Validation of the Effectiveness of Near-Infrared Spectroscopy for Detecting Impurities in Milk Powder using ANN and SVM

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Abstract. Nowadays, there are so many productions on the market that based on dairy product that include milk powder. The milk powder has different categories which is for children, adult and others. The milk powder involves the local product until the import product. The transparency of the content in the milk powder cannot be identified easily and can cause food poisoning to be happened. Hence, with the use of near-infrared spectroscopy, NIRS it can be use easily to detect the content in the food simply. There are many methods in NIRS which is reflectance and absorbance. This method being uses to detect which milk powder is adulterated. Ocean Optic XR-1 ES, USA device and Ocean View software have been used in this project to take data from the sample. The device use wavelength between 200nm-1025nm. The milk powder obtained from the supermarket and nearby stores. Data that have been taken then transferred into suitable table and will go through two different analysis method which is SVM and ANN. The reflection method is not suitable to detect the adulterated milk powder. From the result ANN shows the higher accuracy to classify the pure and Adulterant milk powder.
1 Introduction

There are so many varieties of dairy product that have been produced that include the production of milk powder. Usually milk is produces from cow’s milk other than that maybe came for other mammal such as sheep, goat and others. Milk are rich in protein and calcium that good for all generation like infant, children, adult and also elderly. Hence, many people consume and purchasing milk in their daily live to get enough protein and calcium. Food fraud become famous nowadays without they concerned about the health of the user. Although this scandal has been a problem of the integrity of the food chain, there are cases of food fraud that pose safety problem where consumer may become ill or die [1]. For instances like, China milk powder scandal melamine adulteration that affected 300,000 children with six deaths was reported [1]. The food adulterant can be found physically or can be found after the test [2]. NIR is usually the first choices for quality control of solid and powder due to numerous advantages, including skim milk powder (SMP) and non-fat dry milk (NFDM) [3]. There are three main measurement mode in NIRS which is reflectance, transmittance and absorbance. Basically, for this research two measurement will be used which is reflectance and absorbance. This project is likely to study and analyses the whether the milk powder contain adulteration or not and to know type substance contain in the milk powder. By using the NIR method, the food that contain adulteration can be analyses by using two difference measuring modes which is reflectance and absorbance. NIR can essentially do more about material, intermediate and final product compositional, functional and sensory analysis. Basically, near-infrared is more likely to result in light absorption, emission, reflection and diffuse reflection in the 800nm-2500nm range [4]. In other words, this project is more about researching and evaluating the efficiency of the NIR system for detecting and predicting adulteration. The advantages using NIR method is that it can save more time, real time analysis and chemical free. SVM are a group of similar supervised methods for training used for classification and regression [5]. SVM is also a software algorithm that can quickly detect fraud for instance to allocate labels to objects [6]. Artificial neural network or ANN comprises of handling units called neurons, its attempts to reproduce the structure and conduct of the common neuron. The neuron has a capacity that decides the enactment of the neuron [7]. ANNs are currently generally perceived as ground-breaking displaying instruments and most significant sellers have remembered them for their information mining programming [8]. The ANNs model is a learning cycle that consists of three separated phases for example training, validation and training [9].

2 Material and method

2.1 Sample Preparation

The milk powder is a full cream milk powder obtained from the supermarket and store nearby. The milk powder will separate into two categories which is food contain adulteration and food not contain adulteration. The specimen in powder structure was independently filled in a glass test vial [10].

2.2 Near Infra-Red Spectroscopy (NIRS)

The device used for this project to determine the adulteration of milk powder is Ocean Optic XR-1 ES-USA. The device has a wavelength of 200nm-1025nm. Before starting take the data NIRS device need to be setup. After can start taking data by also using OceanView software. Data need to be taken five times. The detection mode use in this project is the reflectance and absorbance method.
3 Result and discussion

3.1 Reflectance Method

The analysis is completed to decide the adulterated milk powder in a room with insignificant light source. The pure milk powder is being put inside the glass vial, and the reading for the pure milk powder must be taken for five times.

3.1.1 Pure Milk powder

![Graph of pure milk powder using reflectance method.](image1)

Based on the Fig 1 show the graph of the pure milk powder using reflectance method. For this project the wavelength will be use is between 400nm-1000nm, other than that will be known as a noise. The reading for reflectance 1, reflectance 2, reflectance 3, reflectance 4 and reflectance 5 is approximately the same and does not have any differences.

3.1.2 Adulterant Milk Powder

![Graph of the Adulterant milk powder using reflectance method](image2)

Fig 2 show the graph of the Adulterant milk powder using reflectance method. Based on the graph the reflectance rate is the lowest. The wavelength is within 400nm-1000nm will be used. The data gathered other than the range will be set as a noise. The data gathered for reflectance 1 until reflectance 5 does not have many differences.
3.2 **Absorbance method**

The analysis is taken same as the reflectance method, the sample of the pure milk powder for the reflectance method being used again for the absorbance method. The data also must be taken for five times.

3.2.1 **Pure Milk Powder**

![Graph of pure milk powder using absorbance method.](image1)

**Figure 3.** Graph of pure milk powder using absorbance method.

The wavelength that can be taken for this project is between 400nm-1000nm, other data that being gathered is consider as a noise. Based on the Fig 3 of the initial reading for the pure milk powder the absorbance rate for this is higher. Other than that, the data pattern for absorbance 1 until absorbance 5 does not show any differences.

3.2.2 **Adulterant Milk Powder**

![Graph of the Adulterant milk powder using absorbance method.](image2)

**Figure 4.** Graph of the Adulterant milk powder using absorbance method.

Based on the graph of the Adulterant milk powder in the Fig 4 there are not have many differences for the data absorbance 1, absorbance 2, absorbance 3, absorbance 4 and absorbance 5. Moreover, the absorbance rate for this experiment is high. The wavelength use is same as before which is 400nm-1000nm, other than that consider as a noise.
3.3 Statistical Analysis

The statistical analysis is carried out by these two methods which is SVM and ANN. Therefore, based on the previous observation, reflectance method is not suitable to detect the adulterated milk powder because it’s not given stable result. For this statistical analysis only absorbance method will be analyses using SVM and ANN.

3.3.1 Comparison of SVM and ANN

| Table 1. SVM and ANN |
|----------------------|
| Method      | Pure Milk Powder | Adulterant Milk Powder |
| SVM         | 91%              | 71%                   |
| ANN         | 95%              | 86%                   |

Based on the table 1 there are different accuracy for SVM and ANN value of the pure milk powder and Adulterant milk powder. First of all, for pure milk powder the accuracy of for SVM are 91% and ANN are 95%. Secondly, the accuracy for Adulterant milk powder for SVM is 71% and ANN is 86%. This result show that by using ANN, the accuracy is more higher to classify the Pure and Adulterant milk powder

4. Conclusion

Near infrared or NIR is the best method to detect adulterant and non-adulterant milk powder, it is because of its advantages that can save time, environment friendly, easy to setup, allowed multiple constituents to be analyses simultaneously and also real time. The choice of the wavelength is the most significant which is between 400nm-1000nm. Other than that, absorbance method is suitable to detect the adulterant of the milk powder than the reflectance method. The cause of this happen is because reflectance gives the unstable result that resulting it is not suitable to detect the adulterant of milk powder. Furthermore, ANN and SVM function well with the absorbance that resulted to obtain the accuracy value. Besides, when comparing both SVM and ANN, ANN show that it can be used to detect the adulterated milk powder and non-adulterated milk powder for higher accuracy. Finally, in the future the research must undergo with more sample that uses variety techniques of detection and analysis to detect the adulteration of milk powder.

5. References

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