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Efficiency of Black Soldier Fly Carcass Flour on Growth and Growth Sangkuriang Catfish (*Clarias gariepinus*)

Efesiensi Tepung Karkas Lalat Black Soldier Fly Terhadap Pertumbuhan dan Kelulushidupan Ikan Lele Sangkuriang (*Clarias Gariepinus*)

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ABSTRACT

Sangkuriang catfish (*Clarias gariepinus*) is a type of freshwater fish that is popular in Indonesia because it grows quite quickly compared to other types. Feed is an important component in fish farming activities to support growth. An increase in the price of fish feed without an increase in the selling price of fish is a problem that every farmer must face. Therefore, efforts need to be made to find raw materials at cheap and easy prices. Black soldier fly carcasses can be used as an alternative to fish meal. Currently, not many black soldier fly carcasses are used as raw material for fish feed, even though this type of insect contains a relatively high source of protein. The aim of this research was to examine the potential of adding black soldier fly carcass meal for the growth and survival of Sangkuriang catfish. Black soldier fly carcasses have the potential to be used as a 50% substitute for fish meal. The formulated test feed contains 37-38% protein. The performance of the test feed was compared with the control using Duncan's test. After acclimatization, Sangkuriang catfish measuring 5-7 cm were randomly distributed into 15 aquariums measuring 100 cm x 50 cm x 51 cm with a stocking density of 25 fish/m3 and fed 6% of the total weight of all test fish for 35 days. maintenance. The results showed that the growth of Sangkuriang catfish was significantly different between the 50% KL formulation test feed and the control feed ($P<0.05$). Using black soldier fly carcass flour can increase absolute weight growth by 3.26 g to 5.22 g and survival of sangkuriang catfish by 77.33 – 86.67%.

ABSTRAK

Ikan Lele Sangkuriang (*Clarias gariepinus*) merupakan jenis ikan air tawar yang menjadi primadona di Indonesia karena memiliki pertumbuhan yang cukup cepat

dibandingkan dengan jenis lainnya. Pakan merupakan salah satu komponen penting dalam kegiatan budidaya ikan untuk mendukung pertumbuhan. Kenaikan harga pakan ikan tanpa disertai kenaikan harga jual ikan merupakan permasalahan yang harus dihadapi oleh setiap pembudidaya. Oleh karena itu, perlu dilakukan upaya pencarian bahan baku dengan harga murah serta mudah. Karkas lalat black soldier memungkinkan sebagai alternatif pengganti tepung ikan. Saat ini karkas lalat black soldier belum banyak yang digunakan sebagai bahan baku untuk pakan ikan, padahal jenis insekta ini mengandung sumber protein yang relatif tinggi. Tujuan dari penelitian ini untuk mengkaji potensi penambahan tepung karkas lalat black soldier untuk pertumbuhan dan kelulushidupan ikan Lele Sangkuriang. Karkas lalat black soldier memiliki potensi untuk dijadikan pengganti tepung ikan sebanyak 50%. Pakan uji yang diformulasikan mengandung protein 37-38%. Performa pakan uji dibandingkan dengan kontrol menggunakan uji Duncan. Setelah diaklimatisasi ikan lele Sangkuriang ukuran 5-7 cm yang ditebar secara acak ke dalam 15 akuarium berukuran 100 cm x 50 cm x 51 cm dengan padat tebar 25 ekor/m3 dan diberi pakan sebanyak 6% dari total bobot seluruh ikan uji selama 35 hari masa pemeliharaan. Hasil penelitian menunjukkan bahwa pertumbuhan ikan lele Sangkuriang berbeda nyata antara pakan uji formulasi KL 50% dengan pakan kontrol ($P<0.05$). Dengan penggunaan Tepung Karkas lalat black soldier dapat meningkatkan pertumbuhan bobot mutlak sebesar 3.26 g sampai 5.22 g dan kelangsungan hidup ikan lele sangkuriang 77.33 – 86.67%.

Kata Kunci	*Lele sangkuriang, karkas lalat black soldier, pertumbuhan*
Keywords	*Sangkuriang catfish, black soldier fly, growth*
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INTRODUCTION

Sangkuriang catfish (*Clarias gariepinus*) is a type of freshwater fish that is popular in Indonesia for cultivation as a food fish. This fish is widely consumed because it has a fairly high protein content and also has a fast growth time (Sitompul, 2012). According to (DJPB KKP, 2019), catfish production from 2015 to 2019 had quite good value with an increase in production of 15.84%. In 2017, catfish production experienced a very significant increase reaching 1.2 million tons and in 2019 it increased 44% from the previous year. The price of sufficient feed actually causes problems in fisheries cultivation, especially catfish cultivation in the aquaculture sector.

Feed is a source of energy that fish need for growth. Success in cultivation is determined by the feed provided because 60-70% determines profitability (Kari et al., 2021). In general, the feed given to Sangkuriang catfish is in the form of commercial pellets. According to Halijah et al., (2019), if the feed provided is of poor quality, it will cause stunted fish growth. In cultivation activities, the availability of feed must take into account several things such as quantity, timely, sustainable, balanced nutrition, has a distinctive odor and can be digested by the fish's body (Kurniawan, 2019).

One of the raw materials often used to make fish food is fish meal. Fish meal is the main raw material which has a high protein content. The high protein content in fish tuber reaches 65% which is supported by complex and balanced amino acids so that it provides nutrition for livestock. (Parakkasi, 1999). This is supported by the opinion of Boniran (1998) who states that the nutritional content of fish meal reaches 58-68% with a water content of 5.5-8.5%. With the high nutritional value of fish meal, the price of fish meal becomes expensive and difficult to obtain. This is supported by the opinion of Muntafiah (2020) who stated that the high cost of the main raw material for feed in the form of fish meal has caused its existence to become increasingly rare, resulting in increasingly expensive feed prices. One solution to overcome the problem of expensive fishmeal raw materials is by substituting fishmeal. One substitution to replace fish meal is using black soldier fly carcasses.

Black soldier fly carcasses can be used as an alternative to fish meal. Currently, not many black soldier fly carcasses are used as raw material for feed, especially fish feed, even though this type of insect contains a relatively high source of protein. From the results of proximate tests conducted by Mawaddah et al., (2018) it was stated that the black soldier fly carcass had nutrient content, namely water content 7.05%, ash 9.52%, crude protein 42.65%, crude fat 17.95%. %, and crude fiber 6.98%. This is supported by the opinion of Rachmawati et al., (2010) that Maggot H. illucens has protein reaching 61.47% which can be used as an alternative raw material for feed.

The type of insect that can be used as a substitute for fish meal is black soldier fly carcass meal. Black soldier fly carcasses contain 42.65% protein Lestari et al., (2013) and relatively the same as fish meal (46.87%) (Mawaddah et al., 2018). In terms of economic value, black soldier fly carcasses are more economical because they are easy to obtain. Apart from that, the black soldier fly carcass is a type of insect that is not widely used but has very good benefits, especially as a raw material to replace fish meal. The aim of this research is to examine the potential of adding black soldier fly carcass meal for the growth and survival of Sangkuriang catfish.

RESEARCH METHODS

This research was conducted in June – September 2022 at the Matauli Fisheries and Marine College Laboratory, Pandan, Central Tapanuli, North Sumatra.

The design used in this research was a Completely Randomized Design (CRD), consisting of 5 treatments and 3 replications. The treatment used is Black Soldier Fly Carcass Meal (KL-BS) as a substitute for Fish Meal (TI) with the following formulation:

A = 100% TI + 0% KL-BS
B = 75 % TI + 25 % KL-BS
C = 50 % TI + 50 % KL-BS
D = 25 % TI + 75 % KL-BS
E = 0 % TI + 100 % KL-BS

Table 1. Tools used during the research

No	Tools	Numbers	Specification	Function
1	Aquarium	15 pieces	P=100 cm, L=50 cm, T=51 cm	Fish Keeping Container

2	Hose and air stone	15 pieces	The material is made of plastic with a length of 1.5 and 3 m	Dissolved oxygen supplier
3	Blower	1 Unit	D= 80 mm, Thickness=15 mm, and W=400 g	Air Pump
4	Heaters	15 Units	W=4 kg, generic brand, size 4 inches, and days of electricity=550 Watts	To stabilize the temperature of the media
5	Thermometer	15 Units	Brand Amara, Type=HT 50, Power=50 Watt	Know the temperature of the media
6	Alcohol	2 nits	Min=-10 and Max=+110oC temperature,	Cover the top of the aquarium
7	Waring	1 Unit	Mess size=2 mm, L=20 m, Polyethylene material and blue in color	Weighing fish
8	Analytical scales	1 Unit	Accuracy=0.01 gr, Capacity-300 gr, Brand Ohanus AX 124	Measuring the length of the fish
9	Ruler	2 Units	L=30 cm, Accuracy=0.1 cm, and made of plastic	Fish grading place
10	Plastic Bucket	1 Unit	Made of plastic, has a capacity of 30 kg, and D=60 cm	To dry a material

Table 2. Tools used during the research

No	Materials	Number/Volume/Weight	Function
1	Water	V=90 L and 150 L	As a medium for raising fish
2	Salt	3 ppt	Kills bacteria and regulates
3	PK	5 gr	balance processes in the body
4	Test fish	275 tails	To sanitize equipment during research
5	BS fly carcass meal	8.5 kg	As testing material

The test material used in this research was black soldier fly carcasses originating from the Slaughterhouse, Bubulak, Bogor. The black soldier fly carcass used was 15 kg in wet condition (wet weight) which was put into a plastic container, and after that it was dried first (to get the dry weight). The drying process is carried out using an oven at a temperature of 60oC for ± 24 hours. After being in the oven, then weigh the dry weight of the black soldier fly carcass. If the black soldier flies are not completely dry, dry them again in the sun using a container for ± 3 hours until dry, then record the dry weight. After the drying process, the weight of the black soldier fly carcass became 9.2 kg. After drying, it is then processed into flour. The process for making black soldier fly carcass flour is by sieving using a blender. The black soldier fly carcass flour is then dried in the sun for 15 minutes and after drying, it is then put into a dismill (milling machine). The result of the flouring process was 8.5 kg. then put into a plastic bag.

Other ingredients used are fish meal, soybean meal, black soldier fly carcass meal, fish oil, CPO oil, vitamin premix, minerals, DDGS, bran, palm oil meal, tapioca flour, MSG, chlorine chloride, di-calcium phosphate, NaCl, chlorella, CGM and Cr2O3. Once the raw materials are complete according to the formula, the test feed will be perambulated. Before perambulating the test feed, the raw material to be tested is first subjected to a proximate test. After carrying out the proximate test, the feed formula is then calculated using a supporting application, namely Microsoft Excel, to determine the percentage of each raw material used. According to SNI (2014), feed is registered with the Ministry of Maritime Affairs and Fisheries with a minimum protein content of 30%. The feed used is not floating but sinking.

In the process of perambulating test feed, the first thing to do is prepare the raw materials in the form of flour. Weigh raw materials according to a predetermined formula and mix evenly. Put the mixed feed into each container (5 containers). The container used is a bucket. Then boil the water until it boils and add it to the raw material mixture with a percentage of 40% (800 ml) using a measuring cup. After that, stir until evenly mixed. After that, put the mixture into a pellet press with a size of 2 mm and then dry it under the sun for 2 hours. If it is not dry, put the pellets in the oven at 50 oC for 4 hours, then put the pellets in a plastic bag. After drying the pellets, a sample of 20 grams was taken for proximate testing. The composition of the feed used can be seen in Table 3 below:

Table 3. Composition of black soldier fly carcass meal as a nutritional replacement fish flour

Raw material	Feed Formula				
	A (0%)	B (25%)	C (50%)	D (75%)	E (100%)
Fish flour	35,000	26,250	17,500	8,750	
Soybean Meal Flour	25,000	25,000	25,000	25,000	25,000
BSF Bankai Market	-	-	-	-	-
Carcass Fly BS	-	8,750	17,500	26,250	35,000
Meat Bone Meal-MBM	-	-	-	-	-
Fish oil	3,500	2,700	1,910	1,120	0,330
CPO Oil	3,500	2,700	1,910	1,120	0,330
Vitamin-Premix	2,000	2,000	2,000	2,000	2,000
Mineral	1,000	1,000	1,000	1,000	1,000
DDGS	3,000	3,000	3,000	3,000	3,000
Bran	15,000	15,000	15,000	15,000	15,000
Palm Oil Meal	5,000	5,000	5,000	5,000	5,000
Tapioca flour	3,290	4,310	5,330	6,340	7,350
Supplements*	3,210	3,210	3,210	3,210	3,210
CGM		0.580	1,150	1,720	2,290
Cr2O3	0,500	0,500	0,500	0,500	0,500
Total	100,000	100,000	100,000	100,000	100,000
Proteins	32,57	32,59	32,16	33,01	33.00

Fat	13,25	12,49	12,33	12,62	13,20
BETN	33,63	35,75	37,50	34,16	34,47
Energy (kcal/g)**	337,965	337.199	338.343	336.167	341.595
Ratio E/P (kcal g P)***	10.38	10.52	10.52	10.18	10.35

Note :

* Supplement consists of MSG, Chlorine chloride, Di-Calcium phosphate, Nacl and MSG.

** Calculated based on Digestibility Energy according to NRC (2011): 1 gram of protein is 4.5 kcal, fat is 8.1 kcal, and 1 gram of carbohydrate is 2.5 kcal

*** According to NRC (2011), the optimal E/P value for fish growth is in the range of 8-kcal/g.

The fish used in this research were Sangkuriang catfish (*Clarias gariepinus*) with a size of 5 cm - 7 cm which came from Sipange Village, Tukka District, Central Tapanuli Regency, North Sumatra. In the fish preparation process, grading is first carried out to obtain relatively the same size. The preparation process carried out is preparing the aquarium for the acclimatization process. The aquarium used has a water height of 30 cm with a volume of 150 liters. Acclimatization is carried out for 4-7 days. Feeding acclimatized fish is adlibitum, that is, feeding them as much as they are full. With a feeding frequency of 2 times a day in the morning at 07.00-08.00 WIB and 15.00-16.00 WIB. The feed given is in the form of commercial pellets. The fish that will be used in the test experiment, namely Sangkuriang catfish, are healthy and agile. In preparation for the test fish, proximate testing was carried out by taking 50 fish, then weighing them and measuring their length.

The fish rearing process begins with grading to obtain relatively similar weight and size of fish. Grading is carried out with the aim of getting fish that are healthy and of uniform size by measuring length with an accuracy of 0.1 cm and weight with an analytical scale with an accuracy of 0.01 g. After that, the Sangkuriang catfish were put into each treatment aquarium with a stocking density of 25 fish equipped with aeration.

In the rearing process, the percentage of feeding for Sangkuriang catfish fry is 6% of the total weight of the fish and the frequency of feeding is 3 times a day at 07.00- 08.00 WIB, 12.00 - 13-00 WIB and 17.00 - 18.00 WIB. The feed process is first prepared and weighed using an analytical scale then placed in a plastic container.

In the maintenance process, every day the number of dead fish is recorded. Sampling for measuring fish weight is carried out every 7 days and the data is used to determine FR. Sampling is carried out by turning off all cultivation systems such as aeration and other systems. After that, reduce the water by 50% with the aim of making the Sangkuriang catfish easy to take from the aquarium. After that, weigh the total weight and count the number of fish from each aquarium. After that, the fish were put back into the treatment aquarium. The number of fish and total weight were recorded to determine the amount of feed given the following week. The amount of feed obtained is then divided into 3 with a percentage of 30% in the morning, 35% in the afternoon and 35% in the afternoon. The amount of feed calculated from the sampling results will be used for the next 1 week.

Pertumbuhan Bobot Mutlak

Weight gain is calculated based on the difference in fish weight at the beginning and end of rearing. Weight gain is calculated based on the formula (Watanabe 1988):

$$\Delta W\ (g) = Wt\text{-}W0$$

Information
ΔW = Absolute weight gain
Wt = Fish weight at the end of the experiment (g)
W0 = Fish weight at the start of the experiment (g)

Survival Rate (Survival Rate)

The survival rate of Sangkuriang catfish (*Clarias gariepinus*) during maintenance can be calculated using the formula as (Effendie, 1997):

$$SR=Nt/No\times100\%$$

Information
SR = Survival rate of Sangkuriang catfish (%)
Nt = Final number of Sangkuriang catfish (tails)
N0 = Initial number of Sangkuriang catfish (tails)

The data obtained was analyzed using statistical analysis. If the effect is significantly different then Duncan's further test will be continued using calculations based on a 95% confidence level.

RESULT AND DISCUSSION

The results of absolute weight growth and survival of Sangkuriang catfish obtained during the 35 days of research can be seen in Table 4 below:

Table 1. Absolute weight of growth and survival of sangkuriang catfish during the study

Parameter	Black Soldier Fly Carcass Meal (%)				
	0	25	50	75	100
W_{35} (g)	4,69±0,28^{bc}	4,17±0,20^{ab}	5,22±0,14^{c}	3,80±0,15^{ab}	3,26 ±0,55^{a}
SR (%)	77,33±6,11^{a}	86,67±14,05^{a}	77,33±12,86^{a}	78,67±19,73^{a}	81,33±6,11^{a}

Absolute weight growth is the increase in weight data for fish kept until the end of rearing. Fish fry are declared to have grown if the fish weight increases during rearing. The absolute weight growth of Sangkuriang catfish obtained during the research ranged from 3.26 g to 5.22 g. can be seen in Figure 1 below:

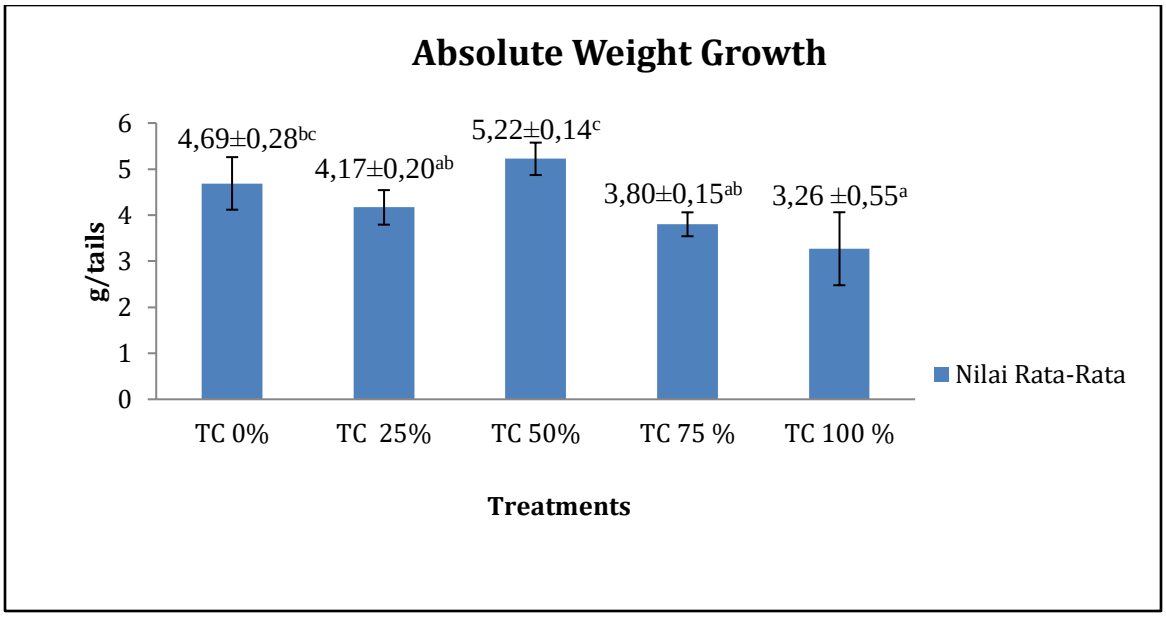

Figure 1. Graph of the absolute weight of Sangkuriang catfish during the research

According to Efendie (1997), growth is an increase in the weight and length of fish over a certain period of time, where this is influenced by feed, temperature, age and size of the fish. The results obtained from statistical analysis showed that the fly carcass treatment (KL) 50% when compared with the control (KL 0%) was significantly different ($P<0.05$), this treatment showed the best treatment, so that the performance of giving black soldier fly carcass flour to 50% KL treatment in the feed formula gave the best results in increasing the weight of Sangkuriang catfish. The difference in weight gain in each treatment is due to differences in the nutritional content of the feed (Arifin and Rumondang, 2017). For the KL 25%, KL 75%, and KL 100% treatments, the results were not significantly different ($P>0.05$) when compared to the KL 0% treatment because the value in this treatment was lower than the KL 0% treatment which was the reference (control). comparison of each treatment.

According to Khairuman and Amri (2002), good feed has criteria such as having raw materials that are continuously available, cheap prices, good nutrition, easy to digest and suitable for the fish's mouth openings. One example of a raw material that meets these criteria is black soldier fly carcass meal in feed formulations where the raw material is available continuously and adequately and does not compete with human needs and has been proven to increase body weight gain in Sangkuriang catfish.

Survival rate is a percentage comparison between the number of living organisms at the end of the period. The survival rate of sangkuriang catfish obtained during the research was 77.33 – 86.67%. can be seen in Figure 2 below:

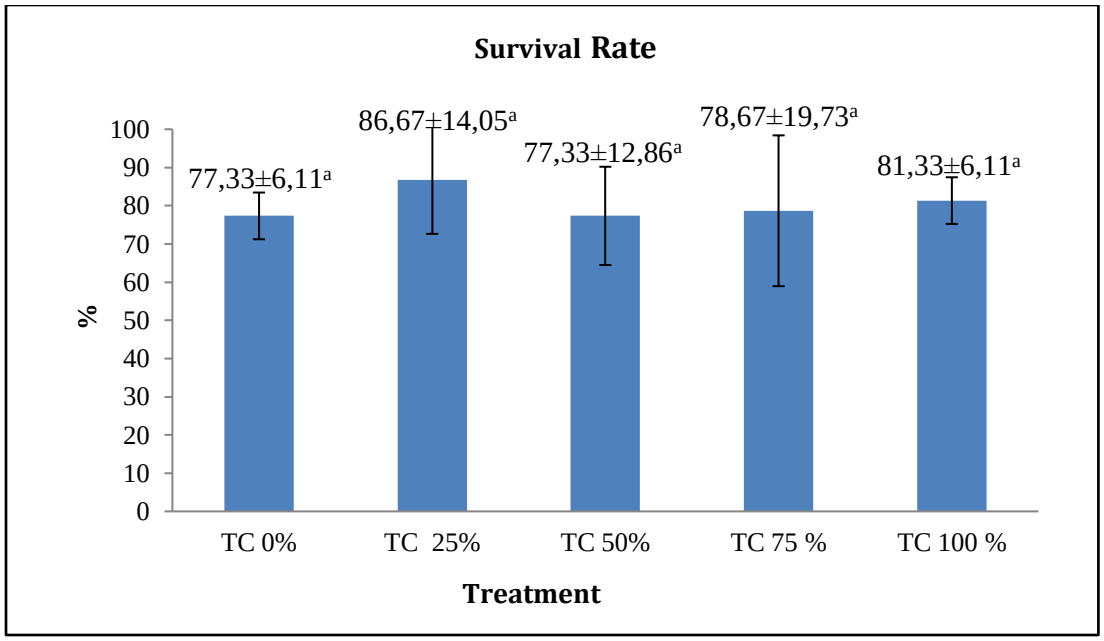

Figure 2. Graph of survival rate for Sangkuriang catfish during the research

The highest survival rate in the treatments during the study was in the second treatment (TC 25%) with a value of 86.67% ± 14.05a. The high survival rate in the KL 25% treatment is due to good water quality. This statement is supported by Lisna and Insulistyowati (2015), that water quality greatly influences the survival and growth of fish.

The lowest survival rate in the treatments during the study was in the third treatment (TC 50%) with a value of 77.33 ± 12.86a. The low survival rate in the 50% TC treatment is thought to be because the water quality in this treatment is not good, so that the Sangkuriang catfish experience stress and cause death. Even though the survival rate in the KL 50% treatment gave poor results (the lowest), in terms of growth performance, other cultivations gave the best results. In cultivation activities, the survival rate is said to be an important parameter because it can indicate the good quality of Sangkuriang catfish, but if the growth performance of other cultivation is low, it will affect cultivation activities. For Sangkuriang catfish breeders, survival rate is not given much priority because a high survival rate does not necessarily give good results. Catfish breeders prioritize other growth performance such as the weight of the Sangkuriang catfish produced, but with a fairly good survival rate too. This is because good weight and survival rate will produce large profits. In the 50% TC treatment, both of these benefits have been fulfilled even though the survival rate is low, but in terms of other cultivation growth performance, 50% TC provides the best results and can be used by Sangkuriang catfish breeders. According to SNI 6484.4 (2014), it states that the survival rate for raising Sangkuriang catfish is at least 60%. From the SNI data, the survival rate in the research conducted was still within the normal range, namely between 77.33-86.67%.

CONCLUSION AND SUGGESTION

Black soldier fly carcass meal can be used in feed as much as 50%, so it is very likely that black soldier fly carcass meal can have the potential to replace fish meal as a raw material for Sangkuriang catfish (*Clarias gariepinus*).

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