1932. Further observations on the relation of pH value to toxicity of preservatives to microorganisms. *Journal of Bacteriology* 23:163-165.
- [36] Filtenborg, O., Frisvard, J.C. and Thrabe, U. 1996. Moulds in food spoilage. *Journal of Food Microbiology* 33:85-102.
- [37] Wen, T.Y. 2006. *Penghasilan sos buah nanas*. Tesis sarjana muda. Sekolah Sains Makanan dan Pemakanan. Universiti Malaysia Sabah.
- [38] Chipley, J.R. 1993. *Sodium benzoate and benzoic acid. Antimicrobials in Foods*. 2nd Edition, pp. 11-48. New York: Interscience Publishers.
- [39] Despande, S.S. and Salunkhe, D.K. 1995. *Food Acidulants*. *Food Additive Toxicology*. United States: Marcel Dekker.
- [40] Mohd Khan, A., Aminah, A., and Zawiah, H. 1992. *Pengenalan Sains Makanan*. Dewan Bahasa dan Pustaka.
- [41] Haines, R.G. 1973. *Food Preparation for Hotels, Restaurants and Cafeterias*, pp. 265-268. United States: American Technical Publishers.
- [42] Eklund, T. 1983. *Organic acids and esters. Mechanisms of Action of Food Preservation Procedures*, pp. 161-200. London: Elsevier Applied Science.
- [43] Ford, L.D., Raju, P.B., Pechak, D. and Schwimmer, B. 2004. *Dressings and sauces. Food Emulsions*, 4th Edition. New York: Marcel Dekker Inc.
- [44] Arocas, A., Sanz, T. and Fiszman, S.M. 2009. Improving effect of xanthan and locust bean gums on the freeze-thaw stability of white sauces made with different native starches. *Food Hydrocolloids* 23:2478-2484
- [45] Devey, J.D. and Dakin, J.C. 1971. *Pickle and Sauce Making*. 3rd Edition. London: Food Trade Press.