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"Improving Food Security : The Challenges for Enhancing Resilience to Climate Change"

Volume I

The University of Lampung

Indonesian SEARCA Fellow Association

Southeast Asian Regional Center for Graduate Study and Research in Agriculture

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USR INTERNATIONAL SEMINAR ON FOOD SECURITY

Improving Food Security : The Challenges for Enhancing Resilience to Climate Change

Emersia Hotel and Resort, Bandar Lampung, Lampung, Indonesia

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Preface
COMMITTEE CHAIR

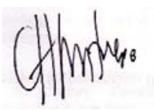
Recently, there are many discussions about food security as a complex issue of sustainable development. One of important topics is will the food needs in the future be met by the current production levels? In addition, the future production faces another sustainable development issues, one of which climate change that affects all four food security dimensions: food availability, food accessibility, food utilization and food systems stability. Improving food security, therefore whilst reconciling demands on the environment conditions which becoming the greatest challenges.

To response that challenges, The University of Lampung collaborated with ISFA (Indonesia SEARCA Fellow Association) and SEAMEO-SEARCA conduct an International Seminar on "Improving Food Security: The Challenges for Enhancing Resilience to Climate Change" in Bandar Lampung, Indonesia on August 23-24, 2016. There are 4 topics are offered as follows: (1.) Food Security and Food Production System, (2.) Food Security, Post Harvest Science and Technology, (3.) Food Security and Socio-Economic Environment Aspect and (4.) Ecological Perspectives on Food Security.

At this seminar, 111 research articles were submitted from 6 countries i.e. Indonesia, Lao, Malaysia, Myamar, Thailand, and Vietnam. The authors are researchers, practitioners included NGO, policy makers, academics as well as industrial professionals. The ultimate aim of this seminar is to deliver state-of-the-art analysis, inspiring visions and innovative methods arising from research in a wide range of disciplines. Through this activity, it is expected that research articles in all aspects related to food security can be documented, rapidly spread, communicated and discussed throughout the countries.

Thank you for your participation and looking forward to having productive discussion among participants.

Sincerely yours,



Christine Wulandari, Ph.D

Preface
The University of Lampung Rector

Many Asian countries face serious challenges on their food security due to changing consumption patterns including the demographics, declining of agriculture productivity, degradation of natural resources, rising input costs as well as cost for transportation of supply chains. All of these, need various trends anticipation of short to medium term, and this is clearly becomes efforts focused on mitigating towards the challenges. Together with SEAMEO-SEARCA and Indonesian Searca Fellows Association (ISFA), the University of Lampung (Unila) collaborated to conduct an international seminar with theme in "Improving Food Security: The Challenges for Enhancing Resilience to Climate Change" on 23-24 August 2016 in Emersia Hotel, Bandarlampung. From this international seminar, 111 research articles from six countries in Southeast Asia were compiled and expected to be used as a stepping stone for preparation of development strategies in Indonesia country or other Asian countries resolving the issues of Food Security.

This cooperation among Unila with ISFA and SEARCA in accordance with the Unila statement mission for Unila goals of 2005-2025, one of which Unila is able to build joint effort in many development aspects within various parties, including governments, publics, businesses, non-governmental organizations either national and overseas, with mutual benefit basis in sustainable frame for natural resources conservation in supporting Food Security. The other Unila goals related to the Food Security is the community welfare, in which Unila become the agent of changes and maintain the certainty and justice for the community benefits.

My very sincere appreciation to invited speakers and participants for their great contributions, to all advisory boards SEAMEO-SEARCA and Indonesian Searca Fellows Association (ISFA), reviewers, colleagues and staffs for putting remarkable efforts and their contribution to the organization of this seminar. Finally, I just hope that this seminar is able to inspire and deliver benefits to all participants, in which together we are able contribute to development of Food Security in our countries as well as to global.

We look forward to working with you and getting to know you in years ahead.
Thank You.

Your sincerely,

Prof. Dr. Hasriadi Mat Akin

Preface
SEARCA DIRECTOR

MESSAGE

The Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) is pleased to support the Indonesian SEARCA Fellows Association (ISFA) in organizing this *International Seminar on Improving Food Security: The Challenges for Enhancing Resilience to Climate Change.*

SEARCA's support to this event and many similar others is a testament of our commitment to promote food and nutrition security via the route of Inclusive and Sustainable Agricultural and Rural Development (ISARD). Food and nutrition security continues to be a major problem in the region and in the rest of the world in varying degrees and complexities. This is further exacerbated by the impacts of climate change on agriculture which not only serves as the backbone of the economy but is also key to feeding a growing population that continues to struggle with poverty and hunger.

Addressing multi-faceted concerns such as food security and climate change requires collaborative efforts among various stakeholders across the region. That is why SEARCA has developed umbrella programs on food and nutrition security, and climate change adaptation and mitigation which identifies areas for cooperation in research, capacity building, and knowledge management in these two related concerns.

In all these, we are glad to have the cooperation of SEARCA's graduate alumni spread across the region. They have organized themselves into the Regional SEARCA Fellows Association, with at least 8 country chapters including ISFA. The country associations have conducted various knowledge sharing activities such as this International Seminar and plans are also underway for collaborative research projects in the regional alumni organization. By working in synergy, we have seen how the modest contributions of our graduate alumni can make a big difference to agricultural and rural development in the region – truly making them SEARCA's ambassadors in Southeast Asia and beyond.

I congratulate ISFA headed by Dr. Sugeng Prayitno Harianto for organizing this International Seminar which serves as a platform for knowledge sharing on various researches and development activities that contribute to food and nutrition security amidst the detrimental effects of climate change.

Finally, I also thank all our keynote speakers and delegates for their participation in this event and hope to see all of you again in future knowledge sharing events important to the development of the region.

Gil C. Saguiguit, Jr.
Director

KEYNOTES SPEECH

Dr. Siti Nurbaya Bakar
(Minister of Environment and Forestry, Republic Indonesia)

KEYNOTES SPEAKERS

Dr. Ageng S. Herianto, FAO Representative

Prof. Dr. Wickneswari Ratnam FASc, Universiti Kebangsaan Malaysia

Prof. Dr. Neti Yuliana, the University of Lampung

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Prof. Dr. Buhri Arifin, Prince of Songkla University - Thailand

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DETECTION AND QUANTIFICATION OF ADULTERATION IN LUWAK COFFEE THROUGH ULTRAVIOLET-VISIBLE SPECTROSCOPY COMBINED WITH CHEMOMETRICS METHOD

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ABSTRACT

Luwak coffee is the most expensive coffee in the world and currently, the authentication of Luwak coffee has become very important due to the possible adulteration of Luwak coffee with non-Luwak coffee. In this research, we investigated the potential application of using ultraviolet-visible (UV-Vis) spectroscopy combined with chemometric techniques (partial least square/PLS1) for quantification of adulteration in Luwak coffee. The adulterant was Arabica coffee which was added into Luwak coffee with degree of adulteration in the range of 10-50%. A number of 30 samples were used. All samples were extracted with distilled water and filtered. The spectral acquisition was performed with 10 mm of cuvette cell using a UV - Vis spectrometer (Genesys™ 10S UV-Vis, Thermo Scientific, USA) in the range of 200-500 nm. PLS1 model correlates the actual and UV-Vis estimated values of adulterants (concentration of Arabica coffee in Luwak coffee) with coefficients of correlation (r) of 0.99 and 0.97 for calibration and validation, respectively. The low RMSECV values of 0.044 gram could be obtained. The method, therefore, is potential to be used as a rapid method for quantification of adulterant in Luwak coffee.

Keywords: Luwak coffee, chemometrics, PLS1 regression, calibration, UV-Vis spectroscopy

1. INTRODUCTION

Coffee is one of the most popular beverages in the world (Duarte *et al.,* 2005) with high consumption level in developed countries; 4 kg per capita in the US and 5 kg per capita in Europe (http://www.worldmapper.org/posters/worldmapper_1038_coffee_consumption_ver2.pdf). On other hand, coffee is mostly produced in several developing countries. Four countries account for more than half of the world's production: Brazil, Vietnam, Colombia and Indonesia. (http://www.worldmapper.org/posters/worldmapper_1037_coffee_production_ver5.pdf).

Luwak coffee is a name for Arabica or Robusta coffee which has been eaten by Asian palm civet (*Paradoxurus hermaphroditus*). The coffee bean which is eaten by Asian palm civet (*Paradoxurus hermaphroditus*) is the best and ripest berries. After several hours inside the civet animal, the best coffee berries passed through the digestive tract of civet animal resulted in a unique flavour of Luwak coffee. This kind of unique production is a reason why the production of Luwak coffee is very limited and worldwide it is approximately only 250-500 kg per year (http://www.most-expensive.coffee).

Luwak coffee is one of the most expensive and the rarest coffee in the world. Due to its commercial importance, detection of adulterated matters has been a constant concern in fraud verification, especially when it is difficult to percept adulterations with the naked eye in samples of Luwak roasted coffee ground. The inspection of adulteration materials becomes more difficult in samples of Luwak powder coffee. In Indonesia, Luwak coffee is adulterated with other cheaper non-Luwak coffee. Around 70% of Luwak coffee or civet coffee available at coffee stores and the internet (online store) is not 100% pure Luwak coffee and sometimes it does not contain anything of the genuine coffee (http://www.most-expensive.coffee).

In order to protect the authenticity of Luwak coffee, it is important to develop a simple method which can be used to detect and quantify the degree of adulteration. Recently, there is no internationally accepted method of verifying whether a bean is civet coffee or Luwak coffee. Traditionally, coffee aroma has been used to characterize coffee quality. Sensory panel evaluation is commonly used to assess the aroma profile of coffee. However, this technique has some limitations. For example, it is quite difficult to train the panel effectively in order to limit subjectivity of human response to flavour and the variability between individuals (Shilbayeh and Iskandarani, 2004). Human sensory method is also difficult to verify the authenticity of Luwak coffee when a small amount of adulterated materials such as cheaper non-Luwak coffee is added. Indonesia, as one of important player in Luwak coffee production, is now just starting to develop an advanced technology for coffee processing. It is including a search for a novel inspection system for Luwak coffees characterization.

This technology is very important for coffee industry to protect high expensive Luwak coffees from any adulteration. In the previous study, Souto *et al.* (2010) reported the use of UV-Visible spectroscopy as an analytical method for the identification of adulterations in ground roasted coffees (due to the presence of husks and sticks). This analytical method is one of the most common and inexpensive techniques used in routine analysis and it will be compatible with situation in Indonesia for further technology development. For this reason, in this research, we attempt to use UV-Visible spectra combined with PLS regression method to detect and quantify content of adulterant in Luwak- Arabica blend coffee samples.

2. MATERIALS AND METHODS

2.1. Sample preparation

A number of 1 kg ground roasted Luwak coffee (Indonesian palm civet coffee) samples were collected directly from coffee farmers at Liwa, Lampung, Indonesia (Hasti coffee Lampung). Another 1 kg ground roasted Arabica coffee samples were also provided for making Luwak coffee adulteration. All coffee samples were ground using a home-coffee-grinder (Sayota). Since that particle sizes in coffee powder has significant influence to spectral analysis, it is important to use same particle size in coffee powder samples (Suhandy *et al.,* 2016). In this research we use particle size of 420 μm by sieving through a nest of U. S. standard sieves (mesh number of 40) on a Meinzer II sieve shaker (CSC Scientific Company, Inc. USA) for 10 minutes. The experiments were performed at room temperature (around 27-29°C). In this research we prepare 30 samples of Luwak-Arabica blend coffee samples which different content of adulteration. The adulteration content range is 0-50% by adding Arabica coffee into Luwak coffee samples.

The spectral acquisition of Luwak-Arabica blends coffee samples were done in solution samples. For this purpose, an aqueous extraction procedure of the coffee samples was performed as described by Souto *et al.* (2010). First, 1.0 g of each sample was weighed and placed in a glass beaker. Then, adding 10 mL of distilled water at 90-98°C then mixed with magnetic stirring (Cimarec™ Stirrers, model S130810-33, Barnstead International, USA) at 350 rpm for 5 min. Then the samples were filtered using a 25 mm pore-sized quantitative filter paper coupled with an erlenmeyer. After cooling process to room temperature (for 20 min), all extracts were then diluted in the proportion of 1:20 (mL: mL) with distilled water. UV-Vis-NIR spectra from the aqueous extracts were acquired using a UV-Vis spectrometer (Genesys™ 10S UV-Vis, Thermo Scientific, USA).

2.2. Spectral acquisition

The spectral data of coffee blend (Luwak-Arabica) were acquired using UV-Vis spectrometer (Genesys™ 10S UV-Vis, Thermo Scientific, USA) in the range of 200-450 nm. This spectrometer is a dual-beam spectrometer equipped with 5 cell sample holder and 1 cell for blank or reference holder. The wavelength accuracy is 1 nm with dual silicon photodiodes as detector and Xenon flash as illumination source.

The absorbance data of Luwak-Arabica coffee blend in solution samples were acquired in the range of 200-450 nm at room temperature. For this, we put 2 mL of solution samples into cuvettes. Before the sample measurements step, blank (the same distilled water used in extraction process) was placed inside reference cell holder to adjust the 100% transmittance signal.

2.3. PLS regression

The correlation between spectral data and content of adulteration (content of Arabica) was investigated using partial least squares (PLS) regression. The spectral data has many overlapped information. Some information is important and it has strong relation to the target response (content of adulteration). However, some information is not related to the target response. So, the general idea of PLS is to try to extract those information. PLS find several latent factors which account for most of the variation in the response. For this reason, the acronym PLS has also been taken to mean ‘‘projection to latent structure.’’ It should be noted, however, that the term ‘‘latent’’ does not have the same technical meaning in the context of PLS as it does for other multivariate techniques. In particular, PLS does not yield consistent estimates of what are called ‘‘latent variables’’ in formal structural equation modelling (Dykstra, 1983). PLS regression model has been used widely for multivariate data analysis including spectral data for qualitative and quantitative analysis from UV to terahertz region (Suhandy *et al.,* 2012; Shan *et al.,* 2014)

In this study, PLS regression model was developed using The Unscrambler® version 9.7 (CAMO, Oslo, Norway), statistical software for multivariate calibration. A student’s t-test was performed using Statistical Package for the Social Science (SPSS) version 11.0 for Windows in order to evaluate the significance level of the model.

3. RESULTS AND DISCUSSION

3.1. Spectral data of Luwak-Arabica coffee blend

In Fig. 1 we can see the original spectra of coffee blend (Luwak-Arabica) in the range of 200-450 nm. We notice the difference of absorbance intensity due to difference of content of adulterant (content of Arabica). However, the spectral difference is not consistent and it may be due to baseline differences. In order to remove the influence of baseline effect, we processed the spectra using smoothing and derivation algorithm (Savitzky-Golay 1st derivative with polynomial order 2 and number of segments 11) as shown in Fig. 2. Here we can see that it is not easy to see the spectral differences among the samples having different content of adulterant. So it is really necessary to use multivariate analysis to extract such kind of spectral information. From Fig. 1 and 2 we can see that there are several peaks which may be related to the information of content of adulteration. The peak at 280 nm can be found both in original and processed spectra. This wavelength is close to the wavelength related to caffeine absorbance at 272 nm in the previous study (Belay *et al.,* 2008). The shift of caffeine absorbance peak (from 272 nm to 280 nm), it might be happen due to the presence of other component in coffee solution (not pure distilled water).

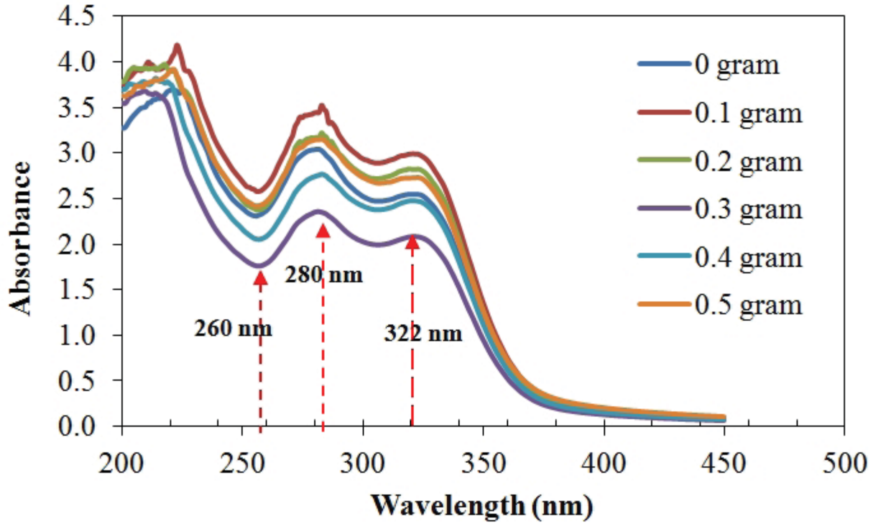

Figure 1. Original spectra of coffee blend (Luwak-Arabica) with different content of adulterant (Arabica) in the range of 200-450 nm

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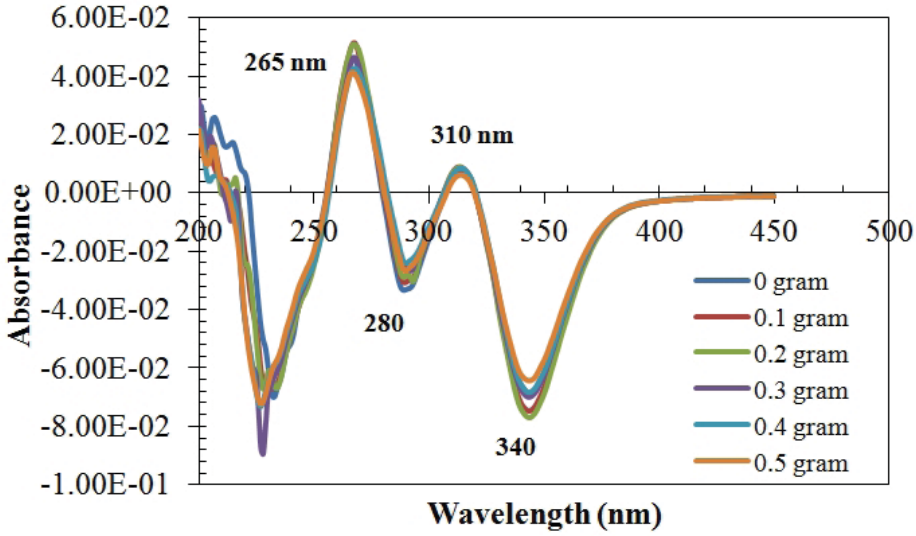

Figure 2. Processed spectra (smoothing +Savitzky-Golay derivation) of coffee blend (Luwak- Arabica) with different content of adulterant (Arabica) in the range of 200-450 nm.

3.2. Developing a PLS regression model for prediction content of adulteration

Here we perform a quantitative study for prediction content of adulteration in Luwak-Arabica coffee blend. For this purpose, we develop a PLS regression model using all wavelength in the range of 200-450 nm as predictor (*x* variables) and content of adulteration or content of Arabica coffee added into Luwak-Arabica coffee blend as target response (*y* variable). Fig. 3 shows the result of PLS regression model in calibration step. It can be seen that there is a strong correlation between actual content of adulteration and predicted one using UV-Vis spectra with high coefficient of determination (R^2) = 0.99 and low RMSEC = 0.013884 gram. The developed PLS model was well validated as shown in Fig. 4. The cross-validation resulted in low RMSECV = 0.044242 gram and low bias = 0.003850 gram.

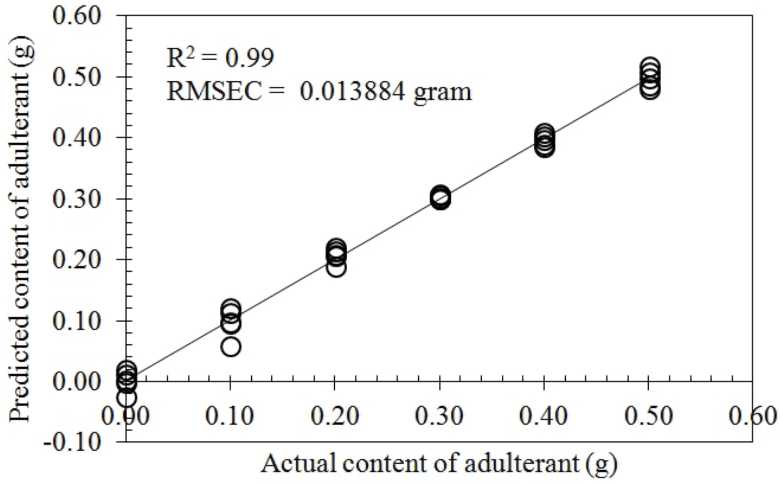

Figure 3. Scatter plot between actual and predicted content of adulteration in calibration step in the range 200-450 nm.

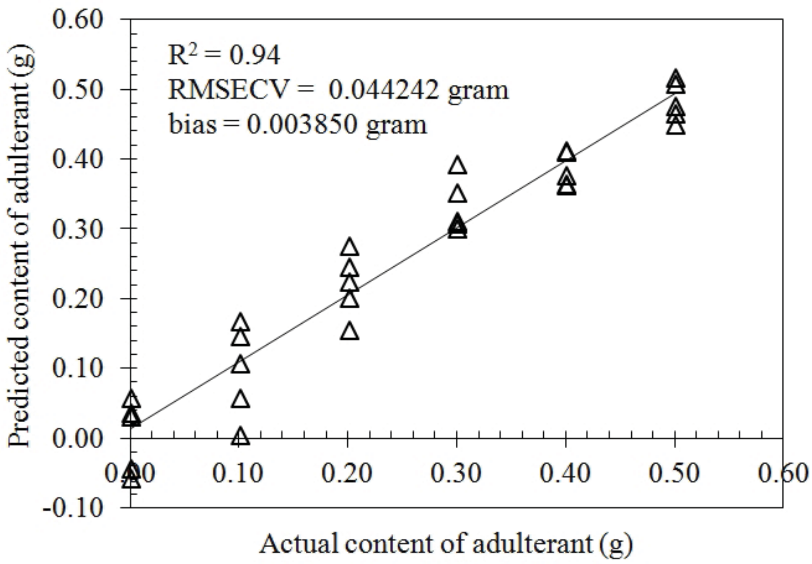

Figure 4. Scatter plot between actual and predicted content of adulteration in cross-validation step in the range 200-450 nm.

By a 95% confidence pair t-test, there were no significant differences between the actual content of adulteration and that predicted by UV-Visible spectroscopy. This result showed that a calibration model for determination content of adulteration in Luwak-Arabica blend using UV-Visible spectroscopy could be well developed.

In order to understand the structure of the developed PLS model, we plot a relationship between the wavelength and regression coefficient as shown in Fig. 5. It can be noticed several wavelengths have significant value of regression coefficient. Those wavelengths are 275 nm, 300 nm, 342 nm and 378 nm. The wavelength at 275 nm is related to absorption of caffeine. The wavelength at 300 nm may be related to absorption of caffeic acid (Souto *et al.,* 2010).

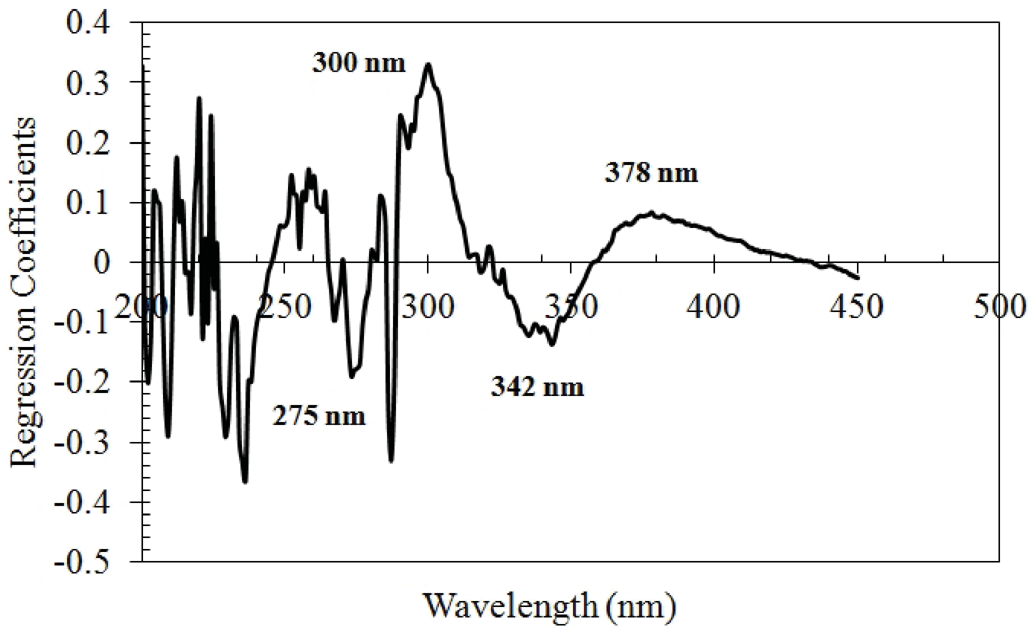

Figure 5. The regression coefficient versus wavelength plot of PLS model determination for prediction content of adulteration in Luwak-Arabica coffee blend.

This study has demonstrated the promising application of using PLS regression model for prediction the content of adulteration in Luwak-Arabica blend coffee samples. The developed PLS model resulted in a strong correlation between actual and predicted content of adulteration with R^2 = 0.99. The cross-validation resulted in low bias. By a 95% confidence pair t-test, there were no significant differences between the actual content of adulteration and that predicted by UV-Visible spectroscopy. This result may open a development of simple and fast method to detect and quantify the content of adulteration in Luwak-Arabica blend coffee samples.

ACKNOWLEDGEMENT

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