Reproductive phenology and sugar production of nipa palm (*Nypa fruticans*) in Labuk Bay, Sandakan

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Introduction to Nipa palm (*Nypa fruticans*)

- Sugar sap/nira – traditionally made into various products from foods (sugar, vinegar, alcoholic drink/tuak etc.) to roofing material & cigarettes wrappers.

- Nipa palm (*Nypa fruticans*) is currently back as a focus in the world (Rozainah et al., 2010; Tsuji et al, 2011; Tamunaidu, 2011; 2013; Matsui et al., 2014 etc) since first research done in the 70’s & 80’s (Uhl 1971; 1972; 1977; Päivöke, 1985; Tomlinson 1979; 1983; 1987 etc).

- Newly found interests mainly focus on sugar sap (nira) production, sugar content, demographic study & bioethanol potential.
• Widely distributed in Southeast Asia & Oceania.

• Can be found in brackish water, coastal zones, tidal flats and creeks, small channel of river, as long as tide exist (Fong, 1982 and Rozainah, 2010).

• In Sabah, it can be found in 331,620,12 hectare of protected mangroves forest reserves (Annual Report, 2012; 2013).
Methods to get sugar sap

Traditional
By locals – massaged for 64 times, bending and kicking the base of stalk 4 times for 4-12 weeks (n=6)
(Paivoke, 1985)

New – Heated water
Any type of water heated for 80-90°C, applied to stalk from stalks’ base to the infructescences’ base.
Duration: 2 weeks (n=5)
Observation on amount of nira every 4 hours in 3 days (n=6).

- Average sap (right) peaks at 6:00 and 10:00 am daily.
- Sugar concentration (left) peaks at 10:00 am.
Average sap ranges from 636.2 mL to 753.4 mL daily.
Average brix concentration ranging from 17.8% to 20.2% daily.
In average, the palms are able to produce ≥1L nira for 30 days (n=5, SD=12.9).
Average sap producing days ranges from 51 to 138 days.

<table>
<thead>
<tr>
<th>Tree</th>
<th>Total Day of Sap Produced (days)</th>
<th>Average Sap Daily (mL/d)</th>
<th>Total Sap (L)</th>
<th>Average Brix Concentration (%)</th>
<th>Days Sap Produced ≥1L (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>138</td>
<td>774.1</td>
<td>106.8</td>
<td>19.0</td>
<td>52</td>
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<td>56</td>
<td>66</td>
<td>761.3</td>
<td>50.3</td>
<td>18.2</td>
<td>20</td>
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<tr>
<td>58</td>
<td>113</td>
<td>652.3</td>
<td>73.7</td>
<td>19.2</td>
<td>26</td>
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<tr>
<td>66</td>
<td>80</td>
<td>753.4</td>
<td>60.3</td>
<td>17.8</td>
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<tr>
<td>70</td>
<td>84</td>
<td>450.6</td>
<td>37.9</td>
<td>17.8</td>
<td>-</td>
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<tr>
<td>73</td>
<td>65</td>
<td>636.2</td>
<td>41.4</td>
<td>18.7</td>
<td>22</td>
</tr>
</tbody>
</table>
• Average sap from 71.1 mL to 540.85 mL daily
• Average brix concentration ranging from 18.78% to 20.26% daily
• In average, the palms are able to produce ≥1L nira for 30 days (n=5, SD=12.9).
• Average sap producing days is 55 days (ranges from 20 to 92 days).
• Traditional method – produced higher amount of sap but heated method produced higher sugar content.
• Soil is the factor that influence the production of sap (Matsui, 2014)
• Further study need to be done on ideal temperature for heated method.
• More samples for sugar/sap production are needed in order to get comprehensible analysis. Lack of samples for nira tapping is due to inexperiece and skills. Other reasons are environmental factors caused by temperature, soils, rainfall and water conditions.
• Furthermore, other methods apart from heated water must be explore. Thus disadvantages of high demand for manual labor in nira tapping as mentioned by Paivoke (1996) could be reduce and the use of heavy machinery could be avoided.

• High sap & sugar amount in the morning - The factor could be caused by photosynthesis process. The intensity of photosynthetic rate under the sun starts to increase during sunrise, reached maximum rate at mid-morning and then showed depression during mid-day (Koyama & Takemoto, 2014).

• However, without further information and experiments done the factors can't be determine.
Reproductive phenology

- 54 nipa palms observed for a year
- Phases of reproductive phenology divided into 6
Reproductive phenology

**Phase 1** – occurrence of flower bud.
Duration: Average 43.9 days
(n=12, sd= 27.68)

Peaks in July.
Phase 2 – emergence of female flower

Pistillate phase and staminate phase occurred a day apart.

The yellow pistil head of female flower emerged for average 5.5 days (n=10, SD=1.08) before pollination occurred.
Phase 3 – emergence of male flowers

Spikes of staminate flowers blooms for 9 days (n=11, SD=4.69) before wilted.

Peaks in July.
Phase 4 – immature infructescence


Duration: 137 days (n=18, SD=27.3).
Phase 5 – mature infructescence

Hardened endosperm. Nira tapping is not possible. Peaked on July – August.

Duration: 85.2 days (n=41, SD=47)
Phase 6 – no reproductive process occurred.

A gap in a year where no reproductive cycle occurred. Vegetative process still occurred during this time. Can be seen throughout the year.

Duration:
243.3 days (n=40, SD 53.6)
• Seasonal fruiting pattern in palms has been recorded before in numerous study.

• Fruiting and flowering ability of palms had so far been influenced by weather. (Galetti et al., 1999; Silva et al., 2013; Genini et al., 1999; Kubickova, 1990; Marten et al., 1999).

• July-August is the start of Phase 1-5, which is the beginning of rainy season in 2014.

• Slight decreased in fruiting activity of palms usually occurred during the wet-dry season transition (De Steven, 1987). This can be seen in October and November where only three individuals bear mature infructescences which dropped by the end of November.
• July is the beginning of rainy season in 2014.

• Sugar sap production diminished due to heavy rain and floods.
Conclusion:

Suitable tapping months starts from July – August. Amount of sugar sap using traditional method of tapping still surpassed the method of heated water. Phase 1-5 (flowering & fruiting) begins in July-August.
Challenges

• Disturbance by animals; *Macaca nemestriana & Macaca fascicularis*, ants, bees, orangutan, squirrels, mice etc. exposed the stalk to dried up & the next day reading to differed.

• Environment; high tides, heavy rain, floods.
Future recommendation: Improvised methods of heat treatment hopefully could generate a better production of sap in the future.

Furthermore, other methods apart from heated water must be explored. Thus disadvantages of high demand for manual labor in nira tapping as mentioned by Paivoke (1996) could be reduce and the use of heavy machinery (if there’s any) could be avoided.

Production of nira will certainly bring profits to the local people and the government through production of various products.
Acknowledgement

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Thank you