PROXIMATE AND ULTIMATE ANALYSIS OF EMPTY FRUIT BUNCH AND SHOREA SP. WOOD

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Abstract —**This project aimed to analyse and characterize the empty fruit bunch (EFB) of oil palm and *shorea sp*. wood in the area under study through the proximate and ultimate analysis. The proximate analysis consists of analytical evaluation of properties such as moisture content, fixed carbon, volatile matter and ash content of the EFB. Based on the recent study, the moisture content in the unprocessed EFB of oil palm ranges around 67% while moisture content for processed EFB ranges between 30% to 50% (Salman zafar, 2015).The volatile matter varies from 71.2% to 79.7%, the ash content ranges between 3.02 – 7.54% and the fixed carbon content ranges between 8.65 – 18.3% (Rozita Omar, 2011). The ultimate analysis is quantitative analysis of various elements present in a sample, such as carbon, hydrogen, sulphur, oxygen, and nitrogen (Ultimate and Proximate Coal Analysis, n.d.).The concentration of carbon for EFB ranges between 45 – 48.8% , the oxygen content varies from 40.2 – 47.3%, hydrogen ranges between 6.4 – 7.33%, nitrogen ranges between 0.0 – 0.25% and the sulphur content varies from 0.68 to 1.06% (Rozita Omar, 2011). Moreover, the proximate and ultimate analyses when interpreted in detail may form an effective tool to characterize the EFB.**

I. INTRODUCTION

Nowadays, the source of fossil fuels are decreasing due to its demand. Thus, it is best to find an alternative way to replace the fossil fuels with renewable sources to conserve the remaining sources of fossil fuel. One of the alternative way is to convert EFB to source of fuel. The characterization of EFB is important to determine its potential utilization for application in other industries. EFB can be found in large quantities and it can be used in many application such as bio-ethanol production due its high content cellulose. The characterization can be done by proximate and ultimate analysis to determine the EFB's and shorea sp. wood's elemental, isotopic composition, moisture content, fixed carbon, volatile matter and ash content. Proximate analysis is a standard method that divides and determines categories of compounds in a mixture. Proximate analysis consists of parameters such as moisture content, ash content, and volatile matter. From these three parameters, the fixed carbon can be calculated. The selection of suitable measurements is based on the American Standard Test Method. While, ultimate analysis is a quantitative analysis in which percentages of all elements such as Carbon, Hydrogen, Oxygen, Nitrogen and Sulphur in the substances are determined. The selection of relevant method is based on the American Standard Test Method. The objective of this experiment is to evaluate proximate (moisture content, volatile matter, ash and fixed carbon) and ultimate (carbon, hydrogen, oxygen, nitrogen and sulphur) characteristic of Empty Fruit Bunch of Oil Palm and *shorea sp.*

METHODOLOGY

A. *PROXIMATE ANALYSIS*

The proximate analysis is carried out by following the American Standard Test Method(ASTM) standards D6980, D5142, and D3174 ; for moisture content, volatile matter, and ash content, respectively (ASTM International, 2004).

Moisture Content Test

The moisture content of a sample is determined by the loss of moisture in a sample after leaving the sample under the temperature of 105 ºC.

Moisture Analyzer is used to determine the moisture content of the sample. Firstly, the power supply is turned on and ON switch is pressed on the side of the moisture analyser. The lid is opened and an aluminium pan is inserted at the centre of the machine. Reset button is pressed. Then, 1 gram of a sample is weighed in the aluminium pan. The moisture content is calculated by the machine.

Volatile Matter Test

The volatile matter content in a sample correspond to the products that evolved in the temperature of 110-900ºC as a result of a thermal decomposition. It also can be determined as products given off by a material as gas or vapor. Percentage of volatile matter can be calculated by:

$$Volatile\ Matter\ (\%) = \frac{sample\ weight - residue\ weight}{sample\ weight} x\ 100$$

Procedure:

The equipment and materials needed are furnace, crucible with lid, and analytical balance. Crucible with lid is weighed by using analytical balance. Then, 1 gram of sample is weighed inside the crucible with lid. The furnace is set for 900 ºC. The sample is inserted into the furnace for 7 minutes under 900 ºC temperature. After 7 minutes, the sample is taken out from the furnace and is let cool for few minutes. The crucible with lid is weighed and the data is recorded.

Ash Content Test

Ash is the remaining that remains after the sample has undergone loss of moisture and volatile matter analysis and the fixed carbon analysis which is combustion at 815ºC for 3 hours. The percentage of ash content can obtained by :

$$Ash\ Content\ (\%) = \frac{ash\ weight\ (g)}{sample\ weight(g)}\ x\ 100$$

Procedure:

Furnace was set at 815 ºC. Sample from the volatile matter analysis is used. The lid is removed from the crucible. The burned for 3 hours inside the furnace. After 3 hours, the crucible is pulled out and let cool for a few minutes. The weight of the crucible + ash is recorded. Ash content are calculated using the formula.

Fixed carbon Test

Fixed carbon content is the solid combustible material that remains after loss of moisture and volatile matter minus the ash after the combustion is completed. Carbon content in a sample can be known by (Roberto García, 2012) :

Carbon Content (%) = 100% - (%volatile matter + %ash content)

B. ULTIMATE ANALYSIS

Ultimate analysis measures the five elemental fractions of Oil Palm EFB including C, H, O, N, and S. The elemental composition of C, H, O, N, and S in the terms of the mass percentages was determined by following ASTM standards D5373 for carbon, nitrogen and hydrogen, and ASTM D4239 for sulphur (Tree Power , 2016).This analysis can be performed by using Elemental Analyzer under two configurations. Two different reactor columns were used for the determination of CHNS composition and the determination of O composition. For the determination of CHNS composition, the sample undergoes complete combustion at 1800

^{0}C and high purity oxygen was used at a rate of 250 ml/min. From this process, the carbon is converted to carbon dioxide, hydrogen to steam, nitrogen to nitrogen oxides and sulphur to sulphur oxides. The gases separated in the chromatographic column and measured by the thermal detection method. While, the determination of O composition involves the process of pyrolysis of the sample under 1600 ^{0}C and helium was used as carrier gas at 100 ml/min. The carbon monoxide, nitrogen and hydrogen gases produced are separated in the chromatographic column followed by oxygen quantification by the thermal detection method (Isam Janajreh, 2014).

II. RESULTS AND DISCUSSION

A. *Proximate analysis*

Sample	Shore asp. wood (meranti)			**average value**
	1	2	3	
Moisture Content	15.78%	15.36%	15.26%	**15.47%**
Volatile Matter	86.95%	87.26%	87.11%	**87.10%**
Ash Content	0.3491%	0.3399%	0.3053%	**0.3281%**
Fixed Carbon	12.70%	12.40%	12.58%	**12.56%**

Sample	Empty Fruit Bunch			**average value**
	1	2	3	
Moisture Content	6.82%	7.95%	6.26%	**7.01%**
Volatile Matter	71.49%	75.61%	77.46%	**74.85%**
Ash Content	5.31%	4.39%	3.95%	**4.55%**
Fixed Carbon	23.2%	20%	18.59%	**20.59%**

Table A1 : Experimental result

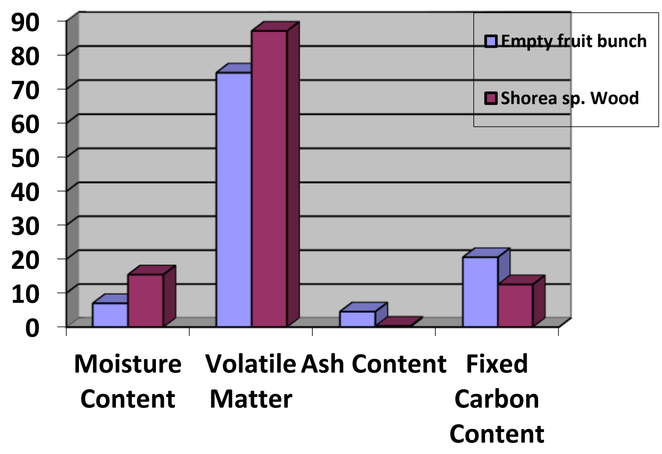

Figure 1 : Experimental Result for Proximate Analysis

Sample	Shore asp. wood (meranti)	
	Literature Value 1	Literature Value 2
Moisture Content	6.2%	7.8%
Volatile Matter	71.6%	78.8%
Ash Content	1.2%	0.11%
Fixed Carbon	22.7%	21.1%

Sample	Empty Fruit Bunch	
	Literature Value 1	Literature Value 2
Moisture Content	4.68%	7.18%
Volatile Matter	76.85%	72.83%
Ash Content	5.19%	3.95%
Fixed Carbon	18.07%	16.04%

Table A2: Literature Value

Based from the tables above, the experimental value of moisture content, volatile matter, ash content and fixed carbon content for the shorea. sp wood is 15.47%, 87.10%, 0.3281% and 12.56%. The experimental value of shorea sp. wood is not close to both literatures value due to several factors, which are the way it been stored, the presence of the bark and the storing duration of the sample before the experiment. While, the experimental value of empty fruit bunch for the moisture content , volatile matter, ash content and fixed carbon is 7.01%, 74.85%, 4.55% and 20.59%.

However, the experimental value of moisture content and volatile matter for shore asp. woods is higher than empty fruit bunch but the percentage of ash content and fixed carbon content for empty fruit bunch is higher than shore asp. wood.

B. *Ultimate analysis*

Sample	Shore asp. wood	Empty Fruit Bunches
	(%)	(%)
C	55.86	47.22
H	6.13	5.37
N	0.33	0.69
O	48.24	46.00
S	0.13	0.04

Table B1 : Experimental result

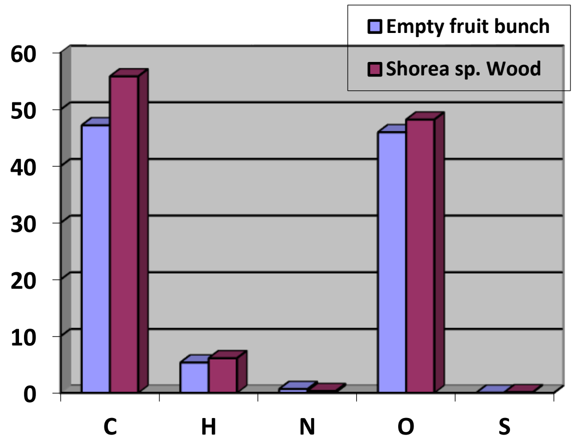

Figure 2 : Experimental Result for Ultimate Analysis (%)

Sample	Shore asp. wood	Empty Fruit Bunches
	(%)	(%)
C	52.3	48.9
H	5	6.3
N	0.17	0.7
O	42.4	38.29
S	0.06	<0.10

Table B2 : Literature Value

Based from the table above the experimental value of the percentage of carbon, hydrogen, nitrogen, oxygen and sulphur for the shore asp. wood are 55.86%, 6.13%, 0.33%, 48.24% and 0.13%. However, the experimental value of the percentage of carbon, hydrogen, nitrogen, oxygen and sulphur for the empty fruit bunch is 47.22%, 5.37%, 0.69%, 46.00% and 0.04%.

According to Leco Corp (2008), carbon and hydrogen determination is part of the ultimate analysis, assisting to characterize the materials and providing details that can be utilized in calculating material and energy balances, efficiencies and emissions potentials for the fuel.

From the figure 2, the shore asp. wood has the higher percentage of carbon and hydrogen than the empty fruit bunch. Thus, the shore asp. wood can also be the alternative fuels as it has great efficiencies and emissions potential for the fuel due to high carbon and hydrogen content.

III. CONCLUSION

From this experiment, the proximate analysis and ultimate analysis for the empty fruit bunch and shorea sp. woods has been obtained. The moisture content is 7.01% and 15.47%, the volatile matter is 74.85% and 87.10%, the ash content is 4.55% and 0.33%, and the fixed carbon content is 20.59% and 12.56%. While, the percentage of C, H, N, O, and S for both empty fruit bunch and shorea sp. wood are 47.22% and 55.86%, 5.37% and 6.13%, 0.69% and 0.33%, 46% and 48.24%, and 0.04% and 0.13%. From the result obtained, it can concluded that, for proximate analysis, the empty fruit bunch has higher ash content and fixed carbon content than shore asp.woods but has lower percentage of moisture content and volatile matter than the shore asp. woods. However, the shore asp. woods has higher carbon, hydrogen and oxygen percentage than empty fruit in the ultimate analysis.

Thus, the objective of this experiment to evaluate proximate (moisture content, volatile matter, ash and fixed carbon) and ultimate (carbon, hydrogen, oxygen, nitrogen and sulphur) characteristic of Empty Fruit Bunch and *shorea sp.* wood has been achieved.

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