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REVIEW **(Open Access)**

Review: importance of establishing and running a breeding program in the developing fish farming industry

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Abstract

Fish farming in developing countries including the Republic of Kosova is largely based on unimproved fish strains. In aquaculture research the main focus has been on increasing productivity through improvements in management, technology, disease control etc. Anyhow, is accepted worldwide that the full benefits can be obtained thorough genetically improved fish. In many countries are given evidence indicating the potential of genetic improvement programs and a range of selection methods may be used. In a survey during year 2012 in fish farms in Kosova, we found that 93.33% (28 of 30) fish farms use own brood fish for future generation, and most of the farms have started fishing farming with buying fish from the same fish farm without any precaution to avoid inbreeding. The main objective of this review is to highlight the importance of running a breeding program in fish farming, strategies for improvements and by controlling inbreeding accumulation.

Key words: Breeding program; inbreeding; fish farming; Kosova.

1. Introduction

The science of applied selective breeding and genetics has contributed greatly and steadily in increasing productivity in fish, domestic animals and plants. The profitable and sustainable genetic improvement is documented in several fish species. This potential is exploited through the effective and sustainable genetic improved strains with better performance, resource efficiency and product quality. The productivity may increase through improvement in management, feed and feeding practices, control of disease, which must completed with genetically improved animals in other side in order to increase benefits [12, 18]. The commercial breeding program may be partitioned into 10 elements: industry assessment, establish goals, measure goals, initial stocks, estimate parameters, mating system, selection criteria, ancillary studies, monitoring procedures, and periodic reconsideration [29].

The high reproductive capacity in most aquaculture species is a great advantage compared to farm animals. These, together with external fertilization, give the possibility to design more efficient breeding programs, than for farm animals. The high selection intensities can be practiced and possibilities for genetic improvement for most examined traits are very good, for traits which show genetic variation [16, 1].

Improvement in selective breeding need a good understanding of genetics, because improper breeding practices used have an adverse effect. There are several strategies that lead to improvements of breeding goals. And we have to choose the best one to achieve that, meantime we have to consider constrains like inbreeding accumulation and negative genetic correlation of the traits, to be sure that the breeding program is progressing in desired direction.

The survey in all current 30 fish farms in Kosova it is found that none of fish farms is running any planned breeding program and none of them is aware about harmful inbreeding effects. The main source of broodfish was from one oldest fish farm in Kosova and they have used for many years own broodfish. The objective of this review is briefly to present the main breeding goals on fish farming, selection methods that may be used, inbreeding accumulation and its harmful effects in breeding programs which is often constrained in inadequate hatchery management practices and selection.

2. Objective of breeding program

The main objectives of a breeding program are to move the mean value of the trait in the desired direction for a normally distributed trait, or to increase the frequency of the desired class (es) for a trait with discrete classes. Hence, changes in the population mean or in class frequencies from one generation to the next are termed genetic gain [25, 16].

3. Breeding strategy

Breeding strategy which is also known from traditional farm animals is that additive genetic

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improvement is the best strategy for long term progress. The basic requirement of this strategy is that we want to utilize an additive genetic variation. The important is to have a continuous response to selection which depends on the maintenance of genetic variation which has to maintain through properly designed programs [12].

4. Breeding goals

Definition of the breeding goal is an important part of a breeding program and is set by following steps as: definition of trait to be improved, evaluation a breeding capacity (genetic capacity) of potential breeding animal and selecting highest ranking individuals as parents for the next generation. For a trait to be included in the breeding goal the following prerequisites must hold: a) The trait must be of economic and ethical importance; b) The trait must show genetic variance; c) It must be possible to measure or judge (score) the trait, to a reasonable price [11, 16].

4.1 Growth rate, Growth is a heritable trait and of the most important trait in farmed fish. So, selective breeding program may be taken up for higher growth rate, which will decrease the duration of the production cycle, reduce the cost of production and increase the profit, reported from many authors. Reported heritability for body weight in juveniles is rather low around 0.10 [14], while medium heritabilities 0.2-0.4 for body weight in adults [13].

*4.2 Feed conversion***,** one of the most expensive constituents in total fish production is fed. It is finding a high positive genetic correlation in young rainbow trout between growth rate and gross feed conversion (growth/feed consumed) and a negative genetic correlation between growth rate and net feed conversion (growth/feed consumed less the maintenance ration) [20].

4.3 Disease resistance, the mortality and morbidity in fish production may cause serious problems. In general the heritability is low for this trait. The application of the challenge test has shown the large genetic variation in disease resistance [11, 22].

4.4 Age at sexual maturity, Sexual maturation in salmonids result in reduced growth rate, reduced meat quality and increased mortality [13, 11]. On average for rainbow trout the heritability for early maturity is 0.05 and 0.20 for late maturity respectively, with considerable additive genetic variation [14]. Thus, the potential for genetic improvement for this trait is promising.

4.5 Fecundity, the high reproductive rate in salmonids makes the expenses low for keeping broodfish [13]. However selection for egg size and egg quality could be used which have correlation with early survival and growth rate [14]. The data give a strong evidence of significant additive genetic variance for egg size, egg number and egg volume.

4.6 Quality traits, as the industry is developing and peoples awareness of product quality is increasing.. The different regions and different culture for fish consumption have an effect on what should be produced. Fish quality is usually a question of size, fat percentage, fat distribution, flesh color, taste, structure, firmness, shape of body and filet yield, dressing percentage and so on [15, 11].

5. Inbreeding

Inbreeding means the mating of individuals that are related to each other by ancestry. The degree of relationship between the individuals in a population depends partly on the size of population [7, 4]. Using the small number of broodfish can lead on increasing the risk for inbreeding accumulation. The basic impact of inbreeding on the genetic constitution of a population is a shift in the distribution of genotypes toward fewer heterozygotes and more homozygotes [31, 3, 27, 6, 8].

The reproductive characteristics of fish allow high selection intensities, which may result in a rapid accumulation of inbreeding. One prominent consequence of increased inbreeding is the reduction in mean phenotypic value of one or more traits with respect to fitness. This phenomenon is known as inbreeding depression [21]. Inbreeding depression causes reduced growth, viability and survival and increased numbers of abnormalities [30, 22, 23].

5.1 Effect on growth rate, the reported estimates imply a reduction in the expected genetic gain per generation of about 1% for the highest inbreeding rate (ΔF =2%) [13, 17].

5.2 Effect on fitness, it is reported that inbreeding on the male had no deleterious influence on fertility and hatchability this, at least in low levels of inbreeding, in contrast in female had a strong negative effect [30]. As reported in [16] the average inbreeding depression was found to be 10.0% for survival of eyed-eggs, 5.3% for alevins and 11.1 for fry.

6. Base population

The first step to start breeding program is to collect the genetic material that form base population.

When developing breeding program in aquaculture it is very important to start with a broad genetic base, because there are examples of failure as a narrow genetic variation in the base. Selecting from different farms, in this case we reduce risk of inbreeding. Other possible contributors for base population are wild stock with a moderate genetic difference from cultured animals [26, 2, 12, 18, 11].

7. The importance of variation

Genetic variation is important for genetic change. If there is a little genetic variation in a trait-more specifically, if there is little genetic variation in a trait response will be low (selection will be difficult) because no individual is much better than any other as genetic parent [4]. If there exists tremendous genetic variation in a population for a particular trait, and if breeders select only the best individuals based on accurate measures of the trait, then the selected individuals and their offspring will be far better than average, and the rate of genetic change will be faster. For this purpose it is recommended (10) that taking the broodfish from different genetic origin can differ great in average performance, therefore the variation within broodstock is generally large and provides the highest potential for within population selection.

8. Selection and mating

The method chosen for selection depend on several factors, among which the heritability of the trait(s) and the reproductive capacity of species are most important [16]. So far the additive genetic variation has been found for all traits of economic importance in all species. The selection of breeders in a breeding program is based on its breeding value, how much superior the selected individual is from population average, because the breeding value of an individual cannot measure directly. It can only be estimate from the phenotypic values of the trait(s). They are several alternatives available to fish breeders: individual (mass) selection, family selection and combined family and within-family selection, pedigree selection, progeny selection [10, 22]. By controlling mating is necessary to avoid mating of close relatives and inbreeding accumulation in population. The choice of the mating system is a primary tool of the breeder. Inbreeding, outcrossing, population sizes, and choice of mates are but a few areas of decision for the geneticist.

*8.1 Individual selection***,** when breeding candidates are selected according their own performance, this is called individual or mass selection [12, 22]. The best performing individuals compared to the population mean are selected. This method is most widely used method of selection in aquaculture [16, 11].

8.2 Within family selection, whole families are selected or rejected as units according to the mean phenotypic value of the family. The family selection is relatively efficient compared to individual selection for traits with low heritability. Each family must be reared in separate tanks before they can be tagged, since it is impossible to tag newly hatched larvae or fry [16, 11]. Another important factor affecting the efficiency of family selection is the number of individuals in the families, or the family size. This accuracy depends on the heritability of the trait, family size, family type (full and/ or half sibs) and the variation due to the environment [16, 22, 12].

8.3 Combined selections, in this method of selection, the criterion for selection is the deviation of each individual from the mean value of the family to which belongs. Selection within families would eliminate large non-genetic component of variation operated on by selection [16, 22], and high selection intensities may be applied without increasing the rate of inbreeding.

8.4 Progeny testing and pedigree selection, these methods of selection on breeding animals are chosen based on the performance or breeding values on their parents, grandparents or more remote ancestors. The progeny testing as reported [11] is not so valuable since the generation interval will be increased and usually doubled. This method can be practiced by using cryopreserved spermatozoa in selective breeding [22], which show good results in egg fertilization [28].

8.5 Testing strategies, in the breeding program the standardization of environmental conditions and facilities during the testing period for the genetic groups under comparison should be given priority. They are many factors that should be standardized like water temperature and quality, amount, content and quality of feed, light intensity and photoperiod, density of fish and so on.

8.6 Registration of records, incorrect records will give false value of breeding candidates. Thus, records, measures and scores of trait should be taken according the breeding goal. This is done to ensure that important traits don’t change in an undesirable way due to unfavorable genetic correlation with traits selected for. Very often it is also necessary to record traits that are not selected for. This for example growth rate can be recorded as body weight or carcass weight. Appropriate experimental designs and statistical methods [19] are the basis for estimation of genetic parameter from breeding populations.

8.7 Correlated effects The correlated effects among traits must be well defined before the trait of the selection is included in breeding goal. There are cases when we have to select indirectly for interest trait. A good example is feed conversion in order to increase weight gain. Therefore, accuracy of selection may greater for the correlated trait that for the trait of interest [4]. Such the correlated response may be advantageous to the productivity and disadvantageous to the productivity in antagonist correlation [11].

9. Concluding remarks

In order to utilize the maximum farm production potential, the breeding plan must start as soon as possible in order to achieve highest yield. Investments in this field need to be multidirectional such as establish breeding station, well educated personnel in quantitative genetics, and training of fish farmers in order to maintain what is achieved.

Individual selection is the most common method of selection used in fish breeding, because is simple to apply and efficient in improving growth rate. Reports of very good genetic gain per generation in average should encourage farmers and government support promising genetic improvement. Taking into account the heritability of economically important traits, breeding program must be established in fish farming which improves feed conversion, improve growth rate and disease resistance, including improvements of quality traits. The initiatives could come from several directions including the fish farmers, genetic researchers, or government in order to stimulate aquaculture production. The dissemination of improved fish could be directly with eggs, fry or broodfish from breeding station. This might have a direct impact on developing industry and direct increase of fish farmer's income.

In countries where fish farming is in developing phase and without any established fish breeding program, inbreeding can be a serious constraint. The improper use of selection methods may cause negative and unfavorable inbreeding depression and consequently the negative effects reducing genetic variation, fitness and growth rate. The rate of inbreeding using mass selection is determined from the number used as parents. Thus, recommended in different authors by selecting 50 pairs for each sex the rate of inbreeding might be kept at 1% per generation, is the recommended limit to minimize loss of genetic variation or to avoid loss of fitness [2] and minimize an immediate loss of heterozygosity or genetic variation [5, 8, 31].

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