International Journal of TechnoChem Research
ISSN:2395-4248 www.technochemsai.com
Vol.02, No.03, pp 212-216, 2016

Prosopis juliflora – A Bioenergy Resource

[1]Seethalashmi, A.N.,[2]Veerakalyanamunnadi, C., [3]Muthuraj, D.

The M.D.T.Hindu College, Tirunelveli 627 010, India

Abstract : Since wood is a renewable resource for energy and environmentally, friendly material, there is an increased interest in using waste wood for energy production. A fuel characteristic of biomass is a significant factor to recommend a material as a feed stock for energy conversion. The scope of the present study is to investigate the chemical elemental and thermal characteristics of *Prosopis juliflora*woody material. *P. juliflora*a Mesquite is a shrub or small tree in the Fabaceae family. It is also one of the biomass which is available hundred hectares in our area. In order to characterize the physical and chemical properties of *P.juliflora* as feed stocks for energy conversion process, we developed protocol. The particle size of sample was found to be 8nm from X-ray diffraction (XRD) technique. Surface morphology of the samples was studied by scanning electron microscopy. Proximate, structural and elemental analyses showed that *P.juliflora* has lower moisture content and high fixed carbon indicates that it is appropriate to meet requirements of thermochemical process. Also, considered as one of the strengths of biomass utilization for energy purposes in terms of contribution to environmental protection, *P.juliflora* contains very low level of Mg and Ca (0.39% & 2.32% respectively). Higher proportion of carbon and lower proportion of oxygen content in *P.juliflora* leads to high calorific value 3891Kcal/kg.1

Keywords: *Prosopis juliflora*, Proximate analysis, Calorific value, Elemental analysis, Gasifier efficiency.

Introduction

Biomass is one of the earliest sources of energy especially in rural areas where it is often the only accessible and affordable sources of energy [1]. Biomass is made up of carbohydrates. Biomass is a renewable energy source with very specific properties. Compared to other renewable technologies such as solar or wind, biomass has few problems with energy storage: in a sense, biomass is stored energy; moreover, biomass is a versatile fuel that can produce bio-gas, liquid fuels and electricity[2].*Prosopis juliflora* is one of the biomass residues which are used to generate electricity. *P. juliflora* has a negative impact on plant diversity [3].It is well known as Mesquite. It is fast growing, nitrogen-fixing and tolerant to arid conditions and saline soils. Under the right conditions, *P. juliflora* can produce a variety of valuable goods and services: construction materials, charcoal, soil conservation and rehabilitation of degraded and saline soils. Concern about deforestation, desertification and fuelwood shortages in the late 1970s and early 1980s prompted a wave of projects that introduced *P. juliflora* and other hardy tree species to new environments across the world. *P. juliflora* has survived where other tree species have failed and in many cases become a major nuisance. *P. juliflora* has invaded, and continues to invade, millions of hectares of rangeland in India. In 2004 it was rated one of the world's top 100 least wanted species (Invasive Species Specialist Group of the IUCN, 2004). The Mesquite tree grows to a height of up to 12 meters (39 ft.) and has a trunk with a diameter of up to 1.2 meters (3.9 ft.).However to use biomass efficiently for energy production a detailed knowledge of its physical and chemical properties are required. These properties more specifically average and variation in elemental compositions is also essential for modeling and analysis of energy conversion process [4]. Ash forming elements such as Si, Ca, Fe, K, Mg, Na, and P in biomass are important to be documented for any thermo chemical conversion process [5]. Actually, high contents of alkali are well-known to conduct to critical technical problems when biomass is used as feedstock for thermal power production, since they contribute to slagging, fouling and sintering formation. Actually, information on concentration and speciation of some elements is useful both for energy and environmental issues. Therefore the investigation of physico-chemical properties of biomass fuels would help finding for them suitable and appropriate energy conversion technologies. In the present work the physical and chemical properties of *P.juliflora* has been investigated.

Materials and Methods

One to two kilograms of *P.juliflora*was collected from the plantation. They were oven dried at 70°C during 24h. The samples were then ground into powder.

Material characterization

The particle size of the sample was determined using X-ray diffraction (XRD) in a wide range of Bragg angles 2θ (10°<2θ<90°) with Co radiation (1.54054 Å). The surface morphology was recorded using field emission scanning electron microscope. The proximate analysis to measure moisture, volatile, fixed carbon and ash content was performed by ordinary oven and muffle furnace. The calorific value of the samples was measured using bomb calorimeter. FT-IR analysis is used to find out the presence of carboxylic acids, amines and hydroxyl substituted compound. Elements presented in the sample were identified using EDAX analysis. Gasifier efficiency of the woody material was calculated using updraft gasifier.

Results and discussion

Structural

The XRD pattern of the samples was shown in Fig.1. The size of the samples was determined using the broadening of a few XRD peaks using Scherr's equation [6]$D=.89\lambda/(\beta_{1/2}\cos\theta)$, where λ= 1.54054Å and $\beta_{1/2}$ is the peak width of the reflection at half intensity. The average particle size was found to be 8nm for *P.juliflora* Fig.1 (inset) shows the scanning electron micrograph of the samples at room temperature. Aggromolahar structure was observed.

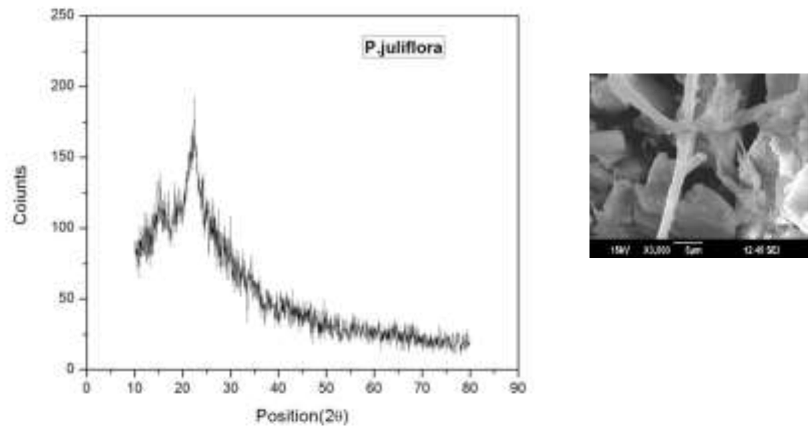


Fig.1.Room temperature XRD pattern and SEM micrograph of *P.juliflora*

EDAX Results

From the EDAX analysis *P.juliflora* has low concentration 0.39% of Mg 2.32% of Ca (Fig.2). The good heat of combustion of *P. juliflora* is due to its higher proportion of carbon and lower proportion of oxygen [7]. Higher proportion of oxygen leads to calorific value reduction. Obtained results of minor elements of *P.juliflora* by EDAX analysis is reported in Table.1.

Table.1. Elemental analysis of *P.juliflora*

Element K	P.juliflora Mass%
C	75.3
O	17.92
Mg	0.39
Ca	2.32
Cu	4.05

Proximate analysis results

Proximate analysis is reported in Table. 2. Moisture content is of important interest since it corresponds to one of the main criteria for the selection of energy conversion process technology. Thermal conversion technology requires biomass fuels with low moisture content, while those with high moisture content are more appropriate for biological-based process such as fermentation or anaerobic digestion. From Table 2, it is noted that *P.juliflora* has moisture content of lesser than 10% and hence more suitable to serve as feedstock for thermal conversion technologies. The ash content of biomass influences the expenses related to handling and processing to be included in the overall conversion cost. On the other hand, the chemical composition of the ash is a determinant parameter to consider for the operation of a thermal conversion unit, since it gives rise to problems of slagging, fouling, sintering and corrosion. Higher proportion of carbon content leads to high calorific value 4200Kcal/kg (Khan *et al.* 1986).Since *P. juliflora* has low ash content and high volatile matter and low fixed carbon (8.17%) therefore *P.juliflora* is the best candidate for thermal conversion technologies.

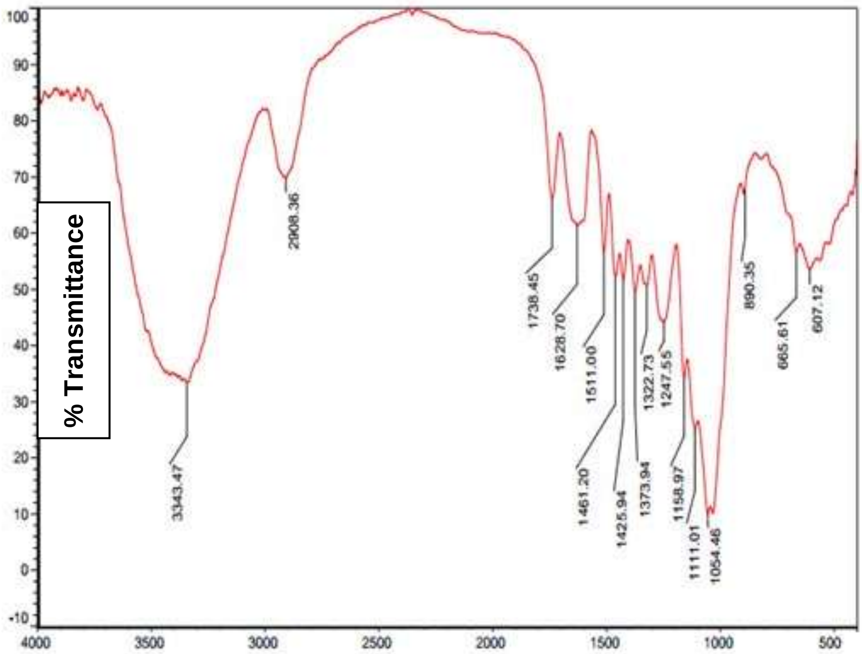
Table.2. Proximate analysis of *P.juliflora*

Species	Moisture (%)	Ash (%)	Volatile matter (%)	Fixed Carbon (%)	Calorific value Kcal/kg
P.juliflora	5.35	1.01	79.23	15.69	3891

FT-IR Analysis:

The FT-IR spectrums of the biomass materials have O-H stretching vibrations at around 3200-3600 cm^{-1}. The O-H stretch carboxylic acids appear at 2908.36 cm^{-1} for *P. juliflora*, C=O stretch appears at 1738.45 cm^{-1} .The peak at 1373 cm^{-1}, for *P. juliflora*, is assigned for strong C-N stretching of aromatic amino group. The peaks obtained at 1158 cm^{-1}, 1111 cm^{-1}, 1054 $cm^{-1}$for C-N stretching alcohols assignment. The region from 1400-600 cm^{-1} is called finger print region because the pattern of absorptions in this region is unique to any particular compound, just as a person's fingerprints are unique. The Presence of carboxylic acids, amines and hydroxy-substituted compounds which are responsible for volatility[8]

FT-IR spectrum of *P. juliflora* wood



Wave number (cm^{-1})

Table3. FT-IR spectral assignments for *P. juliflora*

Wave Number Cm^{-1}	Assignments
3343	O-H Stretch
2908	O-H Stretch Carboxylic acids
1738	C=O Stretch
1628	N-H bend primary amines
1461	CH_2& CH_3 bend
1373	C-N Stretching of aromatic amino
1247	C-O Stretch
1158	C-N Stretching alcohols
1111	C-N Stretching alcohols
1054	C-N Stretching alcohols

Gasifier Efficiency

Gasifier efficiency and Thermal output result (Table.4) shows that the biomass material has considerable thermal output (6 to 11 kW/hr) and also better flame length [9]. Therefore this biomass material is the most suitable candidates for gasification.

Table 4. Measured parameters used to calculate the Gasifier efficiency and Thermal output using updraft Gasifier

Samples	CV of wood KJ/Kg	Gasifier running time (Hrs)	Wood consump-tion rate (Kg/hr)	Air flow rate (M^3/hr)	Gas production rate (M^3/hr)	Ash produced (Kg)	Gasifier efficiency (%)	Thermal output (KW/hr)
P. juliflora	30055.48	1.30	8.0	12.00	20.00	0.20	37.30	11.0

Conclusion

In order to characterize the physical and chemical properties of *P.juliflora* to be used as feedstock for energy conversion process, we developed an analytical protocol. Proximate and EDAX analysis showed that *P.juliflora* is of low moisture content; low proportion of oxygen indicates it is appropriate to meet requirements of thermochemical process. The FT-IR analysis reveals that the presence of carboxylic acids, amines and hydroxyl substituted compound presence, which confirms the volatility of the species. The volatiles in biomass promote better burnout of the fuel and lower emissions so according to our observations the biomass *P.juliflora*wood has higher volatile 79.23% therefore it is most suitable for gasification. Environmental benefits of using *P.juliflora* as fuel for thermal power generation units also more. This study could serve to establish a database of biomass fuels or feedstock that would support decision making in terms of energy conversion technology selection and operating conditions setting.

References

1. Demirbas A. Combustion characteristics of different biomass fuels. Prog Energy Combust Sci., 2004, 30:219-30.
2. Kopetz H. Biomass - a burning issue., 2007,52-85. Available from: www.refocus.net (accessed 22.02.10).
3. Singh G, Rathod T R, Mutha S, Upadhyaya S and Bala N, Tropical Ecology., 2008,49(1): pp13–23.
4. Nordin A, Biomass and Bioenergy.,1994, 6(5): pp.339-347.
5. Cuping L, Changzhi W, Yanyongijie and Haitao H, Biomass and Bioenergy.,2004, 27:pp 119-130.
6. Vincent C A., Solid State Ionics. Lithium batteries: a 50-year perspective, 1959-2009., 2000, 134: 159-167.
7. Goel V L, Behl H M, Biomass and Bioenergy.,1996, 10(1): pp. 57-61.
8. John Coates, Interpretation of Infrared Spectra, A Practical Approach., 2000.
9. Reed T.B. (Ed.), Biomass Gasification Principles and Technology Park Ridge: Noyes Data Corporation., 1996.

*****