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WATER SOLUBLE HYDROCOLLOID FROM BASIL SEED (*Ocimum basilicum* L.) MUCILAGE

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ABSTRACT

Basil seed (*Ocimum basilicum* L.) mucilage is categorised as a plant-based product that can be used as an alternative source of food hydrocolloid. The gel needs to be extracted before being applied to food products. This study was focused on the effect of temperatures and agitation speeds on the yield and functional properties of the mucilage. Basil seed mucilage was extracted using water soluble extraction method by using selected temperatures (30 and 50°C) and agitation speeds (50 and 100 ppm) for 20 min. Significantly ($p<0.05$), higher extraction yield (sample F) was found at 50°C and 100 rpm compared to other extraction parameters. However, the extraction method did not affect the proximate composition of the extracted gel. Sample F has the highest ($p<0.05$) water holding capacity compared to control. In addition, the viscosity of the gels was not significantly ($p>0.05$) affected by heat. This finding highlight the extracted basil mucilage is a good alternative source of natural hydrocolloid as a thickening and gelling agent which are resistant to high-temperature conditions of the food products.

Key words: Basil seed, hydrocolloid, mucilage, water extraction

INTRODUCTION

Basil (*Ocimum basilicum* L.), a plant that is grown in different regions of Asia, Europe, and the Middle East (Razmkhah *et al.,* 2010). Basil seeds are grown in several regions of Asia such as India, Pakistan, Iran, Thailand and other countries (Makri & Kintzios, 2008). Basil is used as a herb in flavouring food. Its seed has a reasonable amount of gum with good functional properties which are comparable to commercial food hydrocolloids (Razmkhah *et al.,* 2010). Food industries are focusing on the uses of new plant-based food hydrocolloid as gelling agents in product development with unique sensory characteristics. The main reason for the use of hydrocolloid in food is due to its ability to modify the rheology of the food systems by the long polymer chains of polysaccharides and proteins which has a property to develop gel-like characteristic when soaked in water (Salehi *et al.,* 2014). Basil seeds extrude gelatinous mucilage which able to swell when immersed in water and can be extracted. The swollen basil mucilage can be extracted by water solubilisation and mechanical extraction. Polysaccharides will influence the viscous dispersion of the mucilage, while protein can act as an effective surface active agent (Osano *et al.,* 2014). The yield of basil seed gel increased with elevation of extraction temperatures (50 to 80°C) which caused the reaction time to reduce. The temperature increased the ability of the solvent to solubilise the compound, thus decreasing the viscosity and improving the penetration of the solvent into the gel matrix (Salehi *et al.,* 2014). Meanwhile, the agitation leads to mix and promote the adsorption of the water molecule (Dickinson, 2003). However, the combined effects of different extraction factors such as temperature and agitation

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speed in basil seed gel are not well studied. The extraction techniques may impact on the functional properties of the mucilage. Therefore, the objectives of this study were to determine the effect of agitation speeds and temperatures on the yield and functional properties (water and oil holding capacity and rheological characteristics) of basil seed mucilage.

MATERIALS AND METHODS

Materials

Commercially available basil seeds (Brand: Giant) were purchased from Giant Supermarket Serdang, Selangor, Malaysia.

Sample preparation

Basil seed mucilage was extracted using water extraction method as described by Amid and Mirhosseini (2012). Basil seed was agitated by using a shaking water bath (WNB 7, Memmert, Germany) in deionised water (water to seed ratio of 30:1) for 20 min. Different combination of temperature (30 and 50°C) and agitation speed (0, 50 and 100 rpm) (Table 1). A temperature of 30°C was selected to represent the room temperature while, 50°C was chosen based on the study by Salehi *et al.* (2014). The hydrated basil seeds were blended for 30 sec using a blender (Pensonic, Malaysia) to extract the mucilage. The extracted mucilage was then filtered through a muslin cloth. The separated mucilage was dried in an oven (Memmert Universal, Germany) at 45°C until constant weight to form a powder. The amount of dried basil mucilage yield (%) was determined.

Proximate chemical analysis

The extract from the extraction technique that resulted in the highest yield was compared with the control for its composition. Moisture, ash content, Kjeldahl protein content, fat content and crude fibre content were determined according to AOAC method (AOAC, 2005). The carbohydrate content was determined by difference as per Muller and Tobin (1980).

Table 1. The different type of basil seed extracted using different temperature and agitation speed

Sample type	Temperature (°C)	Speed of agitation (rpm)
A (control)	30	0
B	30	50
C	30	100
D	50	0
E	50	50
F	50	100

Water and oil holding capacities

Analysis of water and oil holding capacities were determined with some modification as described by Coorey *et al.* (2014).

Thermal treatment on rheological properties

Dried basil seed mucilage solution 0.2% (w/w), was prepared by dispersing the mucilage powders in distilled water using a magnetic stirrer. The solution was shaken using a water bath (WNB 7, Memmert, Germany) for 24 hr at 25°C to complete hydration (Zameni *et al.,* 2015). Then, the solution was poured into centrifuge tubes and hold in a water bath which set at a different temperature (25, 50, 75 and 100°C) for 20 min to mimic different food processing temperature.

Viscosity measurement

Steady shear rheological measurements were conducted using a Rheometer (Physica RheolabQC, Germany) using 0.2% dried basil mucilage solution which is loaded into the coaxial cylindrical chamber at 25 ± 0.1°C (Zameni *et al.,* 2014).

Statistical analysis

The data were analysed using Minitab (version 17) statistical package (Minitab Inc, USA). All analysis was conducted in triplicate. The one-way analysis of variance (ANOVA) measured the significant different by Tukey pairwise comparisons test. The probability level of $p<0.05$ was considered significant.

RESULTS AND DISCUSSION

Mucilage extraction

Mucilage extraction from the basil seed was conducted to evaluate the optimum temperature and agitation combination to achieve the highest extraction. The non-agitate and room temperature extract methods were considered as a control technique. A general full factorial design was adopted for the study. The study showed that there was a significant difference ($p<0.05$) in the yield when heat (50°C) was applied when compared to the control. It is an indication that heating does improve the extraction of the basil seed mucilage as stated by Salehi *et al.* (2014), where the temperature increased from 20 to 80°C had caused the viscosity of the basil mucilage to decrease making it easier to be extracted out thus, increase the yield. It also further showed an increasing trend with the increase in the speed of agitation (Table 2). Dickinson (2003) reported that the mixing process could increase the water absorption into the seed matrix prompting mucilage development, which would increase its yield. The highest yield of gums extracted at 50°C

Table 2. Effects of temperature and speed of agitation on the extract yield

Sample type	Temperature (°C)	Speed of agitation (rpm)	Yield (%)
A (control)	30	0	12.69 ± 0.16[a]
B	30	50	13.30 ± 0.28[a]
C	30	100	14.94 ± 0.52[a]
D	50	0	13.48 ± 0.37[b]
E	50	50	15.13 ± 0.37[b]
F	50	100	15.37 ± 0.53[b]

[a,b] Different letters indicate significant ($p<0.05$) different within a column.

Table 3. Comparison of proximate analysis between sample F and control

Proximate analysis	Sample F (% w/w)	Control (% w/w)
Ash	8.52 ± 0.57[a]	8.54 ± 0.22[a]
Protein	1.57 ± 0.27[a]	1.49 ± 0.16[a]
Fat	0.19 ± 0.04[a]	0.20 ± 0.01[a]
Moisture	9.27 ± 2.81[a]	9.34 ± 0.33[a]
Fiber	25.40 ± 1.59[a]	24.46 ± 0.27[a]
Carbohydrate	55.14 ± 3.71[a]	55.97 ± 0.56[a]

Similar symbol represents no significant different ($p>0.05$) within a row.

Table 4. Water and oil holding capacities of sample F and control

	Sample F	Control
Water holding capacity (WHC)	32.82 ± 0.93[a]	28.49 ± 1.82[b]
Oil holding capacity (OHC)	8.37 ± 1.02[a]	8.03 ± 1.53[a]

[a,b] Different superscripts across the row indicate a significant difference ($p<0.05$).

and 100 rpm (Sample F) was further studied for composition and functional properties. Based on the linear model of general factorial regression, it shows that both selected temperature and agitation speed significantly ($p<0.05$) affected the yield of dried mucilage with an R^2 value of 92.55%. Multiple response predictions have stated that the optimum extraction was at a temperature of 50°C and agitation speed at 100 rpm. Meanwhile, minimum extraction was at a temperature of 30°C with no agitation. The decrease in viscosity of the mucilage indicates that the water could penetrate efficiently into the seed making it swell completely. The reduction in the viscosity could make the mucilage less sticky and can be easily separated from the seed (Salehi *et al.,* 2014).

Proximate chemical analysis

Proximate analysis was conducted for both samples F (highest yield) and the control. This analysis was conducted to determine the effect of the different temperatures and agitation speeds that may have a significant effect on the composition of the mucilage extract. The temperature and agitation speed did not have a significant effect on the chemical composition of the extracted mucilage (Table 3).

Water and oil holding capacities

Water holding capacity was conducted to measure the amount of water absorbed by the basil mucilage while oil holding capacity is its ability to absorb oil. As basil seed gels form similar mucilage, it could be expected a similar absorption by the basil seed gels. WHC represents the percentage of the hydrophilic fraction, which has a greater affinity to absorb water. Table 4 showed that WHC value was significantly different ($p<0.05$) between sample F (32.82 ± 0.934) and control (28.49 ± 1.82). The lower WHC in the control mucilage extract could be due to the presence of impurities (fat, protein, fibre, a natural pigment and endogenous enzymes) in the crude gum which would interfere in the absorption of water. Amid and Mirhosseini (2012) reported the extraction at the elevated temperature caused in faster and easier mass transport of water-

Table 5. Comparison of water and oil holding capacities of basil seed mucilage, chia seed gel, chia flour gel, commercial guar gum and commercial gelatin

Sample	Water holding capacity	Oil holding capacity	References
Basil seed mucilage	32.82 ± 0.93	8.37 ± 1.02	–
Chia seed gel	266.55 ± 6.12	58.61 ± 0.56	Coorey *et al.* (2014)
Chia flour gel	12.42 ± 0.29	19.18 ± 0.81	Coorey *et al.* (2014)
Guar gum	24.83 ± 0.82	0.87 ± 0.06	Coorey *et al.* (2014)
Gelatin	7.20 ± 0.31	1.05 ± 0.02	Coorey *et al.* (2014)

Table 6. Effects of thermal stability on the viscosity of basil mucilage extract

Different temperature (°C)	Viscosity (mPas)	
	Sample F	Control
25	$5.50 \pm 0.10^{b,A}$	$5.43 \pm 0.06^{b,A}$
50	$5.73 \pm 0.06^{a,A}$	$5.77 \pm 0.15^{a,A}$
75	$5.63 \pm 0.12^{ab,A}$	$5.73 \pm 0.06^{a,A}$
100	$5.76 \pm 0.06^{a,A}$	$5.70 \pm 0.00^{a,A}$

[a,b] Different letter indicates significant different (p<0.05) between the column of different samples and same capital letter ([A]) across the row of different temperatures indicates not significant (p>0.05).

soluble polysaccharide from the cell wall into the extract. This could lead to the control sample extracted without heat treatment has less ability to hold water. Meanwhile, oil holding capacity shows no significant difference (p>0.05) for both sample F (8.37 ± 1.02 g/g) and control (8.03 ± 1.53 g/g) of dried mucilage extract. Table 5 showed basil seed mucilage has higher WHC compared to guar gum, chia flour gel and gelatine. However, chia seed gel has proven to have the highest WHC compared to other analysed gels. Increase water holding capacity will enhance the swelling capacity and it is an important function in the preparation of viscous foods such as soup, gravies, dough, and baked food products.

Thermal analysis of rheological properties

The viscosity of basil seed gels were significantly (p<0.05) increased when temperatures elevated from 25 to 100°C (Table 6). However, there was no significant effect of heat on the viscosity (p>0.05) between the sample F and control. It shows that the basil seed mucilage remained unaffected by the high processing and extraction temperatures. The increase in viscosity of the mucilage extract after heating might be due to the intermolecular re-arrangements that lead to a semi-rigid chain which are responsible for the association of high shear thinning and aggregation thus leads to high viscosity at the high-temperature treatment of gum mixed solution (Kayacier & Dogan 2006).

CONCLUSION

In this study, the yield of basil seed mucilage was significantly (p<0.05) affected by temperature and speed of agitation at 50°C and 100 rpm respectively. Sample F had significantly (p<0.05) the higher capacity to hold water compared to control which means that it could provide good mouthfeel when applied to food products. In addition, there was no significant effect of heat on the viscosity between samples studied and remain stable after heated at 50 up to 100°C. This may suggest that the basil seed mucilage is resistant to processing condition which involves heat in the food products.

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