Some Properties of Raw Banana Flour and Starch from Thai Banana Cultivars

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Abstract
Banana (Musa sp.) has been grown in most parts of Thailand and its price is cheap. In its raw stage, banana contains mainly carbohydrate especially starch; therefore, flour and starch production from banana can be plausible. Banana flours and starches were investigated by using 2 Thai banana cultivars Musa (AAA) sp. (11.95 %mc) and Musa (ABB) sp. (12.32 % mc). The AAA and ABB cultivars had yielded 56.71 % and 54.11% of flour, respectively. Banana starches, isolated by using 0.05N NaOH (alkaline method), both cultivars showed insignificantly different in % mc and % yield (9.84 and 9.75 % mc, 29.15 and 31.12 %yield of AAA and ABB respectively). The chemical compositions of banana flours such as protein, fat, ash and fiber were higher than banana starch. Banana starch granules from 2 cultivars had irregular in shape and appeared as elongated oval. Granules from AAA cultivar had longer elongated side than ABB cultivar. The surfaces of green banana starch granules appeared smooth. Their swelling power patterns of green banana flour and starch had 2-stage-swelling. Swelling power was in the range of 1.81-18.31 and solubility was around 3.31-27.68. The pasting properties of green flour and starch showed high viscosity after the temperature reached 95°C. Peak viscosity, breakdown and setback of banana flour and starch were in range 1811-1841 RVU, 543-1551 RVU and 824-2473 RVU, respectively.

Keywords: Banana flour, banana starch, morphology, swelling power and pasting properties

Introduction
Bananas (Musa sp.), important food crops after rice and tapioca are grown extensively in many parts of Thailand. This fruit contains high amount of sugar and is very perishable when it is at ripen. While in the raw stage, it consists mainly of starch. The banana starch might be able to use as substitution of other starches such as potato, corn and wheat. However, the banana starch is not popularly used because there are not hitherto enough researches carried out on its properties unlike its composition (Kayisu et al., 1980; Lii et al., 1982 and Bello-Perez et al., 1999). From the previous experiments, there were differences among the results due to variety of banana species, banana’s ripening stage as well as the isolation method of starches.

Starch, one of the principal and important constituents in plant materials, is usually in fruits as the form of granules, partially crystalline. The morphologies, chemical compositions and the molecular structures of starches are specific of each particular plant species (French, 1984). Starches from different sources vary, particularly in their quantitative and qualitative nature as well as some of the physicochemical properties. Furthermore the methods of starch isolation have an impact on their compositions. In addition, the characteristics of starch such as whiteness, compositions and some properties are also dependent on the procedures used. There are various kinds of reagent used in the isolation of banana starch (Kayisu et al., 1980 and Lii et al., 1982).

The objectives of this study are to produce banana flour and starch including to determine properties of flour and starch obtained from two varieties of Thai cultivar those are ‘Kluai Hom tong’ (AAA group, Gros Michel) and ‘Kluai Nam Wa’ (ABB group).

Materials and Methods

Raw materials
Unripened banana, obtained from local market (Ying Jareaun Market), was collected at the 115th day after fertilization. The bananas have green peel and sharp edges. Banana used for starch isolation was at the first stage of ripening as describe by Von Loesecke (1950) with slightly modified, according to the color of banana peel.
**Starch isolation method**

Bananas were peeled and sliced into small pieces (0.5-1 cm. thick), placed in aluminum trays and dried by hot air oven at 50 °C for about 5 hr. Dried banana slices were milled and passed 60-mesh sieve. The sequences of the starch isolation are shown in Fig. 1.

1. **Banana flour**
   - Suspended in 0.05 N Sodium hydroxide 1:5 (flour: solution)
   - Blended by using over-head stirrer at 500 rpm for 5 hr.
   - Centrifuged at 3000 ×g for 20 min at 25 °C and the scraped off dark materials on the top
   - Suspended in distilled water (1:2)
   - Passed the slurry through 80, 140 and 170 mesh sieve
   - Let the suspension stand for 45 min
   - Decanted the supernatant and then added distilled water (1:2) 2-3 times
   - Adjusted pH (6.5-7.0)
   - Centrifuged at 3000 ×g at 25 °C, for 25 min
   - Decanted the supernatant and scraped off the dark material on the top
   - Dried in hot air oven at 50 °C for 5-8 hr

2. **Pass through 100 mesh sieve, dried starch was stored at room temperature in sealed a container.**

**Figure.1** The sequences of banana starch isolation.

**Color parameter**

Color of banana flour and starch were measured five times in duplicate with Minolta color meter (3500d) by using Hunter System (L, a, b). Whiteness index of banana flour and starch were calculated from this formula:

\[ Whiteness\ index = 100 - \sqrt{(100 - L)^2 + a^2 + b^2} \]

**Compositions Analysis**

Moisture content, protein, fat and ash content of two cultivars banana flour and starch were determined by AOAC method (AOAC, 2002).

**Morphological of Thai banana Varieties**

Light micrographs of samples were obtained from Freeze State Light Microscope(LIECA, USA350) and scanning electron micrographs were obtained from Scanning Electron Microscope(SEM).

**Swelling power and percent of solubility**

Swelling and solubility of banana flour and starch were determined by apply
Waliszewski’s method (Waliszewski et al., 2003). Swelling power and percent of solubility of 2 Thai banana varieties flours and starches were obtained from

\[
\text{Percent solubility} = \frac{\text{weight of dried sample} \times 100}{\text{sample weight (db)}}
\]

\[
\text{Swelling power} = \frac{\text{weight of wet sample} \times 100}{\text{sample weight (db)} \times (100 - \% \text{ solubility})}
\]

**Pasting Characteristic**

Pasting characteristic of banana flour and starch were measured by using Rapid Visco Analyzer (RVA) by AACC method (AACC, 2000)

**Statistical analysis**

The statistical analysis was performed using single factor analysis of variance (ANOVA) for all data and also the SPSS for Windows program, version 13, was employed to analyze. Comparisons of means were carried out by Duncan’s multiple range test (DMRT) at the 5% significance level.

**Results and Discussion**

Due to the differences of flour and starch characteristics among two cultivars of Thai banana, ‘Kluai Hom Tong’ and ‘Kluai Nam Wa’ were determined for some properties.

Dried basis yield recovery (from whole fresh fruit) of ‘Kluai Hom Tong’ and ‘Kluai Nam Wa’ flour, material for starch isolation, were 54.50% and 56.50% respectively. Dried basis yield recovery (from flour) of ‘Kluai Hom Tong’ and ‘Kluai Nam Wa’ starch were 29.15% and 31.12% respectively. Other compositions of both Thai banana cultivars has shown in Table 1

**Table 1 Compositions of 2 Thai banana varieties flours and starches**

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Type of Sample</th>
<th>Moisture (%)</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Kluai Hom Tong’</td>
<td>flour</td>
<td>11.95±0.091</td>
<td>4.76±0.051</td>
<td>0.47±0.849</td>
<td>4.40±0.025</td>
</tr>
<tr>
<td></td>
<td>starch</td>
<td>9.84±0.19</td>
<td>0.06±0.05</td>
<td>0.10±0.06</td>
<td>0.06±0.30</td>
</tr>
<tr>
<td>‘Kluai Nam Wa’</td>
<td>flour</td>
<td>12.32±0.043</td>
<td>1.93±0.039</td>
<td>0.30±0.088</td>
<td>2.39±0.035</td>
</tr>
<tr>
<td></td>
<td>starch</td>
<td>9.75±0.04</td>
<td>0.05±0.1</td>
<td>0.11±0.02</td>
<td>0.05±0.06</td>
</tr>
</tbody>
</table>

Protein content and color of starch were used as indicator for purity of isolated starch (Lii et al., 1981). Whiteness index of banana flour has lower than banana starch. Starch obtained from ‘Kluai Nam Wa’ gave higher whiteness value (98.39) than ‘Kluai Hom Tong’ (98.08) but it is not significantly difference \((p<0.05)\) so it means that banana starch from Thai varieties can be offered for clear starchy products.

Banana starch granules from 2 cultivars had irregular in shape and appeared as elongated oval. Granules from AAA cultivar had longer elongated side than ABB cultivar as shown in fig. 2 and 3. The surfaces of green banana starch granules appeared smooth. The granules size of two varieties were in range of 7.55-62.37 µm.
Figure 2 Normal light micrographs of ‘Kluia Nam Wa’ flour and starch granules (a and c), and ‘Kluai Hom Tong’ flour and starch granules (b and d) with 40X magnification.

Figure 3 Scanning electron micrographs of ‘Kluia Nam Wa’ (a) and ‘Kluai Hom Tong’ (b) starch granules with magnification 2,500X.
Swelling power (g/g)

Percent solubility

Figure 4 Swelling power (a) and percent solubility (b) of two banana varieties flours and starches

Swelling power was in the range of 1.81-18.31 and solubility was around 3.31-27.68. Their swelling power and percent solubility patterns of green banana flour and starch had 2-stage-swelling because of there were two 2 steps that be destroyed hydrogen bond. Hydrogen bond at amorphous region was destroyed so swelling power in first state showed slightly increased then temperature was increased hydrogen bond at the crystalline region was destroyed so in this state swelling power showed rapidly increased. This result was correlated to Kayisu et al. (1981) which determined swelling power and solubility of banana starch (AAA group). This pattern showed 2-stage-swelling. The swelling power was closed to mung bean and milo starch and the percent solubility closed to milo starch.

In Fig. 4-(b), percent solubility pattern of ‘Kluai Hom Tong’ flour was different from the others that may cause of starch suspension used in this (1% w/w) experimental did not suitable or there was other compositions that limited solubility of ‘Kluai Hom Tong’ flour.

Pasting characteristic of four samples were shown the same pattern. The pasting properties of green flour and starch showed high viscosity after the temperature reached 95°C. Peak viscosity, breakdown and setback of banana flours and starches were in range 2,700-4,650 Cp, 630-1,651 Cp and 1,224-2,273 Cp, respectively. ‘Kluai Nam Wa’ starch was the highest viscosity and ‘Kluai Hom Tong’ flour was the lowest viscosity. The viscosity of banana starch was high but didn’t show the highest point of peak, as same as showed in result of Kayisu et al. (1980) and Liu et al. (1981). This pattern of pasting characteristic was shown the type of restricted-swelling starches. Starch granules had much more stable than other types so the peak viscosity doesn’t show the highest point of peak viscosity. Viscosity of Thai banana varieties flours and starches were showed in Fig. 5.
**Conclusions**

Banana flours and starches from two varieties showed significantly difference ($p<0.05$) in % yield recovery, protein content, color parameter, pasting profile. Starch from ‘Kluai Nam Wa’ (ABB group) gave the best result in color(98.39), percent yield recovery(31.12%). Morphology of banana starch was irregular shape. Pasting temperature of both ‘Kluai Nam Wa’ flour and starch showed significant different ($p<0.05$) and were in the range of 630-4,650 Cp. The pasting characteristic of all starch was shown the same trend which didn’t show the highest point of the peak viscosity.

**Literature Cited**


