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The Similarity of Fourier Transform Infrared (FTIR) Spectroscopy Absorbance in Several Products of Cooking Spice in Indonesia

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Abstract

This study aimed to find out the causality of raw materials, food additives and supportive materials used to produce several cooking spice products available in Indonesia and their direct correlation with monosodium glutamate as a flavor enhancing ingredient. Ten brands of cooking spice were randomly selected and observed using Fourier Transform Infrared (FTIR) Spectroscopy. The results of the observation were processed using main component analysis and classification tree. The results of the analysis show that the ten brands of cooking spice are made from similar food additives and supportive materials with eigenvalues of 9.477 or 94.771% of variant. There is a direct causality with synthetic flavor enhancing ingredient of monosodium glutamate and Chinese Flavor Enhancing Ingredient. Such direct causative direct correlation applies to *balado* flavored cooking spice, currie flavored cooking spice, Indofood magic cooking spice, straw mushroom broth flavored cooking spice, beef broth flavored cooking spice, chicken broth flavored cooking spice, and *totole* mushroom. The flavored cooking spice has a causative direct correlation with Chinese flavor enhancing ingredient which eigenvalues is of 8.240 or 82.399% of variant. Balado flavored cooking spice, currie flavored cooking spice, Indofood magic cooking spice, mama cooking spice, and totole mushroom flavored cooking spice have a causative direct correlation with monosodium glutamate with eigenvalues of 1.237 or 12.372% of the variant. The results of classification tree analysis indicated that the fixed variable is Chinese flavor enhancing ingredient and the free variables are those 9 (nine) cooking spices (BM08, BM09, BM05, BM04, BM02, BM03, BM10, BM07 and MSG). There are 7 (seven) free variables with a significant value of

Keywords: Similarity of Fourier Transform Infrared (FTIR), Spectroscopy Absorbance in Several Products, Cooking Spice in Indonesia

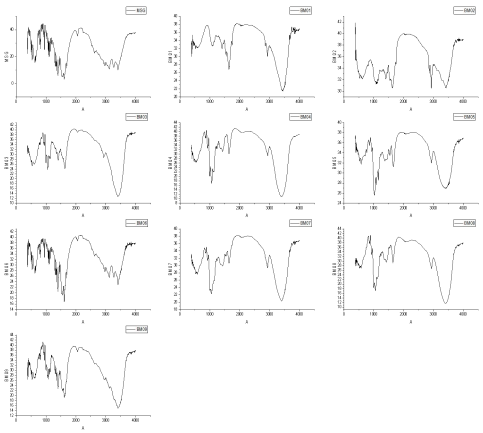
more than 50%. Those are BM08 (100%), BM09 (96.70%), BM05 (93.30%), BM04 (73.60%), BM02 (68.90%), BM03 (62.10%) and BM10 (57.00%). The fixed variable of MSG indicates that there are 4 (four) free variables with a significant value of more than 50%, namely BM07 (100%), BM10 (73.40%), BM02 (56.90%), and BM04 (54.00%)

1. Introduction

The history of spices is entwined with exploration, adventure, religious missions, commerce, and conquest. Treasured like gold and precious stones, spices have had enormous commercial value in ancient and medieval times. Most spices and flavorings had origins in the tropics or subtropics. They were much sought after in the West, and the quest for spices tremendously changed the course of history (1). The total consumption of spices in 1993 was 16,545 tonnes (with per capita consumption of 290 grams), of which more than 50% was black pepper. The main market is the retail sector with over 100 million consumer packs of spices sold in 1993, valued at US$150 million. The catering market in 1993 was worth US$20–25 million. Other major importing regions are the Middle East and North Africa, whilst there are growing markets in other countries. In South Africa, for example, the annual spice trade is worth US$94 million, but it is predicted to grow as consumers demand more exotic tastes in food (2). The commonly used synthetic cooking spice is based on monosodium glutamate. FDA's policy states that it is safe for its intended use. However, because of public concern, the use of MSG must be indicated on all food labels and the flavor labeling exemption that the FDA has for flavors does not allow flavor enhancers, specifically MSG (3). Monosodium glutamate contains sodium and glutamate or glutamic acid. Glutamic acid is an amino acid found naturally in human body and in high-protein foods. Meat, fish, dairy foods, and some vegetables contain glutamic acid (4). There is an increasing demand for natural flavors and colors at the expense of synthetics. Similarly, the demand for natural antioxidants over synthetic ones is growing (5). The addition of these flavour enhancers can mask the reduced salt amount, thereby lowering not only the level of sodium in the diet, but also the levels of toxic contaminants such as chloro propanediol esters or glycidyl ester (6). Glutamate is an abundant amino acid that is present in protein-rich foods as well as in the widely used flavor enhancer monosodium glutamate. This amino acid has a taste, termed *umami*, that is distinct from the other four basic tastes. Adults can detect glutamate at a concentration of approximately 1 mM. Glutamate is also a widely used neurotransmitter, and thus, not surprisingly, several classes of receptors for glutamate have been identified in the nervous system (7). The effect of continuous ingestion of monosodium l-glutamate (MSG) on cognitive function and dietary score in dementia patients (8). Production of clean spices without any chemical residues is important in the era of free international trade. Organic spices which fetch 20 to 50% higher prices than spices from conventional farms are devoid of pesticides and chemical residues and are superior in quality (9). This study aims to : 1) find out the similarity of the Fourier Transform Infrared absorbance patterns of 10 (ten) cooking spices that circulate in Indonesia by using principal component analysis (PCA), 2) find out the importance of the 10 (ten) seasonings with fixed variable monosodium glutamate and china vetsin using classification tree analysis, 3) find out the difference in Fourier Transform Infrared absorbance patterns at wavelengths of 400 nm to 2250 nm with absorbance values between 0% to 25% using paired samples "t" test.

2. Material and Methods

The materials used in this study are 10 (ten) types of (MSG, BM02, BM03, BM04, BM05, VC, BM07, BM08, BM09, and BM10) synthetic flavor enhancing ingredient of monosodium glutamate (MSG), Balado flavored cooking spice (BM02), Currie flavored cooking spice (BM03), Indofood magic cooking spice (BM04), Straw mushroom broth flavored cooking spice (BM05), Chinese Flavor Enhancing Ingredient (VC), Mama cooking spice (BM07), Beef broth flavored cooking spice (BM08), Chicken broth



flavored cooking spice (BM09), and Totole mushroom flavored cooking spice (BM10) bought at commercial markets in Surabaya. The observation results of Fourier Transform Infrared (FTIR) spectroscopy were processed using OriginLab software version 8.5. Main component analysis, classification tree and paired samples test analysis employed SPSS 25 software.

3. Results and Discussion

3.1. The similarity of Raw Materials, Food Additives and Supportive Materials of several Cooking Spices

The method applied to see the similarity of raw materials, food additives and supportive materials of several types of cooking spice available at commercial markets is observation of the absorbance pattern of Fourier Transform Infrared (FTIR) spectroscopy and main component analysis and classification tree. Main component analysis was used to identify data pattern, data similarity, and several data differences. Infrared (IR) spectroscopy is a well-established technique in chemical

analysis. Infrared radiation is absorbed by molecules, including taste components such as sugars and acids, causing molecular vibrations and rotations at specific wavelengths which depend on the chemical bounds within the molecule (10). Starches and films based on native and modified starches were characterized using FTIR spectroscopy and the results revealed that the employed reactions can add hydrophobic functional groups to improve the water resistance of the biodegradable films based on starches (11).

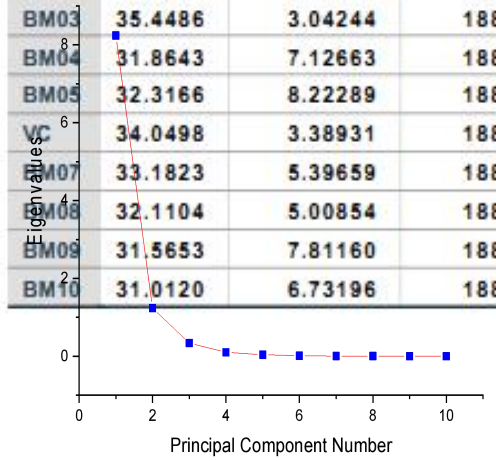
Figure 1. Absorbance pattern (spectrogram) of 10 cooking spices (MSG, BM02, BM03, BM04, BM05, VC, BM07, BM08, BM09 and BM10).

The observation results of the absorbance pattern of 10 (ten) cooking spices using FTIR spectroscopy can be seen in figure 1.

Table 1. Data Description of 10 (ten) Cooking Spices (12)

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
MSG	26.7945	10.66356	1881
BM02	33.6646	4.21051	1881
BM03	35.4486	3.04244	1881
BM04	31.8643	7.12663	1881
BM05	32.3166	8.22289	1881
VC	34.0498	3.38931	1881
BM07	33.1823	5.39659	1881
BM08	32.1104	5.00854	1881
BM09	31.5653	7.81160	1881
BM10	31.0120	6.73196	1881



Fourier Transform Infrared (FTIR) absorbance pattern of 10 (ten) cooking spices (MSG, BM02, BM03, BM04, BM05, VC, BM07, BM08, BM09, and BM10) on wavelength from 400 cm^{-1} to 4,500 cm^{-1} in the above figure 1 shows that there is absorbance pattern similarity (spectrogram). The significant difference is on the absorbance pattern of wavelength from 400 cm^{-1} to 2,250 cm^{-1} with absorbance value (transmitting) from 0% to 35% or n (D) and from 35% to 50% or n (A) as shown in table 4. Similar varieties of complex food were chosen and a multivariate technique, PCA, was used to examine the volatile profiles released (13).

Figure 2. The correlation between eigenvalues and Main Component (12)

The correlation between the score of eigenvalues and the main component in the above figure indicates that the score of eigenvalues almost achieved 0 (zero) up to the second main component (F2) and the cumulative % (percentage) of described variant is 94.771%.

Table 2. The Result of KMO Testing and Bartlett's Testing on FTIR Absorbance of 10 (ten) Cooking Spices(12)

The testing results of KMO value > 0.5, which is 0.817 > 0.500 meaning that variables can be predicted and further analyzed. Bartlett's test of < 0.05 that is 0.000 < 0.050 indicates that inter-variables have high correlation.

F1 = 0.755 BM02 + 0.663 BM03 + 0.829 BM04 + 0.958 BM05 + 0.920 VC + 0.938 BM08 + 0.948 BM09 + 0.646 BM10 …… (1)

F2 = 0.961 MSG + 0.576 BM02 + 0.590 BM03 + 0.533 BM04 + 0.948 BM07 + 0.743 BM10 …… (2)

Remarks:

F1 = The similarity of raw materials, food additives and supportive materials of cooking spice with Chinese flavor enhancing ingredient (VC)

F2 = The similarity of raw materials, food additives and supportive materials of cooking spice with monosodium glutamate (MSG)

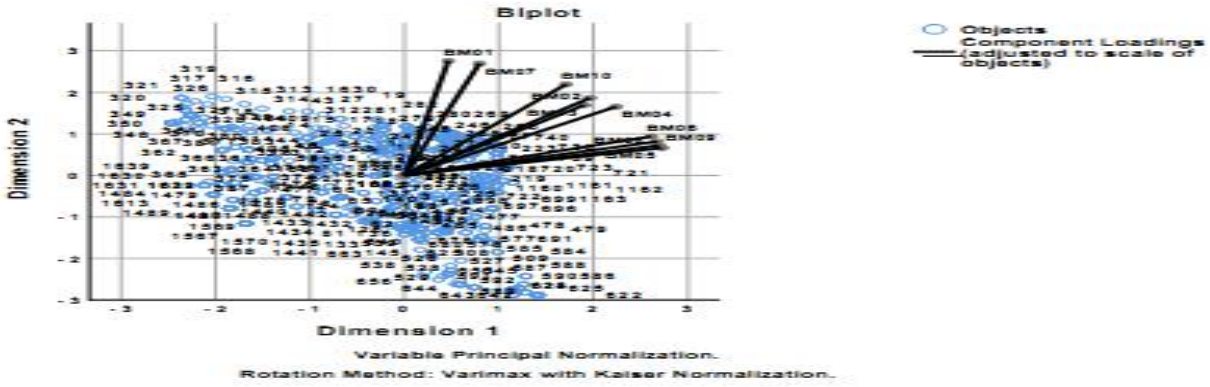
Point measured spectroscopy (Vis-point) and spatial-measured hyperspectral imaging (Vis-HSI) were applied to collect visible spectra (400–740 nm) from the fruit peel. Three classification methods, K-Nearest Neighbour (K-NN), soft independence modelling of class analogy (SIMCA) and partial least square discriminate analysis (PLSDA), were applied for maturity stage classification (14). Infrared (IR) spectroscopy refers to measurement of the absorption of different frequencies of IR radia- tion by foods or other solids, liquids, or gases (15).

Table 3. Component Matrix After Rotation of 10 (ten) Cooking Spices(12)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.817
Bartlett's Test of Sphericity	Approx. Chi-Square	57204.530
	df	45
	Sig.	.000

Figure 3 shows that 10 (ten) cooking spices (MSG, BM02, BM03, BM04, BM05, VC, BM07, BM08, BM09, and BM10) have similarity as shown by the image located in 1 (one) quadrant.



BM03	.663	.590
BM04	.829	.533
BM05	.958	.251
VC	.920	.322
BM07	.304	.948
BM08	.938	.310
BM09	.948	.278
BM10	.646	.743

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

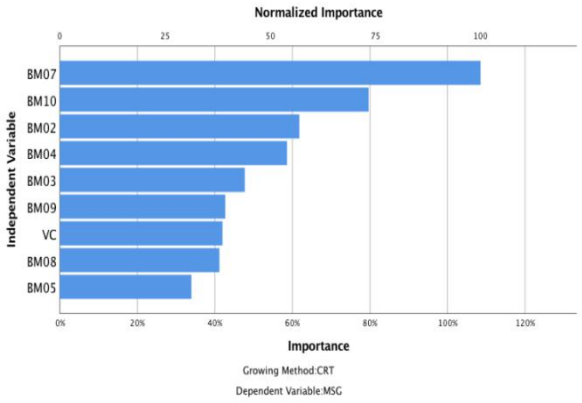
Figure 3. The correlation between the First (F1) Main Component and the Second (F2) Main Component of 10 Cooking Spices.(12)

By virtue of the above table 3, the equation for the first (F1) main component constitutes the similarity function of raw materials, supportive materials and additives of cooking spice of Chinese flavor enhancing ingredient (VC) type. On the other hand, the equation for the second (F2) main component is the similarity with cooking spice of monosodium glutamate (MSG) type. Based on the above equation (1) the biggest variable coefficient score is BM05. It indicates that BM05 (mama cooking spice) contains Chinese flavor enhancing ingredient (VC) type with the biggest proportion compared to other types of cooking spice (BM09, BM08, BM04, BM02, BM10, and BM03). Equation (2) is the second (F2) main component, and the biggest variable coefficient score is BM07. It indicates that BM07 (beef broth flavored cooking spice) contains flavor enhancing ingredient of monosodium glutamate (MSG) with the biggest proportion compared to other types of cooking spice (BM10, BM03, BM02, and BM04). The results of FTIR absorbance pattern observation of 10 (ten) cooking spices at wavelength from 400 cm^{-1} to 4,500 cm^{-1} with total number of observation point is 18,800. The ultimate benefit from informed and optimal choices of principle component analysis (PCA) graph, single nucleotide polymorphism (SNP) coding, and PCA variant, is expected to be discovery of more biology, and thereby acceleration of medical, agricultural, and other vital applications. (16).

3.2. The Causality of Fourier Transform Infrared Monosodium Glutamate and Chinese flavor enhancing ingredient Absorbance Pattern with the Absorbance Pattern of Several Cooking Spices.

The principles of the widely used chemometric methods, such as PCA, PCR, and PLS are explained together with their applications in IR spectroscopy (17). Electromagnetic radiation (EM) is an invaluable tool for structural elucidation of organic compounds. The EM radiation with frequencies between 4,000 and 400 cm–1 (wave numbers) is termed infrared (IR) radiation and its application to organic chemistry is known as IR spectroscopy (18). The method applied to see the causality between monosodium glutamate absorbance pattern and the absorbance pattern of several cooking spice types is by observing the absorbance pattern of

fourier transform infrared (FTIR) spectroscopy and using classification three and main component analysis. The causality between FTIR absorbance pattern of monosodium glutamate and the absorbance pattern of several types of cooking spice can be identified at wavelength from 2,250 cm^{-1} to 4,500 cm^{-1} with absorbance value from 0% to 55%. Protein is amino acid poly which functional group is R-NH (amine). The savory taste organoleptically comes from amino acid substance, especially the glutamate acid. The distribution of absorbance observation for 10 (ten) types of cooking spice can be seen in table 4 which starts at wavelength of 400 cm^{-1} to 2,250 cm^{-1} with absorbance value from 55% to 100% or n (A). Meanwhile, at wavelength from 400 cm^{-1} to 2,250 cm^{-1}, the absorbance value is from 0% to 55% or n (D). At wavelength from 2,250 cm^{-1} to 4,500 $cm^{-1,}$ the absorbance value is from 55% to 100% or n (B), and at wavelength from 2,250 cm^{-1} to 4,500 $cm^{-1,}$ the absorbance value is from 0% to 55% or n (C). The simplest tastant, the hydrogen ion, is perceived as sour. Other simple ions, particularly sodium ion, are perceived as salty. The taste called umami is evoked by the amino acid glutamate, often encountered as the flavor enhancer monosodium glutamate (7). Infrared radiation is electromagnetic energy with wavelengths (λ) longer than visible light but shorter than microwaves. Generally, wavelengths from 0.8 to 100 micrometers (μm) can be used for IR spectroscopy and are divided into the near-IR (0.8–2.5 μm), the mid-IR (2.5–15 μm), and the far-IR (15–100 μm). The mid-IR regions of the spectrum are most



useful. One μm is equal to 1 × 10^{-6} m. The near- and quantitative and qualitative analysis of foods (15).

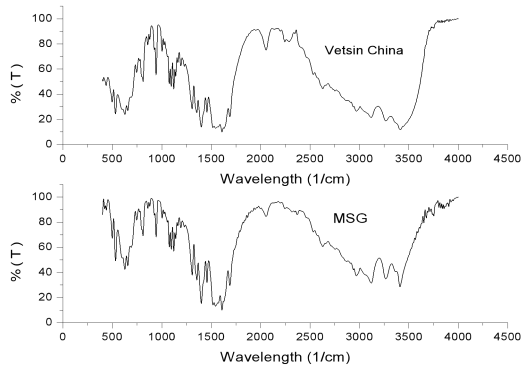


Figure 4. FTIR absorbance pattern of Chinese flavor enhancing ingredient (VC) and Monosodium Glutamate (MSG)

Extraction (separation) process of variables with MSA (measure of sampling adequacy) score that meets the requirement of > 0.5 produces 2 (two) main components. The total eigenvalue of 2 (two) main components is 94.771%.

Factorization or matrix component extraction before varimax rotation produces factor of 2 (two) main components. The first (F1) main component has 10 (ten) variables, namely MSG, BM02, BM03, BM04, BM05, VC, BM07, BM08, BM09, and BM10. The second (F2) main component factor has 2 (two) variables, namely MSG and BMBM07. A classification tree comprehensibility survey in order to derive an exhaustive comprehensibility metrics better reflects the human sense of classifier comprehensibility and obtains new insights about comprehensibility of classification trees. (19).

The results of test using classification tree with fixed variable that is Chinese flavor enhancing ingredient (VC) and free variables which are BM08, BM09, BM05, BM04, BM02, BM03, BM10, BM07 and MSG indicate that there are 7 (seven) free variables whose significant value is above 57.00%. They are BM08 (100%), BM09 (96.70%), BM05 (93.30%), BM04 (73.60%), BM02 (68.90%), BM03 (62.10%), and BM10 (57.00%). The results of this analysis indicate similarity with the results of main component analysis as shown in table 4 below. The decision tree is constructed and the system can be used to predict the situation of new patients with regards to Alzheimer's disease (20)

Tabel 4. Independent Variable Importance with Dependent Variable MSG(12)

Independent Variable	Importance	Normalized Importance
BM07	108.522	100.00%
BM10	79.635	73.40%
BM02	61.778	56.90%
BM04	58.612	54.00%
BM03	47.705	44.00%
BM09	42.668	39.30%
VC	41.956	38.70%
BM08	41.147	37.90%
BM05	33.951	31.30%
Growing Method: CRT Dependent Variable: MSG		

Figure 5. The correlation between Free Variables (BM08, BM09, BM05, BM04, BM02, BM03, BM10, BM07 and VC) and Level of Interest(12)

For fixed variable that is Monosodium Glutamate (MSG) and free variables those are BM07, BM10, BM02, BM04, BM03, BM09, VC, BM08, and BM05, it indicates that there are 4 (four) free variables with a significant value above 54.00%. They are BM07 (100%), BM10 (73.4%), BM02 (56.90%) and BM04 (54.00%) as shown in table 5 below. The analysis results of classification tree with fixed variable (MSG) and free variables (BM07, BM10, BM02, BM04, BM03, BM09, VC, BM08, and BM05) also indicate similarity with the results of main component analysis.

Table 5. Independent Variable Importance with Dependent Variable Vetsin China(12)

Independent Variable	Importance	Normalized Importance
BM08	10.887	100.00%
BM09	10.525	96.70%
BM05	10.158	93.30%
BM04	8.016	73.60%

BM02	7.499	68.90%
BM03	6.765	62.10%
BM10	6.21	57.00%
BM07	1.757	16.10%
MSG	1.503	13.80%

Growing Method: CRT

Dependent Variable: VC (Vetsin China)

The distribution of absorbance observation for the 10 (ten) types of cooking spice starts at wavelength from 400 cm^{-1} to 2,250 cm^{-1} with absorbance value from 25% to 50% or n (A) with 277 points of minimal value (BM 02) and 928 points of maximal value (BM 01). Meanwhile, at wavelength from 400 cm^{-1} to 2,250 cm^{-1}, the absorbance value is from 0% to 25% or n (D) with 45 points of minimal value (BM 01) and 698 points of maximal value (BM 02). At wavelength from 2,250 cm^{-1} to 4,500 $cm^{-1,}$ the absorbance value is from 25% to 50% or n (B) with 496 points of minimal value (BM 02) and 663 points of maximal value (BM 01). At wavelength from 2,250 cm^{-1} to 4,500 $cm^{-1,}$ the absorbance value is from 0% to 25% or n (C) with 245 points of minimal value (BM 01) and 412 points of maximal value (BM 02). Classification and Regrssieon Tree reflects these two sides, covering the use of trees as a data analysis method, and in a more mathematical framework, proving some of their fundamental properties (21). A classification tree comprehensibility survey was done in order to derive an exhaustive comprehensibility metrics better reflecting the human sense of classifier comprehensibility and obtain new insights about comprehensibility of classification trees (19). Those are shown in table 4 Below.

Fourier transform infrared spectroscopy (FTIR) was used to assess the biochemical changes in normal skin caused by squamous cell carcinoma induced by multi-stage chemical carcinogenesis in mice. Changes in the absorption intensities and shifts were observed in the vibrational modes associated to proteins, indicating changes in secondary conformation in the neoplastic tissue (22). FTIR spectroscopy in combination with chemometric techniques exhibits a great potential for microbial species identification. Reliability of identification is high for both bacteria and yeasts and even sensitive typing systems obtain high classification rates (23). Infrared and Raman microspectroscopies and imaging are sensitive enough to differentiate and classify Glycosaminoglycan (GAG) types and subtypes in spite of their close molecular structures. Spectroscopic markers char- acteristic of reference GAG molecules were identified (24). The 't' test results of paired samples among the following pairs indicate that the number of absorbance points at n (D) is clearly different. Those pairs (BM01-BM02, BM01-BM03, BM01-BM04, BM01-BM05, BM01-BM08, BM01-BM09, BM01-MSG, BM02-BM03, BM02-BM04, BM02-BM05, BM02-VC, BM02-BM07, BM02-BM08, BM02-BM09, BM02-MSG, BM03-BM04, BM03-BM05, BM03-VC, BM03-BM07, BM03-BM08, BM03-BM09, BM03-MSG, BM04-BM05, BM04-VC, BM04-BM07, BM04-BM08, BM05-VC, BM05-BM07, BM05-BM08, BM05-BM09, VC-BM07, VC-BM08, VC-BM09, VC-MSG, BM07-BM08, BM08-BM09, BM08-MSG, and BM09-MSG) indicate that the number of absorbance points at n (D) is clearly different (25). However, the results of paired test between n (D) on BM01- VC, between n (D) on BM01-BM07, between n (D) on BM03-BM07, and between n (D) on BM08-MSG indicate that there is not any clear difference. The development of a mid-infrared spectroscopic method, recording spectra with little sample preparation. Spectral data were classified using a bootstrap-aggregated (bagged) decision tree method, evaluating the protein and carbohydrate absorption regions of the spectrum (26). The development of a mid-infrared spectroscopic method, recording spectra with little sample preparation. Spectral data were classified using a bootstrap-aggregated (bagged) decision tree method, evaluating the protein and carbohydrate absorption regions of the spectrum (26). A classification tree comprehensibility survey was done to derive an exhaustive comprehensibility metrics better reflecting the human sense of classifier comprehensibility and obtain new insights about comprehensibility of classification trees (19). A classification tree modeling framework for investigating complex feeding relationships and illustrating the method using stomach contents data for yellowfin tuna (Thunnus albacares) was collected by longline fishing gear deployed off eastern Australia between 1992 and 2006 (27). Classification tree analysis (CTA) was used to identify predictors of dental problems in a nationally representative cohort of Irish pre-school children. CTA was used to classify variables and describe interactions between multiple variables including socio-demographics, dietary intake, health-related behaviour, body mass index (BMI) and a dental problem (28). The classification tree was able to identify the protein dissimilarity score, which was recorded and a sequence distance matrix was produced (29). A novel gene prediction method that is both fast and accurate, by

making use of protein homology and decision tree classification (30).

Figure 6. The correlation between Free Variables (BM08, BM09, BM05, BM04, BM02, BM03, BM10, BM07 and MSG) and Level of Significance(12)

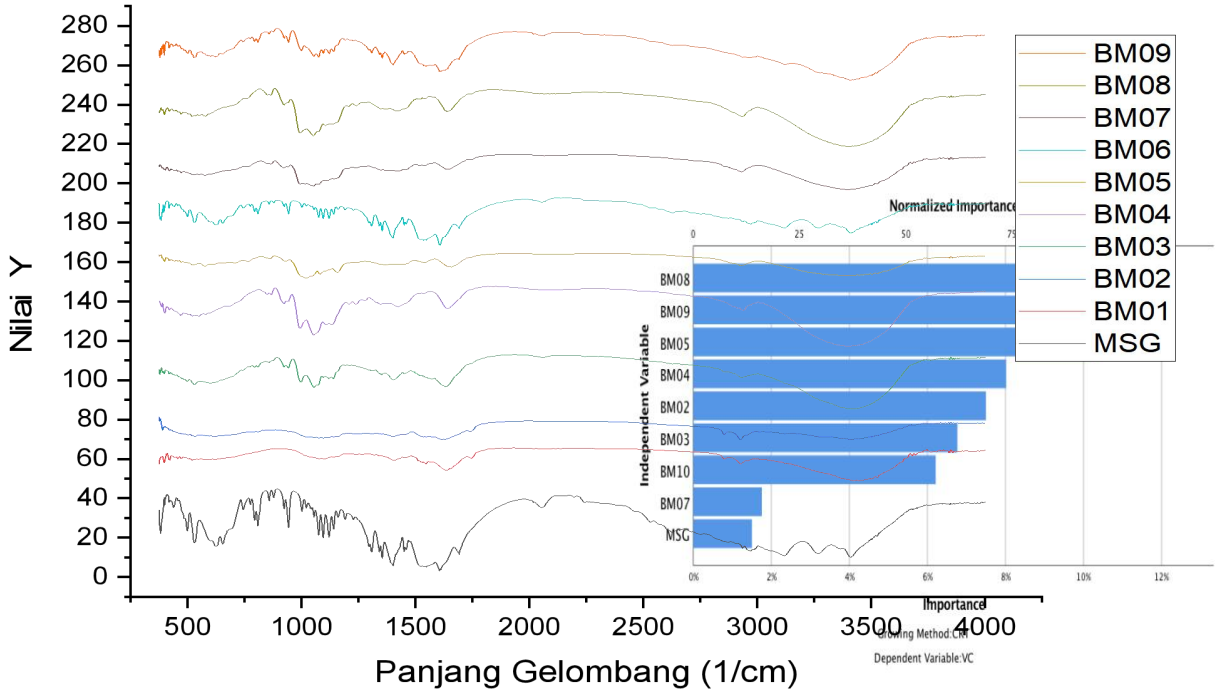


Figure 7. The absorbance pattern (spectrogram) of 10 (ten) cooking spices (MSG, BM02, BM03, BM04, BM05, VC, BM07, BM08, BM09, and BM10)

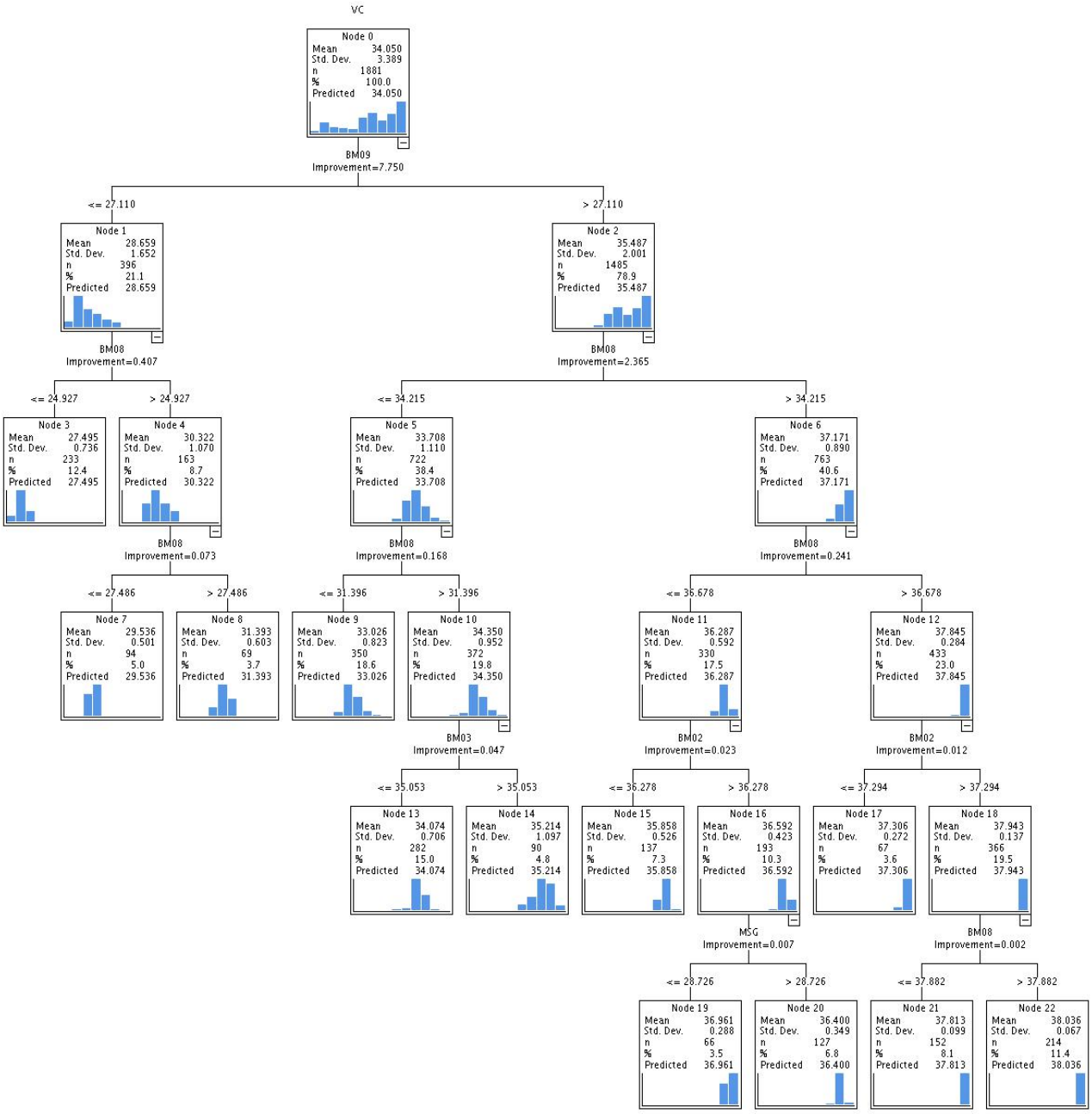


Figure 8. Classification Three with Chinese flavor enhancing ingredient (VC) Bond Variable and Free Variable : BM08, BM09, BM05, BM04, BM02, BM03, BM10, BM07 and MSG (12)

Table 4. Absorbance (n) Point Observation Results of Fourier Transform Infrared (FTIR) of 10 (ten) Cooking Spices

NO	MATERIAL	CODE	n (A) 400-2250	n (B) 2250-4000	n (C) 2250-4000	n (D) 400-2250	TOTAL ABS POINT
1	Balado Flavored Cooking Spice	BM01	928	663	245	45	1881
2	Totole Mushroom Powder Cooking Spice	BM09	709	513	395	264	1881
3	Indofood Magic Cooking Spice	BM03	828	635	273	146	1882
4	Straw Mushroom Flavored Cooking Spice	BM04	824	640	268	149	1881
5	Chicken Broth Flavored Cooking Spice	BM08	874	641	267	99	1881
6	Beef Broth Flavored Cooking Spice	BM07	800	652	256	173	1881
7	Currie Flavored Cooking Spice	BM02	277	496	412	698	1883
8	Mama Cooking Spice	BM05	842	629	279	131	1881
9	Chinese Flavor Enhancing Ingredient	BM06	763	651	257	210	1881
10	MSG	BM10	695	545	363	265	1868

Table 5. Interpretation Results of FTIR Absorbance Pattern Variable of Cooking Spice for 18,800 Observation Points (12)

NO	VARIABLE	FACTOR	EIGEN VALUES	LOADING FACTOR	% VARIANCE	CUMULATIVE%
1	VC	The similarity of raw materials, supportive materials and additives those compile product composition with Chinese flavor enhancing ingredient (F1)	8.240	0.920	82.399	82.399
2	BM 02			0.755		
3	BM 03			0.663		
4	BM 04			0.829		
5	BM 05			0.958		
7	BM 08			0.938		
8	BM 09			0.948		
9	BM 10			0.646		
1	MSG	The similarity of raw materials, supportive materials and additives those compile product composition with MSG (F2)	1.237	0.961	12.372	94.771
2	BM 02			0.576		
3	BM 03			0.590		
4	BM 04			0.533		
5	BM 07			0.948		
6	BM 10			0.743		

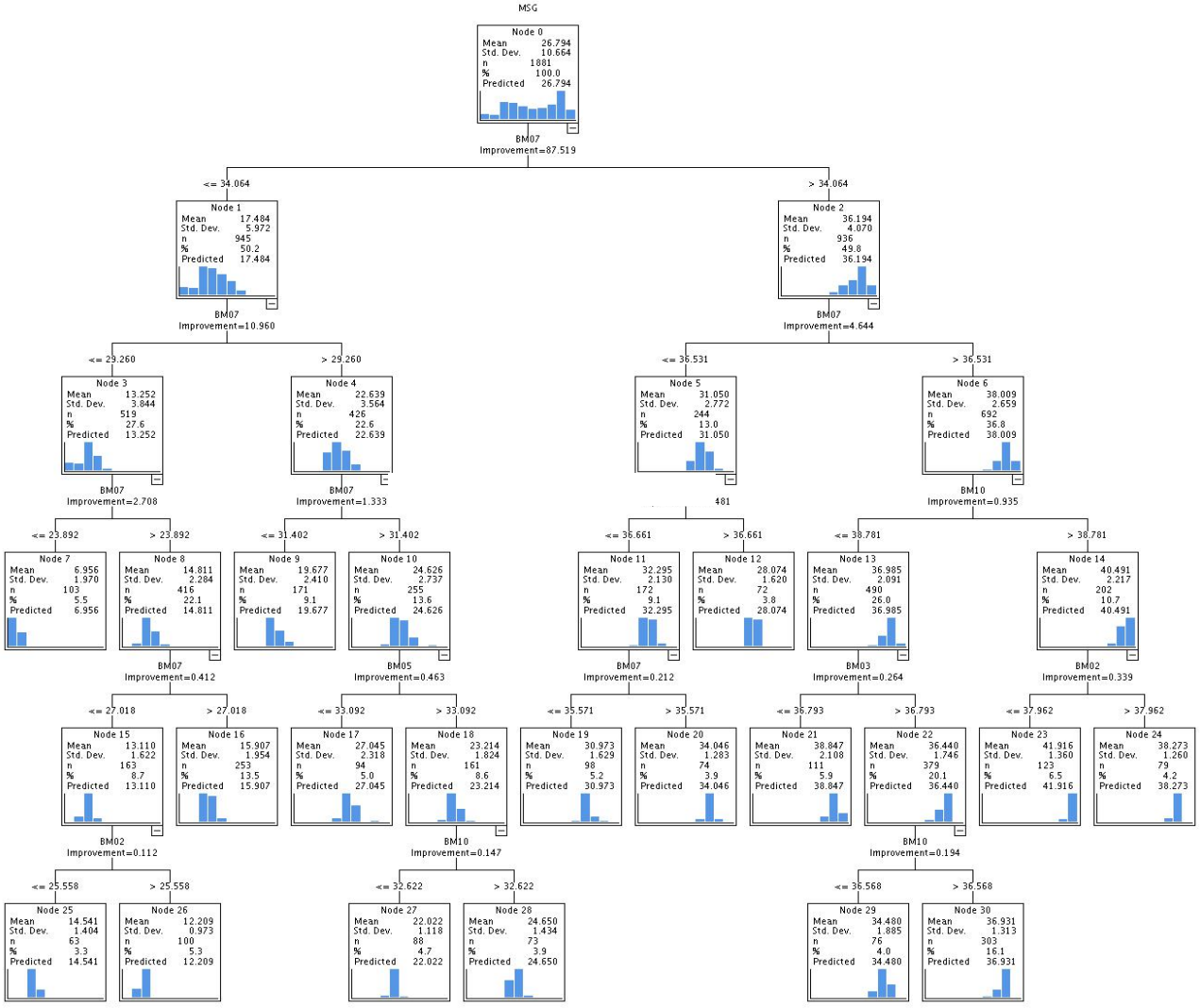


Figure 10. Classification Three with Monosodium Glutamate (MSG) Bond Variable and Free Variable : BM08, BM09, BM05, BM04, BM02, BM03, BM10, BM07 and VC (12)

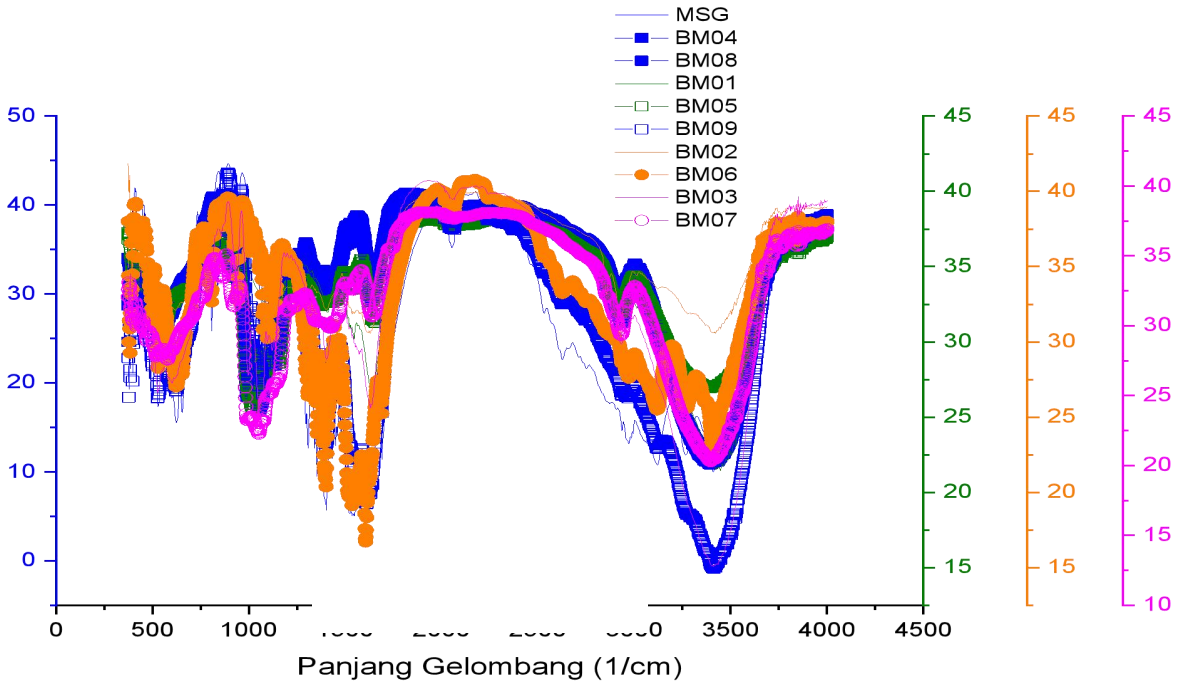


Figure 9. The combined absorbance pattern (*spectrogram*) of 10 (ten) cooking spices (MSG, BM02, BM03, BM04, BM05, VC, BM07, BM08, BM09, and BM10)

4. Conclusion

1. The results of main component analysis indicate that cooking spices (BM02, BM03, BM04, BM07 and BM10) have similar FTIR absorbance pattern with monosodium glutamate (MSG) with eigenvalue of 8.240. Meanwhile, cooking spices (BM02, BM03, BM04, BM05, BM08, BM09 and BM10) have similar FTIR absorbance pattern with Chinese flavor enhancing ingredient (VC) with eigenvalue of 1.237.
2. The results of classification tree analysis with fixed variable, that is Chinese flavor enhancing ingredient (VC), and free variables, which are 9 (nine) cooking spices (BM08, BM09, BM05, BM04, BM02, BM03, BM10, BM07 and MSG), indicate that there are 7 (seven) free variables whose significance value is above 50%. They are BM08 (100%), BM09 (96.70%). BM05 (93.30%), BM04 (73.60%), BM02 (68.90%), BM03 (62.10%), and BM10 (57.00%). For fixed variable, which is MSG, it indicates that there are 4 (four) free variables whose significant value is above 50.00%. They are BM07 (100%), BM10 (73.4%), BM02 (56.90%) and BM04 (54.00%)
3. The 't' test results of paired samples of the total number of absorbance point (n) at wavelength from 400 cm^{-1} to 2,250 cm^{-1} with absorbance value from 0% to 25% or n (D) indicate that all paired tests are clearly different except 4 (four) paired tests. Those are between n (D) on BM 01 and VC, between n (D) on BM 01 and BM 07, between n (D) on BM 03 and BM 07 and between n (D) on BM 08 and MSG.

Data Availability

All data are available in the Department of Agriculture Industry Technology, Faculty of Engineering, Wijaya Kusuma University of Surabaya, East Java. Raw data are stored in computers and research reports.

Conflicts of Interest

The authors declare that they have no conflicts of interest

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