Substitution of commercial feed with fermented banana peel flour (*Musaceaea* sp.) and fish meal to crude protein, energy, crude lipid and organic matter of meat in siamese catfish (*Pangasius hypophthalmus*)

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Abstract This study aims to determine the effect of commercial feed substitution using fermentation of banana peel flour and fish meal on crude protein content, energy, crude fat, and organic matter in siamese catfish. This research used a completely randomized design (CRD) consisting of five treatments and four replications. The treatments used included P0 (100% commercial feed), P1 (commercial feed 95% + 5% FTKPTI), P2 (commercial feed 90% + 10% FTKPTI), P3 (commercial feed 85% + 15% FTKPTI) and P4 (commercial feed 80% + 20% FTKPTI). The parameters observed were crude protein content, energy, crude fat, and organic materials in the siamese catfish meat. The data obtained were then analyzed using ANOVA. The results showed that crude protein content in fish receiving fermentation of banana peel flour was significant different than those fish receiving fish meal (p <0.05). Furthermore, there was no significant difference (p> 0.05) on energy content, there was a significant difference (p<0.05) on crude fat content and there was no significant difference (p> 0.05) on the organic matter content in the siamese catfish meat. Fermented banana peel flour and fish meal can be used as a substitute for commercial feed up to a dose of 20%.

1. Introduction
Siamese catfish is one type of consumption fish that is very popular with the public. However, the development of siamese catfish culture still faces obstacles, especially the high commercial feed price which results in low profits for fish cultivators. The cost of siam catfish feed can reach 60% -70% of the production cost, so an effective and efficient alternative feed management is needed and can reduce production costs. Alternative feed management can be done by utilizing local feed raw materials that are easily available and usually in the form of waste that has not been optimally utilized. One of the wastes that can be used is banana peel.

According to Hernawati and Aryanti [1] that banana peels contain 5.15% crude protein, 16.14% crude fibre, 15.29% fat. The crude fibre content possessed by banana peels makes it difficult to digest because it has a strong cell wall so that it is difficult to crack [2]. Therefore, it is necessary to improve the nutritional content so that its use in feed ingredients can be used. This can be done in various ways,
one of which is the fermentation process. Banana peel fermentation can be carried out using probiotics containing cellulolytic bacteria (Enterobacter spp., Cellulomonas spp., and Actinomyces spp.) and proteolytic (Bacillus spp.) To increase crude protein content and reduce crude fibre content as an alternative feed ingredient in the feed formula. Fish to support the productivity of aquaculture. In this study, the fermentation of banana peels and the addition of fish meal can be used as a feed substitution for siamese catfish. This study aimed to determine the effect of commercial feed substitution using fermentation of banana peel flour and fish meal on crude protein, energy, crude fat and organic material of siamese catfish.

2. Materials and methods
The tools used in this study were 20 pieces of aquaria with a size of 50x30x30 cm³, tanks, aerators, aeration, hose, spoon, ruler, milling, pellet moulding device, thermometer, pH pen, DO meter, ammonia test kit, Petridisk, analytical scales, plastic clips, 1 kg plastic bags, basin, spoon and label paper.

The fish used to be tested in this research are 9-12 cm siam catfish (P. hypophthalmus) obtained from the Puri Fish Seed Center, Mojokerto. Each aquarium contains 10 siam catfish with a total of 200 fish. The materials used in this study were fermented banana peel flour, fish meal, commercial feed, Aquades, BioMC4 probiotics, molasses. Banana peel waste is obtained from a seller of processed bananas in the Tegalsari area, Surabaya.

The study was conducted in December 2019 until April 2020 which is located at the Laboratory of Anatomy and Cultivation of the Faculty of Fisheries and Marine Airlangga University Surabaya. Proximate analysis was carried out at the Laboratory Examination Service Unit for the Consultation and Training of Veterinary Testing and Feed Analysis Units at the Faculty of Veterinary Medicine, Airlangga University, Surabaya. The method used in this study is the experimental method using a Completely Randomized Design (CRD) consisting of 5 treatments with each of 4 replications as follows:

- **T0** = 100% commercial feed
- **T1** = 95% commercial feed + 5% fermented banana peel flour and fish meal
- **T2** = 90% commercial feed + 10% fermented banana peel flour and fish meal
- **T3** = 85% commercial feed + 15% fermented banana peel flour and fish meal
- **T4** = 80% commercial feed + 20% fermented banana peel flour and fish meal

2.1. Produced of fermented banana peel flour
Banana peels that have been obtained are then cut and dried in the sun for 7 days. After drying, the banana peel is ground until it becomes flour. Then, the banana peel flour is placed in a container for mixing fermentation materials, then put in a plastic bag and tied, stored at room temperature 28-32°C with a closed state for 7 days; then dried and analyzed proximate to determine the content of crude fibre and crude protein, then mixed with a fish meal so that the crude protein content of fermented banana peel flour is equivalent to commercial feed.

2.2. Preparation of siam catfish feed formula
The feed ingredients in the form of crushed commercial feed, fermented banana peel flour, and fish meal are collected according to a predetermined dose, namely offering a fermented mixture of banana peel flour and fish meal of 0%, 5%, 10%, 15%, and 20%. The homogeneously mixed feed ingredients are then printed using a pellet moulding tool. The pellets are then dried using sunlight for 1 day. The dried pellets are stored in a plastic clip bag and labelled, stored in a dry place. The results of the calculation of feed proximate analysis can be seen in Table 1.

| Table 1. Results of calculation of proximate analysis of treatment feed |
|-----------------|------|------|------|------|------|
|                | T0   | T1   | T2   | T3   | T4   |
| DM (%)         | 95.51| 94.722| 93.935| 93.148| 92.361|


2.3. Aquarium preparation
The aquarium used is 50x30x30 cm³ with 20 pieces. Before use, first cleaned and sterilized using clean water and chlorine. Fish culture media uses freshwater that has been aerated for one day to increase the dissolved oxygen content in the water.

2.4. Fish culture
The fish used to be tested in this research were siam catfish (P. hypophthalamus) size 9-12 cm. Each aquarium is filled with 10 fish. The acclimatization process is carried out first to adjust the physiology of the fish with culturing media. Total feeding was 3% of the weight of fish biomass with the frequency of giving 2 times per day.

2.5. Data collection
The main test parameters in this study were the content of crude protein, energy, crude fat, and organic materials in the siamese catfish meat using the method of taking the siamese catfish meat by fillet method to separate the meat from the skin. Furthermore, doing a proximate analysis of siamese catfish meat to determine the content of crude protein, energy, crude fat and organic matter. the formula for the content of organic matter, namely dry matter minus dust.

2.6. Data analysis
The data obtained were analyzed using the Statistical Product and Service Solution (SPSS). Analysis of the data used in Analysis of Variance (ANOVA) to see the effect of the treatment given, if there are significant results, the analysis is calculated using Duncan's multiple distance test (Duncan's Multiple Range Test) with a real level of 5% [8].

3. Results and discussion
3.1. Crude protein content
The data from the test results of commercial feed substitution using fermentation of banana peel flour and fish meal on the crude protein content of siam catfish (P. hypothalamus) showed a significant difference. Calculation of the crude protein content of siamese catfish can be seen in Table 2.

| Ash (%)  | CP (%) | CF (%) | CFa (%) | NFE (%) | EM (Kkal/kg) |
|----------|--------|--------|---------|---------|--------------|
| 9.91     | 39.73  | 2.13   | 4.96    | 38.78   | 3112.82      |
| 10297    | 39.729 | 2.688  | 5.23    | 37.334  | 2975.997     |
| 10.686   | 39.729 | 3.247  | 5.5     | 35.888  | 2839.175     |
| 11.074   | 39.729 | 3.805  | 5.771   | 34.442  | 2702.352     |
| 11.463   | 39.729 | 4.365  | 6.041   | 32.997  | 2565.53      |

Information: P0 (Commercial F. 100 % + FTKPTI 0 %), P1 (Commercial F. 95 % + FTKPTI 5 %), P2 (Commercial F. 90 % + FTKPTI 10 %), P3 (Commercial F. 85 % + FTKPTI 15 %), P4 (Commercial F. 80 % + FTKPTI 20 %). Different superscripts show a marked difference (p<0.05)
Table 2 shows that the substitution of commercial feed using fermentation of banana peel flour and fish meal to crude protein content shows a significant difference (p <0.05) in each treatment on the crude protein content of siamese catfish which ranges from 16.901-17.855%.

Protein is the most important nutrient for supporting new tissue growth, repairing damaged tissue, metabolism for energy and production [3]. Protein also acts as a protective and defensive body and helps metabolic processes [4]. The amount of protein required by fish is influenced by several factors such as fish size, water temperature, the amount of feed eaten by fish, availability and quality of natural food and protein quality [5].

The results of statistical analysis on the crude protein content of this study showed that the substitution of commercial feed using fermentation of banana peel flour and fish meal to the crude protein content of catfish meat showed a significant difference. Treatments P1, P2, P3, and P4 were significantly different from treatment P0, this is because P0 is a control treatment or without substitution of banana peel flour and fish meal fermentation. In treatment, P1-P4 can increase crude protein content compared to P0.

Judging from the nutritional content of the feed, the treatment given has an energy content that decreases in each treatment, therefore the amount of feed consumption increases, which indirectly increases the protein consumed. This is one of the factors in increasing protein absorption which causes the value of crude protein content in siamese catfish to increase. This is because the feed given is a substitute feed where the nutritional content is almost the same as commercial feed, which indicates that there is no decrease in the quality of the feed replaced with FTKPTI. This is because the protein that has been absorbed is first used by the siamese catfish for activity, metabolism and maintenance needs. Then if the excess will be stored in the body to build body protein tissue (used for growth). The use of feed containing the appropriate protein content and the optimum amount will lead to the formation of new tissue so that the growth rate increases.

In this study, the protein content of catfish in treatment P1, P2, P3, and P4 was significantly higher than treatment P0. This shows that FTKPTI substitution of 5-20% can significantly increase the crude protein content.

3.2. Energy content
Data from the test results of commercial feed substitution using fermentation of banana peel flour and fish meal on the energy content of catfish (Pangasius hypothalamus) meat showed no significant difference. Calculation of the energy content of siamese catfish can be seen in Table 3.

| Treatment | Energy Content (Kcal) ± SD |
|-----------|-----------------------------|
| P0        | 749.852 ± 10.936            |
| P1        | 757.832 ± 18.410            |
| P2        | 755.330 ± 18.875            |
| P3        | 752.085 ± 17.457            |
| P4        | 737.203 ± 7.647             |

Information: P0 (Commercial F. 100 % + FTKPTI 0 %), P1 (Commercial F. 95 % + FTKPTI 5 %), P2 (Commercial F. 90 % + FTKPTI 10 %), P3 (Commercial F. 85 % + FTKPTI 15 %), P4 (Commercial F. 80 % + FTKPTI 20 %).

Table 3 shows that the substitution of commercial feed using fermentation of banana peel flour and fish meal on energy content shows no significant difference (p> 0.05) in each treatment of the energy content of siamese catfish meat ranging from 737,203-757,832 Kcal.

The results of statistical analysis on the energy content of this study showed that the substitution of commercial feed using fermentation of banana peel flour and fish meal on the energy content of catfish meat showed no significant difference. Based on the calculation of the data, it can be seen that
the highest average energy content is found in the P1 treatment with FTKPTI substitution treatment as much as 5% of the amount of feed, which is 757,832 Kcal, while the lowest energy content is in the P4 treatment with the FTKPTI substitution treatment as much as 20% of the total feed, namely amounting to 737,203 Kcal. Low feed energy content will be followed by increased consumption. Appendix 4 states that the higher the substitution, the lower the energy so that the fish consume more feed, which in the end all treated fish get the same energy intake.

Substitution of commercial feed using fermentation of banana peel flour and fish meal on the energy content of catfish meat from treatment P0 to P4 showed almost the same results as commercial feed, so fermentation of banana peel flour and fish meal can be used as a substitution of up to 20%. However, to be more optimal, you should use a dose of 5% (P1) because it has greater energy content than other treatments. Judging from the nutritional content of the feed, the treatment given has an energy content that increases then decreases in each treatment, therefore the amount of feed consumption increases which indirectly increases the consumption of carbohydrates, as evidenced by treatment P1-P3 the energy content increases which is one of the factors increased energy consumption of Siam catfish.

In this study, the energy content in the siamese catfish meat which was fed treated feed was not different from P0. This shows that the energy in the treated feed can be utilized properly by the Siam catfish.

### 3.3. Crude lipid content

Data from the test results of commercial feed substitution using fermentation of banana peel flour and fish meal on the crude fat content of siamese catfish (P. hypothalamus) showed a significant difference. Calculation of crude fat content of siamese catfish can be seen in Table 4.

| Treatment | Crude Lipid Content(%) ± SD |
|-----------|----------------------------|
| P0        | 1.2150a ± 0.0221            |
| P1        | 1.3042b ± 0.0348            |
| P2        | 1.2145a ± 0.0327            |
| P3        | 1.2102a ± 0.0318            |
| P4        | 1.2432b ± 0.0471            |

Information: P0 (Commercial F. 100 % + FTKPTI 0 %), P1 (Commercial F. 95 % + FTKPTI 5 %), P2 (Commercial F. 90 % + FTKPTI 10 %), P3 (Commercial F. 85 % + FTKPTI 15 %), P4 (Commercial F. 80 % + FTKPTI 20 %).

Table 4 shows that the use of fermented banana meal and fish meal substituted for commercial feed in the siamese catfish feed formula had a significant effect (p <0.05) on crude fat content. The results of further tests using Duncan showed that P0 treatment was not significantly different (p > 0.05) with P2, P3, and P4. While P1 treatment was significantly different (p <0.05) with treatment P0, P2, P3, and P4. Fats are a class of lipids that are soluble in non-polar solvents and insoluble in water. This property is different from other compounds such as protein and carbohydrates which are generally insoluble in non-polar solvents. Fat serves as a supplier of energy for the body [11].

The high crude fat content in treatment P1 (1.3042%) compared to P2 (1.2145), P3 (1.2102), and P4 (1.2432) can be caused by the crude fibre content in the feed. As well as crude in P2, P3, and P4 treatment feeds higher than P1, this causes disruption in the absorption of nutrients, one of which is fat, so that high crude fibre in feed makes it difficult for fish to digest feed and carry fat out with faeces [9].

The crude fibre in feed affects the absorption of fat in fish because fat is bound to crude fibre and leaves with faeces. Crude fibre also has a function in helping the peristalsis of the digestive tract [10]. The high crude fibre content in feed has a negative effect, namely the more difficult it is for the fish to digest the feed (Bakara et al. 2012).
3.4. Organic matter content

The data from the test results of commercial feed substitution using fermentation of banana peel flour and fish meal on organic matter content of siamese catfish (*P. hypothalamus*) did not show a significant difference. Calculation of organic matter content in siamese catfish meat can be seen in Table 5.

**Table 5.** The average organic material content of siamese catfish meat in commercial feed substitution treatment used fermentation of banana peel flour and fish meal (%)

| Treatment | Organic Material Content(%) ± SD |
|-----------|----------------------------------|
| P0        | 21.3650 ± 0.3235                 |
| P1        | 21.5373 ± 0.5170                 |
| P2        | 21.5761 ± 0.5537                 |
| P3        | 21.4779 ± 0.4742                 |
| P4        | 20.9798 ± 0.1264                 |

Information: P0 (Commercial F. 100 % + FTKPTI 0 %), P1 (Commercial F. 95 % + FTKPTI 5 %), P2 (Commercial F. 90 % + FTKPTI 10 %), P3 (Commercial F. 85 % + FTKPTI 15 %), P4 (Commercial F. 80 % + FTKPTI 20 %).

Based on Table 5, it shows that the use of fermented banana peel flour and fish meal substituted for commercial feed in the siamese catfish feed formula does not cause a significant difference (p > 0.05) to the organic matter content. The value of organic material content of siamese catfish meat on treatment P0, P1, P2, P3, and P4 are the same.

According to Parakkasi [6], organic matter is a dry matter that has been reduced by ash, the dry matter component when fermented in the rumen will produce fatty acids which are a source of energy for livestock. The content of organic material in siamese catfish includes food substances in the form of organic material components such as carbohydrates, proteins, fats, and vitamins.

There was no significant difference in the organic matter content because all feed used in this study, both commercial feed and substituted feed, had equal nutritional content. Although substitution feed has a higher crude fibre content than commercial feed, the increase is not too high so that it can still be accepted by fish bodies. Organic materials include crude protein, crude fat, crude fibre and extracts without nitrogen. The increase in crude fibre in substituted feed is also balanced with the increase in crude fat so that it can be used as an energy source. This is consistent with Watanabe [7] that crude fat in feed has a high energy source value that can be used by fish for activities such as swimming, foraging, avoiding enemies, and growth.

Substitution of commercial feed using fermentation of banana peel flour and fish meal against the organic material content of siamese catfish meat from treatment P0 to P4 shows almost the same results as commercial feed, so fermentation of banana peel flour and fish meal can be used as a substitution of up to 20%.

4. Conclusion

Commercial feed substitution using fermented banana peel flour and the fish meal at a dose of 5 - 20% can increase the crude protein content and does not affect the energy content of siamese catfish. As well as commercial feed substitution using fermented banana peel flour and the fish meal at a dose of 5% can increase the crude fat content in siamese catfish meat and does not affect the organic matter content in siamese catfish meat.

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