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Utilization of Artificial Neural Network (ANN) To Predict Fat Passion Fruit Seed Content (*Passiflora ligularis*) Based On NIR-S Value

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Abstract. The research was conducted in July-October 2018 at the Laboratory of Food Processing Techniques for Agriculture, Center Instrumentation and AMGIS Laboratory of Agricultural Engineering, Andalas University, Padang. Using the experimental method between wavelength data and fat chemical data of passion fruit seeds. PC utilization as a grouping of data and input data on Artificial Neural Networks (ANN). ANN uses the matlab R2015a application with the TRAINLM training method, Dividerand as a grouping of data and performance based on Mean Squared Error (MSE). Random use of data for set train, set test and set validation. The data set is 70% of the total data, 15% of the other data is used for the set test model, the rest is used for testing the model through a set of validations of 15% of the total sample. The number of samples used was 180 samples. The best value from PC treatment is PC 6 in both original data and SNV. The best value of neuron treatment is on 5 PC 6 neurons in both original data and SNV. The correlation value resulting from the estimation model of passion fruit seed content is 0.85958 with a very strong level of relationship between predictive fat content and laboratory fat content. The best value for validation of MSE on PC 6 neurons 5 with SNV data is 0.95881. **Keywords:** artificial neural network (ANN); fat content; passion fruit seeds; spectrum NIR

1. Introduction

Passion fruit is a horticultural plant that lives by propagating. Sweet passion fruit producing centers in Indonesia, namely West Sumatra, especially in Solok Regency. [1] stated that sweet passion fruit is grouped into three types, namely super solinda sweet passion fruit, gumanti and local sweet passion fruit. Sweet passion fruit production in Indonesia is 77190 tons in 2017 [2] Based on the study of Solok [3] passion fruit production was 92983.7 tons, with the largest production centers in the Valley Gumanti District as many as 87449.7 tons and the smallest production in Pantai Cermin District.

Passion fruit is not only consumed fresh but is also often used as a processed product in the form of syrup, pudding or flavorings. Passion fruit passion generally causes waste. According to [4] the seed waste and passion fruit skin ranges from 65-70%. The high waste generated results in a buildup of waste, therefore it is necessary to process waste. Passion fruit skin waste treatment has been carried out to avoid the accumulation of passion fruit skin waste which is used for complete pellet feed mixtures conducted by [5] besides that passion fruit skin can be processed as alternative energy.

The chemical content of passion fruit seeds can be used as raw material for making various processed products. The chemical content of passion fruit seeds which is very possible to be processed products is one of the fat content. According to [6]) there are 30.39% fat content in passion fruit seeds, another opinion about the fat content of passion fruit seeds according to [7] where there are 23.8%. This high fat content in passion fruit seeds can be used as raw material for medicines, oil extraction and so on. [6]) state that the fat characteristics of passion fruit seeds are similar to other vegetable fats with high antioxidant activity, thus the fat of passion fruit seeds can be used as raw material for food products, detergents, cosmetics, vitamin supplements and biodiesel.

The fat content in general can be known through the chemical test phase of passion fruit seeds. Chemical tests take a long time, other chemical compounds and damage the material and cause the rest of the analysis process in the form of waste and pollution. Another way to observe the fat content of passion fruit seeds can use Near Infrarad Spectroscopy. Near Infrarad Spectrocopy Method is easy to do, does not damage materials, does not cause pollution or waste. The use of Near Infrared Spectroscopy method is supported by quantification analysis using chemometrics in the form of PLS, PCR, Multiple Linear Regression (MRL) and Artificial Neural Networks (ANN), this was stated by [4]. Artificial Neural Networks (ANN) have the advantage of analyzing non-linear data while other methods for linear data analysis. Estimating the fat content using ANN is expected to represent chemical analysis data.

Research on analyzing using ANN has been widely carried out including Estimation of Fish Flour Composition [9] Chemical Composition of Corn[10], Prediction of Quality of White Crystal Sugar [11] Estimation of Violence and Total Dissolved Solids [12] The development of ANN is not only used for estimating the content but also used as a prediction of various needs as done by [13], [14] and [15] The purpose of this study is to develop a measurement method with NIR-S to determine the fat content using Artificial Neural Networks (ANN) in passion fruit seeds.
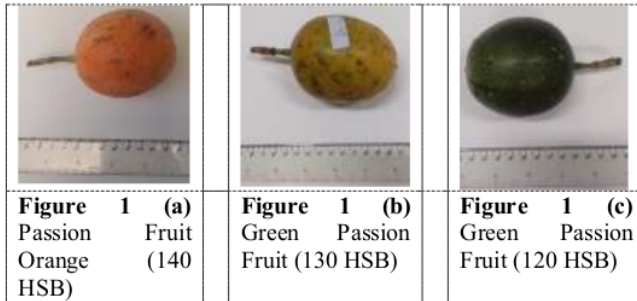
2. Method

2.1 Time and Place
The research was conducted in July 2018- February 2019 at the Laboratory of Food Processing Techniques for Agriculture, Center Instrumentation and AMGIS Laboratory of Agricultural Engineering, Andalas University, Padang.

2.2 Materials and Tools
The material in this study is sweet passion fruit (Passiflora ligularis) in Green (120 HSB), Green Orange (130 HSB) and Orange (140 HSB). Sweet Passion Fruit (Passiflora ligularis) is harvested in the Aie Sonsang area, Nagari Aie Dingin, Lembah Gumanti District, Solok Regency, West Sumatra. Other materials in the form of Aquades, Water, Plastic Clips, Work Sheets, Lebel Paper, Filter Paper, Diethyl (petroleum ether) and Tissue solvents. The tools used in this study were bucket, sieve, handkerchief, KERN PLI 360-3 NM digital scale serial No. WL 122169, Buchi NIRflex N-500 Solids spectrophotometer, petri dish, laptop set, Vivo Y53 camera, Soxhlet, condenser, fat pumpkin.

2.3 Material Preraration Process
Passion fruit harvested based on age after flowering was observed based on fruit skin color to determine the level of fruit maturity, the fruit maturity level used was three levels of maturity namely green (120 HSB), orange green (130 HSB) and orange (140HSB). The process of separating passion fruit pulp from passion fruit seeds. The process of drying seeds to avoid fungal growth in passion fruit seeds. Passion fruit is used as seen in Figure 1.

Figure 1 (a) Passion Fruit Orange (140 HSB)	**Figure 1 (b)** Green Passion Fruit (130 HSB)	**Figure 1 (c)** Green Passion Fruit (120 HSB)

Note: HSB = (Day After Flowering)

2.4 Measurement of the passion fruit seeds spectrum

Collecting data spectrum by measuring sample reflectance uses intervals on 4 cm-1 data on a scale that ranges from 10000-4000 cm-1 or 1000-2500 nm which produces 1501 variables. The spectrum results obtained in each sample are averaged to build a model with calibration data and then the data is stored as reflectance (R) value. Reflectant spectra data obtained from NIR-S as much as the samples were processed original and pre-treatment of SNV treatments. The original spectra of spectra and the pre-treatments obtained were extracted in the form of PCA. PCA used in this analysis is processed using IBM SPSS 19 so that PCA data is obtained as ANN input. PCA used is PC 6 and PC 9 as PC treatment.

2.5 Chemical analysis

Development of models with Artificial Neural Network (ANN) methods must use laboratory analysis. Chemical analysis of fat is used as reference data in the form of actual fat content data. According to [16] fat content can be measured in the Laboratory using extraction methods using Soxhlet. This method is the easiest method for measuring fat content. The fat content can be obtained after the measurement so that the buffer is cured using the following equation.

$$L = {BL}/{BS} \times 100\% \qquad (1)$$

Information:
L   = percentage of fat content (%)
BL   = fat weight (grams)
BS   = sample weight (gram)

2.6 Artificial Neural Networks (ANN)

The structure and architecture of artificial networks in general can be seen in the study of [9]. The Artificial Neural Network used in this study is the backpropagation network and trained using a network of backpropagation algorithms. Hidden layer used as many as one hidden layer with three neuron treatments. The treatment of neurons used is 3, 4, and 5 neurons in each PC treatment.

Analysis of Artificial Neural Networks uses a sample of 180 samples where 70% of the sample is set train data, 15% is a data set test and another 15% is a data set validation. Samples used 126 for train 27 tests and 27 validations. Construction of ANN model using Matlab R2015a. The matlab application selects randomly the data used for set train, test and validation using dividerand, the training used is Levenberg-Marquradt (Trainlm), looking at the quality of the model based on Mean Squared Error (MSE). The results obtained in the form of regression values, training state and performance.

3. Resullts and Discussion

3.1 Sample Spectrum and Chemical Analysis

The sample spectrum is obtained by scanning samples using NIR-S which has a wavelength of 4000-10000 cm^{-1} or 2500-1000 nm. Data obtained from NIR-S is reflected data from passion fruit seeds in the form of reflectance data. The reflectance data produced in each sample is 1501 wave variables with wave intervals of 4 cm^{-1}. So that the wave is obtained as shown in Figure 2.
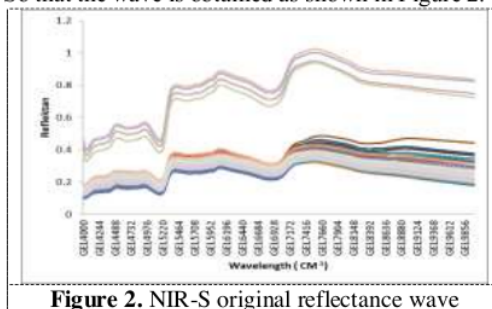

Figure 2. NIR-S original reflectance wave

The picture above explains that the wave valley has a chemical content detected. The pre treatmean treatment used aims to avoid the noise that is too high. This can be seen in Figure 3. Explaining that the SNV pre-treatment makes the wave in the same position, this reduces the impact of the nois. Figure 2 and Figure 3 show the difference between the two original wave data and after standardization (SNV) wave changes are seen. The original wave value is more diverse than the wave value in the SNV treatment. Data waves after SNV are gathered in one data stack so that data grouping is easier.
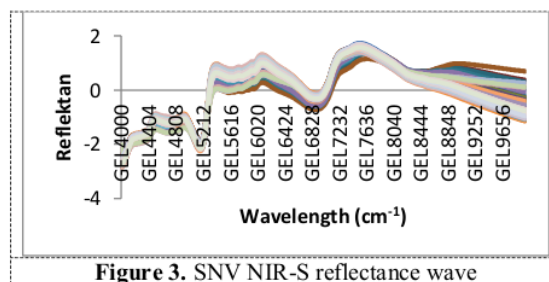

Figure 3. SNV NIR-S reflectance wave

The fat content of sweet passion fruit seeds harvested at three levels of maturity based on skin color after flower bloom ranges from 13% - 24%. The average fat content of the 180 samples used was 19.711%. The maximum value of fat content obtained from laboratory tests is 23,866%. The highest fat content is found at the orange maturity level (140 HSB). The minimum value of fat content obtained is 13,396%. The lowest fat from laboratory tests is at the green maturity level (120 HSB). The chemical content obtained is in accordance with the reference according to [7] that the passion fruit fat content is 23.8%.

3.2 Artificial Neural Networks (ANN)

Artificial neural networks are used to construct non-linear models. The artificial neural network used in this study is a back propagation network with alternating model flow. Data input used in this study is reflectance data from NIR-S waves. Reflective data is used with two treatments of original data and pre-treatment data using SNV. Both of these data are made in the form of PCA which is used as input to ANN exercises. The PC treatment in this study is PCA 6 and PCA 9. The formation of PCA uses the IBM SPSS 19 application. How to make PC A by entering the wave transpose results on the IBM SPSS 19 then selecting analyze is then copied by the factor and determining the desired PC.

4

The data target in ANN training is chemical data from fat. ANN training uses matlab R2015a. The matlab R2015a application uses a non-tool tool that simplifies work from ANN. The network formation on ANN uses the Feed-Forward backprop type with the training function in the form of Levenberg-Marquardt (Trainlm) and performance of Mean Squared Error (MSE). The following training parameters are used:

ShowWindow   : true
Show Cammand Line   : False
Show   : 25
Epochs   : 1000
Time   : Inf
Goal   : 0
Min-grad   : 1e-07
Max_fail   : 6
Mu   : 0.001
Mu_dec   : 0.1
Mu_inc   : 10
Mu_max   : 10000000000

Artificial neural networks have three main layers, namely the input layer, hidden layer and output layer. Hidden Lapisa in this study uses 3 treatments, namely based on the neurons in the hidden. The number of neurons used is 3, 4, and 5 neourons. So that results are obtained as found in Table 1.

Tabel 1. Data on Artificial Neural Network Processing Results

Pre Treatment	Treatment		R Trains	R Tests	R Validations	R All	Best Validation MSE	Gradient
	PC	Neuron						
Original	6	3	0.80223	0.82661	0.84968	0.8122	1.1678	0.001038
		4	0.86642	0.80427	0.83254	0.8514	1.0886	0.005803
		5	0.85988	0.8571	0.82529	0.85537	1.083	0.033646
	9	3	0.81432	0.86026	0.83828	0.8252	0.95613	0.41365
		4	0.84973	0.84077	0.85246	0.8453	1.3933	0.25489
		5	0.83997	0.85742	0.87978	0.84302	0.90951	0.046126
SNV	6	3	0.78942	0.84845	0.85953	0.80517	1.3647	0.1812
		4	0.81177	0.87034	0.91015	0.83398	0.7467	0.60467
		5	0.86488	0.84735	0.83422	0.85958	0.95881	0.078872
	9	3	0.84232	0.77045	0.75841	0.81749	1.4389	0.041599
		4	0.82341	0.86005	0.86856	0.83663	1.2797	0.33918
		5	0.86382	0.79473	0.81772	0.84897	1.5344	0.01468

The table above explains that the r All value on the original data generated on PC 6 is higher than that on PC 9 seen in Neuron 4 and 5, whereas in Neuron 3 there is an increase in the value of R on PC 9. This proves that PC 6 is better at detection. fat content compared to PC 9 for neurons 4 and 5. The highest r all the second data PC treatment with 3 neuron treatments in neouron 5 PC 6 amounted to 0.85537, with the output equation = 0.75 * target + 4.9. This r value explains the relationship between the chemical value of fat and predictive value of ANN has a very strong relationship based on [17] the correlation values as follows: 1) 0.00-0.19 with a very low level of relationship, 2) 0.20-0.39 low relationship level, 3) 0.40-0.59 medium level, 4) 0.60-0.79 strong relationship levels and 5) 0.80-1.00 has a very strong relationship. Gradient

The r value on standardized data (SNV) at Neuron 3 and 4 on PC 9 experienced an increase from PC 6, but experienced a decrease in neurons 5. The highest value of the correlation coefficient was

found on PC 6 with the number of neurons 5 with a value of 0.85958 or 85.958% , with the output equation = 0.76 * Target + 4.6. The acquisition value of PC 6 has a very strong level of relationship. The highest r value in the original data and SNV is on PC 6 with the number of neurons 5 where the values are respectively 0.85537 and 0.85958. of the two values above, it is explained that the pre-treatment of SNV can improve wave performance in detecting the fat content found in passion fruit seeds. Judging from the best value of validation, the MSE obtained MSE after pre-treatment was also decreased. The MSE value of the original data with PC 6 neuron 5 is 1,083 while the SNV value is 0.95881. Research using this method has been carried out. One of them is [18] conducting research using artificial neural networks as pendektesi and electricity production planning in this study. Another study conducted by [14] uses Artificial Neural Network to design an electric power optimization scenario with the acquisition of a correlation coefficient value of 0.87607 which produces an output equation = 0.8 * target +570.

4. Conclusion
The estimation model of the passion fruit fat content using Artificial Neural Networks (ANN) using two data in the form of original data and pre-treatment data obtained different results. The best value from PC treatment is PC 6 in both original data and SNV. The best value of neuron treatment is on 5 PC 6 neurons in both original data and SNV. Increased correlation results were seen after the data used was carried out by pre SNV treatment. The correlation value resulting from the estimation model of passion fruit seed content is 0.85958 with a very strong level of relationship between predictive fat content and laboratory fat content. The best value for validation of MSE on PC 6 neurons 5 with SNV data is 0.95881.

Acknowledgements

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