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Addition of Rice Bran, Soy Protein, Yeast, and Its Combinations to the Styrofoam Degradation by Hongkong Caterpillar (*Tenebrio molitor L*)

Jenuinfri Expriana AN* and Hanifa Marisa

Biology Dept. FMIPA University of Srivijaya, Jl. Raya Palembang- Prabumulih KM 32 Indralaya, Ogan Ilir, South Sumatra, Indonesia

ABSTRACT

The use of plastic as food packaging dominates polystyrene plastic, namely Styrofoam, because of its light characteristics and the fact that it can be carried without realizing it, releasing large amounts of waste into the environment. Overcoming Styrofoam plastic can be made by using insects from the Coleoptera order, namely Tenebrio molitor L., better known to the common people as the Hongkong Caterpillar. This insect has been extensively explored as a plastic degradation agent. An important component in increasing the rate of styrofoam degradation by Tenebrio molitor L. by providing nutrients in the form of feed such as rice bran, yeast and soy protein. This study aims to determine which feed has the best effect based on styrofoam degradation, biodegradation rate, and survival rate on the performance of Tenebrio molitor L. in degrading styrofoam plastic. This research was conducted from 28 December 2022 to 26 February 2023 at the Biosystematics Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Sriwijaya University, Indralaya. The research is begun used by cultivating and caring stage of Tenebrio molitor L caterpillar. Beetle to obtain the Tenebrio molitor L caterpillar. The next stage is the preparation of EPS styrofoam material and feed in the form of rice bran, yeast and soy protein used for research experiments. The results of this study showed that the combination of rice bran and yeast increased the performance of Tenebrio molitor L. in styrofoam plastic degradation based on the biodegradation rate and 100% survival rate. The conclusion of this study is that rice bran and yeast can improve the performance of Tenebrio molitor L. in degrading styrofoam plastic L.

***Corresponding author**

Jenuinfri Expriana AN, Biology Dept. FMIPA University of Srivijaya, Jl. Raya Palembang Prabumulih KM 32 Indralaya, Ogan Ilir, South Sumatra, Indonesia.

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Introduction

The demand for plastic has made the industry produce it around 4.68 million tonnes. The use of plastic as food packaging dominates polystyrene plastic, namely Styrofoam (Kemenprin, 2017).

Styrofoam is a non-biodegradable plastic because its high molecular weight and stable structure make this plastic water-resistant and stiff which makes it difficult to decompose in nature, causing natural pollution both on land and in the sea. The advantages of Styrofoam plastic felt by humans unknowingly contribute large amounts of waste to the environment. Based on data from the Ministry of Environment in 2016, it is projected that the volume of waste will increase in 2017 by 65.8 million tons from 2015 and 14% of this amount comes from polystyrene-type plastic waste which results in the accumulation of plastic waste in the environment.

Usage of insects in tackling the problem of plastic waste done because cultivation And availability Can obtained with easy so that insects in the alternative as an effective solution in dealing with environmental pollution by the public generally.

Tenebrio molitor L. or better known to the general public as the Hong Kong caterpillar has been extensively explored as a plastic degradation agent. The ability of *T. molitor* to degrade styrofoam is due to the presence of enzymes in the digestive tract of *T. molitor* which comes from the bacterium Exiguobacterium sp strain YT2. A study by reported that *T. molitor* which was given additional feed in the form of rice bran and soy protein was able to increase the rate of styrofoam degradation [1]. Furthermore, *T. molitor* showed a high percentage of Styrofoam degradation and biodegradation rate with the addition of feed in the form of rice bran and yeast [2]. So this study aims to find out which feed is good for Tenebrio's abilities molitor in degrading plastics styrofoam based on degradation rate, degradation rate and survival rate

Method

Tools and Materials

The tools used in the study included writing tools, basins, a cutter, oven, a ruler, plastic gloves, iron spoons, analytical scales, gold scales, used egg trays, plastic containers. The materials used are rice bran, baker's yeast, *Tenebrio molitor L*. larvae, styrofoam type (EPS) Expanded Polystyrene.

How it Works

Preparation and Cultivation-and *Tenebrio molitor L*. (Hong Kong Caterpillar)

Tenebrio molitor beetle L. was obtained from breeders in the Talang Jambe Village, Palembang, South Sumatra. T molitor beetle were cultivated in the Animal Biosystematics Laboratory, Department of Biology, Faculty of Mathematics and Natural

Sciences, Sriwijaya University. The beetles are kept in large trays that are given egg-laying media in the form of former egg trays. Feed for the *T. molitor* beetle in the form of pur chicken brand boiler and chayote (jipang) as water nutrition.

Preparation of Feed Media

The feed media used in this study were rice bran, soy protein and yeast. Before conducting research experiments, the three feeds were tested for pH and water content. After that, the feed was given to *T. molitor* larvae according to the predetermined treatment. The addition of the feed combination in the research experiment was 4 grams per treatment for 4 days once a day. Change of feed every 4 days is done to prevent mold from appearing in the feed. The styrofoam used is (EPS) Expanded Polystyrene cut into 2 x 3 cm with a weight of 2 grams [1].

Research Experiments

First measurements on rice bran, soy protein and yeast namely pH, temperature ter content then measurements of room temperature and humidity in the laboratory room. After that, continue with research experiments on test animals, namely *Tenebrio molitor L*. larvae that have reached instar 9 will be placed in a research container, namely Thinwal with a size of 1000 ml. Each treatment and repetition contained 40 *Tenebrio molitor L*. larvae and the feed tested. Measurements will be taken every 4 days based on the observed variables and the results of the research will be recorded.

Observation Variable

Determination of the Percentage of Styrofoam Degradation [2].

$$\text{Degradation } (\%) = \left[\frac{w_1 - w_{fn}}{w_1}\right] x\ 100\%$$

Information:
W_1 = initial mass (g)
W_2 = final mass (g)

Determination of Biodegradation Rate [2].

$$V = \left[\frac{w_1 - w_f}{\Delta t}\right]$$

Information:
V = Biodegradation rate (g/ day)
Δt = time required for degradation (Days)

Survival Rate (Continuity live) *Tenebrio molitor L* arvae

Measurement of Survival Rate (Continuity live) *Tenebrio molitor L*. larvae were counted live larvae from the beginning to the end of the study counted in a unit percent [1].

Data Analysis

Data from this study will be presented in the form of tables and graphs in the form of degradation percentage, biodegradation rate and survival rate on *Tenebrio molitor L*. Data changes from the observed variables will be carried out by a one way analysis of variance (ANOVA) test, if there is a difference between the treatments then a further test will be carried out Duncan

Results and Discussion

Degradation and Rate of 'Styrofoam' Plastic Degradation by *Tenebrio molitor L*.

Table 3.1 degradation at P 1 shows a significant difference from other treatments. Meanwhile, P2 showed no significant difference to P3.

No	Treatment	Degradation Average (%)
1	P1 (Bran + Styrofoam)	$3,68^a \pm 0,12$
2	P2 (Bran + Yeast + Styrofoam)	$7,26^c \pm 0,21$
3	P3 (Bran + Soy Protein+ Styrofoam)	$6,65^b \pm 0,28$

Information : The numbers followed by the same letter are different not real on α = 0,05.

Table 3.1: Average Degradation Styrofoam Plastic By *Tenebrio molitor L*. for 20 days

A high percentage of styrofoam plastic degradation was shown in P2 with the addition of rice bran and yeast to *Tenebrio molitor L*. in degrading EPS styrofoam plastic with a high percentage of 7.26 ± 0.21. According to Riberio et al (2018), yeast is used as a feed source of protein which is used as a stimulant for *Tenebrio molitor L*. to eat so that it can stimulate the larvae to increase their ability to degrade styrofoam.

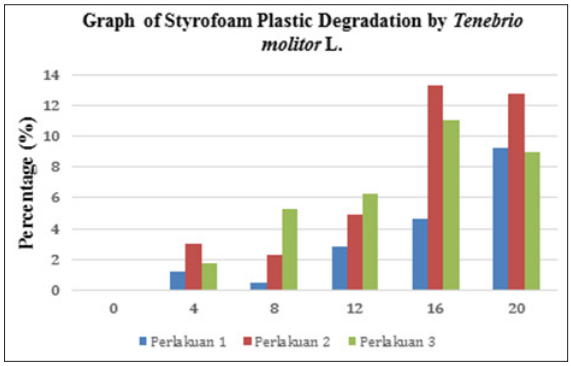

Figure 3.2: Chart Stryrofoam Degradation Plastic by *Tenebrio molitor L*

Figure 3.2 shows that treatment 2 experienced a decrease in degradation on day 16 to day 20 which was not too significant compared to other treatments and treatment 3 also showed a decrease in degradation from day 12 to day 20 because some of the larvae in this study had metamorphosed into pupae which where the pupal phase of *Tenebrio molitor L*. does not consume any available feed.

Figure 3.3: Degradation plastic by *Tenebrio molitor L*.

The degradation process by was initiated by the interest of *Tenebrio molitor L*. to EPS feed like picture 3. 3 that changes the styrofoam into smaller parts such as holes until the EPS condition is degraded. According to that EPS is a type of polystirine plastic that produces organic compounds which can evaporate so that the Tenerbio molitor larvae , which have instincts to maintain survival, are attracted to visiting the plastic so that it can accelerate degradation [3].

The Styrofoam given to *Tenebrio molitor L*. is rich in carbon but lacks the nitrogen needed by the larvae so when it is degraded it will not be sufficient to meet its nutrients. According to Yang Y, in fulfil nitrogen requirement for *Tenebrio molitor L*. helped with microbes in the digestive tract that have activity can bind and fix nitrogen in the atmosphere which later nitrogen can become a new substance in the digestive tract [4].

Rate Degradation plastic styrofoam by *Tenebrio molitor L*. during 20 day

No	Treatment	Degradation Rate (g/day)
1	P1 (Bran + Styrofoam)	$0{,}0173^{a} \pm 0{,}0005$
2	P2 (Bran + yeast + Styrofoam)	$0{,}3188^{c} \pm 0{,}0008$
3	P3 (Bran + soy protein + Styrofoam)	$0{,}0293^{b} \pm 0{,}0011$

Information : The numbers followed by the same letter are different not real on α = 0,05.

Table 3.2: Average Degradation rate Styrofoam Plastic By *Tenebrio molitor L*. for 20 days

Table 3.2. showed the results of Duncan's advanced test that the lowest degradation rate was in P1 using rice bran, namely 0.0173 ± 0.0005 and the highest degradation rate was in P2 using bran and yeast feed added to *Tenebrio molitor L*. showed a value of 0.3188 ± 0. 0008 grams/day. and P3 approached the rate of degradation in the second treatment.

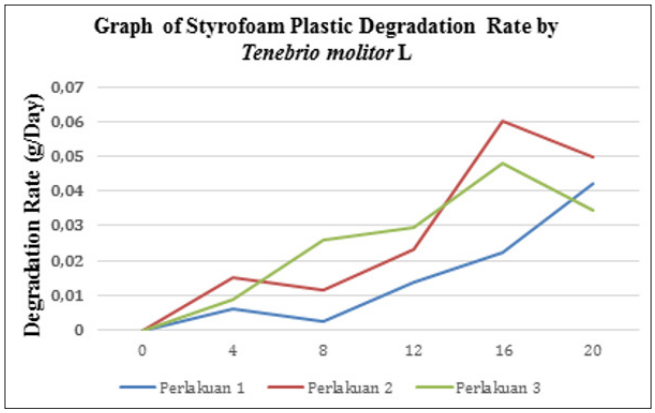

Figure 3.4: Graph Degradation Rate Styrofoam Plastic by *Tenebrio molitor L*

Measurement of the rate of degradation in this study was carried out to see the speed of plastic k Styrofoam which is degraded faster by *Tenebrio molitor L*.

Increasing the rate of degradation in *Tenebrio molitor L*. using additional feed as a nutrient will help meet the needs of the digestive tract which will later be active in degrading plastic. According to that the addition of nutrients in the form of feed such as products from protein or bran can extend the high feeding rate by *Tenebrio molitor L*. on styrofoam plastic compared to no additional nutrients for degradation [1,2,5]. styrofoam plastic so that it can increase the ability of *Tenebrio molitor L*. to accelerate the rate of degradation of styrofoam plastic. Comparison with the research that be done by, it is found that degradation rate of them, looks faster, about 27.26 mg/day; but used 120 caterpillar in a research unit [2].

Survival Rate (Survival Live) *Tenebrio molitor L* Deep Degrade Styrofoam

No	Treatment	*Survival Rate* (%)
1.	P1	100 %
2.	P2	100 %
3.	P3	100 %

Table 3.3: Survival Rate (Continuity live) *Tenebrio molitor L*. in Degrade Styrofoam

The three treatments tested on *Tenebrio molitor L*. larvae had a Survival Rate of 100% as shown in Table 3.3. that there was no death in the larvae so the survival rate of *Tenebrio molitor L*. in degrading styrofoam plastic did not harm the larvae. Maha et al., reported that the styrofoam feed given to *Tenebrio molitor L*. did not cause death and it was proven that the biomass produced by Tenebrio molitor L. was marked with a survival rate above 70% so that styrofoam was safe to be degraded by a degrading agent, namely *Tenebrio molitor L* [3].

The effect of styrofoam given to *Tenebrio molitor L*. is known as not lethal but the microbes in their digestive tract have an important role in helping *Tenebrio molitor L*. larvae to survive. According to that some microbes in the digestive tract can detoxify and add to the ability to detoxify is a form of symbiosis between insects and certain microbes [3.6,7].

Summary

Based on the research results that have been obtained, several conclusions are obtained as follows:

1. Addition of bran , yeast and soy protein help increase performance Tenebrio molitor in degrade plastic Styrofoam
2. The combination of rice bran and yeast that has a good effect on *Tenebrio molitor L*. in the degradation of styrofoam is the degradation product of 7.26% and degradation rate as big 0.3188 g/ day and Survival Rate as big 100% indicating _ that styrofoam No have character turn off on *Tenebrio molitor L*.

References

1. Yang SS, Brandon AM, Flanagan JCA, Yang J, Ning D, et al. (2017) Biodegradation of polystyrene wastes in yellow mealworms (larvae of *Tenebrio molitor L*innaeus): factors affecting biodegradation rates and the ability of polystyrene-fed larvae to complete their life cycle. Chemosphere 191: 979-989.
2. Sari SA, Yenie E, Muria SR (2019) Effect of Nutritional Composition on Styrofoam Biodegradation Rate Using Hong Kong Caterpillar (Larva Tenebrio Molitor). Student Online Journal (JOM) in Engineering and Science 6: 1-6.
3. Maha IV (2022) The Effectiveness of *Tenebrio molitor L*. (Coleoptera: Tenebrionidae) As a Styrofoam Degrading Agent to Solve Waste Problems. Journal of Environmental Science & Technology 14: 40-49.
4. Yang Y, Hu L, Li X, Wang J, Jin G (2023) Nitrogen fixation and diazotrophic community in plastic-eating mealworms *Tenebrio molitor L*. Microbial ecology 85: 264-276.
5. Wang X, Tang T (2022) Effects of Polystyrene Diet on the Growth and Development of Tenebrio Molitor. Toxics 10: 608.

6. Genta Fernando A, Rod J Dillon, Walter R Terra, Clélia Ferreira (2006) Potential role for gut microbiota in cell wall digestion and glucoside detoxification in *Tenebrio molitor L*arvae. Journal of insect physiology. 52: 593-601.

7. Fitasari, Eka, Erik priyo Santoso (2015) The Use of a Combination of Gross Energy and Protein on Feed Consumption and Body Weight Development of Hong Kong Caterpillars. Journal of Buana Science 15: 127-136.

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