NATURAL INDIGENOUS SWEETENERS:
SUGAR COMPOSITION AND GLYCEMIC INDEX

Trinidad P. Trinidad, Ph.D.,
Aida C. Mallillin, Rosario S. Sagum, Ph.D.

Food and Nutrition Research Institute-Department of Science and Technology
Bicutan, Taguig City, Metro Manila 1631 Philippines

Sugar imparts sweetness in food.

In the form of glucose, it has important functional and physiological roles in the body.

Sugar is increasingly seen as one of the main contributors to rising obesity rates.

For example:

Sugar Intake ↑ Calorie Intake ↑ Energy Expenditure

WORLD RECORD
World Resources Institute: http://www.wri.org/our-work/topics/food
World Hunger Organization: http://www.who.int/nutrition/challenges/en/
FAO: http://www.wfp.org/hunger/stats

2 Billion Malnourished

870 Million Undernourished

1.4 Billion Overweight

500 Million Obese

Prevalence of Overweight/Obese Adults 20.0 yrs old and above: Philippines, 2013

3 out of 10 or 31.1% overweight/obese

BMI: ≥ 25

FNRI-DOST 2013 National Nutrition Survey Data
Natural sugars are not created equal. They may not only contain simple sugars like sucrose but also complex carbohydrates such as fructooligosaccharides, inulin and dietary fiber that may contribute in the sustainable and slow release of glucose in the body that may play an important role in the proper control and management of overweight/obesity as well as in type II Diabetes Mellitus.

**GLYCEMIC INDEX (GI)** is a classification of food based on the blood glucose response of a food relative to a standard glucose solution or a starchy food e.g. white bread.

Classification:
- low ≤ 55
- medium - 56-69
- high ≥ 70

**Objective of the study:**

To determine the sugar composition and glycemic response / index of natural indigenous sugars from local sources.
Indigenous Natural Sugars from Local Sources Studied:

- Coconut sap sugar
- Coconut sap syrup
- Sorghum sugar
- Kaong sugar
- Nipa sap sugar
- Buri sugar
- Sugar cane granules
- Muscovado

**COCONUT (Cocos nucifera, ) SAP SUGAR/SYRUP**

Containers used to collect the sap are made out of hollow bamboo tubes that are fastened onto the thick fleshy stems covered in small flowers.

The freshly gathered coconut tree sap is oyster white in color, has a nearly neutral pH, and is already inherently sweet tasting by nature.

**NIPA (Nypa fruticans) SAP SUGAR: COLLECTION AND PROCESSING**

The basic process for producing nipa sap sugar involves the following simple steps: freshly gathered sap is weighed, strained, cooked/boiled forming into granules or crystals then cooled to room temperature. The finished product is golden brown to yellowish brown in color and has a shelf life of more than 2 years at room (30±2°C) temperature. The sugar is packed using appropriate packaging materials, sealed properly, packed in carton boxes, sealed, labelled, and stored in a cool, dry storage room.

Data from PCA:

- 2 gallons = 1 kg
- 7 gallons = 1 gallon

Present production from 2 hectares of coconut:

- 300 hybrid coconut varieties = 3.5 metric tons coconut sugar
- = 205 gallon of coconut honey

1 ½kg of nipa sap sugar from 10 liters of nipa sap.
KAONG (*Arenga pinnata, Wurmb Merr.*) SAP SUGAR

Sweet sap: A single tree can yield a total if 6 liters per day, from 3 harvests that yields 2 liters per tap. The sweet sap is processed to brown sugar by continuous boiling for up to 6 hours, requiring regular stirring to ensure good mixing and avoid burning. Soon after coagulation, it is put into coconut shells or bamboo moulds where it cools and hardens.

BURI (*Corypha Elata, Roxb*) SUGAR

The sap is sugary and the buds are edible. The sweet juice from this large tree is boiled for about a quarter of a day, set aside, and then poured into molds like small *casitas* of palm leaves.

SORGHUM SUGAR

The tall, broad-leaf plant resembles corn in the field, but the grain crop is best known for its end product: sweet sorghum syrup.

Many sorghum syrup producers extract the juice from freshly cut plants right in the field. The bright green juice then goes back to the mill, where it is kept, heated, in a holding tank. To avoid spoilage and produce the best syrup, they cook it the next day, thickening into light amber syrup that is then bottled.

Ten gallons of raw sorghum juice yields about 1 gallon of syrup.

White sugar in its crystalline form is eventually obtained from the thick juice by crystallization in vacuum pans at reduced temperature and pressure. The mixture of crystals (sucrose only) and mother liquor (green syrup) are separated in centrifuges, where the sugar is washed with hot water.

Analytical Methods:

Nutrient Composition: AOAC Methods
Dietary Fiber: AOAC Methods
Monosaccharides: GC Method
Inulin: Medallion Laboratories, Minnesota, USA
Study Participants:

10 Apparently Healthy Human Adults

Inclusion Criteria:

- Fasting blood glucose ≤ 6.2 mmol/L but not less than 3.5 mmol/L
- BMI: 20-25 kg/m²
- Age: 30-65 years
- No medication for glucose
- Non smokers

Glycemic Index

Calculation of GI of Food

GI of food = \( \text{IAUC}^* \text{ of test food} \) \times 100 \( \text{IAUC of control food} \)

* Incremental Area Under the Curve

Protocol of the Study:

Feeding of test foods

Blood collection at 0, 15, 30, 45, 60, 90 and 120 mins

Clinical Chemistry Analyzer

Nutrient Composition of Natural Indigenous Sugars, g/100g Sample

<table>
<thead>
<tr>
<th>Sugars</th>
<th>Moisture</th>
<th>Ash</th>
<th>Protein</th>
<th>Fat</th>
<th>CHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut sap sugar</td>
<td>1.80</td>
<td>2.2</td>
<td>1.2</td>
<td>0.1</td>
<td>94.9</td>
</tr>
<tr>
<td>Coconut sap syrup</td>
<td>18.40</td>
<td>1.7</td>
<td>1.0</td>
<td>0.1</td>
<td>79.0</td>
</tr>
<tr>
<td>Sorghum</td>
<td>1.10</td>
<td>3.9</td>
<td>2.0</td>
<td>0.1</td>
<td>92.9</td>
</tr>
<tr>
<td>Kaong</td>
<td>2.20</td>
<td>1.4</td>
<td>1.1</td>
<td>*</td>
<td>95.4</td>
</tr>
<tr>
<td>Nipa</td>
<td>7.60</td>
<td>3.3</td>
<td>2.0</td>
<td>0.3</td>
<td>85.2</td>
</tr>
<tr>
<td>Buri</td>
<td>0.17</td>
<td>0.3</td>
<td>0.2</td>
<td>&lt;0.1</td>
<td>99.3</td>
</tr>
<tr>
<td>Sugar cane granules</td>
<td>2.80</td>
<td>1.4</td>
<td>0.2</td>
<td>0.2</td>
<td>95.4</td>
</tr>
</tbody>
</table>

* Not Detected
SUGAR COMPOSITION OF NATURAL INDIGENOUS SUGARS, % w/w

<table>
<thead>
<tr>
<th>SUGARS</th>
<th>SUCROSE</th>
<th>GLUCOSE</th>
<th>FRUCTOSE</th>
<th>MANNOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coconut sap sugar</td>
<td>83.14</td>
<td>11.45</td>
<td>3.69</td>
<td>2.78</td>
</tr>
<tr>
<td>Coconut sap syrup</td>
<td>36.02</td>
<td>14.03</td>
<td>15.45</td>
<td>3.91</td>
</tr>
<tr>
<td>Sorghum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Kaong</td>
<td>95.80</td>
<td>0.37</td>
<td>0.80</td>
<td>-</td>
</tr>
<tr>
<td>Nipa</td>
<td>85.20</td>
<td>0.13</td>
<td>0.22</td>
<td>-</td>
</tr>
<tr>
<td>Buri</td>
<td>87.50</td>
<td>0.55</td>
<td>0.33</td>
<td>-</td>
</tr>
<tr>
<td>Sugar cane granules</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Muscovado</td>
<td>89.15</td>
<td>2.78</td>
<td>1.88</td>
<td>-</td>
</tr>
</tbody>
</table>

- Not Analyzed

TOTAL SHORT CHAIN FATTY ACIDS FROM COCO SAP SUGAR AND SYRUP

SHORT CHAIN FATTY ACIDS PRODUCED FROM COCO SAP SUGAR AND SYRUP
### Glycemic Index of Natural Indigenous Sugars

<table>
<thead>
<tr>
<th>Sugar Type</th>
<th>Glycemic Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>SORGHUM</td>
<td>HIGH</td>
</tr>
<tr>
<td>KAONG</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>BIRI</td>
<td>HIGH</td>
</tr>
<tr>
<td>NIPA</td>
<td>LOW</td>
</tr>
<tr>
<td>MUSCOVADO</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>SUGAR CANE GRANULES</td>
<td>LOW</td>
</tr>
<tr>
<td>COCO SAP SUGAR</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>COCO SAP SYRUP</td>
<td>MEDIUM</td>
</tr>
</tbody>
</table>

**Antioxidant Activity of Coconut Sap Sugar and Syrup**

- **DPPH** measures % inhibition
- **FRAP** measures reducing power expressed in mg Trolox/100g

### Glucose Response of Coco Sugar/Syrup Against a Standard Glucose Solution

- **Glucose**
- **Coco Sugar**
- **Coco Syrup**
In conclusion:

Natural indigenous sugars with inulin and fructose greater than glucose resulted in low glycemic response/index and may be recommended in the prevention for risk of overweight/obesity as well as type II diabetes mellitus.

From SCIENCE to MARKET

Coconut Sap Sugar:

Currently there are 36 coco sap sugar producers in the Philippines, mostly in Mindanao, and the rest in Luzon and Visayas; Region 10 (Northern Mindanao) has eleven producers, followed by Region 12 (Soccsksargen) with seven, while Regions 13 (Caraga) and 11 (Davao) have five producers each e.g. Succhero, Spythe Global and Aroman Women’s Natural Food Producers Multipurpose Cooperative.
Food and Nutrition Research Institute
Department of Science and Technology

PROJECT TEAM
SUGARS AND GLYCEMIC INDEX

Trinidad P. Trinidad, Ph.D.
Aida C. Mallillin
Rosario S. Sagum, Ph.D.
Amster Fei P. Baquiran
James David S. Alcantara

THANK YOU and GOOD DAY!