Production of Ethanol from Cassava Processing Wastes in Nigeria

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Top ten cassava producers in the world (2013)

Country	Production (t/year)
Nigeria	47,406,770
Thailand	30,227,542
Indonesia	23,936,920
Brazil	21,484,218
Angola	16,411,674
Ghana	15,989,940
DR Congo	14,611,911
Viet Nam	9,757,681
Cambodia	7,572,344
India	7,236,600

Total world production = 268,000,000

Production of fresh cassava tubers in Nigeria

Year	tonnes
2007	43,410,000
2008	44,582,000
2009	36,822,248
2010	42,533,180
2011	46,190,248
2012	50,950,292
2013	47,406,770
2014	56.328,480
2015	57,643,271
2016	57,134,478

Source: FAOSTAT

Major products from cassava in Nigeria

Garri

Fufu

Cassava Flour

Cassava starch

Garri
Fufu

Family/cottage processors
Wastes are scattered and used for animal feed

Cassava flour
Cassava starch

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

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**

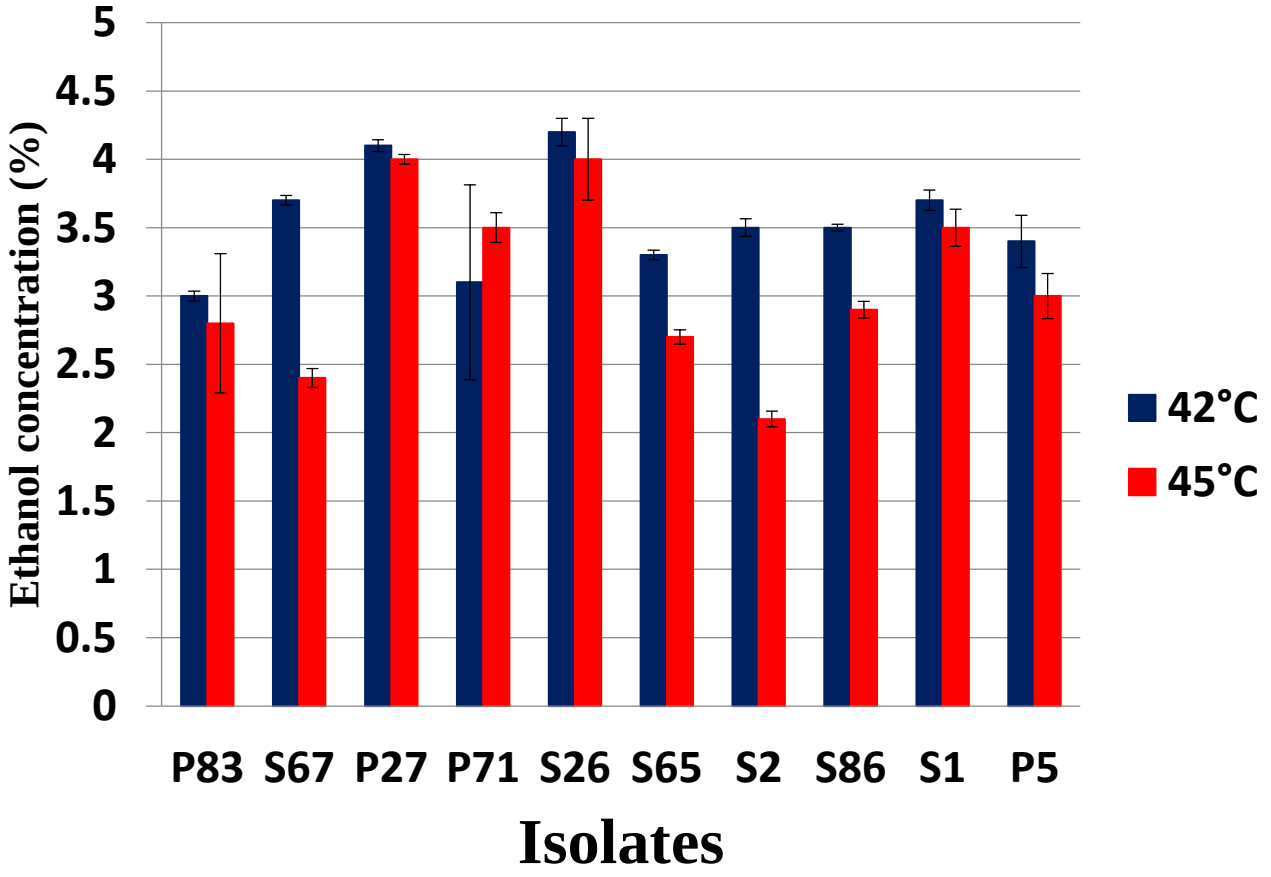
Partially decayed and infested parts are also good substrate for bio-ethanol production

In order to develop a process for efficient conversion of the cassava processing wastes to ethanol, we:

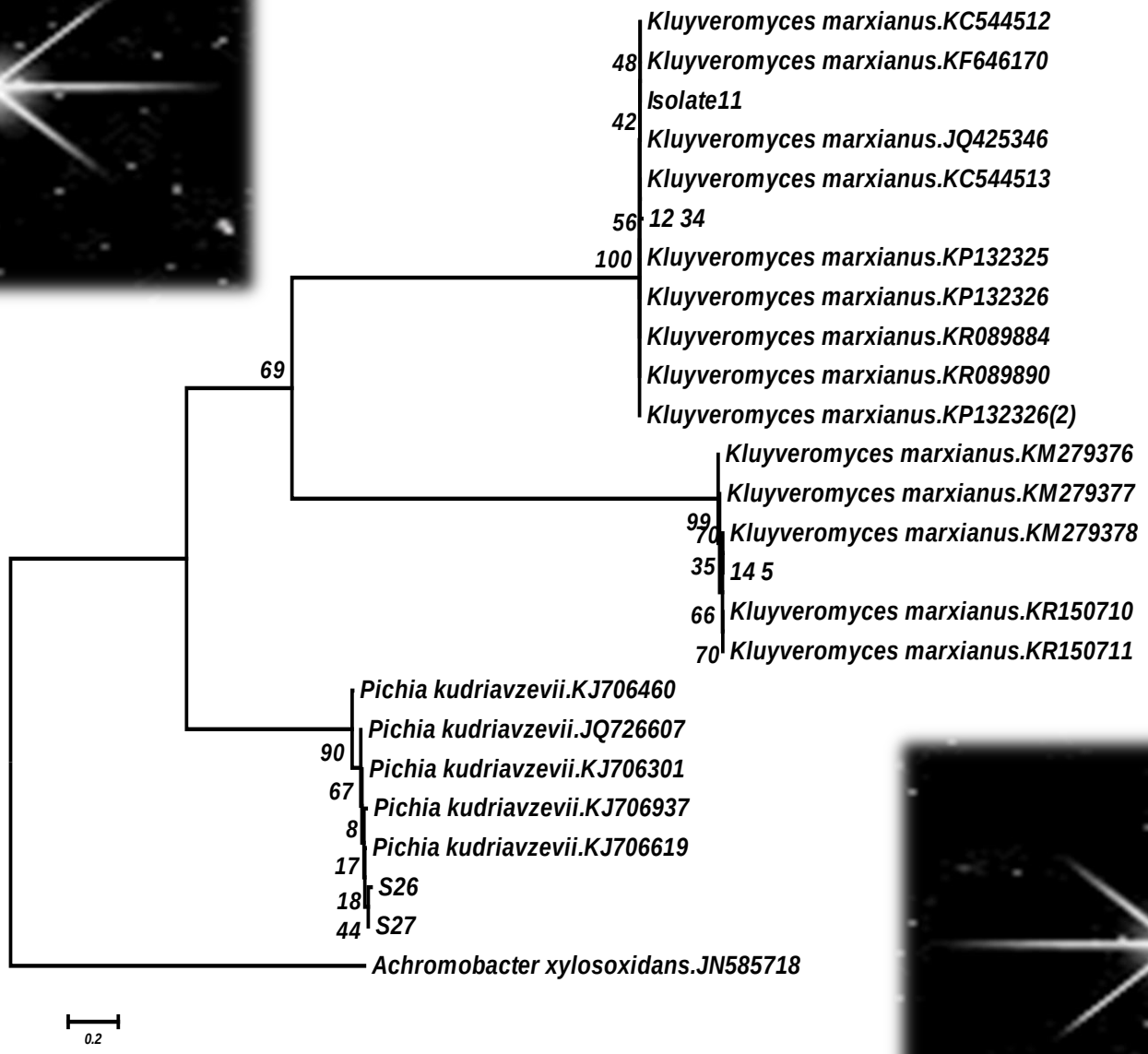
1. **Screened for thermo-tolerant strains of yeast**

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

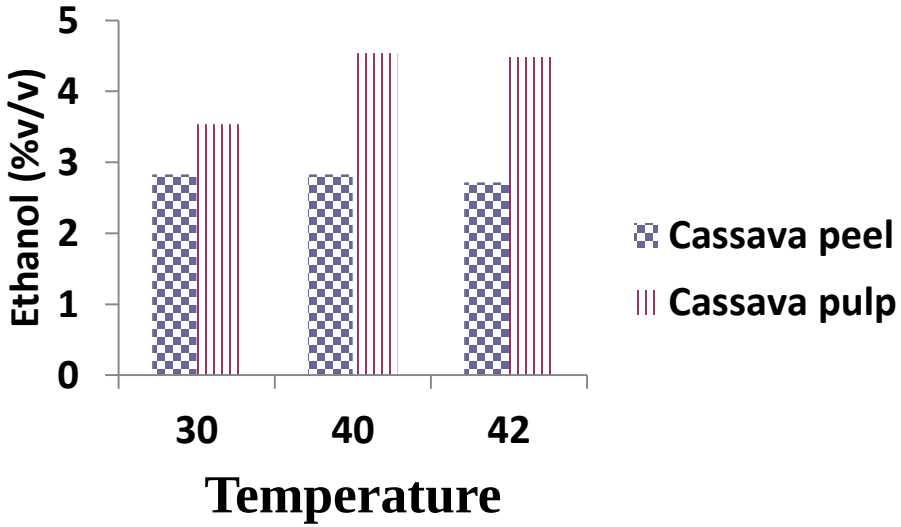
3. **Produced ethanol from the wastes using a 5-L jar fermentor**



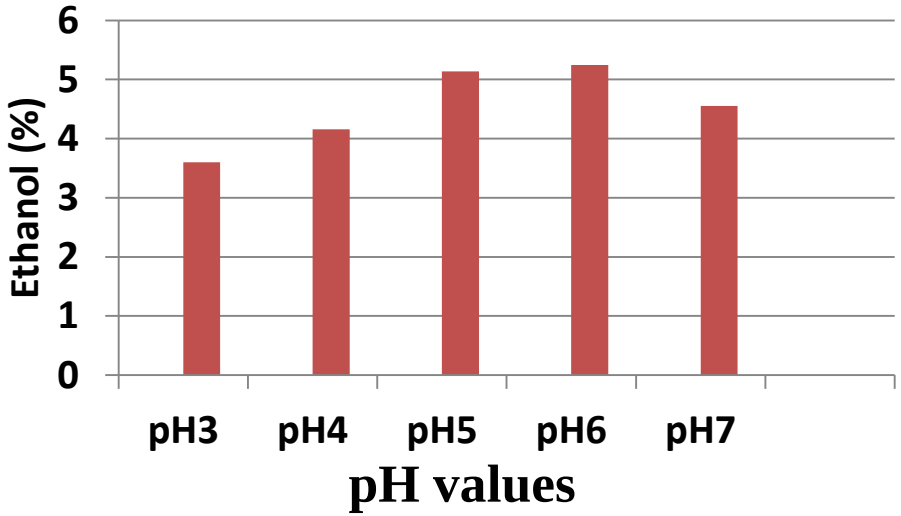
Ethanol production by the 10 best isolates from Nigeria at 42°C and 45°C.



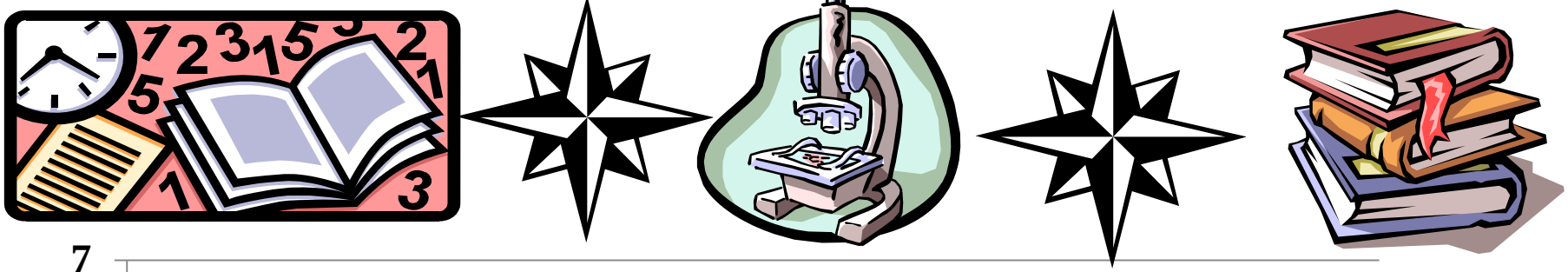
Phylogenetic tree for the isolates

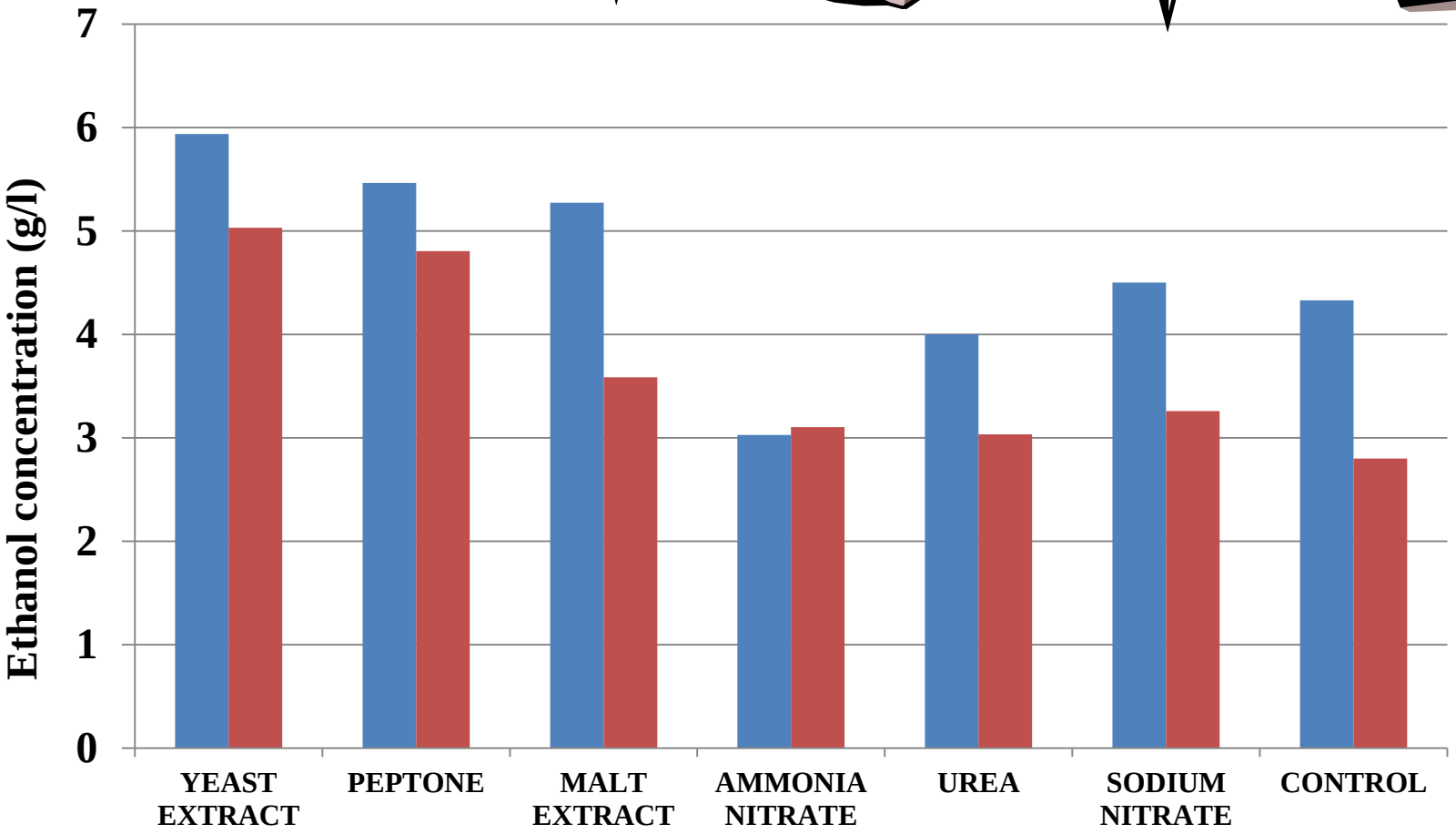


Effect of temperature on simultaneous saccharification and ethanol production from cassava pulp and peel.

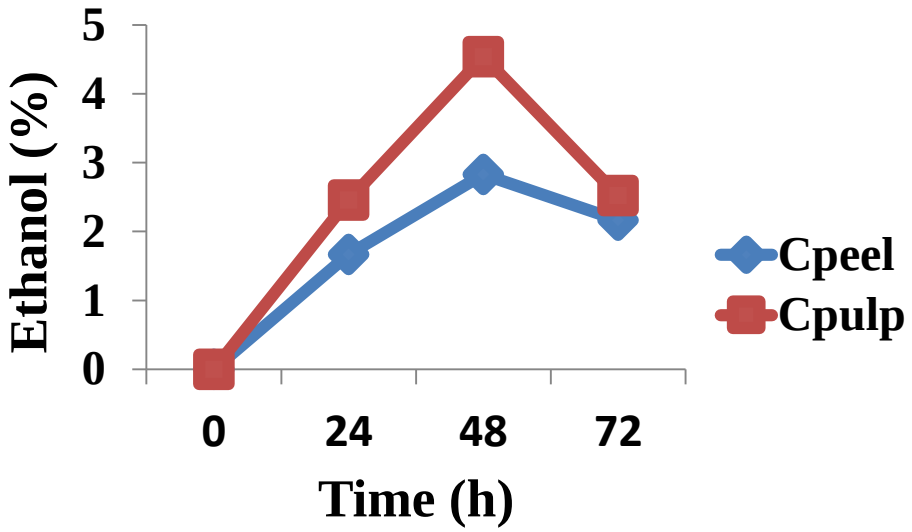


Effects of pH on the maximum ethanol concentration produced from 20% cassava pulp.

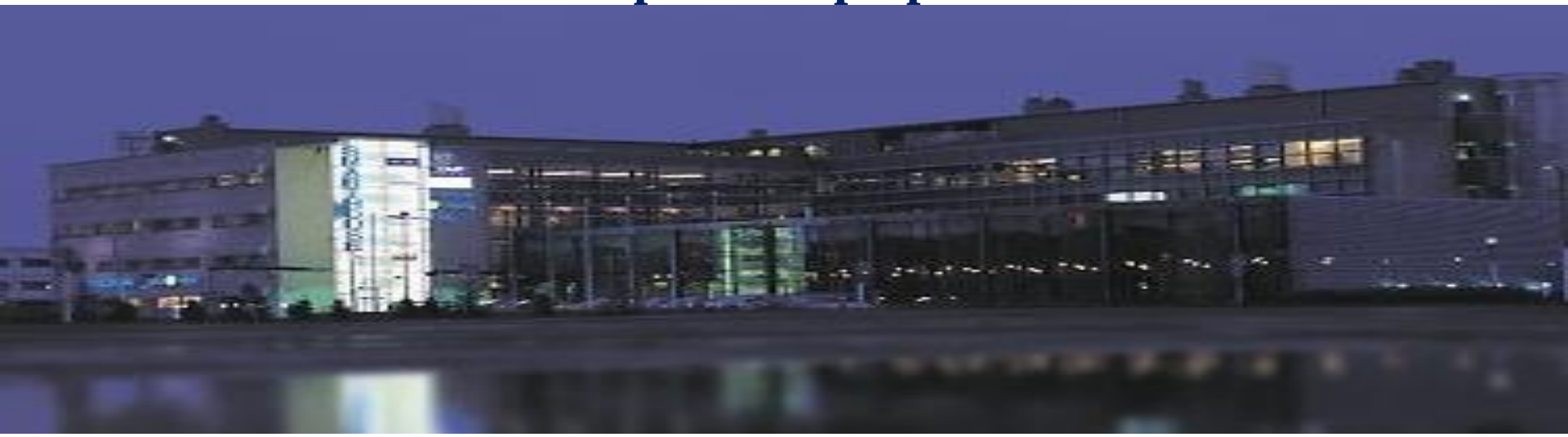


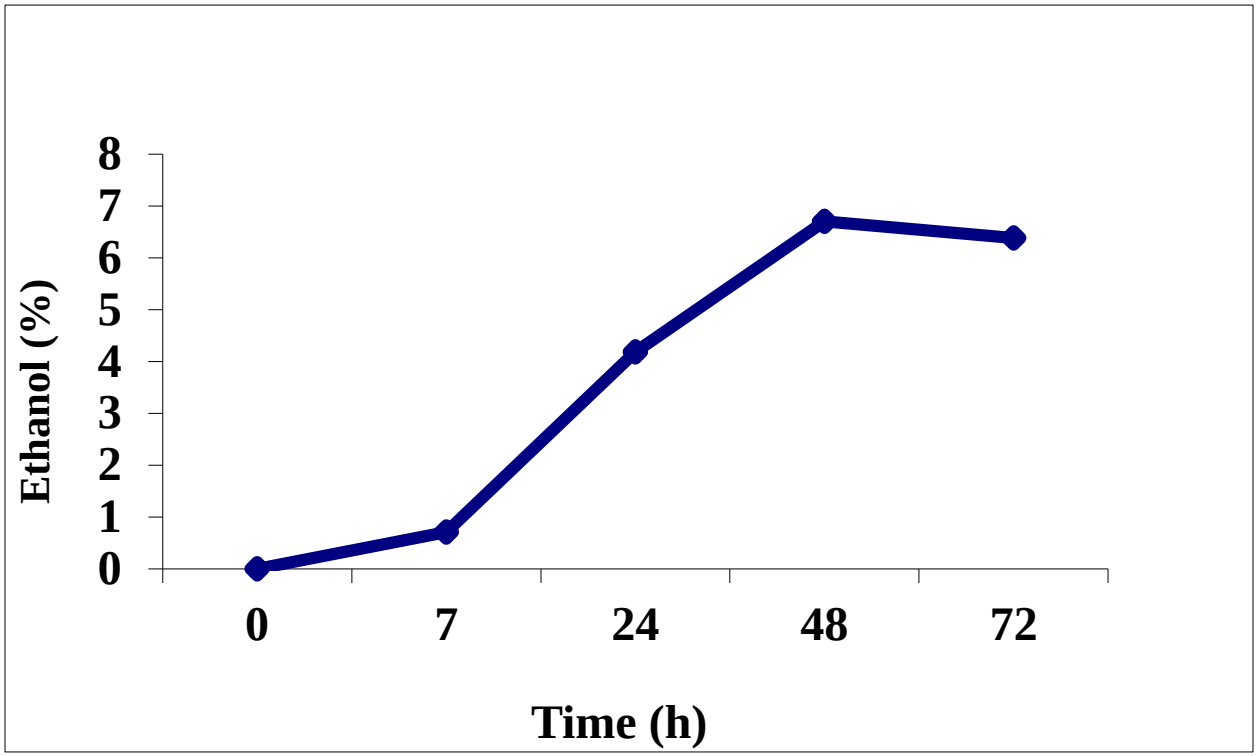


Effect of nitrogen source on ethanol production from cassava pulp and peel

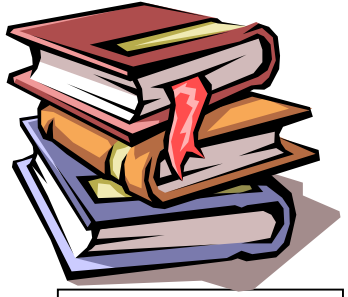


Time courses of ethanol production from 20% cassava peel and pulp in flask cules





Fermentation of Cassava pulp using a 5 L jar fermentor



Small scale cassava processors

Cassava peels/pulp

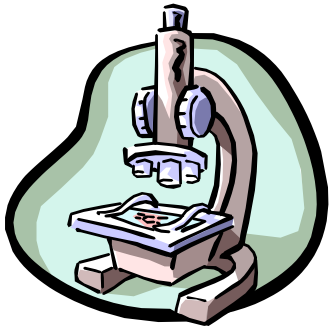
Yeast seed culture Companies

Yeast paste or broth

Small scale ethanol production Companies

Crude amylase

Crude enzyme companies



40~60% Ethanol

Large scale Re-distillation, Rectification and Dehydration Company

99.5% Ethanol

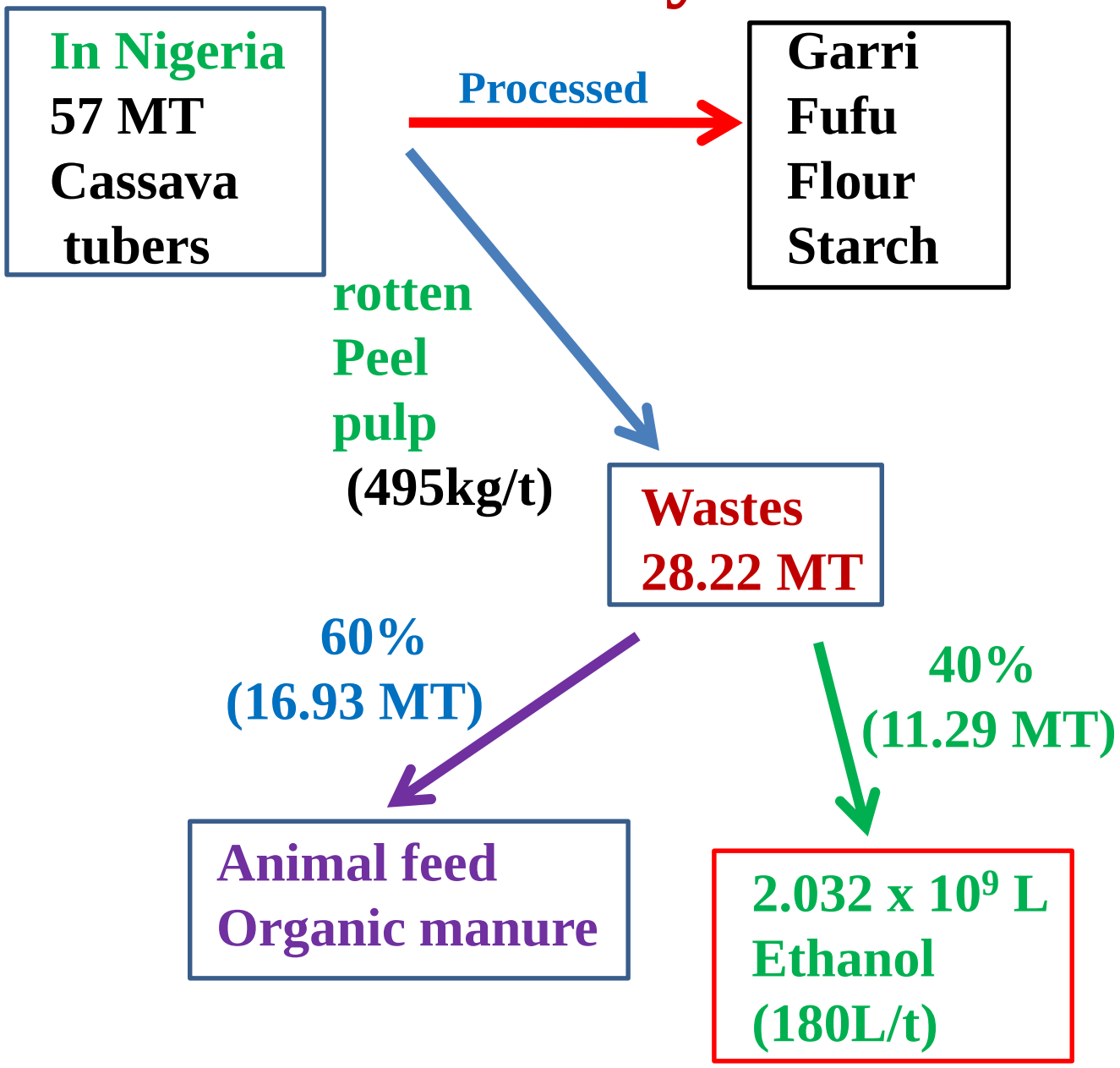
Petroleum Refinery Industry

Gasohol

Gasoline Retailers

Industrial cluster model for commercial fuel ethanol production

Summary


In Nigeria
57 MT
Cassava
tubers
Processed
Garri
Fufu
Flour
Starch
rotten
Peel
pulp
(495kg/t)
Wastes
28.22 MT
60%
(16.93 MT)
40%
(11.29 MT)
Animal feed
Organic manure
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.