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Study of raft forming anti-reflux preparation of mucilage from *Basella alba* L.

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Rationale

Heartburn and acid reflux are primary symptoms of gastro-oesophageal reflux disease (GERD). A variety of non-prescription products are used for the symptomatic treatment of heartburn, acid indigestion, and acid reflux disorders such as antacids, bismuth-containing products, and alginate rafting products. Alginates are natural polysaccharide polymers from brown seaweed which can rapidly form viscous gel with low density in the acid environment of stomach. The alginate raft was proved to provide sufficient viscosity to reduce gastric acid reflux disorders (Mandel, 2000, p.669–690, Yaswantrao, 2015, p.178-192).

Puk Pang Kao (*Basella alba* L.) is a perennial succulent vine which belongs to family Basellaceae. The fresh leaf is thick heart-shaped with mucilaginous texture. Mucilage isolated from *B. alba* is composed of D-galactose as a major component. It is viscous with low swelling capacity and exhibits suitable pH for skin (5.3 - 5.4). The mucilage was reported to use as gelling agent in cosmetics and provided a good stability (Palanuvej, 2009, p.837-850, Haneefa, 2012, p.1642-1648). Additionally, mucilage can be used for pharmaceutical aid as thickener, water-retention agent, suspending agent, and film former (Jani, 2007, p.90-98, Tosif, 2021, p.1-24). The present study was to isolate mucilage from stems and leaves of *B. alba* and the isolated mucilage was subjected to formulate the raft forming anti-reflux preparations. As well as physical properties of the preparations were studied.

Research Objectives

The objectives of this study are to formulate raft forming anti-reflux preparations using isolated mucilage from stems and leaves of *B. alba* and to evaluate physical properties of the preparations.

Methodology

The fresh stems and leaves of *Basella alba* L. planted in Huachiew Chalermprakiet University, Bang Phli district, Samut Prakan province, Thailand were used in this study. The fresh stems and leaves were rinsed with tap water and dried at 45°c using hot air oven before grounded into coarse powder.

Extraction and isolation of mucilage

The plant powder (1.543 kg) was defatted before extracted by boiling in DI water (18 L) for 30 minutes. The extract was filtered after cool to room temperature. Mucilage was precipitated by EtOH at 2°c. The precipitate was separated and washed with cold EtOH before dried at 40°c. The dry precipitate was ground and passed through a 100-mesh sieve.

Evaluation of physicochemical properties of mucilage

- ***Physical appearance***
- ***Swelling index***
- ***Weight loss on drying***
- ***Thin layer chromatography analysis***
- ***Fehling's test for monosaccharides***
- ***Fourier transform infrared spectral analysis***

Preparation of raft forming anti-reflux suspension

Five different formulations (F1 – F5) were prepared. Primarily the isolated mucilage and suspending agents each was separately dispersed in DI water before mixing. Calcium carbonate, sodium bicarbonate, and saccharin sodium were dissolved in DI water and added. Then, the remain excipients were added and stirred continuously till uniform dispersion was obtained (table 1).

Evaluation of physical properties of suspension

- ***Physical appearance***
- ***Sedimentation volume***
- ***Redispersibility rate***
- ***Raft forming***

Table 1 Composition of raft forming anti-reflux suspensions (F1 - F5)

Excipients	Amount (%W/V)				
	F1	F2	F3	F4	F5
Isolated mucilage	6.00	6.00	6.00	6.00	6.00
HPMC	-	0.75	1.00	-	-
Na CMC	-	-	-	0.50	0.75
Calcium carbonate	1.60	1.60	1.60	1.60	1.60
Sodium bicarbonate	2.67	2.67	2.67	2.67	2.67
Saccharin sodium	1.00	1.00	1.00	1.00	1.00
Peppermint oil	0.20	0.20	0.20	0.20	020
Methylparaben	0.40	0.40	0.40	0.40	0.40
Propylparaben	0.06	0.06	0.06	0.06	0.06
DI water q.s.	100.00	100.00	100.00	100.00	100.00

Results and Discussion

The isolated mucilage (76.88 g) was obtained as brown to grey green fragment shown in figure 1 with the percentage yield of 4.98% w/w of plant powder. The percentage loss on drying of the mucilage was 8.95% ± 0.51. The pH and swelling index of the mucilage dispersion were 6.61 ± 0.11 and 10.07 ± 0.03, respectively. The acid-hydrolysis mucilage was tested with Fehling's reagent and the brick red precipitates occurred to confirm the presence of monosaccharides. Additionally, TLC analysis of the acid-hydrolysis mucilage exhibited spots comparable to glucose and galactose which in agreement with previous reports. Chatchawal (2010) indicated that D-galactose was the major monosaccharide in the mucilage extracted from stems and leaves of *B. alba* by TLC analysis (p.101-112).

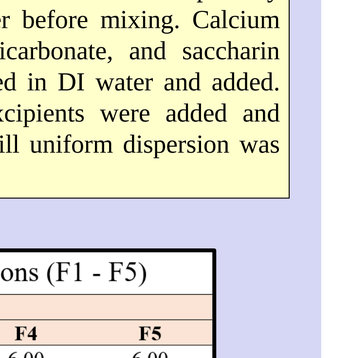

Figure 1 The isolated mucilage from *B. alba* L.

The FTIR spectrum of the isolated mucilage indicated the presence of stretching vibration of hydroxyl groups (O-H) at 3,369 cm^{-1} (broad), stretching vibration of alkyl group (C-H) at 2,928 cm^{-1}, stretching vibration of carboxyl and carbonyl (COO-) at 1,638 cm^{-1}, bending vibration of alkyl group (C-H) at 1,369 cm^{-1}, and polysaccharide group (C-O-C) at 1,015 cm^{-1}. The band corresponding to carboxylate group indicated the presence of uronic acid which is commonly found in mucilage (Quintero-García, 2021, p.1-18). As well as the wavenumbers between 800-1200 cm^{-1} characterizes the fingerprint region for carbohydrate (Singh, 2014, p.713-725).

Among five formulations of raft forming anti-reflux suspensions, F1 did not contain any suspending agents, and consequently the isolated mucilage could not suspend throughout the liquid media. Accordingly, F1 was not subjected to further studies. Physical appearance and pH of F2 - F5 are shown in table 2.

Results and Discussion (cont.)

Table 2 Physical appearance and pH of suspensions (F2 - F5)

Physical appearance	F2	F3	F4	F5
Color	Brown	Brown	Brown	Brown
Odor	Peppermint	Peppermint	Peppermint	Peppermint
Taste	Sweet	Sweet	Sweet	Sweet
Viscosity	+++	++++	+	++
pH*	9.12 ± 0.01	9.11 ± 0.01	9.13 ± 0.01	9.12 ± 0.01

(+) = very low; (++) = low; (+++) = moderate; (++++) = high
* Values are presented as mean ± SD; n = 3

The viscosity of all suspensions increased when the amount of suspending agents increased. Formulations prepared with HPMC (F2 and F3) were found to be more viscous than that with Na CMC (F4 and F5). The highest viscosity was shown in F3 whereas the lowest viscosity was shown in F4.

The percentage sedimentation volume of suspensions decreased with an increase time of storage (table 3). The sedimentation volumes of F2 and F3 which used HPMC as suspending agent were higher than of F4 and F5 which used Na CMC as suspending agent. At 4 weeks of storage, the sedimentation volumes of F4 and F5 were constant.

Table 3 The percentage sedimentation volume of suspensions (F2 - F5)

Periods	Sedimentation volume (%V/V)			
	F2	F3	F4	F5
1 weeks	60	62	46	42
4 weeks	56	56	44	40
8 weeks	54	54	44	40

Redispersibility rates of suspensions increased when the storage periods increased (figure 2). F4 and F5 which used Na CMC as suspending agent were easily redispersed than F2 and F3 which used HPMC as suspending agent. At 45 days of storage, F4 containing Na CMC at 0.50%. was easily redispersed by 10 times of human shaking.

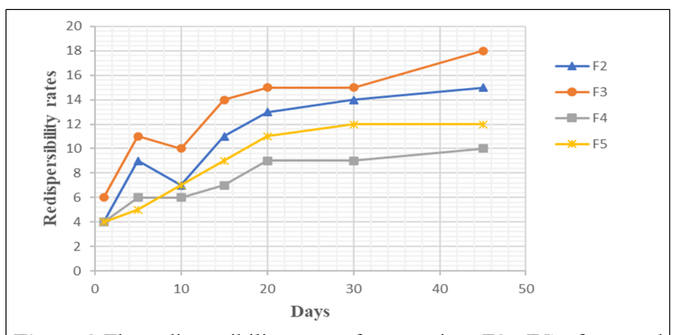

Figure 2 The redispersibility rates of suspension (F2 - F5) after stand for 1, 5, 10, 15, 20, 30, and 45 days at room temperature.

The character of raft formation of each formulation (F2 - F5) was observed under simulated gastric acid conditions, 0.1 M hydrochloric acid at 37°c for 10 minutes. The results showed that no raft was formed in all formulations. This may be due to the amount of calcium carbonate and sodium bicarbonate in each formulation is not enough to provide raft. Raft formation and raft strength depend on several factors. Calcium ion was reported as an extrinsic factor which increase raft strength by its ability to cross-link polysaccharide polymers. Bicarbonate, another extrinsic factor, acts as a carbon dioxide generating agent which produces carbon dioxide bubbles in the presence of gastric acid. The bubbles are entrapped within the gel matrix allowing the gel to float on the surface of gastric fluid (Mandel, 2000, p.669–690). In addition, the concentration of mucilage as well as its physicochemical properties also impact to raft formation.

Conclusion

The isolated mucilage from stems and leaves of *B. alba* was composed of glucose and galactose with a swelling index of 10.07 ± 0.03, pH 6.61 ± 0.11, and loss on drying of 8.95% ± 0.51. Suspension containing 6% of the isolated mucilage and 0.5% of Na CMC exhibited good physico-chemical properties. It was easily redispersed by 10 times of human shaking with the percentage of sedimentation volume of 44%. However, raft-forming performed under simulated gastric acid conditions revealed that no raft was formed in all formulations. Different concentrations of mucilage and carbon dioxide generating agent for formulation of good raft forming anti-reflux preparation should be further study.

Acknowlagement

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