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Key findings Aquatic Products (FAO 2007)

SURVIVAL, GROWTH AND RNA/DNA RATIO OF PAGRUS MAJOR CULTURED UNDER THREE DIFFERENT FEEDING REGIMES DURING EARLY DEVELOPMENT

J.G. Sharma, W.-S. Gwak, R. Masuda, M. Tanaka, R. Chakrabarti-2007

Asian Fisheries Science 19(4): 389-400

Abstract:

The nutritional status of red sea bream *Pagrus major* (30-day-old) cultured under three different feeding regimes: 1) rotifer, *Artemia* and artificial diet (RAA), 2) rotifer and artificial diet (RA) and 3) artificial diet (A) only were evaluated depending on RNA/DNA ratios. The duration of the experiment was four weeks. The final average weight of fish was significantly ($P < 0.05$) higher in RAA (1555 ± 119 mg) than RA (1010 ± 145 mg) and A (927 ± 170 mg). Specific growth rate was significantly ($P < 0.05$) higher in RAA (7.376) and RA (5.617) at the end of the first week of culture compared to the other weeks. In artificial diet fed fish, SGR was significantly ($P < 0.05$) higher at the end of the second week (4.542) compared to the other weeks. The DNA concentration was significantly ($P < 0.05$) higher at the end of the second week of feeding than in the remaining culture period regardless of feeding conditions. The RNA concentration increased from the first to the second week of culture, followed by a decrease in RNA concentration at the end of the third week and then a re-increase at the end of the fourth week in three treatments. The amount of RNA of fish was significantly ($P < 0.05$) higher in RAA and RA treatments than in artificial diet fed fish at the end of the second week. The RNA/DNA ratio showed a direct relationship with growth rate in these three different treatments. The RNA/DNA ratio was significantly ($P < 0.05$) higher in RAA than RA and A showing the superiority of this feeding regime during early development.

CAPTIVE BREEDING AND NURSERY REARING OF THE INDIAN SEAHORSE, HIPPOCAMPUS KUDA (TELEOSTEI: SYNGNATHIDAE)

A.P. Lipton, M. Thangaraj, S.R. Sreekrakha-2007

Asian Fisheries Science 19(4): 423-428

Abstract:

Breeding of laboratory-reared 21 pairs of broodstock *Hippocampus kuda* (Bleeker 1852) and rearing of their young ones indicated that 262.00 ± 59.00 offsprings were released during each spawning. A newly born seahorse was (mean \pm SE) 7.83 ± 0.11 mm in length with a weight of 1.17 ± 0.009 mg. It could attain a mean length of 31.14 ± 0.66 mm with a mean weight of 16.13 ± 0.60 mg in 30 days when fed ad libitum with *Artemia nauplii*. The mean survival per brood cycle was enhanced to 65.22 ± 1.87 % from almost less than 1.0 % by improving the rearing conditions.

USE OF CYCLOP-EEZE AS A SUBSTITUTE FOR ARTEMIA NAUPLII IN LARVAL REARING OF GIANT FRESHWATER PRAWN MACROBRACHIUM ROSENBERGII (DE MAN 1879)

C. Mohanakumaran Nair, K.R. Sa lin, K. Ashok Kumar-2007

Aquaculture Nutrition 13 (2): 88-93

Abstract:

Four feeding experiments, replacing 25% (T1), 50% (T2), 75% (T3) and 100% (T4), by dry weight, of the live feed *Artemia nauplii* for Cyclop-eeze, a new larval feed that was claimed to contain the highest known levels of astaxanthin and omega-3 polyunsaturated fatty acids, were compared against a control that was fed with *Artemia* and egg custard alone, to the larvae of giant freshwater prawn *Macrobrachium rosenbergii* (De Man 1879). Analysis of different production characteristics of the

larvae revealed that the highest survival up to postlarvae (PL) stage was obtained for T2 in which 50% of the *Artemia* nauplii were replaced by Cyclop-eeze [freeze-dried (FD) deep frozen (DF)], and the highest astaxanthin content of the larval tissue obtained in T4 in which the larvae were fed 100% Cyclop-eeze, although the survival rate was the lowest in this treatment. The costs of different treatments were also compared. The *Artemia* consumption million¹ larvae was the highest in control (11490 g), followed by T1 (8240 g), T2 (4990 g), T3 (3730 g) and T4, which completely replaced *Artemia* from stage 5 onwards (1830 g). The highest consumption of Cyclop-eeze million¹ larvae was in T4 (1670 and 10 880 g), followed by T3 (850 and 5560 g), T2 (410 and 2690 g) and T1 (230 and 1490 g) of FD and DF, respectively. The astaxanthin contents of the late-stage larvae fed under the four treatments were 24.90, 27.40, 28.60 and 35.60 µg g⁻¹ tissue for T1, T2, T3 and T4, respectively, while that of the control was 23.70 µg g⁻¹. The lowest cost of live feeds million¹ PL was obtained for T2 (US\$ 428.60), followed by T1 (US\$ 490.46), control (US\$ 529.07) and T3 (US\$ 583.26), while it was the highest for T4 (US\$ 890.93). The results indicated that Cyclop-eeze could economically replace *Artemia* nauplii at 50% level that could significantly improve the survival and carotenoid composition of the larvae of *M. rosenbergii*.

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THE WHOLE AMINO ACID PROFILE AS INDICATOR OF THE NUTRITIONAL CONDITION IN CULTURED MARINE FISH LARVAE

J.B. Cara, F.J. Moyano, J.L. Zambonino, F.J. Alarcón-2007

Aquaculture Nutrition 13(2): 94–103

Abstract:

The effect of variations in the amount or quality of food provided on the amino acid profile of larvae, was tested in two marine fish species, the Senegal sole (*Solea senegalensis*) and the sea bass (*Dicentrarchus labrax*). The objective was to assess whether such nutritionally suboptimum dietary patterns, which simulate situations that may occur in hatcheries, result in variations in the concentration of one or more amino acids that could be used as indicators of nutritional condition of larvae. Restriction in the normal food ration by 60% had no clear effect on the amino acid profile of sea bass, while the concentration of some amino acids (Arg, Ala and Phe) showed significant variations in sole. Feeding on artificial diets, which have shown their inadequacy a priori, resulted also in no significant effect on the profile of sea bass, but in a dramatic modification of the amino acid profile in sole. In addition, changes in the amino acid profiles considered as a whole were evaluated using the cluster analysis instead of paired comparisons between amino acid concentrations in each treatment. The analysis clearly separated profiles of larvae fed restrictedly or inadequately from their controls, irrespective of the species. This demonstrated the potential value of evaluating whole changes in amino acid profile as nutritional indicator. Besides, it was demonstrated that sensitivity of larvae to nutritional changes that may be reflected in the amino acid profile is greatly conditioned by the species and developmental stage.

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EFFECT OF BACILLUS SUBTILIS ON GROWTH DEVELOPMENT AND SURVIVAL OF LARVAE MACROBRACHIUM ROSENBERGII (DE MAN)

M.A. Keysami, C.R. Saad, K. Sijam, H.M. Daud, A.R. Alimon-2007

Aquaculture Nutrition 13(2): 131–136

Abstract:

A feeding experiment was conducted to investigate the effect of *Bacillus subtilis* bacterium, on larval growth and development rate of *Macrobrachium rosenbergii* (de Man) during February 28 to April 8, 2005 in University Putra Malaysia hatchery. Newly hatched larvae of *M. rosenbergii* were reared with two dietary treatments consisting of newly hatched *Artemia salina* nauplii with *B. subtilis* (10⁸ cells ml⁻¹), and newly hatched *A. salina* nauplii without *B. subtilis* carried out in triplicate in 60-L aquarium

(50 L1). After trial, the larvae that fed *B. subtilis*-treated *Artemia* naupli were found to have higher survival and a faster rate of metamorphosis than larvae that were fed with nontreated *Artemia* naupli. There were significant differences between *B. subtilis*-treated *Artemia* naupli and nontreated *Artemia* diet in larval growth and development rate of metamorphosis ($P < 0.05$). Larval survival after 40 days was significantly greater ($P < 0.05$) in the *B. subtilis*-treated groups (55.3 ± 1.02) compared with the nontreated groups ($36.2 \pm 5.02\%$).

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TOLERANCE OF *PENAEUS MONODON FABRICIUS* EMBRYOS TO OZONATED SEAWATER

Greg J. Coman, Melony J. Sellars-2007

Aquaculture Research 38(4): 420–428

Abstract:

The tolerance of *Penaeus monodon* embryos from five spawnings (families) to four different ozone doses in seawater [0.0, 0.5, 1.0 and 2.0 mg L⁻¹, measured by the residual oxidant concentration (ROC)] was examined when applied for three exposure times (1, 2 and 4 min) at three post-spawning treatment times (25, 120 and 480 min post-spawning). Ozone dose typically had a larger affect on embryo hatching than exposure time and the ozone dose \times exposure time interaction for most combinations of family and post-spawning treatment time. At ozone doses of 2.0 mg L⁻¹, embryos had lower hatchings than controls for all families at 25 and 120 min post-spawning, and for several combinations of family and exposure time at 480 min post-spawning. At ozone doses of 1.0 mg L⁻¹, the effect on embryo hatching was more varied between families and exposure times for the three post-spawning treatment times, but typically embryos were less affected when exposed at later post-spawning treatment times. Ozone doses of 0.5 mg L⁻¹ typically had minimal effects on hatching for all exposure times and post-spawning treatment times. In summary, later-stage *P. monodon* embryos typically tolerated ozone doses of up to 1.0 mg L⁻¹ in seawater for durations of up to 4 min.

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DESIGN OF A PILOT-SCALE TROPICAL MARINE FINFISH HATCHERY FOR A RESEARCH CENTER AT MAZATLÁN, MEXICO

L. Alvarez-Lajonchère, M.A. Reina Cañez, M.A. Camacho Hernández, S. Kraul-2007

Aquacultural Engineering 36(2): 81-96

Abstract:

A multispecies, 2668 m² pilot-scale tropical marine finfish hatchery was designed to fulfill the requirements of finfish juvenile research and development (R&D) at the Research Center for Food and Development, in Mazatlán, México. The main goals of the facility were (1) scale-up and study experimental results at a pre-commercial-scale; (2) assess technical and financial feasibility and improve these technologies before transfer to commercial-scale; (3) adapt technology to other fish species. In the hatchery, a semi-intensive, green water strategy is used for larval rearing, and rotifers are produced using a high density, intensive production technique. An intensive, tank-based nursery is used to study juvenile husbandry. Although the main objective of the facility is to package technology, the annual production capacity for juvenile to supply to industrial partners is about 160,000–200,000 one-gram juveniles produced in three or four rearing cycles. Seawater intake is based on a sand and gravel prefiltered system and two 30 hp seawater radial pumps, each with the capacity to fulfill the whole system requirements (500 gpm, 31 L/s, sustained flowrate). Most of the water is delivered directly to the broodstock and nursery areas after sand and cartridge filtration and a UV lamp ($\leq 60,000 \mu\text{W s/cm}^2$), and the rest is used to fill four 25 m³ high density polyethylene (HDPE) storage tanks. From the storage tanks, the seawater is directed through three pressurized sand filters and a series of high capacity cartridge filters (16 μm). For live feed production and larval

rearing, water is further filtered using line cartridge filters (as small as 0.22 μm) and a continuous-flow UV lamp ($\leq 60,000 \mu\text{W s/cm}^2$). There is a freshwater system for 60 m^3/day and an air distribution system that includes three 10 hp blowers, each with the required capacity for the entire facility. The broodstock areas have 40 tanks (0.6–50 m^3) with a total capacity of 410 m^3 . Initially there are six 3 m^3 larval rearing tanks and in a second stage a 40 m^3 mesocosms tank facility will be added. The indoor (160 m^2) live food culture facility is capable of a daily production of about 8 m^3 of four microalgae species ($1\text{--}40 \times 10^6$ cells/ml, depending on the species), 2.5×10^9 enriched rotifers, 6×10^8 enriched *Artemia metanauplii* and 4×10^7 copepods.

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PRODUCTION OF A DIATOM-BACTERIA BIOFILM IN A PHOTOBIOREACTOR FOR AQUACULTURE APPLICATIONS

Ruben E. Avendaño-Herrera, Carlos E. Riquelme-2007

Aquacultural Engineering 36(2): 97-104

Abstract:

Navicula veneta biofilm improves the settling of marine larval shellfish. We attempted to optimise the production of *N. veneta* biofilm by the addition of native bacteria. As a first step, the ability of six bacteria to grow in extracellular products of *N. veneta* was evaluated, the best growing strain was NC1 (*Halomonas* sp.). Subsequently, three culture cycles in the Tanaka photobioreactor confirmed that the diatom gave highest production values when cultured with this bacterium, with cell densities of $1.3\text{--}2.4 \times 10^6$ cells ml^{-1} ; without NC1 the cell production was about 65% less. Comparing microalgal growth, chlorophyll a concentration, and bacterial load showed a positive statistical correlation, verifying that these three variables increased simultaneously. The results suggested the feasibility of using the NC1 strain as a promoter of growth of *N. veneta* and the potential use of the Tanaka photobioreactor for the mass production of mixed biofilms consisting of diatoms and bacteria, which could be used in settlement of mass cultures of marine invertebrates of commercial importance and/or improving of food in aquaculture.

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AUTOMATIC MEASUREMENT OF ROTIFER BRACHIONUS PLICATILIS DENSITIES IN FIRST FEEDING TANKS

Morten Omholt Alver, Torodd Tennøy, Jo Arve Alfredsen, Gunvor Øie-2007

Aquacultural Engineering 36(2): 115-121

Abstract:

Rotifers are an important live food in the culture of marine fish, but the process of measuring rotifer culture densities is time consuming. This is especially true at low densities such as those applied in first feeding tanks. A particle counter for making automatic measurements of rotifer densities has been designed. The instrument automatically extracts samples, and relies on a digital camera and image processing to measure the rotifer density. Due to its autonomous nature, the instrument is suited for use as a component in a process monitoring and control system.

The rotifer counter design is presented, and the statistical properties of the measurement derived. The accuracy achieved in practical countings is then investigated in a series of test counts. To assess the quality of measurements achieved in an actual first feeding tank with samples extracted from a single location, the rotifer counter is used in an experiment studying rotifer dynamics in a continuously diluted tank. The results indicate that the rotifers are approximately evenly distributed in the water column, and that one needs to consider rotifers attaching to the tank wall to be able to predict rotifer densities under these conditions. The experiment gives an example of the considerable potential for experimental work assisted by the automated rotifer counter.

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TEMPERATURE-DEPENDENT AND SURFACE SPECIFIC FORMALDEHYDE DEGRADATION IN SUBMERGED BIOFILTERS

Lars-Flemming Pedersen, Per Bovbjerg Pedersen, Ole Sortkjær-2007

Aquacultural Engineering 36(2): 127-136

Abstract:

This study investigated formaldehyde removal in submerged fixed media biofilters in commercial and pilot scale recirculation aquaculture systems. Steady removal of formaldehyde (F) was observed immediately after simulated therapeutic treatment in closed systems and complete removal occurred within 1–4 days depending on water temperature. Formaldehyde removal was dependent on available biofilter surface area, and comparable rates of surface specific removal (SSR) were observed in two different systems. SSR was positively correlated to temperature ($Q_{10} = 3.4$) with estimates of 2.1 mg F/(m² h) at 5.7 °C to 6.5 ± 0.2 mg F/(m² h) at 14.5 °C. The estimates for SSR of formaldehyde can be used to predict actual treatment and effluent concentration with more accuracy. Furthermore, the results allow calculation on biofilter removal capacity of formaldehyde, applicable for developing biofilters ensuring sufficient formaldehyde removal in effluent water.

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LARGE-SCALE RACEWAY NURSERY FOR IMPROVED SCALLOP (PECTEN MAXIMUS) SPAT PRODUCTION

Thorolf Magnesen, Gyda Christophersen-2007

Aquacultural Engineering 36(2): 149-158

Abstract:

Variable survival of small hatchery-produced *Pecten maximus* after transfer to sea has been considered a constraint to scallop spat production in Norway. A land-based raceway nursery was introduced as an intermediate step to bridge hatchery post-larval growth and growout in the sea to increase yield and stabilise spat production. The nursery was of a flow-through type with 10 parallel raceways (10 m × 0.6 m × 1.0 m). Seawater (8–19 °C) was filtered through 100 µm mesh and pumped into the nursery at a rate of 6 m³ min⁻¹ (2 cm s⁻¹). Efficiency of the nursery was evaluated based on different growth trials comparing initial spat size, settlement technology and nursery type. Scallops settled either on downwelling screens or collector bags in the hatchery. Spat settled on screens were placed on trays before transfer to nursery, while collector bags were placed directly into raceways. The nursery facilitated growth of scallop spat from 1.5 mm until saleable seed >15 mm shell-height. Growth rates were 1.4–2.3% day⁻¹ for spat of initial size 3, 5 and 7 mm, and 4.2–5.2% day⁻¹ for the fastest growing spat of mean initial size <2 mm. The filter removed fouling organisms and predators successfully, and resulted in stable survival on land (85%), while survival varied from 36 to 84% in the sea. Yield of spat >5 mm per collector bag varied from 46 to 2780, and was not affected by settlement conditions (colour of bag, water circulation and light conditions). Yield of competent larvae from trays averaged 18.9% on land and 14.2% in the sea and was superior to yield from collector bags (2.8%). The downwelling screen-tray method resulted in higher output per unit raceway than did the settlement and growth on collector bags and was thus regarded the most economical method. The land-based nursery had about 20% higher operational costs than the sea-based, but higher survival counterbalanced the extra costs. Using intermediate land-based nursery was proven advantageous to achieve a more cost-effective and stable production of 15–20 mm *P. maximus* spat available to scallop growers in Norway.

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MEMBRANE BIOLOGICAL REACTOR TREATMENT OF A SALINE BACKWASH FLOW FROM A RECIRCULATING AQUACULTURE SYSTEM

Mark J. Sharrer, Yossi Tal, Drew Ferrier, Joseph A. Hankins, Steven T. Summerfelt-2007
Aquacultural Engineering 36(2): 159-176

Abstract:

A recirculating aquaculture system (RAS) can minimize water use, allowing fish production in regions where water is scarce and also placing the waterborne wastes into a concentrated and relatively small volume of effluent. The RAS effluent generated during clarifier backwash is usually small in volume (possibly 0.2–0.5% of the total recirculating flow when microscreen filters are used) but contains high levels of concentrated organic solids and nutrients. When a RAS is operated at high salinities for culture of marine species, recovering the saltwater contained in the backwash effluent could allow for its reuse within the RAS and also reduce salt discharge to the environment. Membrane biological reactors (MBRs) combine activated sludge type treatment with membrane filtration. Therefore, in addition to removing biodegradable organics, suspended solids, and nutrients such as nitrogen and phosphorus, MBRs retain high concentrations of microorganisms and, when operated with membrane pore sizes $<1 \mu\text{m}$, exclude microorganisms from their discharge. In this research, an Enviroquip (Austin, TX) MBR pilot-plant was installed and evaluated over a range of salinities to determine its effectiveness at removing bacteria, turbidity, suspended solids, nitrogen, phosphorus and cBOD₅ content from the approximately 22 m³/day concentrated biosolids backwash flow discharged from the RASs at The Conservation Fund Freshwater Institute. The MBR system was managed at a hydraulic retention time of 40.8 h, a solids retention time of 64 ± 8 days, resulting in a Food: Microorganism ratio of 0.029 day⁻¹. Results indicated excellent removal efficiency (%) of TSS (99.65 ± 0.1 to 99.98 ± 0.01) and TVS (99.96 ± 0.01 to 99.99 ± 0.0) at all salinity levels. Similarly, a 3–4 log₁₀ removal of total heterotrophic microbes and total coliform was seen at all treatment conditions. Total nitrogen removal efficiency (%) ranged from 91.8 ± 2.9 to 95.5 ± 0.6 at the treatment levels and was consistent, provided a sufficient acclimation period to each new condition was given. Conversely, total phosphorus removal efficiencies (%) at 0 ppt, 8 ppt, 16 ppt and 32 ppt salinity were 96.1 ± 1.0 , 72.7 ± 3.5 , 70.4 ± 2.3 , and 65.2 ± 5.4 , respectively, indicating reduced phosphorus removal at higher salinities.

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REMOVAL OF NITROGENOUS SUBSTANCES BY ASPERGILLUS NIGER IN A CONTINUOUS STIRRED TANK REACTOR (CSTR) SYSTEM

Shyi-Chyuan Hwang, Chan-Shing Lin, I-Ming Chen, Jy S. Wu-2007
Aquacultural Engineering 36(2): 177-183

Abstract:

A filamentous fungi was isolated from the biofilter of a freshwater aquacultural system and identified as *Aspergillus niger* NBG5, which can consume ammonium nitrogen, at rates of 0.247 g N (g cell)⁻¹ day⁻¹, at 30 °C. A high concentration favors removal of nitrogenous wastes.

In this investigation, *A. niger* NBG5 was employed in a continuously stirred tank reactor (CSTR) system to remove nitrogen. A total ammonia nitrogen (TAN) of 25 mg L⁻¹ was removed within 35 h from artificial wastewater. TAN and nitrite-N concentrations were decreased to 0.35 and 0.12 mg L⁻¹, respectively, passing CSTR at a hydraulic retention time (HRT) of 3.3 h.

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THE DEVELOPMENT OF A MECHANISTIC MODEL TO INVESTIGATE THE IMPACTS OF THE LIGHT DYNAMICS ON ALGAL PRODUCTIVITY IN A HYDRAULICALLY INTEGRATED SERIAL TURBIDOSTAT ALGAL REACTOR (HISTAR)

Barbara C. Benson, Maria T. Gutierrez-Wing, Kelly A. Rusch-2007

Abstract:

A deterministic model was developed to predict microalgal productivity within the Hydraulically Integrated Serial Turbidostat Algal Reactor (HISTAR). HISTAR consists of two turbidostats, which concomitantly inoculate the first of a series of CFSTRs. The CFSTRs function as a biomass amplifier of the inoculated culture. The model included an analysis of the internal light dynamics within each CFSTR and the effect of the instantaneous average irradiance ($I_{an}(PAR)$) on the instantaneous growth rate (μ_n) within CFSTR $_n$. The latter effect was accomplished using Steele's equation. The instantaneous average irradiance was determined by integrating the Lambert–Beer Law over the depth of the culture within the CFSTRs. Fourier series analysis was used to model the biorhythms of the microalgae. The model was calibrated for biomass using four data sets collected at system dilution rates (D_s) of 0.265 day⁻¹, 0.385 day⁻¹, 0.641 day⁻¹ and 1.127 day⁻¹. The ability of the calibrated model to simulate daily volumetric productivity (P_v) within HISTAR was determined through calculation of the percent standard error of prediction. The overall mean for the four data sets was 24.8%. The average predicted productivity for the data sets was 24.2 g m⁻³ day⁻¹ (16.2 g m⁻² day⁻¹) and the average actual productivity of the data sets were 25.5 g m⁻³ day⁻¹ (19.9 g m⁻² day⁻¹), resulting in only a 5.1% error. Simulations produced by the calibrated model were used to estimate the optimum D_s (between 0.641 day⁻¹ and 0.884 day⁻¹). The model predicted a P_v of 70.2 g m⁻³ day⁻¹ ($P_a = 46.8$ g m⁻² day⁻¹) at optimum D_s . The maximum P_a observed in the model simulations was 39.9 g m⁻² day⁻¹.

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