Research Journal of Fisheries and Hydrobiology, 6(4): 546-548, 2011
ISSN 1816-9112

ORIGINAL ARTICLES

Rainbow Trout Fertilization and Hatchery Production

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ABSTRACT

The reproduction of rainbow trout is well understood and the techniques are well-developed. The dry method of fertilization without admixture of water is the most common approach. Eggs are removed manually from females (under anaesthetics) by applying pressure from the pelvic fins to the vent area or by air spawning, causing the fish less stress and producing cleaner, healthier eggs. Insertion of a hypodermic needle about 10 mm into the body cavity near the pelvic fins and air pressure (2 psi) expels the eggs. The air is removed from the body cavity by massaging the sides of the fish. Up to 2 000 eggs/kg body weight are collected in a dry pan and kept dry, improving fertilisation.

Key words: Rainbow Trout, Fertilization,Hatchery, Production

İntroduction

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Males are stripped in the same way as females, collecting milt in a bowl, avoiding water and urine contamination. Milt from more than one male (ensures good fertilisation) is mixed with the eggs. It is recommended that milt from three or four males is mixed prior to fertilization to reduce inbreeding. Water is added to activate the sperm and cause the eggs to increase in size by about 20 percent by filling the perivitelline space between the shell and yoke; a process known as 'water-hardening'. Fertilised eggs can be transported after 20 minutes, and up to 48 hours after fertilization, but then not until the eyed stage (eyes are visible through the shell). Direct exposure to light should be avoided during all development stages, as it will kill embryos.

A technique that has been developed to improve production output is the use of monosex culture of females, or triploids. Triploidy is induced by exposing the eggs to pressure or heat whilst monosex are produced by fertilizing normal female eggs (XX chromosomes) with milt from sex-reversed, masculinised females (XXX chromosomes). The mature testes of sex-reversed fish are large and rounded but have no vent. The testes are removed from the abdomen and lacerated to drain the milt into containers. An equal volume of extension fluid is added to make the sperm motile, and ready for fertilizing normal ova. One advantage of this technique is that only the broodstock is sex-reversed, and they can be grown separately, while the marketed fish are not exposed to hormonal treatment.

Hetchery production:

Eggs are incubated undisturbed until the eyed stage is reached, in hatching troughs, vertical flow incubators or hatching jars. Hatching and rearing troughs are 40-50 cm wide, 20 cm deep, and up to about 4 m in length. They usually have 2 layers of eggs placed in wire baskets or screened trays (California trays) supported 5 cm above the bottom, and water passes through the tray (3-4 L/min). As the eggs hatch (4-14 weeks) the fry drop through the mesh to a bottom trough. The alternative is vertical flow incubators (Heath incubators) that stack up to 16 trays on top of each other. A single water source flows (3-4 L/min) up through the eggs, spills over into the tray below, thus becoming aerated, allowing large numbers of eggs to hatch in a minimal amount of space and water. Sac fry can remain in trays until swim-up at about 10 to 14 days after hatching. Time taken for hatching varies depending on water temperature, taking 100 days at 3.9 °C and 21 days at 14.4 °C (about 370 degree days). Hatching jars, available commercially or constructed from a 40 L drum and PVC pipe, introduce water from the bottom and flow from the top. 50 000 eggs can be incubated inexpensively suspended in a water

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flow that rolls the eggs, provided that the incubator contains two-thirds of the incubator volume in eggs, and the flow rate lifts the eggs 50 percent of their static depth. In all the above methods dead eggs are removed regularly to limit fungal infection. Fungal infections can be controlled using formalin (37 percent solution of formaldehyde) in the inflow water at 1:600 dilution for 15 minutes daily, but not within 24 hours of hatching. Upon reaching the eyed stage addling (dropping eggs 40 cm) removes weak and undeveloped eggs.

Trout hatch (typically 95 percent) with a reserve of food in a yolk sac (which lasts for 2-4 weeks), hence are referred to as yolk-sac fry, or alevins. Hatching of the batch of eggs usually takes 2-3 days, during which time all eggshells are regularly removed, as well as dead and deformed fry. Eggs incubated separately from rearing troughs are transferred to rearing troughs after hatching. After hatching, the trays are removed and trough water depth is kept shallow (8-10 cm) with a reduced flow until fry reach 'swim-up' stage, the yolk sac is absorbed, and active food searching begins.

Rearing Fry:

Fry are traditionally reared in fibreglass or concrete tanks, preferably circular in shape, to maintain a regular current and uniform distribution of the fry, but square tanks are also found. Tanks are usually 2 m in diameter or 2 x 2 m square, with depths of 50-60 cm. Water is delivered to the side of the tank using an elbow pipe or a spray bar to create a circulation of water. The drain is in the centre of the tank and is protected by a mesh screen. This position ensures that the water forms a vortex towards the centre that accumulates wastes for easy removal. The sump or drain pipe is connected to an elbow pipe on the side of the tank that can be used to regulate water level.

Fry are fed specially prepared starter feeds using automatic feeders, starting from when approximately 50 percent have reached the swim-up stage. When most fish are actively feeding, 10 percent of the fish weight should be introduced daily for 2-3 weeks, preferably on a continuous basis using clockwork belt feeders. The feed pellets, made of fish meal (80 percent), fish oils and grains, provide nutritional balance, encouraging growth and product quality, and are formulated to contain approximately 50 percent protein, 12-15 percent fat, vitamins (A, D and E), minerals (calcium, phosphorus and sodium) and a pigment to achieve pink flesh (where desirable). High-energy commercial feeds and good feeding practices yield FCRs as low as 0.8:1. When the fry are 15-25 mm long feeding is based on published charts, related to temperature and fish size. Automatic feeders are useful but hand feeding is recommended in the early stages to ensure overfeeding does not occur, although demand feeders are more efficient for larger fish. As growth continues, dissolved oxygen is monitored and fish moved to larger tanks to reduce density.

Ongrowing techniques:

When fry reach 8-10 cm in length (250 fish/kg) they are moved to outdoor grow-out facilities. These can comprise concrete raceways, flow-through Danish ponds, or cages. Individual raceways and ponds are typically 2-3 m wide, 12-30 m long and 1-1.2 m deep. Raceways provide well-oxygenated water and water quality can be improved by increasing flow rates; however, the stock is vulnerable to external water quality, and ambient water temperatures significantly influence growth rates. The number of raceways or ponds in a series varies with the pH [low pH (6.5-7.0) reduces unionised ammonia concentration] and the slope of the land (a 40 cm drop between each raceway is necessary for aeration). A typical raceway or pond layout is shown above. For hygiene, water quality, and controlling disease problems the parallel design is better, as any contamination flows through only a small part of the system. Fry are stocked in both systems at 25-50 fry/m² to produce up to 30 kg/m² with proper feeding and water supply, although higher production is possible.

Fish are grown on to marketable size (30-40 cm), usually within 9 months, although some fish are grown on to larger sizes over 20 months. The stock is graded, usually four times (at 2-5 g, 10-20 g, 50-60 g and >100 g) in a production cycle (first year), when the density needs to be reduced, thus ensuring fast growth, improving feeding management and creating product uniformity. Fish quantity and size sampling (twice a month) allows estimations of growth rates, feed conversions, production costs, and closeness to carrying capacity to be calculated; essential considerations for proper farm management.

Alternative on-growing systems for trout include cage culture (6 m by 6 m by 4-5 m deep) production systems where fish (up to 100 000) are held in floating cages in freshwater and marine (past fingerling stage) environments, ensuring good water supply and sufficient dissolved oxygen. This method is technically simple, as it uses existing water bodies at a lower capital cost than flow-through systems; however, stocks are vulnerable to external water quality problems and fish eating predators (rats and birds), and growth rates depend on ambient temperature. High stocking densities can be achieved (30-40 kg/m²) and fish transferred to marine cages have faster growth rates, reaching larger market size. Fry of about 70 g weight can attain 3 kg in less than 18 months.

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Feed Supply:

Feeds for rainbow trout have been modified over the years and cooking-extrusion processing of foods now provide compact nutritious pelleted diets for all life stages. Pellets made in this way absorb high amounts of added fish oil and permit the production of high-energy feeds, with over 16 percent fat. Dietary protein levels in feeds have increased from 35-45 percent and dietary fat levels now exceed 22 percent in high energy feeds. Feed formulations for rainbow trout use fish meal, fish oil, grains and other ingredients, but the amount of fish meal has reduced to less than 50 percent in recent years by using alternative protein sources such as soybean meal. These high energy diets, are efficiently converted by the rainbow trout, often at food conversion ratios of close to 1:1. Feeding methods vary for production systems. Hand feeding is suitable for small fish eating fine food. Mechanical feeders, driven by electricity or solar power, are frequently used to feed set amounts at set intervals depending on fish size, temperature and season. Demand feeders can be used for fish greater than 12 cm.

Harvesting Techniques:

Methods of harvesting vary but water levels in the holding facilities are generally lowered and the fish netted out. In pens and cages, the fish are crowded using sweep nets and are either pumped from the holding pen alive and transported to the slaughter plant, generally by well boat, or slaughtered on the side of the pens. The whole process is carried out with the aim of keeping stress to a minimum, thus maximising flesh quality.

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