Microencapsulated fish oil powder by spray drying using combination of wall materials in Kasetsart University, Bangkok

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Abstract. Oil is a source of saturated fatty acids commonly referred as omega-3, in particular EPA (eicosapentaoenoic acid) and DHA (docosahexaenoic acid) and has been recognized major health component, being used in many key ways as body supplements and heart organs in particular. The omega-3 content of fish oil is highly oxidizing due to exposure to oxygen. One way to be treated is to do microcapsule storage using a spray dryer. Applications of materials coated-based fish oil for the microcosulation are generally varied. The purpose of this internship is to figure out the microencapsulated of fish oil by spray dry using combination of wall materials. This internship was held in Department of Fishery Product, Faculty of Fisheries, Kasetsart University, on January 1th until January 30th, 2020. The process is done through of three stages of pretreatment, spray dry, and testing. Pretreatment process includes to making fish oil emulsion with gum arabic, maltodextrin, and whey proteins. Spray dry includes microencapsulated preparation using spray dryer machine. The testing process is done by some parameters like yield, color, water content, oil content, and water activity.

1. Introduction
Fish oil is a nutrient food with rich of fatty acids. Fish oil have big benefits because it contains about 25% saturated fatty acids and 75% saturated fatty acids. Fish oils are a natural source of non-saturated fatty acid (pufa) omega-3, particularly eicosapentaoenoic acid (EPA) and docosahexaenoic acid (DHA) [1]. Omega-3 fatty acids have been recognized as having an important role in health. The fatty acids contained in fish oil
are so easily oxidized by oxygen in the air, uv rays and other large energies that readily break a thick bond of fatty acids into a radical. Oxidation of fish oil would decrease quality marked by rancid smell. One example to maintain the quality of fish oil from oxidation by protecting it on binding agent material by spray dry process [2].

Microencapsulation is a method of using solids or liquids to extract particles of desired physical chemical properties through spray dry. The use of spray methods provides several benefits when compared with other methods like relatively low costs, decreases in treatment (from laboratory scale to industrial scale), capsules have high qualities, small size and stability, short - cut processes, and can sustain products by reducing water activity in low level so can degradation of bacteria. Based on this background, microencapsulation process of fish oil using a combination of binding agents to maintain quality of fish oil from fisheries processing industry. Thus, the research in fisheries product departments, Kasetsart University, Thailand needs to be done to understand the process of microencapsulation of fish oil.

2. Material and Method
2.1 Preparation
The materials used in emulsion are tuna-renifed fish oil, maltodextrin, gum Arabic, whey protein, aquades. The device used was beaker glass, spatula, analytic sheet, homogenizer, glass beaker, spray dry machine. Prepare 8 type of emulsion consists of several components including maltodextrin (15 and 20%), gum Arabic (15 and 20%), protein whey (5 and 10%), and a combination of maltodextrin with an Arabic gum. Transferred emulsion in test-tubes and suspended in the refrigator for 24 hours to see stability of emulsion.

2.2 Spray drying
The basic principle of spray spray is to change liquids to powder with adding some binding agent and concentrated by hot air [3]. Spray dry process using the most stable emulsion from combination maltodextrin with gum Arabic (15% and 20%). Spray dry emulsi with temperature inlet 160°C and temperature outlet 121°C with pump speed 10%. Storage fish oil powder in dark bottle for other analyze.

2.3 Yield
Meassured yield of fish oil powder by hand calculations created from spray dry 400ml of emulsion, and calculations are made using the following equations [4].

\[
\text{\%Yield} = \frac{\text{fish oil powder (g)}}{\text{initial sample weight (ml)}} \times 100\%
\]

2.4 Color
Analysis color using a minolta spectrophotometer coloration. Put 5 grams of sample on a small plate in machine and then the reading would begin when start button was pressed.

2.5 Water activity
Analysis water activity using aw meters machine, calibrated aw meters before used and then put sample into small container wait up to 3 minutes. After 3 minutes, aw meters will show the value of water activity.

2.6 Moisture content
Analysis of the moisture using a moisture analyzer device. The analyzer tools that are used must be calibrated first before we use it. Then insert an empty aluminum tinplate and make sure the plate is in the right position. Close the flap, the tare will do automatically. Inserts 5 grams of sample and machine will shows the value of a constant moisture water in sample.

2.7 Oil content
Oil-level analysis procedure refers to (AOAC, 2005). Prepare sample 2 grams (s) was put in the filter paper, and then in a persistent distillation (w1). The extraction tube is installed on a soxhlet extraction and then heated at a temperature of 40 recombines over 5-6 cycles. After the extraction process of liqueurs is deducted until all liqueurs become evaporated using a rotary evaporator with temperature 70°C and rotation of 50 RPM, after that dried in the oven at 1 hour and cooled in the desikator until the weight is constant (w2). Calculation of fish oil levels using the following equations [5]:

\[
\%\text{Lipid} = \frac{w_1 - w_2}{s} \times 100\%
\]

3. Results
3.1 Yield
The average output of the yield is 3.6%, which is different from the standard for the fish-oil spray dry method of 20.93% [6]. The value of yield will be affected by material in spray process.

| Treatments                  | Yield |
|-----------------------------|-------|
| Maltodextrin 10% : Gum Arabic 15% | 4.1%  |
| Maltodextrin 10% : Gum Arabic 20% | 3.24% |

3.2 Color
Analyze color of fish oil powder shows L* value notation as a degree of brightness ranging from 92-93 to a highly bright category of fish oil, a* value notation shows minus (-), this is indicating the color of the powder that tended to be green. And b* value notation ranges between 14-15 and positive conditions to indicate yellow color of the powder. It differs from mehrad research, et al (2015), which shows L* 92.54, a* 2.82, b* 0.92.

| Treatments                  | Week | Color                  |
|-----------------------------|------|------------------------|
| Maltodextrin 10% : Gum Arabic 15% | 1    | L*: 93.28 a*: -0.70 b*: 14.05 |
|                             | 2    | L*: 93.5 a*: -1 b*: 14.63 |
| Maltodextrin 10% : Gum Arabic 20% | 1    | L*: 92.97 a*: -0.45 b*: 14.50 |
|                             | 2    | L*: 92.99 a*: -0.62 b*: 15.67 |
3.3 Water activity
Water activity result between 0.07-0.1. The result is still below from maximum limits of standard powdered products on the food industry in general is 0.3 aw [7].

| Treatments                  | Week | Water activity |
|-----------------------------|------|----------------|
| Maltodextrin 10% : Gum Arabic 15% | 1    | 0.0805 aw      |
|                            | 2    | 0.0987 aw      |

Table 3. Water activity values

3.4 Moisture content
Moisture fish oil powder between 1.74%-3.89%. The result is still below from maximum limits of standard powdered products on the food industry in general between 3-4% [8].

| Treatments                  | Week | Water activity |
|-----------------------------|------|----------------|
| Maltodextrin 10% : Gum Arabic 15% | 1    | 2.77 %         |
|                            | 2    | 2.32 %         |

Table 4. Moisture values

3.5 Oil content
The test of oil levels projected between 7.37%-14.44%, where the fish oil powder from combination maltodextrin and gum Arabic 15% is more higher than gum arabic 20%.

| Treatments                  | Oil content |
|-----------------------------|-------------|
| Maltodextrin 10% : Gum Arabic 15% | 14.44 %     |
| Maltodextrin 10% : Gum Arabic 20% | 7.37 %      |

Table 5. Oil content

3.6 Discussion
Microencapsulation is a method of using solids or liquids to extract particles of desired physical chemical properties through spray dry process. The basic principle of spray dry is to dehydrated liquids with binding agent so that can make powder from concentrated by hot air [9]. The value of the yield will be affected by the properties of the liner material in spray dry process. Differences value in powder mass obtained relate to the characteristics of emulsion. The homogenization phase is an essential stage for producing a good micro-capsule powder [10]. Concentration of Arabic gum causes high viscosity emulsion of fish which can block processing of spray dry, which leads yuslinawati (2014) Driving that emulsion with high viscosity can block spraying in spray dryer because of a blockage drying chamber. Furthermore, the high viscosity of emulsion can also prevent drying in the inlet tube and producing powder with high water compound.

The measuring of the color of the powdered fish show s a different result from mehrad research, et al
The difference can be attributed to a different concentration of free oil during the treatment and color of each fish oil we are used because each species has a different fatty content. The presence of fatty acids is affected by such factors as seasons, temperatures, a place of growth, fish species, age, gender, and eating habits [11].

Water activity is the free amount of water in food item and affects the quality of the food product, the higher value of the aw in a microcapsule means the higher water content of fish oil powder, so microorganism also can increase. The process of storage fish oil powder can increase water activity because of a hygroscopic or an absorption water from the environment, so the water contend continues to increase with a certain amount of storage time [12]. The value of the oil content is influenced by emulsion viscosity, high viscosity will make lower efficiency of the microencapsulation process because it will complicate atomization of spray dry and thus produce powder with low value of oil content [13].

4. Conclusions
The microencapsulation of fish oil have through three stages, which in preparation emulsi of fish oil with some kind of binding materials, spray dry process, and analyze. The most stable emulsion comes from combination of maltodextrin with gum Arabic to do the spray dry process. Spray dry quality test with some parameters like colors, water content, water activity, and oil content.

5. References
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