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Research Article

PREDICTION OF VALUE OF AGRICULTURAL BIOMASS WASTES BY USING THE :LINEAR REGRESSIONMETHOD WITH MACHINE LEARNING TOOL IN R (RATTLE)

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ABSTRACT

This study was to establish a relationship between the experimental higher heating value which was determined by a bomb calorimeter and the theoretical higher heating value, which was calculated using biomass input values and a machine learning technique and presents the heating value of the selected agricultural biomass materials (soya husk, rice husk, bagasse, cotton stalk, peanut shell, coconut shell, eucalyptus wood, and wood sawdust) experimentally by using the conventional bomb calorimeter and the heating value also predicted based on the input parameters of the selected biomass materials such as elemental analysis and proximate analysis by using the novel machine learning tool R (rattle) and found very close output values of the heating value. This method can provide the authentic values of the output heating values with minimum errors and it can be useful for research work on biomass, biofuels and industrial use for power production. The Higher Heating Values (HHV) of the entire sample set were then predicted from the results of both analyses using a variety of empirical equations that contain linear and nonlinear terms. Finally, compare the actual HHV to the predicted HHV.

Keywords*:* Biomass; Heating value, Linear regression; Regression coefficient; Rattle (R) software

INTRODUCTION

Macromastia, or sometimes known as symptomatic mammary hypertrophy, is a common condition in women. Excessive breast tissue can cause physical problems such as musculoskeletal pain, posture difficulties and erythema intertrigo. Moreover, it can cause psychological distress and negatively impact body image perception and quality of life [1,2].

The mainstay treatment for macromastia is a reduction mammoplasty, which is a highly prevalent aesthetic breast procedure. There are various techniques for reducing mammoplasty, and the type of nipple pedicle employed in breast reconstruction is a matter of debate. There has been considerable development and refinement in the different techniques of reduction mammoplasty, categorized by different pedicle designs and skin pattern reductions [3-8]. One of those commonly used procedures is the Central Mound (CM) mammoplasty, which has proved effective at volume reduction, minimizing scar burden and retaining the neurovascular pedicle and lactational potential.

In 1981, Balch introduced the CM technique as an unconventional approach, but it has come forth as a safe and effective approach consisting of a wide range of advantages. This technique revolves around opting for a highly vascular glandular pedicle directly from the chest wall, with a specific feature that it can be used reliably in re-reductions regardless of the pedicle design in the prior reduction [3,4].

This study has revisited the central mound technique with touch up modifications to maximize the overall outcome. The aim was to analyze and evaluate the postoperative results using this technique in terms of post operative complications and patient's satisfaction.

FORMULATION AND METHODS

Calculation of heating value

The heating value has been calculated by using the bomb calori--meter and instrument discussed below in Figure 1. Heat capacity of the solid biomass sample can be analyzed.

Linear regression method

Regression analysis is a simple statistical technique for the prediction of the output results based on linear inputs. This method is based on one input and one output. In simple linear regression only one regressor X and one output Y. The goal of regression analysis is to determine the values of parameters for a function that causes the function to best fit a set of data observations provided. In linear regression, the function is a linear equation. When there is more than one independent variable, multiple linear regression analysis is used to get the best-fit equation [8].

Linear regression command for heating value

In Rattle software, the command for finding the linear regression is also presented by the below formula:

Call: lm (formula = CV ~., data = crs$dataset [crs$train, c (crs $input, crs$target)]w5

Where,

lm= linear model

Inputs=VM, Ash, C, H, N, O, N and S.

Target value=HV=Heating Value

Agricultural biomass characterization

Agricultural biomass physico-chemical properties have been given below in Table 1, it represents the volatile matter is higher in woody biomass (eucalyptus, wood sawdust, cotton stalk, bagasse, soya husk and coconut shell) as compared to agricultural wastes due to the holo-cellulosic contents and ash content is lower in a coconut shell, wood sawdust and eucalyptus wood, the presence of ash content represents the alkali metals. Alkali metals decreased the heating values in the biomass materials. Carbon and hydrogen content are found higher in woody wastes (eucalyptus wood and wood sawdust). The presence of hydro-carbon content can have increased the heating value.

the Physico-chemical characterization of biomass materials (proximate and ultimate analysis) and heating value estimated by using these parameters. The maximum heating value analyzed in the wood sawdust and eucalyptus wood, 20.32 MJ/ kg and 22.14 MJ/kg due to high volatile matter, carbon and hydrogen contents and low ash content but other agricultural biomass wastes represented the low carbon and hydrogen content. Woody biomass also represented less oxygen content. According to the analysis it was found that the woody wastes and coconut shell has high thermal stability as compared to the agricultural waste, so woody wastes can be used for higher energy production such as pyrolysis and gasification. The high ash content can be decreased the calorific value due to the presence of alkali metals (Na, K).

Recently, the deforestation rate has been increased because the rapid urbanization by the increasing population and all of these causes air pollution and environmental problems and it is also affecting the health of human beings. In the North India region, in the states Punjab, Haryana and Delhi also faced problems during the open burning of the rice straw ("Parali"), it increased the aerosols and carbons level in the environment. All of these problems can be removed by using the biomass wastes for clean energy production by using different renewable techniques such as pyrolysis, gasification, combustion and liquefaction. Biomass briquette can be provided promising solutions for the safety of the environment and clean energy production by using waste materials because all of these resources have a good heating value and can be used as solid fuel for clean energy production. The current study also provides the solution to use the simple regression technique for the determination of the heating value by using the different characteristic properties of the biomass wastes.

Determination of calorific value

Calorific value of biomass was analyzed using automatic bomb calorimeter (Toshniwal make) which follows ASTM E870-82 (2006) (E711) test method.

Figure 1: Bomb calorimeter.

Figure 1 presents the automatic bomb calorimeter for the determination of the heating value of the biomass samples, before using the sample, it first calibrated by using the benzoic acid and determined heating value of the benzoic acid, it has been used for the reference value with including heating values of cotton thread and nichrome fuse wire, for the determination of the heating value, first sample crushed and converted in the powder form and first weighted 1 g sample and prepared pellet by using the pelletizer machine and bind by using the cotton thread with nichrome fuse wire. Sample combusted in the presence of the O2, it used around 25 atmospheric pressure. Sample fired by the B.C. firing unit and bomb is dipped into the water jacket. When the sample is burned it and released heat and it raise the temperature of the water. Increasing temperature measured by using the automatic software in the attached computer.

Prediction of the higher heating value of biomass wastes by using linear regression with R (rattle)

R rattle interface has been attached below, this software is working without coding and accuracy percentage of the output results based on the independent inputs. The accuracy and response time of the software has been found satisfactory during the analysis. Figure 2 is demonstrated the Rattle software. The software can open by using the R software with writing the commands "library (rattle)"+Enter and "rattle"+Enter. These commands can open the rattle software, and then after files can be executed through simple commands and the model can be deployed through the selection of the output result as target and independent variable as input. Linear regression is a supervised learning method but the accuracy of the output result was very close to the experimental result.

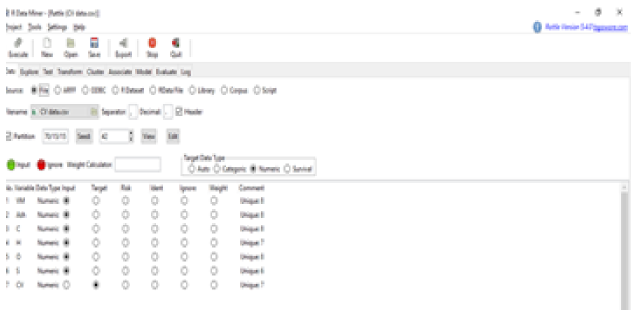

Figure 2: Demo of rattle machine learning tool.

Prediction of the heating value determined by using the input parameters proximate analysis (volatile matter, ash content), ultimate analysis (C, H, N, O and S). Linear regression analysis is a very popular method and earlier some researchers already used this technique by using the different statistical software for the determination of the heating value of the biomass but the current study presents a novel method for the analysis of the heating value by using the rattle software, earlier this tool did not use by any researchers on the basis of the literature survey. Efforts were also made to analyze the comparative analysis for finding the heating value by using linear regression by using the R(Rattle) and Microsoft excel and it was analyzed that regression coefficient was found by using R (Rattle) R2=1 and by using the excel, determined R2= 0.99.

Result and Discussions

Prediction result by using R (Rattle): Table 1 presents the weka repressor values and experimental and predicted heating value and both are very close because regression coefficient was found 1 and predicted results can be written by following mathematical equation:

Heating value = Intercept + VM* 0.04164 + Ash * (-0.24097) + C * (0.27700) + H*(0.85451) + O * (0)+ S* (0) (5)

Table 1: Test analysis of heating value.

S.No.	Regressor coefficients	Values	Experimental	Predicted heating value	Predicted heating value by Microsoft excel (MJ/Kg)
	By R(Rattle)		heating value (MJ/Kg)	By R(Rattle) (MJ/Kg)	
1	Intercept	-3.56612	15.35	15.35	14.62
2	VM	0.04164	11.59	11.59	12.93
3	Ash	-0.24097	13.82	13.82	14.46
4	C	0.277	19.39	19.39	19.34
5	H	0.85451	13.82	13.82	13.37
6	O	NiL	17.81	17.81	15.87
7	S	NIL	22.14	22.14	22.56
8	R^2 (regression coefficient)	1	20.32	20.32	20.89
9	Residual error	0	-	-	-
10	Time taken	0.02 seconds	-	-	-

Table 2, presents the Anova analysis of linear regression by using the R (Rattle) software. DF value found 1 and residual value found zero and sum of square error and mean square error have been analyzed were close.

Multiple linear equations can be written for the calculation of heating value such as:

Where, value of the intercept is zero.

Some researchers also reported the prediction of heating value by using the linear regression method these methods and techniques (Table 3).

Heating value = Intercept + VM* 0.17 + Ash * (0.62) + C * (0.28) + H*(-1.92) + O * (-0.04) + S* (-2.12) (6)

Table 2: Anova analysis by R (Rattle)

S.No.	Contents	DF Values	Sum of square	Mean of square
1	VM	1	15.2194	15.2194
2	ASH	1	6.6354	6.6354
3	C	1	2.3472	2.3472
4	H	1	0.233	0.233
5	Residual	0	0	0

Table 3: Anova analysis for multiple linear regression by Microsoft excel.

S.No.	Contents	DF Values	Sum of square (SS)	Mean of square(MS)	F	Significance F
1	**Regression**	**6**	**2340.97**	**390.16**	**108.2**	**0.07**
2	**Residual**	**2**	**7.21**	**3.6**	**NIL**	**NIL**
3	**Regression coefficient**	**0.99**				

CONCLUSION

Agricultural biomass is a solid waste and has a high potential to generate energy by using different techniques like thermo-chemical conversion method (pyrolysis, gasification, combustion and liquefaction) and biochemical method. Biomass provides energy during the combustion due to the emission of thermal radiations because it has a heating value of either LHV (Lower Heating Value) or HHV (Higher Heating Value). In this study statistical models were used for the prediction of heating value by using the linear regression with R rattle and multiple linear regression by using Microsoft excel based on proximate analysis (volatile matter, ash content) with ultimate analysis (C, H, N, O and S) of the biomass and carried out very close predicted values of the heating values of the biomass fuels, after the comparative study it was observed that R (Rattle) is very efficient and accurate machine learning method, it's response time is very less 0.02 Second and R2 value found 1 and by excel R2 found 0.99

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