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Calorific Value of Leaves of Selected Dipterocarp Trees Species in Piah Forest Reserve, Perak

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Abstract

Information on calorific value is very important factor in fuel evaluation. The objective of the study was to investigate the calorific values of the leaves of five (5) selected trees species of dipterocarp in Piah Forest Reserve, Perak, Malaysia. The species are *Hopea* sp., *Shorea parvifolia*, *Shorea leprosula*, *Shorea macroptera* and *Dipterocarpus* sp. The calorific values were determined using the Adiabatic Bomb Calorimeter. The difference of calorific value between the five species were also examined. It was found that, the mean calorific value for the dipterocarp species were within the range of 4041.28 Cal g^{-1} to 4820.78 Cal g^{-1}. The leaves of the *Shorea macroptera* contain higher calorific value compared to other four species. The findings will be useful in the preparation of forest fire management plan, and also in the development of bioenergy project of wood-based biomass from forest species.

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1. Introduction

Calorific value refers to the quantity of energy released as heat when a unit of fuel is completely combusted. Abe [1] stated that, calorific value of wood may differ according to place of production, individual trees in the forest and position of tree components, for example, leaf, trunk and twig. Information on calorific value is useful in the preparation of forest fire management plan, and also in the development of renewable energy such as wood-based biomass or biofuel. According to Aguilar and Garret [2], woody biomass possibly will be an important feedstock in producing renewable energy. Besides that, forest fire risks can be reduced by conducting proper forest fire risk and fuel assessment. In this regards, information on the calorific value of tree species can be used in enhancing the effectiveness of the assessment. This includes using the information in the preparation of a good forest fire management plan. However, information on calorific value for tropical forest, particularly on dipterocarp trees species are still lacking. In this regards, this study was carried out with the objective to determine the calorific value of leaves for five (5) selected trees species of dipterocarp in the Piah Forest Reserve, Perak, Malaysia. The selected species were *Hopea* sp., *Shore parvifolia*, *Shorea leprosula*, *Shorea macroptera* and *Dipterocarpus* sp. In the study, the calorific value of leaves of the species were determined in laboratory using the Adiabatic Bomb Calorimeter (ABC) machine.

1.1. Calorific Value

Lisardo et al. [6], define calorific value as the quantity of heat released in per unit of combustible mass, and it is measured in calories per gram (Cal g^{-1}). Meanwhile, the calorific value obtained from the wood is defined as the heat liberated when the materials are

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combusted to carbon dioxide and liquid water at 25˚C [10]. Its value is measured either as gross or net calorific value. According to Artsybashev [3], the quantity of heat, which is liberated on complete combustion of one kilogram of fuel in an absolutely dry state, is called gross calorific value. In the combustion of moist wood, part of the heat is used in the evaporation of water and therefore, the quantity of heat liberated is less than in combustion of dry wood. This is referring to the net calorofic value of the fuel. Generally, the calorific values of various combustibles are determined by means of a special apparatus called a calorimetric bomb [3].

There were a number of studies on the calorific value of forest combustibles have been carried out. These include the study conducted by Mohd Hamami et al. [9]; Khider and Elsaki [5]; Abe [1]; Ramachandra and Kamakshi [8]; Golley [4]; Nagi et al. [7]; and Lisardo et al. [6]. In their study on the calorific value and the potential of some plantation species for energy production, Mohd Hamami et al. [9], found that at oven dry condition, *Gmelina arborea* exhibited the highest calorific value of 4741 cal/g followed by Acacia mangium 4734 cal/g, *Hevea brasiliensis* 4676 cal/g and *Paraserianthes falcataria* 4536 cal/g. Khider and Elsaki [5] in their study is used oxygen bomb to determine the calorific value for four species. They found that *Eucalyptus tereticornis* contains high calorific value of 19485 KJ/kg, followed by Acacia mellifera of 19117KJ/kg, *Acacia senegal* 19097 KJ/kg, and *Moringa oleifera* 17515 KJ/kg. Abe [1] in his study on the calorific value of Japenese coniferous species found that the mean calorific value for the species was 4972 cal/g. Ramachandra and Kamakshi [8] in their study on biosource potential of Karnataka, India found that the highest calorific value in the leaf component was due to its higher extractive contain. The study by Golley [4]in the tropical forest found that the calorific values of canopy leaves were higher than understory leaves, that was approximately 3852 cal g^{-1} and 3612 cal g^{-1} respectively. Nagi et al. [7] in their study on the physical-chemical properties of palm biodiesel and petroleum diesel found that calorific value of palm biodiesel was lower (41,3 MJ/kg) compared to petroleum diesel (46.8 MJ/kg). However, the tendency of palm biodiesel to form carbon during combustion is not as much as petroleum diesel. Meanwhile, Lisardo et al. [6] recommended that knowledge on calorific values of different forest species is very important in the prevention of potential damage cause by wildfires. They observed that the correct interpretation of different calorific values of forest species can be helpful in the assessment of the behaviour of the different zones in response to wildfires.

2. Materials and Methods

2.1. Study Site

The study was conducted in Piah Forest Reserve (PFR), which is located in the state of Perak, Malaysia. Dipterocarp species are the main tree species of the PFR.

2.2. Preparation of Materials

There were five species of Diptrocarps, that is, *Hopea* sp., *Shorea parvifolia*, *Shorea leprosula*, *Shorea macroptera* and *Dipterocarpus* sp. selected in this study. The leaves of the species were grinded and sieved to get the fine formed of 40 mesh size, and divided into five samples of 0.2g for each species.

2.3. Determination of Calorific Value

The calorific values of the five samples were determined by using the Adiabatic Bomb Calorimeter. The samples were tested three times in order to obtain the good results. They were completely combusted under 3000kPa pressure.

3. Results and Discussion

The mean calorific values for the leaves of the five Dipterocarps species are shown in Table 1. The study found that the leaves of Shorea macroptera contain the highest calorific value of 4820.78 cal g-1.The second highest was Shorea parvifolia with the calorific value of 4688.58 cal g-1. It was followed by Shorea leprosula with the value of 4334.10 cal g-1, Hopea sp. of 4278.05 cal g-1, and Dipterocarpus sp. of 4041 cal g-1. Generally, the calorific values of the leaves of Shorea macroptera, Shorea parvifolia, Shorea leprosula, and Hopea sp. were not significantly different. It was found that only the leaves of Dipterocarpus sp. contain significant different calorific value with the other four species.

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Table 1: Calorific value of the leaves of Dipterocarp species

	Calorific Value (cal g^{-1})	
Species	Leaf	Standard Error
Hopea sp.	4278.05[a]	±20.89
Shorea leprosula	4334.10[a]	±11.71
Shorea parvifolia	4688.58[a]	±23.95
Shorea macroptera	4820.78[a]	±17.88
Dipterocarpus sp.	4041.28[b]	±22.40

* The error term is Mean Square(Error) = 11983.062.

** Means with the same letter in the same row are not significantly different

4. Conclusion

The study shows that the four species, *Hopea* sp., Shorea leprosula, *Shorea parvifolia*, *Shorea macroptera* had similar calorific values while *Dipterocarpus* sp. was significantly lower compared to the four species.The findings of the study will be useful in fuel assessment particularly in enhancing the efficiency of forest fire management and in the development of bioenergy of wood-based biomass from forest species. However, further studies on the calorific values of other forest species need to be done. It is recommended that, the scope of the study should also be expanded to cover other aspects such as on the relationship between calorific values of the tree components and forest flammability.

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References

[1] Abe, F. 1986. Calorific value of Japanese coniferous wood. Forest Products Chemistry, 36, 91-100.

[2] Aguilar, F. and Garret, H.E. 2009. Perspective of woody biomass for energy: survey of state foresters, state energy biomass contacts, and national council of forestry association executives. Journal of Forestry, 107 (6).

[3] Artsybashev, E. S. 1983. Forest fires and their control. K. Badaya Trans., V. Pandit ed., Oxonian Press Pvt. New Delhi. India.

[4] Golley, F. B. 1969. Caloric value of wet Tropical Forest vegetation. Ecology,50(3), 517-519.

[5] Khider, T. O., & Elsaki, O. T. 2012. Heat value of four hardwood species from Sudan. Journal of Forest Products and Industries, 1(2), 5-9.

[6] Lisardo, N.R., Rodriguez, J.A., and Castifieiras, J.P. 1996. Calorific values and flammability of forest species in Galicia. Coastal and Hillside Zones. Bioresource Technology, 57, 283-289.

[7] Nagi, J., Nagi, F. and Syed Khaleel, A. 2008. Palm biodiesel an alternative green renewable energy for the energy demands of the future. In International Conference on Construction and Building Technology, ICCBT (pp. 79-94).

[8] Ramachandra, T. V., Kamakshi, G., & Shruthi, B. V. 2004. Bioresource status in Karnataka. Renewable and sustainable energy reviews, 8(1), 1-47.

[9] Mohammad Hamami, S., Nuruddin, A. A., and Chee Ling, L. 1989. Calorific value and the potential of some plantation species for energy production. In Proceeding : Regional Symposium on Recent Development in Tree Plantation of Humid/Sub-Humid Tropics of Asia, 5 June 1989, Universiti Pertanian Malaysia, Serdang.

[10] Wolowicz, M., and Szaniawska, A. 1986. Calorific value, lipid content and radioactivity of common species from Hornsund, Southwest Spitsbergen. Polar Research, 4(1), 79.

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