Characterization of microcapsule containing black cumin seed (Nigella sativa) extract as preventive antioxidant

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Abstract. The aim of this analysis was to complete antioxidant activity in microcapsule and to develop black cumin seed extract microcapsules by spray drying technique. The analysis was performed using a non-factorial completely randomized design. Firstly, microcapsules were made with 4 formulations using maltodextrin and soy protein as coating materials for the microcapsule and with black cumin extract and water. Formulation were using in this research were formula A (28,57:14,29:42,86:200), formula B (28,57:14,29:51,43:220), formula C (28,57:14,29:60,00:240), formula D (28,57:14,29:68,57:260). The analysed parameters moisture content, solubility and antioxidant activity (IC\textsubscript{50} value). The result showed that the addition black seed extract provides a very significant different (P<0,01) effect on content of moisture, solubility, and antioxidant activity. The best formulation was formula D (28,57:14,29:68,57:260) with result activity antioxidant (IC\textsubscript{50}) 22,29 µg/ml.

1. Introduction
Indonesia as one of developing countries has limitation in prevention the health problem. The infection disease is still high which is followed by the increase in degenerative disease. According to World Health Organization (WHO) 2012, causes of death in Indonesia are stroke (15,4%), tuberculosis (6,5-7,5%), diabetic and cancer (5,7%). Therefore, the degenerative disease is the serious health problem in Indonesia. Oxidative stress has an important rule on pathophysiology the process of various degenerative disease, such as cancer, diabetic, and also atherosclerosis [1]. Hence, antioxidant such us black cumin seed is required by body for preventing the oxidative stress.

Black cumin seed (Nigella sativa) is a herbal plant that is known to have potential biology activities likes antioxidant, anti inflammatory, anti cancer, and anti microbial [2]. Moreover, the black cumin seed (Nigella sativa) have chemical elements such us: water, protein, fat, vitamin A, vitamin B\textsubscript{2}, ascorbic acid, niacin, fiber, and mineral. Additionally, black cumin seed (Nigella sativa) contains essential extracts, 15 amino acids (alanine, arginine, isoleucine, lysine, tryptophan, tyrosine, threonine, asparagine, cysteine, glycine, glutamic acid, methionine, and proline), sodium, potassium, thiamine, riboflavin, pyridoxine, niacin, Cu, and Zn. The black cumin seed mainly contains of thymoquinone (TQ), dithymoquinone (DTQ), thymohydroquinone (THQ), and Thymol (THY) which are act as antioxidants. Black cumin seed (Nigella sativa) also contain nigellon and glutathion which can be functioned as a protector or protect body from dangerous substance [3]. Unfortunately, the antioxidant in black cumin seed easy to break, so that the use of microencapsulation is expecting to keep the stability of antioxidant from the black cumin seed.
Microencapsulation is a convert in which microscopic molecules or droplets are surrounded by a coating to give small capsules of many useful properties. Microcapsule can cover solid, liquid or gases. The component inside the microcapsule is assign to as the core, internal phase, or fill, whereas the wall is sometimes called shell, coating, or, membrane [4]. The spray drying method is one of the most important strategies for the synthesis of spherical particles which involves solvent evaporation and self assembly of matrix material inside the droplet system. The selection of the appropriate coating agent is crucial for successful encapsulation in spray drying process. One of the most commonly used biopolymers as carrier is maltodextrin [5]. Maltodextrin has many advantages such us cheap in price, has low viscosity at high concentration, has flavour binding ability, and reduce of the oxygen permeability of the coating matrix. However, the maltodextrin itself cannot be used to coat the materials, therefore, it is need to be blended with soy protein to improve functional and structural properties of the maltodextrin matrices [6].

Black cumin seed play a big role for determination of the appropriate antioxidant microcapsule formulation. Therefore, the objective of this analysis was to complete antioxidant activity containing in microcapsule and to develop black cumin seed extract microcapsules by spray drying technique. The discovery results are hopefully not only to provide more information on the black cumin seed as potential antioxidant, but also to be added in food for commercial use.

2. Equipment and materials

The raw component for this research was black cumin seed acquired from local market. The reagents used in the analysis were aquadest, maltodextrin, soy protein, and DPPH (2,2-diphenyl,1-1-picrylhydrazil).

2.1 Research methods

The microcapsule was made by preparing extract black cumin seed, which was blended with water and then concentrated by using waterbath. Microcapsule black cumin seed was made by firstly mixing maltodextrin and soy protein with warm water (50-60 °C). The mixture was then, homogenized by using a homogenizer with speed of 1100 rpm for 1 minute. Then, the black cumin seed was added and homogenized again with speed of 1200 rpm for 3 minutes. Furthermore, the mixture was spray dried with inlet of 180 °C, outlet of 80 °C, and flow rate of 8,3 mL/minutes to produce the microcapsule. The microcapsules were made with 4 formulations (Table 1) according to journal [7].

| Table 1. Formulation microcapsule |
|-----------------------------|
| Formulation | Maltodextrin (MD) | SPI | Black cumin seed | Water | Total |
| A            | 28.57            | 14.29 | 42.86        | 200   | 285.71 |
| B            | 28.57            | 14.29 | 51.43        | 220   | 314.27 |
| C            | 28.57            | 14.29 | 60.00        | 240   | 342.84 |
| D            | 28.57            | 14.29 | 68.57        | 260   | 371.41 |

Note: Formula A (BC : MD+SPI 1:1), Formula B (BC : MD+SPI 1:1,2), Formula C (BC: MD+SPI 1:1,4), Formula D (BC : MD+SPI 1:1,6).

BC: Black cumin, SPI: Soy protein isolate, MD: Maltodextrin

2.2 Data analysis

This analysis used a non factorial completely randomized design with 3 replications so that the total sample were 12. Parameter analysed were moisture content, solubility, and antioxidant activity (IC50). The data retrieved were processed using variance analysis. Significant treatments were tested further using the Least Significant Range test.
3. Result and discussion

3.1 Content of moisture

Figure 1 indicate black cumin seed microcapsule had a very significant effect (P<0.01) on moisture content of microcapsule. The highest content of moisture (3.74%) was retrieved in formula D and the lowest content of moisture (3.14%) was retrieved in formula A. The increase in moisture content of the product was following the water added to the formula while making the microcapsule. The amount of the water added to formula A and D was 200 ml and 260 ml, respectively. Therefore, more water addition was resulted in the higher moisture content of the microcapsule. The similar result, moisture content ranging 3-9%, was also previously reported [8]. The moisture content in this research is in good quality range. For instance, according to Indonesian National Standard, the maximum of moisture content of milk powder (SNI 01-2970-1999) and instant coffee (SNI 01-2983-1992) 4,0%.

![Figure 1. Moisture content of the black cumin seed microcapsule](image)

Note: The diagram show significantly different effects at the 5% (lower case) and 1% very different (upper case). Formula (MD:SPI:BC:Water), Formula A (28,57:14,29:42,86:200), Formula B (28,57:14,29:51,43:220), Formula C (28,57:14,29:60,00:240), Formula D (28,57:14,29:68,57:260).

3.2. Solubility

Figure 2 shows that black cumin seed microencapsule has a very significant effect (P<0.01) on solubility of microcapsule. Powder solubility in this study was varied between 50 and 70% in which the higher solubility (69,34%) was obtained with formula B and the lowest solubility (53,26%) was obtained with formula C. The solubility percentage was similar to the value analysis in jussara pulp microencapsulated using capsule, inulin, and maltodextrin as the wall components [9]. The high solubility values were moderately expected, due to the high water solubility of the encapsulating components used.
Figure 2. Solubility of the black cumin seed microcapsule

Note: The diagram show significantly different effects at the 5% (lower case) and 1% very different (upper case). Formula (MD:SPI:BC:Water), Formula A (28,57:14,29:42,86:200), Formula B (28,57:14,29:51,43:220), Formula C (28,57:14,29:60,00:240), Formula D (28,57:14,29:68,57:260).

3.3 Antioxidant activity (IC\textsubscript{50})

Figure 3. Antioxidant activity of black cumin seed microcapsule (IC\textsubscript{50})

Note: The diagram show significantly different effects at the 5% (lower case) and 1% very different (upper case). Formula (MD:SPI:BC:Water), Formula A (28,57:14,29:42,86:200), Formula B (28,57:14,29:51,43:220), Formula C (28,57:14,29:60,00:240), Formula D (28,57:14,29:68,57:260).

Figure 3 shows that black cumin seed microcapsule has a very significant effect (P<0.01) on antioxidant activity (IC\textsubscript{50}) microcapsule. The highest antioxidant activity (IC\textsubscript{50} = 22.29 µg/ml) was obtained in Formula D and the lowest antioxidant activity (IC\textsubscript{50} = 43.16 µg/ml) was obtained in Formula A. This similar result, ranging from 50-21 µg/ml was also previously reported [10]. The
black cumin seed extract addition to high antioxidant of black cumin seed was followed by the increase of antioxidant activity (IC\textsubscript{50}). In other world, the black cumin seed extract addition caused the elevation of the antioxidant activity (IC\textsubscript{50}). Combination of maltodextrin and soy protein can bind the active substance, so that the stability of core material can be protected and antioxidant activity of the microcapsule increased [11]. Mixture of maltodextrin and soy protein can protect functional value core materials and can decrease free radical from DPPH.

4. Conclusions
It was found that microcapsule containing black cumin seed extract has very significant different effects on moisture content, solubility, and antioxidant activity (IC\textsubscript{50}). The finding result showed that black cumin extract can be used a potential antioxidant and microcapsule have very active antioxidant activity, so that it is good for health. Based on antioxidant activity result, the best microcapsules were made with formula D. Therefore, it is suggested that microcapsule could be added to increase nutrition.

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