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Analysis of protein content of deffated black soldier fly (BSF) maggot flour with variations in drying temperature

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ABSTRACT

This study aims to determine the protein content in maggot flour based on differences of conventional drying temperatures. Maggots or black soldier fly larvae are currently known for their high protein content and have the potential as a substitute for animal feed. The flouring process is carried out by drying the maggots and then extracting the drying results to obtain flour. The results of the study showed that the higher the drying temperature, the more flour would be produced during the extraction process. Protein content testing was carried out using the Kjeldhal method. The results of this study showed that with a drying temperature of 120 ℃, flour had the highest average protein content of 22.63% while with a temperature of 60 ℃ it had the lowest protein content of 16.25%. Other results also showed that drying with the roasting method could provide a difference in protein content of 18.45%. The decrease in protein levels during the roasting process itself can occur as a result of the protein denaturation process that occurs during the drying process.

1. Introduction

Waste is the residue of human daily activities in solid form. Household waste is one type of waste that we often encounter in everyday life. [1] without effective waste management measures, more than 2.24 billion tons of solid waste were generated globally in 2020 and expected to increase by 73% to 3.88 billion tons in 2050 along with the expansion of the population, economic development, changing consumption patterns, and urbanization. Household waste is classified as organic waste and requires proper handling. This aims to reduce the impacts that arise from the waste itself, such as pungent odors and sources of disease.

Fig. 1. Black Soldier Fly (BSF) maggots [2]

Black Soldier Fly (BSF) is a type of fly that comes from the animal kingdom, Arthropoda phylum, Insecta class, Diptera order, Brachycerera suborder, Stratiomyidae, Hermetinae subphylum, Hermetia genus, Hermetia illucens species that can be found throughout the world in warm areas including Australasia and oceanic regions [3]. BSF flies have a relatively fast life cycle based on figure 2, which is around 15-32 days where at the age of 12 days, BSF flies enter the prepupa stage or what is known as BSF maggots [4]. BSF maggots can be easily found in organic waste with the ability to reduce organic waste by 50-70% [5]. BSF fly larvae in figure 1 can also reduce pollutants, harmful microorganisms and unpleasant odors by reducing 50-60% of the mass of the waste itself.

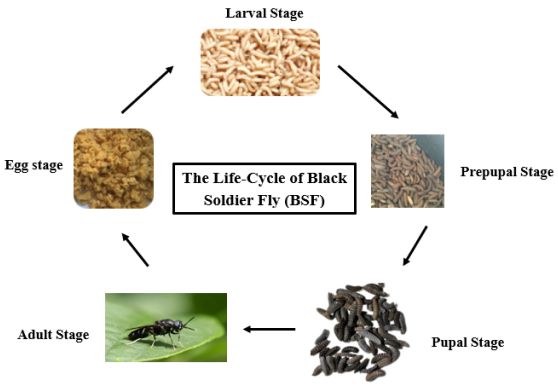

Fig. 2. Black Soldier Fly (BSF) maggots life cycle [2]

BSF larvae have a fairly high protein content, which is

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around 44.26% and a fat content of around 29.65% [6]. Referring to [7] and [8], the nutrients contained in maggots can be significantly influenced by the maggot growth medium itself. The selection of growth media in maggot cultivation needs to be considered more carefully, this aims to ensure that the increase in protein levels in the maggots themselves can remain at maximum condition [9] stated that the age of the maggot also affects the nutritional content of the maggots shown in Table 1.

Table 1. Maggot nutritional content based on age

age	Content (%)			
	dry ingredients	crude protein	crude fat	coarse ash
5	26,61	61,42	13,37	11,03
10	37,66	44,44	14,60	8,62
15	37,94	44,01	19,61	7,62
20	39,20	42,07	23,94	11,36
25	39,97	45,87	27,50	9,91

This study used maggots that had been fed fermented cow manure for 15 days. The nutritional value of maggots was taken from research conducted by [10], shown in Table 2.

Table 2. Nutritional value of maggots fed cow manure

Proximate (%)	Fermented Cow Manure
Moisture	2.30 ± 0.04^a
Ash	11.14 ± 0.04^a
Crude Lipid	4.47 ± 0.02^a
Crude Protein	46.64 ± 0.04^a
Carbohydrate	35.45 ± 0.06^a

Note: Mean ± standard error followed by different alphabet superscript in the same row, is considered as significantly different at $P<0.05$.

The high nutritional content of maggots can also provide benefits to the livestock sector. The high protein content of maggots can help meet the protein needs of livestock. [11] in their research stated that the addition of maggot flour to pomfret fish feed can affect the growth rate, increase the length of the fish and can provide efficiency in feeding. Other studies have shown that the addition of maggot flour to livestock needs to pay attention to the nutritional content in it. [12] in their research stated that the provision of maggot flour needs to be done properly to obtain maximum growth results. Providing excessive maggot flour in livestock feed will actually have a negative impact on livestock.

2. Materials and Methods

2.1. Materials

The tools used in this study were baking pans, aluminum foil, ovens, maggot extraction tools, scales, and flour and oil storage containers. The materials used in this study were 500 grams of cleaned maggots for each drying experiment.

2.2. Drying method

The cleaned maggots are then placed evenly on a baking sheet that has been lined with aluminum foil. The baking sheet is placed in an oven that has been set to the desired temperature for 3 hours while occasionally weighing it to determine the reduction in water content of the sample. After 3 hours, the sample is left to stand and then weighed. The extraction process is carried out by taking 100 grams of dried maggots and then slowly inserting them into the extraction tool until the extraction tool begins to release flour and oil. The flour is then put into a sample container for testing.

2.3. Protein level testing

Protein content testing was conducted in the analytical chemistry laboratory, POLITANI Samarinda using the kjeldahl method. The test results were then processed to obtain results from the tested samples.

3. Results and Discussion

3.1. Drying result

Drying was carried out using an oven, for 3 hours and at varying temperatures. Drying was carried out to remove the water content contained in the maggots as shown in figure 3. The drying results showed that the samples experienced a reduction in water content, where sample 1 was 34.73%; sample 2 was 45.28%; and sample 3 was 63.09%. The increase in water content reduction that occurred showed that in the drying process, an increase in temperature would cause a decrease in the mass of the maggots after drying. More study show that drying temperature is one of the main factors that affect dry matter contents [13]. Likewise the drying temperature, drying method and drying time also affect the content inside the BSFL like crude protein and crude fat [14].

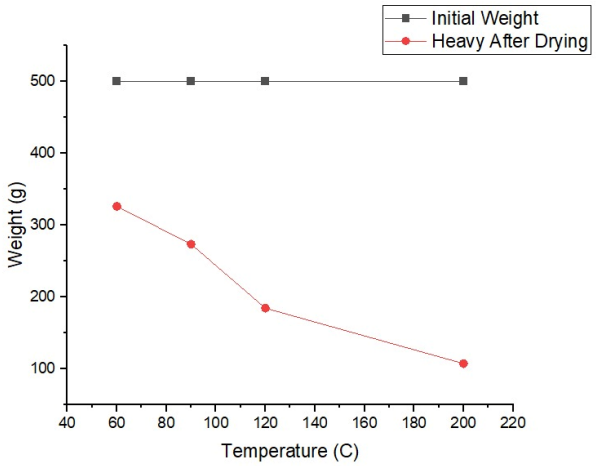

Fig. 3. Graph of result before and after drying

3.2. Extraction result

The maggot extraction process using a maggot press tool will produce flour and oil. Figure 4 shows that sample 1 produces less flour with a value of 81.23 grams, while sample 4 using the roasting method produces flour with the highest yield of 94.16 grams. The extraction results show a contrasting comparison between oil and flour yields. The test results show that an increase in the mass of flour obtained will reduce the percentage of oil obtained. The results of observations on oil show that there are other liquid components that are extracted together with maggot oil. The results of the study showed that the higher the temperature, the more easily the liquid in the maggot will evaporate. This is in accordance with [15] where trapped water will undergo an evaporation process during the drying period so that samples with low temperature drying do

not experience maximum evaporation of water content so that the trapped liquid will come out together when extraction is carried out.

The value of component from extraction also affected by pre-treatment method. [16] this study point that the pre-treatment method using Pulsed Electric Field (PEF) affect significantly. Combination of pre-treatment and drying method have a significant impact to the value of extracted larvae. Furthermore, slaughter method and drying method also can clearly affect nutritional composition [17].

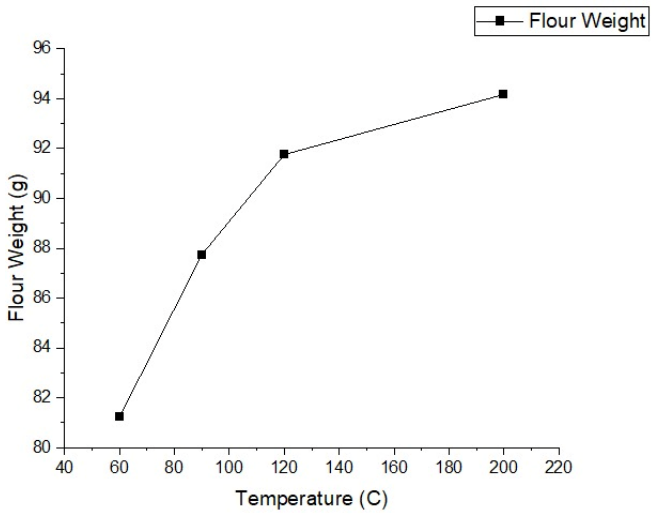

Fig. 4. Maggot flour production graph

3.3. Protein content test result

Figure 5 shows that there is an I ncrease in protein levels along with increasing temperature. [18] in their research stated that the increase in protein levels is caused by the loss of water content so that the protein contained in maggots begins to concentrate. The test results showed that at a temperature of 120 ℃, the protein content value had the highest value with an average value of 22.63%. Meanwhile, sample 1 had the lowest protein content value of 16.25%. Sample 4 with the roasting method had different results from the drying sample using an oven where the protein content in sample 4 was 18.45%. The drying process using the roasting method itself is a drying process at high temperatures. The drying process using roasting can conduct heat well through sand as an intermediary medium and continuous stirring causes the heat distribution to be more even [19]. [20] in their research stated that the use of high temperatures, in this case drying, can cause protein denaturation. According to [21] in [22], protein denaturation is a condition in which the protein experiences changes or destruction of its secondary, tertiary and quaternary structure, which can be caused by several factors, one of which is heating. [17] mention that denaturation appears because the proteins were polymerized by high heat in drying section.

The results of the protein test showed that the flour from the drying of maggots can be used as an additional ingredient in animal feed for beef cattle and breeding cattle where the protein requirement is for livestock needs. It needs at least 13% protein content for fattening beef cattle, while 12% for breeding beef cattle and male beef cattle [23].

In addition to being used as an additional ingredient in cattle feed, maggot flour can also be used as a substitute for fish meal in fish farming [24].

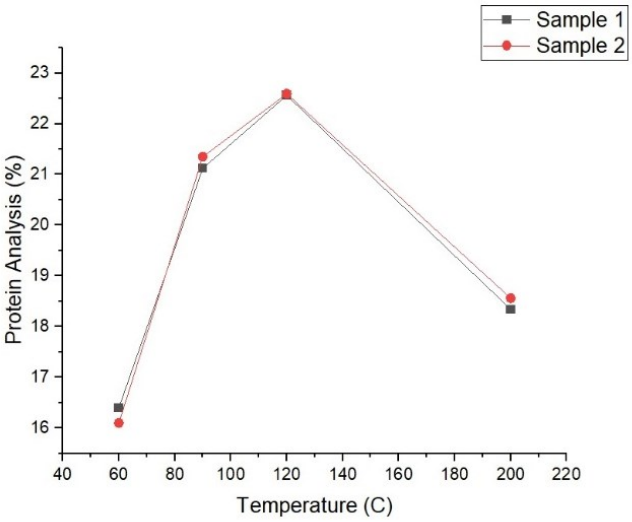

Fig. 5. Result of protein content in maggot flour

4. Conclusion

The study aimed to discover the difference of protein content inside the Maggot Black Soldier Fly (BSF) deffated flour base on conventional drying method used. Based on the results of the research and discussion that has been carried out regarding the Analysis of Protein Content of Maggot Black Soldier Fly (BSF) deffated flour with Variations in Drying Temperature, it was concluded that using a drying temperature of 120℃ would provide flour with the highest protein content. Another result of this study was that the drying process cannot be carried out using temperatures that are too high because it can cause a decrease in protein content caused by the denaturation process.

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