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Made of Combustible Briquette By Using Azadirachta indica Dead Leaves Associated to Stem Of Sorghum sp

Alexis Dzokom

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The Sahelian Journal of Engineering and Applied Sciences (RSIA) is a "Bilingual Journal" (French and English) dedicated for exchanges between Research and Development, concerning subjects having a direct impact on development of the populations from Sudano-Sahelian zones or Sudano-Sahelian African Savannas and their natural environment. The topics covered by the journal are agricultural sciences, civil engineering, rural engineering, architecture, environmental sciences, applied climatology, renewable energies, textile and leather engineering, hydrology and hydraulic engineering, IT and telecommunications... and all other disciplines that recommend the use of engineering sciences tools and methods to solve concrete problems with direct impact on development.

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SOMMAIRE/SUMMARY

GROWTH AND YIELD ATTRIBUTES OF SOLANUM TUBEROSUM L. AS INFLUENCED BY SOIL SOLARIZATION AND COMPOST/COMPOST TEA AMENDMENT UNDER FIELD CONDITIONS	6
ATTRIBUTS DE CROISSANCE ET DE RENDEMENT DE SOLANUM TUBEROSUM L. TELS QU'INFLUENCES PAR LA SOLARISATION DU SOL ET L'AMENDEMENT DE COMPOST/TEA DE COMPOST DANS DES CONDITIONS DE TERRAIN	6
Rapmo Kononer Serge ^{1*} , Toukam Takoukam Steve ² , Adamou Souleymanou ³ , Abdou Boubou Armand ¹ , and Ngakou Albert ²	6
ANALYSE DE L'INTERACTION GÉNOTYPE X ENVIRONNEMENT ET STABILITÉ DE QUELQUES CULTIVARS D'OIGNON POUR LES TAUX D'ACIDITÉ ET DE SUCRES DES BULBES EN ZONE SOUDANO-SAHÉLIENNE DU CAMEROUN.	20
ANALYSIS OF THE GENOTYPE X ENVIRONMENT AND STABILITY INTERACTION OF SOME ONION CULTIVARS FOR THE ACIDITY AND SUGAR LEVELS OF BULBS IN THE SUDANO-SAHELIAN ZONE OF CAMEROON.	20
Moutsavara Gabriel ¹ , Philippe Kosma ¹ , Noubissié Tchiagam Jean Baptiste ² , Dounia Désiré ²	20
CONTRIBUTION DE LA LEGUMINEUSE CROTALARIA JUNCEA L. A LA REHABILITATION DES SOLS DEGRADÉS AU NORD-CAMEROUN.	29
CONTRIBUTION OF CROTALARIA JUNCEA L. TO THE REHABILITATION OF DEGRADED SOIL IN NORTH CAMEROON	29
Hinimbio Taïda Pierre ^{*1} , Madi Ali ² , Mvondo Awono Jean Pierre ³ , Abdou Boubou Armand ² , Fokam Kamdom Chimène ⁴	29
ACTIVITE ANTIBACTERIENNE DE L'EXTRAIT HYDRO-ETHANOLIQUE DES FEUILLES ET ECORCES DE DEUX ESPECES DE ZIZIPHUS DE L'EXTREME-NORD CAMEROUN.	39
ANTIBACTERIAL ACTIVITY OF THE HYDRO-METHANOLIC EXTRACT OF THE LEAVES AND BARK OF TWO SPECIES OF ZIZIPHUS FROM FAR NORTH CAMEROON	39
Mohamadou Salamatou ^{1*} , Djoulde Darman Roger ¹ , Tatsadieu Ngoune Leopold ² ,	39
PERCEPTION DES POPULATIONS LOCALES DANS LA MISE EN ŒUVRE DES ACTIONS D'ADAPTATION AUX CHANGEMENTS CLIMATIQUES : CAS DE LA GRANDE MURAILLE VERTE AU TCHAD.	48
LOCAL POPULATIONS'S PERCEPTION OF THE IMPLEMENTATION OF ACTIONS FOR ADAPTATION TO CLIMATE CHANGE: CASE OF THE GREAT GREEN WALL IN CHAD.	48
Djimndiguim Korom ¹ , Mekila Mbaikoubou ¹ , Djim-Assal Datoloum ¹ , Sitack Yombatian Beni ¹ Et Madi Ali ²	48
VARIABILITÉ CLIMATIQUE ET DYNAMIQUE SPATIOTEMPORELLE DES SURFACES D'EAU DES BARRAGES DE RETENUE D'EAU EN ZONE SAHÉLIENNE (EXTREME-NORD CAMEROUN)	60
CLIMATIC VARIABILITY AND SPATIAL TEMPORAL DYNAMICS OF WATER SURFACES OF WATER RETAINING DAMS IN THE SAHELIAN ZONE (EXTREME NORTH CAMEROON)	60
Mouhammadou Nadjirou ¹ , Fita Dassou Elisabeth ^{1*} , Ombolo Auguste ¹ , Djanteng Wandji Caleb ² , Amina Wassile Germaine ¹	60
MADE OF COMBUSTIBLES BRIQUETTES BY USING <i>Azadirachta indica</i> DEAD LEAVES ASSOCIATED TO STEM OF <i>Sorghum sp</i>	71
PRODUCTION DES DE BRIQUETTES COMBUSTIBLES À L'AIDE DE FEUILLES MORTES D'AZADIRACHTA INDICA ET LA TIGE DE SORGHO	71
Alexis Dzokom ¹ , Joël Tize Koda ² , Vondou Vondou Sébastien ³ , Roger Djoulde Darman ⁴	71
ÉVALUATION DES PARAMÈTRES DE POLLUTION DES EAUX ET DES SÉDIMENTS DU FLEUVE CHARI AVANT SON DÉVERSEMENT DANS LE LAC TCHAD DANS LA ZONE DE MANI (TCHAD)	76
EVALUATION OF WATER AND SEDIMENT POLLUTION PARAMETERS OF THE CHARI RIVER BEFORE ITS DISCHARGE INTO LAKE CHAD IN THE MANI AREA (CHAD)	76
Dorim Ngarbaroum ^{1,2} , Houkabe Eric ^{1,3} , Arabi Mouhaman ² , Madi Ali ²	76

MADE OF COMBUSTIBLES BRIQUETTES BY USING *Azadirachta indica* DEAD LEAVES ASSOCIATED TO STEM OF *Sorghum sp*

PRODUCTION DES DE BRIQUETTES COMBUSTIBLES À L'AIDE DE FEUILLES MORTES D'AZADIRACHTA INDICA ET LA TIGE DE SORGHO

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ABSTRACT

Combustibles briquettes are energetics resources, which could be use to substitute other types of energy. Optimization of energetic efficiency of combustible briquette lead us to made it so that to contribute to thrift wood resources and local sustainable development. Valorization of dry dead leaves of *Azadirachta indica* associated to dry stems of *Sorghum sp.* upon to made combustibles briquettes is the object of this work. By using mechanics process, production of combustibles conducts us to show their physicals characteristics where it average density is 0.34 ± 0.09 and average ratio surface/volume is $22.68 \pm 3.97 \text{ cm}^{-1}$. Chemicals characteristics permit us to identify $7.68 \pm 0.32\%$ as moisture content when the fixed carbon content average is $91.00 \pm 4.83\%$. Inflammability test demonstrate that maximal duration of inflammation is 0.19 ± 0.02 minutes with time limit of 0.09 ± 0.02 minutes. Combustion test show that combustion duration average is 19.03 ± 7.07 minutes with $66.50 \pm 9.18\%$ as loss mass of combustible briquette.

Keys words: Valorization, vegetables solids wastes, selective sorting, combustibles, resources thriftiness, energetics efficiency, environmental impact.

RESUME

Les briquettes combustibles sont des ressources énergétiques qui pourraient être utilisées pour se substituer à d'autres types d'énergie. L'optimisation de l'efficacité énergétique de la briquette combustible nous a conduits à faire en sorte de contribuer à l'économie des ressources en bois et au développement durable local. Valorisation des feuilles sèches mortes d'*Azadirachta indica* associées à des tiges sèches de *Sorghum sp.* sur les briquettes combustibles faites est l'objet de ce travail. En utilisant des procédés mécaniques, la production de combustibles nous amène à montrer leurs caractéristiques physiques où sa densité moyenne est de $0,34 \pm 0,09$ et le rapport moyen surface/volume est de $22,68 \pm 3,97 \text{ cm}^{-1}$. Les caractéristiques chimiques nous permettent d'identifier $7,68 \pm 0,32 \%$ comme teneur en humidité lorsque la moyenne de la teneur en carbone fixe est de $91,00 \pm 4,83 \%$. Le test d'inflammabilité démontre que la durée maximale de l'inflammation est de $0,19 \pm 0,02$ minutes avec une limite de temps de $0,09 \pm 0,02$ minutes. Le test de combustion montre que la moyenne de la durée de combustion est de $19,03 \pm 7,07$ minutes avec $66,50 \pm 9,18\%$ de perte de masse de briquettes combustibles.

Mots clés : Valorisation, déchets solides végétaux, tri sélectif, combustibles, économie des ressources, efficacité énergétique, impact environnemental.

INTRODUCTION

In the world, energy production is widely depending on forest, is one of the key factors of deforestation, and contributes to climatic variations. According to FAO (2017), the essential source of energy of more than 2.4 billion of the world population is produce from wood. It has been observe that the demand of solid bio combustible is greatly increasing and consequently leading to deforestation (FAO, 2017). In west Africa, around 90% of the population depend on firewood to satisfy their cooking energy needs (Dossou, et al., 2014). In addition, 90% of trees cut down in Africa forest are to produce firewood and charcoal. In Cameroon, biomass is the source of 73% of energy consumed by more than 80% (Tchatat, 2014). According to experts, wood for energy will rest for many decades the basic source of domestic energy in Cameroon (Minfof, 2014). Although other cooking energy sources exist, the choice by users depends on their availability and cost (Horgan, 2002). For

example, in town of Maroua with more 500 000 inhabitants, less than 1% of the population use cooking gas. The rest use wood to satisfy their energy need for cooking. The consequences of this situation in a Sahelian zone like Maroua are the advance of the desert, the disappearance of forest; the loss of soil fertility, etc. The most worrying situation is the inability of the vulnerable population to have access to cooking energy sources especially in urban areas. So, it's urgent in sahelian towns to think about alternative ways to produce cooking energy instead wood, which can be low coast (Minfof, 2014) and environmental friendly. Combustible briquette produced from *Azadirachta indica* dead leaves combined with *Sorghum sp* stem targeted by this study is an initiative that aims to offer new sources of cooking energy. In fact, it has been found that dead neem leaves daily produced in the town of Maroua are 54 tons during the dry season. This huge biomass is simply burie or burnt (Tizé and al., 2016). Our main preoccupation

with this research study is to produce combustible briquette using dead neem leaves combined to dry stem of Sorghum. In addition, briquettes produced are characterize.

METHODS AND MATERIALS

1. Zone of the study

Maroua town, in far north region of Cameroon is situated at 423 m altitude, between 10°29' to 10°41' latitude North and 14°15' to 14°27' longitude East. It's a linear town spread on 15 km in the west-East direction and cloak 56 km² (Bouba, 2009). In Maroua, the climate is Sudano Sahelian type with 7 to 8 months of dry season (Atlas, 2011). Neem trees *Azadirachta indica* and accessory *Khaya senegalensis*, planted during the project of Sahel vert several decades ago, dominate vegetation. Main crops cultivated are millet, cotton, groundnut etc. (Ndongo *et al.*, 2015)

2. Preparation Material and briquettes formulations

Sorting dead biomass of *Azadirachta indica* was done manually. Fork, pick, shovel, wheelbarrow and bags are tools, which permit us to collect and manipulate this biomass. Dry sorghum stem collected was crushed and sieved using AFNOR type sieves of 40µm, 50µm and 80µm. Mold we use is made with wood. It has three compartments with three. Compaction is realized by using a jack.

3. Methods

Test of Density

According to De Demirbas (1999) and Kers, *et al.* (2010), higher is density, higher is the ratio energy/volume. Kers, *et al.*, (2010) show that, density of briquettes depends on the density of used biomass, applied pressure during manufacturing, temperature and exposure time during drying. It is calculated using the following formula:

$$\rho_N = m_N/V_N \quad (1)$$

Where V_N is the volume of briquette and m_N is the mass of briquette

Moisture content

Moisture contents (H_{brute} and H_{dry}) of 10 grams of initial mass (M_0) of briquettes is obtained by drying in an oven at 105°C for 24 hours, following standard protocol BS EN 14,774-1. Dry samples are thereafter weighted to obtain

final mass ($M_{f at}$ dry step). The below equation is used to do the calculation.

$$H_{dry} = \frac{M_0 - M_f}{M_0} \times 100 \quad (2)$$

Where M_0 is initial mass and $M_{f est}$ finale mass

Volatile matter content

Volatile matter is one of the common parameters measured in bio-combustible. One gram of each crushed briquettes has been taken and put in the oven at 105°C for drying. After that, dried samples of briquette are calcinated during 7 minutes at 550°C. Volatile matter content of combustibles is expressed with the following equation:

$$MOV = [(M_{105^\circ C} - M_{550^\circ C}) \times 100] / M_{dry} \quad (3)$$

with: MOV: volatiles matter content, $M_{105^\circ C}$: Mass obtained after heating at 105°C, $M_{550^\circ C}$: mass obtained after heating at 550°C.

Ash content

According to Doat and Petroff, (1975), ash is essentially constituted of chemical elements, which are silica (SiO_2), phosphorus, sulfur in majority. One gram of each crushed vegetable matter was measured and dried at 105°C in the oven for 24 hours. After that, it was introduced in stove for roasting at 800°C during 5 hours before weighing. It following formula is:

$$A_{sh} (\%) = \frac{M_{ash}}{M_v} \times 100\% \quad (4)$$

with: M_{ash} at 850°C: mass of powder obtained after incineration at 850°C, M_v : mass of dry samples at 550°C.

Fixed carbon content

Fixed carbon content of each samples of combustible briquette has been determined with the following equations (2), (3) and (4). It becomes:

$$C_f (\%) = 100 - (M_v + H_{dry} + A_{sh})$$

Where C_f (%) is fixed carbon content, M_v is volatile matter content, H_{sec} is moisture content and A_{sh} is ash content.

RESULTS

Volumique and porosity or emptiness index of crushed material

Skeletal density average obtained for crushed vegetable matter is between 396.06 ± 190.7 and 975.6 ± 345.3 kg/m³, whom higher maximum value is $831-937$ kg/m³ obtained by Tihay (2007) for Skeletal density of crushed leaves acme vegetable. By using value of apparent

density and Skeletal density obtained previously, we obtain porosities of nine

samples of crushed vegetable matter represented in following table 1:

Table 1: Densities and porosities of crushed vegetable matter

	Dead leaves <i>Azadirachta indica</i>	Dry stem of <i>Sorghum sp.</i>	Leafstalk of <i>Azadirachta indica</i>
Apparent density (kg /m ³)	354.48 ± 203.65	601.66 ± 258.0604	568.39 ± 267.24
Skeletal density (kg /m ³)	444,4±138,8	746,9±674,4	465,05±272,02
Porosity	0.55	-0.35	0.27

For our case, higher porosity is for dead leaves of *Azadirachta indica* particles, either 0.78, whereas small value is those obtained for particles of petioles of *Azadirachta indica*, either 0.19. This show that particles of dead leaves of *Azadirachta indica* are very porous (between 0.78 to 0.32) than particles of petioles of *Azadirachta indica* (between 0.42 et 0.19), whereas particles of stem of *Sorghum sp.* have small porosity

(between 0.35et -0.52). In the case of experiences propagation realized by Dupuy (1995), porosity of litter acme pine tree is 0.97.

Density test and pressure of briquettes

Density test for each briquette we realized permit us to define that combustibles are comparably in terms of density.



Fig. 1 : Combustible briquettes dried at room temperature

According to Biao (2018), average density of *Azadirachta indica* wood are between 0.75-0.90 g/cm³. In our study, density of briquettes with dead leaves of *Azadirachta indica* associate with stem of sorghum is between 0.17 and 0.50. the average is 0.34±0.09 g/cm³. Kers, et al., (2010) show that density of briquettes depends on density of bio-waste used, the applied pressure during fabrication of briquette, the temperature and exposure time for drying. Low density of ours briquettes is attribute to its mixed compound having fostered the partial molecular breakdown.

Moisture content of combustibles briquettes

Moisture content of our combustible briquettes dried at room temperature during 24hours is 76.81 ± 3.32%. This means that the briquettes after a hole day of drying remain wet and cannot be used as source of cooking energy. It is probably caused by the fact of experiment which was done in the rainy season (month of

August) and the air moisture is very high. The dry moisture content, when briquettes have been dried in an oven at 105°C for 24 hours, is 3.40 ± 0.67 %. Regarding moisture content average (3.4%), the briquette is an excellent solid combustible.

Volatiles matter, ash content and fixed carbon content

Volatiles matter of combustibles briquettes obtained is 66.07 ± 7.40 %. This result is higher than 33.21% obtained by Dzokom, et al., (2021) for waste paper and higher than 77.7% obtained by Ajimotokan, et al (2019) for Pine. Ash content of briquettes in our case is 1.48 ± 0.93wt%. The ash content of the other mixing ratios was found to be within the acceptable ash limit (5–40wt%)for a solid biomass briquette (United Nation Environmental Programme, 2014) our result is small 19.5wt% obtained by Ndagana, et al., (2014). Fixed carbon content of briquettes is 29.05± 2.99%. This is small than

49.2wt% obtained by Ajimotokan, et al (2019) for Pine. Higher Fixed carbon rate (39.99%) gives an idea of potential energy. Water resist average obtained is 60.41 ± 15.69 %. Mixing biomasses particles of dead leaves of *Azadirachta indica* and dry stem of *Sorghum sp.* with water operate a partial decomposition of cellulose (Okia, 2016).

CONCLUSION

Objective of our study was to contribute to the energetic valuation of dead leaves of *Azadirachta indica* linked to dry stem of *Sorghum sp.* for this, we propose a way for treatment and valorization of vegetable wastes which means to make combustibles briquettes for minimize their effects on pollutions. Porosity for crushed particles range between 0,32 and 0,78 for dead

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leaves of *Azadirachta indica*, between 0.19 et 0.42 for petioles of dead leaves of *Azadirachta indica* and between -0,52 and 0,35 for dry stem of *Sorghum sp.*: we conclude that only association of vegetables particles with small emptiness index can link to another can resist to manutention.

Their moisture rate is $3.40 \pm 0.67\%$ and their capacity to resist rehydration which is define by average of water resist average of combustibles briquettes is $60.41 \pm 15.69\%$. Fixed carbon rate is $29.05 \pm 2.99\%$, whereas volatile matter is $66.07 \pm 7.40\%$. Combustion quality defined from ash is $1.48 \pm 0.93\%$.

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