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Evaluation of the Fiber Content of Maggot (*Hermetia Illucens*) Growing Media : Based on Organic Waste

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Abstract. Organic waste is waste that can be decomposed entirely from biological processes and is easily decomposed. Organic waste has low nutrient content and high fibre. Efforts are made to increase the low nutrient content and reduce the high fibre content contained in organic waste, then fermented using local microorganisms (MOL) for Maggot (*Hermetia illucens*) growing media. This study aimed to determine changes in fibre content (NDF, ADF and hemicellulose) in various fermented organic wastes. The method is an experimental method with a completely randomized design (CRD) with two factors, namely various organic wastes and fermentation time, with three replications. The parameters of this study consisted of NDF, ADF and Hemicellulose. The study showed that the treatment of various organic wastes had a very significant effect ($P < 0.01$) on NDF, ADF and hemicellulose. Fermentation time had a very significant effect ($P < 0.01$) on ADF but had no significant effect ($P > 0.05$) on NDF and hemicellulose. There was a significant interaction ($P < 0.01$) between organic waste and fermentation time on ADF content, but there was an interaction with NDF and hemicellulose. Conclusion that fermentation of various organic wastes and duration of fermentation using local microorganisms (MOL) can reduce the fibre content of NDF, ADF and hemicellulose. The best fermentation was obtained on vegetable media fermented for two days.

Keyword: ADF, fermentation, hemicellulose, maggot, organic waste

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1. Introduction

Maggot (*Hermetia illucens*) is one type of fly commonly found in places with organic waste. These flies use waste as a food source. Utilization of organic waste can indirectly reduce organic waste so that it functions in handling organic waste that has the potential to pollute the environment. Organic waste is waste that is wholly decomposed from biological processes and is easily decomposed. Organic waste has low nutrient content and high fibre, but maggot can break down the organic waste.

Organic waste can be used in agriculture, animal husbandry, and fisheries. The waste obtained in the market is generally vegetable and fruit waste. Maggot (*Hermetia illucens*) ability to live in

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organic waste proves that Maggot (*Hermetia illucens*) can utilize the organic waste as feed ingredients [1]. One way to reduce the accumulation of organic waste is to involve a bioconversion process. Hermetia Illucens can be used as an alternative to convert organic waste[2]. Organic waste will be converted into a source of nutrition for Hermetia Illucens, such as protein and fat, through a fermentation process that will involve living organisms [3]. Organic waste that is widely found in market waste includes agricultural waste such as vegetables, fruits and leaves, as well as from fisheries and livestock products. The organic waste can be used as animal feed which has more economic value and is more profitable. However, market waste has low nutritional value, as indicated by its high crude fibre and water content [4]. Vegetable waste has a crude fibre of 5-38%. This crude fibre is very high and can be derived by fermentation with Local Microorganisms (MOL) [5].

Local Microorganisms (MOL) is a fermented solution containing a variety of microorganisms, bacteria, fungi and yeasts that live in a consortium and synergize with each other[6]. Microorganisms originating from their environment have a high ability to degrade their substrates[7]. Fermentation can reduce the content of fiber fractions (NDF and ADF) due to the presence of microbial activity. Microbes can produce multiple enzymes (endo-β-1,4-glucanase, xylanase, mannanase and lignin peroxidase) and synergize with each other in degrading fibre [8]. The decrease in fibre content (NDF and ADF) was due to the breaking of lignocellulosic bonds during fermentation[9]. The low fibre content in maggot media will make it easier for the maggot to reduce waste. One of the processing that can be done to reduce the fibre content of the media is to use of the fermentation method. Palm coir fermentation with MOL (5%) as a maggot medium for 14 days can reduce the fibre content of the media from 41.98% to 36.10(%)[10]. Various organic waste materials can be used as maggot-growing media. However, the material used for maggot media must be considered for its nutritional content because the better the media used, the higher the maggot biomass produced. Maggot biomass produced varies depending on the source of the growth medium, including the fibre content.

2. Materials and methods

This research was conducted at the Livestock Production Laboratory, Central Laboratory of the Faculty of Agriculture and the Nutrition and Animal Feed Laboratory, University of North Sumatra. This research took place from August to December 2021.

The materials used in this study were vegetable waste, fruits, the food processing industry, local microorganisms (MOL) and materials for analysis of fibre content (NDF, ADF and hemicellulose), including a solution of NDF, ADF, H2SO4, boiling water, and alcohol.

The tools used in this study were silos for fermentation containers, basins, buckets, ovens, trays, test tubes, tube racks, Bunsen, hot plates, ose needles, scales, sintered glass, vacuum pumps, desiccators, petridiscs, stationery and cameras. Research design

This research was conducted using a completely randomized design (RAl) with a 3 x 3 factorial pattern.

Factor 1. various types of waste, namely

D1= Vegetable waste

D2= Fruit waste

D3= Food processing industrial waste

Factor 2. duration of fermentation, namely

L1= 2 days

L2= 4 days

L3= 6 days

Observed variables

The variables observed were the content of NDF, ADF, and hemicellulose from the fermentation of various organic media.

2.1. Data analysis

The data were obtained and analyzed using a completely randomized design. If the data obtained are accurate, proceed with Duncan's test.

2.2. Research Stages

2.2.1. Production of Local Microorganisms

MOL solution was made from organic waste materials, namely 0.15 kg of papaya waste, 0.15 kg of pineapple waste, 0.15 kg of banana waste, 0.15 kg of mustard waste, 0.15 kg of cabbage waste, 0.15 kg of flower leaf waste. Cabbage, 0.15 kg of cassava waste, 0.15 kg of coconut pulp, 0.15 kg of tofu and bran, 0.3 kg of bran, 0.5 kg of molasses and 5 litres of water from well water and coconut water. All ingredients were stirred evenly, put in a closed container, and incubated for 14 days.

2.2.2. Making fermentation media

Fermentation media using MOL as a starter. Before fermentation, the wastes are washed in running water and then drained. Weighed 1.45 kg of each waste, 0.25 kg of rice bran, 0.15 kg of

molasses, 0.1 kg of salt and inoculated with 3% MOL. All materials were mixed until homogeneous put into a plastic bag (silo), and incubated according to treatment (2, 4, and days). The results of the fermentation of all treatments were analyzed for fibre content (NDF, ADF and hemicellulose).

2.2.3. Analysis

a. Penentuan Kadar Neutral Detergent Fiber (NDF)

b. Penentuan Kadar *Acid Dete*

3. Results and Discussion

3.1. NDF (Neutral Detergent Fiber)

The purpose of measuring NDF (Neutral Detergent Fiber) is to determine the effect of fermentation of various organic wastes and the duration of fermentation on the content of NDF (Neutral Detergent Fiber).

Figure 1 shows that the treatment of various organic wastes had a very significant effect ($P < 0.01$) on the NDF content. In contrast, the duration of fermentation had no significant effect ($P > 0.05$) on the NDF content, and there was no interaction between the two. This is because fermentation of various wastes as maggot media does not depend on the length of fermentation to reduce NDF levels.

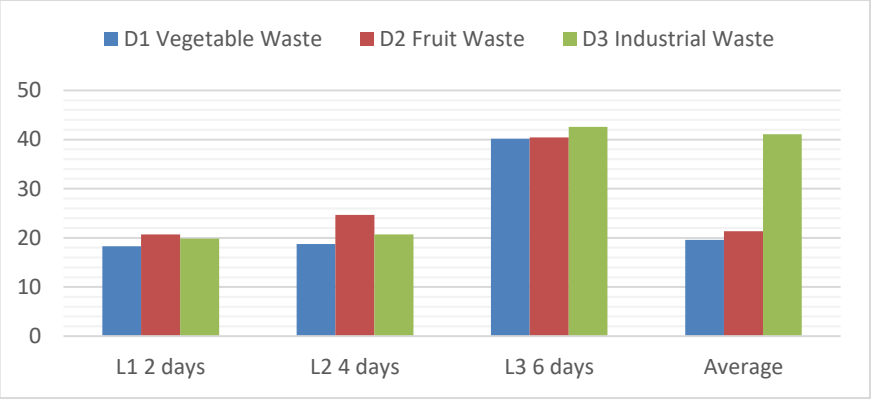

Figure 1. Effect of fermentation of various organic wastes and duration of fermentation on the content of NDF (Neutral Detergent Fiber)

Based on the results of the analysis of the NDF content of vegetable waste before fermentation on "Figure 1", it was around 26.31% after fermentation, the average value was 19.59%, fruit waste before fermentation was around 28.21% after fermentation, the average value was 21.36% and food processing waste before fermentation. Fermentation ranged from 49.87% after

fermentation, the average value was obtained at 41.05%. From the data above, it can be seen that the highest decrease in NDF content was found in treatment D1 (Fermentation of vegetable waste) by 25%, and the lowest decrease in NDF content was in treatment D3 (food processing waste) by 17%. This decrease in fibre content (NDF) occurs because fermentation can reduce the content of fibre fraction (NDF) due to microbial activity that simultaneously degrades fibre [11].

The decrease in the NDF content in various organic wastes shows that the nutritional quality of fermented organic waste is improving because decreasing the fibre content will increase the digestibility of feed ingredients and the content of other nutrients. With decreasing levels of NDF, it indicates that there has been a breakdown of cell wall cellulose, so the feed will be more easily digested by livestock [12]. Meanwhile, increasing levels of NDF indicate that cellulolytic microbial activity is insufficient in breaking down complex compounds into simpler compounds. This is due to the low availability of nutrients in the substrate and the increasing number of fibres, so cellulolytic microbes' growth rate decreases and is not optimal in secreting enzymes. Microbial growth rate due to reduced nutrient supply and accumulation of metabolic substances that inhibit cellulolytic microbial growth that is not optimal causes the work of cellulase enzymes to remodel cell walls (NDF), which mostly contain cellulose and lignin into simpler compounds, so that the portion of the cell wall is not sufficient [13].

The effect of fermentation on the NDF content in various organic wastes shows that the nutritional quality of fermented organic waste is improving because decreasing the fibre content will increase the digestibility of feed ingredients and the content of other nutrients.

3.2. *ADF (Acid Detergent Fiber).*

The purpose of measuring ADF (Acid Detergent Fiber) is to determine the effect of fermentation of various organic wastes and the duration of fermentation on the content of ADF (Acid Detergent Fiber).

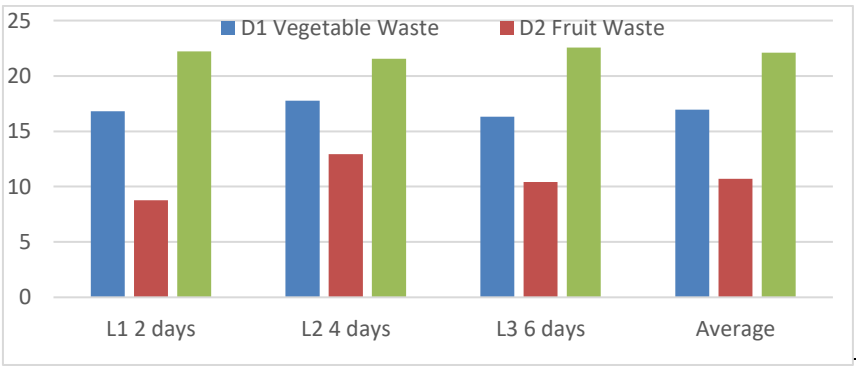

Figure 2. Effect of fermentation of various organic wastes and duration of fermentation on the content of ADF (Acid Detergent Fiber)

The analysis of diversity showed that various organic wastes and fermentation time had a very significant effect ($P < 0.01$) on ADF content and interaction between various organic wastes and fermentation time. This shows a positive synergy between various organic wastes and the length of fermentation in reducing the ADF content of organic waste.

It can be seen on "Figure 2", that the lowest ADF content is in the D2L1 interaction (fermentation of fruit waste and two days of fermentation), which is 8.78%, with before fermentation around 15.20%, there is a decrease in ADF content of 42%. While the highest ADF content is the interaction of D3L3 (fermentation of food processing waste and fermentation time of 6 days) which is 22.56%, with before fermentation around 28.25%, there is a decrease in ADF content of 25%.

The decrease in fibre content (ADF) occurs because fermentation can reduce the content of fibre fraction (ADF) due to the joint microbial activity in degrading fibre.

In the 2-day fermentation, the ADF content decreased due to the breakdown of the cell wall into simpler components, namely hemicellulose and glucose, during the fermentation process. Decreased ADF levels were caused by the dissolution of some cell wall proteins and hemicelluloses in an acidic detergent solution, thereby increasing the ADS portion and causing a decrease in ADF levels.

The content of ADF changes according to the fermentation time [13]. The longer the fermentation time, the higher the ADF content produced by this condition is thought to be due to decreased microbial activity. It is suspected that this is influenced by the high N in ADF, which cannot be degraded by enzymes produced by microbes, so the availability of soluble carbohydrates is reduced in the substrate. These carbohydrates are utilized by rumen microbes to maintain their life so that their number decreases, resulting in a proportional increase in the components that make up ADF followed by an increase in ADF levels. The rate of microbial growth decreased due to the reduced nutrient supply of the substrate that the high content of N in the ADF caused the protein in the feed material to be low in use, and the high ADF also caused the digestibility of the feed material to be low.

The effect of fermentation on the content of ADF in various organic wastes shows that the nutritional quality of fermented organic waste is improving because decreasing the fibre content will increase the digestibility of feed ingredients and the content of other nutrients.

3.3. Hemicellulose

The purpose of measuring ADF (Acid Detergent fibre) is to determine the effect of fermentation of various organic wastes and the duration of fermentation on the hemicellulose content.

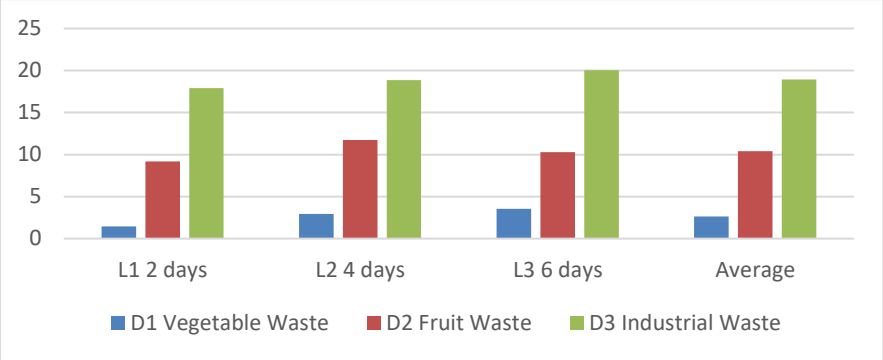

Figure 3. Effect of fermentation of various organic wastes and duration of fermentation on hemicellulose content

"Figure 3" shows the effect of fermentation of various organic wastes and the duration of fermentation ranging from 1.45% to 20.04%. The treatment of various organic wastes had a very significant effect on the hemicellulose content. In contrast, the duration of fermentation had no significant effect on the hemicellulose content, but there was no interaction between the two. This is because the use of fermentation of various wastes as maggot media does not depend on the length of fermentation to reduce hemicellulose levels.

Based on the results, the hemicellulose content of vegetable waste before fermentation was around 4.59% after fermentation, the average was 2.64%, fruit waste before fermentation was around 13.01% after fermentation, the average was 10.40%, and food processing waste before fermentation was around 21. ,62% after fermentation obtained an average of 18.94%. The data above shows that the highest percentage decrease in hemicellulose content was in the D1 treatment (fermented vegetable waste), which was 42%. At the same time, the lowest percentage decrease in hemicellulose content was in the D3 (food processing waste) treatment, which was 12%. The decrease in hemicellulose content is suspected in the fermentation process [13]. A reshuffle of dietary fibre is carried out by microorganisms that produce cellulase enzymes that can degrade fibrous feed. The effect of fermentation on the hemicellulose content in various organic wastes shows that the nutritional quality of fermented organic waste is improving because decreasing the fibre content will increase the digestibility of feed ingredients and will also increase the content of other nutrients.

4. Conclusion

Fermentation of various organic wastes using local microorganisms (MOL) can reduce the fibre content of NDF, ADF, and hemicellulose. The length of fermentation can decrease or increase

the fibre content of NDF, ADF and hemicellulose. There is an interaction between organic waste and fermentation time on the ADF content, while the NDF and hemicellulose contents do not.

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