Survival rate and growth rate of milkfish (*Chanos chanos*, Forsskal 1775 ) seeds in the acclimatization process at Ir. H. Djuanda Reservoir

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Abstracts. Milkfish is one of the important economical fish species that usually lives and cultivated in estuarine areas. However, milkfish can adapt to habitat with salinity ranging from 0 - 40 ppt. Therefore, milkfish is a potential choice of introduced fish in freshwaters. This study aims to determine the survival rate and growth rate of milkfish seed in the waters of Ir. H. Djuanda Reservoir. H. Djuanda. The study was conducted experimentally in November – December 2017, every week for five weeks in floating net cages with a size of 7 x 3 m and depth 0.75 m at Ir. H. Djuanda Reservoir with three treatments of densities that are 4,000; 6,000 and 10,000 seeds. The size of milkfish seeds used was 3-5 cm because it was able to adapt in freshwaters. The milkfish was cultivated by the extensive system without a commercial feed so they only use natural food. The results showed that the number of dead milkfish increased with increasing density and the highest mortality occurred on the day 7th in 10,000 density treatment. The milkfish seed mortality began to decrease on the day 9th of the trial and the deaths did not occur again on the day 19th-21st. The highest survival rate was 79.21% for 6,000 densities. The smallest estimated investment was 10,000 densities, but it has the largest losses due to seed death. Because the condition was dense, there was competition for food, oxygen, and space. Therefore, seed acclimation is carried out in stages.

1. Introduction
Milkfish are euryhaline fishes, which can adapt in low to very high salinity range. Milkfish is a type of fish that grows rapidly and tends to be disease resistant [1]. Adult milkfish with sizes around 50 - 150 cm able to be fast and strong swimmers. During breeding, milkfish tend to go to the beach more often, especially in corals and sandy [2]. Juvenile and adult milkfish can survive in freshwater, which means that milkfish can be cultivated or introduced in lake or reservoir waters [1].

The introduction of fish is one of the efforts that can be done to increase fish stocks in the mainland waters through manipulation of the structure of the fish community [3]. Non-predatory fish stocking does not hurt native species and results in increased fishery production in these waters [4]. Fish stocking is not only aimed at increasing fish production, but also an effort to improve the environment [5]. The ability of scattered fish to consume plankton as its natural food will determine the success of environmental improvement. Besides, the factors that determine the success of environmental improvement by stocking are stocked fish biomass [6]. This has an impact on aquatic productivity,
chlorophyll-a concentration and water turbidity [7]. The spread of milkfish in Laguna Bay, Philippines is carried out because milkfish is a plankton feeder and Laguna Bay is a high eutrophic water of plankton production so that milkfish can utilize plankton that is not utilized by the native fish of waters [8].

Milkfish generally live in waters with temperatures over 20°C. Broodstock will spawn at the age of 5-7 years with a salinity of 29 ppt in seawater. Total length ranging from 65-85 cm and weighing 4-6 kg, generally have become mature gonads. The maximum length of female fish reaches 124 cm and male fish reaches 180 cm. Fecundity of milkfish ranges from 100,000 to 400,000 per kilogram of body weight with a diameter of 1.1-1.2 mm. In the Philippines, milkfish are cultivated in cages with a density of 20-30 individual/m² can result in 2.4 to 3.6 tons or 40-60 tons/ha/year for 600 m³ of cage size [9].

The growth rate of milkfish in the sea cages is relatively fast at around 1.7 - 2% per day [10]. Milkfish fry showed 3-32% survival on detritus fed and 40-60% on natural plankton as feed [2]. The survival rate in the polyculture system of shrimp and milkfish (30 individual of white shrimp and 30 individual of milkfish per m²) was 75% [11]. Growth and production of milkfish juveniles in a nursery pond with supplemental feeding have survival rate 86, 9% and daily weight gain of 0.14 g/day with a specific growth rate of 4.96%/day [12].

The acclimatization treatment in milkfish introduction activity which has brackishwater native habitat is needed to reduce the rate of seed death due to sudden changes in water quality and stress due to transportation. This study aims to determine the survival rate and growth rate of milkfish seeds during the acclimatization period at Ir. H. Djuanda Reservoir.

2. Methods

The study was conducted by experimental research at a floating net cage in Ir. H. Djuanda Reservoir in November - December 2017. Milkfish seeds come from the hatchery at Karawang with a size of 3-5 cm. The study used a completely randomized design with one treatment factor, namely milkfish seeds density. The stocking density of milkfish cultivation as a consumption target is 400 individual/m³ [10]. Hence used three density treatments namely (1) 4,000; (2) 6,000; and (3) 10,000 seedlings. Each treatment had three replications and without commercial feed. Milkfish seed feed is a natural food found in waters as microphytobenthos that grow in a waring net or is called Klekap. Milkfish can grow well and faster in the pond where a lot of klekap (microphytobenthos and their associated meiofauna) because they like to eat it and other associated meiofauna. Klekap becomes good natural feeding for milkfish. Klekap is consisted of some microalgae and benthic fauna such as Oscillatoria, Phormidium, Lyngbya, Spirulina, Navicula, Nitzschia, Amphora, Odontella, Cocconeis, Achnanthes, Pleurosigma, Protozoa (Zoohamnium, Vorticella, Epistyli, Acineta), bacteria, Rotifera, and Anelida [13,32]. Klekap forms a sheet of brown, greenish-brown, yellowish-green, or bluish-green, depending on the type and percentage of its constituent algae [15]. The waring type was used as the floating net cage with 7 m of length, 3 m of width, and 0.75 m of depth. Milkfish seeds that come from the hatchery in brackish waters with 16 ppt of salinity and 4 ppt of salinity were packed in plastic. Therefore it is necessary to have an acclimatization process in freshwater. The number of dead milkfish seeds was noted every day by enumerator.

Observation of water quality
Observation of water quality was done every week with the parameters of dissolved oxygen, temperature, pH, and chlorophyll-a. Oxygen and temperature were observed using an oxygen meter. The sampling of chlorophyll-a using Kemmerer Water Sampler at 1 m of depth. The water sample was put into a sample bottle and preserved with 1 mL of MgCO₃ solution. Subsequently, the samples were analyzed at the water quality Laboratory of the Research Institute for Enhancement Fish Resources by the Trichometric method [33].

Determination of Survival Rate
The Survival Rate (SR) can be calculated using the formula [16], namely:

$$SR = \frac{N_0}{N_t} \times 100\%$$

Explanation:
- **SR** = survival rate (%)
- **N_t** = number of the end stocking (individual)
- **N_0** = the number of initial stocking (individual)

**Determination of growth rate**

The growth rate (GR) of weights and the length of the milkfish seeds according to the following formula [14]

$$GR = \frac{W_t - W_0}{t} \times 100$$

Explanation:
- **GR** = weight or length growth rate (g/day or mm/day)
- **W_t** = final average weight or length (g or mm)
- **W_0** = initial average weight or length (g or mm)
- **T** = time (day)

3. Results and Discussion

Water quality of floating cage for milkfish seed at the acclimatization process in Ir. H. Djuanda Reservoir is presented in Table 1. Milkfish can be introduced into freshwaters (for example lakes or reservoirs). However, natural mortality is still high (36% within three days after stocking) due to poor acclimatization process [17].

| Weeks | Dissolved oxygen (mg/L) | Chlorophyll a (mg/m³) | Water temperature (°C) | pH |
|-------|-------------------------|-----------------------|------------------------|----|
|       |                         |                       |                        |    |
| 0     | 4.29                    | 4.03                  | 3.58                   | 4.29 | 3.58 | 15.85 | 14.18 | 11.80 | 29.5 | 29.6 | 29.6 | 6.7 | 6.9 | 6.9 |
| 1     | 4.03                    | 3.97                  | 3.66                   | 4.03 | 3.97 | 1.31 | 1.95 | 2.40 | 30.7 | 30.8 | 30.7 | 7.2 | 7.4 | 7.4 |
| 2     | 2.21                    | 2.49                  | 2.14                   | 2.21 | 2.49 | 2.74 | 2.56 | 3.79 | 29.3 | 29.2 | 29.3 | 6.7 | 6.8 | 6.6 |
| 3     | 2.27                    | 2.29                  | 2.26                   | 2.27 | 2.29 | 2.38 | 2.27 | 1.75 | 29.0 | 29.0 | 29.0 | 6.7 | 6.8 | 6.7 |
| 4     | 3.50                    | 3.54                  | 3.33                   | 3.50 | 3.54 | 4.72 | 4.35 | 3.85 | 29.3 | 29.4 | 29.2 | 7.0 | 7.0 | 7.0 |
| 5     | 4.82                    | 4.80                  | 4.82                   | 4.82 | 4.80 | 20.85 | 22.09 | 23.31 | 29.7 | 29.7 | 29.7 | 6.6 | 6.6 | 6.6 |

Milkfish is a type of brackish water fish but can grow in freshwaters with requirements. Milkfish has a high tolerance to changes of salinity (0-40 ppt) and temperature (10-40°C). The size of milkfish seeds <10 cm is included in the juvenile stage. Juvenile milkfish tolerance at water temperatures up to 38°C, sensitive at low temperatures but tolerance at low oxygen. However, waters with temperatures <23°C can reduce fish activity, responsiveness, and growth. The milkfish temperature was > 42.5 °C and <8.5 °C [2]. Table 1 showed that the condition of dissolved oxygen and water temperature is suitable for milkfish. Optimal water temperature for the life and growth of milkfish ranges from 23-32°C [18]. Optimal dissolved oxygen for life and growth of milkfish must not be less than 3 mg/L [19]. On the 4th and 5th observations (table 1), the dissolved oxygen concentration tends to be low because it was raining for a few days before the observation so that the photosynthesis process was inhibited and watercolored like tea was indicating contain high organic matter. There were occasional levels of low dissolved oxygen in the floating cage experiment, but the levels were still within the tolerable levels for milkfish that are reared in modified extensive systems. If the dissolved oxygen in
the water decreases, resulting in fish movements get slow, not agile and almost all will move to the top of the water surface. Milkfish can survive at a dissolved oxygen concentration of 1 ppm, but stop feeding at this level [12]. The oxygen concentration and temperature between the three treatments tends to be no different. Likewise, the chlorophyll-a concentration tends to be the same among the three treatments. This is because the floating net cage builds at an open water so that water circulation occurs and floating cage is near because it is still in the same unit. The value of pH during the study on all treatment was ranged 6.6 – 7.4 and did not differ between treatments.

Milkfish can be candidates for introduction fish besides tilapia and catfish in the Culture Based Fisheries (CBF) program in Ir. H. Djuanda Reservoir, so that the acclimatization process is needed. The acclimatization activity aims to make milkfish able to adapt to the new environment so that it can survive in freshwater. Though milkfish have a tolerance to salinity changes, they are unable to suddenly adapt to freshwater [2]. The result of acclimatization process showed that the average number of dead milkfish treated seedlings decreased with the increase of maintenance time. The dead number was greater along with increasing seed density (figure 1). Generally, the highest mortality occurred on day 7th. Milkfish seed mortality began to decrease on day the 9th of the trial and death did not occur on the day 19-21th of the experiment. This happens because fish have been able to adapt to freshwater environmental conditions and can utilize the kelekup attached to waring.

![Figure 1](image)

**Figure 1.** The average number of dead seeds in the floating cage experiment.

The highest milkfish seedling mortality was the 3rd (10,000 stocking densities) with an average of 2,368 individual. The results of the calculation of the survival rate (SR) and the growth rate of milkfish during the acclimatization process is presented in table 2.

| No | Parameters                                | Treatment |
|----|-------------------------------------------|-----------|
|    |                                           | 1 | 2   | 3   |
| 1  | Number of dead seeds (individual)         | 872 | 1248 | 2368 |
| 2  | Survival Rate (%)                         | 78.21 | 79.21 | 76.32 |
| 3  | Weight growth rate (g/day)                | 0.017 | 0.013 | 0.01 |
| 4  | Length growth rate (mm/day)               | 0.9 | 0.93 | 0.9 |

Survival rate-values at 1, 2, and 3 treatment are not different from as result study as 77 - 93% for freshwater [17]. The highest SR was treatment 2 with 6,000 stocking densities and the lowest was treatment 3 with 10,000 seeds stocking density. At high densities occur competition for places, food, and oxygen, so the higher population density, the lower survival rate becomes [20].
The raised milkfish have an average initial total length of 3.9 cm and a weight of 0.4 g. At the end of cultivation, it has a total length of 4.6 cm and weight of 0.62 g for treatment 1; a total length of 4.7 with a weight of 0.57 g for treatment 2 and a total length of 4.4 cm with a weight of 0.49 g for treatment 3. The highest weight growth rate in treatment 1 while the highest length growth rate for treatment 2. The length growth rate in the first week of observation was the lowest growth rate of 0.01 mm/day [20]. The growth rate of milkfish depends on genetic and environmental factors such as food availability, competition, predators, dissolved oxygen, pH, and toxins [2].

The aim of planktivorous fish stockings are food needs and improvement of the environment. Stocking of tilapia with the density of 8-15 g/m³ in Yuehu Lake could control of phytoplankton (Cyanophyceae abundance) so that the concentration of chlorophyll-a decreases and increasing of transparency [21]. Mola and bighead carp stocked in Donghu Lake could reduce the abundance of phytoplankton and increase transparency [5]. The success of increasing fish production through stocking is the ability of fish stock to utilize available natural food. The success of biomaniuplation for improving the tropical waters environment is influenced by the composition of plankton where is low of cladocerans abundance [22]. The presence of planktivorous fish can reduce algal biomass and increase transparency [23]. The concentration of P in milkfish fed of 25-40% protein content is 0.6-0.7% P [24]. Planktons that are preferred by milkfish as natural food are Chlorella sp., Closteriopsis sp., Oscillatoria sp., Mastogloia sp., Rhizosolenis sp., Peridinium sp., and Protoctentrum sp. [25]. The natural feed of milkfish seed weighing 6 mg is Oscillatoria sp. The juvenile milkfish feed in aquaculture ponds is the same as natural ones, namely cyanobacteria, diatoms, algal filaments, and detritus. Juvenile consumes about 65% algae and 35% animals during the day and 54% animals and 46% algae at night. The change in food is observed because it depends on the availability of food organisms [2]. The length of milkfish that were fed Oscillatoria sp. was 2.56 cm/week [17]. The juvenile growth rate in Naburut Lagoon, the Philippines was 7-9 mm/week [26].

The number and size of seeds stoked up will determine the stocking efficiency in waters to the optimal suitable carrying capacity [27]. Stocking of fish in the pen at Laguna de Bay, the Philippines was able to produce 4-7 tons/ha of milkfish with a survival rate of 80% [28]. Milkfish is often cultivated extensively in Indonesia, Taiwan, and the Philippines with stocking ranges of 1,500-6,000 individual/ha with yields of 300-4,000 kg/ha/year [28]. The growth of milkfish which is extensively cultivated with a density of 750 fish/ha (polyculture with vanamei shrimp) is 2.83-3.63 g/day [29]. Polyculture of milkfish and vanamei shrimp also conducted to increases the production of vanamei shrimp as the main commodity and to improves the water quality [11]. The spread of milkfish can be done in stages with several sizes so that natural food can be utilized optimally. Seed stocked at Lake Laguna de Bay, the Philippines is 30,000-50,000 individual/ha of which size 250-300 g/individual is reached in the 4th month after stocking [30]. The density of milkfish seeds stocked in extensive aquaculture is 1,000-2,000 individual/ha depending on aquatic productivity [31].

Based on the number of seed deaths and SR, it can be estimated that the seed needs to be prepared and the costs to be incurred. Through the assumption approach, if the carrying capacity for the stocking of milkfish in Ir. H. Djuanda Reservoir is 8,000,000 individual/year and price of seed is Rp 150 per individual, so the estimated costs can be calculated. Stocking is done in stages as much as 4 times/year so that the seed needs as many as 2,000,000 individual/stage. For the milkfish seed acclimatization process with a floating cage with waring measuring 7 x 3 x 0.75 m, it is estimated to require around Rp 2,000,000 per plot with an estimated of a lifetime to use is 4 years. Estimated cost for the acclimatization process is presented in table 3.

| Table 3. Estimated costs in the acclimatization process for three treatments. |
|---------------------------------|---------------------------------|---------------------------------|
| No | Parameters | Treatment 1 (4,000 densities) | Treatment 2 (6,000 densities) | Treatment 3 (10,000 densities) |
|---|---|---|---|---|
| 1 | Number of Floating | 500 | 500 | 334 | 334 | 200 | 200 |
5. utilized as a milkfish seed hatchery ready for stocking in freshwater.

smallest total investment 10 respectively. E number of dead fish, namely 2 stress due to transportation.

Milkfish seed acclimatization activities in freshwater are seed acclimatization activities. This can increase the economic value of milkfish stages several times a year.

highest SR value 3

Table 3 shown that treatment 3 has the lowest investment total but has largest losses of seeds or lowest SR value. Besides SR value and cost of seeds, consideration of the acclimation process is the investment in floating net cages. The smallest investment value is in the treatment 3 although it has the highest SR value. This can be caused by the stocking program and acclimatization which carried out in stages several times a year. Floating net cage investment can be used as a hatchery of milkfish seedlings that are ready to be stocked in freshwater. This can increase the economic value of milkfish seed acclimatization activities.

4. Conclusion

Milkfish seed acclimatization activities in freshwater are done based on the differences in salinity and stress due to transportation. The study results showed that 10,000 stocking densities had the highest number of dead fish, namely 2,368 individual. The highest survival rate and the highest length growth rate were in treatment with 6,000 seed stocking densities, around 79.21% and 0.93 mm/day, respectively. Economically, the gradual acclimation process based on the stocking plan showed that 10,000 stocking densities have the largest total loss due to seed death of Rp 284.16 x 10^6 but have the smallest total investment of Rp. 1,584.16 x 10^6. The floating cage investment in acclimatization-can be utilized as a milkfish seed hatchery ready for stocking in freshwater.

5. References

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| No | Parameters                                      | Treatment                                                                 |
|----|------------------------------------------------|--------------------------------------------------------------------------|
|    |                                                | 1(4,000 densities) | 2 (6,000 densities) | 3 (10,000 densities) |
|    |                                                | 1 stage | One year | 1 stage | One year | 1 stage | One year |
| 2  | Floating cage Investment (Rp x 10^6)           | 250     | 250      | 167     | 167      | 100     | 100      |
| 3  | Seeds investment (Rp x 10^6)                   | 300     | 1,200    | 300     | 1,200    | 300     | 1,200    |
| 4  | Number of life seed (individual)              | 1,564,200 | 6,256,800 | 1,584,200 | 6,336,800 | 1,526,400 | 6,105,600 |
| 5  | Number of dead seeds (individual)             | 435,800 | 1,743,200 | 415,800 | 1,663,200 | 473,600 | 1,894,400 |
| 6  | Loss of dead seeds (Rp x 10^6)                | 65.27   | 248.96   | 62.37   | 249.48   | 71.04   | 284.16   |
| 7  | Investment total (Rp x 10^6)                  | 1,698.96 | 1,616.48 | 1,584.16 |
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