Production of Ethanol from Cassava Processing Wastes in Nigeria

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<table>
<thead>
<tr>
<th>Country</th>
<th>Production (t/year)</th>
<th>Year</th>
<th>tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nigeria</td>
<td>47,406,770</td>
<td>2007</td>
<td>43,410,000</td>
</tr>
<tr>
<td>Thailand</td>
<td>30,227,542</td>
<td>2008</td>
<td>44,582,000</td>
</tr>
<tr>
<td>Indonesia</td>
<td>23,936,920</td>
<td>2009</td>
<td>36,822,248</td>
</tr>
<tr>
<td>Brazil</td>
<td>21,484,218</td>
<td>2010</td>
<td>42,533,180</td>
</tr>
<tr>
<td>Angola</td>
<td>16,411,674</td>
<td>2011</td>
<td>46,190,248</td>
</tr>
<tr>
<td>Ghana</td>
<td>15,989,940</td>
<td>2012</td>
<td>50,950,292</td>
</tr>
<tr>
<td>DR Congo</td>
<td>14,611,911</td>
<td>2013</td>
<td>47,406,770</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>9,757,681</td>
<td>2014</td>
<td>56,328,480</td>
</tr>
<tr>
<td>Cambodia</td>
<td>7,572,344</td>
<td>2015</td>
<td>57,643,271</td>
</tr>
<tr>
<td>India</td>
<td>7,236,600</td>
<td>2016</td>
<td>57,134,478</td>
</tr>
</tbody>
</table>

Total world production = 268,000,000

Source: FAOSTAT
Major products from cassava in Nigeria

Garri

Fufu

Cassava Flour

Cassava starch
Garri and Fufu

Families and cottage processors

Cassava flour and Cassava starch

Many companies. Many with capacity of more than 5 t/day and generate an average of 495 kg wastes per tonne.

Wastes are scattered and used for animal feed.

These wastes can be economically converted to bio-ethanol.
**Cassava Processing Wastes**

### Cassava flour
- Peels: 250-300 kg/t
- Dust: 30 kg/t
- Fibers: 20-40 kg

### Cassava starch
- Peels: 250-300 kg/t
- Pulp: 400 kg/t
Partially decayed and infested parts are also good substrate for bio-ethanol production
In order to develop a process for efficient conversion of the cassava processing wastes to ethanol, we:

1. Screened for thermo-tolerant strains of yeast

2. Optimized their ethanol production from cassava processed wastes in flask cultures

3. Produced ethanol from the wastes using a 5-L jar fermentor
Ethanol production by the 10 best isolates from Nigeria at 42°C and 45°C.
Phylogenetic tree for the isolates
Effect of temperature on simultaneous saccharification and ethanol production from cassava pulp and peel.
Effects of pH on the maximum ethanol concentration produced from 20% cassava pulp.
Effect of nitrogen source on ethanol production from cassava pulp and peel
Time courses of ethanol production from 20% cassava peel and pulp in flask cultures.
Fermentation of Cassava pulp using a 5 L jar fermentor
Large scale Re-distillation, Rectification and Dehydration Company

Petroleum Refinery Industry

Gasohol

Gasoline Retailers

99.5% Ethanol

Crude amylase

40~60% Ethanol

Small scale ethanol production Companies

Cassava peels/pulp

Crude enzyme companies

Yeast paste or broth

Yeast seed culture Companies

Small scale cassava processors

Industrial cluster model for commercial fuel ethanol production
In Nigeria
57 MT
Cassava
tubers

Processed

rotten
Peel
pulp
(495kg/t)

Garri
Fufu
Flour
Starch

Wastes
28.22 MT

Animal feed
Organic manure

60%
(16.93 MT)

40%
(11.29 MT)

2.032 x 10^9 L
Ethanol
(180L/t)
Conclusion

According to National Bureau of Statistics, Nigeria consumed 54.3 million liters of PMS daily within the first quarter of 2017. This requires 5,430,000 L of ethanol per day to make E10 gasohol (90% gasoline with 10% ethanol), amounting to 1,981,950,000 liters of ethanol per year. This can be supplied by converting wastes from 40% of the annual 57 million tones of cassava to ethanol.

Currently, Nigerian local refineries are producing only about 8 million liters of PMS per day. This requires only 800,000 liters of ethanol per day (292,000,000 L per annum) and can be supplied by converting wastes from only 5.84% of cassava produced in Nigeria.
THANKS

I hereby express my gratitude to IRENA for inviting me to participate in this meeting and thank all of you for listening.