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The Utilization of Corn Starch Hydrolysateas the Source of Carbohydrates in the Milkfish Feed (*Chanos chanos* Forks.)

Damang Suryanto*, Anik Martinah Hariati, Hardoko

Faculty of Fisheries and Marine Sciences, Universitas Brawijaya, Jl. Veteran, Malang 65145, Jawa Timur Province, Indonesia

Abstract : This research aims to know the effect of corn starch hydrolysate in different level of feed formulation towards the life, growth, feed conversionratio and milkfish energy retention. The research was conducted in March-April 2016 at the Fish Reproduction Laboratory, Universitas Brawijaya, Malang. The fish which is used as the test object in this study is milkfish (Chanos chanos Forsk.) with the average weight of 0.77±0.16 g and with the deployment density of 1 fish/l. This research was implemented by using the experimental method with a Completely Randomized Design (*Rancangan Acak Lengkap* or RAL) with 5 treatments and 3 replicates. The treatments in this study are: treatment A (the feed with a source of carbohydrate such as polar, rice bran and tapioca), B (the source of carbohydrates is substitute with 25% corn starch hydrolysate), C (the source of carbohydrates is substitute with 50% corn starch hydrolysate), D (the source of carbohydrate is substitute with 75% corn starch hydrolysate), and E (the source of carbohydrate is substitute with 100% corn starch hydrolysate). The data observed in this research include the Specific Growth Rate (SGR), the Feed Conversion Ratio (FCR), water quality and energy retention. The results showed that the addition of corn starch hydrolysate as a substitute source of carbohydrate (polar, rice bran and tapioca) in the fish feed gives such an influence which is not really different on the growth (SGR) and on the feed conversion ratio (FCR) but it is quite different towards the retention of energy. Corn starch hydrolysate can be used as a substitute material of the carbohydrates (polar, rice bran and tapioca) in the milkfish feed formulations. The percentage of the corn starch hydrolysate optimal level towards the energy retention is on the substitution level of 50,75%. The water quality which is used for milkfish farming still in a good condition.
Keywords: milkfish, carbohydrate source, feed.

Introduction

Milkfish (*Chanoschanos*Forsskal) is one of the economically important fish because it is known as a source of protein that has a high nutritional value and a good market share. In the brackish water cultivation development, milkfish is a superior species next to the shrimp commodity. The consumption of milkfish from time to time is continue to grow. The production reached 421.757 tons in 2010, 467.449 tons in 2011, 518.939 tons in 2012, and 626.879 tons in 2013 (DJPB Fishery Statistics). We could find a lot of milkfish cultivation in the northern coast of Java which are mostly done in traditional ponds.

The open market is not yet given enough profits for the milkfish farmers. The profit of milkfish farming is still small due to the high production cost, especially the cost of feed. The feed costs 35-60% of the total production cost[1]. Biologically, milkfish is an herbivore fish which eat plankton, namely *klekap* (local

language for colonies of micro- and macro-organisms which consist of blue algae-*Cyanophyceae* and diatomae-*Bacillariophceae*) which is growing at the base of the pond[2]. Back then, the milkfish farmers rely on the availability of milkfish natural feed i.e. *klekap* (*complex benthic algae*), but currently the pond fertility is shrinking. So that, in some period, the milkfish farmers give the feed formula for their fish. The feed formula is expected to accelerate the fish's growth. The feed formula is given during 2-3 months near the harvest time. However, the feed cost which is relatively high is the cause of the small profit.

The feed cost which is relatively high is the impact of the main material availability which is mainly the protein source. Protein is an important component of all the necessary nutrients to the fish as it is the constituent and the main source of energy[3]. The efforts that can be made in order to reduce the role of the protein is by maximizing the use of carbohydrate. Carbohydrate is a cheap source of energy in fish feed. It could be a sparring protein effect, which can save the protein. Each 0.023 grams of carbohydrates per 100 grams of feed can save about 0.05 grams of protein, it means that most of the feed can be conserved for the fish growth while the energy requirement is supported by carbohydrates[3]. The source of the carbs in fish feed, among others, polar, rice bran and tapioca. Corn is one of the carbohydrate sources that can be used as an alternative in the fish feed. Corn prices are also relatively cheap and easy to be found compared with other energy sources such as fats and proteins. However, the corn is still in the form of a polysaccharide, so a simplification of its compound is needed. The simplification of the polysaccharide compound can be done by hydrolysis.

The purpose of this research is to know the effect of the corn starch hydrolysate in different level of feed formulation towards the life, growth, feed conversion ratio and milkfish energy retention.

Method

The fishused in this research is milkfish (*Chanos chanos* Forsk.)which comes from *Balai Besar Perikanan Budidaya Air Payau Jepara*(a brackish water aquaculture in Jepara Regency, Jawa Tengah Province, Indonesia). There are 300 fish with the average weight of 0.77 ± 0.16 grams and and with the deployment density of 1 fish/l. The fish are being placed in 15 aquariums, and each aquarium has 20 fish. The cultivation media in this research is the brackish water with the salinity of 15 ppt. Each aquarium is equipped with aeration system and heater. Before the research was began, the fish was adapted to the environment and feed which is being tested. After the fish is adapted to the new environment and feed, the fish would be fasted for 1 day before the feed test is conducted. The fish feed which is given for the test is the feed with a standard composition of protein energy ratio as many as 0.44% and contains carbohydrate sources such as polar, rice bran and tapioca. Those standard feed are used as the control for the other feed test by substituting corn starch hydrolysate as a source of carbohydrate. As for the design of the feed composition substitution can be seen in Table 1. The fish feed used is an artificial feed formulation as shown on Table 1. Before the feed material is being formed, it was steamed for 15 minutes in order to be formed and digested easily by the fish. The fish feed which are already formed is aerated to dry and once it dried, the fish feed is stored in a plastic bag. The feeding is performed twice a day during 10 am and 3 pm.

This research is implemented by using experimental methods and carried out with a Completely Randomized Design (Rancangan Acak Lengkap or RAL) with 5 treatments and 3 replicates. After that, the data were analyzed using SPSS program version 16.

Table 1. Feed Formulation

NO	MAIN MATERIAL	FEED FORMULA				
		A (0%)	**B (25%)**	**C (50%)**	**D (75%)**	**E (100%)**
1	T. Fish	25	25	25	25	25
2	Soybean Meal	20	20	20	20	20
3	MBM	12	12	12	12	12
4	Pollar	12	9	4	2	0
5	Rice Bran	16	12	6	3	0
6	Corn Hydrolysate	**0**	**10**	**20**	**30**	**40**
7	Tapioca	12	9	10	5	0
8	Soybean Oil	0.5	0.5	0.5	0.5	0.5
9	Fish Oil	1	1	1	1	1
10	Mineral Mix	0.5	0.5	0.5	0.5	0.5
11	Vitamin Mix	0.5	0.5	0.5	0.5	0.5
12	Cr2O3	0.5	0.5	0.5	0.5	0.5
TOTAL		**100**	**100**	**100**	**100**	**100**
PROTEIN		**30.76**	**30.68**	**30.15**	**30.29**	**30.42**
ENERGY		**282.01**	**276.07**	**272.24**	**265.24**	**258.24**
PE-RATIO		**0.44**	**0.44**	**0.44**	**0.46**	**0.47**

Specific Growth Rate

The specific growth rate is calculated based on the formulation[4]:

$$SGR = \frac{\text{Ln Wt-Ln W0}}{t} \times 100\%$$

Description:
SGR =Specific Growth Rate (%/day)
Wt = Fish average weight in the end of the research(g)
Wo =Fish average weight in the beginning of the research(g)
t =Research duration(day)

Feed Conversion Ratio (FCR)

The feed conversion ratio is calculated based on the formulation:

FCR = F : Final fish biomass

Description:

FCR = Feed Conversion Ratio
F = The quantity of the feed during research(g)
Biomass = Fish biomass in the end of the research(g)

Energy Retention

According to Buwono[5], the energy retention can be calculated by using the following formula:

RE = [(Et – Eo)/Ef] x 100%

Description:

RE : Energy Retention (%)
Et : the amount of energy stored in the fish body at the end of the research (g)
Eo : the amount of energy stored in the fish body at the beginning of the research (g)
Ef : the amount of energy given (g)

Result and Discussion

The observations per parameter in each treatment during the study are presented in Table 2.

Table 2. The average value and statistical analysis of the test parameter during the study.

Parameter	substitution treatment of corn starch hydrolysate				
	A (0%)	B (25%)	C (50%)	D (75%)	E (100%)
SR (%)	58.3 ±7.6[a]	53.3±5.7[a]	55±5[a]	58.3±2.9[a]	55±13.22[a]
SGR (%)	2.41±0.14[a]	2.18±0.18[a]	2.2±0.23[a]	2.27±0.44[a]	2.05±0.15[a]
FCR	10.71±0.84[a]	12.60±3.27[a]	10.31±0.83[a]	9.78±2.19[a]	11.97±2.5[a]
RE	7.77±0.52[a]	9.01±1.0[ab]	12.31±0.69[c]	10.00±0.52[b]	8.13±0.32[a]

Description: the same notation indicates that there is no difference in the 95% extent of credit. On the Tukey test as shown in the table above, it is noted that the treatment substitution of corn starch hydrolysate in the milkfish feed formulation does not give any effect on the fish life, growth, and FCR but it gives a different effect towards the fish energy retention.

Survival Rate (SR)

Survival rate is the percentage of the fish quantity at the end of the study with the comparison between the fish quantity at the end and at the beginning of the study. Survival rate data of the milkfish is presented on the attachment. Based on the milkfish survival rate data, there are not any real differences between the treatments. It indicates that the use of corn starch hydrolysate in the feed formulation does not give any effect on the milkfish survival rate during the research.

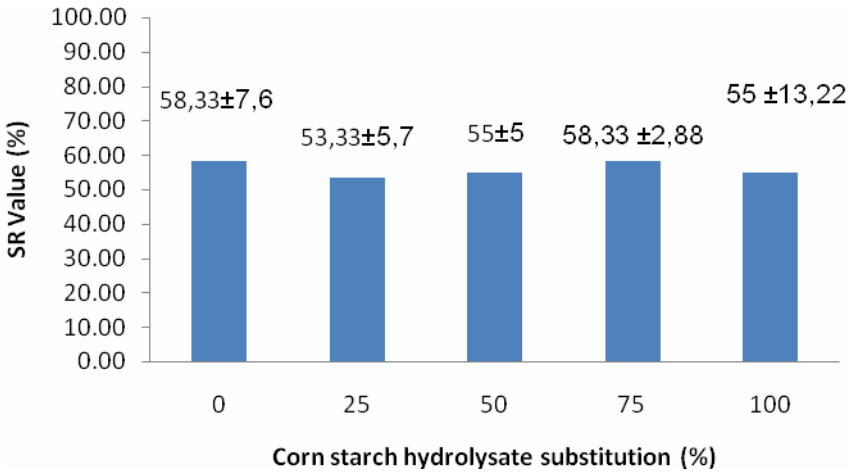

Figure 1. The Graphic of Fish Survival Rate

The low value of survival rate occurred during the study. This death is caused by the temperature fluctuations. The milkfish which is farmed in the coastal area with a relatively hot temperature when it kept in Malang which temperature is relatively cold experienced many deaths. This is in accordance with the opinion of Nybakken[6]that every species has different tolerance against the environmental condition. The value of survival rate is influenced by several factors, such as the fish adaption to the environment, the handling of fish when it was being distributed, the quantity of the distribution, the quality of the water and feed[7].

The solution that can be done in order to reduce the death rate during the study is by applying a heater, but the extreme weather is caused the water temperature of the research media to be unstable. The research was carried out in April in the transition period (*pancaroba*). The temperature fluctuations is due to the transitional seasons[8]. *Pancaroba* season occurs twice in a year which is in March-April and October-December.

Specific Growth Rate (SGR)

This research was conducted during 35 days by doing a sampling in every 7 days, then the milkfish SGR value is obtained and then analyzed statistically by using SPSS version 16. Normality and homogeneity test shows that the SGR distribution is normal and homogeneous. The results of the one-way examination analysis indicate that the specific growth rate (SGR) of the milkfish during research does not show any real effect between the treatment.

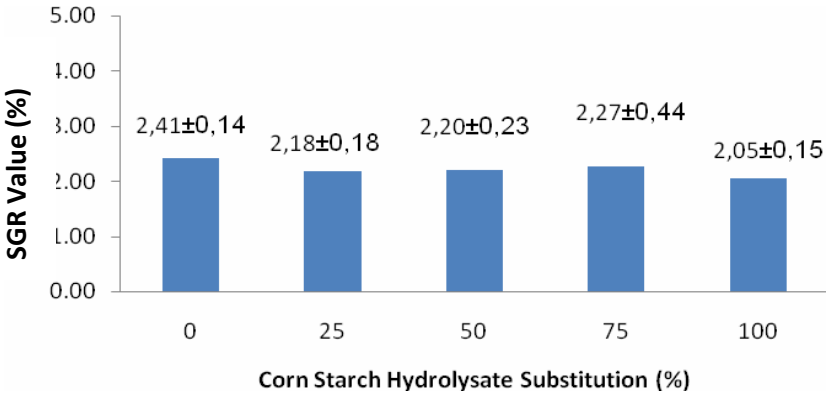

Figure 2. The Graphic of Fish SGR Test

Based on the graph, it indicates that the feed containing corn starch hydrolysate does not provide any different growth influence with real controls. The growth which is not really different in between the treatment might be due to the feed which is consumed by fish is already met its nutritional content. So in other words, if the variation of the feed constituents on the control treatment is in the form of polar, rice bran and tapioca as a source of carbohydrate, then it can be substituted with the corn starch hydrolysate. The corn starch hydrolysate allows the feed to be easily digested and it could improve the growth rate. The feed with a good nutrition and fulfill the nutritional needs of fish can accelerate the rate of growth[9].

The number of fish distribution at the beginning of the study is as many as 20 fish in each aquarium with 50x40x30 cm^3, with 20-liter water or in other word is 1 fish per liter. With that number of distribution, it allowed the fish to moves freely and gets the feed so that the fish will grow well. This is in accordance with Minggawati[10] who states that the number of optimal distribution for the parrot fish is 1 fish per meter. Then, the milkfish research[11]is by using the distribution density as many as 1 fish per liter.

The specific growth rate (SGR) of this research are lower compared to Ayuniar et al.'s study[12]with an average value of 2.3 ± 0.09%/day, whereas the lowest value is 1.45 ± 0.03%/day. The different results may be due to the difference in the composition of the feed constituent, the fish age, the cultivation duration and the quality of the water during the cultivation. The composition of the feed constituent on this research is concentrated on the carbohydrates instead of the protein which is functioned primarily as the substances for growth. Some types of feed ingredients have different nutrient content[13].

Feed Convertion Ratio (FCR)

The feed conversion ratio is a reflection of the feed usage efficiency during the cultivation. The feed conversion ratio calculation of the milkfish feed can be seen in the attachment which will be further analyzed statistically by using SPSS version 16.0. The normality and homogeneity test suggests that the FCR data is spreading normally and homogeneously. The results of the one-way examination analysis indicate that the specific growth rate (SGR) of the milkfish during research does not show any real effect between the treatment. The same value of the FCR shows that the feed which is given can be utilized and absorbed by the fish for the body growth.

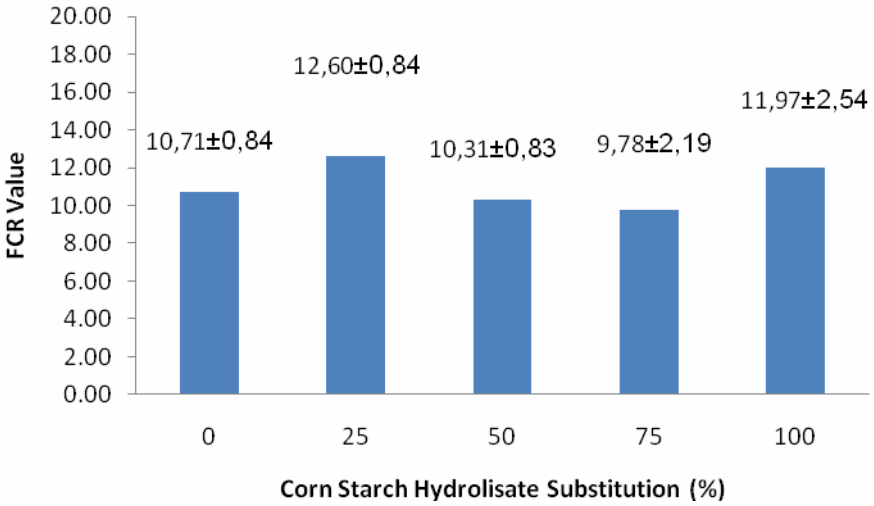

Figure 3. The Graphic of Fish FCR Test

The largest FCR value of this research is 12.6 and the lowest value is 9.8. The results of such research are still lower if compared to the research of Hassan[14]with the highest FCR value of 82.02 and the lowest FCR value of 63.50. The small or big amount of the feed conversion is influenced by several factors, including the feed quality and quantity, species, size and water quality[15]. The value of low feed conversion shows a better feed utilization and the feed which is absorbed by the body is used to promote the fish growth. Meanwhile, the high feed conversion value is due to its high feed nutrient which is not optimally utilized by the body or it was being wasted because of the fish's lack appetite.

Energy Retention

Based on the homogeneity and normality test, it shows that the energy retention is spreading normally and homogeneously. The result of the one-way examination analysis indicates that energy retention of the milkfish during the research is showing a real effect between the treatment.

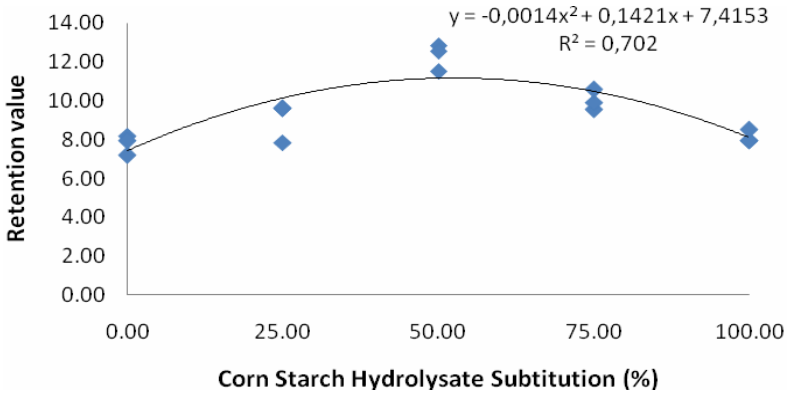

Figure 4. The relationship between the use of corn starch hydrolysate in the feed formulations towards the energy retention

Based on the graphic above, the relationship between the use of corn starch hydrolysate in feed formulation towards the average value of the milkfish carbohydrate energy retention during the researchshowsan quadratic equation with the Y equation= $-0.0014x^2 + 0.1421x+7.4153$with a value of $R^2 = 0.702$**.** From the results of the equation, it is obtained an optimal carbohydrate energy retention on the substitution of corn starch hydrolysate as many as 50.75%.

The retention data of these different energies are not comparable to the different growth. It is possible that the energy is used by the fish to maintain the body from the unstable weather during the study. The growth of fish due to the amount of feed nutrients which can be digested and absorbed by the fish is greater than the amount of the nutrients that is needed for the maintenance of his body[16]. While the different growth rate which is not really visible may be due to the protein source.

The balance between energy and protein is very important in increasing the fish growth rate because when the energy requirements are less than the protein, the protein will be divided and used as an energy source, so that the amount of the protein that should be utilized for the growth will be reduced[13]. Moreover, the utilization of the energy is influenced by several factors, namely the level of energy consumed, digestion power, the energy content in the feed and fish physiological function[3]. The needs of fish energy are derived from proteins, fats and carbohydrates which are consisted in the fish feed.

Water Quality

Water quality is the parameter support in this research, because water is a living medium for the fish. Water as the living medium for the fish should always be conditioned in the optimum state during the research. Based on the water quality data at the time of the research (35 days), the average value obtained from the water quality parameters are presented in Table 3below.

Table 3. The average value of the water quality during the cultivation

Parameter	Treatment				
	A (0%)	B (25%)	C (50%)	D (75%)	E (100%)
pH in the morning	7,97± 0,10[a]	7,98 ± 0,10[a]	7,99 ± 0,13[a]	7,99 ± 0,12[a]	7,98 ± 0,10[a]
pH in the afternoon	7,96 ± 0,09[a]	7,98 ± 0,10[a]	7,99 ± 0,13[a]	7,98 ± 0,12[a]	7,98 ± 0,10[a]
Morning temperature (^{0}C)	28,05 ± 0,35[a]	28,08 ± 0,33[a]	28,08 ± 0,41[a]	28,08 ± 0,51[a]	28,02 ± 0,43[a]
Afternoon temperature (^{0}C)	29,97 ± 0,38[a]	29,88±0,57[a]	29,89 ± 0,37[a]	29,89 ± 0,47[a]	29,80 ± 0,52[a]
DO Morning (ppm)	7,54 ± 0,28[a]	7,68 ± 0,26[a]	7,54 ± 0,24[a]	7,55 ± 0,24[a]	7,52 ± 0,29[a]
DO Afternoon (ppm)	7,54 ± 0,28[a]	7,68 ± 0,26[a]	7,54 ± 0,24[a]	7,55 ± 0,24[a]	7,52 ± 0,29[a]
Ammonia (ppm)	0,08 ± 0,04[a]	0,07 ± 0,30[a]	0,09 ± 0,01[a]	0,11 ± 0,05[a]	0,12 ± 0,02[a]
Salinity (ppt)	16,19±1,35[a]	16,08±1.45[a]	16,35±1,38[a]	16,26±1,30[a]	16,02±1,40[a]

The pH, temperature, DO and Ammonia has a similar notation. Based on a statistical analysis of the water quality during the cultivation, it is known that the treatment of the research has no effect against the water quality. It shows that the use of corn starch hydrolysate in feed formulation does not give such influence to the water quality of water during the milkfish cultivation The range of the water quality media for the milkfish cultivation according to some references can be seen in the Table 4.

Table 4. The range of water quality during the milkfish cultivation

Water Parameter	**Result**	**Normal**	**References**
pH	7,7 – 7,95	7,5 – 8,5	SNI[17]
Temperature (^{0}C)	28 – 30	28 – 32	
DO (ppm)	7,52 – 7,68	> 3,5	
Ammonia (ppm)	0,07 – 0,11	< 0,1	
Salinity	16	5-35	

Water quality has an important role that can support the fish's life and growth of the milkfish seed, so the water quality measurements is really need to be performed. Beside that, the water quality has an impact on the fish's health which will be resulted in the low levels of fish growth. Water is the medium for the milkfish cultivation during the research activities, it always conditioned in the optimum state for the cultivation and milkfish growth. It is performed by using an aeration system to supply oxygen for the milkfish and to keep the water circulation in each day as much as 20%-50% of the total water volume depending on the condition of the water.

Based on the research results, it can be summed up that corn starch hydrolysate can be used as a source of carbohydrate substitute (polar, rice bran and tapioca) in the milkfish feed formulations (*Channos channos* Forks.). Moreover, the feed which contains the corn starch hydrolysate does not have any specific different effect against the Survival Rate, Specific Growth Rate, and Feed Conversion Ratio but it has a specific difference against the energy retention. Finally, pptimal levels of cornstarch hydrolysate towards the energy retention is 50.75%.

Based on the discussion above, it can also be suggested that more researchabout the corn starch hydrolysate as a source of carbohydrates need to be implemented. Furthermore, corn starch hydrolysate can be used as a source of carbohydrates on the milkfish feed formulation.

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