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EXTRACTION AND CHARACTERIZATION OF MUCILAGE FROM LEAVES OF *Pereskia bleo* (ROSE CACTUS)

[*Ekstraksi dan Karakterisasi Getah Daun Kaktus Mawar (Pereskia bleo)*]

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ABSTRACT

Pereskia bleo (rose cactus) is a type of tropical herbs which has long been used for its medicinal benefits among Malays and is also known to contain complex polysaccharide called mucilage. In this study, mucilage from leaves of rose cactus was extracted by using distilled water or 0.14 M sodium hydroxide (NaOH) solution at three different temperatures (i.e. 50°C, 70°C or 90°C). There was a significant ($p<0.05$) interaction effect between type of medium used and temperature on yield of mucilage. Extraction using 0.14 M NaOH solution at 70°C provided the highest yield (2.55%) of mucilage as compared to other extraction conditions. The mucilage extracted with 0.14 M NaOH solution at 70°C was further characterized in terms of physicochemical properties and compared with arabic gum. The crude protein, moisture and ash content of the mucilage were 4.81%, 13.59% and 28.67% respectively. It possessed appreciable amount of elements such as calcium (48.96 mg/g sample), and potassium (15.58 mg/g sample). The pH value of the mucilage was 10.89 (alkaline) and it exhibited a clear thixotropic flow behavior with acceptable emulsion capacity (7.08%) and stability (7.31%) at 1% concentration. The colour of the mucilage and water holding capacity (WHC) was L*= 68.81, and 461.87 % respectively. These findings suggest that rose cactus mucilage could be an interesting functional food ingredient as it originated from a well-known medicinal plant though further study should be done in order to fully understand its potential as one of alternative food hydrocolloids.

Keywords: characterization, extraction medium, mucilage, *Pereskia bleo,* physicochemical

ABSTRAK

Kaktus mawar (Pereskia bleo) merupakan tanaman herbal yang sudah lama digunakan sebagai obat bagi masyarakat Melayu dan memiliki kandungan polisakarida kompleks semacam getah. Pada penelitian ini, getah daun kaktus mawar diekstrak menggunakan air destilata atau larutan 0,14 M sodium hidroksida (NaOH) pada tiga suhu (yaitu 50°C, 70°C atau 90°C). Terdapat pengaruh interaksi yang signifikan (p<0,05) antara pelarut dan suhu terhadap rendemen getah yang diperoleh. Ekstraksi menggunakan larutan 0,14 M NaOH pada suhu 70°C memberikan rendemen getah tertinggi (2,55%) dibandingkan dengan kondisi ekstraksi yang lain. Getah yang diekstrak menggunakan larutan 0,14 M NaOH pada suhu 70°C selanjutnya dikarakterisasi sifat fisiko-kimianya dan dibandingkan dengan gum arab. Kandungan protein kasar, kadar air dan abu dari ekstrak getah adalah 4,81%, 13,59% dan 28,67% berturut-turut. Ekstrak getah tersebut juga mengandung kalsium yang cukup (48,96 mg/g contoh) dan kalium (15,58 mg/g contoh). Nilai pH getah adalah 10,89 (alkali) dan menunjukkan sifat aliran thixotropic yang jelas dengan kapasitas emulsi yang baik (7,08%) dan stabilitas (7,31%) pada konsentrasi 1%. Warna getah dan water holding capacity (WHC) adalah *L*= 68,81 dan 461,87% berturut-turut. Hasil penelitian ini menunjukkan bahwa getah kaktus mawar dapat menjadi bahan pangan fungsional yang potensial karena berasal dari sebuah tanaman obat yang sudah dikenal, meskipun penelitian lebih lanjut harus dilakukan agar dapat memahami secara penuh potensinya sebagai salah satu alternatif hidrokoloid pangan.*

Kata kunci*: karakteristik, pelantara pencabutan, getah, Kaktus mawar, fisiko-kimia*

INTRODUCTION

Pereskia bleo is from the family of Cactaceae, commonly known as 'Tujuh Duri' in Malay community in Malaysia or known as Rose cactus. It is originated from the dry forest habitats of Caribbean and South America but cultivated in many tropical areas (Edwards *et al*., 2005). The leaf has been used as natural remedy in cancer related diseases, either eaten raw or taken as a concoction brewed from fresh plant (Sim *et al*., 2010). Its stem and leaf features are known to contain distribution of mucilage-bearing structures (Butterworth and Edward, 2008), which is a unique characteristic of plants from family of Cactaceae and has been suggested that it was a safe alternative source of industrial food ingredient for consumption. Mucilage is a type of hydrocolloid, a long chain substance of high molecular weight polysaccharide and protein which is hydrophilic; in food industry, mucilage is widely used as a food additive such as thickening agent, emulsifier, and gelling agent. It is known that *Pereskia* species have mucilaginous material. Thus, it is worth mentioning

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that rose cactus might have potential to provide a high yield of mucilage from its leaf. In this study, arabic gum was used as a material for comparison with mucilage from rose cactus.

MATERIALS AND METHODS

Materials

The leaves of rose cactus were collected from China town of Kuala Terengganu, Malaysia. Arabic gum was bought from R & M Chemical, UK and used as a material to be compared with mucilage from leaves of rose cactus.

Mucilage extraction

Method of extraction was adapted from Lai and Liang (2011) and Prabakran *et al*. (2011), it was done by soaking the blended leaves of rose cactus in different solutions, distilled water or 0.14 M sodium hydroxide (w/v) 1:3 for 3 hours then heated up to 50°C, 70°C or 90°C by using water bath (Techne 12/TE-10 D, UK) and subsequently filtered. The filtrate was precipitated with acetone (1:3 v/v), then dried in an oven at 40°C and grinded before storing at 4°C. The mucilage yield was calculated as:

$$\text{Yield (\%)}=\frac{\text{Weight of dried mucilage (g)}}{\text{Weight of raw leaves (g)}}\times 100$$

Chemical analyses

Determination of crude protein, moisture and ash contents were carried out as described by AOAC (1990) standard gravimetric methods. Determination of pH was done by using a pH meter (inoLab pH 730, Germany) at 1.0% w/v as described by Prabakran *et al*. (2011). For mineral analysis, dried mucilage (1 g) was mixed with 8 ml of concentrated nitric acid and 1 ml of hydrogen peroxide and digested in Microwave Digester (Milestone ETHOS 1600 Microwave Digestion Labstation, UK) for 1 hour. The resulted solution was then diluted to 50 ml with deionized water. The solution obtained was used directly to determine the mineral content using Atomic Absorption Spectrophotometer (Analyst 300, Perkin Elmer, USA). Minerals in the sample were determined, i.e. sodium, calcium, magnesium, potassium, copper, iron and zinc (Modified from Amiza *et al*., 2007).

Physical analysis

Colour value was determined by Chroma Meter (Minolta CR-400, Japan) as described by Grebesamuel and Gebre-mariam (2011).The water holding capacity was determined by using centrifuge (Hettich Universal 32, Germany) modified from Thanatcha and Pranee (2011) and calculated as:

$$\text{Water holding capacity}=\frac{\text{weight of wet sample (g)-weight of dry sample (g)}}{\text{weight of dry sample (g)}}$$

Emulsion Capacity (EC) was determined by homogenizing (Ultra Turrax, USA) hydrocolloid suspension (0.1, 0.25, 0.5, 1.0% concentration) with corn oil (0.1% relative to the volume of the hydrocolloid suspension) at speed 2 for 1 minute then centrifuged the fresh emulsion at 800 r.p.m for 10 minutes at room temperature using centrifuge (Hettich Universal 32, Germany). Emulsion Stability (ES) was determined after the emulsion was heated in water bath (Techne 12/TE-10 D, UK) at 800°C for 30 minutes and centrifuged at 800 r.p.m. for 10 minutes (modified from Sciarini *et al*., 2008). The EC and ES were calculated as:

$$\text{EC \textbackslash ES}=\frac{\text{Height of emulsion layer}}{\text{Height of whole layer}}\times 100$$

Experiment design and statistical analysis

Leaves of rose cactus were used as experimental unit for this experiment. Three different batches (n = 3) of this plant's leaves mucilage (the mucilage used was under the extraction condition which gave the highest yield) were used in this research to determine the chemical and physical properties. The assignment rule used in this study was a Completely Randomized Design (CRD). The arrangement of this experiment was 2 x 3 full factorial designs. The first factor was types of extraction medium namely distilled water and 0.14 M sodium hydroxide solution. There were three levels of the second factor (temperature), which were 50°C, 70°C, and 90°C. All analyses were done on mucilage of rose cactus with three replications and all data were reported by mean ± standard deviation. Data were analysed by using a Two-way and/or one-way ANOVA followed by Tukey's Multiple Comparison test to find significant differences between means of yield of mucilage, emulsion capacity and emulsion stability at α = 0.05. Data were analyzed using Minitab 14 (Minitab Inc., USA) statistical software package.

RESULTS AND DISCUSSION

Yield of mucilage

The yield of mucilage was found to be the highest by using 0.14 M sodium hydroxide (NaOH) solution at 70°C, the yield was calculated to be 2.55%, where the pH of 0.14 M NaOH was ~12.68. There was a significant ($p<0.05$) interaction effect between type of medium used and temperature on yield of mucilage. To date, alkaline solution is widely used to give higher yield of mucilage (Estevez *et al*., 2004; Lai and Liang, 2011; Munoz *et al*., 2011). Alkaline conditions could increase yield by hydrolyzing insoluble constituents into soluble which increases the extraction yield (Karazhiyan *et al*., 2010).

During the extraction process, the polysaccharide/mucilage suspension in distilled water is more viscous than in 0.14 M NaOH. This phenomenon was previously observed by Estevez *et al*. (2004) and Yamazaki *et al*. (2008). Yamazaki *et al*. (2008) stated that increasing the viscosity of the polysaccharide suspension was not desirable, since it could decrease the yield, degrade the polysaccharide, and also decrease the efficiency of the work. In addition, the phenomenon which mucilage suspension's viscosity was higher while at higher temperature and higher pH was also supported by Koocheki and Razavi (2011). The apparent viscosity of polysaccharide solution in alkaline condition was low which might probably due to a reduction in the weight of the molecules and also due to the suppression of intermolecular association (Koocheki *et al*., 2008). In addition, the increased in yield with temperature might be due to the decrease in viscosity of the mucilage linked to the sample, which make them less sticky and can be effectively released under high temperature (Koocheki *et al*., 2008).

Table 1. Total yield of mucilage from leaves of rose cactus

Extraction Condition		Yield (%)
0.14 M NaOH	50°C	1.17 ± 0.12[c]
	70°C	2.55 ± 0.13[a]
	90°C	2.50 ± 0.08[a]
Distilled Water	50°C	1.10 ± 0.00[c]
	70°C	0.90 ± 0.10[d]
	90°C	2.12 ± 0.06[b]

Data are reported in mean ± standard deviation (n = 3)
[a-d] Means with different letters are significantly different (p<0.05)

With alkaline medium, The yield of mucilage from leaves of rose cactus increased with increases in temperature during the extraction, until 70°C, but slightly decreased at 90°C. It shared the same trend as reported by Cai *et al*. (2008). At higher extraction temperature decreased the yield of mucilage/ polysaccharides due to the hydrolysis of the polysaccharide (Huang *et al*., 2010; Karazhiyan *et al*., 2010). Table 1 shows the yield of mucilage at different extraction condition. The mucilage extracted using 0.14 M NaOH solution at 70°C was further characterized in terms of physicochemical properties and compared with arabic gum.

Chemical properties

According to Table 2, crude protein, moisture and ash content of mucilage was higher than those of arabic gum. A small protein amount that present in a food system could significantly influence the physical properties of the food (John, 1999). According to John (1999), leaves protein that has been extracted from macerated leaves are very labile, which are readily denatured at about 50°C. It undergoes surface denaturation in the pH range 4.5 to 6.0. At higher extraction temperatures the amount of protein is enhanced due to superior mass transfer rates; on the other hand, increasing extraction pH decreased protein content (Koocheki *et al*., 2008; Karazhiyan *et al*., 2010). On the other hand, research done by Razavi *et al*. (2009), revealed that effect of extraction temperature on the protein was highly significant, which in a lower temperature led to a lower protein content and a higher purity, and the effect of pH was not significant. High protein content in mucilage is noteworthy due to protein content is known to have effects on the emulsifying behaviour.

Moisture content facilitates the solubility of hydrophilic carbohydrates and hydrophobic proteins in arabic gum (Lelon *et al*., 2010). It is also an important factor in influencing the rate of the browning reaction, where rate of browning increases with increasing water content (John, 1999). Ash content of rose cactus was much higher than arabic gum. It is similar to *Opuntia ficus indica*'s and *Opuntia stricta*'s mucilage which also contained high amount of ash i.e. 33.96 and 29.96%, respectively (Gebresamuel and Gebre-mariam, 2011). This was supported by Espino-D´ýaz (2010) as well. In addition, Fuentes-Rodriguez (1997) reported that most of the *Opuntia sp.* possessed high ash content ranges from 13.1 to 40.1%. It can be noted that mucilage extracted from the Cactaceae or plants from the Cactaceae possessed high ash content, containing high inorganic material.

Table 2. Chemical properties of mucilage from leaves of rose cactus and arabic gum

Chemical Properties	Mucilage	Arabic Gum
Protein (%)	4.81 ± 0.62	1.34 ± 0.05
Moisture Content (%)	13.69 ± 0.45	11.37 ± 0.04
Ash Content (%)	28.67 ± 0.05	2.75 ± 0.04
pH	10.89 ± 0.18	4.53 ± 0.03

Data are reported in mean ± standard deviation (n = 3)

The pH value of arabic gum was 4.53 (slightly acidic) which in a good agreement as reported by previous study (Yusuf, 2011) (Table 2). Mucilage from leaves of Tujuh Duri at 1% w/v suspension was determined and it was found to be alkaline mucilage with pH of 10.89. This result seems to be in contrast with reported data from the previous researches whereby the mucilage was neither acidic nor neutral. The pH of 1% w/w solution of *Portulacea oleracea* mucilage was found to be about 3.14 (Chattoraj and Bandyopaghyay, 2010), *Opuntia ficus indica* and *Opuntia Stricta* gave pH of 6.43 and 6.93, respectively (Gebresamual and Gebre-Mariam, 2011). The difference might be due to the extraction methods that have been used. There might be some residue of NaOH left on the mucilage extracted in the present study. This pH value of mucilage from rose cactus and arabic gummight contribute to its physical behaviour like emulsifying properties.

Table 3. Mineral content of mucilage from leaves of rose cactus and arabic gum

Mineral	Mucilage	Arabic Gum
K (mg/g)	15.58 ± 3.25	1.40 ± 0.29
Mg (mg/g)	6.17 ± 0.69	2.52 ± 0.09
Ca (mg/g)	48.96 ± 7.65	66.54 ± 1.95
Na (mg/g)	0.13 ± 0.01	1.90 ± 0.22
Fe (mg/g)	0.52 ± 0.06	0.45 ± 0.13
Zn (mg/g)	6.92 ± 2.92	2.09 ± 0.52
Cu (mg/g)	trace	trace

Data are reported in mean ± standard deviation (n = 3)

Table 3 shows the mineral content in mucilage and arabic gum. Many naturally occurring ionic polysaccharides are mixed salts of alkali-earth and transition metals with different insolubilities, especially salts of alkali are invariably soluble (Walter, 1998). Rose cactus mucilage was high in Ca and K; whereas arabic gum was high in Ca. John (1999) found that arabic gum contained most of Ca, Mg, Na and K, suggesting that arabic gum containing slightly acidic salt of a complex polysaccharide. The difference of mineral content reported for arabic gum from previous researches might be due to the differences in techniques used or growing conditions (Ali *et al*., 2012). Polysaccharide type compounds act as a ligand and interact with metals. Specifically, metal ion is bound to the organic ligand through multiple attachments either ionic or covalently with the metal ion occupying a central position in the structure. For instance, high divalent cations such as Ca might form bridges between neighbouring carbohydrate molecules resulting in gel formation (John, 1999). This polysaccharide is able to form chelating compounds (John, 1999).

Physical properties

L* value of rose cactus mucilage was lower than that of arabic gum (Table 4). Arabic gum exhibited brighter yellowish colour, while the mucilage exhibited a darker green-yellowish colour. This probably due to arabic gum used was high in purity, compared to the mucilage. The leaves of rose cactus possessed high total phenolic content (Nor Aziyah Bakhari *et al*., 2010), and oxidation of phenolic content could results a deep brown colour on a sample. Thus, there are possibilities that the mucilage also contains phenolic compound. In addition, high extraction temperature was able to induce browning in colour of the mucilage/polysaccharide and thus might affect the properties of the mucilage/ polysaccharide (Qian *et al*., 2011). When greenly plants are heated, there is evidence for the loss of the phytol side chain of chlorophyllide as well as the loss of magnesium, giving the product with a deep brown colour (Coultate, 2002).

Table 4. Colour of mucilage from leaves of rose cactus and arabic gum

Value	Mucilage	Arabic Gum
L*	68.81 ± 1.63	87.91 ± 0.16
a*	-0.04 ± 0.08	1.72 ± 0.10
b*	1.96 ± 0.32	1.99 ± 0.35

Data are reported in mean ± standard deviation (n = 3)

The bright colour of mucilage obtained could be reserved (or to obtain high L* value) by using ethanol (Amiza *et al*., 2007; Mirhosseini and Amid, 2012); bleaching by using alkaline hydrogen peroxide method (Tranatcha and Pranee, 2011); or by using activated carbon (Lai and Liang, 2011). Methods of preventing browning could consist of measures intended to slow reaction rate such as control of moisture, temperature, or pH or removal of an active intermediate (John, 1999).

The water holding capacity of mucilage was 461.87% whilst arabic gum was 17.13% (Table 5). The water holding capacity of arabic gum reported previous was rather low (7.49%) as reported by Torio *et al*. (2006). The water holding capacity of arabic gum was different as compared to previous study might due to different methods that have been used and the materials have been purchased from different manufacturer. The water holding capacity expressed the amount of water that the sample capable to hold per weight and ability of substance to associate with water under a limited water condition. High concentration of hydroxyl groups in the polysaccharide had high water binding capacity which had the ability to absorb large amount of water (Naqvi *et al*., 2010). The water holding capacity depends on capillary, pore size and the charges on the protein molecules due to strong correlation of protein hydration with polar constituents along with the hydrophilic interaction through hydrogen bonding (Shad *et al*., 2011). However, the water binding capacity of gums did not only depend on the functional group of carbohydrates that are hydrophilic but also to the proteins present in the gums since they also contain functional groups that were able to bind with water molecules (Torio *et al*., 2006; Onweluzo and Odume, 2007). This fact has been supported by John (1999), who found that the binding of water is localized at hydrophilic group on proteins such as polar side chains containing carboxyl, amino, hydroxyl, and sulphydryl groups and also the non dissociable carboxyl and amino group of the peptide bonds. According to Koocheki and Razavi (2011), the water holding capacity of mucilage was dependent on extraction temperature, which decreased with increase of extraction temperature. This has been demonstrated by Mirhosseini and Amid (2012) that extraction temperature exhibited a significant ($p<0.05$) effect on water holding capacity. Mineral like zinc present in gum/mucilage could influence its water holding capacity too (John, 1999). Water retention in mixed food products throughout their shelf life has becoming an important requirement in foods of low fat content (John, 1999).

It is worth mentioning that rose cactus mucilage might possess a significant gelling property since its water holding capacity was found to be much higher than that arabic gum. During gelation, junction zones are formed causing the network in polysaccharide solution becomes dense and able to hold or entrapped more water within the gel network. This favors more hydrodynamic interaction among water and polysaccharide molecules. This behaviour explains a well-known gelling property of some commercial gums such as xanthan and guar gums. The water holding capacity of xanthan gum has been reported to be much higher (232 mL/g) than that of guar gum (40 mL/g) (Sanchev *et al*., 1995), which the later is known to exhibit much weaker gelling property.

Table 5. Water holding capacity of mucilage from leaves of rose cactus and arabic gum

Sample	Water Holding Capacity (%)
Mucilage	461.87 ± 1.47
Arabic gum	17.13 ± 0.90

Data are reported in mean ± standard deviation (n = 3)

The emulsified solution of mucilage from rose cactus was at the pH of 10.4, whilst arabic gum was at the pH of 4.93. It was known that arabic gum possessed good emulsifying properties. Arabic gum is the commonly recognized hydrocolloid emulsifier under acidic conditions (Wang and Cui, 2005). According to Figure 1, increasing the concentration of mucilage and arabic gum was found to increase the emulsion capacity within the samples significantly ($p<0.05$). Similar trend was observed for emulsion stability result as depicted in Figure 2. Both mucilage and arabic gum were found to be comparable in terms of their emulsifying properties with no significant differences in these results. An acceptable emulsion capacity of mucilage of rose cactus might due to its own alkalinity (10.89), and the emulsified solution was at pH of 10.4. This has also been observed by Nassar (2008), that at high pH, protein had higher solubility which could increase the emulsion capacity, which best in the range of pH 10. To use gum/mucilage to create an emulsion system, the protein-rich molecules in that sample are absorbed onto the surface of oil droplets while the carbohydrate portion inhibits flocculation and coalescence by electrostatic repulsions and steric forces (Wang and Cui, 2005).

Generally gums required high concentration to exhibit a good emulsifying property (John, 1999). Increment of the gum/mucilage concentration, increases its emulsion capacity and stability which also results in higher viscosity of the gum/mucilage solution (Koocheki and Razavi, 2011; Gebresamuel and Gerbre-Mariam, 2012). It was revealed by Wang and Cui (2005), that further increase of polysaccharide concentration will result in continued decrease of surface tension of water, resulting in a polysaccharide like arabic gum and mucilage exhibits good emulsifying properties.

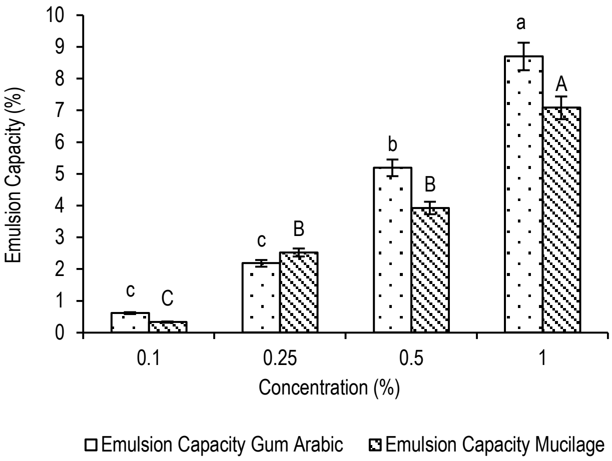

Figure 1. Emulsion capacity of arabic gum and mucilage at different concentration. [A-C] or [a-c] Means with different letters are significantly different ($p < 0.05$ ($n = 3$)

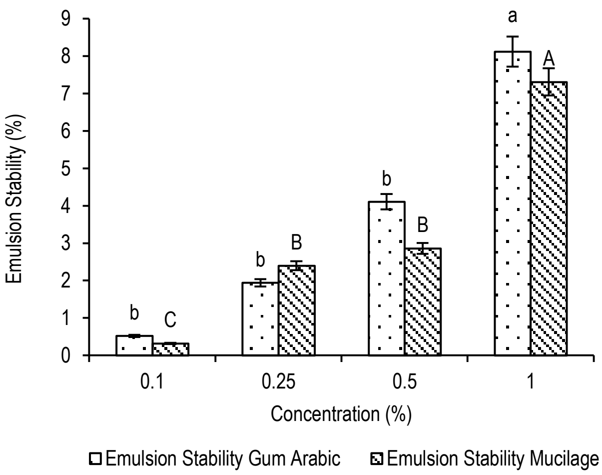

Figure 2. Emulsion stability of arabic gum and mucilage at different concentration. [A-C] or [a-c] Means with different letters are significantly different ($p<0.05$ ($n = 3$)

Emulsions are stabilized by variety of macromolecules such as protein and starches (John, 1999). Therefore, it was suggested that mucilage is a macromolecule comprises of polysaccharide with protein, as protein and carbohydrate were found within the sample. The ability of proteins present in that sample that could served as emulsifiers varies among proteins, which depends on its distribution of the polypeptide chains and some effective emulsifier that possessed little secondary structure are able to be unfold at the interface (John, 1999). Heat could be applied to unfold that particular structure of protein of mucilage, making it to be an effective emulsifier. It was revealed by John (1999), for emulsion to possess stability; the proteins in that emulsifier have to form a cohesive film which depends much on the emulsion droplets and the nature of the protein. In addition, smaller emulsion droplets produce more stable emulsions because smaller droplets are able to form a three dimensional network of aggregated particles that extends the emulsion system (Mao and McClements, 2012).

In arabic gum, it is well-accepted that, simultaneous presence of hydrophilic carbohydrate and hydrophobic protein in the form of arabinogalactan-protein complex can bridge the hydrophilic barrier at oil-water interphase (Williams *et al.*, 2006) and thus emulsify the oil into dispersed tiny droplets. However, this is not the case when protein found in mucilage is not associated with the carbohydrate molecule. In relation to this, high amount of protein present in the mucilage is much due to its crude nature which is suggested to contain protein impurities either in associated or unassociated form. According to Amid and Mirhosseini (2012), main impurities commonly detected in gums and mucilage include minerals, tannin, and natural pigments, in additon to protein. This explains why high protein content in rose cactus mucilage did not appreciably contribute to its' emulsifying properties.

Extraction temperature is also one of the important parameter for production of mucilage with good emulsion stabilizing properties which emulsion stability would be higher if the mucilage was extracted using lower pH and lower extraction temperature (Koocheki and Razavi, 2011). A thermodynamically unstable emulsions could causes quality problems during production and storage of food products, thus a good emulsifier could be used to extend a shelf life of a food product by stabilizing a food product system which could be achieved by imposing viscosity to the aqueous phase, thereby modifying the texture and retarding droplet creaming (Wang and Cui, 2005).

CONCLUSION

This study revealed that rose cactus mucilage can be efficiently extracted in an alkaline condition when considering on the extraction yield. The mucilage was found to be pronouncedly different from commercial arabic gum in most physicochemical properties measured. It is interesting to highlight that this mucilage exhibited a much higher water holding capacity as compared to arabic gum which could be attributed to its gelling property. In terms of emulsifying properties, both mucilage and arabic gum are somehow considered to be comparable. In order to encourage the use of mucilage from leaves of rose cactus, more researches have to be done on its extraction optimization as well as characterization of the mucilage structure and functional properties. The stems and fruits of rose cactus are also known to be mucilaginous. It is believed that this whole plant could give a better yield of mucilage rather than only its leaves.

The determination of colour of the mucilage, suggesting that the mucilage might contains pigments like carotenoid which signifies that mucilage of rose cactus might contain antioxidant compounds.

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