# ESTABLISHING SELECTIVE BREEDING PROGRAM FOR RAINBOW TROUT (*ONCORHYNCHUS MYKISS*, WALBAUM) IN SERBIA

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## USPOSTAVLJANJE PROGRAMA SELEKTIVNOG UZGOJA KALIFORNIJSKE PASTRMKE (*ONCORHYNCHUS MYKISS*, WALBAUM) U SRBIJI

***Abstrakt***

Zahtev za sve većim količinama hrane za ljudsku upotrebu, efikasnost iskorišćavanja hraniva i prostora za gajenje domaćih životinja, kao i pojava mnogih bolesti doveli su do intenzivnog razvijanja selekcionih programa u svim granama poljoprivrede. Za razliku od ostalih gajenih životinja, programi selekcije u akvakulturi su se razvili nešto kasnije usled nedostatka potrebnih procena heritabilnosti, koeficijenata varijacija i korelacija za ekonomski bitne osobine. Trenutno se u akvakulturi samo 1-2% od ukupne proizvodnje zasniva na genetički unapređenim vrstama riba (Gjedrem, 1997). Korišćenjem selektovanih linija riba postiže se više korisnih stvari. Na prvom mestu, programi selekcije riba predstavljaju jedini način stalnog unapređenja ekonomski bitnih osobina kao sto su prirast, konverzija hrane, otpornost na bolesti, smanjenje masnoće u mesu riba. Ribe iz selektovanih linija efikasnije iskorišćavaju hraniva i na taj način smanjuju pritisak na divlje populacije riba koje se koriste za proizvodnju ribljeg brašna, kao glavnog izvora proteina u smešama za ishranu pastrmki. Ribe koje potiču iz divljine ne napreduju zadovoljavajućim brzinom, što znači da su konstantno pod stresom, za razliku od riba poreklom iz selekcionih programa koje pokazuju manji uticaj stresa usled gajenja u zarobljeništvu. Tako se na ovaj način korišćenjem selektovanih linija riba postiže efikasna i održiva proizvodnja uz vođenje računa o dobrobiti životinja. Drugi dobar razlog za uspostavljanje programa selekcije pastrmke u Srbiji je dobro dokumentovano postojanje interakcije genotip x okolina kod kalifornijske pastrmke, kao što su pokazala istraživanja (McKay et al., 1984; Hanke et al., 1989; Sylven et al., 1991; Winkelman and Peterson, 1994; Kettunen et al., 1999; Kause et al., 2003). Na kraju, ali ne i najmanje važna je i kontrola bolesti kod kalifornijske pastrmke i mogućnost stvaranja otpornih linija pastrmki na neke bolesti putem selektivnog uzgoja (Henrion, 2005). Jedno od rešenja za ovaj ozbiljan problem, pored boljeg sistema kontrole pastrmske ikre poreklom iz uvoza, je i stvaranje lokalnih selektovanih matičnih jata sa proverenim poreklom i povećenom otpornošću na bolesti.

Obzirom da za kalifornijsku pastrmku postoje pouzdani podaci o varijabilnosti i heritabilnosti proizvodnih osobina ovo pruža mogućnost efikasne selekcije, a samom tim i značajnog unapređenja proizvodnje uz smanjen ukupni mortalitet, putem odgovarajućeg programa selekcije u Srbiji.

***Ključne reči***: *kalifornijska pastrmka, program selekcije, genetički parametri.*

## INTRODUCTION

The theory of selective breeding of plants and animals used for human consumption first appeared in the early 20th century. Request for larger quantities of food for human consumption, feed utilization efficiency and lack of space for breeding of domestic animals, as well as the occurrence of many diseases has led to intensive development of breeding programs in all branches of agriculture. Unlike at the other cultivated animals, selective breeding programs in aquaculture have been developed later due to lack of heritability estimates, coefficient of variation and correlation of economically significant traits. Nowadays, only 1-2% of total aquaculture production is based on genetically improved fish species (Gjedrem, 1997).

The selective breeding programs are the only way to consistently improve economically important traits such as growth, feed conversion and disease resistance. In some fish species, heterosis effect also can be used in production, but this requires further detailed investigation of interaction among local line fish. Thus, a studies in rainbow trout like Gall (1975), Ayles and Baker (1983) and Gjerde (1988) showed significant effect of heterosis for body weight of fish obtained by the crossing of different lines of cultivated trout. Fish from selected lines more efficiently utilize nutrients and thus reduce pressure on wild fish populations used to produce fishmeal as the main protein source in diets for feeding trout. Fish originating from the wild are not progressing at a satisfactory pace, which means they are constantly under stress, in contrast to the fish originated from breeding programs that show less effect of stress due to breeding in captivity. At this way, by using the selected lines of fish, we achieve efficient and sustainable production with due consideration for animal welfare.

Another good reason to establish a trout-breeding program in Serbia is well-documented existence of genotype by environment interaction in rainbow trout, as evidenced by research (McKay et al., 1984, Hanke et al., 1989; Sylven et al., 1991; Winkelman and Peterson, 1994, Kettunen et al., 1999, Kaus et al., 2003). This phenomenon, together with the possibility of using heterosis effect, shows the need to create local rainbow trout lines and need for detail examination of these important influences concerning each selective breeding program. Finally yet importantly are the control of diseases in rainbow trout production and the potential for creating resistant trout races against some diseases through selective breeding (Henrion, 2005). Occurrence of some diseases outbreaks in trout farms and hatcheries, some of which were recorded for the first time in Serbia, as shown by Jeremic and Radosavljevic (2009), represent a growing problem for trout producers in Serbia. One solution for this serious problem, together with better system of disease control of imported trout eggs, is to create a local trout lines with proven background and increased resistance to specific diseases. As there are reliable data on genetic parameters of rainbow trout, we are expecting a good response to selection, increase of production and reduced impact of some diseases on rainbow trout farms in Serbia.

**Phenotypic and genetic parameters in rainbow trout**

For some fish species, such as rainbow trout, there are sufficient genetic parameters for traits such as growth rate, feed conversion, percentage of body fat, meat color and resistance to some diseases (Gjedrem, 2000). Well-performed experiments provided us good estimates of these parameters, with a sufficiently large number of specimens examined, so we can use these data as very reliable.

For the specific trait as weight of rainbow trout, heritability estimates are above 0.2 and coefficient of variation is above 20, which means that one can expect a good response to selection ranging from 10-15% per generation. For traits related to the quality of meat, such as the percentage of fat and meat color, heritabilities are 0.47 and 0.27 respectively, also with high average values for the coefficients of variation (Gjerde and Schaeffer, 1989). Trait resistance to diseases such as infectious pancreatic necrosis (IPN), (Wetten et al., 2011), viral hemorrhagic septicemia (VHS), enteric red-mouth disease (ERM) and the rainbow trout fry syndrome (RTFS), (Henryon et al., 2005) show a high heritability in the range 0.42 to 0.57, and suggest the possibility of a successful response to selection.

The correlation coefficient between traits growth rate and feed conversion ratio for rainbow trout is high Rg =- 0.87 (Gjoen et al., 1993) and between growth rate and overall survival Rg = 0.23 (Rye et al., 1990). These correlation values indicate positive indirect impact on feed conversion ratio and overall survival (as a measure of resistance to disease) when selecting for improved growth rate. Between traits body weight and fat content there is a negative correlation, which prevents successful selection for weight gain and low fat content at the same time (Gjedrem, 2000).

**Objectives and selection method**

Before defining the objectives of selective breeding program, it is necessary to construct a breeding plan of selection. Basic breeding plan would, in principle, look like this: create the base population, define the goals of the selection, choose the method of selection, predict breeding values, choose candidates for the next generation, calculate the selection response and commercialize a program of selective breeding for rainbow trout. The objectives of the selection of rainbow trout, which would be conducted at the Center for Applied Hydrobiology and Fisheries (CRPH), Agricultural Faculty in Belgrade, are as follows:

- faster pace, with the indirect reduction in feed conversion ratio;
- increased resistance to certain diseases of trout;
- improvement of meat quality;

Taking into account the heritabilities for these traits the primary method of selection would be the selection of families combined with methods of individual selection and selection within the families of rainbow trout. Family selection assures the greatest accuracy in predicting the breeding value of future broodstock candidates. Challenge testing for particular disease of some individuals from each family will give us wanted data, without challenging the potential broodstock for next generation. Methods for improving the meat quality are requesting sacrifice of individuals; in this case, the selection of families is the only suitable method for assessment of needed estimates. Method of individual selection would have an advantage only in case of selection for faster growth rate of rainbow trout.

The breeding scheme would use factorial design as crossing method in order to achieve higher selection intensity of females, for given number of tanks and the number of individuals per family (Martinez et al., 2006, Boring and Knudsen, 2007).

**Base population and experimental matings**

Central place of implementation of selective breeding program for rainbow trout are the objects at the Centre for Applied Hydrobiology and Fisheries (CRPH), Faculty of Agriculture, University of Belgrade.

In the first phase of the project, technological equipment at the Center was modernized by adding additional equipment for water enriching with oxygen to provide optimum environmental conditions for rearing rainbow trout. In the second phase, we collected broodstock from various trout ponds in Serbia (Table 1.) which we used for mating trials and for investigation of technological possibilities of selective breeding at CRPH. In the process of gathering the broodstock primary criteria was diversity of trout farms and that this farms did not had a practice of importing eggs and fry from abroad (in order to avoid the possibility of transmission of infectious disease).

**Table 1**. Origin of rainbow trout broodstock for mating trials

| Name of pond-location | Origin of broodstock | Number of individuals |
|---|---|---|
| Žubor (Lisine) | Istok (Kosmet) | 4 |
| Lazic (Resava) | Tropik ribarstvo | 5 |
| Bast komerc (Resava) | Imported | 12 |
| Jablanica (Boljevac) | Soko Banja | 10 |

The third phase is experimental mating, spawning and breeding of rainbow trout and rearing fry up to the age of 10g when hatchlings will be tagged with PIT tags (passive integrated transponders) and transported to one of partnership trout farm. There we will continue to monitor and record the production traits of fish, as planned in selective breeding program.

In the period from 08.12.2010. to 25.02.2011., mating the broodstock individuals at the Center for Applied Hydrobiology and Fisheries, we created the 20 families of rainbow trout. Until the moment of crossing, we kept the potential candidates for spawning in 1000 liters capacity tanks and we were checking readiness for spawning every 5 days. Before spawning all broodstock candidates were marked and their body weight and body length was recorded. During the incubation, hatching and rearing of fry we recorded the following parameters: egg diameter and average weight, water temperature, oxygen saturation of water, duration of incubation and overall mortality of rainbow trout fry.

**Future steps in selective breeding of rainbow trout**

At the Center for Applied Hydrobiology and Fisheries, as Breeding organization with a special authority, we planned to produce 70 families of rainbow trout annually. Number of fish per family should be 50, which means that at the end of the season the number of potential breeding candidates would be 3500 individuals. Objectives of breeding program would be as indicated above: faster growth, increased resistance to certain diseases and improvement of meat quality. The goal of increasing the growth rate is to obtain a commercial size (250g) within 12 months (from the current average period over 15 months), which would significantly reduce production costs and thus made this type of fish more accessible to end users. The aim of increasing resistance to some disease at rainbow trout at Serbia is to increases survival from current 30 - 40% (from eggs to commercial fish) to over 50%, which would further reduce costs in production and increase production efficiency. The goal of improving meat quality should reflect the fat percentage, color and taste of fillet.

Fulfillment of long-term goals of the selective breeding program would provide genetically improved races of rainbow trout, which would form the basis for economically efficient and sustainable production of this fish species in Serbia.

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