# ABSENCE OF ENDOPARASITES AMONG GROUPERS (*Epinephelus spp.)* IN COMMERCIAL FARMS IN BACHOK AND PENGKALAN CHEPA, KELANTAN.

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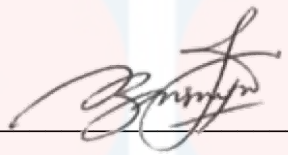
## CERTIFICATION

This is to certify that we have read this research paper entitled '**Absence of Endoparasites Among Groupers in Commercial Farms at Bachok and Pengkalan Chepa, Kelantan'** by Raghinhy Mohana Dass. It is satisfactory in scope, quality, and presentation as partial fulfillment of the course DVT 5436 – Research Project requirement.



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## DEDICATIONS

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## ABSTRACT

Endoparasitism is one of the common fish diseases affecting both marine fish and freshwater fish. The socio-economic impacts of endoparasitism in fish are loss of income and employment, reduced customer confidence in purchasing fish from sellers, food shortage, increased cost of disease research, control and health managements. This study is done because the prevalence of endoparasites in groupers caught from the wild and caged culture in Penang were 77.1% and 97.2% which are high, thus, this study was conducted to identify the endoparasites and determine the prevalence of endoparasitism in grouper fish from two different commercial farms: Farm A located in Bachok and Farm B located in Pengkalan Chepa, Kelantan. A total of 32 groupers have been collected altogether from the commercial farms. Post-mortem and organ scraping of the stomach, pyloric ceca, and intestines were conducted to collect the endoparasites. However, no endoparasites were obtained from the groupers. The length and bodyweight of the groupers, and water quality results were recorded. The average length of groupers in Farm A and Farm B was 22.0cm to 28.5cm and 4.3cm to 6.5cm respectively. The average weight of groupers in Farm A and Farm B was 202.8 g to 465.3g and 1.2g to 4.6g respectively. Based on the water quality results, both Farm A and Farm B have the optimum range of dissolved oxygen (DO), temperature, pH, ammonia, and nitrate. The other factors that contributed to the absence of endoparasitism could be due to age and size since a younger age and smaller size fish have a higher affinity towards parasitism. In addition, the administration of vitamins boosts the immunity of fish which helps to combat the parasitic infestation. In conclusion, good environmental condition as reflected by optimal parameters of water quality may contributed to the absence of endoparasites among groupers sampled from both Farm A and Farm B in this study.

***Keywords**: Groupers, Endoparasites, Water quality, Factors*

## ABSTRAK

Endoparasitisme adalah salah satu penyakit ikan yang menjejaskan kedua-dua ikan laut dan ikan air tawar. Antara kesan sosio-ekonomi disebabkan oleh endoparasit dalam ikan ialah kehilangan pendapatan dan pekerjaan, pelanggan kurang yakin untuk membeli ikan, kekurangan makanan, peningkatan kos dalam penyelidikan dan pengawalan penyakit serta pengurusan kesihatan. Kajian ini dilakukan kerana kelaziman endoparasit dalam ikan kerapu yang dibela di sangkar dan ikan kerapu yang liar adalah 77.1% dan 97.2% di Penang. Oleh itu,,kajian ini dijalankan untuk mengenal pasti endoparasit dan menentukan kelaziman endoparasitisme dalam ikan kerapu dari dua ladang komersial berbeza iaitu Ladang A di Bachok, dan Ladang B di Pengkalan Chepa,Kelantan. Sejumlah 32 ikan kerapu telah diperolehi dari dua buah ladang komersial. Post mortem dan pengikisan organ seperti perut, pilorik ceca, dan usus telah dilakukan untuk mengenal pasti endoparasit. Walau bagaimanapun, tiada endoparasit diperoleh daripada kesemua kerapu. Ukuran kepanjangan, berat badan dan kualiti air telah direkodkan. Purata ukuran kepanjangan ikan kerapu di Ladang A dan Ladang B ialah 22.0cm hingga 28.5cm dan 4.3cm hingga 6.5cm. Purata berat kerapu di Ladang A dan Ladang B ialah 202.8g hingga 465.3g dan 1.2g hingga 4.6g. Berdasarkan keputusan kualiti air, Ladang A dan Ladang B mempunyai julat oksigen (DO), suhu, pH, ammonia dan nitrat yang optimum. Faktor-faktor yang menyumbang kepada ketiadaan endoparasitisme adalah disebabkan oleh umur dan saiz kerana usia yang lebih muda dan saiz yang lebih kecil mempunyai kadar imunisasi badan yang lebih tinggi. Tambahan pula, vitamin yang digunakan meningkatkan imuniti ikan untuk mencegah parasit. Secara konklusinya, keadaan persekitaran yang baik adalah disebabkan oleh kualiti air yang optimal yang menunjukkan ketiadaan parasit antara ikan kerapu dari Ladang A dan Ladang B dalan kajian ini.

***Kata kunci**: Groupers, Endoparasites, Water quality, Factors*

# 1.0 INTRODUCTION

Worldwide, most groupers aquaculture production farms are located in Southeast Asia. Taiwan and Indonesia are the primary producers of farmed groupers, followed by Thailand and Malaysia (Rimmer, 2017). The high value of groupers in the export market ensures that farmers are able to generate profits although stocks suffer heavy mortalities. Despite high initial investment costs, previous studies have shown that with appropriate support, even the poorest can benefit from groupers culture, with implications for both household well-being and community development (Tupper, 2008). The fisheries sector remains an important instrument to produce food and nutrition, generate incomes and indirectly improves the welfare of the communities (Kaur,2021) Seven species of groupers were identified at the fish jetty in Pulau Kambing, Kuala Terengganu and Kuala Dungun, Terengganu (Piah, 2021). Based on the data collected by the Department of Fisheries written (Baharuddin, 2019), the number of groupers produced was 2,319 metric tonnes in 2019.

Grouper (*Epinephelus* sp.) farming is one of the successful aquaculture productions with high economic importance in Malaysia and form a major component of the coastal artisanal fisheries in the tropics (Leong, 1998). Fish parasites of groupers such as *Cromileptes altivelis*, *Ephinephelus areolatus* and *Ephinephelus fuscoguttatus* from tropical marine waters have been of special interest in recent years. According to Leong (1990), a study carried out in Penang shows that the fish that were collected from the floating cages shows lesions such as hemorrhage on the body, fin rot and scale loss. The common endoparasites found were *Pseudorhadbosynochus epinepheli*, *Ectanurus* sp, *Helicometrina nimia* and *Raphidascaris* sp (Leong at al, 1990).

The endoparasites that were found infesting groupers in Indonesia are *Pseudorhabdocynochus* sp, *Trichodina* sp, *Prosorhynchus* sp, *Raphidascaris* sp and *Cainocraedium* sp (Kleinertz et al, 2015). Other endoparasites that have been identified infesting groupers are *Cryptocaryon irritans*, *Ectanurus* sp, *Helicometrina* sp and *Bothriocephalus* sp. (Leong et al, 1990).

Common parasitic diseases in fish are dactylogyrosis, gyrodactylosis and tapeworm infestation (Neary et al, 2012; Hansen et al, 2016; Zargar et al, 2012 ). Dactylogyrosis is a parasitic disease caused by *Dactylogyrus* spp which is a monogean parasite which has higher specificity towards the fish host. The parasite-host interaction is influenced by season, size, and reproductive stage of the host (Neary et al, 2012).

Gyrodactylosis is another disease caused by monegean parasite known as *Gyrodactylus* spp. It is a host specific parasite especially seen in trouts and also groupers. The most common lesions seen on fish are excessive mucus production, damaged fins and pale body colour (Hansen et al, 2016).

Tapeworm infestation is caused by cestodes such as Bothriocephalus spp. The most common lesions that are observed is perforated intestine, inflammation and haemorrhage of the intestinal mucosa (Zargar et al, 2012).

The aim of this study is to identify the common endoparasites infesting groupers and also to determine the severity of endoparasitism that leads to clinical signs among the groupers. Data collected from this study will be a reference to veterinarians and public health officers in case of the potential risk to human consuming groupers that are infested with endoparasites. The data is also beneficial for the Department of Fisheries Malaysia to provide information about endoparasitism to the grouper's farmers.

# 2.0 RESEARCH PROBLEM

In a study carried out in Indonesia, the prevalence of Raphidascaris sp is 28.6% and Pseudorhabdosynochus sp is 97.1% which suggests groupers caught in the wild has high infestation of endoparasites (Kleinertz et al, 2015).Endoparasites in groupers lead to clinical signs such as impairment in feeding which will then lead to decreasing in growth rate and emaciation (Nagasawa et al, 2004).

The impacts that are caused by endoparasitism are increased in cost to manage environmental factors and farm management factors. Loss of production, control of the condition for a long-term period, and managing the infections are the issues that are faced by farmers (Shinn et al, 2015). It may give a high impact on the public health as well.

If the fish farmers did not step up treating parasitic diseases in fish with the consultation and advice from veterinarians or any aquatic experts, it will be difficult to eradicate parasitic infestations in the fish farms. Endoparasitism may cause severe health issues if the groupers that has been consumed by people are raw or undercooked. Ingestion of parasites from fish might lead to severe liver issues especially ingesting of flukes, asthma or allergic reactions (Amer, 2014).

Several studies have been conducted to identify the endoparasites of groupers but such studies have never been conducted in Bachok and Pengkalan Chepa, Kelantan. Thus, the occurrence of endoparasitism among groupers in these areas are still unknown.

## 3.0 RESEARCH QUESTIONS

a) What are the common genus of endoparasites found in groupers reared in commercial farms in Bachok and Pengkalan Chepa, Kelantan?
b) What is the prevalence of endoparasite infesting the groupers in the commercial farm in Bachok and Pengkalan Chepa, Kelantan?

## 4.0 RESEARCH HYPOTHESIS

The most common endoparasites that are expected to be identified from grouper fish collected from commercial farms in Bachok and Pengkalan Chepa, Kelantan would be nematodes such as *Raphidascaris sp*, digenea such as *Cainocraedium epinepheli* isolated from the stomach, *Prosorhynchus* sp. isolated from the pyloric ceca, *Ectanurus* sp and *Helicometrina nimia* as well as cestode such as *Bothriocephalus* sp isolated from pyloric ceca. Digenea such as *Pseudorhabdosynochus epinepheli* is also a parasite of interest in this study as it is the most common parasite of groupers (Kleinertz et.al , 2012). The infection level is determined by the prevalence, which can be calculated by the total number of fish infected with parasites over the total number of samples (Ozuni et al,2021)

## 5.0 RESEARCH OBJECTIVES

a) To identify the genus of endoparasites infesting groupers that are reared in commercial farms in Bachok and Pengkalan Chepa, Kelantan.
b) To estimate the prevalence of endoparasites infesting the groupers in the commercial farms in Bachok and Pengkalan Chepa, Kelantan.

# 6.0 LITERATURE REVIEW

## 6.1 Groupers

Groupers are from the *Serranidae* family and subfamily Epinephelinae which is an important commercial fish in the aquaculture production of many countries (Rimmer, 2017). The unique features of groupers are they have opercles with three spines. One main spine together with lesser spine above and below. Groupers are usually in solitary and only be in pair during spawning. There are 64 genera and 521 species of groupers worldwide. In Malaysia, there are 15 genera and 68 species (Ambak et al, 2012). Groupers are harvested at 0.6 to 1.2 kg of body weight before being exported to Singapore and Malaysia (Rimmer, 2017).

The most common feed that are given to groupers are in pelleted form and trash fish. The feed conversion ratio ranges from 5:1 to 7:1 for trash fish compared to pellets which ranges from 2:1 to 2.5:1 (Rimmer, 2017). The prevalence and mean intensity of infection of *P. epinepheli* in health groupers in Malaysia were 86.0% and 39.6 helminths per infected fish (Leong at al, 1990). The diseased groupers originated from Malaysia had a prevalence of 88.5% for monogenean with a mean intensity of 17.4. The major factor for disease outbreak among groupers in Malaysia is due to the infection from *P. epinepheli* together with protozoa species such as *Cryptocaryon irritans* and *Trichodina* sp (Leong et al,1990).

## 6.2 Common Endoparasites in groupers

Parasites will either cause major disease outbreaks in cultured fish or rather contribute to a chronic sub-clinical effect. The fish that are more susceptible at the early ages would be at the hatchery and nursery stages of the culture cycle. The intensity of monogenean infection in relation to the size of the fish may be an important cause of disease outbreak in cultured fish as the smaller the size of fish, the easier it is to succumb to endoparasitism than larger sized fish (Leong et al, 1990)

According to Leong (1990), based on their research in Penang grouper floating cages, the common endoparasites isolated from groupers were protozoa such as *Cryptocaryon irritans* and *Trichodina sp*. Monogeneans that were isolated were *Megalocotylonidae epinephli* and *P. epinephli.* Trematode that were isolated from groupers were *Ectanurus* sp, *Helicometrina nimia* and *Prosorhynchus pacificus*. Cestodes of unknown species were also found. Nematode that was isolated was known as *Raphidascaris sp*.

*P. epinephli* is a monogean parasite which inhabits the gills. Their infestation in the gills will cause swollen operculum which then cause excessive mucus production and the fish often shows signs of lethargic swimming, loss of appetite and in severe cases may cause ulcerative lesions of the skin (Hoa, 2007). The common clinical signs associated with monogenean infestation are lethargic, swim near the water surface, have clamped fins, rubbing the bottom or sides, scale loss and gills may be swollen (Reed et.al, 2012 ).

*Ectanurus sp* is a digenean parasite which inhabits the stomach of fish (Jacob et al, 2001). *Helicometrina nimia* is a digenean parasite which is commonly seen in fish of the Serranidae family. This parasite usually inhabits the stomach and intestine (Braz J Biol et.al, 2014). *Prosorhynchus pacificus* is a digenean parasite inhabiting the intestine of fish (Rodney, 2006). The common clinical signs that are associated with digenean infestation would be blindness due to heavy infestation and affected fish will have black ovoid patches on body surfaces (K.P Jithendran, 2010)

*Raphidasscaris* sp is a nematode which inhabits the intestine of fish. The common pathological lesions that are associated with this nematode infestation would be granulomatous enteritis and intestinal perforation which lead to granulomatous peritonitis (Schmidt, 2013)

## 6.3 Economic impacts of endoparasitism in fish

The impacts of endoparasitism in fish are loss of productions, reduced income and employment, loss in investment, reduced customer confidence, shortage of food and even closure of business. The increased in cost of investment for disease research, control and health management programmes are some of the economic impacts (Beantaso et al, 2010).

The loss of income occurs when the morbidity and mortality in the particular farm increases. There will be reduced productions and dead of the fish due to disease causes a huge impact in the total turnover of the business. The income loss happens when there will be increased in expenditure to treat the infected fish which includes medicated feed and chemical applications (Peterman et al, 2019).

# 7.0 MATERIALS AND METHODOLOGY

## 7.1 Sampling sites:

The study was conducted in commercial groupers' farm in Bachok (6° 3' 36.756" N102° 23' 50.424" E) about 17.0 km from Kota Bharu (Farm A) and in a commercial groupers farm in Pengkalan Chepa, (6° 9' 12.348" N102° 19' 38.316" E) about 15.2km from Kota Bharu (Farm B).

## 7.2 Collection of fish

Thirty-two (32) samples of grouper were collected from Farm A and Farm B. The fish were placed in an icebox before being transported to Aquatic Laboratory, University Malaysia Kelantan. Upon arrival to the laboratory, the length and weight of the fish were measured. In Farm A, the fish ranged from 22.0cm to 28.5cm in length and 202.8 g to 465.3g in body weight. In Farm B, the fish ranged from 4.3cm to 6.5cm in length and 1.2g to 4.6g in body weight.

## 7.3 Post-mortem of fish

The fish was placed on cutting board. An incision was made along the ventral midline of the body from the vent towards the operculum. Then, incision along the operculum was made and the skin attached together with muscle will be reflected to expose the abdominal cavity. All the organs in the abdominal cavity were identified. Organs such as stomach, pyloric ceca and intestines were isolated and transferred into normal saline solution for microscopic examination.

## 7.4 Endoparasite identification

Scrapings from the mucosa of the organs was taken and placed on microscopic slides together with a few drops of normal saline. Cover slip was placed on the sample. The fixed slide was then observed under the microscope.

## 7.5 Water quality analysis

The water sample from the groupers' rearing tank was collected. Water quality test was conducted to measure the pH level of the water, temperature, dissolved oxygen, ammonia and nitrate concentration.

# 8.0 RESULTS

Table 8.1 The mean body length (cm), mean body weight (g) and number of endoparasites obtained from grouper collected from Farm A (Bachok) and Farm B (Pengkalan Chepa)

| Farm | Number of fish | Body length (cm) | Body weight (g) | Number of endoparasites obtained |
|---|---|---|---|---|
| Farm A | 10 | 25.6 (22.0 – 28.5) | 386.4 (202.8 – 465.3) | 0 |
| Farm B | 22 | 5.2 (4.3 – 6.5) | 2.4 (1.2 – 4.6) | 0 |

Based on the 10 groupers collected from Farm A (Table 8.1), the average length of groupers was 22.0cm to 28.5cm. The average body weight of groupers was 202.8g to 465.3g. There was no endoparasites obtained from the post-mortem examination.

Based on the 22 groupers collected from Farm B (Table 8.1), the average length of groupers was 4.3cm to 6.5cm. The average body weight of groupers was 1.2g to 4.6g. There was no endoparasite obtained from the post-mortem examination.

Table 8.2. Water quality test results in Farm A

| Farm A | |
|---|---|
| Parameters | Results |
| Dissolved oxygen | 5.85 ppm |
| pH | 6.09 |
| Temperature | 25℃ |
| Ammonia | 0.4 |
| Nitrate | 0ppm |

pH=potential of hydrogen; ppm= part per million

Based on the water quality result tabulated in Table 8.3, the optimum amount of dissolved oxygen was 5ppm however in Farm A, the dissolved oxygen level was 5.85ppm which was considered normal. The pH of the tank from the farm is 6.09 which was within the normal range of pH that is 5.6 to 8.4. The temperature of the fish tank was 25℃ which is an ideal temperature. As for the ammonia and nitrate, the amount was 0.4 and 0ppm respectively which is also within the normal range.

Table 8.3. Water quality test results in Farm B

| Farm B | |
|---|---|
| Parameters | Results |
| Dissolved oxygen | 3.27 ppm |
| pH | 7.01 |
| Temperature | 32℃ |
| Ammonia | 1.2ppm |
| Nitrate | 0.02 |

pH=potential of hydrogen; ppm= part per million

Based on the water quality result tabulated Table 8.4, the optimum amount of dissolved oxygen was 5ppm however in Farm B, the dissolved oxygen level was 3.27ppm which is considered lower and might cause health issues. The pH of the tank from the farm was 7.01 which is within the normal range of pH that is 5.6 to 8.4. The temperature of the fish tank was 32℃ which is slightly higher which might be due to the weather. As for the ammonia, the amount was 1.2 which is high when compared to the normal range. This is considered not safe and might cause stress in the fish and succumb them to diseases. The nitrate level was 0.02ppm which is considered within the safe range.

# 9.0 DISCUSSION

In this study, we were able to obtain the body weight and length of the groupers from Farm A and Farm B. The prevalence of endoparasites among groupers in these farms could not be obtained since there was no finding of endoparasites from all fish that were collected and sampled in this study. The absence of endoparasites among groupers in the present study suggests that both farms have good management and control practices to prevent occurrence of endoparasitism in the fish.

According to Iyaji (2009), the parasitic infestation would be higher in fish that has increased in age and size. But in this study, even though the groupers in Farm A had considerably larger size than the groupers in Farm B, they were still young of about a few weeks old. Whereas in Farm B, the groupers are fry which has little weight and small size. According to Iyaji (2009), an increase in the size of fish gives opportunities for parasites to accumulate internally and externally due to the space, and also the fish tend to consume more prey that inhabits parasites which indirectly increases the worm burden.

Another factor that could contribute to the unavailability of endoparasites in fish would be due to season. This study was carried out during the hot season. According to Iyaji (2009), the prevalence and intensity of endoparasites will reach peak during the rainy season. Majumder (2013) stated that during the rainy season when temperature is low, the parasites growth will be elicited. However, as the temperature increases, the growth of the parasites will be ceased and eventually cause death. Both Farm A and Farm B use multivitamins to boost the fish immunity. According to Herrera (2019), vitamins such as Vitamin C and Vitamin E act as immunostimulant and antioxidant for the fish.

The optimum recommendation of dissolved oxygen for fish is 5ppm (Floyd, 2013). In this study, Farm A had a dissolved oxygen reading at 5.85ppm which is optimum for fish health

while Farm B had a dissolved oxygen reading at 3.27ppm which is low when compared to the range. The fish's health will be compromised when the range of dissolved oxygen is between 2ppm to 4ppm. However, in this study, there were no health problem issues identified.

According to Kurovskaya (2016), the optimum pH level for fish is between 5.6 to 8.4. pH less than 5.5 is considered an acidic environment while pH more than 8.5 is considered an alkaline environment for the fish. A slight change in pH will affect the toxic effects that exhibit by the parasites. In this study, both Farm A and Farm B had pH levels within the optimum range which suggests the absence of endoparasites among the fish.

Ammonia in a fish tank should be 0ppm and any amount beyond that is considered not safe and would cause stress and eventually cause death. However, incorporating a biofilter in a tank would help to reduce the toxicity caused by ammonia (Floyd, 2015). In this study, Farm A had 0.4ppm of ammonia while Farm B had 1.2ppm of ammonia which exceed the recommended level. However, the tank had biofilter which helps to reduce the ammonia toxicity which did not cause death to the fish.

The ideal concentration of nitrate in a fish tank should be less than 5ppm. Higher nitrate levels will cause the fish to succumb to stress and susceptible to diseases (Jackson,2018). In this study, both Farm A and Farm B had nitrate level 0ppm to 0.02ppm respectively which is considered acceptable thus suggests a good environment for the fish.

# 10.0 CONCLUSION

In conclusion, water quality test is one of the important factor which contributes to the absence of endoparasites in groupers. The difference in results of water quality test from both Farm A and Farm B explains the health condition of the fish in both farms too. This study was only focused on commercial farms which has good biosecurity and management practices.

# 11.0 RECOMMENDATIONS AND FUTURE WORK

Several limitations were noted in this study. For future study, it is recommended to increase the sample size as in this study only 32 groupers were collected. More samples will provide more validating and reliable results. Secondly, the type of sample collection area should be widened. This is because both Farm A and Farm B are commercial farms which are aware of economic impact in case of endoparasitism in fish. The farm types should be widened to farms that are not linked with government sectors, cage farming and farms that practice feed supplementation which could be the risk factors for endoparasitism among the groupers.

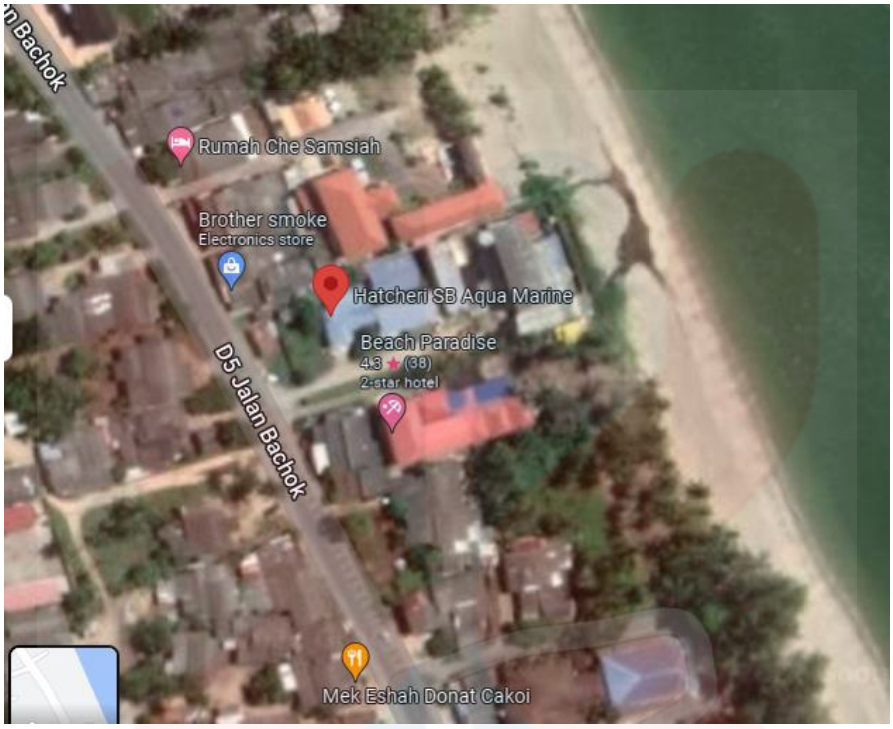
# APPENDIX A

| Farm A | | | | | |
|---|---|---|---|---|---|
| No | Groupers | Total length (cm) | Standard length (cm) | Body weight (g) | Number of endoparasites obtained |
| 1 | Fish 1 | 28.0 | 23.0 | 387.5 | 0 |
| 2 | Fish 2 | 25.5 | 21.0 | 392.9 | 0 |
| 3 | Fish 3 | 27.3 | 22.0 | 367.5 | 0 |
| 4 | Fish 4 | 26.0 | 23.5 | 399.0 | 0 |
| 5 | Fish 5 | 25.0 | 21.0 | 347.4 | 0 |
| 6 | Fish 6 | 23.0 | 19.5 | 202.8 | 0 |
| 7 | Fish 7 | 27.5 | 22.5 | 437.3 | 0 |
| 8 | Fish 8 | 28.5 | 24.0 | 465.3 | 0 |
| 9 | Fish 9 | 22.0 | 26.5 | 435.5 | 0 |
| 10 | Fish 10 | 23.0 | 27.5 | 428.7 | 0 |

*Appendix A.1: The total length, standard length, body weight and number of endoparasites obtained from Farm A*

| Farm B | | | | | |
|---|---|---|---|---|---|
| No | Groupers | Total length (cm) | Standard length (cm) | Body weight (g) | Number of endoparasites obtained |
| 1 | Fish 1 | 5.0 | 4.0 | 2.2 | 0 |
| 2 | Fish 2 | 4.8 | 3.9 | 1.8 | 0 |
| 3 | Fish 3 | 4.8 | 3.9 | 1.9 | 0 |
| 4 | Fish 4 | 4.5 | 3.7 | 2.0 | 0 |
| 5 | Fish 5 | 4.5 | 3.8 | 1.5 | 0 |
| 6 | Fish 6 | 4.8 | 4.1 | 1.6 | 0 |
| 7 | Fish 7 | 5.5 | 4.6 | 2.5 | 0 |
| 8 | Fish 8 | 4.5 | 3.8 | 2.0 | 0 |
| 9 | Fish 9 | 4.8 | 4.1 | 1.9 | 0 |
| 10 | Fish 10 | 4.3 | 3.8 | 1.2 | 0 |
| 11 | Fish 11 | 5.5 | 4.5 | 2.4 | 0 |
| 12 | Fish 12 | 4.0 | 3.5 | 1.3 | 0 |
| 13 | Fish 13 | 6.5 | 5.6 | 4.6 | 0 |
| 14 | Fish 14 | 6.0 | 5.3 | 3.7 | 0 |
| 15 | Fish 15 | 5.5 | 4.5 | 3.0 | 0 |
| 16 | Fish 16 | 5.7 | 4.5 | 2.5 | 0 |
| 17 | Fish 17 | 5.5 | 8.8 | 3.3 | 0 |
| 18 | Fish 18 | 5.7 | 5.0 | 2.9 | 0 |
| 19 | Fish 19 | 5.5 | 4.5 | 2.5 | 0 |
| 20 | Fish 20 | 5.7 | 4.9 | 3.7 | 0 |
| 21 | Fish 21 | 5.5 | 4.5 | 2.7 | 0 |
| 22 | Fish 22 | 5.0 | 4.3 | 1.8 | 0 |

*Appendix A.2: The total length, standard length, body weight and number of endoparasites obtained from Farm B.*




*Appendix A.3: The satellite view of Farm A*


***Appendix A.4: The satellite view of Farm B***

*Appendix A.5: The fish tank equipping Groupers fry in Farm A*

*Appendix A.6: The fish tank equipping Groupers juveniles in Farm A*


*Appendix A.7: The fish tank equipping Groupers fry in Farm B*

*Appendix A.8: The fish tank equipping Groupers juveniles in Farm B*

***Appendix A.9: The juvenile grouper collected for sampling from Farm A***

***Appendix A.10: The Groupers fry collected for sampling from Farm B***

***Appendix A.11: The visualization of internal organs of a grouper.***

# APPENDIX B



UNIVERSITI
MALAYSIA
KELANTAN

Fakulti Perubatan Veterinar

RUJ. KAMI *(Our Ref.)* : UMK/FPV/ACUE/FYP/006/2022
TARIKH *(Date)* : ٢٥ FEBRUARY 2022

**DR BASRIPUZI NURUL HAYYAN BINTI HASSAN BASRI**
Main Supervisor
Faculty of Veterinary Medicine
Universiti Malaysia Kelantan

Dear Dr,

**APPROVAL OF INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC) TO CONDUCT RESEARCH INVOLVING ANIMALS**

We are pleased to inform you that your application for approval to conduct research from Institutional Animal Care and Use Committee (IACUC), Faculty of Veterinary Medicine, Universiti Malaysia Kelantan has been approved. Please refer the table below for approval code:

| | |
|---|---|
| APPROVAL CODE | *UMK/FPV/ACUE/FYP/006/2022* |
| TITLE | *IDENTIFICATION OF ENDOPARASITES AMONG GROUPER (Epinephelus spp.) IN A COMMERCIAL FARM AT KAMPUNG PERUPOK, BACHOK* |

2. Please be noted for the Final Year Project, you are responsible to supervise your student to conduct all animal-related procedures as stated during ethic application. The co-supervisor(s) for the project are encouraged to help with the procedures as well.

3. You are advised to always follow "3R" (REDUCE, REFINE, & REPLACE) and all animal ethics and animal welfare principles to reduce suffering in animal.

Thank you.

**"RAJA BERDAULAT, RAKYAT MUAFAKAT, NEGERI BERKAT"**
**"WAWASAN KEMAKMURAN BERSAMA 2030"**
**"BERKHIDMAT UNTUK NEGARA"**

Yours sincerely,

**DR. NOR FADHILAH BINTI KAMARUZZAMAN**
Chairman
Institutional Animal Care and Use Committee
Faculty of Veterinary Medicine
Universiti Malaysia Kelantan

UNIVERSITI MALAYSIA KELANTAN اونيۏرسيتي مليسيا كلنتن | Karung Berkunci *(Locked Bag)* 36, Pengkalan Chepa, 16100 Kota Bharu, KELANTAN, MALAYSIA | Tel :609 771 7277 Fax :609 771 7282

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