# Types, Abundance, and Biomass of Microalgae in Soil Fish Cultivation Pool Habitat in Pekanbaru City, Riau, Indonesia

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*Abstract:* - Microalgae habitats can be found in almost all waters, including groundwater ponds. This study aims to determine the types of microalgae that live in fish pond waters in Pekanbaru City. Riau. This study uses a survey method, namely by observing and collecting samples from the waters of fish farming ponds that are assigned randomly from fish farming ponds in the Pekanbaru City area. Sampling was carried out at 4 stations, and at each station, there were 3 sampling points. The collected samples were then observed under an Olympus light microscope. This research was conducted at the Laboratory of Aquatic Biology, Faculty of Fisheries and Marine Affairs, University of Riau. The results of the study found 13 species of microalgae that live in fish farming soil ponds in the city of Pekanbaru. The 13 types of microalgae include *Scenedesmus quadricauda, Pediastrum duplex Mey, Tetrastrum heteracarthum, Spirulina plantensis, Microcystis aeruginosa, Chlorella vulgaris, Scenedesmus dimurphus, Pediastrum duplex var, Closeterium parvulum, Coelastrum microforum, Scenedia pediatus* and *Scenedestrum acuminatus.* Based on the abundance calculation, it is known that 316440 cells/L, and biomass 0.23 g/L. Water quality was recorded Temperature ranged from 28.5-29.33m $^{o}$C, Water brightness ranged from 18.25-38 cm, pH 6.00, DO ranged from 2.45-6.53 (mg/L), CO2 Free ranged from 3.00 - 14.98 (mg/L), Nitrate (NO3-) ranged from 0.1-0.3 (mg/L), and Phosphate (PO43-) ranged from 0.005-0.008 (mg/L).

*Key-Words:* - Microalgae, Pekanbaru City Pond, Identification, abundance, biomass, species diversity

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## 1 Introduction

Riau Province is dominated by public waters, and lowlands and most of its areas are peat areas. One of the uses of public waters in Riau province is using as a fish farming business in-ground ponds. The waters of this earthen pond are used by the community to maintain various types of freshwater fish of economic value for cultivation. Most people understand that the early stages of fish life, it is very dependent on the availability of natural food found in their habitat, such as microalgae. Algae have a microscopic size (small size that is visible) that live floating, float in water and have limited mobility, have chlorophyll-a, and have photosynthesis.

Microalgae have a variety of shapes, some of which have shapes such as ribbons, plates, and balls, and some are joined to form colonies. In addition, microalgae also have different color pigments, some of which are green, blue, blue-green, red, yellow, and brown. According to experts, microalgae can be used to determine water quality. Microalgae can live in almost all waters, including ground pond waters. The diversity, fertility, and development of microalgae species in ponds are strongly influenced by water conditions and the fertility of the waters. The diversity of microalgae species found in pond waters is positive, but some are detrimental to fish survival. To get the type of microalgae that is suitable for living and breeding in the pond waters can be seen from its abundance (population), and knowing its biomass. By knowing the type, abundance, and biomass of microalgae in the habitat of fish cultured ponds, in the future, for the success of fish farming in soil ponds, it is necessary to prepare sufficient natural food needed by the cultured fish.

## 2 Problem Formulation

Fish farming activities in soil ponds in peat areas in Pekanbaru City are very developed, these fish farming are in great demand by the community, but the operational costs for purchasing fish feed are very expensive, and must be supported by the fertility of natural feed derived from microalgae. Until now, the type, abundance, and biomass of microalgae that live in the peat soil fish pond habitat in Pekanbaru City, Riau, Indonesia are unknown.

### 2.1 Study area

This study uses a survey method, namely by observing and collecting samples from soil and pond waters randomly in the Pekanbaru City area. This research was conducted in September-November 2021. This study used soil and water samples from fish farming soil ponds in the city of Pekanbaru, Riau province, Indonesia. Sampling was carried out at 4 stations and each station there were 3 sampling points.

### 2.2 Sampling technique

The collected samples were taken to the Aquatic Biology laboratory, Faculty of Fisheries and Marine Affairs, Riau University, where they were observed using an Olympus light microscope, and chemically analyzed to determine the nature of the peat swamp soil. The tools used in this study were preparations, microscopes, identification books, pipettes, plankton nets, buckets, and sample bottles. The materials used are alcohol, formalin, and pool water.

## 3 Problem Solution

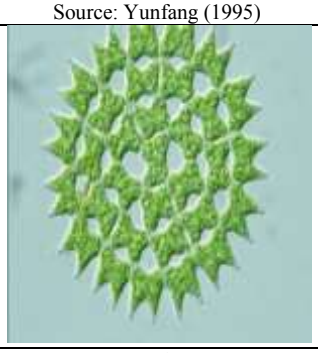
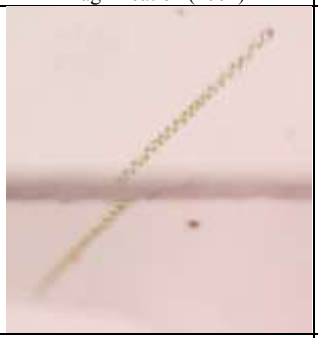
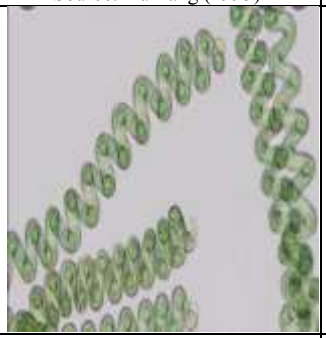
The results of the analysis of samples obtained from the field and after being analyzed in the Aquatic Biology laboratory obtained results that answered the problem of microalgae that live in the waters of fish ponds on peat soil, which are shown in Table 1, Table 2, Figure 1, Figure 2, and Figure 3.

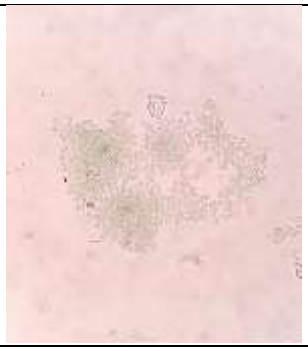
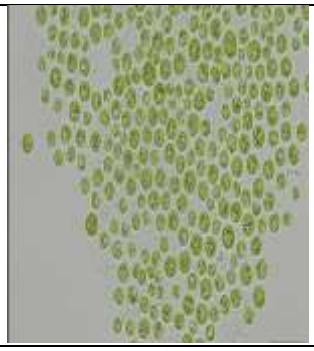
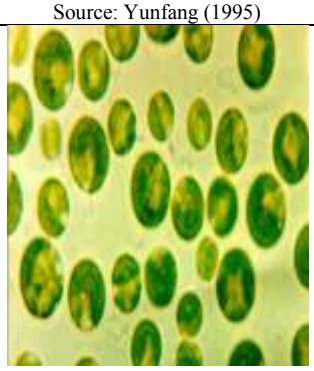
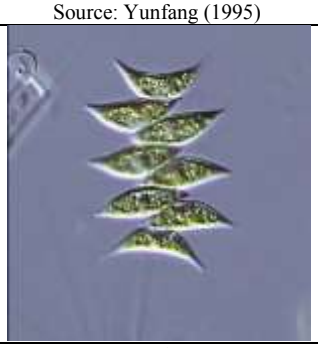
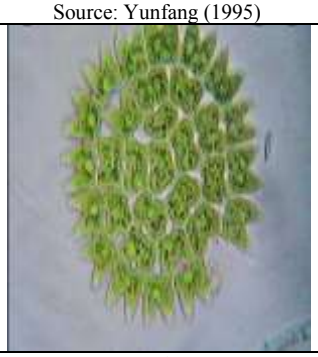
After surveying the research location in fish farming ponds in Pekanbaru City, then a sample collection was carried out. Then the samples were brought to the Aquatic Biology Lab, Faculty of Fisheries and Marine Affairs. Riau University. The results of the identification of microalgae samples from pond waters in Pekanbaru City, the results are shown in Table 1.

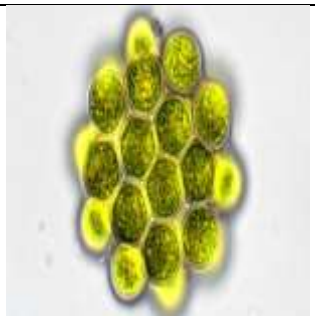
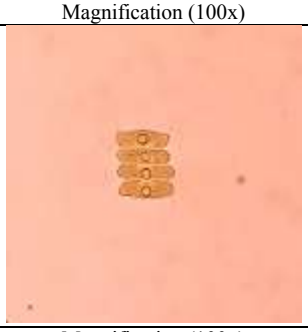
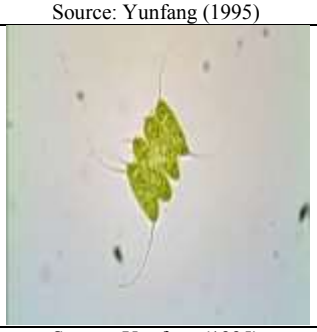
The location of this fish farming land pond is in Pekanbaru city, Riau province is one of the largest peat swamp areas in Indonesia. This peat swamp is widespread in almost all areas of Riau province [1]. Peat swamp areas are generally flat and located between two large rivers. Although it is called flat, this peat swamp land is generally dome-shaped, so there is an elevation difference between the riverbanks and the middle between the two rivers as the peak of the dome. Under certain conditions, it is possible to move water from the top of the dome to the edge of the river. This movement of water allows the peat swamp ecosystem to support life [2].

Such geographical characteristics are closely related to the characteristics of the soil and also the characteristics of the forest vegetation that grows on it. The properties and physical characteristics of peat lands are determined by the decomposition of the material itself. The bulk density of peat generally ranges from 0.05 to 0.40 gram/cm3, where this value is largely determined by the level of weathering of organic matter and mineral content [3]. In Soil Taxonomy [2], peat or Histosols are classified into 4 sub-orders based on the level of decomposition, namely: Folists, Fibrists, Hemists, and Saprists, where the lowest level of decomposition of the folists, while the high

Table 1. Identification of Microalgae in Ponds in Pekanbaru City.

| No | Classification | Observations under a Light Microscope | Image morphology cell sourced from reading material | Description of microalgae |
|---|---|---|---|---|
| 1 | Kingdom : Plantae<br>Phylum : Chlorophyta<br>Class : Chlorophyceae<br>Order : Chlorococcales<br>Family : Scenedesmaceae<br>Genus : Scenedesmus<br>Species : *Scenedesmus quadricauda* |  |  | - Unicellular Cell wall with hemicellulosic and sporopolleninic layers<br>- Cells unite and connect.<br>- Can to move |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 2 | Kingdom : Plantae<br>Phylum : Chlorophyta<br>Class : Chlorophyceae<br>Order : Chlorococcales<br>Family : Scenedesmaceae<br>Genus : Scenedesmus<br>Species : *Scenedesmus obligus* |  |  | - Form flagella isocontae<br>- Bright green<br>- Live in the colony |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 3 | Kingdom : Plantae<br>Phylum : Chlorophyta<br>Class : Chlorophyceae<br>Order: Chlorococcales<br>Family : Scenedesmaceae<br>Genus : Scenedesmus<br>Species *: Scenedesmus dimorphus* |  |  | - Colonize<br>- Cells are elliptical to lanceolate<br>- Thorn |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 4 | Kingdom : Plantae<br>Phylum : Chlorophyta<br>Class: Chlorophyceae<br>Order : Chlorococcales<br>Family : Scenedesmaceae<br>Genus : Scenedesmus<br>Species : *Scenedesmus acuminatus* |  |  | - Shaped<br>- Spiky<br>- Green color |
| | | Magnification (100x) | Source: Yunfang (1995) | |

| | | | | |
|---|---|---|---|---|
| 5 | Kingdom :Plantae<br>Phylum : Chlorophyta<br>Class : Chlorophyceae<br>Order : Sphaeropleales<br>Family : Hydrodictyaceae<br>Genus : Pediastrum<br>Species: *Pediastrum biradiatum* |  |  | - Reproduce asexually by producing autocolonies<br>- The protoplast of each parent cell gives rise to zoospores.<br>- Number of colonized cells<br>- Disc-shaped and marked like a peripheral horn |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 6 | Kingdom :Plantae<br>Phylum : Chlorophyta<br>Class : Chlorophyceae<br>Order : Sphaeropleales<br>Family : Hydrodictyaceae<br>Genus : Pediastrum<br>Species: *Pediastrum duplex may* |  |  | - The flagella are always the same length, called isocontae<br>- Consists of the pigment Chlorophyta A<br>- Food reserves are carbohydrates in the form of flour and protein in the form of pyrenoids<br>- Cell wall is composed of cellulose<br>- It is an order of colonizing Chlorococcales |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 7 | Kingdom :Plantae<br>Phylum : Chlorophyta<br>Class : Chlorophyceae<br>Order: Sphaeropleales<br>Family : Hydrodictyaceae<br>Genus : Pediastrum<br>Species : *Pediastrum duplex var* |  |  | - The body is flat and resistant to drought<br>- Spores form hypnospores<br>- Cells are green, red, and brown<br>- Small in size, unicellular, and have flagella |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 8 | Kingdom : Plantae<br>Phylum : Charophyta<br>Class : Chlorophyceae<br>Order : Desimidiales<br>Family : Closteriaceae<br>Genus : Closterium<br>Species : *Closterium parvulum* |  |  | - Shaped like an elongated sickle<br>- Curved and tapered at the ends<br>- There have chloroplasts so they can photosynthesize<br>- They has many vacuoles at the ends. |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 9 | Kingdom : Chromista<br>Phylum : Chlorophyta<br>Class : Chlorophyceae<br>Order : Chlorococcales<br>Family : Chlorellacea<br>Genus : Chlorella<br>Species: *Chlorella* sp. |  |  | - The cells are spherical in shape and small in size<br>- There have cell walls<br>- This algae has chlorophyll<br>- Includes green algae |
| | | Magnification (100x) | Source: Yunfang (1995) | |

| | | | | |
|---|---|---|---|---|
| 10 | Kingdom : Eubacteria<br>Phylum : Cyanobacteria<br>Class : Cyanophyceae<br>Order : Spirulinales<br>Family : Spirulinaceae<br>Genus : Spirulina<br>Species : *Spirulina* sp. |  |  | - The cells are thread-shaped colonies<br>- The threads are unbranched<br>- Cells are like green beads<br>- Between the cells of the body there are empty cells<br>- Includes green algae |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 11 | Kingdom : Plantae<br>Phylum : Chlorophyta<br>Class : Chlorophyceae<br>Order : Sphaeropleales<br>Family : Scenedesmaceae<br>Genus : Coelastrum<br>Species : *Coelastrum microforum* |  |  | - The cell walls of these organisms are double layered.<br>- This wall layer contains many short projections called papillae.<br>- Binds coenobium cells together with a dividing nucleus.<br>- A vegetative cell exhibits a peripheral disposition and contains a single located ribosomal nucleolus. |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 12 | Kingdom : Eubacteria<br>Phylum : Cyanobacteria<br>Class : Cyanophyceae<br>Order : Chroococcales<br>Family : Microcystaceae<br>Genus : Microcystis<br>Species : *Microcystis aeruginosa* |  |  | - They have small cells<br>- They does not have individual membranes<br>- The color of the protoplast looks dark or brown |
| | | Magnification (100x) | Source: Yunfang (1995) | |
| 13 | Kingdom : Plantae<br>Phylum : Chlorophyta<br>Class : Chlorophyceae<br>Order : Sphaeropleales<br>Family : Scenedesmaceae<br>Genus : Tetrastrum<br>Species : *Tetrastrum Heteracarthum* |  |  | - Live in colonies<br>- They have branches<br>- Divide cells |
| | | Magnification (100x) | Source: Yunfang (1995) | |

Information:

- Personal documentation
- Identification using the Yunfang (1995) manual
- Image source image from Algae Base (www.algaebase.org)

decomposition rate of saprists. Another physical property of peat soil is irreversible drying. Dried peat, with a moisture content of <100% (by weight), cannot absorb any more water when wet [4]. This dried peat has the same properties as dry wood, which is easily washed away by the flow of water and is flammable.

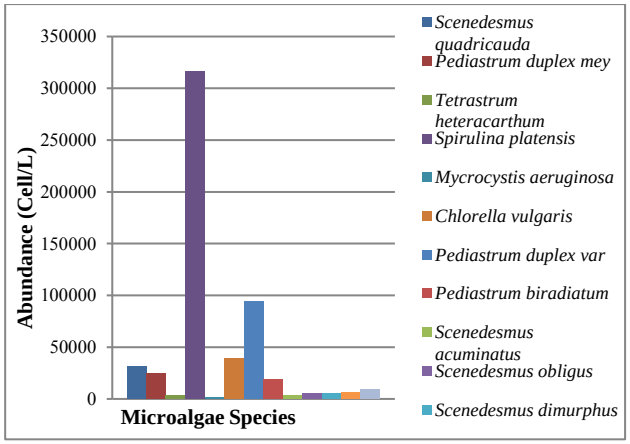



Figure 1. Average abundance of microalgae in fish farming soil ponds in Pekanbaru Cit

Peatlands in Pekanbaru City generally have a high level of acidity with a pH range of 3-5. Oligotrophic peat that has a quartz sand substrate in Berengbengkel, Central Kalimantan has a pH range of 3.25 – 3.75 [5]. Meanwhile, the peat around Air Sugihan Kiri, South Sumatra has a higher pH range between 4.1 to 4.3 [2]. Peatlands naturally have a low fertility level, characterized by pH, and low content of micro and macronutrients. Based on the level of fertility Fresher [6] divides peat into three types, namely Eutrophic (fertile), mesotrophic (moderate), and oligotrophic (infertile). Topogenous peat that is shallow and influenced by groundwater and rivers is generally categorized as mesotrophic to eutrophic, while embryogenic peat that is only affected by rainwater is categorized as oligotrophic [7].

From table 1, the types of microalgae were successfully described and classified during the study. The class Chlorophyceae is a group that is commonly found in the waters of fish farming soil ponds in the city of Pekanbaru. Several previous studies [8] stated that Chlorophyceae is the most abundant group of microalgae living in general waters in Riau Province. Microalgae are microscopic unicellular algae, usually found in freshwater and marine environments and exist individually or in chains or groups [9] – [11]. Microalgae are a very diverse group of organisms, including both prokaryotes and eukaryotes, and spanning 14 phyla with described examples from almost every possible habitat. It is estimated that 200,000 – 800,000 species of microalgae are found widely, of which only about 35,000. Microalgae habitats include freshwater, seawater, soil, and extreme environments [12]–[14].

Based on the highest number of microalgae species found during the study in week 1, week 2, and week 3, it showed that the highest number of species were Spirulina plantensis (316440 Cell/L), Chlorella vulgaris (38748 Cell/L), and Scenedesmus quadricauda (31553 Cell/L). (Figure 3). The types of microalgae found in the waters of this fish farming pond are different from the types of microalgae found by [15], [16], in the waters of the islands of Gumilamo and Magaliho, North Halmahera. He reported that his study found seven genera of diatoms, namely: Chaetoceros sp. with the highest abundance (5,061 cells/L), followed by Nitzschia sp. (611 cells/L), Thalassionema sp. (569 cells/L), Skeletonema sp. (446 cells/L) Coscinodiscus sp. (176 cells/L), Navicula sp. (40 cells/L) and Amphora sp. (11 cells/L).

Based on the results of the analysis of the abundance and dominance of microalgae conducted by previous open researchers [17]–[21], several types of microalgae are abundant and have the potential to be developed as natural feed on a larger scale or industry, one of which is microalgae as a substitute (substitution) sources of carbohydrates and animal protein in artificial feeds for cultured fish. Experts [22]–[26] also stated that based on existing technology, and research that continues to be developed today, the species or genus Chlorella and Spirulina are the most likely types of microalgae for development towards mass cultivation.

However, the use of microalgae as an artificial feed substitute for fish, to support aquaculture activities requires several suitability criteria for the cultivation of the developer, especially the feasibility of the quality of the location or waters in the location to be developed [27]–[30]. Some of the eligibility criteria include the results of direct measurements of the abundance of a type of microalgae in nature, eligibility criteria for physical and chemical properties of soil or water at the location or field, community support, land topography, and supporting facilities [31]–[34]. In the results of this study, almost all of the eligibility criteria have been answered.

Based on Figure 2 above, the highest density of microalgae is, *Spriluna platensis* 33%, Chlorella Vulgaris 29%, and *Scenedesmus quadricauda* 10%.

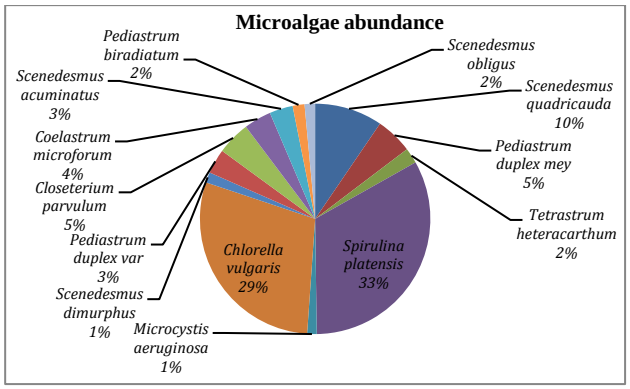



Figure 2. The density of Microalgae from Groundwater Pond Fish Cultivation in Pekanbaru City

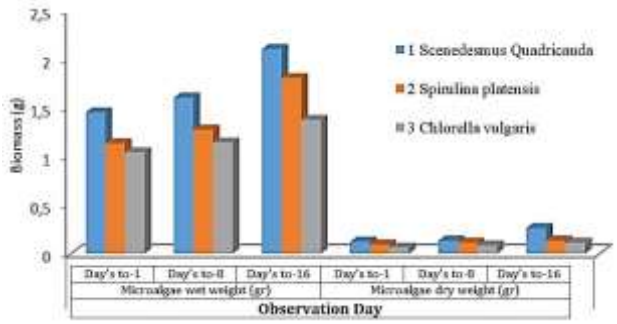



Figure 3. Biomass of the three most abundant types of microalgae from fish farming soil ponds in Pekanbaru City which are cultured on a laboratory scale

The diagram above shows that Scendesmus quadricauda is higher than Spirulina platensis and Chlorella Vulgaris. Meanwhile, the research reports that the microalgae found in the waters of the river and estuary of the Pelangan River consist of 2 divisions, namely the Chrysophyta division and the Chlorophyta division. The total types of microalgae found at all sampling points were 85 species, including 13 species at the point I, 23 species at point II, 7 species at point III, 24 species at point IV, and 18 species at point V. The highest microalgae species diversity index (H'=3,010) was found at sampling point IV, medium category, and also with the highest number of species (24 species) with 77 individuals. The highest total abundance (1,540 ind/L) occurred at sampling point II. While the type of microalgae with the highest abundance was Chlorococcum humicola: 1045 ind/L occurred at sampling point II. At sampling points, I, II, and III based on importance, the dominant species were Chlorococcum humicola and Coscinodisccus lacustris. While at points IV and V, the dominant species was Thalassiotrix fruenfeldii with a dominance percentage of 15.795% and 21.840%, respectively.

Based on the results of the calculation of the highest dry weight biomass of microalgae found in pond waters of fish culture in Pekanbaru City is Scenedesmus Quadricauda 0.26 (gr). The 3 highest types of biomass found were Scenedesmus Quadricauda 0.26 (gr), Spirulina platensis 0.13 (gr), and Chlorella vulgaris 0.11 (gr). According to experts [28], [35]–[39], microalgae are known to have superior characteristics as potential raw materials for commercial biodiesel production. However, it is still hit by the high cost of production when compared to fossil-based diesel fuel. Therefore, various efforts to improve its economic feasibility must be carried out. One of the surefire steps in solving this problem is to maximize the production of microalgae biomass, so that lipid productivity and biodiesel productivity can be increased. Optimization of microalgae biomass production was carried out on four main cultivation parameters, such as supplementation of carbon dioxide (CO2), composition of growth media, optimization of environmental conditions and addition of growth factors/hormones [40]–[44]. Operational microalgae cultivation under optimal conditions will maximize its biomass production until it can finally achieve maximum biodiesel productivity [45]–[51].

Table 2. Results of Water Quality Measurement in Ponds in Pekanbaru City.

| Water Quality | Value range |
|---|---|
| Temperature ($^0$C) | 28,5-29,33 |
| Turbidity (cm) | 18,25-38 |
| pH | 6,00 |
| DO (mg/L) | 2,45-6,53 |
| $CO_2$ Bebas (mg/L) | 3,00-14,98 |
| Nitrat (NO3-) | 0,1-0,3 |
| Fosfat ($PO_4^{3-}$) | 0,005-0,008 |

Based on research reports from other researchers [25],[34],[41],[54], microalgae are photosynthetic microorganisms that utilize carbon dioxide and sunlight to form biomass and produce about 50 percent of the oxygen in the atmosphere. There are four types of microalgae, namely Bacillariophyceae (diatoms), Chlorophyceae (green algae), Chrysophyceae, (gold algae) and Cyanophyceae (blue algae) [52], [53]. Although Indonesia has a high diversity of microalgae, its potential is still not fully utilized. In many countries, microalgae have been used as agents for biofuel production, because microalgae are capable of producing high levels of fatty acids and carbohydrates. Through the

esterification process, microalgae fatty acids can be converted into biodiesel.

The potential of microalgae is very promising to be used as an agent in the production of biofuels in the future because it has advantages in its growth, namely fast, high productivity, does not require a large area of land for breeding, and can use water for growing nutrients [54]. In addition, the use of microalgae as a source of biodiesel does not interfere with the food supply. This is because microalgae do not compete with foodstuffs [35]. Another potential of using microalgae is its ability to use carbon dioxide and convert it into oxygen. This ability can create a clean environment from CO2 gas pollutants so that it can suppress the effects of global warming.

Chlorella Vulgaris is a type of microalgae that is commonly found in Indonesian waters, but its potential for producing biodiesel has not been developed [55]. A local strain of Chlorella Vulgaris has been developed for biodiesel production. Microalgae Chlorella Vulgaris was grown in DG11 medium with a CO2 supply. Optimization of media and fermentation conditions was carried out so that the fermentation could produce biomass with high fatty acid content [56]. The biomass content of microalgae produced in the fermentation process is determined by measuring its optical density, while the content and composition of fatty acids in biomass will be determined by titration and GC-MS methods.

Microalgae Chlorella Vulgaris can be grown well on BG-11 media which contains several mineral mixtures. The growth of this microalgae takes place more optimally when a cell starter with a concentration of 16% (v/v) is used. The local strain of Chlorella Vulgaris biomass can produce lipids with quite high levels, namely 31% (v/v) when extracted with a mixed solvent of n-hexane-ethanol (1:1). Analysis by GC-MS can be seen that the lipid content in Chlorella Vulgaris is composed of dominant fatty acids, namely pentadecanoic acid, hexadecanoic acid, heptadecanoic acid, stearic acid and nonadecanoic acid [22], [57]. Biodiesel production from the microalga Chlorella Vulgaris has been carried out both ex-situ and in-situ. The in-situ process of lipid transesterification in the microalgae Chlorella Vulgaris biomass can produce higher biodiesel yields than ex-situ [58], [59].

In-situ biodiesel production can take place optimally when subjected to ultrasonication at a power of 25 kHz (270W), using n-hexane co-solvent, and with a ratio of biomass to methanol weight of 3:50. The comparison of 3:50 resulted in a higher percentage of biodiesel conversion and biodiesel yield of 20.31% w/w and 3.87% w/w using the sonication method. This in situ process can produce biodiesel of 20.31% w/w. These results can prove that microalgae that are abundant in Indonesian waters can be developed as a source of biodiesel production so that it can help supply alternative energy to fossil fuels. The scale of biodiesel production by pilot plant and industry needs to be supported by the government, either by policy or by providing adequate infrastructure, given its enormous potential.

# 4 Conclusion

From this research, 13 species of microalgae have been found that live in fish culture pond habitat in Pekanbaru City, which consist of Scenedesmus quadricauda, Pediastrum duplex mey, Tetrastrum heteracarthum, Spirulina plantensis, Microcystis aeruginosa, Chlorella vulgaris, Scenedesmus dimurphus, Pediastrum duplex var. , Closeterium parvulum, Coelastrum microforum, Scenedesmus acuminatus, Pediastrum biradiatum and Scenedesmus obligus. The most common type was found in Spirulina platensis (316440 cells/L), and the least common was Mycrocystis aeruginosa (1228 cells/L). The highest density was found in Spirulina platensis 33 %, and the lowest density was in Mycrocystis aeruginosa 1 %. Meanwhile, the order of biomass from the highest to the lowest of the 3 most common types from ground pool waters was Jenensi Scenedesmus quadricauda 0.26 (gr), Spirulina platensis 0.13 (gr), and Chlorella vulgaris 0.11 (gr). Then the water quality parameters recorded in the soil pond include temperature 29oC, pH 6, brightness 21 Cm, dissolved oxygen 3.81 Mg/L, CO2 5.75, Mg/L, Phosphate 0.55 mg/L, and Nitrate 1, 26 mg/L..

Conflict of interest: None.

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