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The Effect of Different Concentrations of Gelatine derived from Shark Skin as Stabiliser in Pineapple Juice

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Gelatine is widely used in foods and pharmaceuticals as a stabiliser, thickener or emulsifier agent. However, commercial gelatine is mostly prepared from the bones and skin of animals such as pig, which is a taboo for the Muslims and the Jews. Therefore, it is necessary to look for other sources of gelatine to cater to the halal and kosher markets. This study aimed to determine the effect of the addition of shark skin gelatine at different concentrations on the physicochemical (viscosity, total dissolved solids, stability, colour, pH, and vitamin C content) and organoleptic (taste and aroma) properties of pineapple juice. The experiment was performed in a completely randomised design with a single factor, the concentration of shark skin gelatine that consisted of 6 treatments (0.0, 0.5, 1.0, 1.5, 2.0 and 2.5%) in triplicates. The extraction method used in this study yielded 4.35% gelatine of the initial shark skin weight, with the gelatine characterised by a gel strength of 50.65 g Bloom, a pH of 6.30, and a protein content at 80.83%. The results showed that the addition of gelatine derived from shark skin significantly affected the viscosity, total dissolved solids, stability, pH and colour of the pineapple juice. The addition of 2.5% gelatine derived from shark skin was the best treatment to produce pineapple juice characterised by a viscosity of 17.07 cP, total dissolved solids of 13.77°Brix, 94.00% stability, colour component L* value of 78.44, hue angle of 92.66 (greenish yellow), pH 4.62, and a vitamin C content of 12.66 mg/100 g. The treatment did not significantly affect the preference and acceptance for the pineapple juice, but the panellists scored "like" for the taste and aroma of pineapple juice added with 2.5% shark skin gelatine which was considered to be slightly sour and had the typical scent of pineapple juice.

Keyword: gelatine; shark skin; stability; pH; pineapple juice

I. INTRODUCTION

Pineapple (*Ananas comosus* L. Merr) has a sweet, sour and refreshing taste at the same time, and contains the complete nutrient content, e.g. vitamins (A, B and C) and minerals (calcium, phosphorus, and iron). In addition, it is also rich in antioxidants such as flavonoids and polyphenols (Hossain & Rahman, 2011). Fresh pineapple cannot be stored for too long, since it has a high moisture content of about 90%, and its shelf life is only 1–7 d at room temperature (Hounhouigan *et al*., 2014a). Therefore, further processing of the pineapple is needed to maintain the nutritional content and to lengthen the shelf life of the fruit. One technique that could be applied is to transform the fresh pineapple fruit into juice. Fruit juice drinks are soft drinks made from fruit and drinking water with or without the addition of sugar and permitted food additives (BSN, 1995). The pineapple juice is turbid and loaded with dissolved solids, with slightly sour taste.

The problem with pineapple juice is the formation of sediments during storage. During the production of cloudy fruit juice drinks, stabilisers are added to maintain turbidity and to prevent the settlement of dissolved solids.

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The use of stabiliser at a concentration too high will cause the juice to become too thick, while a concentration too low will cause precipitation. The recommended range of gelatine concentration in a fruit juice product was between 0.5 and 1.5% (Koswara, 1992).

Gelatine is an important functional biopolymer widely used in foods to improve elasticity, consistency and stability. The use of gelatine as a stabiliser is supported by its high protein content (Zhang *et al.*, 2011), and its ability to change its form reversibly from sol to gel. Gelatine can be obtained not only from the skin and bones of land animals, but also from fish and insects. In recent years, fish and edible insects provide an alternative source of gelatine that is acceptable for use in halal and kosher products that cater to the Muslims and the Jews. Gelatine from marine sources (skin, bones and fins of the warm-water and cold-water fish) become an alternative to bovine gelatine since the outbreak of bovine spongiform encephalopathy (Wassawa *et al.*, 2007).

This study aimed to investigate the use of gelatine derived from shark skin as a stabiliser in pineapple juice to achieve the recommended stability of at least 50% (BSN, 1995). We also investigate the stabilising effect of different shark skin gelatine concentrations in the production of pineapple juice. The physicochemical and organoleptic properties were also evaluated to assess the commercial feasibility of using gelatine derived from shark skin as the stabiliser in pineapple juice.

II. MATERIALS AND METHODS

A. Production of Gelatine from Shark Skin (Modified from Pelu et al.*, 1998)*

Shark (*Prionace glauca* L.) skin recovered from the filleting waste was obtained from traders in Rumbuk Village, Sakra sub-district, East Lombok Regency. The dried skin was first soaked in hot water at 80°C for 2 min to remove the dirt, cut into small pieces of about 1 cm × 1 cm and weighed for 500 g. The pieces of shark skin were then demineralised by soaking in 3% acetic acid for 24 h, and washed to remove the acidic solution. The extraction of gelatine was carried out by soaking the pieces of skin in distilled water at a ratio of 1:3 in a glass beaker maintained at 80°C in a water bath for 3 h. The shark skin extract was then filtered with Whatman filter paper no. 42 to separate skin residues from the gelatine solution. The filtrate was placed in the refrigerator for gelling, and the gel was then dried in an oven at 50°C for about 15 h until a gelatine layer was formed. After drying, the gelatine sheet was pureed using a blender.

B. Production of Pineapple Juice (Modified from Kumalasari et al.*, 2015)*

Pineapples with a maturity level of about 70% were obtained from the Kebun Roek market. The production of pineapple juice involved the preparation of pineapples with sorting, peeling, washing, cutting, blanching at 50°C, crushing of fruit flesh, and filtering. After that, the juice was diluted and treated with gelatine derived from shark skin at various concentrations: 0.5, 1.0, 1.5, 2.0 and 2.5%. A control without the addition of shark skin gelatine was also prepared.

C. Determination of Shark Skin Gelatine and Pineapple Juice Quality

The quality of gelatine prepared from shark skin was determined based on the gelatine yield measured using gravimetric method (Marzuki *et al.*, 2011), gel strength measured using a Brookfield texture analyser (Zhang *et. al.*, 2011; Fatimah & Jannah, 2009), pH measured using a Schott pH meter (Sudarmadji *et al.*, 1984), and protein level measured using the micro Kjeldahl method (AOAC, 1999). The quality of pineapple juice subjected to all treatments was assessed in terms of the physicochemical and organoleptic properties of the juice. The assessed physicochemical parameters were as follows: viscosity measured using a Brookfield RVT viscometer (AOAC, 1999), total dissolved solids measured using an Atago N1 hand-held refractometer, stability, colour, vitamin C content (AOAC, 1999) and pH (Sudarmadji *et al.*, 1984). The stability of fruit juice produced in this study was calculated from the percentage of sediment formed during a period of one-week storage (Kumalasari *et al.*, 2015). Colour analysis was carried out using a Minolta CR 300 chroma meter to determine the degree of whiteness or the brightness of pineapple juice based on the L^* value, and the fruit juice colour (hue) based on the a^* and b^* values. L^* value represents the degree of lightness or brightness that ranged from 0–100, for which a value of 0 indicates a dark tendency while a value of 100 indicates a bright tendency (Herlina *et al.*, 2015). Hue is the dominant spectral colour of specific wavelength defined by the values of a^* and b^*, which can be expressed as hue angle. Colours are arranged in a circle which can be divided into ten equally spaced groups based on the hue angle values starting from 0°: red, yellow red, yellow, yellow green, green, blue green, blue, blue purple, purple and red purple.

Organoleptic analysis was carried out using the hedonic and scoring tests, with the taste and aroma of the fruit juice serving as the test parameters (Soekarto, 1985). Twenty-five semi-trained panellists were asked to evaluate the taste and aroma of the samples. The hedonic test was conducted to determine the panellists' preference for the fruit juice, which was scored based on a nine-point scale. A score of 9 denotes "like extremely", and a score of 1 denotes "dislike extremely". The scoring test aimed to determine the level of consumer acceptance, also scored based on a nine-point scale, with a score of 9 represents "extremely strong pineapple aroma" and a score of 1 represents "extremely weak pineapple aroma".

D. Data Analysis

This study was performed using a completely randomised design to test the effect of different concentrations of shark skin gelatine (0.0, 0.5, 1.0, 1.5, 2.0 and 2.5%) on the pineapple juice quality in triplicate. Data were subjected to analysis of variance at a significance level of 5% using Co-Stat software. If there was a significant difference among treatments, further testing was carried out with the Duncan Multiple Range Test for all parameters at the same level.

III. RESULTS

Following the extraction method applied in this study, the gelatine yield was 4.35% of the initial shark skin weight, with the gelatine characterised by a gel strength of 50.65 g Bloom, a pH of 6.30 and high protein content at 80.83%.

The effect of shark skin gelatine concentration on the physicochemical properties of pineapple juice was shown in Table 1. Based on the results, the addition of shark skin gelatine at different concentrations (0.5, 1.0, 1.5, 2.0 and 2.5%) generally had a significant effect on the viscosity, total dissolved solids, stability, pH and colour (L^* value and hue angle). However, the treatment did not significantly affect the vitamin C content in pineapple juice ($p > 0.05$).

Pineapple juice treated with 2.5% shark skin gelatine recorded the highest viscosity of 17.07 cP (Table 1) and total dissolved solids of 13.77°Brix (Table 1), compared to the control that had the lowest viscosity of 15.87 cP and total dissolved solids of 12.37°Brix. Similarly, the highest stability of 94% was found for pineapple juice added with 2.5% gelatine, compared to the untreated juice at 80% (Table 1). The pineapple juice recorded the highest pH at 4.62 when treated with 2.5% gelatine, and the lowest at 3.75 without any treatment (Table 1). The highest average vitamin C content of 12.66 mg/100 g ingredients was recorded for pineapple juice added with 2.5% gelatine, and the lowest was found for the control at 12.07 mg/100 g ingredients (Table 1). The average L^* value of pineapple juice ranged from 70.45 to 92.72, with the lowest L^* value found for pineapple juice treated with 2.5% gelatine, and the highest value for the control, which means the addition of shark skin gelatine caused the pineapple juice to become darker in colour (Table 1). The average hue angle values of the pineapple juice ranged from 83.83 to 92.66, with the highest value found in the juice treated with 2.5% gelatine and the lowest in the control. The colour of pineapple juice changed from yellow to greenish yellow with the addition of shark skin gelatine at increasing concentrations (Table 1).

The scores for the taste and aroma of pineapple juice added with different concentrations of shark skin gelatine were presented in Figures 1 & 2. In general, all treatments showed no significant difference in affecting the preference and acceptance for the taste and aroma of the

Table 1. The effect of shark skin gelatine concentration on physicochemical properties of pineapple juice

Gelatine concentration (%)	**Parameter**						
	Viscosity (cP)	Total dissolved solids (°Brix)	Stability (%)	pH	Vitamin C (mg/100 g)	Colour	
						*L**	°H
0.0	15.87 ± 0.00 b	12.37 ± 0.46 c	80.00 ± 0.00 e	3.75 ± 0.05 a	12.07 ± 0.20	92.72 ± 0.77 a	83.83 ± 0.15 d
0.5	16.00 ± 0.23 b	12.50 ± 0.10 c	89.67 ± 0.57 d	4.14 ± 0.02 b	12.09 ± 0.21	89.54 ± 0.68 b	84.50 ± 0.79 d
1.0	16.13 ± 0.23 b	12.93 ± 0.20 b	90.33 ± 0.57 c	4.31 ± 0.02 c	12.11 ± 0.14	83.58 ± 0.66 c	88.00 ± 0.99 c
1.5	16.13 ± 0.23 b	13.00 ± 0.10 b	91.67 ± 0.57 b	4.45 ± 0.01 d	12.24 ± 0.05	80.71 ± 0.65 d	90.28 ± 0.54 b
2.0	16.13 ± 0.23 b	13.27 ± 0.05 b	91.00 ± 1.00 b	4.54 ± 0.02 e	12.45 ± 0.78	78.44 ± 0.65 e	91.02 ± 0.80 b
2.5	17.07 ± 0.46 a	13.77 ± 0.11 a	94.00 ± 1.00 a	4.62 ± 0.01 f	12.66 ± 0.05	70.45 ± 0.78 f	92.66 ± 0.69 a

Values followed by the same letters within a column are not significantly different ($p < 0.05$).

juices ($p > 0.05$). The average scores for the preference test (hedonic) for the fruit juice taste ranged from 6.65 to 6.95 which represent "quite like" to "like", while the scores for the consumer acceptance test (scoring) ranged from 6.55 to 6.95 or "slightly sour" to "sour". The mean scores for the preference test for the fruit juice aroma ranged from 6.70–7.20 which represents "quite like" to "like", whereas the average scores for the acceptance test ranged between 6.15–6.70 which denote somewhat typical scent of pineapple (Figures 1 and 2).

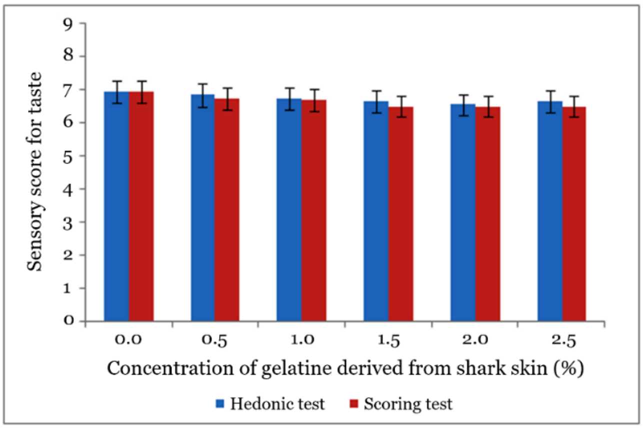

Figure 1. The effect of the addition of shark skin gelatine at various concentrations on the preference and acceptance for the taste of pineapple juice based on the hedonic and scoring tests

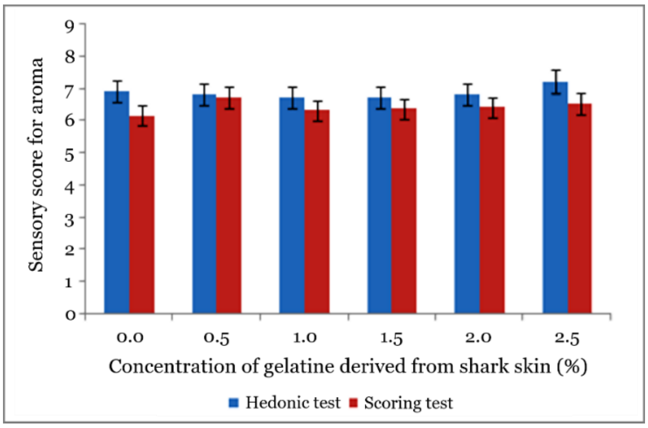

Figure 2. The effect of the addition of shark skin gelatine at various concentrations on the preference and acceptance for the aroma of pineapple juice based on the hedonic and scoring tests

IV. DISCUSSION

A. Quality of Gelatine Derived from Shark Skin

Gelatine is a heterogeneous mixture of peptides derived from collagen by processes that destroy the cross-linkages between the polypeptide chains along with some breakage of polypeptide bonds (Liu *et al.*, 2015). Therefore, the yield of gelatine depends on the amount of the collagen denatured as a result of the breakdown of hydrogen bonds between peptides in the extraction process. The gelatine yield is an important parameter in determining the efficiency and effectiveness of the gelatine production process. Based on the results from this study, it was found that the gelatine extraction procedure produced a rather low yield of 4.35%. According to Ridhay *et al.* (2016), the low gelatine yield may due in part to the higher mineral content in fish skin that bound to the acid and reduced the access of acid to break the cross-links of collagen during hydrolysis. The conversion of collagen to gelatine is influenced by temperature, heating time and pH. The low gelatine yield in this study could also be attributed to the high extraction temperature that caused further hydrolysis and degraded part of the produced gelatine (Johns & Courts, 1977).

The gelling ability of gelatine allows it to be widely used in various industries, therefore the gel strength of gelatine determines the application feasibility of gelatine. Gelatine derived from shark skin in this study had a higher gel strength of 50.67 g Bloom compared to that produced from the skin of *Lethrinus* sp. at 32.40 g Bloom (Prihardhani & Yunianta, 2015). This may be due to the lower content of non-collagen components such as ash in the gelatine derived from shark skin compared to that derived from the fish skin of *Lethrinus* sp. The strength of gelatine gel depends on the length of the amino acid chain. If hydrolysis occurs at the right phase in the polypeptide chain of collagen, where there is a breakup of hydrogen bonds, covalent cross-linkages and some peptide bonds, a gelatinous lysate of long peptide chains with high gel strength will be produced (Ward & Courts, 1977).

pH is another important parameter that determines the quality of gelatine, because it affects other properties of gelatine solution, such as viscosity and gel strength (Astawan, 2002), as well as the application of gelatine in a product. The shark skin gelatine extracted in this study was categorised as type B gelatine based on its pH that fell between the range of 5.00–7.00 outlined in the guideline of Gelatin Manufacturers Institute of America (2012). The gelatine was also suitable for use in food products, as its pH value also met the standards for food and pharmaceutical gelatine released by Norland (2003), i.e. 5.5–7.0. Gelatine with a close to neutral pH is preferred for wide industrial applications (Hinterwaldner, 1977).

Although the gel strength of shark skin gelatine produced in this study was at the lower limit for commercial gelatine (50-300 g Bloom), the protein content of gelatine derived from shark skin at 80.83% was within the range for that of the commercial gelatine from bovine hide between 75 and 85% (Khalaji *et al*.., 2016). The difference in protein content is influenced by the types of raw material used in the gelatine extraction process. Despite the rather low yield, the results indicated that the pre-treatment of shark skin with 3% acetic acid was sufficient to produce good quality gelatine with high protein content. The gelatine derived from shark skin in this study was characterized by gel strength and pH value within the range of commercial gelatine used in food products.

B. Effect of Shark Skin Gelatine on Quality of Pineapple Juice

The addition of shark skin gelatine significantly thickened or increased the viscosity of the pineapple juice compared to the control (Table 1). This is due to the hydrophilic nature of gelatine which caused the molecule to absorb water and swell when added to the pineapple juice, thereby restricting the movement of water and increased the viscosity of the juice (Fennema, 1996). According to Belitz *et al.* (2009), viscosity is affected by the concentration and weight of the stabiliser added. Pineapple juice added with the highest concentration of gelatine derived from shark skin was thickest with a viscosity of 17.07 cP, while the control was least viscous at 15.87 cP. The results of this study were similar to the findings from a study by Kumalasari *et al.* (2015), where mixed juice of papaya and pineapple added with carboxymethyl cellulose (CMC) had a viscosity of 15.39 cP, while that treated with Na alginate-CMC mixture had a viscosity of 18.48 cP. The viscosity of pineapple juice may have increased as a result of the suspended particles such as pectin in the fruit flesh and water binding with protein complexes in the presence of stabiliser (Stainsby, 1977). The binding of the negatively charged methyl ester group of pectin with the protonated amine group of proteins (stabiliser) prevented the settling of stabiliser (Trost, 2006).

The total dissolved solids level is a measure of the combined content of all inorganic and organic substances, including reducing sugars, non-reducing sugars, organic acids, pectin and proteins, dissolved in water present in a food product (Desrosier, 1998; Fahrizal & Fadhil, 2014). The water-soluble components in fruits are usually glucose, fructose, sucrose, and pectin. Based on Table 1, the total dissolved solids in pineapple juice was significantly increased with the addition of gelatine derived from shark skin, from 12.37°Brix to 13.77°Brix. The effect of gelatine addition on fruit juice observed in this study was similar to that reported by Farikha *et al.* (2013), where red dragon fruit juice treated with 1.5% gelatine as a stabiliser showed the highest total dissolved solids of 13.19°Brix compared to the juices added with 0.5% chitosan (12.59°Brix) and the control (12.32°Brix). The increased total dissolved solids in pineapple juice with the addition of shark skin gelatine is due to the ability of gelatine to absorb water in the juice. During the extraction of gelatine from collagen, the triple helix structure of collagen was broken up by heat treatment to form gelatine, with the hydrophilic groups of amino acids became exposed. The tendency for cross-links to form between the functional groups of amino acids and water allowed free water in the juice to be trapped in the gelatine (Belitz *et al.*, 2009), thereby increasing the concentration of soluble substances and thus total dissolved solids level. Water-soluble substances in the juice will remain suspended by being trapped in the stabiliser (gelatine) and do not settle by gravity (Potter & Hotchkiss, 1995). The composition of pectin in fruit also affects the total dissolved solids (Farizal & Fadhil, 2014; Winarno, 2002). Pectin in the fruit will be hydrolysed into soluble components during the fruit ripening process, therefore the amount of pectin will decrease and the amount of water-soluble component will increase.

The stability of fruit juice is proportional to the viscosity and total dissolved solids of the product (Manalo *et al.*, 1985). According to Farikha *et al.* (2013), the stability of a fruit juice can be accessed from the presence or absence of sediment in the product. The more sediment is formed, the more unstable is the fruit juice produced. A fruit juice is considered to be more stable if sedimentation occurs at a slower rate (Tamaroh, 2004). The addition of gelatine derived from shark skin significantly improved the stability of pineapple juice from 80% in the control to 94% in the treatment with highest gelatine concentration at 2.5% (Table 1). This is in line with the findings in a study by Farikha *et al.* (2013) that investigated the effect of natural stabilisers on the physicochemical characteristics of red dragon fruit juice. They showed that red dragon fruit juice with the highest stability was achieved with the addition of 1.5% gelatine (91%) and lowest when treated with 0.5% chitosan (51%), compared to the control (45.75%). The stability of fruit juice increased with the concentration of shark skin gelatine added to the juice. The nature of stabiliser to form a protective layer over the suspended particles in the juice reduces the interfacial tension and aids in the dispersal of insoluble particles to maintain the stability of the juice (Fennema, 1996). The lower stability of the control was due to the sedimentation of suspended particles in the juice as a result of not having enough stabilisers such as proteins and pectin that keep the particles suspended by binding to them during fruit juice production (Trost, 2006).

Judging from the relative amount of sediment formed, which were around 6% to 20%, the addition of shark skin gelatine (stabiliser) to pineapple juice was unable to prevent sedimentation, but the settlement of suspended particles was slowed down within one-week storage. This observation echoed the findings in Ibrahim *et al.* (2011). They found that apple juice treated with CMC, xanthan gum, and pectin continued to form sediment during storage but the treated juices were more stable than the control. According to Manalo *et al.* (1985), precipitation could be prevented by the formation of pectin gel that caused the viscosity and thus the stability to increase during the pasteurisation process. However, according to Farikha *et al.* (2013) and Pollard and Timberlake (1971), pectin in the fruit will be hydrolysed by the naturally occurring enzyme pectin methyl esterase and eventually lost its colloidal properties during the fruit juice extraction process. The breakdown of pectin will cause sedimentation that reduces the consistency and stability of pineapple juice. The occurrence of syneresis, which is the spontaneous or stimulated release of dispersed medium (water) from gel upon storage (Abidin *et al.*, 2013), in fruit juice added with stabilisers also affects the product's viscosity and stability.

An acidic fruit juice product with a pH of 4.5–5.0 is desirable because it can be pasteurised at a lower temperature range of 160–165°F or 71.1–73.9°C (Cruess, 1958). To obtain fruit juice products with a low pH value, acidic ingredients such as citric acid are used to adjust the acidity of the sample. The addition of gelatine derived from shark skin significantly reduced the acidity or increased the pH of pineapple juice from 3.75 in the control to 4.62 (Table 1). The rise in pH with increasing concentrations of gelatine added to the pineapple juice was expected since the gelatine has a higher pH of 6.30.

Vitamin C is one of the most important components in pineapple. The content of vitamin C in pineapple reaches 24.0 mg/100 g of ingredients (Hounhouigan *et al.*, 2014b). The increment of vitamin C content in pineapple juice with the addition of gelatine derived from shark skin was not significant (Table 1), but generally a higher vitamin C content was found when the concentration of gelatine added to the juice increased. The insignificant increase in vitamin C content in the pineapple juice treated with shark skin gelatine may also be attributed to the fact that the gelatine concentration range used in this study was relatively low (0.5–2.5%), such that the ability of gelatine to bind with water and water-soluble components such as vitamin C was not apparent. The increased vitamin C content with the concentration of shark skin gelatine could be caused by the aggregation of more colloidal particles in fruit juice with higher gelatine concentration. As the rate of degradation of ascorbic acid, or vitamin C, is proportional to the concentration of dissolved oxygen in food and beverage, and the aggregation of colloids reduces the availability of free oxygen to initiate oxidation reaction in the fruit juice (Tressler & Joslyn, 1961), the vitamin C content in the pineapple juice would therefore increase with the concentration of gelatine. According to Harris and Karmas (1989), the stability of ascorbic acid increases as pH decreases, that is, vitamin C is more stable in acidic media and degrades easily by heat and oxidation in neutral and alkaline media.

Colour is an important factor that determines the food quality before other factors that are visually considered. A food that is nutritious, tasty and with good texture will be less preferred if it has a colour that deviates from expectation (Winarno, 2002). The addition of shark skin gelatine significantly lowered the L^* value and increased the hue angle value of pineapple juice (Table 1), which means the yellowish pineapple juice became darker in colour with an added tinge of green as the concentration of gelatine increased. The darker shade caused by the greater concentration of shark skin gelatine added was due to the greater amount of water soluble particles in the juice being bound to the gelatine. As the gelatine was brownish yellow in colour, the colour of the pineapple juice shifted to greenish yellow when gelatine was added at a higher concentration.

C. Effect of Shark Skin Gelatine on Organoleptic Properties of Pineapple Juice

Organoleptic testing is an analysis of the sensory properties of a food or beverage product. The reaction or impression caused by the stimuli can be accessed from the attitude, such as to approach or to stay away from the stimuli, or to like or dislike the stimuli. In this study, organoleptic analyses for the taste and aroma of pineapple juice treated with shark skin gelatine at various concentrations were carried out using a hedonic test and a consumer acceptance test by scoring. Taste is a sensation resulting from the composition of ingredients in a food or beverage product that is captured by taste buds. It is an important attribute that influences the level of panellists' preference for a product, because panellists can sense the taste in the product as bitter, sweet, salty, sour and umami (de Man, 1999). Aroma is another attribute that determines the quality of a food or beverage product. The typical aroma can be detected by the sense of smell depending on its constituent ingredients and the ingredients added to the product. The detection of aroma is triggered by volatile components which are easily lost during processing, especially by heat (Fellows, 1990).

Based on both the hedonic and consumer acceptance tests, the addition of shark skin gelatine at various concentrations did not significantly affect the preference and acceptance for the taste and aroma of the pineapple juice. The higher the concentration of shark skin gelatine applied to the pineapple juice, the lower the panellists' preference for its taste (Figure 1). Of all the treatments, pineapple juice added with 2.5% gelatine was scored as less sour and least preferred by the panellists. The results were similar to that of a study by Rahmi *et al.* (2012) who found that the addition of gelatine to a food product will reduce the intensity of taste. A higher concentration of gelatine resulted in an increased amount of water trapped in the gelatine molecules, thereby causing the pineapple juice to taste less sour. However, pineapple juice added with 2.5% shark skin gelatine was most preferred and scored to have a more intense aroma typical of pineapple compared to the control (Figure 2). The insignificant change in the aroma of pineapple juice could be caused by the relatively low amount of shark skin gelatine (0.5–

2.5%) added to the juice which retained the typical pineapple aroma of the raw material.

V. CONCLUSION

The extraction procedure used in this study resulted in a gelatine yield of 4.35% of the initial shark skin weight, and the gelatine was characterised by gel strength of 50.65 g Bloom, pH of 6.30, and a protein content of 80.83%. The addition of shark skin gelatine of different concentrations (0.5, 1.0, 1.5, 2.0 and 2.5%) significantly affected the viscosity, total dissolved solids, stability, pH and colour of pineapple juice, but the treatment did not significantly affect the vitamin C content and organoleptic attributes of the juice. Based on the results, the addition of 2.5% gelatine derived from shark skin provided the best stabilising effect to the pineapple juice.

VI. ACKNOWLEDGEMENTS

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