POTENTIAL UTILIZATION OF DEFECTIVE FRUIT JUICE PRODUCTS FOR BLACK SOLDIER FLY CULTIVATION TO REDUCE WASTE GENERATION IN THE BEVERAGE INDUSTRY

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Abstract

The waste of fruit juice and tea defective products has organic content that conventionally has the potential to be utilized as a medium or place for maggot growth, but until now it has not been equipped with supporting scientific studies. Therefore, the objectives of the study are: 1) Assessing the characteristics of fruit juice and tea product waste, 2) Assessing the effectiveness of maggot in reducing fruit juice and tea product waste. This research is experimental in nature using variations in the composition of fruit juice and tea product waste as a source of nutrition for maggot which is carried out for 12 days. This variation uses the Complete Randomized Design method with 3 (three) treatments, namely variations in the composition of 60% tea + 40% fruit juice waste (S1), 50% tea + 50% fruit juice waste (S2), and 40% tea + 60% fruit juice waste (S3) in duplo. In addition, this study was completed with a control treatment. The results showed that the characteristics of fruit juice and tea waste containing protein (3.78-4.59%), fat (0.90-1.31%), carbohydrates (28.15-29.15%), crude fiber (2.42-3.12%) can be used as maggot cultivation media. The highest protein and crude fiber contents were found in the S3 composition waste at 4.59% and 3.12%. Maggot cultivation results that showed the highest fat and carbohydrate content were found in S1 composition waste at 1.31% and 29.15%. The recommended composition variation is S1 composition with the highest substrate consumption value and waste reduction index of 57.47% and 20.06%.

Keywords: *maggot, defective product waste, waste characteristics, waste reduction*

Introduction

Fruit juice drinks are soft drinks made from fruit juice and drinking water with or without the addition of sugar or permitted food additives (SNI, 1995). The production of fruit juice drinks in Indonesia has increased by 4.12% from year to year (Santy, 2019). Meanwhile, the amount of tea production in Indonesia also continues to increase by 5.00-7.00% per year (Tugiyanti, 2017). The higher the amount of production generally also has the potential to increase the amount of waste generated.

Either from leftover production or defective products that can often still be utilized further. According to Hamali et al. (2018), the percentage of defective product waste generated from the production process reached 4.49%.

One type of industry that produces defective waste products that are still utilized is the beverage industry in the form of fruit juice and tea powder.

The amount of waste generated indicates that effective and efficient management efforts are

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needed so that environmental quality can be maintained. In addition, this also affects the performance of non-B3 waste management for related industries.

According to Masir et al., (2020) fruit juice waste and tea powder have organic content. This condition makes that the waste content has the potential to be utilized as a growing medium and source of maggot nutrition.

Maggot, as is currently known, is widely used as a decomposer of organic waste where maggot is able to degrade organic waste, both waste of plant and animal origin. Maggot can be utilized in organic waste management, which is an innovative strategy because it can produce animal feed containing high protein and fat depending on the source of nutrients (Gabler, 2015). However, no scientific studies have been found that discuss the effectiveness of utilizing the waste of defective fruit juice and tea products. Therefore, further research is needed related to the utilization of fruit juice and tea product waste as a medium for maggot cultivation.

Referring to the potential organic content in both wastes. Further studies are needed to scientifically assess their potential utilization as a medium and source of nutrients for maggots. Therefore, this study aims to assess the characteristics of the waste of defective fruit juice and tea products, and the effectiveness of maggots in reducing both types of waste.

Research Methodology

Waste characteristic test

Analysis of organic matter content as a source of maggot nutrition was conducted on fruit juice and tea waste. The parameters and methods used for the analysis can be seen in table 1.

Table 1. Waste Characterization Test Parameters and Methods

Content	Test method
Protein	Kjedahl
Fat	Soxhlet
Crude Fiber	Luff school
Carbohydrate	Luff school

Experiment

This research is experimental by comparing the composition of fruit juice waste and tea each as much as 40% tea: 60% fruit juice; 50% tea: 50% fruit juice; 60% tea: 40% fruit juice; 40% tea: 60% fruit juice control; 50% tea: 50% fruit juice control; 60% tea: 40% fruit juice control with a total weight of 1000 g which was done in duplicate. A total of 2 grams of BSF larvae eggs were hatched for 3-4 days. BSF larvae that had passed the cultivation period for 5 days were transferred into the cultivation media of each composition and placed into biopons measuring 40 cm x 32 cm x 13 cm. Furthermore, cultivation was carried out for 12 days.

Table 2. Waste Variation in Experiments

Composition	Code
40% tea: 60% fruit juice control	S1 control
50% tea: 50% fruit juice control	S2 control
60% tea: 40% fruit juice control	S3 control
Tea 40% : 60% fruit juice	S1
50% tea: 50% fruit juice	S2
60% tea: 40% fruit juice	S3

During cultivation, waste was provided as a source of nutrients for maggots every day. The composition and quality of the waste provided were in accordance with the variations set out in Table 2.

Nutrient Content Analysis of BSF Larvae During the Cultivation Process

Measurement of maggot nutrient content with water, ash, carbohydrate, protein, fat and crude fiber content. The test method used to determine the nutritional content of maggot can be seen in Table 1.

Waste Reduction Rate Analysis

Analysis of the reduction was carried out by calculating the parameters of substrate consumption and waste reduction index every 3 days, using the formula:

Reduction index

$$\text{WRI} = \frac{D}{t} \times 100\% \quad (1)$$

$$\text{D} = \frac{W-R}{W} \quad (2)$$

Where:
WRI = Waste reduction index (g).
D = Waste degradation rate.
t = Time required to degrade waste.
W = Amount of waste before degradation.
R = Amount of residue

Result and Discussion

Waste Characteristics

The results of the fruit juice and tea waste characteristics test with several parameters, namely fat, carbohydrate, protein, and fiber content are shown in Table 3.

Table 3. Waste Characterization Test Results

Variant	Parameters (%w/w)			
	Protein	Fat	Carbohydrate	Crude Fiber
S1	4.22	1.31	29.15	2.42
S2	3.78	0.90	28.32	3.07
S3	4.59	1.21	28.15	3.12

The highest protein and crude fiber content was found in the S3 variation with content of 4.59% and 3.12%. This is because tea waste contains 19.48% protein (Tugiyanti et al., 2019). According to Sundari (2009), tea grounds waste contains crude fiber, cellulose and lignin. The crude fiber content in tea grounds is around 3.53% (Hariani et al., 2013).

The highest fat and carbohydrate content was found in the S1 variation, which amounted to 1.31% and 29.15%. This is because tea and fruit juice have a carbohydrate content of 25.00% and 10.00% (Wardhana et al., 2016). In addition, tea also contains 3.26% fat (Fiberti, 2002).

The nutrient content contained in the waste shows that all variations of waste can potentially be a source of nutrition for maggots. This is in line with the statement of Cicilia (2018) which states that maggots need a lot of protein, fat, and carbohydrates for growth and reproduction at the age of 0-14 days.

Effectiveness of Maggot Cultivation in Waste Reduction

1. Substrate Consumption

   The value of the waste reduction rate is shown from the calculation of the substrate consumption (SC) value. The SC calculation value shows the ability of maggot to reduce waste, by taking into account the initial waste value and the final waste value.

   The percentage of substrate consumption showed differences in the 3 treatment compositions with the 3 control compositions. This difference states that substrate consumption in experimental media containing treatment with the addition of maggot can reduce more waste, while in control media without any treatment only reduces waste by simple decay caused by bacteria in the control media.

   The results showed that the substrate consumption value of the experimental media ranged from 38.00 - 60.17%, where the highest was found in the S1 variation media with an average value of 57.47%, the second value was obtained by the S2 variation with a value of 52.27%, and the lowest in the S3

variation with 44.67%. The control media obtained substrate consumption values ranging from 18.80% - 36.00%, where the composition of S1 control, S2 control, S3 control obtained an average of 29.42%; 26.88%; 24.01%. The following SC values for 12 days of cultivation are shown in Figure 1.

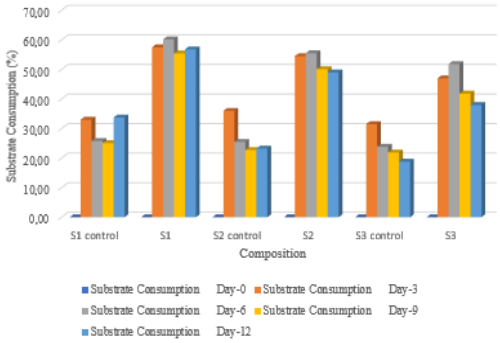

Figure 1. Substrate Consumption.

Based on experiments, the highest result in substrate consumption is the S1 variation which occurs on day 6 to day 9. This is in accordance with the statement of Dewi et al. (2023), which states that on day 6 to day 9, BSF maggots experience rapid growth, thus requiring more nutrients. This increases their appetite and encourages them to consume more substrate.

The highest substrate consumption is in the S1 variation because it has a finer texture compared to the other compositions. Substrate consumption is influenced by substrate nutrient content, substrate water content, and feed texture (Dafri et al., 2022). In general, according to Dormans et al. (2017) the characteristics of feed that are effectively given to maggots are fine food particle size, to facilitate the absorption process.

2. Waste Reduction index

The WRI value is a method to determine the level of waste reduction given in a certain time. The high value of WRI is directly proportional to the level of waste consumption, meaning that the greater the WRI value, the more waste consumption is given to maggot, while the WRI value is in Figure 2.

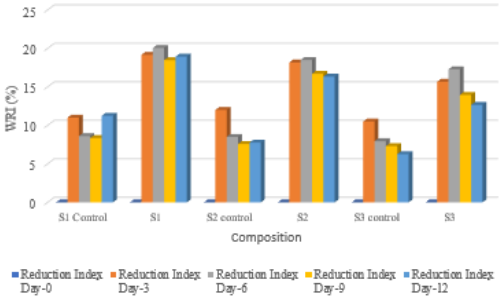

Figure 2. Waste Reduction Index.

The results showed that the highest reduction index fell on the composition of waste in the experimental media with a range of S1 variation values of 18.47-20.06%. The second value is obtained in the S2 variation with a value range of 16.33-18.50%, and the lowest value is in the S3 variation with a range of 12.67-17.28%.

The high value of WRI is directly proportional to the level of substrate consumption obtained (Madu et al., 2022). According to Rofi et al. (2021) the greater the high WRI value states that this ability can cause maggots to reduce waste to be high.

The highest WRI value falls on the S1 variation where the fruit juice waste contained in the S1 variation is more so that it has a soft texture. This will accelerate decay and produce amino acids that can break down fiber and food juice in the bait so that protein can be easily absorbed by maggots (Rofi et al., 2021). The results of the overall waste reduction index state that maggots are able to convert waste with the composition that has been given.

3. Nutritional Content of Maggot.

The composition that has the highest value of nutrient content in the form of protein, fat and crude fiber is found in the S1 composition and the lowest composition S3

The results of the maggot nutrient content test on each media are shown in Table 4.

Table 4. Maggot Nutrient Content Test Results

Variant (w/w)	Parameters (%w/w)				
	Water	Protein	Fat	Carbohydrate	Crude Fiber
S1	82.70	4.22	1.31	29.15	2.42
S2	82.66	3.78	0.90	28.32	3.07
S3	82.39	4.59	1.21	28.15	3.12

Variation S1 contains water content of 82.70%; protein 8.22%; fat 0.45%; ash 2.9%; carbohydrates 5.9%; and crude fiber 2.38%. Variation S2 contains water content of 82.36%; protein 8.78%; fat 0.29%; ash 3.03% carbohydrates 5.53%; and crude fiber 2.03%. variation S3 contains water content of 82.66%; protein 8.42%; fat 0.33%; ash 2.63%; carbohydrates 5.85%; and crude fiber 2.1%.

Based on the test results of the nutritional content of the maggot body in this study, it can be utilized as a feed mixture for poultry and livestock. According to Harmayanda et al. (2016), maggot can be used as a mixture along with commercial feed that has a high protein content to fulfill the nutrients needed by fish, poultry, and livestock.

Referring to SNI standard no 8512: 2018 feed quality requirements for songbird feed, and SNI no SNI 7652-6: 2023 male broilers. The results of the maggot nutritional content test can have potential as a songbird feed and male broiler feed mixture.

Conclusions

The conclusions that can be drawn from the research results are:

1. Waste characteristics consisting of several parameters, namely protein, fat, carbohydrate, and crude fiber content. The S1 composition variation contains 4.22% protein, 1.31% fat, 29.15% carbohydrate, and 2.42% crude fiber. Composition variation S2 contains protein content 3.78%, fat 0.90%, carbohydrates 28.32%, and crude fiber 3.07%. Variation S3 composition contains 4.59% protein, 1.21% fat, 28.15% carbohydrate, and 3.12% crude fiber.
2. The effectiveness of maggot in reducing waste based on research that has been done, the results show that the S1 variation has the highest substrate consumption value and waste reduction index, namely with a percentage of 57.47% and 20.06%.

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