RESEARCH ARTICLE

EVALUATION OF FUEL WOOD CHARACTERISTICS OF SOME DECIDUOUS TREES AND SHRUBS OF THE KASHMIR REGION

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Abstract: Fuelwood characteristics viz. Calorific value, Density, Ash content (%), Moisture content (%) were evaluated for 11 deciduous trees viz. *Robinia pseudoacacia* (Black Locust), *Prunus armeniaca*(Wild apricot), *Morus alba* (Mulbery), *Quercus rober*(Oak),*Ulmus villosa* (Elm), *Salix alba* (White willow),*Melia azedarach*(Drek), *Ailanthus ultissima* (Tree of Heaven), *Populus nigra*(Black Poplar), *Albizia julibrissin* (Siris), *Fraxinus floribunda*(Ash tree) and two shrubs namely *Amorpha fruticosa* (Desert false indigo)and *Parrotia jacquemontina* (hatab)of Kashmir region. The results showed that fuel wood potential of the different tree and shrub species is in order as *Parrotia jacquemontina (hatab)> Prunus armeniaca(Wild apricot)> Robinia pseudoacacia (Black Locust)> Albizia julibrissin (Siris)> Amorpha fruticosa((Desert false indigo) > Ulmus villosa (Elm)> Quercus rober(Oak) > Fraxinus floribunda(Ash tree) > Ailanthus altissima(Tree of Heaven) > Morus alba(*Mulbery*) > Melia azedarach(Drek) > Populus nigra (Black Poplar) > Salix alba (White willow),*

Keywords: Calorific value, Firewood, Fuelwood value index (FVI), Deciduous trees and shrubs, Kashmir

INTRODUCTION

Fuelwood has remained the principal component of rural domestic energy in India and most developing countries. Among the various non-conventional energy sources, forest biomass plays an important role in alleviating the fuelwood crisis. Biomass is one of the oldest resource of energy and the commonest service material known to Man and has been used for over 5 lakh years. Fuel wood gathered from the forest, either by lopping branches, collecting fallen wood or cutting down dry and diseased trees, is the most common source of domestic energy in the rural areas of many developing countries, (Lal, 2008). Biomass fuel has been humankind's very first source of energy. It is estimated that approximately 2.5 billion people living in developing countries meet their energy needs for cooking, heating, and lighting through biomass fuels (fuelwood, crop residues, and animal dung) (Bamiro and Ogunjobi, 2015). The number of people in developing countries that rely on biomass fuels is expected to increase to 2.7 billion by 2030 (about one-third of the world's population) due to population growth (Rafaj *et al.*, 2018). Fuelwood is the dominating biomass energy sources. In India over 77 percent of households from rural areas and 20 percent of households from urban areas depend on firewood for cooking (NOSO, 2008). The annual fuel wood consumption of the country is 216.42 million tons out of which, 58.75 m tons comes from forests. Of the total population, 23% population is dependent on forest for obtaining fuel wood (Kumar *et al.*, 2011). The people of the Himalayan region have been fulfilling their energy needs almost entirely from forests (Bhatt and Sachan 2004).The quantity of fuelwood being consumed annually by the UTs of Jammu & Kashmir and Ladakh (combined) has been estimated to about 12,98,816 tonnes (ISFR, 2019) which arise from forests and trees outside forests.). Biomass is largely consumed as firewood and charcoal. The Jammu and Kashmir wood balance study found decreasing consumption of fuelwood with increasing distance of forest from the village. (MSSRF, 2020). However, shrinking forest cover and population pressure has put tremendous pressure on the supply of fuelwood requirement. With the result, efforts are being made at different levels in promoting energy plantations, but there is a lack of under-standing on firewood farming, indicating that screening of various indigenous tree/shrub species for fuel quality is necessary. The value of a wood as a fuel depends mainly on its combustibility and its heating power or calorific value. Calorific value is the quantity of heat emitted by a given weight of wood during the process of combustion. The calorific value, ash content and moisture content are control parameters of fuel quality and a basic criterion for assessing the energy property of fuelwood. The fuelwood having high calorific value, low ash and moisture content can reduce its consumption to a much extent. Considering a wide variety of fuelwood species of Kashmir the present study was undertaken to screen out some trees and shrubs species with best fuelwood characteristics.

MATERIALS AND METHODS

The study was carried out at Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir (J&K) at $34^0$12′N and $74^0$46′E with an elevation of 1600 m above mean sea level. The study area is characterized by temperate climate experiencing four distinct seasons: a severe winter (December to February), a cold spring (March to May), a mild summer (June to August) and a pleasant autumn (September to November). The site falls in a mid to high altitude area characterized by

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hot summer and very cold winter. The average precipitation is 690 mm most of which is received from December to April in the form of snow and rains. The minimum temperature ranged from -3.98 to 16.61ºC and maximum temperature from 6.89 to 30.57 ºC and the average maximum relative humidity from 73.27 to 93.97 percent, whereas the mean minimum relative humidity ranged from 44.03 to 71.00 percent during the study period.

The fuel wood characteristics viz. Calorific value, Density, Ash content (%), Moisture content (%) were determined for two years by standard procedures reported by Bhatt *et al.* (2004). Branch cuttings of 2-5cm diameter from mature trees and shrubs of these species were collected during dormant season and divide into four replicates of 10 cm length. Calorific value was estimated using the Oxygen digital bomb calorimeter. Test samples (1 g) were sawn longitudinally from the wood. The sample was placed in a crucible inside the bomb calorimeter and subjected to rapid combustion. For this, a 1 g saw dust pellet was burned in the sample holder of the bomb by connecting a nichrome fuse between the terminals to the pellet through a small cotton thread. Prior to ignition, the bomb was filled with oxygen and placed in the calorimeter vessel, to which 1.5 L of distilled water was added. Initial temperature of water (Ti) in the vessel and the maximum temperature attained after burning pellets were recorded (Tf). Calorific value (CV) was calculated by Indian Standard (Shanavas and Kumar, 2003). CV = (Ti – Tf) × Water equivalent value; Where, CV= Calorific Value, Ti = initial temperature of water and Tf = final temperature of water. Wood density of randomly selected branches of trees and shrubs was determined by water displacement method (Smith 1955). For estimation of ash content, wood samples were ground in a mechanical grinder and 2 g of wood sample was burnt in a muffle furnace at 600 ^{O}C. Moisture content of the wood was determined after drying at 100 ^{O}C for 48 hours in an electric oven. For the estimation of suitable fuelwood species, the Fuelwood value index (FVI) was used and defined as the Calorific value X wood density / ash content (Bhatt et al. 2004). In general, high calorific value, high density, low ash and low moisture content are considered as ideal fuelwood properties. SPSS software package was used for statistical analysis and graphs were plotted by Microsoft excel.

RESULTS AND DISCUSSION

Fuelwood characteristics viz. Calorific value, Density, Ash content (%), Moisture content (%) have been evaluated for 11 deciduous trees viz.*Robinia pseudoacacia* (Black Locust), *Prunus armeniaca*(Wild apricot),*Morus alba*(Mulbery), *Quercus rober*(Oak),*Ulmus villosa* (Elm),*Salix alba* (White willow),*Melia azedarach*(Drek), *Ailanthus ultissima*(Tree of Heaven), *Populus nigra* (Black Poplar), *Albizia julibrissin* (Siris),*Fraxinus floribunda*(Ash tree) and two shrubs namely*Amorpha fruticosa* (Desert false indigo)and *Parrotia jacquemontina* (hatab)of Kashmir region for two years. The data on fuelwood properties of the selected trees and shrub species of Kashmir region are given in Table 1 to table 3. *Prunus armeniaca* exhibited the highest calorific value (5075 k cal/kg dry wt), followed by *Parrotia jacquemontina, Albizia julibrissin, Morus alba and Robinia pseudoacacia* respectively. Whereas, the lowest value recorded in *Melia azedarach* (Drek) was 4585 K cal g- 1. All the species had good calorific values. These findings are in agreements with Negi and Todaria (1997) , Puri et al (1994), Abotte *et al.* (1997), Bhatt et al (2004) and Kumar *et al.(* 2011) reported by earlier workers.

Species like *Parrotia jacquemontina, Quercus rober, Robinia pseudoacacia* and *Prunus armeniaca* exhibited higher wood density. Low ash content was observed in *Parrotia jacquemontina, Prunus armeniaca, Albizia julibrissin* and *Robinia pseudoacacia* respectively as compared to other species. Less moisture content was observed in species like *Fraxinus floribunda, Robinia pseudoacacia* and *Amorpha fruticosa* respectively. Earlier researchers (Purohit and Nautiyal, 1987 and Bhatt and Todaria, 1992) reported that tropical species exhibit comparatively higher ash and moisture content than temperate species. Similar results were observed in these temperate species. Based on the FVI (Calorific value X wood density / ash content) of the 13 species analysed, fuelwood potential of the different tree and shrub species is in order as *Parrotia jacquemontina (hatab)> Prunus armeniaca(Wild apricot)> Robinia pseudoacacia (Black Locust)> Albizia julibrissin (Siris)> Amorpha fruticosa((Desert false indigo) > Ulmus villosa (Elm)> Quercus rober(Oak) > Fraxinus floribunda(Ash tree) > Ailanthus altissima(Tree of Heaven) > Morus alba(*Mulbery*) > Melia azedarach(Drek) > Populus nigra (Black Poplar) > Salix alba (White willow),*. Similar results were obtained by Bhat and Todaria (1992), Puri et al (1994) Abotte et al. (1999), Chettri and Sharma (2007), Ramos et al. (2008), Sarvanan et al. (2013) and Chavan et.al (2016) for different characteristics of fuelwood species.

CONCLUSION

The present study revealed that *Parrotia jacquemontina (hatab) ,Prunus armeniaca(Wild apricot), Robinia pseudoacacia (Black Locust), Albizia julibrissin (Siris), Amorpha fruticosa((Desert false indigo), Ulmus villosa (Elm), Quercus rober(Oak), Fraxinus floribunda(Ash tree)* are listed as a best fuelwood species in Kashmir region. The activities such as planting of tree species in

Agroforestry and energy plantation on wasteland, degraded forest, community lands, farmlands can be promoted through existing programme such as Green India Mission, JFM and rural development programmes etc. However, it is necessary to determine the growth and productivity of these tree species under temperate conditions of Kashmir region.

Table 1. Fuelwood characteristics of selected deciduous trees and shrubs of the Kashmir region. (Pooled)

-Plant species	Calorific value (k cal/ kg	wood density (g/cc)	Ash content (%)	Biomass/ash ratio	Moisture content (%)	Fuelwood value index (FVI)
1. ***Robinia pseudoacacia*** **(Black Locust)**	4953	0.73	2.9 (1.97)	36.05	36.92	1266.92
2. ***Prunus armeniaca*** **(Wild apricot)**	5075	0.84	2.5 (1.87)	40.38	42.04	1710.92
3. ***Morus alba*** **(Mulbery)**	4920	0.68	3.6 (2.15)	28.37	48.75	949.84
4. ***Quercus rober*** **(Oak)**	4661	0.78	3.8 (2.19)	26.84	38.81	969.69
5. ***Ulmus villosa*** **(Elm)**	4708	0.62	3.4 (2.09)	29.66	42.71	855.51
6. ***Salix alba*** **(White willow)**	4782	0.49	3.4 (2.09)	32.31	54.02	753.50
7. ***Melia azedarach*** **(Drek)**	4585	0.58	3.6 (2.14)	27.79	39.74	738.39
8. ***Ailanthus altissima*** **(Tree of Heaven)**	4728	0.64	3.7 (2.16)	27.68	37.38	828.19
9. ***Populus nigra*** **(Black Poplar)**	4802	0.56	5.1 (2.48)	19.45	44.38	517.46
10. ***Albizia julibrissin*** **(Siris)**	4935	0.59	3.2 (2.05)	32.32	40.08	917.28
11. ***Fraxinus floribunda*** **(Ash tree)**	4682	0.76	3.5 (2.13)	29.22	31.93	1040.97
12. ***Amorpha fruticosa*** **(Desert false indigo)**	4742	0.71	3.5 (2.11)	29.15	31.94	976.03
13. ***Parrotia jacquemontina*** **(Hatab)**	5035	0.83	2.2 (1.78)	49.25	41.68	2058.23
CD $_{0.05}$	49.41	0.03	0.07	2.13	1.68	-

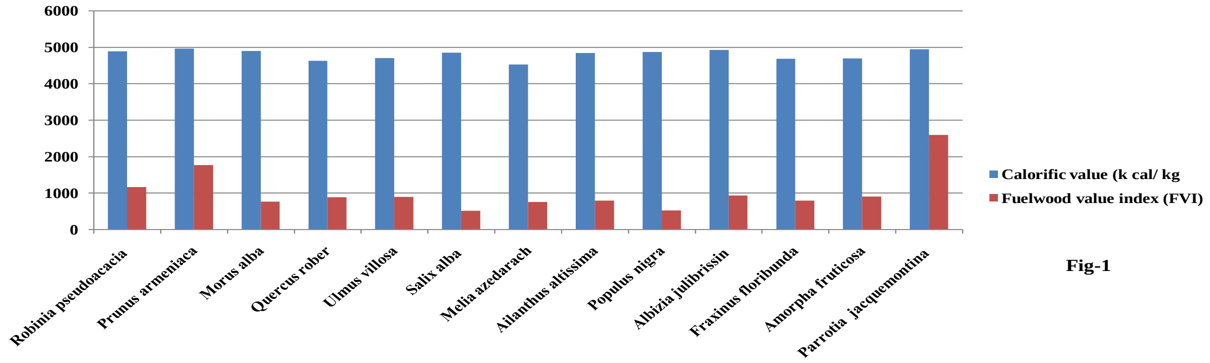

Fig-1

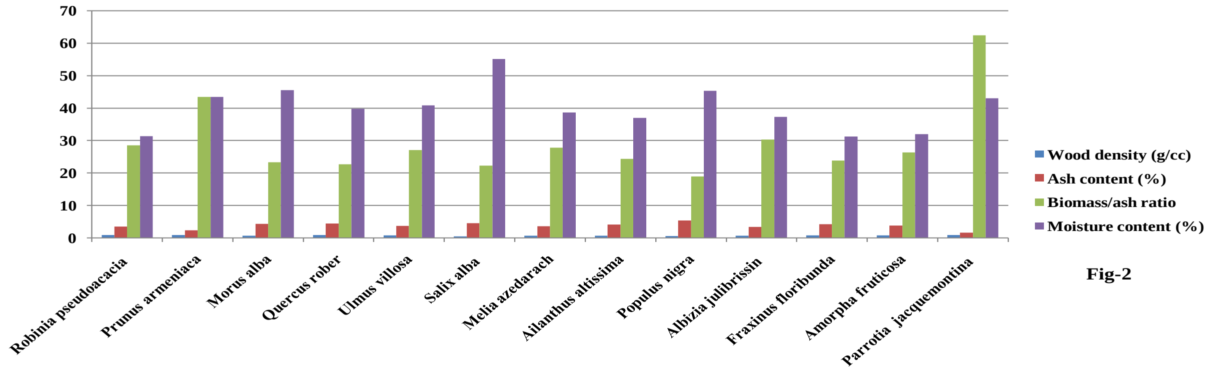

Fig-2

Figure 1 & 2: Fuelwood characteristics of selected deciduous trees and shrubs of the Kashmir region. (1st Year)

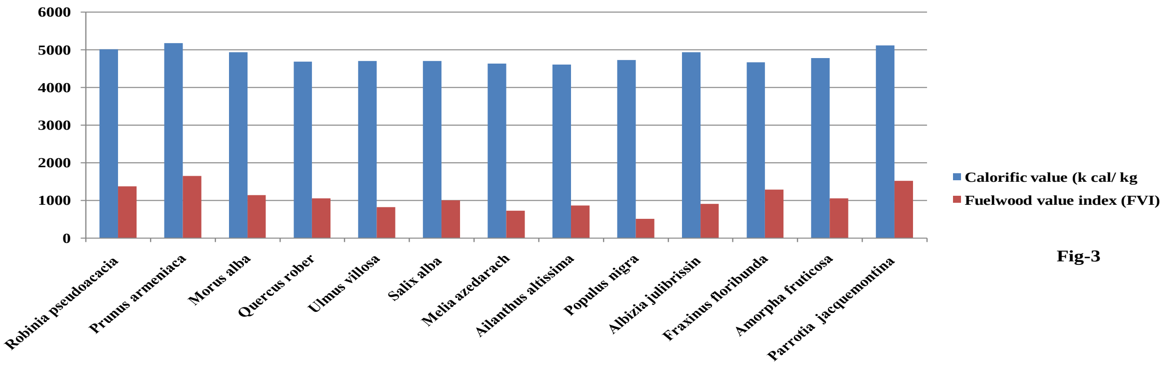

Fig-3

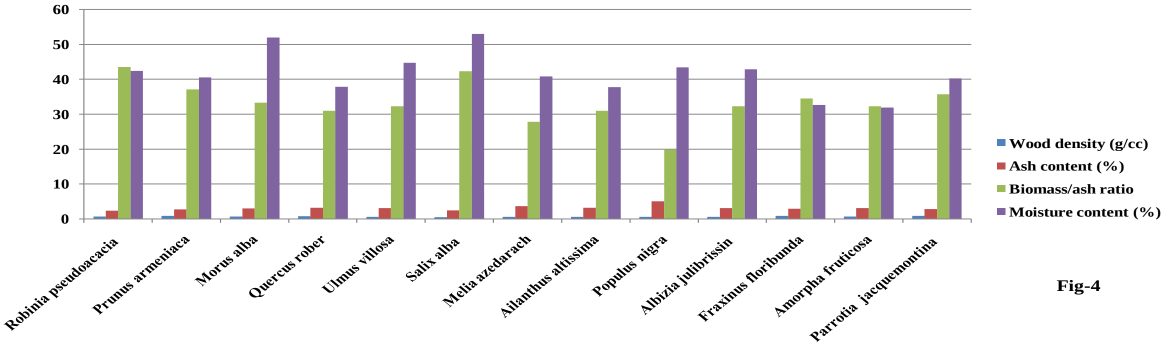

Fig-4

Figure 3 & 4: Fuelwood characteristics of selected deciduous trees and shrubs of the Kashmir region (2nd Year).

REFERENCES

Abbot, P., Lowore, J., C. Khof and Werren, M. (1997). Defining firewood quality: a comparison of quantitative and rapid appraisal technique to evaluate firewood species from a southern African Savana. *Biomass and Bioenergy*. **12** : 429-437.

Bamiro, O. M. and Ogunjobi, J. O. (2015). “Determinants of household energy consumption in Nigeria: evidence from Ogun State,” *Research Journal of Social Science and Management*, 4 (12) : 35–41.

Bhatt, B. P. and Sachan, M. S. (2004). Firewood consumption pattern of different tribal communities in Northeast India. *Energy Policy* **32**:1–6.

Bhatt, B.P. and Todaria, N.P. (1992). Fuelwood characteristics of some Indian mountain tree species. *Forest Ecology and Management*. **47**:363-366.

Bhatt, B.P., Tomar, J.M.S. and Bujarbaruah, K.M. (2004). Characteristics of some Firewood trees and shrubs of the North Eastern Himalayan region, India. *Renewable Energy*. **29**: 1401-1405.

Chavan, S.B , Chauhan, D.S., Keerthika,V, Uthappa, A.R., Jha, A. and Newaj, R. (2016). Fuelwood characteristics of selected tree species from Bundelkhand region of Central India *Eco. Env. & Cons.* **22**: 87-95

Chettri, N. and Sharma, E. (2007). Fuelwood value assessment: A comparison on local preference and wood constituent properties of species from a trekking corridor, West Sikkim, India. *Current Science*. **92 (12):** 25.

ISFR (2019). India State of Forest Report , Dehradun, India.

Kumar, N., Patel, K., Kumar, R.N. and Bhoi, R.K. (2011). An evaluation of fuelwood properties of some Aravally mountain tree and shrub species of Western India. *Biomass and Bioenergy*. **35** : 411-414.

Lal, P. (2008). Role of private sector in agroforestry and supply of high-quality planting stock. *Ind. For.* **134 (5)**: 587-596.

MSSRF (2020). Status report on use of fuelwood in India. M.S.Swaminathan Research Foundation, Chennai, India.

Negi, A.K. and Todaria, N.P. (1997). Fuelwood evaluation of some Himalayan trees and shrubs. *Energy (Oxford)*. **18** : 799- 801.

NOSO (2008). Energy used by Indian households. New Delhi. National Sample Survey Organization, Department of Statistics. Report No.530

Puri, S., Singh, S. and Bhushan, B. (1994). Evaluation of fuelwood quality of indigenous and exotic tree species of Indias semi-arid regions. *Agroforestry Systems*. **26** : 123-130.

Purohit, A. N. and Nautiyal, A. R. (1987). Fuelwood value index of Indian mountain tree species. *International Tree Crops Journal*. **4**:177–82.

Rafaj, P., Kiesewetter, G., Gül, T., Schöpp, W., Cofala, J., Klimont, Z., Purohit, P., Heyes, C., Amann, M., Kleefeld, J. B., and Cozzi, L. (2018). “Outlook for clean air in the context of sustainable development goals,” *Global Environmental Change*, **53**: 1–11.

Ramos, M.A., De Medeiros, P.M., De Almeida, A.L.S., Feliciano A.L.P. and De Albuquerque, U.P. (2008). Can Wood Justify Local Preferences for

Firewood in Area of Caatinga (Dry Land) Vegetation? *Biomass and Bioenergy*. **32** : 503-509.

Saravanan, V., Parthiban, K.T., Kumar, P., Anbu, P.V. and Ganesh Pandian, P. (2013). Evaluation of fuel wood properties of *Melia dubia* at different age gradation. *Research Journal of Agriculture and Forestry Sciences.* **1**:8-11.

Shanavas, A. and Kumar, B.M. (2003). Fuelwood characteristics of tree species in home gardens of Kerala, India, *Agroforestry Systems.* **58**. 11-24.

Smith, DM (1955). A comparison of two methods for determining the specific gravity of small samples of secondary growth, Douglas fir. U.S. For. Prod. Lab. Report No. 2033.