

QUALITATIVE AND QUANTITATIVE CHARACTERS OF THREE COMMON CARP (*Cyprinus carpio* L.) STRAINS IN INDONESIA

(Sifat-sifat Kuantitatif dan Kualitatif Tiga Strain Ikan Mas (*Cyprinus carpio* L.) di Indonesia)

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ABSTRACT

The second generation of gynogenetic diploid common carp of majalaya, sinyonya and mirror strains have been produced in 1992. Some of them were sex-reversed by oral administration of 17 α -methyltestosterone. The females and sex-reversed males were matured on early 1994 and mated to produce progenies of pure strains. This research aimed to measure certain quantitative characters since the early stage of development to the market size. Three different conditions of rearing (i.e. rice field, ponds and concrete tanks) were applied during the nursery phase, while the earthen pond and running water system with intensive feeding were used for the grow-out stage. The results showed that average fecundity of sinyonya carp was higher than mirror and majalaya strains, but its performances of the early development (i.e. fertilization rate, hatching rate and survival rate at 14 days old) was lowest. At the nursery phase, the survival and growth rates of majalaya carp was relatively better than the other two strains, but the mirror carp had highest feed efficiency and lowest protein retention. During culture period, the growth rates of these three common carp strains were relatively similar (1%), but sinyonya carp, among strains had the highest percentage of fillet (38.5%) with the lowest total number of muscular bones (69), the highest level of protein content (77.5%) and the lowest level of lipid content (16.6%) among the three strains.

Keywords: *Cyprinus carpio* L., gynogenesis, growth rate, product quality.

ABSTRAK

Generasi kedua dari 3 strain *Cyprinus carpio* L. hasil gynogenesis, yakni majalaya, sinyonya dan mirror digunakan untuk memproduksi strain murni gynogenot. Penelitian ini bertujuan untuk mengukur sifat-sifat kuantitatif dan kualitatif perkembangan embrio hasil persilangan tetua gynogenesis (G2N). Dalam penelitian ini, 3 kondisi pemeliharaan diberikan pada fase benih yaitu: pola sawah, kolam dan tangki, serta 2 sistem berbeda pada fase pemsaran yakni: sistem kolam air tenang dan air mengalir, dimana pemberian pakan dilakukan secara intensif. Hasil penelitian menunjukkan bahwa rata-rata fekunditas sinyonya lebih tinggi dibanding mirror dan majalaya, tetapi penampilan pada awal pertumbuhan yang meliputi fertilitas, daya tetas dan kelangsungan hidup sampai umur 14 hari rendah. Pada fase benih, parameter kelangsungan hidup (SR) dan laju pertumbuhan majalaya lebih baik dibanding kedua strain lainnya, tetapi efisiensi pakan lebih tinggi pada mirror meskipun retensi proteinnya rendah. Pada periode pemsaran, laju pertumbuhan ketiga strain tidak berbeda, tetapi sinyonya menunjukkan persentase daging paling tinggi (38.5%), jumlah tulang paling rendah (69), kandungan protein tertinggi (77.5%), dan kadar lemak terendah (16.6%) diantara ketiga strain yang diteliti.

Kata Kunci: *Cyprinus carpio* L., gynogenesis, laju pertumbuhan, kualitas produk.

INTRODUCTION

Common carp, *Cyprinus carpio* L., was introduced into Indonesia from China in 19th century, from Europe between 1930 and 1937 (Schuster, 1950), and from Taiwan and also Japan about 1970. Uncontrolled crossing in aquaculture operation has seriously resulted in the merging of those strains that were introduced.

A program of genetic improvement of Indonesian common carp stocks was started in 1989. Studies conducted to describe the morphological and chemical characteristics of those strains, which were locally available were completed in 1990 (Sumantadinata and Taniguchi, 1990a, 1990b). In order to obtain highly homozygous strains, the meiotic gynogenetic technique was applied (Sumantadinata *et al.*, 1990). The second generation of meiotic gynogenetic diploid of some common carp strains were obtained in 1992 and matured at the late of 1994. Thereafter, the genetic improvement was fo-

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cused on three strains namely mirror carp, majalaya carp and sinyonya carp. These strains were easily differentiated morphologically (Sumantadinata, 1995).

Gynogenetic common carps were of all female. The male ones were obtained from sex reversion of those females by oral administration of 17 α -methyltestosterone (Nagy *et al.*, 1981; Satyanarayana Rao *et al.*, 1988). The progenies of sex-reversed male and normal female were all females. The method of sex reversal by hormone 17 α -methyltestosterone immersion was developed during the project.

In present paper the characteristics of highly homozygous common carp strains in Indonesia are determined.

MATERIALS AND METHODS

The second generation of gynogenetic diploid common carp strains (mirror carp, majalaya carp and sinyonya carp), both female and sex-reversed male were cultivated in ponds and floating net cages. The mature stocks were spawned naturally in spawning tanks. Soon after spawning began, five males and one female of each strain were transferred to the laboratory. The eggs were stripped and fertilized artificially by the sperm stripped from five sex-reversed males of the same strain to obtain the progenies and to measure certain characters, i.e., fecundity, performances at the early development (fertilization rate, hatching rate, survival rate), growth-rate at the nursery phase experiments and also for growing-out experiments and flesh quality analysis.

Fecundity and Early development

Five to six mature females of each strain of common carp were sampled for estimation of fecundity using the gravimetric method. A total of 120 eggs were measured each fish as fertilized eggs after two hours immersed in water. One thousand fertilized eggs for each carp strain were incubated in 180 l aquarium at 24 - 26 °C, with 3 replicates. Then, the inseminated eggs were observed for their fertilization rate, hatching rate and survival rate until 14 days old fry.

Nursery phase

To determine the growth-rate and survival rate of each common carp strain during the nursery stage, the research were carried out in 3 different conditions (i.e. rice fields, ponds and concrete tanks) and replicated 3 times each. The three strains were cultured together in each condition for certain rearing period. At fry stage, a 500 m^2 rice field was stocked with 3 weeks old fry of about 0.7 g average body weight at 3 $fish/m^2$, and reared for 3 weeks. While in ponds (200 m^2), chicken manure at 0.5 g/m^2 and agriculture lime ($CaCO_3$) at 0.1 g/m^2 were applied. About 1 kg of rice bran was given daily as supplemental feed after two weeks rearing period. Furthermore, the fingerlings of 6 weeks old (about 3-5 $g/fish$) were treated in the same condition of ponds but the density was anose at 6 $fish/m^2$ and reared for three months. Commercial feed containing 27% protein was given at the rate of 3-4% of fish biomass daily with 3 times feeding frequency. Besides, the experiment was also conducted in 1000 l concrete tanks with continuous flowing water at a rate of 1 l/minute and aerated by one point air supply. Each tank was stocked at density of 30 fish with application of artificial feed containing 38% protein at feeding rate of 5-7% of fish biomass per day, 3-4 times feeding frequency and rearing period during 2 months. Variable observed in this last experiment consist of feed efficiency, protein and lipid retention, either growth and survival rate.

Growth-out stage

Growth-out experiments were conducted in stagnant earthen ponds and in running water ponds, with replicated 3 replicated each. The same ponds preparation was done as in nursery stage. Three 200 m^2 ponds of each were used to test growth performance among the strains during 4 months cultivation period. The experimental fish of 115 g average individual weight were stocked communally at a rate of 600 fish per pond. The feeding rate was 3-4% of fish biomass daily with commercial pellets (27% protein), which were given three times a day. Whereas in the running water pond experiment, the capacity of each running water unit was 12 m^3 at 1 m depth and the fish were stocked at density of 3 kg/m^3 (about 13-85 g individual weight). At the end of the experiment, 10 speci-

mens each strains were used to measure the weight and the length of the body components, number of muscular bones, and proximate analysis of the fish meat.

RESULTS

Fecundity and early developments

The relative fecundity among Indonesian common carp based on number of eggs per kg body weight showed that sinyonya strain had the highest (129), while mirror carps was slightly higher than that of majalaya carp (121 vs 107). Therefore, the level of these fecundity might be related to its egg size, where the small egg size of sinyonya carp (0.9 mm) showed the high fecundity (Table 1). In the early development, the fertilisation rate of majalaya carp was the highest among these three strains. However hatching and survival rates of 14 days old larvae of mirror carp were the highest (90%; 92%), followed by majalaya carp (85%; 71%) and sinyonya carp (85%; 42%).

Table 1. The Fecundity Average and Performances at the Early Development of Common Carp Strains (Mirror Carp, Majalaya Carp, Sinyonya Carp).

Characters	Mirror Carp	Majalaya Carp	Sinyonya Carp
Body weight, kg	2.6±0.4	3.7±0.2	3.2±0.6
Number of eggs/kg fish	121.2±3.7	106.8±3.5	128.9±4.1
Fresh egg diameter, mm	1.0±0.2	1.0±0.2	0.9±0.2
Fertilized egg diameter, mm	1.5±0.1	1.5±0.1	1.5±0.1
Fertilization rate, %	90.9±7.2	96.3±3.1	89.1±2.4
Hatching rate, %	90.4±3.9	85.4±3.5	84.9±2.8
Survival rate of 14 days old larva, %	91.6±3.4	70.7±3.8	41.8±4.1

Nursery phase

The first nursery phase in rice field, majalaya carp showed better survival and growth rates than the two other strains (Table 2). Whereas, the different rearing facilities produced unsimilarity in daily growth rate. The growth rate in ponds (5.8%) was lower than that in rice field (8.6-9.8%). However, it seems that the pond provided a better condition for majalaya strain on the survival rate (52%) compared to the others (46% for mirror carp and 49% for sinyonya carp).

Table 2. Daily Growth Rate and Survival Rate of 3 Weeks Old Fry of 3 Common Carp Strains at the Nursery Stage During 3 Weeks Cultured Period in Rice Field and Ponds.

Characters	Rice Field (1500 fish/500m ²)			Ponds (2000 fish/200m ²)		
	Mi C	Ma C	Si C	Mi C	Ma C	Si C
Daily growth rate, %	8.9	9.8	8.6	5.8	5.8	5.8
Survival rate, %	46.7	50.2	45.5	46.0	52.0	49.0

Mi C = Mirror Carp; Ma C = Majalaya Carp; Si C = Sinyonya Carp

In the second nursery phase, survival rates of the three strains were relatively higher than those in the first nursery phase especially (Table 3). Common carp strains had better growth rates and survival in concrete tank than in ponds. The highest survival rate was attained by sinyonya carp from concrete tank (95%), followed by majalaya carp (90.8%), and mirror carp (89.3%). On the contrary, the rearing condition in pond at the second nursery phase expressed lowest growth rate.

Table 3. Daily Growth Rate and Survival Rate of 3 Common Carp Strains of Fingerlings at the Nursery Stage During Culture Period in Ponds (3 Months) and Concrete Tank (2 Months).

Characters	Ponds (1200 fish/200m ²)			Concrete Tanks (30 fish/1000l)		
	Mi C	Ma C	Si C	Mi C	Ma C	Si C
Daily growth rate, %	1.9	1.9	1.9	5.6	3.7	3.9
Survival rate, %	55.0	62.0	60.0	89.3	90.8	95.0
Feed efficiency, %	-	-	-	84.0	72.9	78.7
Protein retention, %	-	-	-	75.8	85.6	84.3
Lipid retention, %	-	-	-	18.3	18.0	16.2

Mi C = Mirror Carp; Ma C = Majalaya Carp; Si C = Sinyonya Carp

In terms of feed efficiency and protein and lipid retention, the result showed that majalaya and sinyonya carp had better level (72.9%; 85.6%), but the lowest lipid retention was recorded in sinyonya carp (16.2%).

The performance of body components among 3 common carp strains after 4 months cultivation period at growth-out experiment in ponds (600 fish/200 m²) were different (Table 4). Percentage of fillet was largest in sinyonya carp but the body weight was the lowest. While mirror carp had the largest viscera and head with gills portion as well as fillet remnant than those of the other the two other strains. Besides, the

number of muscular bone of each strains were different. Mirror carp contained the largest number of muscular bones among the strains with relatively similar number of branch and straight type. Sinyonya had the fewest number of the bones. Also, the meat of sinyonya carp has higher percentage protein content but lower lipid content compared to those of other two strains.

Table 4. The Performances of Body Components (%) among 3 Common Carp Strains after 4 Months Cultivation Period at Grow-Out Experiment in Ponds (600 fish/200 m²).

Body components	Mirror Carp	Majalaya Carp	Sinyonya Carp
Body weight, g	550.8	390.9	379.7
Total fin, %	2.2	2.2	2.0
Viscera, %	9.0	1.5	8.8
Head with gills, %	35.5	22.3	25.7
Skin, %	0.9	3.2	3.8
Fillet, %	36.8	36.1	38.5
Fillet remnant, %	22.4	21.5	23.1
Number of total muscular bones:	78	73	69
branch type of bones	39	31	25
straight type of bones	39	42	45

Table 5. Proximate Analysis of Fish Flesh Based on Wet and Dry Weight of Common Carp Strains.

Parameters	Wet base			Dry base		
	Mi C	Ma C	Si C	Mi C	Ma C	Si C
Water content, %	82.4	82.4	82.0	-	-	-
Ash, %	0.9	0.8	0.9	5.0	4.4	4.9
Protein, %	13.1	13.0	14.0	74.2	73.9	77.5
Lipid, %	3.6	3.7	3.0	20.4	20.9	16.6
Carbohydrate, %	0.1	0.1	0.2	0.4	0.8	1.0

Mi C = Mirror Carp; Ma C = Majalaya Carp; Si C = Sinyonya Carp

DISCUSSIONS

Comparison among three strains of the third generation of gynogenetic diploid common carp showed that there was differentiation on fecundity of the strain related with egg size. Sinyonya carp has the highest fecundity with the smallest egg diameter. The size of egg was genetically specific to each strain. The condition of fish reared in ponds system and rice field seemed to be similar in terms of the survival rates of fry, but in rice field the fishes had better daily growth rate than in ponds. Also, for

fingerling, ponds provided lowest daily growth rate and survival rate than tank. Geri *et al* (1995) reported that body component characteristic and chemical composition of fish flesh were influenced by age and size of fish, as well as by the rearing environment and genotype characteristic.

Percentage of fillet of Indonesian carp strains were relatively similar to those of French's carp observed by Vallod (1993) which reached 35-40% of the total body weight. Number of muscular bones of the three strains (69-78) were relative fewer compared to French carp (86) observed by Vallod (1993), to carp from Holstein (76-84) and to the wild carp from river and lake Elbe in Turkey (100-102) (Chandler *in* Moav *et al.*, 1975). Lieder (*in* Moav *et al.*, 1975) said that the diversity of muscular bone number was relatively small (95-104) and was not suggested as a factor for selection. On the contrary, Meske (1968) found that carp in German has a large diversity on numbers of the bones which varied about 70-135.

Protein content of the flesh of these three strains (13.00-14.96%) was relatively low compared to mirror carp from Italy (17.02%) observed by Geri *et al* (1995). The difference of protein content of these three strains to the mirror carp from Italy might caused by different age of the carps observed.

CONCLUSION

Daily growth rate in fingerling was lower than fry, otherwise the survival rate better in fingerling from tank than ponds. Rearing condition in rice field was better for fry, but for fingerling reared in tank seemed to be best condition. Mirror carp had excellent fecundity and survival rate on early development, but majalaya carp was better on feed efficiency and protein retention.

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