



The Effectiveness of Addition of Tapioca Flour in Artificial Feed on The Growth of Koi Carp (*Cyprinus rubrofuscus*)

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Abstract

Growth is the process of increasing the number of cell protoplasm in an organism accompanied by an increase in size, weight and number of cells that cannot return to their previous state. One of the factors that influence the growth of koi carp is feed. Good feed is feed that can meet the nutritional needs of the koi carp. The addition of tapioca flour in the feed formula, which contains artificial feed, tapioca flour, and water in the koi carp feed, is one of the proper steps because of the increase in carbohydrate doses that can support the growth of the koi carp. This study aims to determine the benefits of adding tapioca flour to the artificial feed of the koi carp (*Cyprinus rubrofuscus*) and to determine the effect and the most appropriate dose of adding tapioca flour to the artificial diet of the koi carp (*Cyprinus rubrofuscus*). The research method used is a quantitative research method accompanied by direct observation and analysis of research data, which is also accompanied by a literature study method from previous studies to support the findings in the research results. The results showed that the more feed formula was given, the faster the growth of the koi carp produced. But must be accompanied by the right dose, which is 8 grams of feed formula once a day. While the benefits of adding tapioca flour in carp feed are increasing carp production, prolonging goldfish life expectancy, increasing efficiency and nutritional content in carp feed, increasing carp appetite accompanied by increased growth.

Keywords: Goldfish Koi, Growth, Feed, Carbohydrates, Tapioca Starch

A. Introduction

The development of freshwater fish farming in Indonesia provides a fundamental role in economic growth in the fisheries sector. This is because freshwater fish farming is one of the most potential business sectors, especially in fulfilling fish consumption in the community. Koi carp is one fish that can be cultured in freshwater easily and economically. This fish farming can help and provide maximum results in economic development income in the fisheries sector. This koi carp began to be kept in Indonesia in the 1920 (Ramadani, 2017).

Koi carp (*Cyprinus rubrofuscus*) is a freshwater fish with several advantages, namely having a relatively fast growth rate and a high survival rate. This koi carp is usually cultivated in ponds, rice fields, reservoirs, or cages in public waters. The production of koi carp from year to year always increases along with increasing demand (Purwaningsih, 2013).

One of the factors that influence the growth of koi carp is feeding. Good feed will support the health and longevity of koi carp. The addition of a dose of carbohydrates in carp is one of the efforts that can increase carp growth. Efforts to increase the growth of carp can provide many benefits, such as shortening production time, improving feed efficiency, and increasing production (Putri, et al., 2017). So that research on feed modification in koi carp is one of the proper steps to do.

The purpose of this study was to determine the benefits of knowing the benefits of giving tapioca flour to the artificial feed of koi carp (*Cyprinus rubrofuscus*) and to determine the effect and the most appropriate dose of adding tapioca flour in the fake spread of koi carp (*Cyprinus rubrofuscus*). With this research, it is hoped that it can improve the quality of cultivation and the quality of individual koi carp to have individuals who are resistant and live long to meet market needs.

B. Literatur Review

1. Morphology and Taxonomy of Koi Carp (*Cyprinus rubrofuscus*)

The koi carp (*Cyprinus rubrofuscus*) is a type of freshwater fish commonly used as an ornamental fish, which has been kept since 475 BC in China and was kept in 1920 in Indonesia. This koi carp has an elongated body that is flat to the side and has a soft texture. The koi carp found in Indonesia is brought from China, Europe, Taiwan and Japan. The scientific classification of goldfish according to Khairuman and Subbenda (2002) in Ramadani (2017), namely:

Kingdom	: Animalia
Fillum	: Chordata
Subfillum	: Vertebrata
Superkelas	: Pisces
Kelas	: Osteichthyes
Subkelas	: Actinopterygii
Ordo	: Cypriniformes
Subordo	: Cyprinoidea
Famili	: Cypridae
Subfamili	: Cyprinidae
Genus	: <i>Cyprinus</i>
Spesies	: <i>Cyprinus rubrofuscus</i> (Khairuman & Subbenda, 2002).



(Personal documentation, 2021)

Koi carp has a long and flat body shape, commonly referred to as compressed. The cleavage of his mouth is on the front of his head. The teeth of the esophagus are located at the tip of the inside of the mouth. This koi goldfish has two pairs of barbels in its anterior region. All parts of his body were covered with scales. The scales of this koi carp have a large size. When compared to other fish scales, the difference is noticeable. The shape of the tail of this koi carp has a single grooved body. This fish has an elongated dorsal fin. The location of the dorsal fin is opposite the area of the pelvic fin. The location of the pelvic fins is very close to the pectoral fins. Koi goldfish have an operculum and operculum on their pectoral fins. Goldfish use a false stomach to accommodate food. The gills of koi carp consists of several parts such as gill arch bones, gill filters, and gill leaf sheets (Islam, et al., 2016).

The koi carp (*Cyprinus rubrofuscus*) is an all-eating fish or belongs to the omnivorous animal group. The eating habit of koi carp (*Cyprinus rubrofuscus*) is often stirring the pond's bottom, including the bottom of the barrier, looking for organic bodies. Because of his eating habits like this. This koi carp has eggs that are sticky and stick or adhesion to the surrounding environment. The habit before spawning in nature is to look for a green place with aquatic plants or grasses that cover the surface of the water. The sexual development of the koi carp (*Cyprinus rubrofuscus*) is ovivar, or egg-laying, where sexual reproduction is characterized by the release of male and six female eggs, where spermatozoa are fertilization occurs outside the body. Another characteristic is that the egg cell is large because it contains a lot of yolks, which can become outside the body (Ramadani, 2017).

2. Anatomy and Physiology of the Koi Carp

The anatomy of the koi carp (*Cyprinus rubrofuscus*) is as follows: The muscle tissue system of the koi carp can swim with the help of the muscle tissue system. The skeleton of a koi carp can be classified into two types: the main skeleton and the supporting skeleton. Controlled by the nervous system, muscle tissue is attached to the skeleton or bone and makes muscle contractions and activity so that the goldfish can move and swim (Islam, et al., 2016).

The digestive system of koi carp food is characterized by food that will be converted into nutrients by the digestive and absorption systems. In comparison, the food that has been digested will be excreted as feces. The koi carp's digestive system consists of the mouth, pharynx and larynx, pharyngeal teeth, intestines, gallbladder, liver, pancreas and anus. The koi carp cannot swallow large food directly into this digestive system because the koi carp's mouth is small, there are no teeth in the jaw, the mouth protrudes forward, and the digestive system walls are smooth. Thick muscles are found above the lips, which can stretch freely, helping to push food in the mouth into and or out of the mouth (Islam, et al., 2016).

Next to the mouth is the pharynx and larynx, and underneath are the pharyngeal teeth that chew food. After arriving at these organs, the food goes to the esophagus and intestinal tract. The intestinal tract is divided into three parts: the foregut, the middle intestine and the hindgut. There is no stomach in this digestive system. Overeating koi carp will make the front intestine bulge, so that the front belly of the koi carp will look distended, which is not good for the health of the koi carp. It is highly recommended that koi carp do not consume a lot of feed in one feeding. Therefore, feeding the koi carp must be in small amounts but often (Islam, et al., 2016).

The respiratory system or respiratory system of the koi carp is characterized by a device that helps the koi carp breathe oxygen and expel carbon dioxide. In this system, the gills are the organs that play the most important role. The gill organs are located in the gill cavity below the operculum. In each operculum, there are four-gill arches on two-gill lamellae. Gill filaments filled with capillary blood vessels are found in gill lamellae. When the mouth and operculum move in harmony, oxygen dissolved in water will be carried to the capillary blood vessels, water will come out through the gills. In contrast, carbon dioxide in the blood is released into the water (Islam, et al., 2016).

The excretory system of koi carp removes metabolic waste through the organs such as the kidneys, bladder, and gills. The kidneys are two dark red organs located under the spine and attached close to the back of the body cavity. This organ is the kidney which functions to produce urine and get rid of waste. The bladder is flat and oval and is located between the anus and the excretory opening. Behind the bladder is the urinary tract, also known as the urethra. Gills remove a lot of metabolic waste (Islam, et al., 2016).

The circulation system of the koi carp is manifested through cells with their functions. The heart is composed of one atrium and one chamber. As the leading force in the circulatory system, the heart is in the pericardial cavity. Blood makes circulation run well, whose movement itself is regulated by the heart. There are three blood vessels in goldfish: arteries, veins, and capillaries. These three types of blood vessels, capillaries are minimal. There are many capillaries scattered throughout the body of the koi goldfish that provide space for the exchange of air and substances. The blood on the koi goldfish is red. The red colour in the blood of this goldfish comes from hemoglobin which functions to bind oxygen (Islam, et al., 2016).

The urinogenital system of koi carp has reproduction that depends on the urinogenital system. Koi goldfish are living things that reproduce by laying eggs. Koi goldfish are known as two sexes: male and female. Ovaries The main sex glands or also called gonads in female koi goldfish, are a pair of ovaries. The fully mature ovary contains yellow eggs. The zygote that will become the fry is produced from the meeting of the egg and sperm due to fertilization outside the female parent's body (Islam et al., 2016).

Koi goldfish have swim bladders filled with air. The swim bladder organ is often divided into the front, the back with a compressed middle. The primary function of the swim bladder organ is to help the koi goldfish rise or fall to adapt to the water (Islam, et al., 2016).

The koi carp's nervous system consists of the brain, spinal cord and nerves. These nerve endings communicate with all sensory organs in the skin, acoustic organs, olfactory organs, vision organs, and muscle tissue to get impulses. The brain, nerves and spinal cord can control all activities throughout the body. The nervous system controls the endocrine system. The endocrine system functions to adjust all koi carp body activities by releasing hormones (Islam et al., 2016).

3. *Existence of Tapioca Flour in Koi Carp Feed*

Feed is a source of nutrition for cultivated biota consisting of protein, fat, carbohydrates, vitamins and minerals. Kordi (2007) in Suryaningrum et al. (2014) stated that feed absorbs 60% of operational costs in cultivation activities. 25% of the feed given is converted as a product of production. The rest is wasted as waste consisting of 62% in dissolved materials and 13% in the form of precipitated particles (Suryaningrum et al., 2014).

As for koi carp farming activities, feed is an essential requirement that must be met. Feed is used as a source of energy, growth and reproduction of fish. The use of adhesives in feed greatly determines the quality of the pellets produced because adhesives can maintain the integrity of the components that make up the feed and strengthen the bonds that make up the feed so that the resulting feed is not easily brittle and destroyed. Feed adhesives can be divided into two types, namely natural and artificial adhesives. Natural adhesives have been widely used for various feeds, including tapioca flour, cassava flour, molasses, and seaweed. Synthetic adhesives commonly used are CMC or carboxy methylcellulose (Sari, et al., 2016).

Tapioca flour is flour in the form of starch granules from cassava tubers rich in carbohydrates. This tapioca flour has a high amylopectin content. It is not easy to clot, has high adhesion, is not easily broken or damaged, and the gelatinization temperature is relatively low between 52-64°C. The nutritional content of tapioca flour per 100 grams of sample is 362 cal, 0.59% protein, 3.39% fat, 12.9% water, and 6.99% carbohydrates. The use of adhesive material in tapioca flour in artificial fish feed aims to help the gelatinization process of meal to produce fish feed with good nutritional value if given to carp (Lekahena, 2016).

C. Methodology

1. *Desain of Research*

This research was carried out in November-December 2021 at the author's own house in the Cirebon Regency area, precisely on Jl. Bima RT 004 RW 002 Gegesik Kidul Village, Gegesik District, Cirebon Regency, West Java Province. In this area, the air temperature is in the range of 29°C - 34°C during the day and 23°C - 28°C at night because it belongs to the Cirebon Regency area, which is directly adjacent to the North Coast of Java so that this area is one of the strategic places for research on the growth of carp.

This research method is quantitative. Direct observation and analysis of research data are carried out based on accurate data in the field with certain variables, which are also accompanied by literature study methods from previous studies to support the findings in the research results. The research method was carried out by measuring the weight or body mass of the carp and the body length of the carp. The purpose of the measurement was to determine the growth of koi carp after being given tapioca flour into the artificial feed of koi carp with a specific dose.

In the first treatment, artificial feed formulations and tapioca flour were given to koi carp as 4 grams per day. While in the second treatment, as much as 8 grams per day. This is to facilitate the management of research data so that the existing data is rational data.

The tools used in this study include one digital balance, two spoons, two medium buckets or basins, one ruler or meter, one pestle, three bowls or containers, and one glove and a mask. While the materials used in this study, including two koi carp, 2 x 2 litres of plain water or PDAM water, mineral water or drinking water, artificial fish feed, and tapioca flour to taste.

This study consisted of three stages: preparation of koi carp growth media, manufacture of feed formulations, and implementation of observations and feeding formulations. At the stage of preparation of the koi carp growth media, steps are carried out: preparing the tools and materials to be used. Then put PDAM water into a medium bucket or basin as a place for koi carp to grow. The water included consists of 2 buckets containing 2 litres and each bucket containing one koi goldfish. Then the PDAM water is replaced every three days with the same quantity as the initial growth media so that the growth media remains sterile and does not interfere with the survival of the goldfish.

At the stage of making feed formulations, steps are carried out consisting of preparing tools and materials to be used. Then grind the artificial feed using a pestle until smooth. Then the tapioca flour is mixed into the artificial feed. Then add the same amount of water in a mixture of tapioca flour and fake meal until evenly distributed. Then it is moulded into round shapes and dried until it is scorched and the feed formulation can be used for research. The following is a composition table of the koi carp feed formula made by the author in Table 1. The physical form of the feed of Koi Carp can be seen in figure 1. Research specimen can be seen in figure 2.

Table 1. Koi carp feed formula

Material Type	Massa (gr)	Material Percentage
Artificial Feed	20	4
Tapioca flour	10	20
Water	20	40

**Figure 1.** The Physical Form of The Feed of Koi Carp**Figure 2.** Research specimen

2. Instruments

The research instrument used in this study was data on the results of length growth and mass growth of koi carp, which were given two different treatments: added 4 grams of feed formula and 8 grams of feed formula. The data from this research are then presented in a table of the growth results of the length and mass of the koi carp, which is then analyzed based on the existing growth formula.

3. Technique of Data Analysis

The data collection and analysis used was based on a quantitative analysis of the koi carp's body mass and length, which showed the koi carp's growth results after being given a daily feed formulation which was then measured every week based on the treatments in this study. As for the quantitative analysis of the growing research of koi carp, which consists of measuring body mass and body length of this carp, a growth formula based on the procedure of Effendi (1997) in Sari et al. (2016), which are as follows:

- a. The formula for the absolute length growth of koi carp

$$L = L_t - L_o$$

Description:

L = Absolute length growth (cm)

L_t = Final length (cm)

- b. The formula for the absolute mass growth of koi carp

$$M = M_t - M_o \dots\dots\dots(1)$$

Description:

M = Absolute mass growth (grams)

M_t = Final weight (grams)

M_o = Initial weight (grams)

D. Result and Discussion

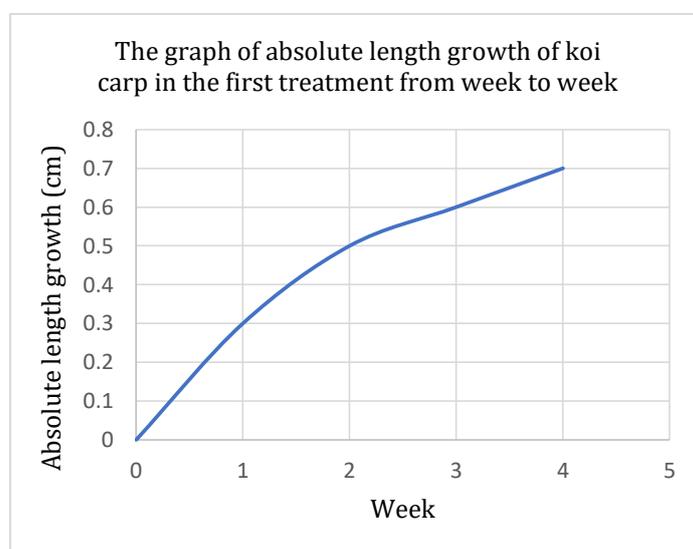
1. Result

The growth of koi carp on feeding formula 4 grams a day can be seen in the table below.

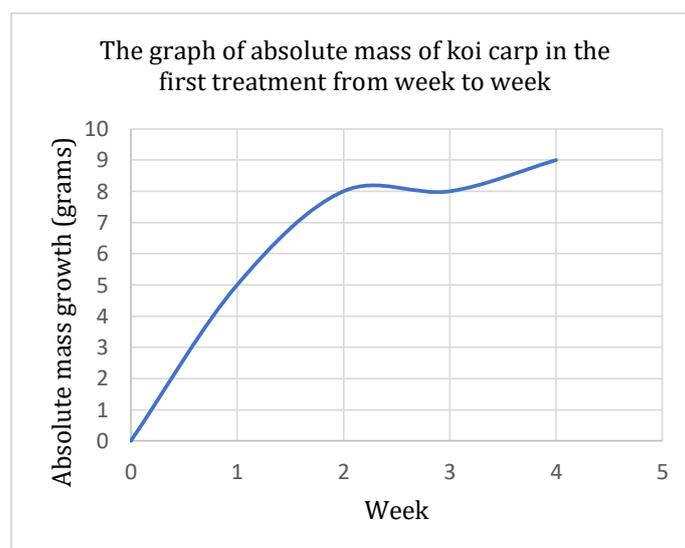
Table 2. The growth results of koi carp given a feed formula of 4 grams

No.	Treatment	Week	Fish Length (cm)	L (cm)	Fish Weight (grams)	M (grams)
1.	Feed formula 4 grams	0	6,0	-	55	-
2.		1	6,3	0,3	60	5
3.		2	6,8	0,5	68	8
4.		3	7,4	0,6	77	9
5.		4	8,1	0,7	86	9
	Average	0-4	6,92	0,525	69,2	7,75

The graph of absolute length growth and absolute mass of koi carp in the first treatment can be seen in the following Grafik 1 and 2:



Grafik 1. The graph of absolute length growth of koi carp in the first treatment



Grafik 2. The graph of absolute mass of koi carp in the first treatment

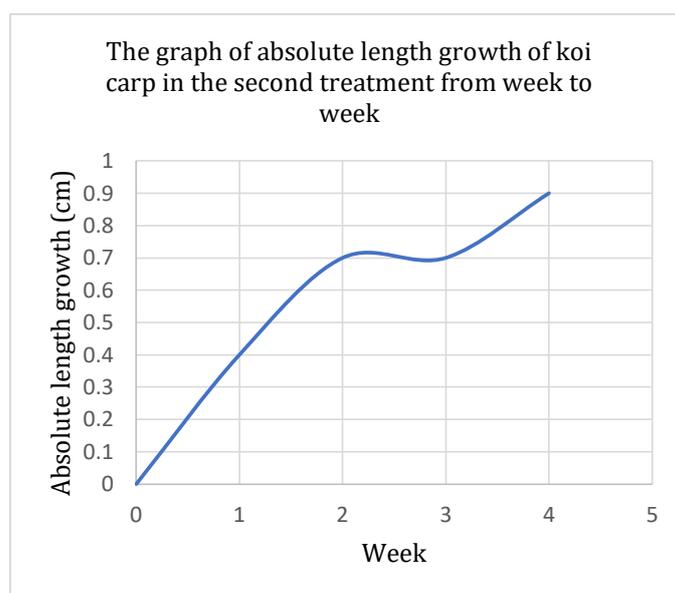
Based on the graph of the absolute length and mass growth of koi carp given the first treatment, which was given a feed formula of 4 grams once a day, it can be ascertained that there was positive growth in the feeding formula. This is supported by the shape of the two charts, which tend to go up. So it can be ascertained that the addition of tapioca flour to the artificial feed of koi carp can accelerate the growth of the koi carp.

The growth of koi carp on feeding formula 8 grams a day can be seen in the table below.

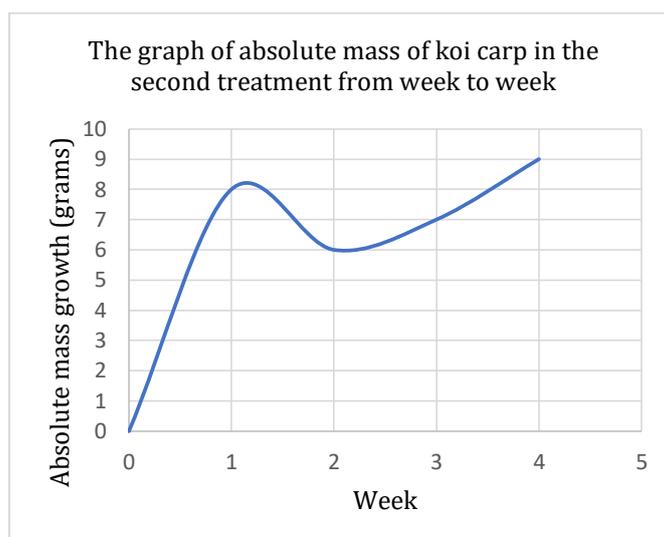
Tabel 3. The growth results of koi carp given a feed formula of 8 grams

No.	Treatment	Week	Fish Length (cm)	L (cm)	Fish Weight (grams)	M (grams)
1.	Feed formula 8 grams	0	5,8	-	57	-
2.		1	6,2	0,4	65	8
3.		2	6,9	0,7	71	6
4.		3	7,6	0,7	78	7
5.		4	8,5	0,9	87	9
	Average	0-4	7	0,625	71,6	7,5

The graph of absolute length growth and absolute mass of koi carp in the second treatment can be seen in the following Grafik 3 and 4:



Grafik 1. The graph of absolute length growth of koicarp in the second treatment



Grafik 2. The graph of absolute mass of koi carp in the second treatment

Based on the graph of the absolute length and mass growth of koi carp given the second treatment, which was given a feed formula of 8 grams once a day, it can be ascertained that there was positive growth in the feeding formula. This is supported by the shape of the two charts, which tend to go up. Soit can be ascertained that the addition of tapioca flour to the artificial feed of koi carp can accelerate the growth of the koi carp.

2. Discussion

Growth is the process of increasing the number of cell protoplasm in an organism accompanied by an increase in size, weight and number of cells that cannot return to their previous state. Characteristics of growth, including this growth, is in the form of a volume increase process that is irreversible (cannot be reversed) and occurs due to an increase in the number of cells and enlargement of each cell. Growth can be measured and expressed quantitatively (Arimbawa, 2016).

The phases of growth in organisms, including starting from one individual cell, then the growth of multicellular organisms can be divided into 3 phases: cell division, cell expansion, and cell differentiation. At the stage of cell division or also called hyperplasia, an increase in the number of cells due to mitotic division and cell division. In the stage of cell expansion or hypertrophy, there is an irreversible increase in cell size due to water uptake or synthesis in the protoplasm. Finally, at the stage of cell differentiation, cell specialization occurs where in this case, growth occurs, which also includes the development (Bahar, 2016).

Based on the research that has been done in the first table, which shows the growth results of koi carp in the first treatment bucket that was given a feed formula of 4 grams once a day, at first the koi carp at week 0 had a fish length of 6.0 cm and a weight of 6.0 cm. fish 55 grams. Then after being given a feed formula of 4 grams, the koi carp experienced growth in the first week, which was shown in the length of this first treatment koi goldfish of 6.3 cm so that it had an absolute length growth from week 0 to week 1 of 0.3 cm. While in mass growth, the first treatment koi carp in the first week had a mass of 60 grams, so that it had an absolute mass growth from week 0 to week 1 of 5 grams.

In the second week after being given a feed formula of 4 grams once a day, the koi carp experienced a length growth indicated by a length of 6.8 cm so that it had an absolute length growth from the 1st week to the 2nd week of 0.5 cm. While in mass growth, the first treatment koi carp in the second week had a mass of 68 grams, so that it had an absolute mass growth from the 1st week to the 2nd week of 8 grams.

In the fourth week after being given a feed formula of 4 grams once a day, the koi carp experienced a length growth indicated by a length of 8.1 cm so that it had an absolute length growth from the 3rd week to the 4th week of 0.7 cm. While in mass growth, the first treatment koi carp in the fourth week had a mass of 86 grams, so that it had an absolute mass growth from the 3rd week to the 4th week of 9 grams.

Based on this, it can be obtained that the average koi carp in the first treatment given a feed formula of 4 grams once a day has an average fish length of 6.92 cm with an average absolute length growth (L) of 0.525 cm. At the same time, the average mass of koi carp in this first treatment was 69.2 grams, with an average absolute mass growth (M) of 7.75 grams.

In addition, based on the results of the second treatment of pangs that have been carried out in the first table, which shows the growth results of koi carp in the second treatment bucket that was given a feed formula of 8 grams once a day, at first the koi carp at week 0 had fish length. 5.8 cm with a fish weight of 57 grams. Then after being given a feed formula of 8 grams once a day, the koi carp experienced growth in the first week, which was shown in the length of this second treatment goldfish of 6.2 cm so that it had absolute length growth from week 0 to week 3. -1 by 0.4 cm. While in mass growth, the second treatment, koi carp, in the first week had a mass of 65 grams so that it had an absolute mass growth from week 0 to week 1 of 8 grams.

As for the second week after being given a feed formula of 8 grams once a day, the koi carp experienced a length growth indicated by a length of 6.9 cm so that it had an absolute length growth from the 1st week to the 2nd week of 0, 7 cm. Whereas in mass growth, the second treatment, koi carp, in the second week had a mass of 71 grams so that it had an absolute mass growth from the 1st week to the 2nd week of 6 grams.

Meanwhile, in the third week after being given a feed formula of 8 grams once a day, the koi carp experienced a length growth indicated by a length of 7.6 cm so that it had an absolute length growth from the 2nd week to the 3rd week of 0, 7 cm. Whereas in mass growth, the second treatment koi carp, in the third week, had a mass of 78 grams, so that it had an absolute mass growth from the 2nd week to the 3rd week of 7 grams.

As for the fourth week after being given a feed formula of 8 grams once a day, the koi carp experienced a length growth indicated by a length of 8.5 cm so that it had an absolute length growth from the 3rd week to the 4th week of 0, 9 cm. Meanwhile, in terms of mass growth, the second treatment koi carp, in the fourth week, had a mass of 87 grams, so that it had an absolute mass growth from the 3rd week to the 4th week of 9 grams.

Based on this, it can be obtained that the average length of the koi carp in the second treatment is 7 cm and the average absolute length growth (L) is 0.625 cm. At the same time, the average mass of koi carp in this first treatment was 71.6 grams, with an average absolute mass growth (M) of 7.5 grams.

The fastest absolute length growth was the koi carp given the second treatment, which was 0.625 cm per week because it was only 1 cm per week in the first treatment. At the same time, the fastest absolute mass growth was koi carp given the first treatment, with a mass of 7.75 grams per week because it only grew by 7.5 grams per week in the second treatment.

Based on these two things, it is inevitable that a dose of 8 grams is the correct dose for koi carp because it can produce effective growth in length and mass. The effect of providing the feed formula made from artificial feed, tapioca flour, and water is that the more feed formula is given, the faster the growth of the koi carp produced will be. But this, of course, must be accompanied by the right dose as previously discussed.

Based on this research, it can be ascertained that the benefits of adding tapioca flour to increase the dose of carbohydrates in carp are one of the efforts that can increase the growth of carp. Efforts to increase the growth of carp can provide many benefits, such as shortening production time, improving feed efficiency, and increasing production (Putri et al., 2017).

Tapioca flour is a natural ingredient added to the artificial feed of koi carp. This tapioca flour has the function to maintain the nutritional characteristics of feed as a preservative, adhesive or binder and can increase appetite (Putri et al., 2017). The addition of tapioca flour in carp-made feed can be one step that can increase carp production, increase efficiency and nutritional content in carp feed, increase carp appetite accompanied by increased growth. The addition of tapioca flour to carp feed is one solution to advance the carp cultivation sector in the community, both in the large aquaculture sector and the small or home aquaculture sector.

E. Conclusion

Growth is the process of increasing the number of cell protoplasm in an organism accompanied by an increase in size, weight and number of cells that cannot return to their previous state. One of the factors that influence the growth of koi carp is feeding. Good feed is feed that can meet the nutritional needs of the koi carp. The addition of tapioca flour in the feed formula, which contains artificial feed, tapioca flour, and water in the koi carp feed, is one of the right steps because of the increase in carbohydrate doses that can support the growth of the koi carp. The effect is that the more feed formula is given, the faster the growth of the koi carp produced will be. But this, of course, must be accompanied by the correct dose, which is 8 grams of feed formula once a day. The benefits of adding tapioca flour in carp feed are increasing carp production, prolonging goldfish life expectancy, increasing efficiency and nutritional content in carp feed, increasing carp appetite accompanied by increased growth.

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