ZIBELINE INTERNATIONAL™ PUBLISHING
ISSN: 2710-6012 (Online)
CODEN: JWBMAO

Journal of Wastes and Biomass Management (JWBM)

DOI: http://doi.org/10.26480/jwbm.02.2022.59.63

CrossMark

RESEARCH ARTICLE

# TRADITIONAL PELLET PRODUCTION FROM SAWDUST AS SOURCE OF ENERGY FOR COOKING USING IMPROVED STOVE IN MOUDA, A LOCALITY OF MAROUA, CAMEROON

**Tize Koda J[a]*, Fadimatou H[a] and Inous Mamate A[b]**

*[a]National Advanced School of Engineering, University of Maroua, P.O Box: 46 Maroua, Cameroon*
*[b]National Committee for Development of Technologies (CNDT), Ministry of Scientific Research and innovation (MINRESI), P.O Box: 1457 Yaoundé, Cameroon*
**Corresponding Author E-mail: tizekodjoel@yahoo.fr*



**ARTICLE DETAILS**

*Article History:*

Received 17 February 2022
Accepted 22 March 2022
Available online 24 March 2022

**ABSTRACT**

In general, the Far North Region of Cameroon and specifically the town of Maroua is faced a great scarcity of firewood which is the major energy sources of cooking used by the population. Its semi desert environment cannot supply the demanded quantity that combustible. This situation is a challenge for research in order to find out other sources of cooking energy accessible to the population. The purpose of this study is to valorise by the production of pellets, a cooking energy source, the sawdust assimilated to waste and regularly burned. The main objective of this work is to provide an alternative source of firewood. More specifically, it involves manufacturing pellets, innovating an improved pellet-type stove and carrying out cooking tests. Thus, three types of pellets containing 30%, 50% and 70% of sawdust are produced using clay as the binder. After the drying of pellets, the moisture content is assessed and various cooking tests have been done. A new type of stove adequate for the use of pellets and charcoal has been constructed. From the results obtained, it has been observed that the maximum moisture content of the pellets is 10.8± 1.1%. During the combustion, pellets containing 50% of sawdust provide more efficiency. Therefore, with about 1.5 kg of this type of pellets, it is possible to prepare a complete millet meal and coffee sufficient to feed 4 to 5 people a day. This is approximately 0.32 to 0.4 kg / person/day or 0.16 to 0.2 kg of sawdust / individual/day. These results clearly indicate that sawdust can be used to produce pellets which are a reliable source of cooking energy. Instead still be burn as waste, their valorisation can contribute to reduce the pressure of the population on the fragile ecology of far north looking for firewood.

**KEYWORDS**

Firewood, Far North, Sawdust, Cooking Energy, Pellets

## 1. INTRODUCTION

In the Far North region of Cameroon, agriculture, overgrazing, use of wood as a source of cooking energy are the main causes of desertification and climate change which have destroyed the environment. Deforestation caused by the massive cutting of trees as a source of heat energy is among the greatest threats to that environment which becomes difficult to control despite the extreme fragility of the ecology. According to a researcher, about 90% of wood exploited from the Congo basin is for the cooking energy source (Megevand, 2013). Therefore, the use of wood as a primary source of domestic energy is the main cause of the loss of forest cover. A group of researchers mentioned that close to 89% of the biomass collected from the forest are for wood fuel in Cameroon (Folefack and Abou, 2009). The control of the situation will remain very difficult. For example, it has been shown that in Sub Saharan Africa, the number of population depending on the wood fuel has increased to more than 29% within 2004 and 2015 and will be around 60% in 2030 while the forest surface is decreasing (Megevand et al., 2013). Estimations indicate that the rate of deforestation will greatly increase to4.1 million hectares of tropical forest each year. Thus, wood fuel has been, is and will remain the primary energy source for many in Sub Saharan Africa for decades to come (Sola et al., 2019; Rubinstein et al., 2021). In Cameroon, annual forest loss was estimated at between 40,000 and 80,000 hectares (Rubinstein et al., 2021). With regard to the supply areas of the city of Maroua in firewood, the findings are increasingly distressing. Estimates indicate that out of 66,000 ha of firewood collection area, 37,000 ha (56%) still bear vegetation and 29,000 ha (44%) are totally degraded and require major rehabilitation measures (Madi, 2012). In terms of adequacy between the available potential and the needs of the populations, significant efforts are to be undertaken. A recent study has indicated that the deficit of wood fuel is close to 43% for a demand of 1.38 million tons (Kodji et al., 2021). Previous researchers have estimated that shortage to 600,000m$^3$/year of wood (Doron and Akagou, 2018). Despite this threat, the demand for firewood remains very high compared to the supply capacity in the region. It is caused on the one hand by the extreme poverty which does not allow the inhabitants to afford a modern source of cooking energy and on the other hand, by the increase in population. For example, at the national level, it is estimated that 25% of households have access to domestic gas, while in the Far North Region, this rate is less than 1% (Rubinstein et al., 2021). This means that close to 100% of the population in the localities of Far North depend essentially on the wood fuel while the average percentage is 90% in Central Africa (Imani and Moore-Delate, 2021).

Assuming that the extraction of the wood fuel is done without affecting the capital and with a cutting system integrating a rotation over 15 years to fit with the regeneration capacity of trees as recommended, it may seem

| Quick Response Code | Access this article online | |
|---|---|---|
| | **Website:** www.jwbm.com.my | **DOI:** 10.26480/jwbm.02.2022.59.63 |

Cite the Article: Tize Koda J, Fadimatou H, Inous Mamate A (2022). Traditional Pellet Production From Sawdust As Source of Energy for Cooking Using Improved Stove in Mouda, A Locality of Maroua, Cameroon. *Journal of Wastes and Biomass Management, 4(2): 59-63.*

unrealistic in the context of the pressure of demand over supply. Considering that the situation is becoming more and more difficult to supply the population with wood fuel from the environment of the Far North region, various initiatives have put aside to look for the possibilities to provide them with charcoal from East Region on a distance of about 1,400Km (the case of charcoal from SEFAC, Libongo) (Doron and Akagou, 2018). However, this alternative is still inappropriate for a good proportion of the population due to the cost of the transportation and other charges making the charcoal on the market of Maroua so expensive. This indicates how critical the situation is. In view of the above, nature seems to be very unfavourable to the population of the Far North. The excessively fragile ecology cannot provide enough wood fuel for its cooking energy needs. In addition, the extreme poverty of the populations residing there, recognized by the Cameroonian government as being economically devastated, does not allow them to acquire domestic gas. This situation is a challenge for the research in order to find out other sources of cooking energy accessible to the population.

It is on the strength of these observations that the purpose of this study is to valorise by the production of cooking energy the sawdust produced in the carpentry workshop of the Bethlehem Foundation of Mouda in the region of Far North Cameroon. Sawdust in that workshop is assimilated to waste and regularly burnt. The main objective of this work is to provide an alternative source of firewood. More specifically, it involves manufacturing combustible pellets, innovating an improved pellet-type stove and carrying out cooking tests.

## 2. Material and Methods

### 2.1 Production of Pellets

To produce the pellets, we used sawdust as the organic material and clay as the binder (Figure 1). These two elements have undergone pre-treatment with the aim of grinding them further in order to facilitate their homogenization. The pellets were made using three biomass proportion, namely 30%, 50%, 70%. The amount of water added was evaluated. Then we pour the mixture into a bucket where we gradually add water as we knead them. When the added water is insufficient, there is difficulty in forming the pellet. However, water should not be added in large quantities so as not to lose the binder. Finally, the pellets produced are spread out in the sun for drying.

(b) (c)

**Figure 1:** Pellets production materials: (a) clay and (b) Sawdust

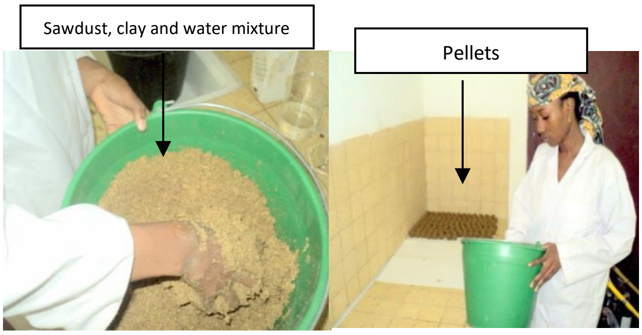


**Figure 2:** Pellets production

The production process of these pellets follows various stages as illustrated by the following figure 3.

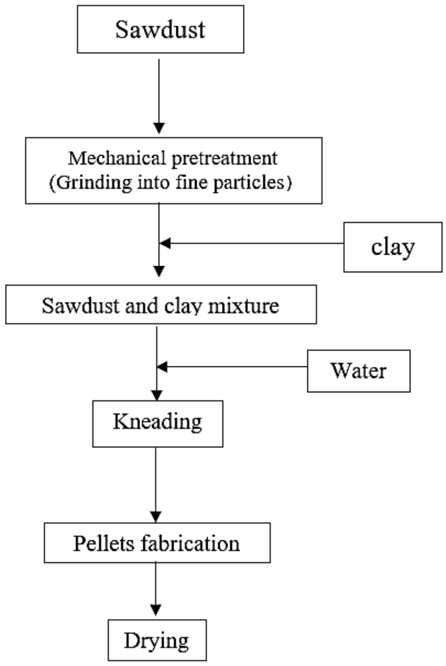


**Figure 3:** Pellet production Process

#### 2.1.1 *Characterization of Pellets*

##### 2.1.1.1 *Determination of the Average Diameter*

The mean diameter was determined using a calliper. For this purpose, the diameters of the 15 samples randomly taken per type of pellets produced were measured. The average diameter was determined by the following formula:

$$Dm = \frac{\sum d}{n} \tag{1}$$

With

d=elementary diameter, n=number of pellets

**Figure 4:** Pellet diameter measurement

##### 2.1.1.2 Moisture Content

Before using pellets for the cooking test, their moisture content was evaluated. To determine it, we put the sample in an oven for 24 hours at 103°C. The moisture content is obtained from the following equation.

$$T = \frac{Mo - M1}{Mo} \times 100 \tag{2}$$

Mo: Initial mass of the sample before drying

M1: Mass of the sample after drying

T: Moisture content

### 2.2 Design of the Pellet-Type Improved Stove (PTI stove)

In order to optimize the energy efficiency produced by the pellets during combustion, we have designed a new type of improved stove. The main limitation of the existing for this type of combustible is that during combustion, the pellets while burning, descend to the bottom of the stove, creating a large distance to the base of the pot. As a result, the heat produced is little valued for the cooking which is in progress. The initiative is therefore to design a stove that at any time the user can bring the combustible closer to the base of the pot as desired throughout the cooking process. The design consisted in creating an adjustable burner in which the pellets are put. This burner with a sleeve can be adjusted. It was made and inserted in the classic improved stove. To do this, we used 8/10 sheet metal.

## 2.3 Cooking Tests

### *2.3.1 Combustion Test*

A combustion test was carried out for the three types of pellets produced. It consisted of taking 0.5Kg of pellets and burning it in the existing improved stove and the stove we made. The objective is to measure the ease with which each type of pellets is consumed.

### *2.3.2 Cooking Test*

The cooking test consisted on the one hand of bringing 02 litters of water to a boiling point using 0.5Kg of pellets. On the other hand, tests were done to cook a meal and to prepare coffee using0.6Kg of each type of pellets. The objective is to determine the time taken for cooking and to assess the level of satisfaction of the consumers. This is why the cooking was done by the women cooks of the foundation (Figure 6).

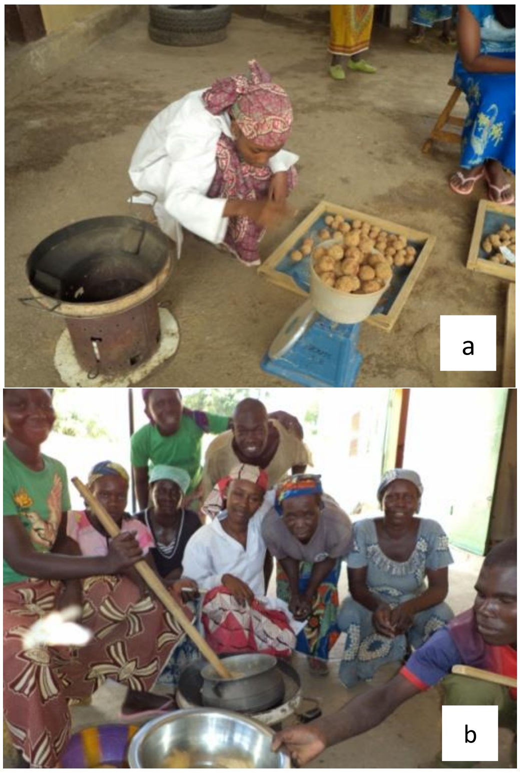


**Figure 5:** Cooking test performed by FBM women (a) weighing 0.6Kg of pellets, (b) cooking couscous by FBM women.

# 3. Results and Discussions

## 3.1 Characterization of Pellets

### *3.1.1 Diameter of Pellets*

After drying, the diameters of the pellets obtained are summarized in the following table.

**Table 1:** Diameter of Pellets

| Diameter (cm) | Pellet 30% | Pellet 50% | Pellet 70% |
|---|---|---|---|
| **Maximum** | 3.2 | 3.4 | 3.4 |
| **Minimum** | 2.7 | 3.1 | 3.2 |
| **Average** | 3.05± 0.35 | 3.22± 0.21 | 3.28± 0.14 |

The results from table 1 shows that the pellets produced have an average diameter varying between 3.05 ± 0.35 cm and 3.28 ± 0.14 cm. The diameters of these pellets are smaller than a similar fuel made from paper waste (4.22 ± 0.07 cm) and used as charcoal for the production of cooking energy (Tizé et al., 2020). However, the smallest pellet diameter comes from the proportion of 30% organic matter. Therefore, when the mixture has more clay, producer tends to form smaller pellets.

### *3.1.2 Moisture Content of Pellets*

The following table shows the moisture content of the pellets just before they are used for combustion.

**Table 2:** Moisture Content of Dried Pellet

| Proportion of the Sawdust in The Pellets | Moisture Content (%) |
|---|---|
| **30%** | 10.8± 1.1 |
| **50%** | 9.73± 1.5 |
| **70%** | 8.77± 2.4 |

It appears from this table that the moisture content is proportional to the clay content of the dried pellets. Indeed, it is found that pellets made up of 30% sawdust or 70% clay have a higher moisture content and need more time to be dried. This would be due to the strong capacity of clay to retain water. Overall, these humidity levels are very low compared to those of naturally dried wood commonly used for cooking energy. According to research, moisture levels after such drying varies between 15 and 20%. In addition, it is known that the lower the water content is, the greater is the calorific value (FAO, 2015; Dzurenda and Banski, 2019).

## 3.2 Description of the Improved Stove Type Pellets

The suitable stove constructed for pellets occupies a space of 36cm x 35cm x 33 cm. It has three compartments: ash collection compartment, combustion compartment and pot compartment. The ash collection compartment is a cylinder constructed with 8/10 sheet metal and has a diameter of 24 cm and a height of 5 cm. There are two openings of 4 cm x 3 cm for the evacuation of the ashes. The combustion compartment is a cylinder of 24 cm in diameter and 18 cm in height built with 8/10 sheet metal in which we have inserted a burner of 23 cm in diameter and 8 cm high built in 10/10 sheet metal. The burner is held in balance by an iron crosspiece. The combustion chamber and the burner are perforated with small openings.


**Figure 6:** Description of the improved stove Type Pellets

The pellet type improved stove is appropriate not only for pellets but also for the efficient energy use of charcoal. In some localities such as Kisangani in Democratic Republic of Congo where more than 80% of the population consume charcoal estimated at an equivalent of 1278826 tons of wood, this technology can help to reduce significantly this quantity of combustible (Imani and Moore-Delate, 2021). In fact, the type of stove used in that locality is a traditional improved stove named Brasero (62.5%) which cannot give the facility to the user to adjust the embers close to the bottom of the pot when needed (Imani et Moore-Delate, 2021).

## 3.3 Preparation Tests with Pellet Type Improved Stove

### *3.3.1 Combustion Test*

During combustion, pellets with a proportion of 50% sawdust proved to be the most efficient. Those with 30% sawdust give too much smoke. And at 70% sawdust, the pellets were found to burn out quickly. The size of the pellet influences the consumption time. However, the clay content seems to be the main factor influencing both the burning time and the size of the pellets. We have found that there are difficulties in burning the pellets in the traditional improved stove. Indeed the pellets are smothered and fail to burn normally compared to the combustion with the pellets type improved stove.

### *3.3.2 Cooking Tests*

#### *3.3.2.1 Boiling Test*

The result obtained when boiling water with the traditional improved stove and the pellet-type improved stove illustrates the added value of the latter. Indeed, with the common improved stove, it takes about 13 ± 2 minutes to bring 02 litres of water to a boiling point. Using the improved stove type pellets, only 6±1minutes are enough to boil the same amount of water using the same quantity of pellets. During this experiment we found that with the traditional improved stove we lose a large amount of energy. This is why for cooking, we only used the improved pellet type stove. Table 3 presents a comparison between those two stoves.

**Table 3:** Comparison Between Classical Improved Stove and Type Pellets Stove

| Classical Improved Stove | Type Pellets Improved Stove |
|---|---|
| Inadequate shape to contain pellets | adequate shape to contain pellets |
| The pellets during combustion descending to the bottom of the stove, no way of bringing them closer to the pot. | Possibility of always bringing the embers closer to the pot |
| Pellets are smothered during combustion | The pellets are better ventilated during combustion |
| Lower energy efficiency of pellets | Optimization of the energy efficiency of pellets |

#### *3.3.2.2 Millet Meal Cooking Test*

Various cooking were tested using the produced pellets. The results are summarized in the following table.

**Table 4:** Cooking Tests Using Produced Pellets

| Cooking | Quantity of Pellets (Kg) | Duration of Cooking (minutes) | Cooking Picture |
|---|---|---|---|
| 2L of okra soup | 0.6 | 15 |  |
| couscous of millet<br>(1kg of sorghum flour and two litres of water) | 0.6 | 20 |  |
| 1Kg of rice | 0,6 | 25 |  |
| 2 litres of coffee | 0,6 | 6 |  |

The results from table 4 clearly indicate that sawdust can be used to produce pellets which are a reliable source of cooking energy. At the end of the various cooking tests, enough embers remained that could be used. Therefore, with about 1.5 kg of pellets which contains 0.75 kg of sawdust, it is possible to prepare a millet dish and coffee sufficient to feed 4 to 5 people a day. This is approximately 0.32 to 0.4 kg / person per day or 0.16 to 0.2 kg of sawdust / individual/day. These quantities of fuel are lower than those of firewood consumed in the locality according to a researcher who estimated it at 0.6 kg/individual/day (Eba'a Atyi et al., 2016). In an earlier study conducted by previous researchers, the consumption was around 1.2 kg/person/day (Folefack and Abou, 2009). The drastic drop in fuel consumed per household could be justified to a certain extent by the use of improved stoves and the systematically use of the agro-pastoral waste for cooking energy production. In a situation of increased scarcity of firewood being the major source of cooking energy, a researcher report that usually farmers use alternative sources of energy such as cow dung and other residues (Sola et al., 2019). In the case of the present work, it has been observed that the pellet-type stove improves energy efficiency and justifies the low need of combustible per individual and per day.

However, the cooking energy crisis that is increasing over time in the Far North region influences cooking habits by shortening the cooking time in order to save fuel. Such behaviour has probably consequences on the quality of food eaten and other social values which need to be assessed.

## 4. Conclusion

This research was aimed at producing pellets by recycling sawdust and using clay as a binder. At the end of this study, it appears that pellets with 50% of sawdust are more efficient. They have an average diameter of 3.22 cm. During the cooking test, the moisture content of these biofuels varies between 10.8±1.1% and 8.77±2.4%. It was also noticed that the amount of clay used as a binder affects the ease of combustion of the pellets. In order to optimize the recovery of energy produced during a cooking, an improved stove called pellets type has been designed. Its main advantage is the possibility offered to the user to be able to adjust the level of the embers in relation to the base of the pot. Cooking tests with the manufactured pellets have shown that an average of 0.32 to 0.4 kg/person/day of this type of fuel is needed to meet household needs.

## References


Doron, A., Akagou, L. 2018. Identification des possibilités logistiques de développement de la chaine de valeur charbon de bois produit à partir des rebuts des scieries de l'Est Cameroun. Programme d'appui à la mise en œuvre de la stratégie de développement du secteur rural volets forêt environnement, pp. 160. http://foretcommunalcameroun.org/download/reboisement1400/Etude_Logistique_developpement_chaine_valeur_charbon_scierie_Est.pdf

Dzurenda, L., Banski A. 2019. The Effect of Firewood Moisture Content on the Atmospheric Thermal Load by Flue Gases Emitted by a Boiler. Sustainability, 11, pp. 284; doi:10.3390/su11010284. www.mdpi.com/journal/sustainability

Eba'a, A. R., Ngouhouo, J.P., Mvondo, A. J-P., Ngoungouré M. A., Sufo, K. R. 2016. Economic and social importance of fuelwood in Cameroon. International Forestry Review, 18(2), pp. 1-14

FAO. 2015. Wood fuels Handbook. Food and Agriculture Organization of the United Nations pristina, pp. 31. www.fao.org/publications

Folefack, D. P., Abou, S. 2009. Commercialisation du bois de chauffe en zone sahélienne du Cameroun. Sécheresse, 20(3), pp. 312-8. DOI:10.1684/sec.2009.0193

Imani, G., Moore-Delate, E. 2021. Rapport d'étude de la consommation de bois-énergie et des équipements de cuisson de la ville de Kisangani. Centre de recherche forestière internationale (CIFOR), pp. 56. https://www.cifor.org/publications/pdf_files/Reports/Imani-GML-Report.pdf

Kodji, E., Tize, K. J., Djouldé, D. R., Awono, A. 2021. Assessment of ecological charcoal production and impact on the ecosystems of the Far North, Cameroon? International Journal of Advances in Engineering and Management (IJAEM), 3(7), pp. 3896-3904. www.ijaem.net, ISSN: 2395-5252

Madi, A. 2012. Etude sur la situation de référence du bois- énergie dans la région de l'Extrême Nord, Cameroun. Programme D'Appui au Programme Sectoriel Forets et Environnement et Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, pp. 232.

Megevand, C. 2013. Dynamiques de déforestation dans le basin du Congo: Réconcilier la croissance économique et la protection de la forêt. Washington, DC: World Bank. doi: 10.1596/978-0-8213-9827-2. License: Creative Commons Attribution CC BY 3.0

Rubinstein, F., Betang, E., Mbatchou, B., Pope, D., Puzzolo, E. 2021. Transitioning to Modern Energy Cooking Services in Cameroon, A policy review of the energy sector. Department of Public Health, Policy and Systems, University of Liverpool, pp. 47.

Sola, P., Schure J., Eba'a, A. R., Gumbo, D., Okeyo, I., Awono, A. 2019. Woodfuel policies and practices in selected countries in Sub-Saharan Africa – acritical review. Bois et Forêts des Tropiques, 340, pp. 27-41. Doi : https://doi.org/10.19182/bft2019.340.a31690

Tizé, K. J., Ango, J. M., Djouldé, D. R., Ngakou, A. 2020. Recovery of cooking energy from waste paper through the production of white coal. International Journal of Engineering Science Invention (IJESI), 9(5), pp. 24-29.