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CONTENTS

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An Intelligent of ANN Towards Agarwood Oil Compounds Pre-processing Based on Stepwise Regression Method to Improve the Oil Quality

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***Abstract*— This paper presents the performance of Artificial Neural Network (ANN) application towards the agarwood oil quality classification. The works involved the selected of agarwood oil compounds based on a feature selection technique. The compounds are selected based on using Stepwise Regression technique. The compounds identified by stepwise regression are β-agarofuran, ϒ-Eudesmol, Longifolol, and Eudesmol. These compounds are fed into ANN as input feature and the output is the quality of the oil either high and low. Three classifier algorithms; Scaled Conjugate Gradient (SCG), Levenberg Marquardt (LM) and Resilient Backpropagation (RBP) and ten hidden neurons in the hidden layer are implemented. The performance of ANN is measured using confusion matrix, mean square error (mse) value and number of epoch. The finding showed that the ANN using four compounds of agarwood oil as input features obtained good performance with a good accuracy, lower mse value and lower number of epoch in one hidden neuron.**

***Keywords*— Stepwise Regression, ANN, SCG, LM, RBP, mse, epochs**

I. INTRODUCTION

Agarwood oil is known as the most precious essential oil in the world. It comes from the plant family Thymelaeaceae [1]. Agarwood produce an aromatic resin which formed based on the immune response to fungal infection [2], [3]. Every part of the agarwood trees have its own uses especially the agarwood stem can produce essential oil [4]. Other application of agarwood oil is to be use in perfume, medication purposes and ceremonies [5].

Agarwood oil is grading according to its quality either high and low. The high quality agarwood oil has a long lasting odor as well as pricey while the low quality has a cheap price [1]. Manually, the grading of agarwood oil based on human's sensory panel but this technique is inefficient and time consuming [6]. Recent years, the grading is invented using modern techniques using chemical properties of agarwood oil. The techniques such as Multilayer Perceptron, Support Vector Machine, k Nearest Neighbor (k-NN) and others have been implemented [4], [7], [8]. These techniques can enhance the accuracy of the grading which has been proven by the previous researcher [9].

This research proposed two techniques which are Stepwise Regression and Artificial Neural Network (ANN) for grading agarwood oil. The part A is stepwise regression technique is used as feature selection to select significant compounds of agarwood oil before fed into the ANN for future classification. The three training algorithms; SCG, LM and RBP is used as classifier to classify the significant compounds selected by stepwise regression into high and low quality. Finally, the model need to go through process of performance checked to be accepted.

II. OBJECTIVES

This work is carried out according to the following objectives:

- To employ Stepwise Regression technique in investigating the relationship between input and output of agarwood essential oil compounds.
- To develop ANN models for agarwood essential oil quality grades classification and investigate the comparative performances of three selected training algorithms; Resilient Backpropagation (RBP), Scaled Conjugate Gradient (SCG), and Levenberg Marquardt (LM) for agarwood essential oil quality classification.
- To evaluate the overall performance of the proposed techniques in (i) and (ii) as a viable and new technique for agarwood essential oil quality grading

III. METHODS

The methodology of the proposed project is including two continuous methods. For part A as in Fig. 1, the experiment starts with the selection process of agarwood oil compounds by stepwise regression technique. It consists forward selection and backward elimination process. The selection process follows the analysis of p-value. In order to accept the significant compounds, it must have p-value less than 0.05 as recommended by [10]. After the significant compounds have been selected to the model, the experimental continued by ANN technique for the part B.

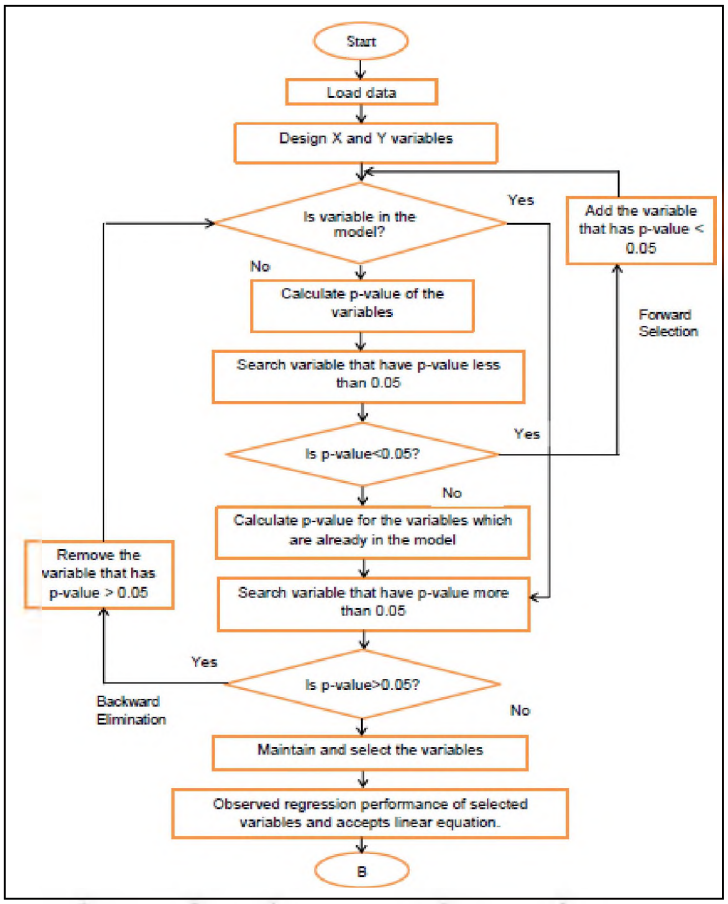

Fig. 1. Detail experiment for Stepwise Regression method

The Fig. 2 showed the part B methodology, which is the classification of agarwood oil compounds from the stepwise regression into high and low quality. The data is normalized, randomized and divided into training (70%), validation (15%) and testing (15%) dataset. The hidden nodes and training algorithms are varied; 10 hidden neurons and three training algorithms which are Scaled Conjugate Gradient (SCG), Levenberg Marquardt (LM) and Resilient Backpropagation (RBP), respectively.

The model is passed based on their performance on the confusion matrix, accuracy, sensitivity, specificity, precision, epochs and mse value.

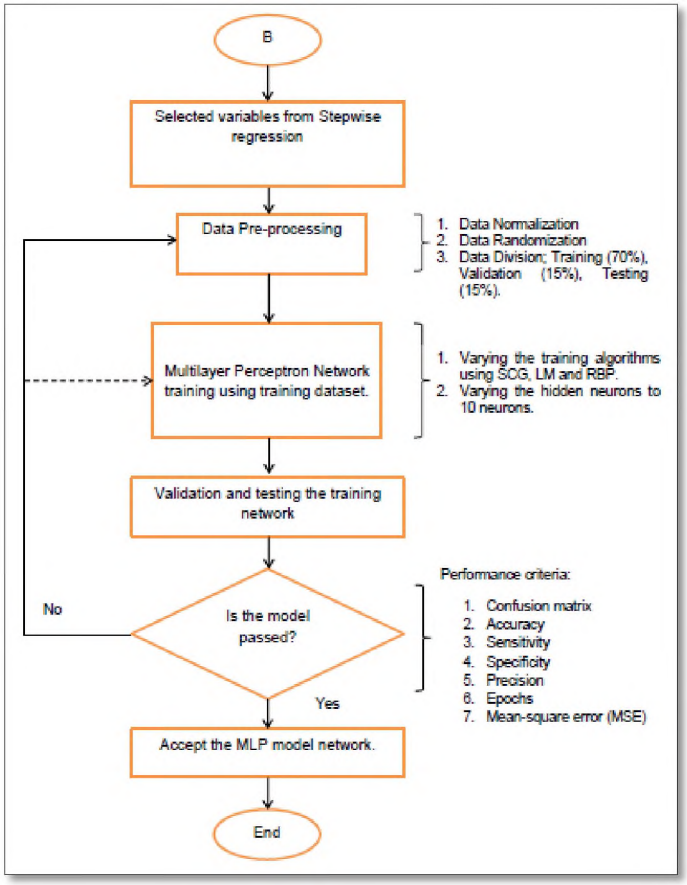

Fig. 2. Detail experiment for ANN method

IV. RESULTS AND FINDINGS

Table 1 show the results finding for output of stepwise regression and Table 2 show the results of Final Design Parameter of ANN. The final linear equation of stepwise regression:

$$Y \sim 1 + X_1 + X_4 + X_5 + X_7$$

$$Y = 1.7337 + 0.031742X_1 + 0.021556X_4 + 0.10766X_5 - 0.25592X_7$$

Table 1. Output of stepwise regression

Independent Variables	Compounds	Estimate Value	Standard Error	t-statistics	P-value
Intercept	[redacted]	1.7337	0.048005	36.115	9.7577×10^{-56}
X1	β-agarofuran,	0.031742	0.012569	2.5255	0.013285
X4	ϒ-Eudesmol	0.021556	0.0049152	4.3857	3.1006×10^{-5}
X5	Longifolol,	0.10766	0.020186	5.3331	6.9926×10^{-7}
X7	Eudesmol	-0.25592	0.032819	-7.7981	$1.0008 \times 10^{+11}$

Table 2. Output of stepwise regression

Training algorithms	Hidden Neurons	Training	Validation	Testing	MSE	Epoch
Scale Conjugate Gradient (SCG)	1	92.6	100.0	100.0	0.0446	32
*Levenberg Marquardt (LM)	1	92.6	100.0	100.0	0.0384	12
Resilient Back-propagation (RBP)	1	86.8	100.0	100.0	0.0468	36

V. CONCLUSIONS

From the research study, the project is able to differentiate between high and low quality of agarwood essential oil based on the pre-processing of the stepwise regression technique. In this project, stepwise regression used to identify the significant compounds that give the major contribution to agarwood essential oil quality. The compounds identified by the stepwise regression are C1=β-agarofuran, C4=ϒ-Eudesmol, C5=Longifolol and C7=Eudesmol. Then, the modelling is continued using three ANN algorithms which are Resilient Back-Propagation (RBP), Levenberg Marquardt (LM) and Scaled Conjugate Gradient (SCG). Among them, LM algorithm is chosen as the best algorithm as the result of classifying the quality of agarwood essential oil obtained best accuracy, the fastest time during training the model by the epoch result and lowest mse value among others.

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