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Effects of Yanang (*Tiliacora triandra*) Gum on Gelation of Waxy Rice Flour

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Abstract

Crude hydrocolloid extract has been prepared from the leaves of Yanang (*Tiliacora triandra*). This research studied effects of Yanang gum on pasting and textureal properties of blending of waxy rice flour. Rapid visco analysis (RVA) results showed that the ratio of Yanang extract to water of 1:3 and 1:4 (w/w) significantly decreased the trough, breakdown, and final viscosities of the waxy rice flour whereas the peak viscosities, peak time, and pasting temperatures of the blends were increased. Textural study revealed that the addition of crude Yanang gum enhanced more hardness and springiness of the blending gels than those of waxy rice flour gel, whereas cohesiveness was less affected. These results would be useful as a guideline for developing frozen starch-based food products containing crude Yanang gum.

Keywords: Yanang, hydrocolloid, waxy rice flour, pasting properties, textural properties, RVA

1. Introduction

Retrogradation is a term used for changes that occur in gelatinized starch from disordered state to a more ordered crystalline state and the tendency of starch pastes to thicken and to form stiff gels [1]. Among the cereal, rice is one of the most utilized grains in many forms. Rice flour does not have good handing properties, thus the incorporation of curtain additives as hydrocolloids may be an approach to achieve the desirable properties. Starch/hydrocolloid combinations have been widely used particularly in the food production. The reason for using combinations is because native starches do not generally have ideal properties for the preparation of food products, such as having tendency to syneresis, retrogradation and exhibiting breakdown, either from extended cooking, high shear or acidic conditions, producing weak-bodied, cohesive, rubbery pastes, and undesirable gels [2]. There are extensive studies to overcome these shortcomings by blending of native starches with polysaccharide hydrocolloids (gums), as reviewed by Appelqvist and Debet [3] and BeMiller [4]. Therefore, the mixtures of starch and hydrocolloids have been used to modify and control rheological and textural properties, improve moisture retention, control water mobility, and maintain overall product quality during processing and storage of food products. Yanang (*Tiliacora triandra*) is a climbing herbal plant with deep green leaves and yellowish flowers. It is a species of flowering plant native to mainland Southeast Asia, and is widespread in

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particularly in many cuisines of the northeast of Thailand and Lao PDR especially in bamboo shoot soup. Yanang leaves contain high levels of beta-carotene which has antioxidant activity, fiber, and minerals, such as calcium and iron. The most important properties of the Yanang leaves extract are their viscosity, including thickening and gelling and water binding [5]. Yanang contains hydrocolloid, the major monosaccharide constituent of Yanang gum is xylose, together with substantial amounts of other neutral sugars. The FT-IR spectra of Yanang gum are similar to that of xylan, as reported by Singthong *et al.* [5].

Thai desserts are simply prepared with flour, coconut milk, and sugar. Flour is the main ingredient in these products and minor ingredients commonly added are legumes, vegetables, and fruits as well as roots and tubers. Retrogradation of staple food always occurs when the products are storage at low temperature or at fluctuated temperature condition.

As far as we are aware, there are no studies that compare the effect of crude hydrocolloid from Yanang on the behaviors of rice starch or rice flour. The purpose of this study, therefore, was to observe the effects of extraction ratio of the Yanang (*Tiliacora triandra*) extraction on pasting and textural properties of waxy rice flour. The waxy flour was chosen on the basis starch-based Thai desert. This research would make a practical implications in further applications of Yanang gum in frozen waxy rice based Thai desert, particularly, Bualoy.

2. Materials and Methods

2.1 Materials

Waxy rice flour (WRF) was purchased from Cho Heng Rice Vermicelli Factory Co., Ltd., Nakhon Pathom, Thailand. Yanang leaves were purchased from Ying Charoen Market, Bangkok, Thailand.

2.2 Extraction of Yanang

Yanang leaves were cleaned with water to remove dust and infected leaves were separated. The ratio of Yanang leaves to distil water were calculated to prepare the extracted Yanang. For the gum solutions, calculated weight amount of Yanang or distil water was made. The prepared leaves and water were then blended thoroughly a mixer (Buono®TSK-9355B). The mixture were stained through cheesecloth and stored at refrigerator in a plastic container before use [6].

2.3 Determination of pasting properties

Pasting properties of 6 % (w/w) waxy rice flour without crude Yanang gum with crude Yanang gum and waxy rice flour with crude Yanang gum blends at the ratios of Yanang leaves to water of 1:3 and 1:4 (w/w), respectively as well as Yanang gum (1:3 w/w, ratio) were determined by a rapid visco-analyzer (Model RVA-4C, Newport Scientific Pty. Ltd., Warriewood, Australia). WRF slurries were prepared by dispersing weighed amounts of WRF (dry basis) in distilled water or gum solutions. The slurries weighing 28 g were then poured into aluminum canisters and stirred manually using plastic paddles for 20-30s before insertion into the RVA instrument. The heating and cooling cycles were programmed following the general pasting method (STD 1). The slurry was held at 50 °C for 1 min, heated to 95 °C within 3 min 42s (i.e. a heating rate of 12 °C/min) and then held at 95 °C for 2 min 30s. It was subsequently cooled to 50 °C within 3 min 48s and held at 50 °C for 2 min, while maintaining a rotation speed of 160 rpm. The viscosity was expressed in rapid visco units (RVU). The data were reported as average of triplicate measurement.

2.4 Determination of textural properties

The waxy rice gel with and without polysaccharide were prepared. The exact ingredient quantities of dough sample were 330 g of waxy rice flour and 280 g of boiling water. The ingredients were mixed, knead, and shaped in a small ball with a size of 7 mm diameter. The dough samples were

boiled for 1.30 min before adding to prepared syrup. Textural characteristics of the waxy rice gel in the presence or absence of Yanang gum were performed by using Texture analyzer (TA.XT *Plus*, Stable Micro Systems Ltd., Surrey, UK). A set of six pieces of the gel sample after ringing of syrup was placed on a flat metal plate. Instrument settings with a cylindrical 36 mm diameter stainless probe were compression mode, trigger type, pretest speed, 5.0 mm/sec; posttest speed, 10.0 mm/sec; test speed, 2.0 mm/sec; strain, 75 %. From the force-distance curves generated, five texture parameters can be obtained but the highest and lowest values were discarded, thus only three strands were used for data analysis: hardness (g), springiness (ratio), and cohesiveness (ratio).

2.5 Statistical analysis

The experiment was designed in completely randomized design (CRD). Results are expressed as mean ± standard deviations of triplicate analyses for each sample unless otherwise stated. A one-way analysis of variance (ANOVA) and Duncan's test were used to establish the significance of differences among the mean values of RVA data at the 0.05 significance level. Textural properties data were analyzed using anindependent t-test. Statistical analyses were performed using SPSS software.

3. Results and Discussion

3.1 Pasting properties of waxy rice flour and Yanang gum blend

Rapid visco analysis (RVA) was used to study the pasting properties of blends of waxy rice flour and Yanang gum at the various ratios of Yanang leaves to water. Typical RVA pasting profiles of 6 % (w/w) waxy rice flour in the absence of or presence of Yanang gum was shown in Figure 1. Pasting curves for crude hydrocolloid from Yanang at the ratio of Yanang to water of 1:3 (w/w) were almost straight lines with viscosities approximately zero (Figure 1). These results indicated that crude hydrocolloid from Yanang did not develop pasting viscosities under the experimental conditions.

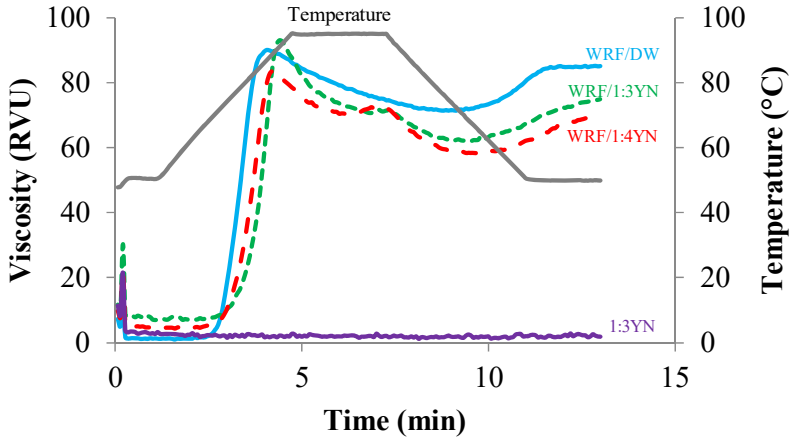

Figure 1. Typical RVA pasting profiles of 6 % (w/w) waxy rice flour in the presence of Yanang gum at the ratios of Yanang to water of 1:3 (WRF/1:3YN) and 1:4 (WRF/1:4YN), w/w respectively, or absence of Yanang gum (WRF/DW) and Yanang gum alone (YN at 1:3, w/w ratio).

The sufficient granules becoming swollen and indicates the water capacity causes a rapid increase in peak viscosity of waxy rice flour in water (WRF/DW) [7]. Addition of crude hydrocolloids from Yanang resulted in a significant decrease in trough, breakdown, and final viscosities of the blends (WRF/1:3YN and WRF/1:4YN) whereas peak viscosities, peak time, and pasting temperatures of the blends were increased ($P \leq 0.05$), except the peak viscosity of waxy rice flour with Yanang gum at the ratio of Yanang leaves to water of 1:4 (w/w), as shown in Table 1. Similar observations were reported by Samutsri and Suphantharika [8] for rice starch with xanthan and guar gum blends. The researchers suggested that because of the interactions between leached starch molecules and hydrocolloid in the continuous phase, resulted in a pronounced increase in the viscosity of the continuous phase and in turn the overall viscosity of the suspension itself, owing to the thickening properties of hydrocolloid added to the thickening produced by swollen starch granules. The peak viscosity of the starch is correlated with the final product quality and it is suggested that high peak viscosity provide the desired product quality [9] and might be used in Thai dessert for good texture. An increase in peak viscosity of waxy rice flour during the hold period of the test at the test minute of 7-8 (Figure 1) therefore hypothesized to be the predominant effect of interactions of protein of waxy rice flour with the other components such as pigment of crude Yanang gum.

Table 1. Pasting properties of 6 % (w/w) waxy rice flour (WRF) in the absence of Yanang gum (WRF/DW) or presence of Yanang gum at the ratios of Yanang to water of 1:3 (WRF/1:3YN) and 1:4 (WRF/1:4YN), w/w respectively.*

Sample	RVA Viscosity (RVU)					Peak time (min)	Pasting temperature (°C)
	Peak viscosity	Trough	Breakdown	Final viscosity	Setback		
WRF/DW	119.06 ± 0.9^{a}	92.25 ± 0.8^{a}	26.81 ± 0.5^{c}	109.41 ± 0.9^{c}	17.16 ± 0.1^{c}	4.07 ± 0.0^{c}	70.10 ± 0.5^{c}
WRF/1:3YN	123.00 ± 4.9^{a}	79.64 ± 1.1^{b}	40.36 ± 4.1^{a}	95.72 ± 0.8^{b}	14.08 ± 0.5^{d}	4.40 ± 0.1^{a}	75.33 ± 1.6^{a}
WRF/1:4YN	110.64 ± 2.0^{b}	74.61 ± 0.7^{b}	36.03 ± 2.1^{b}	88.42 ± 0.7^{c}	13.80 ± 0.8^{d}	4.22 ± 0.1^{b}	72.47 ± 0.4^{b}

*Assays were performed in triplicate. Mean ± standard deviation values in the same column for each sample followed by different letters are significantly different ($p \leq 0.05$).

Table 1 shows the pasting properties of waxy rice flour and Yanang gum at the various ratios of Yanang leaves to water. The pasting temperature of waxy rice flour with the crude Yanang gum at the ratio of Yanang leaves to water of 1:3 and 1:4 (w/w) were much higher (75.33 and 73.47 °C) than waxy rice flour without the gum (70.10 °C). Therefore waxy rice flour granules in the presence of crude Yanang gum were swollen at higher degree than waxy rice flour granules without crude Yanang gum, similar resulted was reported by Han *et al.* [10] that the modified waxy rice exhibited reduce pasting temperature, but increased peak viscosities compared with unmodified starch using in traditional Korean waxy rice cake. [11] hypothesized that the spread of highly swollen granules might lower degree of rice starch retrogradation and consequently reducedspongy structure of freeze-thaw gel. Thus, from this study, it was suggested that the spread of highly swollen granules of waxy rice flour granules in the presence of crude Yanang gum might lower degree of rice starch retrogradation of the waxy rice gel.

During cooling, re-association between starchmolecules, especially amylose, will result in theformation of a gel structure and, therefore, viscosity will increase to the final viscosity. This phase is commonly referred to as the setback region and is related to retrogradation and reordering of starch molecules. The setback reveals the gelling ability or retrogradation tendency of the amylose [12]. The highest setback was observed in the control waxy rice flour, suggesting that the highest amylose retrogradation occurred. The setback of waxy rice flour in the presence of crude

Yanang gum (14.08 and 13.80 RVU) were significantly lower than the control (17.16 RVU) ($P \leq 0.05$).

We hypothesized that crude hydrocolloid from Yanang could reduce the retrogradation of the sample and provide the desirable texture due to the highest peak viscosity. The gel of waxy rice and crude Yanang gum at the ratio of Yanang leaves to water of 1:3 (w/w) was chosen for studying of textural properties of gel sample compared to waxy rice gel alone.

3.2 Textural properties of waxy rice flour and Yanang gum blend

The textural properties of waxy rice gel in the absence of crude Yanang gum (WRF/DW) or presence of crude Yanang gum at the ratio of Yanang leaves to water of 1:3 (w/w) (WRF/1:3YN) was shown in Table 2.

Table 2. Textural properties of waxy rice gel in the absence of Yanang gum (WRF/DW) or presence of crude Yanang gum at the ratio of Yanang to water of 1:3 (w/w).*

Sample	Hardness (g)	Springiness (ratio)	Cohesiveness (ratio)^{ns}
WRF/DW	219.58 ± 24.3^{b}	0.1762 ± 0.02^{b}	0.7933 ± 0.09
WRF/YN	398.18 ± 44.2^{a}	0.1919 ± 0.02^{a}	0.7934 ± 0.08

*Assays were performed in triplicate. Mean ± standard deviation values in the same column for each sample followed by different letters are significantly different ($p \leq 0.05$).

It was found that texture analysis hardness and springiness of the waxy rice gels with crude hydrocolloid extracted from Yanang (398.18 ± 44.2 g and 0.1919 ± 0.02) were significantly different as compared with the control gel (219.58 ± 24.3 g and 0.1762 ± 0.02) ($p \leq 0.05$), however, those of cohesiveness was not significantly different ($p > 0.05$). To increase in gel stability, product formation may be developed by employing polysaccharide gums due to enhancement of water holding capacities, viscosity, and cold storage [4]. In fact, the waxy rice gel alone exhibits more brittle gel than that of waxy rice flour with crude Yanang gum, therefore, it is easy to break the gel. When crude Yanang was used in the waxy rice gel, the peak forces of these mixed gels trended to increase [13]. Springiness represents the extent of recovery of from gel surface deformation and is often referred to as elasticity [14]. In this study, the addition of crude Yanang gum in to waxy rice flour seemed to produce a little impact on hardness and springiness of the gels. Increase in the gel hardness and springiness with containing of crude Yanang gum much more obvious than those gels without gum containing. Compared with waxy rice gel without crude Yanang gum, waxy rice gel with crude Yanang gum showed higher gel elasticity. This might be due to the interactions between leached starch molecules and hydrocolloid in the continuous phase [8]. The texture of blend waxy rice gel with crude Yanang gum might be flavored for cold storage condition.

4. Conclusions

The addition of crude Yanang gum was shown to be an effective agent for improving of waxy rice gels. From RVA profile, the waxy rice flour in the presence of crude Yanang at the ratio of Yanang leaves to water ratio of 1:3 (w/w) might provide a low degree of retrogradation and from texture data, good desirable texture was achieved. Data from this study can be used as guidelines in the development of frozen starch-based products that contain crude hydrocolloid from Yanang to improve gel stability. It also provides a basis for preparing crude Yanang in applications of frozen food products. However, further studies are needed to determine the effect of Yanang gum to reduce retrogradation. Thus, studies on the gel textural properties of freeze-thaw waxy rice flour

in the presence of gum are required.

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