Effect of differences in cocopeat, hydroton, and husk charcoal as an eggplant planting medium (*Solanum melongena*) on the absorption of ammonia (NH$_3$), nitrite (NO$_2$) and nitrate (NO$_3$) dumbo catfish (*Clarias* sp.) water cultivation in aquaponic system

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Abstract. Dumbo catfish known as freshwater commodity which its culturing has been done throughout every region in Indonesia. Compared to other freshwater commodity, dumbo catfish has a fairly higher nutrient content, higher economical value, faster growth and easier maintenance. There are various ways to culture dumbo catfish, one of them is by using aquaponic system, which described as a combination of hydroponic and aquaculture in closed water recirculation system. Aquaponic system uses various type of planting media for filtering water, so that ammonia and nitrite are reduced then modified as nitrate, where nitrate absorbed by plants. This study uses 3 different media: cocopeat, hydroton, and husk charcoal. This study aims to investigate whether three previous media can absorb ammonia, nitrite, and nitrate in dumbo catfish culturing using aquaponic system, also figuring out the most effective one. This study uses RAL method with 4 treatments: control (P0), cocopeat (P1), hydroton (P2), husk charcoal (P3) repeated 5 times. The main parameter are ammonia, nitrite, and nitrate, then analyzed using ANOVA. The result showed 3 different media absorbed ammonia, nitrite, and nitrate significantly, with husk charcoal as the most effective media with ammonia, nitrite, and nitrate level 0.59 mg/L, 0.37 mg/L, and 4.99 mg/L respectively.

1. Introduction
Dumbo catfish is one type of freshwater fish that is easily cultivated almost throughout the region of Indonesia. The advantage of Dumbo catfish compared to other freshwater fish is to have a fairly high nutrient content, economical value, fast growth and easy maintenance [1]. Nutrient content of Dumbo catfish among others 4.5% fat, 17.7% protein, 1.2% minerals, 0.3% carbohydrate and 113 kcal energy [2]. Cultivation of Dumbo catfish intensively produces waste derived from feces and residual fish feed as well as decreased oxygen levels. The intensively cultivated Dumbo catfish can lead to decreased oxygen levels in water and the increased waste of excretion due to high dispersion solids. Such waste can cause a decrease in water quality that affects the physiological process, behavior, growth and mortality of fish [3].

A technological innovation is needed for water quality management and improving productivity due to the depreciation of cultivated land. One of the technological innovations applied is the merging
of fish farming with plants through the aquaponic system. The aquaculture system is a combination of planting crops and cultivating fish in a container. The plant serves as a filter of the cultivated waste water reutilized for fish cultivation [4]. The principle of aquaponic technology is reducing ammonia by absorbing cultivation by using plant roots. This makes the water quality of dumbo catfish cultivation will be better, save water and land use and increase the efficiency of cultivation business.

The plants commonly used in the aquaponic system are vegetable and fruit plants. Vegetable plants can be chosen as an alternative to be planted on the aquaable system so far in this study using eggplant plants. Eggplant (Solanum melongena) is a type of vegetable that is very popular and much liked by Indonesian people. Eggplant contains nutrients that are quite high especially the content of vitamin A and phosphorus, so it is potential to be developed as a contributor to the diversity of nutritious vegetable ingredients for the Indonesian population. In addition, eggplant fruit contains high fiber so it is good for digestion, heart health, depresssing cholesterol and diabetes [5].

One of the factors that can support the success of the aquaponic system is the presence of planting media that is suitable for plant growth. Planting media is also used plants as a place to hold the roots, so that the plant can be firmly upright standing above the media and as a means to support the plant [6]. A good planting medium must meet certain requirements such as not containing seed pests and diseases, able to accommodate water, but also able to remove or drain excess water [7]. In addition the condition of good planting medium is lightweight, easy to get, crumbly and lush (rich in nutrients) [8].

2. Materials and methods
2.1 Research Location
The research locations are in Anatomy and Cultivation Laboratory of Fisheries and Marine Faculty, Airlangga University.

2.2 Tools and Materials
Tools needed are 20 aquarium, thermometer, pH meter, DO meter, ammonia test kit, water pump, aerator, aeration interval, spectrophotometer, digital scales, ruler, netpot. Then the materials are dumbo catfish seeds, pellet feed, eggplant plants, planting media of cocopeat, hydroton and husk charcoal.

2.3 Data Analysis Method
The research method is experimental with 4 treatments of Control, Planting Media Cocopeat, Hydroton and Husk Charcoal, and 5 replications with RAL. Treatment with 8 eggplant plants with a spacing of 10 cm in each treatment. Eggplant plants are placed on the net pot. This study uses the determination of treatment with a density of 14 catfish/24 catfish stocking, this calculation is calculated based on the literature that is 1 tail/1.7 L. The range of good stocking density for Africould catfish is 400 fish / m² to 2,400 fish / m² so that Africould catfish grow optimally.

3. Result and discussion
Calculation of ammonia, nitrite, nitrate, water quality and plant growth for 30 days using three different types of planting media namely cocopeat, hydroton and charcoal are obtained results on each week that can be seen in tables 1, 2, 3, 4 and in Figure 1.

Table 1. Ammonia levels during research

| Treatment | 1st week | 2nd week | 3rd week | 4th week |
|-----------|----------|----------|----------|----------|
| P0        | 0.35±0.09| 0.56±0.04| 0.72±0.02| 0.82±0.02|
| P1        | 0.33±0.02| 0.42±0.02| 0.66±0.04| 0.72±0.04|
| P2        | 0.32±0.02| 0.42±0.02| 0.59±0.06| 0.62±0.02|
| P3        | 0.30±0.03| 0.35±0.03| 0.45±0.03| 0.59±0.02|
Table 2. Nitrite during research

| Treatment | Time Examination | Time Examination | Time Examination | Time Examination |
|-----------|------------------|------------------|------------------|------------------|
|           | 1st week         | 2nd week         | 3rd week         | 4th week         |
| P0        | 0.25±0.05        | 0.41±0.04        | 0.60±0.07        | 0.65±0.03        |
| P1        | 0.23±0.07        | 0.36±0.04        | 0.42±0.02        | 0.52±0.02        |
| P2        | 0.21±0.04        | 0.26±0.04        | 0.33±0.02        | 0.43±0.02        |
| P3        | 0.18±0.02        | 0.23±0.02        | 0.30±0.03        | 0.37±0.02        |

Table 3. Nitrate during research

| Treatment | Time Examination | Time Examination | Time Examination | Time Examination |
|-----------|------------------|------------------|------------------|------------------|
|           | 1st week         | 2nd week         | 3rd week         | 4th week         |
| P0        | 3.09±0.13        | 3.18±0.02        | 3.37±0.06        | 3.70±0.05        |
| P1        | 3.12±0.06        | 3.38±0.02        | 3.60±0.02        | 3.96±0.04        |
| P2        | 3.15±0.03        | 3.66±0.04        | 4.14±0.03        | 4.94±0.04        |
| P3        | 3.18±0.10        | 3.94±0.04        | 4.61±0.02        | 4.99±0.04        |

Table 4. Average water quality during research

| Parameters | Control | Cocopeat | Hydroton | Husk | Charcoal | Optimum value | Reference |
|------------|---------|----------|----------|------|----------|---------------|-----------|
| Temperature (°C) | 27.1-28.3 | 27.2-28.5 | 27.2-28.5 | 27.2-28.6 | 25-30°C | [9]          |
| Dissolved Oxygen (mg/L) | 3.10-5.74 | 3.20-5.81 | 3.45-5.91 | 3.31-5.95 | >3.0 mg/L | [10]        |
| pH         | 7.1-7.7  | 7.2-8.0  | 7.2-8.0  | 7.4-8.0 | 6.5-8.0  | [11]         |

Figure 1. Eggplant growth during research

The aquaponic system reduces ammonia by absorbing aquaculture or wastewater by using plant roots so that ammonia is absorbed by the aid of oxygen and bacteria. In aquaculture activities with no water turnover, bacteria play an important role in reducing ammonia levels through nitrification process [12]. The process of nitrification occurs in two phases, namely the first phase of the decomposition is
carried out by bacteria and decomposition of the second stage of Nitrobaclter bacteria. Nitrosomonas bacteria play a role in transforming ammonia (NH₃) which is contained in the irrigation into nitrite (NO₂⁻), after which the nitrite will be recomposed by Nitrobaclter bacteria into nitrates (NO₃⁻) [13].

Based on observing ammonia levels are still in its normal status. It is in accordance with the statement [14], ammonia on the water should be less than 1,0 mg/L. During the observation of the highest ammonia levels occurring in the last sampling means that the longer the maintenance time the higher the ammonia levels are produced. It is in accordance with the statement [15], ammonia levels during the maintenance of fish will increase as the time of maintenance increases. The decrease in ammonia levels with different values on each treatment is due to the treatment of different planting media, each planting medium has different characteristics of different planting media capability in eggplant will affect absorption of nutrients. The cultivation of the plant in absorbing ammonia can decrease as the pests affect the crop and the higher the concentration of ammonia [16].

Nitrite is one form of inorganic nitrogen in water. Ammonia is oxidized to nitrite in nitritation performed by bacteria Nitrosomonas [17]. Based on the observation of nitrite levels is still in normal status. In accordance with the statement [18], nitrite on the water should be less than 1,0 mg/L. Nitric levels that pass through the threshold of irrigation can result in poisoning in fish marked with limb fish [19]. Nitrite levels in each treatment tend to increase due to the uneaten feed by fish and the presence of Nitrosomonas bacteria that have a function in oxidizing ammonia into nitrite does not work optimally resulting in the process of nitrification obstructed. It is in accordance with the statements of [20], that the environmental factors that do not support will inhibit the growth of Nitrosomonas bacteria in the water so that there is accumulation of nitrite. Consequently, there will be a decrease in water quality in indications by changing the color of water into murky, very low oxygen value and physiological changes in fish such as unstable swimming, loss of appetite until fish growth becomes obstructed [21].

Nitrate is an important nutrient for the growth and metabolism of phytoplankton which is an indicator for evaluating the quality and level of water fertility [22]. Nitrate comes from the oxidation of ammonia to nitrate by bacteria Nitrobaclter [19]. The main source of nitric nutrient is derived from the waters itself that is through the process of decomposition of weathering or the decipherment of plants and remnants of dead organisms [23]. Based on observations of nitrate is still in normal levels. In accordance with the statement [24], nitrate in the water should be less than 10 mg/L. Plants on the aquatic system provide the role of biofiltering by utilizing nutrients derived from cultivation waste. According to [25], nitrate is absorbed by the plant through the roots as a natural fertilizer for growth. Increased levels of nitrate in the water caused by the accumulation of nitrate in the waters due to nitric content that is not fully utilized by the plant thereby causing the process of nitrification of ammonia by nitrobacter bacteria can occur [26].

These results are supported by supporting parameters in this study, namely water quality and the growth of eggplant during the maintenance of the aquaculture system. The result of water quality obtained from each treatment shows optimal value. The temperatures in the P0, P1, P2 and P3 treatments during the study showed results ranged from 27.1°C to 28.6°C. The temperature value during observation can be said to be optimal for Dumbo catfish growth. It is in accordance with the statement of [27], the optimal temperature for the growth of Dumbo catfish ranges from 25-30°C, when the water temperature drops below 20°C then the growth and reproduction of fish will be hampered and cause disease. Dissolved Oxygen (DO) on the treatment of P0, P1, P2 and P3 during the study showed results ranged from 3.10 to 5.95. The dissolved oxygen value (DO) during observation can be said to be optimal for catfish growth. It corresponds to the statement [10], the optimal dissolved oxygen (DO) for the growth of Dumbo catfish is more than 3 mg/L. The pH in the P0, P1, P2 and P3 treatments during the study showed results ranged from 7.1 to 8.0. The acidity degree value (pH) during observation can be said to be optimal for Dumbo catfish growth. It corresponds to the statement [11], the optimal acidity (pH) degree for Dumbo catfish growth is 6.5-8.5.

Water quality affects the provider of nutrients for plants, if the nutrients are satisfied then the productivity and growth of plants will also be maximal. Provider of nutrients for plants that are
nitrogen that can be obtained from nitrate, which is the result of ammonia reshuffle from the rest of feed and feces. In addition, the planting media has a function that is binding nutrients that plants can use when it lacks nutrients to grow [28]. Nitrogenous dirt is degraded in water resulting in ammonia and nitrite with the help of bacteria then produce nitrates attached to the planting media further utilized by plants. Plants describe organic or bacterial substances as well as toxic substances that are produced and can be beneficial to improve water quality. Good quality of water and optimal environment to make fish is comfortable so that the survival rate and growth rate increases [29].

The growth of eggplant during the study has increased every day. The observed parameter of the eggplant is the length of the beginning and end crops as well as the number of early and late leaves from the maintenance period. Results obtained from the measurement of length and the number of leaves of eggplant is increased in each treatment, this is due to the process of absorption of nutrients by the planting media that has a different absorption rate so the utilization of nutrients for the growth of eggplant will also be different [30].

4. Conclusion
The planting of cocopeat, hydroton, and husk charcoal has a difference in the absorption of ammonia (NH$_3$), nitrite (NO$_2$) and nitrate (NO$_3$) with the optimal value for planting husk charcoal with the value of ammonia (NH$_3$) of 0.59 mg/L, nitrite (NO$_2$) of 0.37 mg/L and nitrate (NO$_3$) of 4.99 mg/L.

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