Physical, chemical and sensory properties of brownies substituted with sweet potato flour (*Ipomoea batatas* L.) with addition of black cumin oil (*Nigella sativa* L.)

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Abstract. Effect of addition black cumin oil on the physical (hardness) characteristics, chemical (water, ash, fat, protein, carbohydrate, antioxidant IC50, total phenol and active component) characteristics and sensory (flavor, taste, texture, overall) characteristics of brownies substituted sweet potato flour were investigated. Substituted brownies was added with 0.05%, 0.10%, 0.15%, 0.20% and 0.25% of nigella sativa oil. The result showed that water content, ash, protein, fat, total phenol were increased and carbohydrate, antioxidant IC_{50} was decreased by the addition of nigella sativa oil. Due to the sensory characteristics, panelist gave the high score for substituted brownies which was added 0.05% nigella sativa oil. The result showed that the best formula of substituted brownies which was added 0.05% of nigella sativa oil had 24.89% water content, 1.19% ash content, 7.54% protein content, 37.79% fat content, 53.06% carbohydrate contain, 1043.6 ppm IC_{50} antioxidant and 0.22% total phenol. The active component on the brownies using GCMS identification were palmitic acid, oleic acid, lauric acid, theobromine and vitamin E.

Keywords: brownies, component, cumin, antioxidant

1. Introduction

Free radicals are generated through external sources by unhealthy lifestyles and environmental factors, which can lead to cell degradation. Free radicals are generated through external sources by unhealthy lifestyles and environmental factors, which can lead to cell degradation. Free radicals in the body are responsible for the rapid evolution of more than 100 kinds of diseases (cardiovascular, neurological, endocrine, respiratory, immunity, ischemia, gastrointestinal disease, tumour growth and cancer) [1]. Many efforts can be done to reduce the presence of free radicals in the body, one of them is consuming healthy foods rich in antioxidant content. One of the ingredients rich in antioxidants is purple sweet potato flour, which contains 36.8% of antioxidants. One of the applications of sweet potato flour is the cake flour substitute ingredients. Brownies are a kind of solid chocolate cake, originally a flour and hard dough made from wheat flour, eggs, fat, granulated sugar and chocolate by baking [2] . Brownies usually contain less balanced nutrients, therefore, it is regarded as food that contains a less nutritional value that can be utilized by the body. One way to improve the brownies' nutritional value is to use sweet potato flour as the cake flour substitute ingredients. Besides purple sweet potato powders, spices and medicinal plants also have great potential as a source of food that can raise the functional value of antioxidants and products [3]. One of the herbs that contain antioxidants in Indonesia is black cumin. Along with adding nutritional properties of the product, black cumin oil also utilized due to low consumption and utilization in the product. The black cumin is

known by its seed which has special healing properties as known in the Quran (Al-Bukhari: 815) which states that black cumin seeds are used to treat all kinds of diseases except death itself [4]. Black cumin seed oil is also regarded for its high-level of anti-oxidant activity. Antioxidant activity of black cumin oil is caused by the fatty acid content of oleic fatty acids, tocopherol, phenol, and β-carotene. The antioxidant activity of black cumin oil is associated with the phenolic compound. It has been reported that olive oil is the only vegetable oils that contain higher phenolic content than black cumin oil [5]. The addition of black cumin oil to purple sweet potato brownies products is expected to increase the antioxidant content of the product, know the best addition of black cumin oil which was added substituate sweet potato flour brownies.

2. Materials and Methods

2.1. Materials

Black cumin oil is obtained from CV. Lansida Yogyakarta (Indonesia). Twenty five percent of Purple Sweet Potato Flour [2] used for brownie the brownies flour substitute ingredients are obtained from CV.Kusuka Ubiku, Yogyakarta (Indonesia). Supporting materials such as "Segitiga Biru" flour, dark cooking chocolate "Cholata", sugar, egg, margarine, and cooking oil "Filma" are obtained from Pasar Gede Solo (Indonesia).

2.2. Characteristics Analysis of Raw Material

The Purple sweet potato flour's water content is identified with thermogravimetry method, ash content with dry method, fat with the micro-soxhlet method, the protein with micro-Kjeldahl method [6] and antioxidant IC50 with DPPH method [7]. Black cumin oil's density is determined using pycnometer [6], IC50 antioxidant by DPPH method [7] and components identified by GCMS method [8]

2.3. Brownies production

Brownies production was divided into two steps. The first step, dark cooking chocolate was melted with 110 ml cooking oil. The second step, 3 eggs were whipped with sugar till change into white colour and expand. Then, first step and second step was mixed and was added with 56.25 wheat flour, 18.75 sweet potato flour, 10 g chocolate powder, 80 ml sweetened condensed milk, 1 g vanili, 1 g salt and nigella sativa oil (0.05%, 0.10%, 0.15%, 0.20%, and 0.25%). Then, brownies dough was poured on a baking sheet, then was steamed for 45 minutes.

2.4. Characteristics Analysis of Brownies Product

Brownies product was investigated for physical, chemical and sensory properties. Hardness was investigated as physical properties by Llyod Universe Testing Machine [9]. Chemical properties *i.e* thermogravmetry was used for water content [6], the oven was used for ash content [6], mikro-soxhlet was used for fat content [6], micro-kjedahl was used for protein content [6], by difference was used for carbohydrate contain [6], DPPH was used for antioxidant IC50 [7], GCMS Agilent Technologies Model 6890N was used for identify component product [8]. Scoring was used for sensory properties [10]. All these studys were performed in triplicate, except GCMS identify. After that, brownies product was determined the best formula by compensatory method [11]. The principle of compensatory testing technique gives a score in accordance with the contribution of a characteristic to the resulting formula. The best formula was based on the highest value of all formula.all formulas.

3. Results and Discussion

3.1. Chemical and Physical Properties of Brownies Product

The raw material of purple sweet potato flour and black cumin oil are tested before being processed into brownies. Purple sweet potato flour contains 10.37% water content, the ash content of 0.92%, the fat content of 2.83%, 4.35% protein content, and the carbohydrate content of 92.23%. The IC50 antioxidant content is 1591.5 ppm. Black cumin oil contains 412.2 ppm of antioxidants, a density of 0.922 g / ml and the identified components are oleic acid , linoleic acid (57.24%), lauric acid, palmitic acid (3.11%), limonene (2.57%), jupine (0.83%) and thymoquinone (13.80%), while the highest component carried is linoleic acid

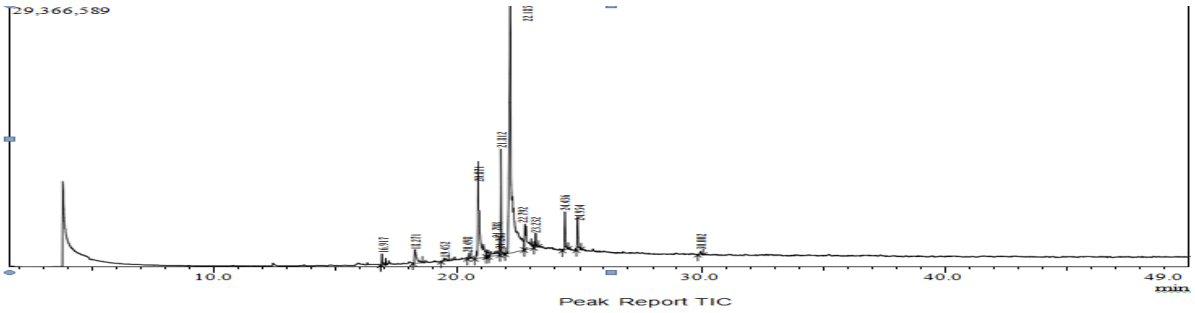

Figure 1. Chromatogram Gc-Ms of black cumin oil

The results of the physical properties of brownies' hardness (table 1). Melapa states that product hardness is influenced by water content, protein, fat, and the use of baking ingredient [12]. The decline in hardness in this study is caused by its high water content and the addition of black cumin oil. According to [13], the increase in water content in a product can decrease its hardness. The higher the water content of the brownies, the lower the hardness will be. [14] states that high water content in the material will cause the texture of the product to become softer. [15] states that the unsaturated fatty acid content and the "air binding capacity" can also cause the texture of brownies to become softer, this indicates that the higher concentration of black cumin oil will result in lower F max because the texture produced is softer. The higher the black cumin oil content, the higher the content of the water, as well as the content of ash, protein, fat, and total phenol. Meanwhile, the carbohydrate and Ic50 antioxidant content will decrease as the black cumin oil content is increased. The highest number of water content, ash, fat, protein and total phenol are recorded in the addition of 0.25% black cumin oil. It is also worth noting that the increased number of water content is caused by protein and cooking process.

The chemical properties (table 1). [16] stated that the higher the protein content the higher the water binding capacity. Along with the increasing amount of protein as the cumin oil increases, the number of hydrophilic groups will also be higher. The higher the hydrophilic group, the water absorption capacity will increase. The steaming process also has a considerable effect. [17] declared that steamed material will give the material the opportunity to absorb water vapour, resulting in an increase in the water content of the material. Increased ash content was caused by black cumin oil containing Zinc 15 mg / ml, copper 13 mg / ml, Iron 16.2 mg / ml, selenium 0.23 mg / ml, manganese 11 mg / ml, based on [18]. The increased protein content is caused by the content of 208 mg / g of protein in black cumin oil based on [18]. Increased fat content caused by the addition of black cumin oil, it is known that black cumin oil content of 70% unsaturated fatty acid and 18.5% saturated fatty acids[19] In addition, the increased fat levels are also caused by supporting materials such as dark cooking chocolate, chocolate powder, cooking oil, and condensed milk sweet.

The decrease in carbohydrate levels in brownies according to [20] is caused by the cooking process resulting in a decrease in levels of chemicals. Table 1 shows the decrease in antioxidant IC50 as black

cumin oil increases. [21] states that the lower the antioxidant activity of IC50 the better the antioxidant content of the product. The amount of antioxidant IC50 in the product are also affected by beta-carotene, total phenol and tocopherol. Total tocopherol in black cumin oil ranged from 9,15-24,65 mg / 100g, β-carotene amounted to 593μg / g, phenol in black cumin seed oil 245-369 mg / kg [22]. Antioxidant activity is also influenced by purple sweet potato flour which contains anthocyanin, [23] stated that the total anthocyanin in purple sweet potato flour is 18,1-25,7 mg / 100 g. The antioxidant activity in the brownies also influenced by Theobromine extracted from dark chocolate added to brownies. In this study, the antioxidant IC50 in brownies is compared with vitamin C. Vitamin C has a value of IC50 13.39 ppm, smaller than the value of IC50 brownies because it is a pure compound. The antioxidant activity of IC50 brownies is 43.39-77.39 times lower than vitamin C. According to [25], the total increase of phenol is due to the phenolic compounds such as vanillic acid and thymoquinone found in black cumin. The vanillic acid and thymoquinone are included in Quinonic phenolic compounds. [25] states that the total phenolic content can be used as an indicator to determine the hydrophilic activity of antioxidants. The higher the total phenol, the lower IC50 antioxidant activity will be. According to [21] the lower the antioxidant activity of IC50, the better the antioxidant content of the product. It is also shown that in this study, the higher the amount of, the higher the antioxidant activity.

Table 1 Chemical and physical properties of brownies product

Black cumin oil (%)	Water content (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Total phenol (%)	Antioxidant Ic_{50} (ppm)	Hardness (N)
0%	24.25^{a}	1.14^{a}	7.35^{a}	36.45^{a}	$55,35^{d}$	0.19^{a}	1275.35^{f}	9.91^{a}
0.05%	24.89^{ab}	1.19^{bc}	7.54^{ab}	37.79^{b}	$53,06^{c}$	0.22^{b}	1043.60^{e}	8.47^{ab}
0.10%	25.33^{bc}	1.23^{bc}	7.66^{b}	38.52^{b}	$52.,21^{c}$	0.23^{b}	943.20^{d}	8.26^{ab}
0.15%	25.84^{cd}	1.24^{bc}	7.86^{bc}	40.10^{c}	50.33^{b}	0.25^{c}	839.25^{c}	7.74^{ab}
0.20%	26.16^{de}	1.25^{bc}	8.03^{bc}	41.08^{cd}	49.15^{a}	0.26^{d}	745.60^{b}	7.56^{ab}
0.25%	26.68^{e}	1.28^{c}	8.17^{c}	41.95^{d}	48.15^{a}	0.29^{e}	580.94^{a}	7.07^{b}

$^{a-e}$ Mean different letter within each line are significantly different ($p<0.05$)%

3.2 Identify Component of Brownies Product

Component was contained in the brownies product (table 2) were palmitic acid, oleic acid, lauric acid, theobromine, vitamin E. In this study, take the five highest of identify component. Theobromine on the brownies product was caused by ingredients such as dark cooking chocolate and chocolate powder. Haryadi reproted that theobromine has functioned as a diuretic, cardiovascular stimulant [26]. Palmitic acid on the brownies due to ingredients was used such as cooking oil, black cumin oil, dark cooking chocolate. Listyawati reported that palmitic acid as an important calori source but has lower antidote of oxidations [27]. Oleic acid on brownies was from dark cooking chocolate, black cumin oil, cooking oil. Peddywati reported that oleic acid as an antioxidant to our body, oleic acid has functioned as an antidote of oxidation which was caused by ROS. Eddison reported that oleic acid was known as omega-9 and has a function to increasing HDL and decreasing LDL [28]. Lauric acid on the brownies product was caused by ingredients additions such as cooking oil and sweetened condesened milk. Lauric acid on the brownies product has a big potential to enhance shelf life product, it was caused by lauric acid has antibacterial properties. Liberman reported that lauric acid can make a monoulaurin on the body, monolaurin as an antibacterial, antiviral was used for destroying the virus such as HIV, influenza, pathogenic bacteria, cytomegalovirus [29]. Vitamin E on the brownies was from the addition of black cumin oil. Eitenmiller reported that main of Vitamin E was tocopherol. Tocopherol was one of the strongest antioxidant as antidote free radically [30].

Table 2. Identify component identify by Gc-Ms identification

Identify component	Formula (%)				
	0.05%	0.10%	0.15%	0.20%	0.25%
Palmitic Acid	14.98	12.98	14.34	14.58	21.20
Oleic Acid	13.87	12.01	13.71	13.97	18.41
Lauric Acid	9.22	8.66	9.28	10.44	14.32
Theobromine	5.54	4.44	4.17	3.75	4.28
Vitamin E	3.35	3.57	3.68	4.07	4.33

3.3 Sensory Evaluation of Brownies Product

Brownies substituted sweet potato flour was assessed for sensory attributes using an acceptance test after production (table 3). The highest scores for brownies substituted sweet potato flour color value was found for 0.05% addition of black cumin oil. The corresponding value was 4.05. The color of brownies substituted sweet potato flour depend on ingredients was used such as dark cooking chocolate and chocolate powder, in another hand the color of brownies substituted sweet potato flour depend on the color of black cumin oil. In this study, the color value of brownies substituted sweet potato flour was not affected by the addition of black cumin oil. The highest scores for brownies substituted sweet potato flour flavor value was found for brownies substituted sweet potato flour with 0.05% addition of black cumin oil. The specific flavor of brownies substituted sweet potato flour due to the volatile component from black cumin oil, one of volatile component was tymnoquinone which can cause distinctive sting flavor [19]. The highest scores for taste value was 0.05% addition of black cumin oil. The specific taste of brownies in this study was bitter. Goerlich reported that bitter taste due to nigellin was contained on the black cumin oil [12]. In this study, the highest panelist acceptance of brownies texture was found for 0.05% addition of black cumin oil. The texture of brownies was affected by the steamed cooking process and unsaturated fatty acid on the black cumin oil.

Acceptance tests showed that no significant difference ($P > 0.05$) for the colour of the brownies substituted sweet potato flour with the addition of nigella sativa oil. In general, these results showed the good acceptance of the brownies (table 3), the brownies substituted sweet potato flour which was added 0.05% black cumin oil had the highest number for color, taste, flavor, texture, and overall acceptance than that of the other of formula brownies. The brownies substituted sweet potato flour was added 0.25% black cumin oil had the lowest score for overall acceptance. The highest panelist acceptance for an overall score on brownies substituted sweet potato flour with was added 0.05% black cumin oil.

Table 3. Sensory evaluation of brownies product

Black cumin oil	Color	Flavor	Taste	Texture	Overall
0.05%	4.05^{a}	3.88^{d}	4.07^{d}	3.60^{c}	4.05^{c}
0.10%	4.00^{a}	3.87^{cd}	3.82^{cd}	3.27^{b}	3.87^{c}
0.15%	4.00^{a}	3.4^{c}	3.55^{c}	3.22^{b}	3.55^{b}
0.20%	3.85^{a}	2.97^{b}	2.75^{b}	2.97^{ab}	2.87^{a}
0.25%	3.85^{a}	2.55^{a}	2.35^{a}	2.82^{a}	2.80^{a}

a-e Mean different letter within each line are significantly different ($p<0.05$)

3.4 Determination the Best Formula of Brownies Product

Best formula from all formulation of brownies was determained with compensatory [11] 0.05% up to 0.25% of nigella sativa oil addition have a score 0.692, 0.626, 0.504, 0.347 and 0.308, respectively.

The best formula was choosen by the high score of the formula, then brownies substituted sweet potato flour with 0.05% addition of black cumin oil as the best formula in this study.

4. Conclusions

Water content, ash content, fat content, protein content, total phenol were increased with the addition of black cumin oil. On other hand, the result of antioxidant Ic50 and carbohydrate content were decreased with the addition of black cumin oil. Identify component on the brownies were palmitic acid, oleic acid, lauric acid, theobomine and vitamin E. Due to the sensory characteristics of brownies substituate sweet potato flour with the addition of black cumin oil, the panelists provide high values for brownies which was 0.05% addition of black cumin oil. The best formula's product was addition with 0.05% black cumin oil.

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