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Physico-chemical characteristics of flavoured dessert gels from semi-refined carrageenan

(Ciri fizikal dan kimia jel berperisa daripada karaginan separa tulen)

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Key words: flavoured dessert gel, semi-refined carrageenan

Abstract

Flavoured dessert gel was made from semi-refined carrageenan (SRC) while other essential ingredients such as sugar, citric acid, permitted food flavouring and food colouring were added for flavour, acid-sugar balance and eye appeal of the product. The major characteristics of the product analysed were gel strength = 112 ± 2.50 g/cm^2, freeze thaw property = 88.50 ± 9.50 g/cm^2, no syneresis, moisture = 80.85 ± 1.01%, pH = 4.43 ± 0.01, TSS = 17.40 ± 0.35 Brix and crude fibre = 2.97 ± 0.10%. Product analysis showed that the flavoured dessert gel produced was comparable to similar products in the market in terms of pH and TSS while gel strength differed from some of the market products.

Introduction

Edible gums find wide applications in the food industry, where they are used as water binders, suspending agents, thickeners and emulsion stabilisers. They are essential in improving the mouth feel in many products. Gums are important in stabilising ice creams, sherbets and other frozen desserts; their water-binding action prevents an undesirable grainy texture and the growth of ice crystals. In addition they can be used in desserts, replacing gelatine in gelled desserts, and starch in milk puddings (Lawrence 1973). The majority of edible gums used in the food industry are of natural origin; some being plant exudates (gum arabic), plant extracts (pectins), plant seed flours (carob gum), seaweed extracts (alginic acid, agar, carrageenan), cereal and tuber starches, vegetable products (soy protein), animal products (gelatin) and even bacterial products (xanthan gum) (Blanshard 1978).

Carrageenans are by far the most important red seaweed polysaccharides in food. They are sulfated polymers which consist of galactose and anhydrogalactose units (Dziezak 1991). Refined carrageenans are categorised based on their three major fractions, known commercially as 'kappa', 'iota' and 'lambda', which differ essentially in the degree of sulphation (Morris 1986). Carrageenans are widely used as thickening agents and stabilizers in the food industry (Glicksman 1969), especially in emulsion stabilisation, for syneresis control and for bodying, binding and dispersion. Carrageenans are unique in their ability to suspend cocoa in chocolate milk at very low concentration.

The major uses of carrageenans in foods are in frozen desserts, pasteurised milk products, cream mixture for cottage cheese, sterilised milk products, whipped products, acidified milk, jellies, syrups, fruit

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drink powders, frozen concentrates, imitation milk and many others (Stanley 1987). Although milk based carrageenan gels are important, water based gels are also of significance, for example, in the manufacture of some pet foods and low calorie jams and jellies (Sanderson 1981). Carrageenans have also found important uses in many dietetic and dietary products, cosmetics and photographic films (Huffman and Shah 1995).

One of the most important and unusual properties of carrageenans especially kappa carrageenan has been the ability to bind with water to form strong, rigid gels. Most of the k-carrageenan sols will set into gel structure at ambient temperatures, without the need for refrigeration. Food service operations i.e. cafeterias and institutions, can prepare water dessert gels and be confident that the dessert will retain its integrity during extended periods at room temperature (Anon. 1993). Carrageenans are also used in combination with locust bean and guar galactomannans as gelling agents in pet foods. However, in recent times, extracted carrageenans have almost entirely been replaced by semi-refined carrageenan from *Eucheuma cottonii* where the type of carrageenan is mostly k-carrageenan (Glicksman 1969).

Water jellies or dessert gels are most familiar, easily identifiable and eaten worldwide. Acid or fruit flavoured, they are freshing desserts with enhanced colours. However, these gels are usually made of gelatine and as such raised religious issues pertaining to its consumption. There is very little information on the performance and application of semi-refined carrageenan (SRC) in food products, especially for human consumption. This study was undertaken to evaluate the performance of SRC in flavoured dessert gel.

Materials and methods

Raw materials

Semi-refined carrageenan (SRC) used was prepared from locally available seaweed, *Eucheuma cottonii* by a method earlier described (Normah and Nazarifah 2003). Other ingredients used in this study were granulated sugar, anhydrous citric acid, permitted food flavouring and food colouring which were purchased from a local market. From preliminary trials, it was found that 0.05% food flavour and 0.025% food colour were adequate for the product.

Processing method

Process for the preparation of flavoured dessert gel from SRC was adapted from a method reported by Lawrence (1973) as outlined in *Figure 1*. The parameters investigated were the level of SRC (0.8–1.7%), sugar (10–17%) and citric acid (0.03–0.1%) to be used. Evaluation was also conducted to compare the flavoured dessert gel produced with similar products available locally such as *Moway*, *Yame* and *Tenten* gels.

Sensory evaluation

Data were collected in a complete randomised block design with 20 trained

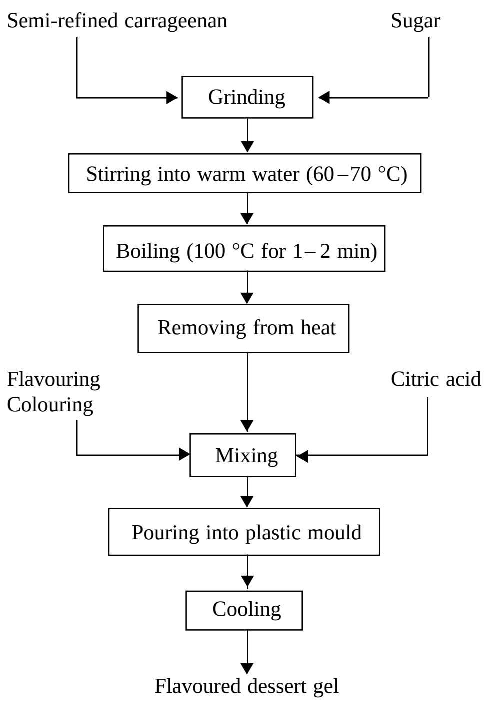

Figure 1. Production of flavoured dessert gel

panellists. The panellists were research staff of Food Technology Research Centre of MARDI who had been trained for general-purpose sensory evaluation (Larmond 1977). Evaluation was conducted in an air-conditioned sensory evaluation laboratory. Each booth was illuminated with fluorescent light. Panellists were asked to evaluate the samples for colour, aroma, texture, taste and overall acceptability. Scores were based on a seven-point hedonic scale of 1 to 7 (7 being the highest score).

The analysis of variance (one-way ANOVA) of the categorical sensory measurements was performed using Microsoft Excel 2000.

Physico-chemical analysis

Physico-chemical analysis was carried out on the most acceptable sample based on the overall acceptability results of the sensory evaluation. The physical properties of the samples analysed were gel strength, freeze-thaw property and syneresis. Gel strength was determined by a 2-cycle compression test using a Stevens Fernell (model QTS 25) texture analyser fitted with TA5 delrin probe. Freeze-thaw property was determined by measuring the gel strength of the completely thawed samples after freezing them at 0 ± 2 °C for 24 h. Syneresis was measured by the percentage of water present when the frozen samples were completely thawed out.

The moisture, fat, protein, ash and crude fibre contents of the samples were analysed using methods by Egan et al. (1981). pH was determined using Acumet Basic pH meter (model AB15), acid insoluble ash was determined according to standard AOAC method (AOAC 1990) and total soluble solids (TSS) was measured using portable refractometer (Atago model N-1E). All analyses were conducted in quadruplicate.

Comparison to commercial products

Comparison was conducted for prepared samples against some locally available commercial products. The parameters used in the comparison include pH, total soluble solids (Brix), gel strength and overall acceptability.

Results and discussion

The gel strength did not change very much at lower concentration of less than 1% SRC *(Figure 2)*. However, as concentration increased from 1% to 1.3%, there was an increase in gel strength after which it remained fairly constant even though the SRC concentration increased. On the other hand, TSS and pH remained fairly constant with an increase in SRC concentration. This may be the resultant of saturation point for the dissolution and entrapment of the water and other solutes within the structural network of the SRC. It has been reported that k-carrageenan normally swelled but dissolved slightly in cold water and heat was required to achieve dissolution (Glicksman 1969). Upon cooling, it would form a three dimensional molecular network or matrix and hold the water and other ingredients in a gelled form (Jensen 1994).

There was an obvious reduction in pH with the increase in citric acid concentration *(Figure 3)*. Both TSS and sourness scores were fairly constant initially but increased as concentration increased from 0.05% to 0.08%. At a concentration of more than 0.08% citric acid, values for both parameters decreased. Acid and oxidising agents may hydrolyse carrageenan in solution leading to loss of physical properties through cleavage of glycosidic bonds.

Carrageenan is quite stable at pH above 7 but below 7, its stability decreases especially with increasing temperature. Degradation at pH 5 – 7 is mild and it is fairly easy to work with carrageenan in this range. In low pH systems, it is recommended that the acidulant be added at the last step of processing or just prior to filling into containers (Anon. 1993). However, once gels are formed, the system is fairly stable even at low pH conditions (Glicksman 1969). This is an important

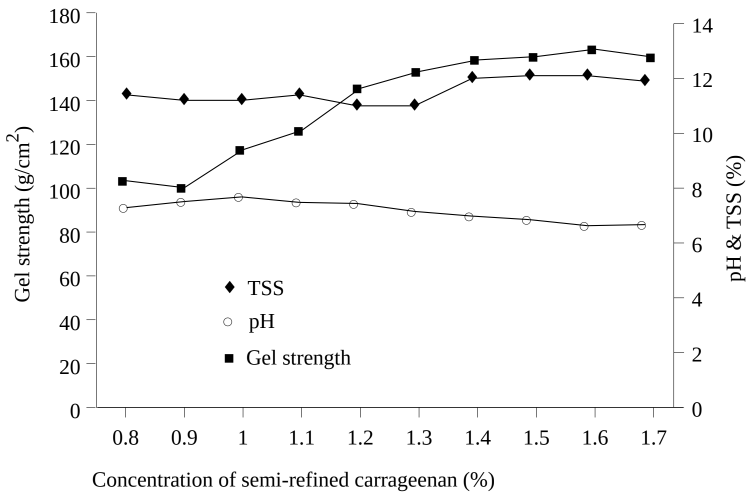

Figure 2. Effect of semi-refined carrageenan concentration on gel strength, TSS and pH

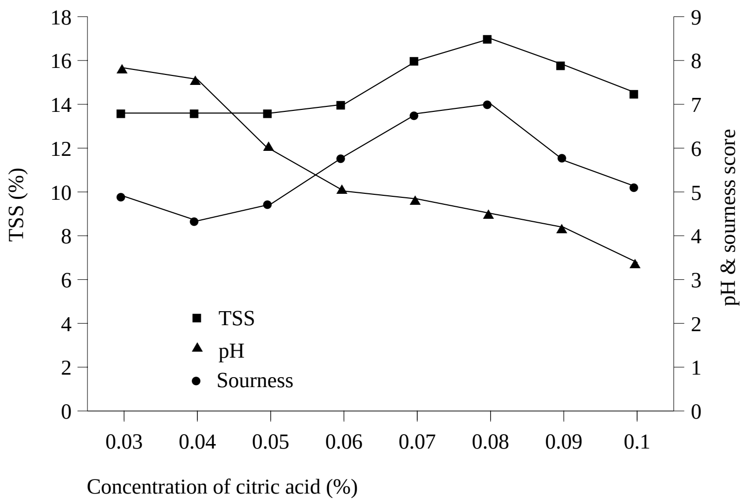

Figure 3. Effect of citric acid concentration on TSS, pH and sourness score

factor whereby low pH and high acid in the final product can also exert a preservative effect, thus helping in the improvement of shelf life as well as the addition of other preservatives that are pH dependent.

The effects of sugar concentration on TSS, pH and sweetness scores of the flavoured gel are shown in *Figure 4*. TSS increased with increase in sugar content while pH remained fairly constant. The sweetness score also showed an increase up to sugar concentration of 15% after which the score reduced slightly. This indicated that acceptability of the gel was reduced due to the taste of excess sweetness in the final product.

High levels of sugar, a common component of water based gels, reduce but do not prevent dissolution of carrageenan (Glicksman 1969). This is because when the soluble solids content increases to more than 50%, the gelling temperature needs to be

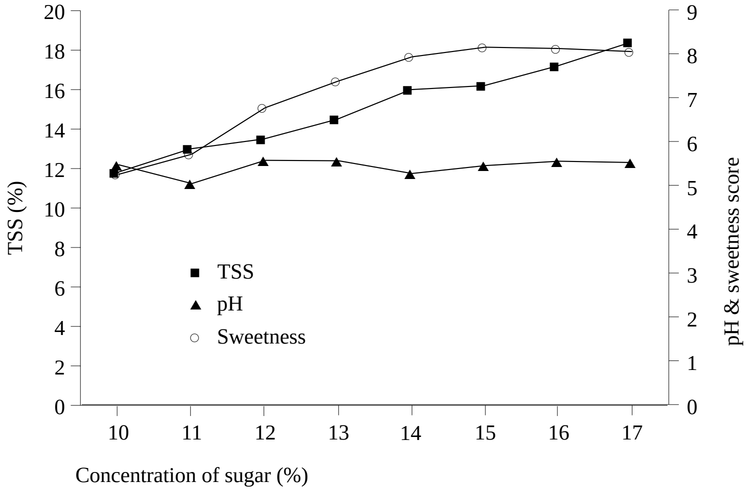

Figure 4. Effect of sugar concentration on TSS, pH and sweetness score

Table 1. Mean score for sensory attributes of flavoured dessert gels from semi-refined carrageenan

	FG1	FG2	FG3
Taste	5.75a (1.02)	5.05a (1.05)	5.45a (0.99)
Colour	6.30a (0.92)	6.35a (0.81)	6.35a (0.75)
Sourness	5.65a (1.27)	5.30b (1.26)	5.40b (1.19)
Aroma	6.50a (0.83)	5.65a (1.35)	5.65a (0.93)
Sweetness	6.05a (1.23)	5.55b (1.32)	5.75b (1.25)
Texture	5.25a (1.62)	5.15b (1.60)	5.00b (1.59)
Overall acceptability	5.60a (1.57)	5.25a (1.19)	5.25a (1.25)

Mean values in the same row with different letters are significantly different (p <0.05)
Numbers in parentheses represent the standard deviation of the mean
FG1 = 1.2% SRC
FG2 = 1.4% SRC
FG3 = 1.6% SRC
Other ingredients: Sugar = 15%,
Citric acid = 0.08%, Flavouring = 0.05%,
Colouring = 0.025%

increased to improve dissolution. High temperature in combination with acid will cause rapid depolymerization of carrageenan (Anon. 1993).

Based on the information obtained, sensory evaluation was conducted on flavoured dessert gels prepared based on the three formulations with varying concentrations of SRC (1.2, 1.4 and 1.6% SRC). The other ingredients used in the formulation remained constant viz. sugar (15%), citric acid (0.08%), flavouring (0.05%) and colouring (0.025%).

Results of the sensory evaluation indicated that all three samples were acceptable *(Table 1).* No significant differences were seen among the samples in taste, colour, aroma and overall acceptability. However, there was a significant difference (p <0.05) in sourness score where the FG1 sample had highest score and differed significantly from the others. Similar results were also observed for sweetness and texture scores whereby in both cases, the FG1 sample had highest score and were significantly different from the others.

The gel had good freeze-thaw property and no syneresis *(Table 2)*. This factor differentiates the stability of SRC gel compared to k-carrageenan gel because k-carrageenan gels are normally brittle and are characterised by the development of syneresis when cut (Glicksman 1969) and this limits its use in frozen products.

Results of the selected physico-chemical characteristics of flavoured dessert gel and commercial samples showed that there were no significant differences among the samples for pH and TSS values *(Table 3)*. However, there was a significant difference in the gel strength where *Yame* gel seemed significantly firmer (p <0.05) compared to SRC and *Moway* gels. A significant difference in gel strength was also noted between the *Yame* and *Tenten* gel samples. Even though the most important attribute of gels is texture, usually measured in gel strength, the sensory attribute of each sample needs also be taken into consideration since it is a complex of physical and sensory properties (Chai et al. 1991).

Table 2. Physico-chemical properties of flavoured dessert gel* from SRC

	Mean values
Physical properties	
Gel strength (g/cm^2)	125.00 ± 2.50
Freeze-thaw property (g/cm^2)	88.50 ± 9.50
Syneresis (%)	0 (no syneresis)
Chemical composition	
pH	4.430 ± 0.010
TSS (Brix)	17.400 ± 0.350
Acid insoluble ash (%)	0.009 ± 0.011
Moisture (%)	80.850 ± 1.010
Ash (%)	0.210 ± 0.010
Fat (%)	0.025 ± 0.002
Protein (%)	0.320 ± 0.001
Crude fibre (%)	2.970 ± 0.100

*Flavoured dessert jelly based on FG1 formulation

Conclusion

An acceptable flavoured dessert gel can be produced from semi-refined carrageenan (SRC) produced from local seaweed. The degree of acceptability of the gels depends on the manipulation of the formulation and production process of flavoured dessert gel. Hence, the possible usage of the SRC in products such as dessert gels widens the scope of the use of locally available SRC for human food.

Acknowledgement

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Table 3. Comparison of flavoured dessert jelly produced to similar products from local markets

	SRC Gel*	*Moway* Gel	*Yame* Gel	*Tenten* Gel
pH	4.43a	4.63a	4.57a	4.28a
	(0.01)	(0.02)	(0.02)	(0.02)
TSS (Brix)	17.40a	16.70a	16.00a	18.60a
	(0.35)	(0.95)	(1.73)	(0.81)
Gel strength (g/cm^2)	112.00a	112.33a	219.00b	199.33c
	(10.71)	(17.32)	(17.38)	(20.17)
Overall acceptability	5.60a	5.58a	5.50a	5.55a
	(1.57)	(1.54)	(1.89)	(1.32)

Mean values in the same row with different letters are significantly different (p <0.05)
Numbers in parentheses represent the standard deviation of the mean
*SRC gel based on FG1 formulation

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Abstrak

Jel pencuci mulut berperisa telah dihasilkan daripada karaginan separa tulen (SRC) dengan menambah bahan lain seperti gula, asid sitrik, perisa makanan dan pewarna makanan yang dibenarkan, yang diperlukan untuk menambahkan perisa, mengimbangkan asid-gula serta untuk kelihatan menarik. Ciri-ciri penting produk yang dianalisis ialah kekuatan jel = 112 ± 2.50 g/cm^2, sifat beku-cair = 88.50 ± 9.50 g/cm^2, tiada sineresis, kelembapan = 80.85 ± 1.01%, pH = 4.43 ± 0.01, TSS = 17.40 ± 0.35 Brix dan serat kasar = 2.97 ± 0.10%. Analisis produk juga menunjukkan bahawa jel berperisa yang dihasilkan setanding dengan produk yang serupa dalam pasaran dari segi pH dan TSS tetapi berbeza sedikit dari segi kekuatan jel.

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