ENGINEERING FACTORS AFFECTING THE PRODUCTIVITY AND QUALITY OF INTENSIVE FISH FARMS

By

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B.Sc. Agric. Sc. (Agric. Engineering), Suez Canal University, 2010.

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ABSTRACT

Ahmed Mohammed Ragab: Engineering Factors Affecting the Productivity and Quality of Intensive Fish Farming. Unpublished M.Sc. Thesis, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, 2016.

The main objective of this work is to study the effect of fish tank design parameters on water flow pattern inside the tank, and then the impact on the distribution and homogeneity of water quality parameters (Dissolved Oxygen) within fish tank, which is consequently reflected in fish productivity. The work is divided into two parts: First part was devoted to choose the number and diameter orifice entering the water to the fish tank in order to maintain the rotational velocity of water suitable for fish. While, the second experiment was carried out to study the effect of diameter: depth (geometric shape) ratio on the water movement and the impact on the distribution of the dissolved oxygen and fish productivity.

We concluded from the first experiment the optimum number of holes (5,10,15,20,25 and 30 with a hole diameter of 10 and 15 mm and 3,6,9,12 and 15 with a hole diameter of 20 and 25 mm which give rotational velocities inside the optimum range to be suitable for tilapia fish at a specific flow rate (5,15,30,45,60 and 75 m^3) with respect to hole diameter (10,15,20 and 25 mm).

The obtained results indicated that the rotational velocity and dissolved oxygen homogeneity were obtained in the first tank of 4:1 diameter: depth ratio. The mean weight of fish increased from 18 to 148, 136 and 114 g after 14 weeks with the diameter: depth ratios 4.0, 6.4 and 8.0, respectively. The average weight gain of fish increased from 2 to 21, 8 to 13 and 3 to 6 g after 14 weeks with the diameter: depth ratios 4.0, 6.4 and 8.0, respectively. The specific growth rate ranged from 0.99 to 6.00, 0.39 to 5.25 and 0.17 to 5.10 % day^{-1} at 4.0, 6.4 and 8.0 diameter: depth ratios. The feed conversion rate ranged from 0.68 to 3.53, 0.88 to 10.91 and 0.93 to 18.51 kg feed/kg fish at 4.0, 6.4 and 8.0 diameter: depth

ratios. The feed efficiency ranged from 0.28 to 1.46, 0.11 to 1.13 and 0.05 to 1.39 at 4.0, 6.4 and 8.0 diameter: depth ratio. The mean daily mortality rates were 0.048, 0.058 and 0.064 % at 4.0, 6.4 and 8.0 diameter: depth ratios, respectively.

Keywords: Rotational velocity, Geometric shape, Recirculating aquaculture, Dissolved oxygen, Tank geometry, Closed system.

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INTRODUCTION

The Egyptian aquaculture sector has witnessed rapid expansion over the past two decades. As a result, farmed fish production increased from 139,389 tons in 1998, representing 25.5 % of total Egyptian fish production, to 1,017,738 t in 2012, where aquaculture production comprised 74 % of total fish production **(GAFRD, 2014)**.The area being farmed increased from 42,000 hectares (ha) in 1999 **(El-Sayed, 1999)** to 120,000 ha in 2012 **(GAFRD, 2014)**. Aquaculture expansion in Egypt has been developed gradually from extensive and semi intensive to more intensive **(El-Sayed, 1999)**. Aquaculture is considered the largest source of fish supply in Egypt, almost 65% from the total fish production with 99% from private production. The most used aquaculture systems in Egypt is the semi-intensive and most of farms are located in Delta region. Nile tilapia (*Oreochromis niloticus*) is most cultured fish species in Egypt and one of the ten native species.

One of the main challenges for sustainable aquaculture is the rational use of resources, mainly water and space. To fulfil this aim, aquaculture production units should be designed to use a minimum rearing volume in which fish can be kept under the best conditions for growth, ensuring fish welfare and minimum resource consumption. These can be achieved when a tank provides uniformity of rearing conditions, favouring a homogeneous fish distribution that consequently guarantees an optimal use of the entire rearing volume.

Tanks used for intensive fish culture are of varied shape and flow pattern. Tanks are designed with considerations for production cost, space utilization, water quality maintenance, and fish management. Circular tanks are the most attractive tank shape for the following reasons: simple to maintain, provide uniform water quality, allows operating over a wide range of rotational velocities to optimize the fish health/condition, settleable solids can be rapidly flushed through the center drain and

permit designs that allow for visual or automatic observation of waste feed to enable satiation feeding**.**

Tank design which adapts to the way certain species behave and swim can aid in reducing stress levels and improving fish welfare, which in turn contributes to enhancing fish growth. Moreover, homogeneous water quality makes it possible to take further advantage of the entire rearing volume, the water flow and the oxygen added to the water. This ensures that all areas of the tank provide optimum rearing conditions.

Therefore, the main objective of this work is to study the effect of fish tank design parameters on water flow pattern (rotational velocities), and then the impact on the distribution of water quality parameters (Dissolved Oxygen) within fish tank, which is consequently reflected in fish productivity. This could be achieved by:

- Studying the effect of diameters and numbers of holes on the rotational velocity with respect to specific flow rates.
- Studying the effect of diameter: depth ratios on the water movement and the impact on the distribution of the rotational velocity, dissolved oxygen and tank productivity.