The plankton abundance fluctuation in traditional ponds by the use of organic fertilizer from poultry manure

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Abstract. Fertilizer is required to fertilize the soil and water in order to develop natural food for fish such as klekap and plankton. The aim of this research is to investigate the fluctuation of plankton abundance by the use of organic fertilizer from poultry manure. The research was carried out in ponds in Mondoe Village, South Konawe Regency, Southeast Sulawesi, Indonesia. Chicken manure (1.5 tons) was composted through a fermentation process with the addition of fermented liquid 100 litre consisting of commercial probiotics, sugar and water (ratio 1: 1: 100) given in two stages with an interval of two-three days (volume 70% and 30%). Fermentation occurs in an-aerobic condition where organic matter was covered with plastic. Fertilizer was ready to be used after being aerated and kept about a month. The two hectare pond was given fertilizer, then after pond soil and water had shown discoloration as a sign of growing klekap and plankton, cultured organisms (100,000 vaname shrimp juveniles) were stocked. Water quality parameters were measured every month for three times including the species and abundance of plankton, diversity and evenness index, as well as physical and chemical parameters of water. The highest density of plankton was accounted for by Chaetoceros, followed by Oscillatoria and Protoperidinium. The diversity index for the plankton (H) ranged between 0.718 and 1.712 cell/L across monthly sampling, while the evenness index (E) ranged between 0.327 and 0.714 cell/L. Plankton abundance increased very sharply in the second month to (21,332 cell/L) and provided a source of nutrition for shrimp. The results show that chicken manure compost supports the growth of plankton as well as the growth of shrimp.

Keywords: poultry, by-products, fertilizer, plankton, pond

1. Introduction
Animal protein needs are pursued through husbandry and fisheries. One of the obstacles in the livestock business and aquaculture is the problem of waste. Especially livestock waste where one adult cow can produce as much as 20-30 kg of solid waste and 100-150 liters of liquid waste that has not been well managed. Livestock waste is a major source of noxious gases, toxic bacteria and odor. The discharge of waste from livestock into the environment will have a detrimental impact on public health, as well as the discharge into waters where these waters are used by the community for various purposes of daily life. Therefore, livestock waste should be managed properly to mitigate production of these pollutants in order to protect the environment [1].

The handling and utilization of livestock waste is an innovation in livestock waste management. Considering the high levels of nutrients contained in the feces, the waste can be treated to maintain soil fertility. Micro nutrients contained by livestock waste include Fe, Zn, Bo, Mn, Cu, and Mo [2]. In order to protect the environment, animal waste must be properly managed to mitigate the production of these contaminants. Proper use of poultry waste in the production of biogas, compost and vermicompost can be very useful in agriculture/aquaculture yield and their sustainability [1].
carbon dioxide is a major component in the product gases from thermo chemical conversion processes from livestock waste [3] which can be used for production of algal biomass.

On the other hand, fish production in ponds is largely determined by water fertility. In ponds, fertilization means supplying phytoplankton with photosynthesis nutrients and promoting the growth of phytoplankton by which zooplankton and other aquatic animals are fed for growth. The availability of feed for cultivated organisms is expected to be available in sufficient quantities and continuously during the maintenance period. Therefore, water carrying capacity can be improved by fertilizing. As a result of fertilization, fish growth is strongly correlated with increased productivity of phytoplankton and zooplankton [4].

Generally, fertilizers used in ponds are usually inorganic or synthetic fertilizers, such as urea and TSP or organic fertilizers such as bran and livestock manure [5]. Organic and inorganic fertilizers each have advantages and disadvantages. Inorganic fertilizer was considered more practical in terms of application and the amount of the dosage was much less. Some time ago, inorganic fertilizer was relatively cheaper than organic fertilizer because at that time the price of fertilizer was subsidized by the government. However, the impact of long-term use of inorganic chemical fertilizers is dangerous because the use of a single inorganic fertilizer continuously in the long run will make the soil hard because of sulfate residues and carbonate content contained in fertilizers and soils react to soil calcium which causes difficulty in tillage [6]. In addition, the rising cost of inorganic fertilizer and its scarcity make it difficult for fish farmers to carry out aquaculture activities.

Some areas in South Sulawesi, Indonesia have vast resources of livestock and poultry, by this very potential to utilize all by-products from livestock. It has a very high potential to be used as fertilizer because of the nutrient content in feces. They are dense in organic matter and a high carbon content, while N, P, K, etc. content varies significantly, depending on the characteristics of the feedstock [7]. The results of the study of *L. vanamei* shrimp kept in ponds using organic fertilizers have increased production and reduced the concentration of Ammonia-N. However, the use of inorganic fertilizers has resulted in increased phytoplankton growth but increased nitrogen levels [8]. Other than that, the production of vanname shrimp was higher in the treatment of either inorganic or organic fertilizer when compared to the non-fertilizing pond. This is an indication that the use of organic fertilizers (livestock manures and other agricultural wastes or by-products) may replace inorganic fertilizers in ponds [9].

To strengthen the previous research, this study aimed to analyze the use of poultry manure as an organic fertilizer applied to traditional ponds to trigger phytoplankton growth and increase the growth of vaname shrimp. The research was carried out in the framework of easy and inexpensive livestock waste management that can be done by the community.

### 2. Materials and Methods

#### 2.1 Time and Research Location

This research was conducted from April to September 2019, which consisted of two main stages of activities, namely field and laboratory activities. Field activities included making organic manure, fish/shrimp rearing and water sampling in the earth pond of the farmer community in Mondoe Village, South Pallangga District, South Konawe Regency, SE-Sulawesi, Indonesia. Laboratory activities were plankton observations carried out at the Fisheries Laboratory, Faculty of Fisheries and Marine Sciences, Halu Oleo University, Kendari, Indonesia.

#### 2.2 Research Procedures

##### 2.2.1 Techniques for Organic Fertilizers (OF)

The ingredients used were commercial probiotics, chicken manure, molasses (sugar) and water. Organic matter (OM) in the form of chicken manure was crushed, then put in a decomposer tub. The fermented solution was made by mixing ingredients with a comparative composition, namely: 1 liter commercial probiotics with 100 liters of water and molasses (1 kg of sugar). The water was flushed evenly on OM while stirring, then added OM in layers and doused again, until the height of OM
reached 1 m and covered with tarpaulin. The fermentation process was allowed to last 2-3 days, then OM fermentation was opened to maintain a temperature of 45-60 °C, humidity 40-50%. plastic tarpaulin was opened and the second watering was done with fermented solution while being flipped through evenly and closed again with plastic tarpaulin. The OM reversal process was performed once every 3 days, within 20-30 days, or until the temperature at 45 °C was stable, the manure mixture turns brownish black and the volume shrinks. Then continue with the OF maturation, allowing for 14 days to stand still. The process of OF preparation was complete and ready to use.

2.2.2 Use of Organic Fertilizer Techniques in Ponds
Before the fertilizer was spread, pond preparation was carried out, the floodgate of ponds. Furthermore, eradication of pests, drying and liming pond bottom were done. OF as basic fertilizer was used 1000-2000 kg/ha. OF as a supplementary fertilizer was done when larvae have been spread with dose of 500-750 kg/ha.

2.3 Observed Parameters
2.3.1 Physicochemical water parameters
Measurement of water physicochemical parameters was carried out on the surface of water pond using a tool in accordance with the parameters measured. Parameter measurements were carried out directly in the field. Water physics parameters measured such as temperature and salinity. Water chemical parameters measured by Nitrate, Phosphate, pH, and DO. Measurement of Nitrate and Phosphate parameters were done by taking seawater using a 600 ml sample bottle and then analyzed in the laboratory of the Faculty of Fisheries and Marine Sciences at Halu Oleo University by the Brucin method (SNI 06-2480-1991) and Phosphate analysis with a spectrophotometer.

2.3.2 Enumeration and Identification of Plankton
Water sampling for plankton analysis was carried out by filtering as much as 50 liters of water to the remaining 100 ml by using plankton net no 25. Then the sample was preserved with 2-4 drops of lugol solution. Concentrated preserved plankton specimens were examined in a Sedgewick-Rafter counting cell (SR-cell) under a compound binocular microscope (Olympus) in the laboratory of the Faculty of Fisheries and Marine Sciences at Halu Oleo University. Plankton data were then calculated in phytoplankton abundance using the formula proposed by APHA (1989), the Diversity index (H') was calculated using the Shannon-Wiener index and so was the Diversity index (E) [10].

2.4 Data Analysis
The results of research as tabulated in tabular form and then carried out quantitative descriptive analysis.

3. Results
Some physico-chemical and biological parameters of the water due to the supply of organic fertilizer, which are the main conditions for shrimp growth, were examined in the present study with the following results.
Figure 1. Organic fertilizer that was ready to spread to the bottom of the pond (A). Aquatic plants that grew in ponds after fertilizing and replenishing water.

Figure 2. Physical and chemical parameters of the waters during shrimp rearing. The parameters of temperature, DO and pH were relatively stable while salinity was somewhat fluctuating during rearing period.
Figure 3. Sampling of nitrate and phosphate content in water samples at different sampling times. Nitrate content increases sharply during the second and third months.

Figure 4. The dominant plankton genus found in water pond fertilized by poultry manure.
Figure 5. Plankton abundance in water samples from ponds during shrimp rearing. Plankton overflows significantly in the second month and then decreases in the next sampling.

Figure 6. Plankton Diversity and Evenness Index in organic fertilized pond during the rearing period.
4. Discussion
The use of by-products from animals and plants has now become a practice for some sustainable agriculture and fisheries activities. The reuse of waste is applied to the processing of useful organic matter, which can be used as fertilizers or as modifications to enhance the soil structure. The sustainable transformation of various types of biomass waste have been applied such as animal manure, sewage sludge, municipal solid waste, and food waste, into organic fertilizers [11]. The result of a good OF quality analysis were: odorless, brownish black color, loose texture and it could
grow aquatic plants. Well fermented organic matter at least has nutrient composition containing N, P, K, and does not contain harmful ingredients. Hence, fertilizer could grow aquatic plants optimal with the nutrients they provided (Fig. 1).

Physico-chemical data of waters in the earthen pond fertilized with organic fertilizer generally showed several parameters that were classified as normal (Fig. 2). Based on the results of temperature measurements during sampling ranged from 29-32°C. The highest water temperature occurs in sampling II with a temperature of 32°C. The high temperature of the time is influenced by the conditions of the waters that are quite shallow and directly influenced by sunlight. In addition, the high turbidity level also affects the high temperature at the station because the suspended solids contained in the water can absorb heat so that the water temperature becomes high [12].

Based on the results of salinity measurements during the study had a range between 28-42 ppt. The highest salinity occurred in sampling II because the temperature at that time was quite high and did not have a direct influence from rainfall. While in sampling III, salinity began to decline because a few days before the sampling was done, it had rained even though with a small frequency. This is consistent with the statement [13], that salinity is influenced by patterns of water circulation, evaporation, rainfall and river flow.

Salinity is one of the limiting factors for limiting and the life of plankton, where appropriate salinity will be a shelter for young organisms (larvae or juveniles) [14]. Usually this happens in estuarine areas because this area has a fairly low salinity due to the many river mouths that flow there and the high rainfall throughout the year. Optimum growth of phytoplankton is at salinity 25-40%, with a temperature of 25-30°C.

The results of measurements of the average water pH in the waters of pond during the study ranged from 8.16-8.24. The pH value of the water is still in the normal and relatively stable range because the values do not stick far apart. Under normal pH conditions, nutrients will still be available in these waters, because under these conditions decomposition activities by microorganisms will continue, mainly nitrates derived from the denitrification process.

The result of denitrification which is nitrate is needed in the life of phytoplankton, so that the nitrate content will affect the abundance of phytoplankton. This is consistent with the statement of [15], who stated that the presence of nutrients in water can indirectly be affected by changes in pH values. If the pH value in water is acidic, it means that the dissolved oxygen content is low. This will affect the activities of microorganisms in the process of decomposition of organic matter. One of them occurs denitrification process which is a microbiological process where nitrate and nitric ions are converted to nitrogen (N2) molecules.

The value of dissolved oxygen (DO) measured during the study ranged from 5.3-6.5 mg/l. The concentration of dissolved oxygen in water mostly comes from the atmosphere, but is strongly influenced by biological activity. In addition, the source of dissolved oxygen in the waters also comes from the results of photosynthesis, the influence of currents and diffusion from the air [16]. Based on quality standards. No. 5/MENKLH/2004 the range of DO values obtained at all sampling shows that the waters of pond are still within reasonable limits for the life of aquatic biota, especially plankton which range > 5 mg/l.

The results of measurements of the average nitrate content in shrimp ponds during the study were not much different, ranging between 0.002-0.017 mg.L-1 (Fig. 3). The first month of nitrate sampling was the lowest because of the condition of the water that was still starting to react with nutrients contained in the subgrade. A good range of nitrates for phytoplankton growth is in the range of 0.9-35 mg/l and concentrations below 0.10 mg/l or above 45 mg/l nitrate will be a limiting factor. The range of nitrate content obtained in this study was in the range of nitrate content which is classified as poor for phytoplankton growth [17].

Phosphat e is very useful for organism growth and is a factor that determines the productivity of waters. Phosphate can be used as a parameter to detect water pollution. Based on research conducted phosphate content contained in the waters of pond, ranging between 0.0077-0.01 mg/l. The value of the phosphate content was still in the poor range. This is consistent with the statement [9] states that
the optimum content for phytoplankton growth is 0.091-1.80 mg/l and is a limiting factor if the value is below 0.02 mg/l.

The three highest density of plankton was accounted for by *Chaetoceros*, followed by *Oscillatoria* and *Protoperidinium* (Fig. 4), while the smallest number was zooplankton Copepoda. The results of the analysis for phytoplankton abundance in the first month are still low (165 cell.L⁻¹), but increased very sharply in the second month (21,332 cell.L⁻¹), then the abundance decreased dramatically in the third month (1,008 cell.L⁻¹) (Fig. 5). Differences in abundance analysis results obtained at each sampling time due to the natural food which is the main food from farmed shrimp has diminished. Plankton provide a source of nutrients consumed by shrimp to grow. There was a significant decline in the number of planktons immediately two months after the ponds were stocked with shrimp post larvae. In addition, each month also changes the physical and chemical conditions of the waters were different. This is in line with the statement of [18] who states that the phytoplankton abundance increased in both tanks/ponds with the fertilization treatments. The composition and distribution of phytoplankton will change at various levels in response to changes in environmental conditions; physically, chemically and biologically. One of the environmental factors that affect the abundance of phytoplankton is nutrient, nitrate as the limiting factor.

In general, based on the results of phytoplankton abundance in the study sites referred to in eutrophic waters or high fertility levels, this is in accordance with the statement of [17], that oligotrophic waters have an abundance of phytoplankton between 0-2,000 cell.L⁻¹, mesotrophic waters have an abundance of phytoplankton from 2,000-15,000 cell.L⁻¹ whereas eutrophic waters have an abundance of phytoplankton> 15,000 cell.L⁻¹.

The diversity and evenness index are index which often used to estimate an aquatic environmental condition based on biological conditions. This relationship is based on the fact that unbalanced environmental conditions will also influence an organism that lives in a waters [10].

The results of the diversity index calculation in between sampling in the first month and second month decreased significantly, the decline continued until the third month. During the study, the diversity of phytoplankton ranged from 1.71-0.72 cell.L⁻¹ (Fig. 6). Based on the Shannon-Wiener index in [10], this diversity was relatively low.

The analysis results for evenness were also the highest in the first month sampling (0.71 cell.L⁻¹), and so on decreased until the third month of sampling (0.32 cell.L⁻¹). This shows that uniformity at each sampling tends to be uneven or has a low level of evenness. According to [18], that if the value of (E) approaches 1 then the distribution of individuals of each species tends to be evenly distributed or has a high level of evenness.

The results of the present study show that average gain in body weight and total length of the shrimp showed optimal growth, especially in the measurement of average weight (13,024 g) for 75 days (Fig. 7 and 8). This is in line with [19] that normal shrimp growth as in vannamei shrimp culture is generally 16-18 g at 100 days. These results are also in confirmatory with those of [4], who studied of carp fish species in earthen ponds through polyculture system fertilized with cow dung and TSP, they reported that the primary productivity has increased and finally caused a significant increase in fish yield.

5. Conclusion
The fertilization of ponds with organic fertilizer made from fermented poultry manure can be presumed to establish favorable conditions for the growth of phytoplankton and zooplankton, thereby increasing the growth of shrimp well.

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