DETERMINATION OF CONDITION FACTOR (CF) AND HEPATOSOMATIC INDEX (HSI) OF *PANGASIUS* SP. FROM JELI MARKET

By

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DECLARATION

I hereby declare that the thesis of this final year project entitled “Determination of Condition Factor (CF) and Hepatosomatic Index (HSI) of *Barbonymusschwanenfeldii* from the Sungai Galas, Dabong, Kelantan”is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ____

Name : ____

Date :____

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LIST OF ABBREVIATIONS

CF	Condition Factor
HIS	Heapatosomatic Index
L_w	Liver Weight
B_w	Body Weight
DO	Dissolve Oxygen

LIST OF SYMBOLS

Zn	Zinc
Mg	Manganese
Pb	Plumbum
Cu	Copper
Fe	Iron
L_w	Liver Weight
B_w	Body weight
%	Percentage

DETERMINATION OF CONDITION FACTOR (CF) AND HEPATOSOMATIC INDEX (HSI) OF *PANGASIUS* SP. FROM JELI MARKET

Abstract

Conditions factors (CF) and hepatosomatic index (HSI) of *Pangasius* sp. from Jeli market been studied for a period of three months (July-September 2016). The total length and weight of fish were recorded. The highest condition factor value is 1.05 while the lowest condition factor is 0.69. There are some factor contribute to the result such as availability of food organisms at a particular time and average temperature at the habitat. The result of this study indicates that the environment is not too suitable for the species. It also indicates that the understanding of local community in Jeli about this issue is still in low level. This study has contributed to the knowledge of fish populations in this economically important area that could assist fishery management scientists in carrying out future ecological studies in line with the strategies of conservation, restoration and management. Sustainable management of the species, however, requires that the environment be protected against anthropogenic pollution to enable the species to survive.

PENENTUAN FACTOR KEADAAN DAN INDEKS HEPATOSOMATIK *PANGASIUS* SP. DARI PASAR JELI

Abstrak

Faktor keadaan dan indeks hepatosomatik *Pangasius* sp. dari pasar Jeli telah dikaji untuk tempoh tiga bulan (Julai-September 2016). Panjang keseluruhan dan berat ikan telah direkodkan. Faktor keadaan yang tertinggi adalah 1.05 manakala faktor keadaan yang terendah adalah 0.69. Terdapat beberapa faktor yang menyumbang kepada hasil kajian seperti terdapatnya organisma makanan pada tempoh masa tertentu dan purata suhu di habitat spesies tersebut. Hasil kajian ini menunjukkan bahawa keadaan di sekitar sungai itu tidak sesuai untuk spesies ini. Ia juga menunjukkan bahawa pengetahuan masyarakat setempat di Jeli mengenai isu ini masih berada pada tahap rendah. Kajian ini turut menyumbang kepada pengetahuan bahawa populasi ikan di kawasan ini penting dari segi ekonomi yang boleh membantu ahli sains dalam jurusan pengurusan perikanan dalam menjalankan kajian ekologi pada masa hadapan seiring dengan strategi pemuliharaan, pemulihan dan pengurusan. Pengurusan kelestarian terhadap spesies tersebut, bagaimanapun, memerlukan alam sekitar dilindungi daripada pencemaran antropogenik untuk membolehkan spesies terus hidup.

CHAPTER 1

INTRODUCTION

1.1 Background

Growth is a process of increase or progressive development of an organism. Typically growth can be defined as the change in size which is in length and weight over time. Increment in size is due to conversation of food matter in to building mass of body by the process of nutrition. Many factors influence the growth of fish such as amount and size of available food, the number of fish utilizing same food source, temperature, water quality factor, the size, age and sexual maturity of the fish. Growth of fish can be considered as no more than the individual production of mass. The growth process is specific for each species of fish. However, it can differ in same species inhabiting different geographical locations and is easily influenced by several biotic and abiotic factors. Growth is a specific adaptive property, ensured by the unity of the species and its environment (Nikolsky, 1963). Fish can attain either isometric growth, negative allometric growth or positive allometric growth. Isometric growth is associated with no change of body shape as an organism grows. Negative allometric growth implies the fish becomes more slender as it increase in weight while positive allometric growth implies the fish becomes relatively stouter or deeper-bodied as it increases in length (Riedel *et al.*, 2007).

Length-weight relationship (LWR) of fishes are important in fisheries biology because they allow the estimation of the average weight of fish of a given length group by establishing a mathematical relation between the two (Beyer, 1987). They are also useful for assessing the relative well being of the fish population. Length-weight relationship has a number of important applications in fish stock assessment. There are including estimating the standing stock biomass, and comparing the ontogeny of fish population from different region (Patrakis and Stergiou, 1995).

This relationship is used by fishery researchers and managers for two main purposes which are to predict the weight from the length of a fish and to compare the average associated parameters between fish groups spatially or temporally (Muzzalifah *et al.,* 2015). From this relationship, weight could be computed from a given length and vice versa through a mathematical equation. The length-weight relationship can be extended for the estimation of fish condition assuming that a heavier fish of a given length is in a better condition. Studies on the length-weight relationship and condition factor have been well documented in many tropical freshwater fishes including the golden mahseer, Tor putitora, striped dwarf catfish, Mystus vittatus, butter catfish, Ompok pabda and scissor-tail rasbora, Rasbora tawarensis (Gupta *et al,.* 2011). Several studies on freshwater fish species in Malaysia have also been conducted in Sungai Batu and Sungai Tua in Selangor, Chenderoh and Kerian River basin in Perak, Pedu Lake in Kedah and Kenyir Reservoir in Terengganu (Kamaruddin *et al,.* 2012).

The condition of the liver and whole body are measured using hepatosomatic index (HSI) and factor for body nutritional status of individuals (condition factor (CF)) which are can provide information on potential pollution impacts. HSI values in fish populations have long been an instrument for bioindicator analysis and there are a noteworthy number of publications on this problem already (Zaripova and Fayzulin, 2012). According to Eastwood and Couture (2002), in ichthyology, the so-called Fulton condition factor (FCF) is used to assess the overall health of fish populations, and the quality of the habitats. In recent years, researchers from different parts of the world successfully demonstrate the practical application of the factor for body nutritional status of individuals in populations of different fish species for bio indicator and bio monitoring (Thammachoti *et al.,* 2012). The leading idea in bio indicator analysis is to examine the hypothesis that in aquatic life populations living in polluted areas, the values of CF are lower than in populations inhabiting control areas (Zhelev *et al.*, 2015)

1.2 Problem Statement

The consumption of fishes is the main concern due to the ability of pollutants accumulate and deposit in the human body (Rohasliney *et al.*, 2014). Fish are the top of the aquatic food chain which are able to concentrated large amount of heavy metal from the polluted water by ingestion, ion-exchange of dissolved metals across lipophilic membrane and absorption on tissue and membrane surface (Chalapathi, 2012).

Condition factor is a measure of various ecological and biological factors such as degree of fitness, gonad development and the suitability of the environment with regard to the feeding condition (Mac Gregoer, 1959). The condition factor of fish can be affected by a number of factors such as stress, sex, season, availability of feeds, and other water quality parameters (Khallaf *et al*., 2003).

Pangasius sp. is chosen from Jeli market as studied sample due to their species abundance and popularity among the local resident. Hence some study needs to be conducted to determine the concentration of heavy metal in the fish sold at the Jeli market and it safety for consumption. It is important to determine the condition factor of *Pangasius* sp. so that the growth rate of the fish species can be assess and determination of hepatosomatic also important in order to know the ability of metal accumulation through the data on hepatosomatic of the fish species.

1.3 Objectives

1. To determine the condition factor (CF) and hepatosomatic index (HSI) of the selected freshwater fish.
2. To determine the knowledge of risk by taking contaminated fish among community in Jeli.

1.4 Significance of study

Condition factor (CF) and hepatosomatic index (HSI) can help us to know whether the fish is healthy or not. In fisheries science, the condition factor is used in order to compare the condition, fatness or wellbeing of fish. It is based on the hypothesis that heavier fish of a particular length are in a better physiological condition (Bagenal, 1978). Besides, HSI provides an indication on rank of power reserve in an animal. In pitiable surroundings, fish typically have a smaller liver with a lesser amount of energy retained in the liver. Consumption of contaminated fish can bring harm to our body so we need to know the level of awareness of the community about the health of the fish so that we can use the result of this research as guideline in determine the health of the fish.

CHAPTER 2

LITERATURE REVIEW

2.1 Condition Factor (CF)

The condition factor of fishes is the most important biological parameter which provides information on condition of fish species and the entire community and is of high significance for management and conservation of natural populations (Sarkar *et al.*, 2009). It is also a quantitative parameter of the state of well-being of the fish that determines present and future population success because of its influence on growth, reproduction and survival (Richter, 2007). Condition factor compares the wellbeing of a fish and is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesch, 1978). Condition factor has been used as an index of growth and feeding intensity (Fagade, 1979). Apart of that, previous study indicated that decreasing value of condition factor are associated with the increasing of length (Fagade, 1979); and also influences the reproductive cycle in fish (Welcome, 1979). Condition factor (K) is widely used in fisheries and fish biology studies.

The length-weight relationship has been widely used in fish biology study with several purposes such as to estimate the mean fish weight of the fish, based on the known length and conversion of the length equations in weight for equivalent of growth in weight (Olusegun 1989). Besides that, it also used for morphometrics, interspecific and intrapopulational comparisons, and to assess the index of well-being of the fish populations (Olusegun 1989). The length-weight relationship research is an approach that is broadly applied in fisheries organization as it provides information on stock condition (Bagenal & Tesch 1978). This connection is used by fishery researchers and managers for two main purposes; to predict the weight from the length of a fish and to compare the standard associated parameters between fish groups spatially or temporally (Muzzalifah *et al.,* 2015). The condition factor is also a useful index for monitoring of feeding intensity, age, and growth rates in fish (Amtyaz *et al.,* 2014). It is strongly influenced by both biotic and abiotic environmental conditions and can be used as an index to assess the status of the aquatic ecosystem in which fish live (Rajput, 2011).

Fulton's condition factor is calculated with formula and in the formula, the constant is simply a scaling factor that is equal to 100000 if metric units are used such as grams and millimetres or 10000 if English units are used is pounds and inches (Blackwell *et al.,* 2000). Fulton's condition factor assumes isometric growth (Bolger *et al.,* 1989). It also used to assess the overall health of fish populations, on the one hand, and the quality of the habitats, on the other (Eastwood *et al.,* 2002). When condition factor value is higher it means that the fish has attained a better condition (Alex *et al.*,, 2012).

The growth and maximum obtainable size of fish species can be seriously influenced by the physical and biological composition of their environment (Olurin and Aderibigbe, 2006). This is for the reason that the environment in aquaculture system is multifaceted, water quality parameters such as temperature, pH, concentrations of dissolved oxygen (DO) and ammonia must be monitored. Though other factors are important, oxygen is more essential for growth and survival of a fish because it affects fish respiration as well as nitrite and ammonia toxicity. As a result, the growth rate is reduced and the possibility of disease outbreaks increases. Furthermore, fish are unable to assimilate the food consumed when DO is low (Tom, 1998).

2.2 Hepatosomatic Index (HSI)

Hepatosomatic index (HSI) is defined as liver weight and fish weight ratio and usually used in fisheries science as an indicator of energy reserves in the liver (Cerda *et al.*, 1996). The condition of the liver and of the whole body, as measured with the hepatosomatic index (HSI) can provide information on potential pollution impacts (Jelodar *et al.*, 2012). Body condition is a practical tool for biologists and managers to gauge the overall health of fish population, and a good indicator of fish habitat quality and pollution levels (Craig *et al.*, 2005). Liver is a major energy store especially in non-fatty fish, since it an important store of energy reserves, where dissection is possible, the hepatosomic index is often used as an estimate of energy status of the fish (Wootton *et al.*, 1978). Although these parameters are not very sensitive, they can serve as an initial screening biomarker to indicate exposure and effects (Van *et al.*, 2003). Hepatosomic values in fish populations have long been a tool for bio indication analysis and there are a significant number of publications on this problem already (Loumbourdis and Wray, 1998). The hepatosomatic index in Osteichthyes is usually about 1 to 2%, though the index is variable according to fish species and also health condition of fish (Schmidt 1975). It is very high and in some species about one-fourth of the body weight is occupied by liver (Schmidt, 1975).

2.3 Fish Species in Research Study

2.3.1 *Pangasius* sp. (Hamilton)

Pangasius sp. (Figure 2.1) is a catfish species of the family Pangasiidae under the order Siluriformes which is widely distributed in India, Bangladesh, Pakistan, Myanmar, Malaya-peninsula, Indonesia, Vietnam, Java and Thailand (Talwar *et al*., 1991). *Pangasius* or commonly called patin by the locals with shark headed features and also have common length of 120 cm long and usually found in tropical countries such as in Asia. *Pangasius* mainly inhabits large rivers and estuaries; but can also be seen in irrigation canals, haors, baors, beels, natural depressions and even ponds especially during the monsoon period (Rahman, 2005). This fish has more tender meat compare than other freshwater fish (Mala *et al.,* 2015).

In feeding behaviour, *Pangasius* sp. is not only carnivorous species but also voracious. It also feeds on rotting animal and vegetative stuff (Talwar and Jhingran, 1991). It shows predatory on snails and other mollusc in river habitat (Rahman, 2005).

Figure 2.1: *Pangasius* sp.

2.3.2 Morphology of fish

Pangasius sp. body is elongated and laterally compressed, without any scale while the head and abdomen are flat, furthermore, the tail is constricted behind the adipose fin but a bit extended before the caudal peduncle. Figure 2.2 shows the morphology of the *Pangasius* sp., the head is slightly granulated above; occipital process is used to reach to basal bone of dorsal fin, snout is fairly prominent while their eyes are in the anterior half of the head, partly on the lower surface of head and the mouth is sub-terminal which is the upper jaw is longer than the lower jaw and mouth gape is of moderate size. Cleft of mouth is used to reach opposite the centre of front edge of the eye. Four groups of teeth are present on the palate, palatine teeth are in a crescent row, vomarine patches are separate from or nearly confluent with those on palate (Sandipan, 2016).

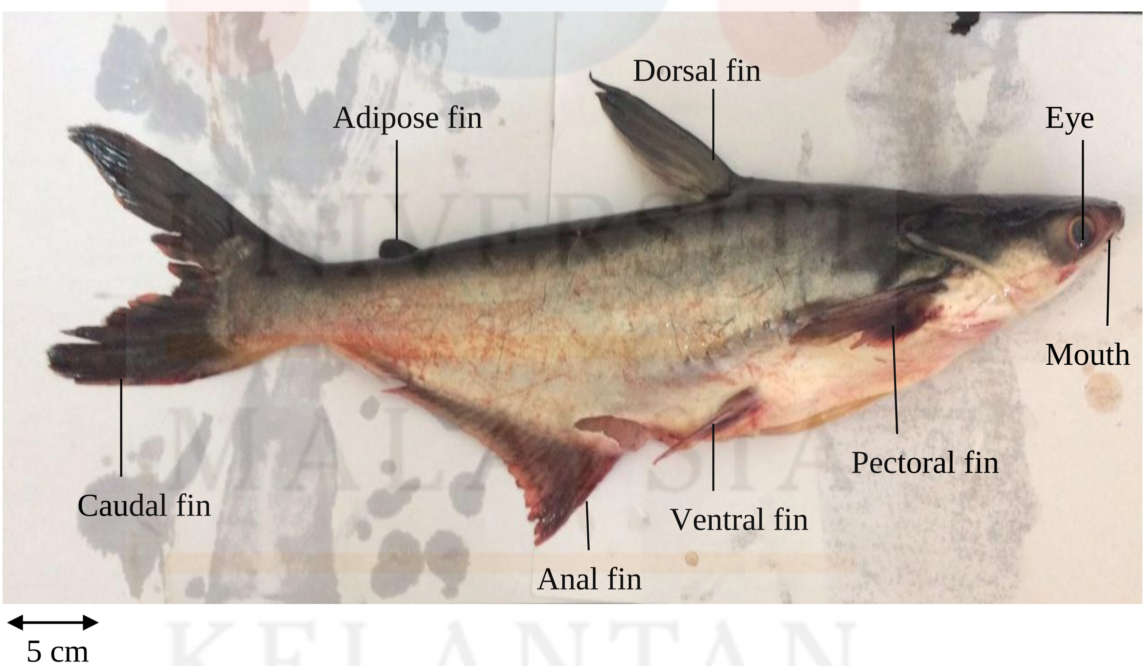

Figure 2.2: Morphology of *Pangasius* sp.

CHAPTER 3

MATERIALS AND METHODS

3.1 Sampling Site

Fish samples were obtained from the Jeli Market (Figure 3.1). This market is a very popular market for local population of Jeli. The operation hour of the market is from 7 am to 12 pm on Saturday, Tuesday and Thursday. This market is chosen because there is no study has been done here and freshwater fishes are commonly available at this market. Hence determining the safety level of fish for consumption from this market is necessarily for local population health.

3.2 Sample collection

The slaughtered *Pangasius* sp. samples were purchased from the Jeli market. This species were selected after some survey is done with the community in Jeli and 65% of them choose *Pangasius* sp. as their diet. Total of twenty fish from different seller were bought in three months. The fish were wrapped individually in low density polyethylene sampling bag, kept in ice box and immediately transported to the laboratory on the same day. They were stored under a ≤ -20 ˚C freezers until dissection can be performed the sampling plastic bag.

Figure 3.1: Jeli Market (source: Google map)

3.3 Sample preparation

3.3.1 Fulton's Condition Factor

The length of the body of the fish is measured using measuring tape while the weight of the fish was measured by using weighing scale. Condition factor can be estimated by the following equation (3.1) adopted by Rajaguru (1992):

$$K = \frac{M}{L^3} x\ 100 \qquad (3.1)$$

Where M is the body weight of the fish in gram and L is the total length of the fish in centimeters (Rajaguru, 1992). Figure 3.2 shows how to measure the total length of the fish accurately.

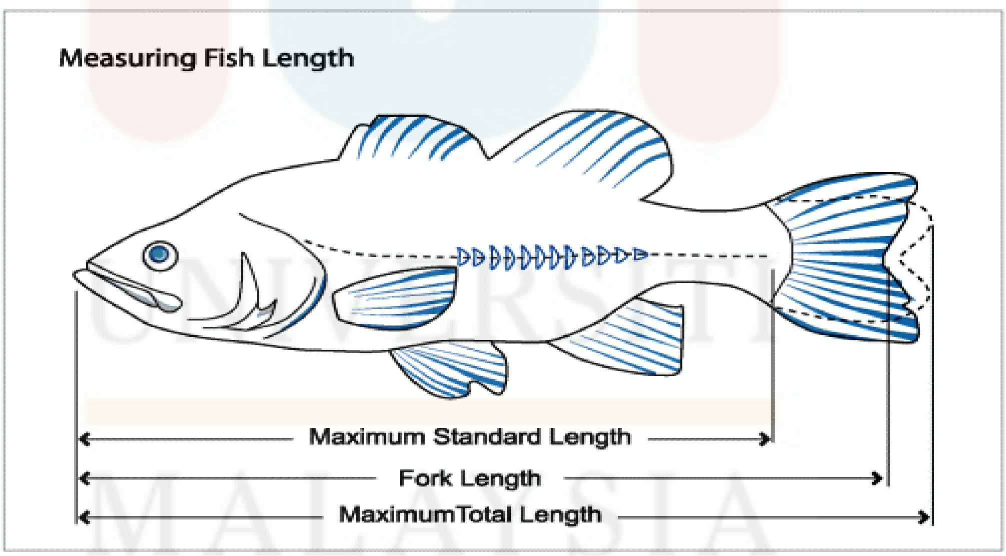

Figure 3.2: Measuring fish length

3.3.2 Hepatosomic Index

A shallow cut along the belly from the base of the pectoral fin to the tail is made. A single cut is made from behind the gill cover to the anus and then the liver of the fish was taken out by using stainless steel dissecting kits to get the value of the hepatosomic index using the following formula (3.2) adopted by Rajaguru (1992):

$$HSI = \frac{L_w}{B_w} \qquad (3.2)$$

Where L_w is liver weight of the fish in gram and B_w are total weight of the fish in gram (Rajaguru, 1992).

3.3.3 Participating interview

A participating interview on determining the knowledge of risk by taking contaminated fish to the customer's health was done. The target respondents for this interview are obviously the customer who goes to the market and 120 respondents was randomly chosen to participate in this interview. The participating interview consists of three questions which can be as a guideline to determine the level of understanding of the community in Jeli about this issue. The following is the question for the participating interview:

1. Do you know the effects of consuming polluted fish?
2. Do you aware that the fish from Jeli market is safe to consume?
3. Do you know the maximum permitted concentration of metals in specified foods (fish)?

CHAPTER 4

RESULT AND DISCUSSION

4.1 Condition factor

The biometric parameters for Pangasius sp. fom Jeli market was recorded in Table 4.1. It shows the condition factors of body length and weight of *Pangasius* sp. from the Jeli market. The average result obtain on the condition factor is 0.83 ± 0.11. The highest K value of the fish is 1.05 while the lowest k value of the fish is 0.67. After comparing the result with K value in Table 4.2, it shows that the fish species from the Jeli market is in poor condition. This might be due to the change in temperature (Alex *et. al.*, 2012) and availability of food organisms at a particular time (Gupta *et. al.,* 2011). The condition factor is an index reflecting interactions between biotic and abiotic factors in the physiological condition of fishes. It shows the population's welfare during the various stages of life cycle (Ahmad Dar *et al.,* 2012). Ahmad Dar (2012) stated that the condition factor does not merely reflect the feeding condition of the adult stage, but includes the state of gonadal development, based on the consumption of fat reserves during the spawning period.

The factor is calculated from the relationship between the weight of a fish and its length, with the intention of describing the condition of that individual fish (Froese, 2006). It is used for comparing the condition, fatness, or well-being of fish, based on the assumption that heavier fish of a given length are in better condition. Therefore, fishes with condition factor values greater than one (≥ 1) were considered as high while those less than one (< 1) were low (Waly *et. al.*, 2015).

Table 4.1: Biometric parameters for *Pangasius* sp. from Jeli market

No. of sample	Body weight (g)	Body length (cm)	Liver weight (g)	Condition factor	Hepatosomic index
1	550	43.4	9.332	0.67	1.7
2	550	41.8	8.034	0.75	1.46
3	700	40.6	7.989	1.04	1.14
4	550	43.0	5.945	0.69	1.08
5	600	43.0	7.530	0.75	1.26
6	480	40.4	5.357	0.73	1.12
7	600	43.5	9.020	0.73	1.5
8	630	42.0	8.595	0.85	1.36
9	550	40.0	6.430	0.86	1.17
10	700	40.6	8.259	1.05	1.18
11	350	33.0	4.657	0.97	1.33
12	500	41.1	6.126	0.72	1.23
13	270	34.0	4.423	0.69	1.64
14	300	34.0	4.632	0.76	1.54
15	880	46.2	11.567	0.89	1.31
16	640	42.0	8.584	0.86	1.34
17	460	37.9	6.354	0.84	1.38
18	500	38.0	7.633	0.91	1.53
19	500	38.9	8.489	0.85	1.7
20	650	41.3	6.256	0.92	0.96
Mean (± S.D)	**548 (± 142.30)**	**40.24 (± 3.44)**	**7.26 (± 1.84)**	**0.83 (± 0.11)**	**1.35 (± 0.21)**

Mean ± S.D.,n = 20

Table 4.2: Condition factor (K) value table

K value	Level of fish
1.60	Excellent
1.40	Good
1.20	Fair
1.00	Poor
0.80	Extremely Poor

The graph of condition factor of *Pangasius* sp. is shown in Figure 4.1, it shows the K value of the 20 samples fish that has been collected from Jeli market. The highest value of K value of the fish species is 1.05 while the lowest value is 0.67. Based on this figure, majority of the fish samples are categorized in poor condition due to the K value below than 1.20. This might be due to environment at the habitat of the fish which is not suitable for them (Muzzalifah *et. al.*, 2015).

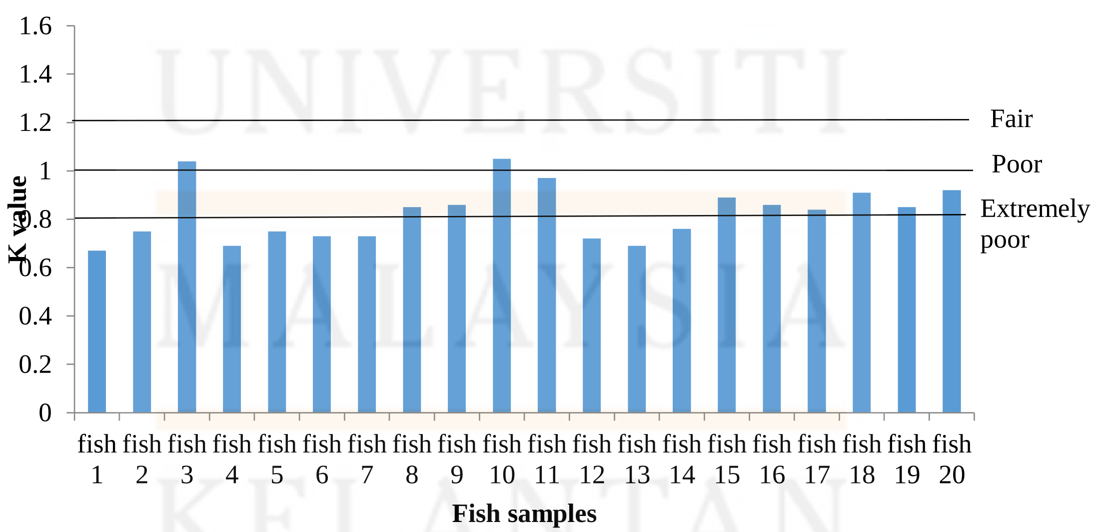

Figure 4.1: Graph condition factor of *Pangasius* sp.

The average body length and weight of *Pangasisus sp.* can also provide important clues on climate and environmental changes, and change in human subsistence practices (Waly *et. al.*, 2015). Different values in K of a fish indicate the state of sexual maturity, the degree of food sources availability, age and sex of some species (Anibeze, 2000). These relationships are also an important component of Fish Base (Froese *et. al.*, 2012). Length-weight relationships can be used as character for differentiation of taxonomic units. An already established length-weight relationship will be useful for assessing the data that contains only length frequency measurements (Waly *et. al.*, 2015). Environmental factors such as food supply and parasitism have great influence on the health of the fish (Le Cren *et. al.*, 1951). It also reflects the well-being of the fish (Kumolu *et. al.*, 2010) and it can give information on the physiological state of the fish in relation to its welfare (Waly *et. al.*, 2015).

4.2 Hepatosomatic index (HSI)

Figure 4.2 is the graph of liver weight of the fish against month, it shows the weight of the liver from the sample fish for three consecutive months that had been used to calculate the HSI. The HSI was calculated by dividing weight of the fish to weight of liver by 100 giving percentage of liver weight in the total body weight. The highest value of HSI indicates heavier liver (Sudarshan, 2013).

The results provide information on variations in the absolute and relative weight of the liver in fish inhabiting conditions of anthropogenic pollution. However, the diverse nature of the identified changes must be acknowledged. The liver in *Pangasius* sp. is the place where nutrients are stored, but also a place for accumulation and detoxification of xenobiotics (Crawshaw and Weinkle, 2000).

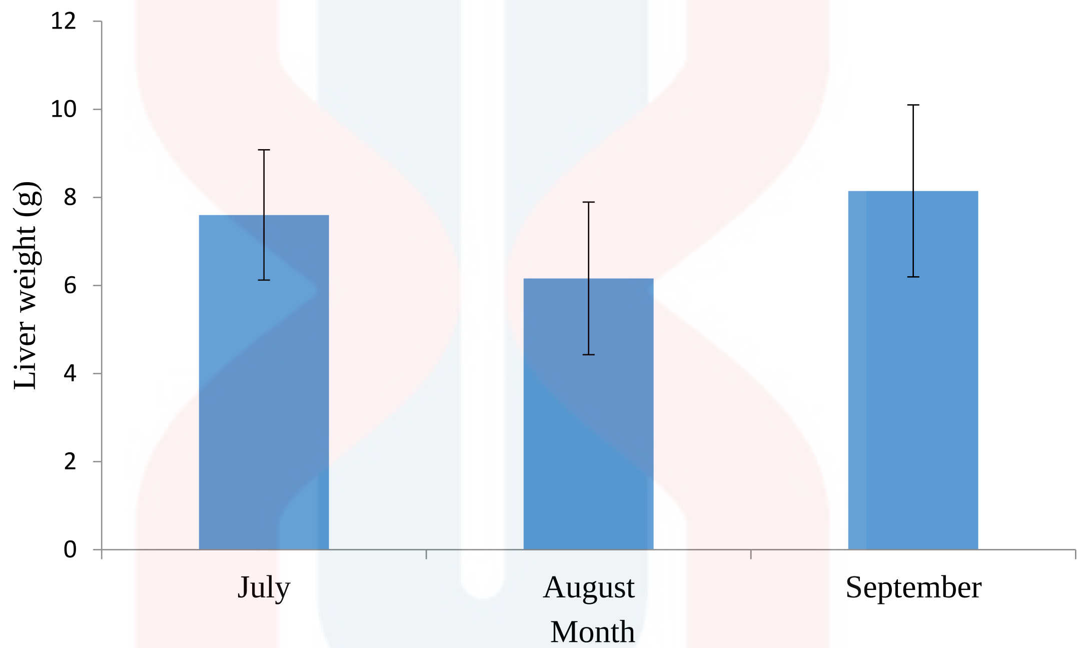

Figure 4.2: Graph liver weight against months

Liver is the metabolic organ and it is target for the metabolism in the fish body, the liver index (HSI) is a useful biomarker to detect the hazardous effects of the environmental stressors. Based on Table 4.1 the average HSI is 1.35±0.21. The average obtain from this study is in higher value range which in contrast to the K value which indicating that the liver of the fish species is also in poor condition due to environmental at the river. The liver is very important to the fish because we can decide whether the fish is healthy or not by measured the weight of the liver of the fish. This is because HSI value also provides us information about the healthy condition of fish and also about the quality of water, because higher HSI value means fishes are growing rapidly and has a good aquatic environment and if H.S.I. value is less it means fish is not growing well and it is facing unhealthy environmental problems (Vibhandik, 2013).

Adult of *Pangasius* is bottom feeding, carnivorous in habit mainly prefer molluscs (David 1963). Apart from molluscs, fishes, insects and crustaceans have also been documented from the gut content of adult *Pangas* (Menon *et. al.*, 1958). According to Ghosh and Saigal (1981), on the other hand, it has reported adult pangas as an omnivorous fish. Larval and post-larval stages of this fish species live mainly upon the planktonic food and small insects (Chondar 1999).

4.3 Relationship between body length and body weight with metal accumulation

Graph in Figure 4.3 shows length of the fish species against month while Figure 4.4 is the graph of weight of the fish species against month. The average length of the fish species is 40.24cm ± 3.44. The highest value of fish body length is in July meanwhile the lowest body length is in August. This might occur due to seasonal change that could slightly change the temperature at the habitat of the fish species. The average of the body weight is 548g ± 142.30. The highest value of fish body weight is in September while the lowest value of fish body weight in July which is affected due to high availability of food as the amount of food eats by the fish influence the growth of the fish and its energy (Muzzalifah *et al.*, 2015). This indicates that there are changes in temperature which effect in different length and weight of the fish (Alex, 2012). Studies from field and laboratory experiments have shown that the accumulation of heavy metals in fish tissue is mainly dependent upon concentrations of the metals in surrounding water, in addition to the exposure period (Yi *et al.*, 2011). Metal accumulation in fish has been found to reach a steady state after a certain age (Douben, 1989). The sizes of marine animals have been shown to play an important role in metal contents of tissues. The dilution of tissue metal concentrations associated with growth and/or lowered metabolic activity in older individuals may not be seen if metal concentrations in the surrounding water are found to be higher than the capacity of these factors. In this case, the continued accumulation of metals may occur, and positive relationships may be seen between animal size and metal concentrations in tissues (Yi *et al.*, 2011).

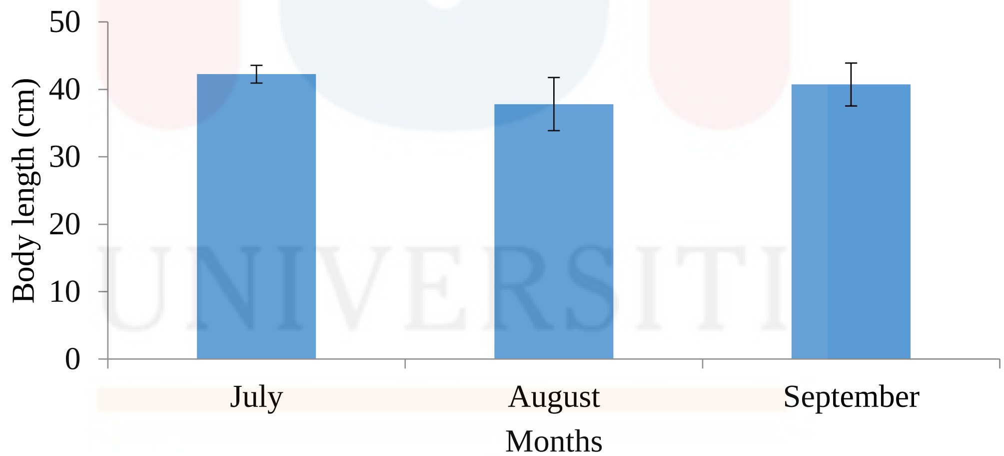

Figure 4.3: Graph length of fish against months

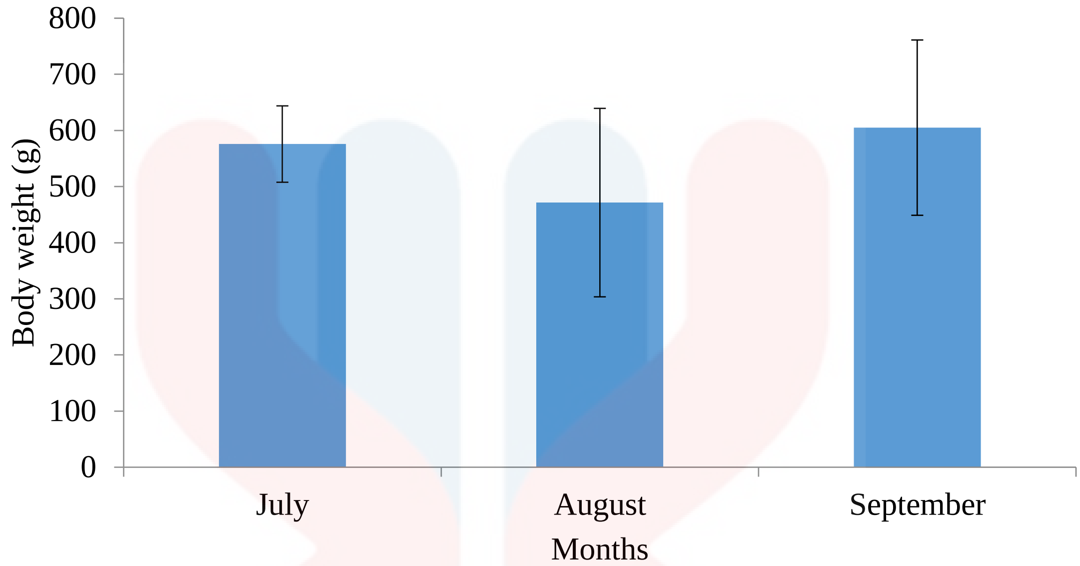

Figure 4.4: Graph body weight of the fish against months

Gills are the primary site of element uptake from water, especially if elements are bound to particulate matters (Klavin *et al.*, 2009), while the liver as metabolically active tissue due to the presence of metal-binding proteins is the accumulation location for elements (Ploetz *et al.*, 2007).

The length-weight relationship of fish varies depending upon the condition of life in aquatic environment (Bashir *et al.* 1993). Length-weight relationship is of great importance in fishery assessments (Garcia *et al.*, 1998). Apart from this, the length-weight relationship can also be used for deriving comparisons between different stages in life history and between fish populations from regions or habitat groups (Petrakis *at. el.*, 1995) and tracking seasonal variations in fish growth (Richter *et al.*, 2000). Length-weight relationships can also be used to know the growth pattern of the fish in the culture system. It is also used to estimate fish biomass from length frequency distributions, infer fish condition (Petrakis *et al.*, 1995).

The relationship between body length and body weight with metal accumulation can be proof based on previous study conducted by Zarith and Mohd (2015), this study was conducted in order to determine the heavy metal that contain in Sungai Galas and accumulation of metal in fish tissue muscle in that river. Data from their study is use as secondary data because the source of the fish is came from the same river although the sample of fish species is different from this study. The fish species used in their study were *B. Schwanenfeldii, H. Macrolepidota, M. Marginatus, C. Apogon and H. Nemurus.* It shows that there were heavy metals content in Sungai Galas and accumulations of heavy metal in fish species also occured. The heavy metals that were detected in Sungai Galas is Zn, Pb, Cu, Mn and Cd. The study shows that Zn has highest concentrations in all tissues of the species, followed by Ni, Cd, Mn, Cu, and Pb. Metal accumulation orders in muscles of *B. schwanenfeldii and H. macrolepidota* were Zn>Ni>Cu>Mn>Pb. The result in Table 4.3 shows that the mean concentrations of heavy metals in tissues were different among species.

Table 4.3: Heavy metal contents (mg/kg wet weight) of fish species from Galas River, Kelantan

Heavy metal	*B. schwanenfeldii*	*H. macrolepidota*	*M. marginatus*	*C. apogon*	*H. nemurus*
Zn	0.3132±0.105	0.274±0.079	0.333±0.12	0.260	0.136
Cu	0.0184±0.009	0.046±0.049	0.018±0.007	0.012	0.027
Pb	0.011±0.011	0.005±0.003	0.0040±0.004	0.010	0.011
Ni	0.072±0.01	0.067±0.01	0.064±0.005	0.058	0.058
Mn	0.014±0.003	0.018±0.005	0.028±0.007	0.021	0.012
Cd	nd	nd	Nd	Nd	Nd

nd=not detected

Metal levels in every fish muscle tissues are different (Kalay et al., 1999). This may be connected to the differences in environmental needs, swimming behaviours and the metabolic actions among different fish species and the differences in metal concentrations of the tissues might be as a consequence of their capability to make metal-binding proteins such as metallothioneins (Mustafa *et al.*, 2003). The adsorption of metals on to gill surface could also be a significant influence in total metal levels of the gill (Heath, 1987). High concentration of metals in water can delay fish growth causing potential alterations in fish size and the fish development can be affected by the presence of heavy metals in water and especially the early life stages such as hatching time, larval development and juvenile growth as they are more sensitive than the mature stages (Heath, 1987).

4.4 Comparison with other study

The data of the condition factor from different species and different location was recorded in Table 4.4. In 2012, a study had been conducted in Tanzania by Alex (2012) who used *Oreochromis urolepis* and *Tilapia zilli* as the sample. The condition factor for the *Oreochromis urolepis* is 0.86 while the condition factor for Tilapia zillis is 2.07. According to Alex (2012), this could happen due to the fact that the average temperature of fresh water ponds was not within the optimal temperature for growth which ranges from 29°C to 31°C. Low average temperature of freshwater ponds could be due to shadow effects caused by the nearby trees.

Besides that, there also some study that had been conducted in Malaysia which is at Temenggor reservoir conducted by Muzzalifah (2015), the sample used in the study were *Pristolepis fasciata*, *Cyclocheilichthys apogon*, *Hampala macrolepidota*, *Labiobarbus leptocheilus*, *Mystacoleucus marginatus*, *Osteochilus hasseltii* and *Oxygaster anomalura*. The entire sample has different K value which is *Pristolepis fasciata* (2.19), *Cyclocheilichthys apogon* (1.33), *Hampala macrolepidota* (1.12), *Labiobarbus leptocheilus* (0.97), *Mystacoleucus marginatus* (1.14), *Osteochilus hasseltii* (1.22) and *Oxygaster anomalura* (0.65). According to Gupta (2011) the difference in condition factor could be due to the availability of food organisms at a particular time as well as the difference of gonad development. From the comparison with other research, there are some same reasons that affect the condition factor of the fish species which is changes in temperature, feeding types and amount of heavy metal accumulation in the fish body. Other previous study with different place and species can also been referred in Table 4.4.

Table 4.4: Comparison with other study

Region	Species	Condition factor	Hepatosomic index	Reference
Malaysia	*Pangasius* sp.	O.8265	1.3465	This study
West Papua	*Melanotaenia boesemani*	-	2.276	Intanurfemi *et al.*, 2015
Malaysia	*Pristolepis fasciata*	2.194	-	Muzzalifah *at el.*, 2015
	Cyclocheilichthys apogon	1.325	-	
	Hampala macrolepidota	1.120	-	
	Labiobarbus leptocheilus	0.974	-	
	Mystacoleucus marginatus	1.141	-	
	Osteochilus hasseltii	1.215	-	
	Oxygaster anomalura	0.648	-	
Pakistan	*Pomadasys stridens*	0.984	-	Amtyaz *et. al.*, 2014
India	*Notopterus*	0.59	0.48	Sudarshan *et. al.*, 2013
Nigeria	*Ilisha Africana*	0.999	-	Abowei, 2010
Tanzania	*Tilapia zilli*	2.07	-	Alex *et. al.*, 2012
	Oreochromis urolepis	0.86	-	
Nigeria	*Niloticus*	1.87	-	Dan-Kishiya, 2013
	Barbus	1.31	-	
	Occidentalis	1.24	-	
	Barilius loati	1.06	-	
Turkey	*Anguilla anguilla*	0.26	-	Cahit, 2014

4.5 Participatory interview

The interview was conducted on 120 respondents who are the customer to the market. The respondents were selected randomly. The questions of the survey were:

1. Do you know the effects of consuming polluted fish?

2. Do you aware that the fish from Jeli market is safe to consume?

3. Do you know the maximum permitted concentration of metals in specified foods (fish)?

Based on Figure 4.5 which is the graph of respondent against question, on question 1, 70% of the respondents answer agree which mean they know the effect of consuming polluted fish to our body while 30% other respondent disagree because they did not know what is the effect of consuming polluted fish to human body.

Furthermore, 92.5% of the respondents agree in question 2 and 7.5% other respondent disagree. This is because they buy the fish at the market based on the physical characteristic of the fish such as their eye, skin and body.

On the last question, only 5% of the respondents agree while another 95% of the respondents disagree. This is because most community at Jeli did not aware about the standard limit of heavy that should contain in fish.

This interview is a good information to indicate whether the community in Jeli is aware or not about the fish health issues. From the result of this interview, it can be conclude that majority of them do not have the knowledge about this issue because of lack of exposure to this kind of issues which is important to their health also. The authorities should pay an attention to this issue so that local community in Jeli can aware about this issue. The authorities need to expose this kind of issue to the local community in Jeli because they have limited knowledge about the current issue.

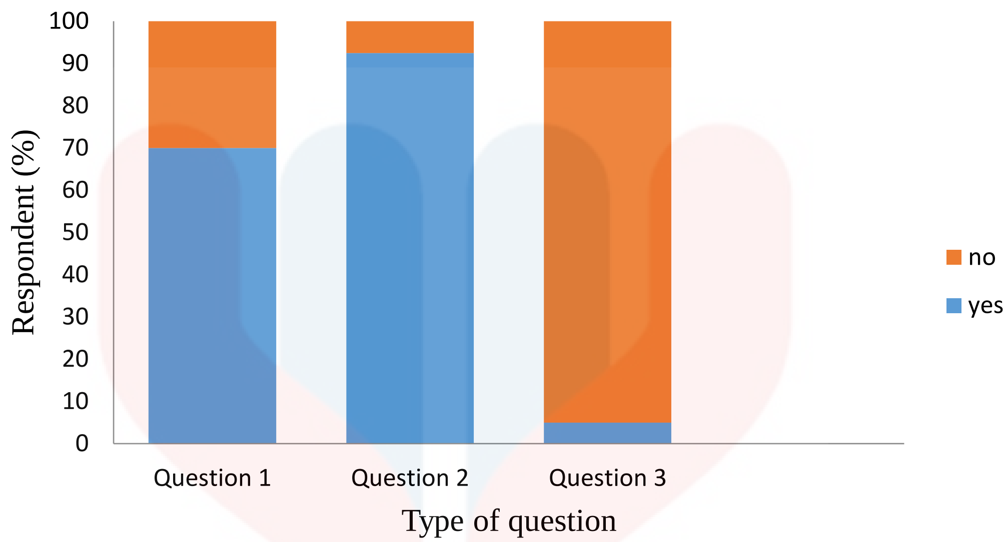

Figure 4.5: Graph respondent against type of questions.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study provides the first basic information on hepatosomic index and condition factor for *Pangasius* sp. collected from Jeli market. HSI and CF are informative parameters objectively reflecting the physiological state of fish in specific living environment conditions. Overall of this study shows that the fish species has poor condition factor which is the K value below than 1.2. This situation happened due to anthropogenic activities along the river such as industrial activities and agriculture runoff. Furthermore, the change in temperature in the river due to seasonal changes and natural feeding types of the fish species also influence the K value of the fish species. Besides that, based on the participatory interview, it can be conclude that the knowledge of the community in Jeli on issues of risky taking contaminated fish is still in low level because they have limited knowledge due to lack of information from authorities organisation. Many awareness campaigns on food safety need to be conducted and the community need to expose to this issue in order to increase the level of awareness among the community in Jeli.

5.2 Recommendation

In order to enhance this study in the future, more than one species are needed from the various sources for the growth rate comparison. Besides, similar study is recommended to be carried where the length and weight for determination of length-weight relationship, condition factors and hepatosomic index be measured long period after time of acclimation so that we can make sure the factors that affect the growth of the fish. As metal pollution extended across many region and high metal concentrations were detected in fish species from previous study, it is also important to study the level of metal concentration in fish species. So that, legislation for water and fish consumption can be build in order to evaluate the effects of metal pollution on fish health.

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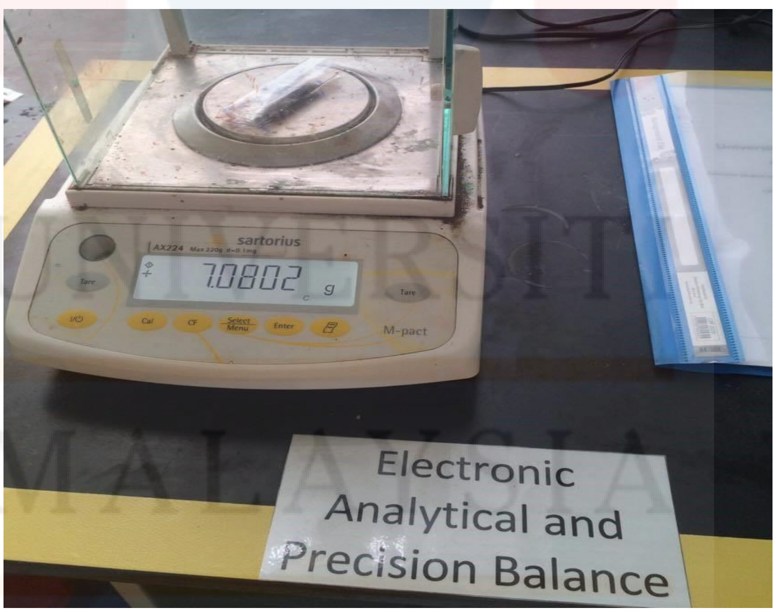
APPENDIX A

Questionnaire for the participatory interview:

1. Do you know the effects of consuming polluted fish?
2. Do you aware that the fish from Jeli market is safe to consume?
3. Do you know the maximum permitted concentration of metals in specified foods (fish)?

APPENDIX B

Liver of *Pangasius* sp.



The liver weight of Pangasius sp. is weight using Electronic Analytical and Precision Balance