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Identification of Flavor Compounds from Soybean Peel Flour (*Glycine max L. Merr*) with the Addition of Kaffir Lime Leaves in the *Blanching Process*

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A B S T R A C T

Soybean husk flour is flour made from the main ingredient of soybean husk which undergoes a flouring process so that it can be substituted in making bakery products such as brownies, bread, and cookies. Apart from having a fairly high nutritional content, soybean epidermis also has an unpleasant odor that consumers don't like, so it needs to be reduced, one way is by blanching and adding kaffir lime leaves. This research aims to find the best treatment for the length of time for blanching and adding kaffir lime leaves. This research used a Completely Randomized Design (CRD) with two factors and two replications. Factor I is the length of blanching time (10 and 20 minutes) and factor II is the amount of added kaffir lime leaves (0, 5, 10, 15, and 20 gr). The data obtained was then analyzed using ANOVA and continued with the Duncan Multiple Range Test (DMRT) at the 5% level. The best treatment results were obtained in the treatment with a long blanching time of 20 minutes with the addition of 20 grams of kaffir lime leaves with characteristics of 9.55% water content, 1.98% ash, 7.77% protein, 1.60% fat, 30.02% crude fiber and flavor compounds found, among others. pentanal, oxirane,2-(1,1-dimethylethyl)-3-ethyl-, cis-, hexanal, furan, 2-pentyl-5-, octen-1-ol, (Z)-1,1-, dodecanediol, diacetate and cedrene.

1. INTRODUCTION

1.1. Research Background

The processing of tempeh in Indonesia using soybeans as raw material is quite well known Indonesia itself is known as the country of origin of tempeh. Tempe is a processed soybean product fermented by the mold *Rhizopus sp.* which is one of the traditional foods of our country. This tempeh can be obtained at a relatively cheap price but has good functional properties and a fairly high protein content so it is very popular with various groups of people [1]. However, during the tempe production process, a lot of waste is produced in the form of soybean epidermis in quite large quantities. So far, soybean husk waste produced by production houses has only been used to feed cattle in the production house area.

The potential of soybean epidermis that can be produced from tempeh processing is 8% [2]. The epidermis that can be produced from 50 kg of soybeans is ±7.5 kg [3]. In one batch of tempe production at a production house, more than 15 kg of soybean hull waste can be produced. This soybean husk waste must be utilized further so that it has more economic value and can reduce waste pollution for the environment if it is simply thrown away. This soybean husk has quite high nutritional content, including 14.45% protein, 3.04% crude fat, 3.15% ash, 47.01% fiber, and 3060.48 kcal/kg metabolic energy [4], so a lot of research has been carried out to utilize it. This waste aims to add nutritional value and economic value to the product to be produced.

Utilization of soybean bran flour can be used in making several types of products, such as bread, biscuits [5], cookies [6], flakes, brownies and dry pastries [7]. The research using soybean husk flour aims to improve product quality, however, the resulting flour still has a distinctive aroma and odor (flavorful) so it needs to be improved by adding kaffir lime leaves.

Kaffir lime leaves have benefits as a flavoring as well as herbal medicines with a distinctive fragrant smell. This distinctive aroma is known to come from the essential oil content in kaffir lime leaves. Kaffir lime leaves are known to contain as many as 38 compounds that can be identified in the essential oil of kaffir lime leaves [8]. Because of this fragrant aroma, it is hoped that the addition of kaffir lime leaves in the blanching process can reduce the unpleasant aroma of soybean epidermis so that better quality soybean epidermis flour can be produced. Research shows

that the blanching process can remove unwanted odors and flavors from ingredients.

Based on these, this research will identify the flavor compounds of soybean husk flour by treating it with a long *blanching time* and the addition of kaffir lime leaves so that the unpleasant odor can be reduced and does not interfere when processed into other products.

1.2. Literature Review

Soybean epidermis has a distinctive odor namely a pleasant smell [7]. This unpleasant smell (beany flavor) is caused by the lipoxygenase enzyme I the form of at least eight volatile compounds, especially ethyl-phenyl-keton [9]. Enzymatic oxidation by the lipoxygenase (LOX) gene of linoleic acid and linolenic acid is thought to be the main cause of unpleasant odors. Hexanal is generally associated with a grassy taste, and hexanol is an aromatic compound that is associated with the pleasant smell of soybeans. The undesirable taste caused by compounds in the soybean epidermis which creates an unpleasant odor and taste can be reduced by turning off the lipoxygenase enzyme using heat [10].

Kaffir lime leaves are known to contain bioactive compounds including essential oils, flavonoids, saponins, and steroids [11]. Essential oils are compounds that can give plants their odor. Essential oils contain volatile components that have certain characteristics [12]. The citronellal content in the essential oil of kaffir lime leaves is high, causing these leaves to have a strong fragrance. The essential oil content in kaffir lime leaves consists of citranellal, ctronellol, linalol and genariol [10].

1.3. Research Objective

This study aims to determine what groups of flavor compounds are contained in soybean husk flour with the addition of kaffir lime leaves and to find out the best treatment from the length of *blanching* time and the number of added kaffir lime leaves.

2. MATERIALS AND METHODS

2.1. Material and Tools

The materials that will be used in this research are soybean epidermis obtained from tempeh processing waste from the tempeh production house in Tenggilis temple village and kaffir lime leaves from the Sopoyono market, Surabaya. The chemicals that will be used for the analysis process of soybean husk flour are distilled water, H_2SO_4, NaOH, catalyst, ethanol, and n-hexane.

The tools used for making flour and analysis during the research include pans, stoves, baking sheets, blenders, 100 *mesh sieves*, tongs, digital scales, analytical balances, *cabinet dryers*, stirrers, desiccants, soxhlets *and* condensers, *water baths*, funnels, Porcelain cup, electric furnace, test tube, closed weighing bottle, oven, Kjeldahl flask, GC-MS brand Chromeleon 7, Version 7.2.10.24543, Thermo Fisher Scientific.

2.2. Design Experiment and Analysis

The research design used in this research was a Completely Randomized Design (CRD) factorial pattern with 2 factors and 2 repetitions. The treatment used was the length of *blanching* time (10 and 20 minutes) and the number of added kaffir lime leaves. when *blanching* (0 gr, 5 gr, 10 gr, 15 gr, 20 gr). The observation variable data was tested statistically using analysis of variance at $\alpha = 5\%$ using the DMRT follow-up test.

2.3. Implementation of Research

2.3.1. Making soybean husk flour

Soybean epidermis weighed 500 grams, washed until clean then drained, blanching process was carried out by adding 0 gr, 5 gr, 10 gr, 15 gr, 20 gr of kaffir lime leaves to water for 10 or 20 minutes. Dry using a cabinet dryer at 65ºC for 10 hours. Puree using a blender and sift with a 100-mesh sieve.

2.4. Observation

2.4.1. Organoleptic analysis

Organoleptic analysis used the hedonic test method for 27 panelists with color, aroma, and taste parameters.

2.4.2. Chemical analysis

Analysis parameters include a content analysis water using the gravimetric method, ash content using the gravimetric method, protein content using the direct extraction method, fat content using the Kjeldahl method, and crude fiber content using the gravimetric method.

2.4.3. Flavour compound analysis

The best treatment obtained from organoleptic analysis and chemical analysis was then analyzed for flavor compounds using *Gas Chromatography Mass Spectrometry (GC-MS)* brand Chromeleo n 7, Version 7.2.10.24543 Thermo Fisher Scientific with the following conditions.

GC Conditions
Column : HP-5MS UI
Column Size : 30m X 0.25mm X 0.25 µm
Oven column temperature : 40ºC
Injector temperature : 230ºC
Carrier gas : helium
District carrier gas : 1000 mL/minute
Column temperature : initial temperature 40ºC for 2 minutes, increased 5ºC/minute to 150ºC and maintained for 3 minutes, within 8 minutes increased 10ºC/minute to 230ºC and maintained for 5 minutes.

MS conditions
m/z range : 25 – 500
Event time : 0.2 seconds

3. RESULT AND DISCUSSION

3.1. Organoleptic Analysis

Organoleptic analysis carried out using sensory panelists is important for determining product quality and can provide an overview of consumers' views of the product that will be made later [13]. The hedonic method with color, aroma, texture and taste parameters can be used to assess the level of panelists liking each sample.

3.1.1. Color

Based on the results of the analysis of variance in Table 1, it shows that the treatment took a long time *for blanching* and the

addition of kaffir lime leaves had a significant effect (p≤0.05) on the color preference value of soybean husk flour. The lowest level of liking was found in the treatment with a long *blanching time* of 10 minutes and the addition of 15 grams of kaffir lime leaves with a value of 3.48 which means "rather like it". Meanwhile, the highest level of liking with a value of 4.63 was found in 2 treatments, namely in the treatment with a long *blanching time* of 20 minutes with the addition of 15 grams of kaffir lime leaves and 20 grams which means "very like".

Blanching and drying processes that occur can change the color of a product due to the heating process [14]. However, because the temperature used during the process is not too high, the color of the flour does not change much from the original color of the soybean epidermis. The flour color that the panelists liked most was the treatment with a long *blanching time* of 20 minutes with the addition of 15 gr and 20 gr of kaffir lime leaves. The flour in this treatment has a brown color that is not too bright and not too dark.

Table 1. Results of Color Analysis of Soybean Skin Flour on Blanching Time and Addition of Kaffir Lime Leaves.

Treatment		Average Value
Boiling time (minutes)	**Orange leaves (g)**	
10	0	4.59
	5	4.19
	10	3.96
	15	3.48
	20	4.15
20	0	4.26
	5	4.30
	10	4.44
	15	4.63
	20	4.63

3.1.2. Flavor

The test results showed that the treatment with long *blanching* time and the addition of kaffir lime leaves during *blanching* were significantly different (p≤0.05) on the taste preference of soybean husk flour. The results of the taste analysis test can be seen in Table 2.

Table 2. Results of Taste Analysis of Soybean Skin Flour on Blanching Time and Addition of Kaffir Lime Leaves.

Treatment		Avarage Value
Boiling time (minutes)	**Orange leaves (g)**	
10	0	3.04
	5	3.37
	10	3.74
	15	3.48
	20	3.52
20	0	3.81
	5	3.70
	10	3.63
	15	3.81
	20	3.96

Table 2 shows that the treatment took a long time *for blanching* and the addition of kaffir lime leaves had a significant effect (p≤0.05) on the panelists' preference for the taste of soybean husk flour. The lowest level of liking for this taste parameter was 3.04 in the treatment with a long *blanching time* of 10 minutes and the addition of 0 grams of kaffir lime leaves, which means "like". Meanwhile, the highest level of taste preference was 3.96 in the treatment with a long *blanching time* of 20 minutes and the addition of 20 grams of kaffir lime leaves, which means "like".

The undesirable taste of soybean husk flour comes from volatile compounds produced during the soaking and crushing process. Apart from the volatile compounds resulting from the lipoxygenase enzyme reaction, hexanal compounds in soybean epidermis are also thought to be the cause of the *grassy taste* in flour. Therefore, the results of the taste analysis are in Table 2 showed that the level of panelists' liking for the taste of soybean husk flour increased as the heating process took longer and the addition of kaffir lime leaves. The flavors that are less desirable due to the reaction of the lipoxygenase enzyme resulting in a bitter and *grassy taste* can be reduced by using a heating process [10].

3.1.3. Aroma

Based on the results of the analysis of variance, it can be seen that there is a significant interaction (p≤0.05) between treatments, length of *blanching time* and the addition of kaffir lime leaves . The average ranking value of aroma parameters with long *blanching* time treatment and the addition of kaffir lime leaves can be seen in Table 3.

Table 3 shows the panelists' preference for the aroma of soybean husk flour with an average r value of 3.17 – 4.59. The lowest level of liking was found in the treatment with a long *blanching time* of 10 minutes and the addition of 0 grams of kaffir lime leaves (3.17) which means "like". The highest level of liking was found in the treatment with a long *blanching time* of 10 minutes and the addition of 15 grams of kaffir lime leaves (4.59) which means "liked it very much".

Table 3. Results of Aroma Analysis of Soybean Peel Flour on Blanching Time and Addition of Kaffir Lime Leaves.

Treatment		Average Value
Boiling time (minutes)	**Orange leaves (g)**	
10	0	3.17
	5	3.56
	10	3.76
	15	4.59
	20	3.50
20	0	3.74
	5	3.69
	10	3.89
	15	4.19
	20	4.35

These results were obtained because the longer the heating process (*blanching*) can reduce *the off-flavor* or unpleasant smell of soybean epidermis. The *off-flavor* or bad smell can be reduced by processing processes such as soaking and heating. To provide an aroma that is more acceptable to consumers, kaffir lime leaves are added to the water during the *blanching process* [15].

Kaffir lime leaves are usually used as a freshener in several dishes because the essential oils contained in them make kaffir

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lime leaves a distinctive fragrant aroma [12]. From Table 3 it can also be seen that the addition of kaffir lime leaves can increase the panelists' preference for the aroma of soybean husk flour because the unpleasant smell has been reduced and there is a fragrant aroma coming from the kaffir lime leaves.

3.2. Chemical Analysis

The chemical analysis carried out to test the quality of soybean husk flour with the addition of kaffir lime leaves during the *blanching process* was an analysis of water, ash, protein, fat, and crude fiber content.

3.2.1. Water content

Based on the results of the analysis, it can be seen that there is a real interaction ($p \leq 0.05$) between the length of *blanching time* and the addition of kaffir lime leaves during *blanching*, thus indicating that there is *a* real influence on the water content value of soybean husk flour. The average value of water content of soybean husk flour with a long *blanching time* and the addition of kaffir lime leaves during *blanching* can be seen in Table 4.

Table 4. Results of Analysis of Water Content of Soybean Skin Flour in Treatment with Long Blanching Time and Addition of Kaffir Lime Leaves during Blanching.

Treatment		Water content (%)
Boiling time (minutes)	Orange leaves (g)	
10	0	$10.21^{e} \pm 0.15$
	5	$10.00^{de} \pm 0.07$
	10	$9.86^{cd} \pm 0.06$
	15	$9.65^{abc} \pm 0.11$
	20	$9.35^{a} \pm 0.08$
20	0	$11.11^{f} \pm 0.24$
	5	$10.59^{f} \pm 0.04$
	10	$10.27^{e} \pm 0.21$
	15	$9.80^{bcd} \pm 0.12$
	20	$9.55^{ab} \pm 0.09$

Note: Water content values accompanied by different letters indicate significant differences at $p \leq 0.05$

Table 4 shows that the average value of water content in soybean husk flour with long *blanching time* and the addition of kaffir lime leaves during *blanching* ranges from 9.35 – 11.11%. The lowest water content was found in soybean husk flour with a long *blanching* time of 10 minutes and the addition of 20 grams of kaffir lime leaves, namely 9.35%. Meanwhile, the highest water content was owned by soybean husk flour with a long *blanching time* of 20 minutes and the addition of 0 grams of kaffir lime leaves, namely 11.11%.

The longer the *blanching time*, the higher the water content of the flour, while the more kaffir lime leaves you add, the lower the water content of the flour. This is because the heat transfer that occurs during the *blanching process* can weaken the hydrogen bonds in the material so that water molecules can more easily enter the material and increase the water content of the product. The longer the *blanching process* takes, the more water vapor can osmosis into the flour. The *blanching process* can open the pores of the material and water vapor from the *blanching process* can enter the material [16].

The greater the number of kaffir lime leaves added during the *blanching process* causes the water content in the flour to be lower. This is because the compounds contained in kaffir lime leaves can help reduce the osmosis process. The tannin compounds found in kaffir lime leaves can reduce the process of osmotic dehydration.

3.2.2. Ash content

Based on the analysis results, it shows that there is no real interaction ($p \geq 0.05$) between the length of *blanching time* and the addition of kaffir lime leaves during *blanching* so it does not have a real effect on the ash content of soybean husk flour. The average value of ash content in soybean husk flour in the treatment of long *blanching time* and the addition of kaffir lime leaves during *blanching* can be seen in Table 5. The average value of ash content in the long *blanching time treatment* and the addition of kaffir lime leaves during *blanching* was between 1.85 – 2.07%. The lowest average value of ash content was found in the treatment with a long *blanching* time of 10 minutes and the addition of 20 grams of kaffir lime leaves at 1.85%. Meanwhile, the highest ash content value was found in the treatment with a long *blanching time* of 20 minutes and the addition of 0 gr, 5 gr, and 10 gr of kaffir lime leaves at 2.07%.

Table 5. Results of Analysis of Ash Content of Soybean Skin Flour in Treatment with Long Blanching Time and Addition of Kaffir Lime Leaves during Blanching.

Treatment		Ash content (%)
Boiling time (minutes)	Orange leaves (g)	
10	0	$1.9^{ab} \pm 0.10$
	5	$2.02^{ab} \pm 0.04$
	10	$1.90^{ab} \pm 0.08$
	15	$1.97^{ab} \pm 0.06$
	20	$1.85^{a} \pm 0.05$
20	0	$2.07^{b} \pm 0.08$
	5	$2.07^{b} \pm 0.06$
	10	$2.07^{b} \pm 0.06$
	15	$1.97^{ab} \pm 0.21$
	20	$1.98^{ab} \pm 0.03$

Note: Ash content values accompanied by different letters mean significantly different ($p \leq 0.05$).

Table 5 also shows that the treatment with long *blanching time* and the addition of kaffir lime leaves during *blanching* did not have a significant effect on changes in the ash content of soybean husk flour. This is because the ash content in a product comes from the minerals contained therein. Meanwhile, in this study, the source of minerals only came from soybean husks and there was no addition of other mineral sources. The ash content in a product comes from mineral elements and other chemical composition. These minerals cannot be evaporated during the ashing process, the amount of minerals remaining during the ashing process indicates the ash content in a material or product [17].

3.2.3. Protein content

Based on the results of the analysis, it showed that there was a real interaction ($p \leq 0.05$) between the long blanching treatment and the addition of kaffir lime leaves during blanching. This means that the long blanching time and the addition of kaffir lime leaves during blanching have a real influence on the protein content of soybean husk flour. The average value of protein

content from each treatment for the length of blanching time and the addition of kaffir lime leaves during blanching can be seen in Table 6.

Table 6. Results of Analysis of Protein Content of Soybean Skin Flour in Treatment with Long Blanching Time and Addition of Kaffir Lime Leaves during Blanching.

Treatment		Protein content (%)
Boiling time (minutes)	Orange leaves (g)	
10	0	$8.00^{ab} \pm 0.05$
	5	$7.88^{bc} \pm 0.08$
	10	$8.03^{ab} \pm 0.07$
	15	$8.15^{ab} \pm 0.05$
	20	$7.87^{bc} \pm 0.07$
20	0	$7.59^{de} \pm 0.14$
	5	$7.40^{f} \pm 0.01$
	10	$7.56^{e} \pm 0.06$
	15	$7.63^{de} \pm 0.13$
	20	$7.77^{cd} \pm 0.06$

Note: Protein content values accompanied by different letters mean significantly different ($p \leq 0.05$).

Table 6 shows that the average value of protein content from the long blanching treatment and the addition of kaffir lime leaves during blanching ranged between 7.40 – 8.15%. The lowest average protein content was found in the treatment with a long blanching time of 20 minutes and the addition of 5 grams of kaffir lime leaves, namely 7.40%. The highest average protein content was found in the treatment with a long blanching time of 10 minutes and the addition of 15 grams of kaffir lime leaves. The longer the blanching treatment, the lower the protein content will be. This is because the longer the blanching process takes, the more protein will be denatured by heat. Exposing food ingredients to heat can cause nutritional content such as protein to undergo a denaturation process [5].

3.2.4. Fat level

Based on the analysis results in the table, shows that the length of *blanching time* and the addition of kaffir lime leaves during *blanching* there is a significant interaction ($p \leq 0.05$) between the two. It can also be concluded that the long *blanching time* and the addition of kaffir lime leaves during *blanching* have a real influence on the fat content of soybean husk flour. The average value of the fat content of soybean husk flour in the treatment of long *blanching time* and the addition of kaffir lime leaves during *blanching* can be seen in Table 7.

Table 7 shows that the average value of fat content for soybean husk flour treated with a long *blanching time* and the addition of kaffir lime leaves during *blanching* ranged from 1.23-1.89% with the lowest average value being the treatment with a long *blanching time* of 20 minutes and the addition of kaffir lime leaves. when *blanching* as much as 0 gr. The highest average fat content value was in the treatment with a long *blanching time of 10 minutes and the addition of* 0 grams of kaffir lime leaves during *blanching.*

The longer the *blanching time* is given, the fat content in soybean husk flour will decrease. This decrease in fat levels is because fat is one of the nutrients in food that will be damaged during the heating process. The *blanching process* affects the nutritional condition of food ingredients [18]. The components contained in fat will break down and turn into volatile compound components, such as aldehydes, alcohols, ketones and other acids [19].

Table 7. Results of Analysis of Fat Content of Soybean Skin Flour in Treatment with Long Blanching Time and Addition of Kaffir Lime Leaves during Blanching.

Treatment		Fat level (%)
Boiling time (minutes)	Orange leaves (g)	
10	0	$1.89^{a} \pm 0.03$
	5	$1.76^{ab} \pm 0.10$
	10	$1.82^{a} \pm 0.11$
	15	$1.78^{ab} \pm 0.01$
	20	$1.86^{ab} \pm 0.04$
20	0	$1.23^{d} \pm 0.13$
	5	$1.42^{cd} \pm 0.03$
	10	$1.65^{e} \pm 0.06$
	15	$1.64^{bcd} \pm 0.09$
	20	$1.60^{bcd} \pm 0.23$

Note: Protein content values accompanied by different letters mean significantly different ($p \leq 0.05$).

3.2.5. Crude fiber content

The results of the analysis in the table show that there is no real interaction ($p \geq 0.05$) in the treatment of long *blanching time* and the addition of kaffir lime leaves during *blanching*, so it can be concluded that the two treatments did not have a significant effect on the crude fiber content of soybean husk flour. The average value of crude fiber content in soybean husk flour with long *blanching time* and the addition of kaffir lime leaves during *blanching* can be seen in Table 8.

Table 8. Results of Analysis of Crude Fiber Content of Soybean Skin Flour in Treatment with Long Blanching Time and Addition of Kaffir Lime Leaves during Blanching.

Treatment		Crude fiber content (%)
Boiling time (minutes)	Orange leaves (g)	
10	0	$31.44^{a} \pm 0.45$
	5	$31.13^{ab} \pm 0.11$
	10	$29.60^{ab} \pm 0.97$
	15	$29.95^{ab} \pm 1.69$
	20	$29.38^{ab} \pm 0.06$
20	0	$30.75^{ab} \pm 0.74$
	5	$30.99^{ab} \pm 0.36$
	10	$29.32^{ab} \pm 0.32$
	15	$29.25^{b} \pm 1.55$
	20	$30.02^{ab} \pm 0.77$

Note: Protein content values accompanied by different letters mean significantly different ($p \leq 0.05$).

Table 8 shows the results of crude fiber content in soybean husk flour which has the lowest average value of crude fiber content found in flour treated with a long *blanching time* of 20 minutes and the addition of 10 grams of kaffir lime leaves at 27.52%. The highest average crude fiber content was found in flour with a long *blanching time* of 10 minutes *and the addition of* 0 grams of kaffir lime leaves when *blanching was 33.18%.* From The table can also be seen that Treatment with long *blanching time* and the addition of kaffir lime leaves during

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blanching did not have much effect on the crude fiber content of soybean husk flour. This is because crude fiber is a non-nutritive food substance that is insoluble in water, acids or bases [20] and there is no addition of other ingredients to the flour so that the two treatments cannot increase or reduce the crude fiber content in the product.

3.3. Flavor Compound Analysis

The results of analysis using GC-MS showed that there were ±80 compounds that were readable, from reagents to flavor compounds. However, many new compounds were discovered resulting from derivatives of compounds found in soybean husk flour. This new compound can be produced from an oxidation process or other reaction so that it can change one compound molecule into another molecule. Of the many compounds read, there are flavor compounds which are the cause of the distinctive aroma of soybean husk flour. Flavor compounds found in soybean husk flour can be seen in Table 9.

Table 9 shows that the flavor compounds contained in soybean husk flour come from the group of Ether, Aldehyde, Alcohol and Essential Oil compounds. The ether compound group comes from the main ingredient of soybean epidermis, while the aldehyde, alcohol and essential oil compound groups mostly come from the volatile components of kaffir lime leaves which are added during the *blanching process.* Kaffir lime leaves contain bioactive compounds such as essential oils, flavonoids and steroids [11]. This bioactive compound is volatile so it evaporates easily.

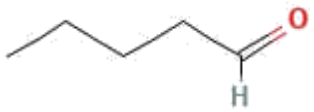

Fig 1. Pentanal Compound Structure

Pentanal is an organic compound belonging to the alkyl aldehyde group. It has the molecular formula C_4H_9CHO and is volatile or evaporates easily. Pentanal compounds can be found in several types of plants, especially in the open seed plant group. One of the compounds found in soybean epidermis is a saturated fatty acid. It is characterized by being a colorless liquid and giving off a distinctive aroma such as nuts and fruit [21].

In this GC-MS analysis, the pentanal compound gave a peak at a retention time of 2,728 minutes with an area of 5.53%.

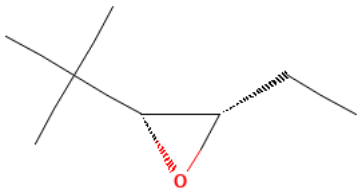

Fig 2. Structure of the Oxirane Compound, 2-(1,1-dimethylethyl)-3-ethyl-, cis-

At a retention time of 3,857 minutes, the Oxirane compound, 2-(1,1-dimethylethyl)-3-ethyl-, cis- produced a peak with an area of 1.51%. This compound has the molecular formula $C_8H_{16}O$ and belongs to the Aldehyde group of compounds. It is characterized by being a colorless liquid and having a strong fruity aroma. This compound is also found in many orange oils and is used as an ingredient in making flavors and perfumes.

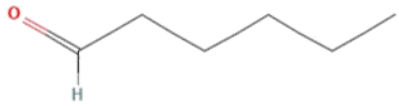

Fig 3. Structure of Hexanal Compounds

The next flavor compound that was read from the GC-MS results was the Hexanal compound ($C_6H_{12}O$). This compound produced a peak at a retention time of 4,411 minutes with an area of 18.63%. Hexanal, which is a flavor compound with the largest area, is a compound derived from soybean husks. Hexanal compounds were found in relatively high concentrations in the analysis of volatile compounds in soybean seeds [22]. The hexanal compound content also causes the *grassy aroma* and the appearance of an *off-flavor* in soybean husk flour.

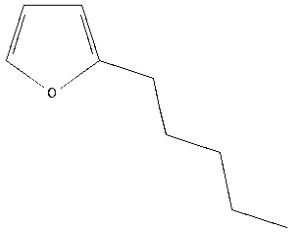

Fig 4. Structure of the Furan Compound, 2-pentyl-

The GC-MS results also read the presence of a peak of the Furan compound, 2-pentyl- at a retention time of 9,577 minutes with an area of 1.52%. The Furan compound, 2-pentyl- is a group of ether compounds with the molecular formula $C_9H_{14}O$. This compound also acts as a flavor compound which has a fruit-like aroma and as a volatile compound that evaporates easily in a material. Another compound that has the same role also appears at a retention time of 9,938 minutes (area of 0.29%), namely the compound 5-Octen-1-ol, (Z)-. This compound is a group of aliphatic alcohol compounds which have a fresh aroma like citrus and fruit. This group of alcohol compounds can be produced from the activity of microorganism metabolites or as a result of carbonyl reduction in alcohol. The alcohol compound group does not really affect the flavor of a material in low concentrations [21].

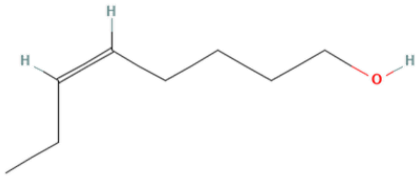

Fig 5. Structure of the Compound 5-Octen-1-ol, (Z)-.

Soybean husk flour with the addition of kaffir lime leaves also shows the presence of essential oil compounds which can be read when testing flavor compounds using GC-MS. The essential oils detected were 1,1-Dodecanediol, diacetate at a retention time of 13,002 minutes with an area of 0.12% and Cedrene at a retention time of 21,495 minutes with an area of 0.05%. These two essential oil compounds come from kaffir lime leaves which are added during the *blanching process* so that they evaporate and stick to the soybean epidermis at the top. The compounds contained in essential oils are volatile or easily evaporate. Apart from having volatile components with certain characteristics, the

essential oil content in kaffir lime leaves can also provide aroma to the plant [12].

Table 9. Flavor Compounds resulting from GC-MS of Soybean Peel Flour with the Addition of Kaffir Lime Leaves.

Ret. Time	Compound Group	Compound Name	% Area	Area	Compound Characteristics
2.728	Volatile Compounds (Alkyl Aldehydes)	Pentanal	5.53	7703043.469	Colorless, smells like fermentation, bready, fruity, nutty, berry.
3.857	Essential Oils (Aldehydes)	Oxirane,2-(1,1-dimethylethyl)-3-ethyl-, cis-	1.51	2098343.331	Liquid form smells like fruit, found in orange oil
4.411	Flavor Compounds (Ether)	Hexanal	18.63	25973459.317	Smells like fresh grass, causing an off-flavor taste in the nuts.
9.577	Volatile Compounds (Ether)	Furan, 2-pentyl-	1.52	2114070.141	Colorless, fruity aroma.
9.938	Volatile Compounds (Aliphatic Alcohols)	5-Octen-1-ol, (Z)-	0.29	405551.647	Smells fresh like citrus and fruit.
13.002	Essential oil	1,1-Dodecanediol, diacetate	0.12	162516.615	Essential Oil, aromatic compounds in leaves or flowers.
21.495	Essential Oils (Steroids)	Cedrene	0.05	76417.241	The smell is seet, woody, fresh, leafy.

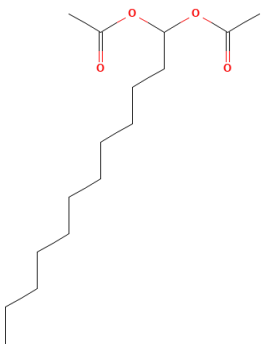

Fig 6. Structure of the Compound 1,1-Dodecanediol, diacetate

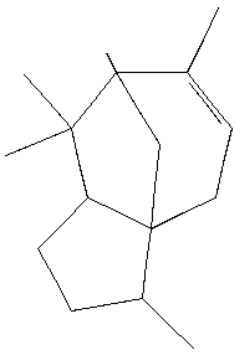

Fig 7. Cedrene Compound Structure

4. CONCLUSION

Research on soybean husk flour with long *blanching treatment* and the addition of kaffir lime leaves can be concluded that: (1) Based on organoleptic tests and chemical characteristics, soybean husk flour produced with a long blanching time of 20 minutes with the addition of 20 grams of kaffir lime leaves is the flour with the best treatment which has a water content of 9.55%, ash content of 1.98%, protein content of 7.77%. The fat content is 1.86% and the crude fiber content is 30.02%; (2) The groups of flavor compounds found in soybean husk flour with the best treatment include the group of aldehyde compounds (Pentanal and Oxirane, 2-(1,1-dimethylethyl)-3-ethyl-, cis-), ether (Hexanal and Furan, 2- pentyl-), alcohol (5-Octen-1-ol, (Z)-) and essential oils (1,1-Dodecanediol, diacetate and Cedrene).

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