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Research Article

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Principle component analysis (PCA) of selected liquid smoke by product

[1]Wahyudi David*, [1]Kurnia Ramadhan, [2]Edi Supandri and [2]Anwar Kasim

[1]Food Science and Technology, Universitas Bakrie, Jakarta, Indonesia
[2]Agriculture Product Technology, Universitas Andalas, Padang, Indonesia

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ABSTRACT

The study is aiming to compare selected liquid smoke by product (coconuts shell, pangium shell, candlenuts shell, cocoa bean shell and palm kernel shell). The principal component analysis (PCA) was used to grouped and reduce the number of variables. The analysis using principal component analysis (PCA) performed by XLSTAT. It is showed that the principle component analysis able to distinguish the tendencies of chemical component obtained by different sources of liquid smoke materials. All liquid smoke samples are in different quadrants except forcocoa bean shell and palm kernel shell which are lie at the same quadrant.

Keywords: pyrolysis, liquid smoke, principle component analysis, preservative agent

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INTRODUCTION

Liquid smoke has been used as an alternative source to replace a traditional smoking process in preserving and flavoring foods. This brought some advantages in comparison with smoking process such as simple application for foods, inexpensive, and less pollution[1]. Preservative effect in food smoking is achieved due to the presence of antimicrobial and antioxidant compounds, such as phenolic compounds, carbonyls, acids [2].

Liquid smoke contains complex chemical composition, which is influenced by the type and moisture content of raw materials used, pyrolysis temperature and length of smoke generation[3]. Vast majority liquid smokes are made from hardwood through pyrolysis process, which thermally degrade several major substances such as cellulose, hemicellulose, and lignin, and minor substances such as terpenes, fatty acids, other carbohydrates, polyhydric alcohols, phenols, nitrogen-containing compounds, and inorganic compounds [4][5]. While some other liquid smokes are made from various agricultural wastes such as coconut shell, corncob, pecan shell, and oil-palm shell [6][7][8].

Liquid smoke flavors with different attributes can be made by varying the feed stock [5]. Liquid smoke flavor have some advantages over traditional smoking methods, such as easy application, lower cost, and environmentally friendliness [1]. Smoke flavoring preparations can show different physical states, colors, and odors. These different properties are due to the carrier used to support the smoke components and to the nature and concentration of the smoke components in the corresponding carrier[9][10].

This study is aiming to compare selected liquid smoke by product including coconuts shell, pangium shell, candlenuts shell, cocoa bean shell and palm kernel shell. It is expected that based on this research can distinguish the tendencies of chemical component obtained by different sources of liquid smoke materials.

EXPERIMENTAL SECTION

Preparation of sample

A total 40 kg each sample were obtained from coconuts shell, pangium shell, candlenuts shell, cocoabean shell and palm kernel shell and crushed in to size 2 mesh. Pyrolysisprocessesof sample for12 hours at 400°C. Three fractionswere obtained, such as bio-charcoal, tar, and liquid smoke. There-distillations were performed at temperature150° C to purify liquid smoke from remaining tar. The sample studied was a water-based smoke flavoring of a light brown color and intense of odor.

Instrumentation

Identification of chemicals compounds by using Gas Chromatography-Mass Spectroscopy (GC-MS) type CG-MS-QP2009.

Procedure

The optimized oven temperature at 100°C oven temperature is maintained for 4 minutes, then the temperature was increased to 200°C with increasing 20°C/minute and maintained for 2 minutes, the temperature will be increasing with the increase in temperature to 300°C and maintained for 16-20°C/ minutes. Ion source temperature is set at a temperature of 230°C while the injector temperature set at 260°C. This analysis uses helium gas which has a purity of 99.99% with a gas pressure of 62.7 kPa. Sample is injected in a gas chromatograph as 1µl, analysis of the molecular weight of 50.00 to 500.00 in 3 until 32 minutes.

Statistical Analysis

Principal component analysis (PCA) was used to reduce the number of variables. All calculations were performed using XLSTAT.The principal component is a useful data reduction technique which works by reducing inter-correlation amongst components [11]. The advantages of PCA are twofold, PCA is able to reduce multi-co-linearity and able to present data with simple structure without losing the essence in it. In PCA [12] produced a new variable that has new combination of components. The properties of PCA consist of eigenvalues, variances, cumulative variances, and eigenvectors [11] [13].

RESULTS AND DISCUSSION

The eigenvalue and percentage variance (variability) of the F1 axis was 3.018 and 50.303%, respectively. Theeigenvalue and percentage variance (variability) of the F2 axis was subsequently 1.647 and 27.447%and this explains that there was a low linearity in axis two (F2). The proportion of the variance is merely the eigenvalue for that axis divided by the total variance, i.e. the sum of the diagonal of the cross-product matrix. These properties have underpinned meaning.

Tabel. 1 Principle component analysis

	F1	F2	F3	F4
Eigenvalue	3.018	1.647	0.741	0.594
% variance	50.303	27.447	12.344	9.906
Cumulative %	50.303	77.750	90.094	100.000

Number of removed trivial eigenvalues: 2

The distribution of chemical component by principle component analysis is obtained. Comparison of chemical component and selected liquid smoke by product can be shown as figure1. Figure 6 show that the PCA bi-plots accounted for 77.75% of the variability in data. Vector line with the same direction shows positive correlation between variability of product (sources of liquid smoke) and chemical component (alkanes, aldehydes, ketones, phenols, and other organic acids) whereas those with inverse direction show negative correlation. The intensity of the correlation it’s depending on the angle of two vector line.

All liquid smoke samples are in different quadrants except cocoa bean shell and palm kernel shell lies at the same quadrant. Candlenut shell liquid smoke has strong positive correlation to obtained aldehyde and it’s derivate. Meanwhile, coconut liquid smoke has positive correlation to obtain alkanes. Both palm kernel shell liquid smoke and cocoa bean shell liquid smoke has correlation to obtain ketones and other organic acid. Pangium kernel liquid smoke has positive correlation to obtain fatty acid. Phenols has correlation in between two quadrants (lower-right quadrant and upper-right quadrant), it means that phenols can be obtained by both component even though the correlation may not be high.

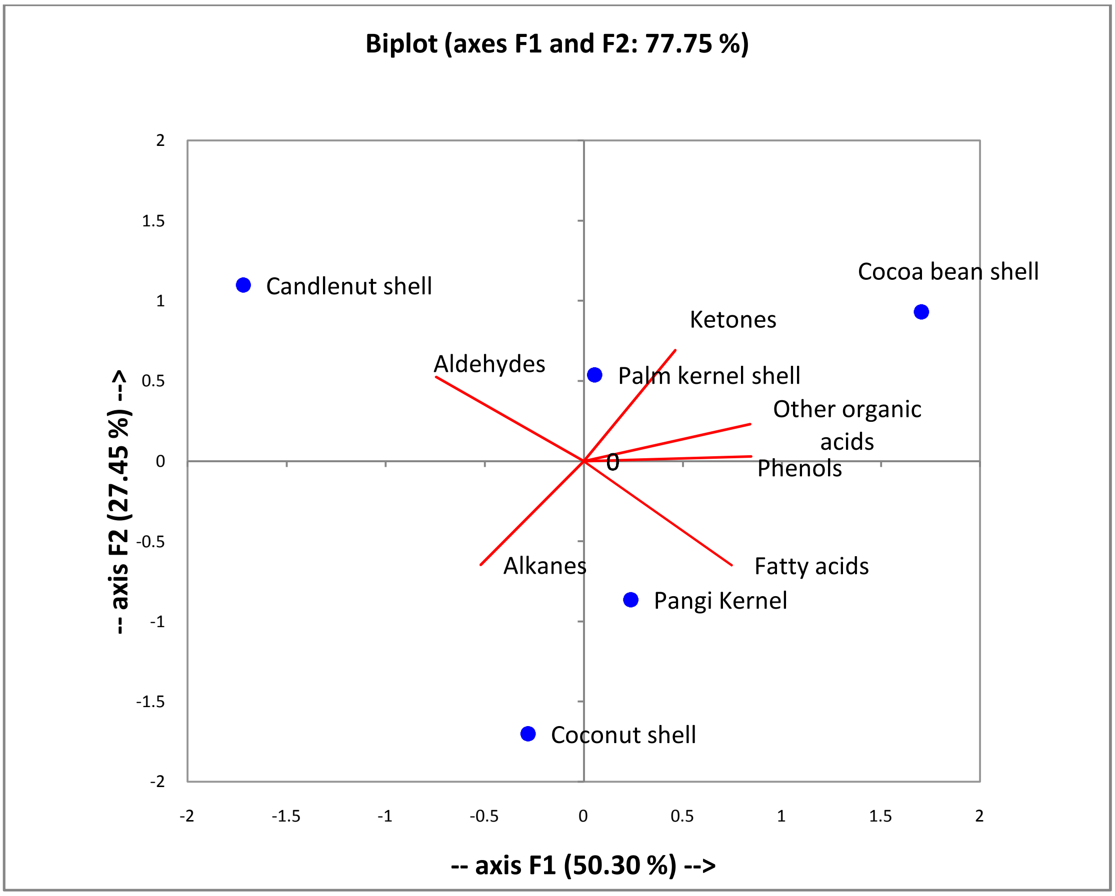

Figure 1. Principle of Component analysis bi-plot based on descriptive analysis performed by XLSTAT

CONCLUSION

Based on the results obtained in this study, it may conclude that the principle component analysis able to distinguish the tendencies of chemical component obtained by different sources of liquid smoke materials. The future research is suggested to analyze the correlation between temperature of purification and chemical component obtained by different sources liquid smoke materials.

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