



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*



CARIBBEAN FOOD CROPS SOCIETY

49

**Forty-ninth
Annual Meeting 2013**

**Port of Spain, Trinidad and Tobago
Vol. XLIX**

PROCEEDINGS
OF THE
49TH ANNUAL MEETING

Caribbean Food Crops Society
49TH Annual Meeting
June 30 – July 6, 2013

Hyatt Regency Hotel
Port of Spain, Trinidad and Tobago

“Agribusiness Essential for Food Security: Empowering Youth and
Enhancing Quality Products”

Edited
by
Wanda I. Lugo, Héctor L. Santiago, Rohanie Maharaj, and Wilfredo Colón

Published by the Caribbean Food Crops Society

ISSN 95-07-0410

Copies of this publication may be obtained from:

Secretariat CFCS
P.O. Box 40108
San Juan, Puerto Rico, 00940

or from:

CFCS Treasurer
Agricultural Experiment Station
Jardín Botánico Sur
1193 Calle Guayacán
San Juan, Puerto Rico 00936-1118

Mention of company and trade names does not imply endorsement by the Caribbean Food Crops Society

The Caribbean Food Crops Society is not responsible for statements and opinions advanced in its meeting or printed in its proceedings; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole.

A STUDY OF CANDIDATE BIOMASS BRIQUETTES FOR LOCAL FUEL CONSUMPTION

R. Manbodh, E. John, and P. Bridgemohan. Centre for Bioenergy, Agriculture and Food Technology, University of Trinidad and Tobago

ABSTRACT: Charcoal briquettes are widely used in Trinidad and Tobago for outdoor recreational cooking. This study evaluated two invasive plant species *Syzygium* and *Gliricidia* as well as dry coconut husks as raw materials for charcoal briquettes. Samples were collected, dried and made into charcoal from a method adopted from MIT D-Lab. Cassava porridge was used as a binder for combining crushed charcoal samples into cylindrical briquettes using a manual mold and mechanical press. Each charcoal briquette sample was tested for burning time, ash content, calorific value, organic carbon, moisture content and phosphorus content. All three charcoal briquette samples displayed burning times of 2.5-3 hours, ash content 8-11%, calorific values 6100-6700 Kcal/Kg, organic carbon 2-4%, moisture content 10-16% and phosphorus $\leq 1.5\%$. These results are comparable to briquettes sold commercially and validate further research into commercializing charcoal briquettes from the sample raw materials.

Keywords: Charcoal Briquettes, *Syzygium*, *Gliricidia*, Dry coconut husks, Fuel

Introduction

Trinidad and Tobago consumes notable amounts of charcoal briquettes for recreational cooking. Most of the charcoal briquettes used are imported from USA and Guyana while a small amount is supplied by an unregulated local cottage industry. The demand for charcoal can potentially be met locally and developed into sustainable businesses as well as provide fuel security in this market. This project attempted to select feasible candidate raw materials to develop a quality charcoal briquette product.

Syzygium and *Gliricidia* are invasive plant species found throughout Trinidad and can be logged sustainably to form charcoal briquettes. Dry coconut husks are usually left to decompose in fields or sent to landfill sites. As such, they were considered ideal candidates to explore for charcoal briquette manufacturing.

Methods

Making Charcoal: The charcoal making process was adapted from instructions provided by MIT D-lab and further supported by similar instructions from Practical Action, UK. Both teams developed a low-cost method to produce charcoal for fuel in poor developing countries such as Haiti. *Syzygium* and *Gliricidia* cuttings about 30 cm in length were sourced at UTT Waterloo Campus as well as dry coconut husks leftover from oil extraction on site. Samples were allowed to dry for at least 6 weeks. They were then assembled one at a time, into a metal barrel with a one square foot hole cut on top and five smaller holes cut at the bottom. The bottom holes were stuffed with old

newspapers and the barrel was fitted on top of three bricks. Dried samples were arranged inside the barrel along with a 5-foot wooden stick extending out of the barrel and the newspaper below was set alight. After 10-15 minutes, when the dried samples inside the barrel was caught alight and flames were emerging from the top hole in the barrel, the barrel was removed from the bricks and placed flat on the ground. The stick was removed and the hole on top was covered with a metal cover and the edges sealed with sand. After 3-4 hours, the cover was removed and the charcoal material was collected.

Forming Briquettes: Each charcoal sample was manually crushed into fine pieces or powder. Cassava porridge was made by finely grating about 500 g of cassava and adding to 1.5 L of warm water to create a cassava binder. This was then split between the three samples of charcoal and mixed until a handful of charcoal/binder mixture retained its shape when squeezed by hand. The briquettes were made with a custom welded mold as well as a mechanical press located on site. The formed briquettes were allowed to dry for three to five days in the greenhouse.

Charcoal Analysis: Each charcoal briquette sample was tested for burning time, ash content, calorific value, organic carbon, smoke, moisture content and phosphorus content using the following methods adopted from UN's Food and Agriculture Organisation guidelines.

Burning time: The larger mechanically-made briquettes were set on top of a wire-gauze over a Bunsen burner for 10-15 minutes until they caught alight properly. Time was noted for the entire briquette to burn out (become cold).

Ash Content: The briquettes above for burning times were weighed before and after burning and ash content was expressed as a percentage of the ash weight compared to the original weight.

Calorific Value: Calorific value was determined using a PARR 1261 oxygen bomb calorimeter.

Moisture Content: Three grams of each charcoal briquette was weighed in triplicate in crucibles and placed in a drying oven at 105⁰ C for three hours then weighed. The samples were placed back into the oven and measurements were taken every subsequent hour until there was no notable change in mass. The total weight loss was used to calculate the average percentage moisture content in each charcoal sample.

Organic Carbon and Phosphorus: Samples were sent to a testing facility and results were provided.

Results and Discussion

Mechanically formed briquettes maintained their structural integrity better than the briquettes made with the manual mold (Figure 1). This result suggests that the cassava

binder was insufficient or ineffective as binding agent for small-scale production. Further research can be done into more environmentally friendly binders.



Figure 1. Finished Charcoal Briquettes.

The chemical composition and combustion properties of the syzygium, gliricidia and coconut husk briquettes are presented in Table 1. They all show similar values within each parameter as well as being similar to published data from commercial coconut briquette manufacturers (Sastha Power). Burning times of 2.5-3 hours, ash content 8-11%, calorific values 6100-6700 Kcal/Kg, organic carbon 2-4%, moisture content 10-16% and phosphorus content $\leq 1.5\%$ were noted.

The long burning times, lack of smoke and low ash content makes all the briquettes attractive options for recreational cooking. However, syzygium briquettes appear to have an overall better rating. The 30 minute longer burning time of the syzygium briquette compared to gliricidia and coconut husk briquettes was probably due to the test briquette being about 20 g heavier than the other samples. An interesting follow-up experiment will be to make a combined charcoal briquette from all three-sample materials as well as a comparison taste test of imported coals to these novel samples.

Property	Syzygium	Gliricidia	Coconut	Sastha Power Coconut Briquette
Shape	Cylindrical	Cylindrical	Cylindrical	Oval-Square
Calorific Value	6600	6722	6156	6000-6500 Kcal/kg
Moisture Content/%	10	15	16	5-7
Burning Time/hrs	3	2.5	2.5	2-3
Ash Content/%	10	8	11	5%+
Phosphorus/%	1.2	1.5	1.2	Nil
Smoke	None	None	None	None

Table 1. Comparison of charcoal briquettes

It should be noted that the 30 cm syzygium and gliricidia logs did not undergo complete pyrolysis so the cuttings were further chopped into pieces 4-6 cm long. This resulted in a greater degree of pyrolysis, but the process was still incomplete. These results indicate that a more effective method for forming charcoal from syzygium and gliricidia needs to be developed. A main concern of producing charcoal by this method is the greenhouse gases carbon dioxide, methane and nitrous oxide released into the atmosphere. This can be considered a trade-off if charcoal is produced locally compared to ocean freight in importing charcoal, which releases greenhouse gases as well. There are also emerging technologies where pyrolysis occurs in chambers which capture the greenhouse gases emitted (threedimensional-timberlands.com). A full life cycle analysis (LCA) of both locally made and foreign briquettes will be completed in the future to determine the most environmentally friendly option.

Though these initial results are encouraging, a full economic analysis of developing a sustainable charcoal industry is necessary. This will include an appropriate commercial carbonization method, annual supply of raw material and charcoal output compared to local demands as well as projected income and expenses. Further uses of charcoal can also be developed, such as water purification and agriculture.

Conclusions

Initial analysis for charcoal briquettes made from invasive plant species *Syzygium* and *Gliricidia* as well as dry coconut husks displayed promising chemical and combustion properties. These findings justify further research into the development of a thriving local charcoal manufacturing industry. Focus can be on improving the manufacturing process of the raw materials and developing a cost-effective and environmentally friendly business model.

Acknowledgements

This work was completed through the collaboration and assistance of the following: UTT, Sarah Mohammed (UTT - SFTI), UTT - Centeno Research Facility, UWI Chemistry Department, UTT- Waterloo Staff, and Mr. Eric and Mr. John.

References

- MIT D-Lab <http://d-lab.mit.edu/>
- Practical Action, UK. <http://practicalaction.org/>
- Quality control of charcoal and by-products
<http://www.fao.org/docrep/x5555e/x5555e09.htm>
- Coconut shell charcoal briquette. <http://www.sasthapower.com/coconutshell.html>
- Pyrolysis: A Centuries-Old Technique. <http://threedimensional-timberlands.com/vacuum-pyrolysis-technology.html>