Selective breeding of food sized rainbow trout against Flavobacteriosis

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Abstract

The world demand for fish in the human diets is increasing due to increasing populations and the improving economic status of the countries in Southeast Asia. The world capture fisheries production has been relatively stable for the last decade [1]. On the other hand aquaculture is the fastest growing animal producing sector. In 2009 aquaculture accounted for 46% of the total fish supply [1]. The increased dependence on aquaculture to supply a larger proportion of the fish consumed increases the need to make aquaculture more efficient. One of the scientific disciplines available to improve aquaculture production is genetics and genetic selection which has been used to improve the production of terrestrial animals.

Selection of aquaculture species is a relatively recent occurrence. Some of the first aquaculture selection programs using quantitative principles were started in Norway in the early 1970's. Since then numerous other selection programs have been implemented for salmon, trout, shrimp, tilapia, oysters and catfish to name a few [2]. In the early stages of the selection programs growth rate was emphasized. In many results the reported improvement in growth rate has been between 10–15% per generation or 3 to 5 times the improvement obtained in terrestrial animals. As the selection programs have evolved more traits have been added for improvement. Traits included in addition to growth are livability or disease resistance, processing yield, product quality, sexual maturation, fecundity and morphology.

Rainbow trout (*Oncorhynchus mykiss*) are a valuable aquaculture production species in the USA where an average 25,000 tons per year of food size rainbow trout were produced during 1988–2002. Clear Springs Foods, Inc. is one of the largest producers of aquacultured rainbow trout, producing 10,000 tons annually. Privately held by an employee owned trust, Clear Springs is a vertically integrated company from brood stock through egg production, feed manufacturing, farm operations, processing, and distribution.

Clear Springs has a significant commitment to research and development. Selective breeding of rainbow trout is an important component of its R&D program. The current goals of the selective breeding program are to improve growth and disease resistance. To improve these traits, data are recorded on thousands of individuals each year. Growth rate is collected at various ages to determine which families and which individuals within each family have the best growth. To improve disease resistance, a portion of the progeny from each family is exposed to specific pathogens in a standardized challenge test. Currently, each family is tested for survivability to infectious hematopoietic necrosis virus (IHNV), *Flavobacterium psychrophilum*, the causative agent of bacterial coldwater disease (CWD) and rainbow trout fry syndrome (RTFS) and *F. columnare* the causative agent of columnaris disease.

Development of standardized challenge tests that mimic "natural" host-pathogen interactions in the laboratory are critical for ultimately translating the potential benefits from a selective breeding program into a true rainbow trout production environment.

A laboratory challenge model for *F. columnare* in rainbow trout was developed [3]. Six *F. columnare* isolates were obtained from rainbow trout experiencing losses due to columnaris disease and were ascribed to genomovar I by 16S rRNA-RFLP analysis. Three of these were chosen for a preliminary assessment of virulence and were used to challenge ten fish per isolate by immersion for 1 h in water containing the bacteria. Each isolate was virulent and induced different mortality patterns in fish following challenge. One isolate, 051-10-S5, was chosen for additional experiments to determine the ability to replicate mortality rates in independent experiments and to determine the variability between replicate groups within an experiment. In two independent experiments, using the same challenge dose and parameters, cumulative percent mortalities (CPM) were 49 and 50% and the standard errors between replicate groups were ± 7.2 and 11.1%, respectively. This reproducible waterborne challenge model for columnaris disease in rainbow trout that was developed has an advantage over an injection challenge in that it more accurately mimics a rainbow trout - pathogen interaction.

Selection to improve growth began when the breeding program was initiated. The average weight of the odd-year generation group increased from 660 g at 328 days of age in 1991 to 921 g at 301 days in 2003. The average weight of the even-year group increased from 620 g at 328 days in 1992 to 866 g at 301 days in 2004. Selection to improve IHN resistance started with the 1994 generation. Using a standardized challenge test, IHN mortality decreased 25.8% in the odd-year generation group and 29.7% in the even-year generation. Growth is a moderately heritable trait that can be changed rapidly and economically with traditional quantitative genetic techniques. Disease resistance has much lower heritability and is more difficult to change. Better knowledge of specific and general disease resistance mechanisms in trout would aid the industry in improving future stocks. It is also extremely important to critically evaluate your selection parameters so that a maximum return on your investment with minimal downside risk is realized.

The results reported for aquaculture genetic selection programs have shown the performance of many domesticated strains can be increased dramatically. However, it is estimated that less than 10% of the world's aquaculture production is from genetically improved stocks [4]. There are many opportunities to help meet the growing demand for aquaculture produced products with the use of genetic selection.

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