AquaExcel at Wageningen University

The Metabolic Research Unit (WU-MRU)

In june 2012 the Aquaculture and Fisheries Group, transferred their experimental facilities to the new 1800 m^2 aquatic indoor research facility on the Campus of Wageningen University (WU). The Aquaculture and Fisheries Group is responsible for undergraduate teaching in the Bachelors of Science (MSc) and provides key education and research for the Master of Science (MSc) Aquaculture and Marine Resources Management (MAM). The group is also one of the biological chairs at WU, providing a graduation outlet for Biology students.

The Wageningen University Metabolic Research Unit (WU-MRU) consists of twelve metabolic chambers of 200L all linked to one recirculation system with a total water volume of ± 7 m^3. The recirculation system supplies the 12 metabolic chambers with water and is equipped with an independent (independent of the MRU measurements) water quality (pH, salinity, temperature) and measurement and control system.



The MRU is commonly used for nutrient and energy balance studies (both over a production cycle and/or for within-day variations) and for adaptive physiology studies.

***Fish species*.** Fish species studied in the WU-MRU were: sea bass, turbot, tilapia, African catfish, European eel and R ainbow trout.

***Measurement of environmental factors*.**

Water. Water temperature, Water flow (each metabolic chamber allows on-line monitoring of actual and cumulative water flow), *Oxygen (* in and outlet per metabolic chamber), *pH*, *Conductivity (µS)*, *Salinity*, *CO_2 production/consumption are all measured electronically.* TAN, Urea, NO_2-N, NO_3-N, Dissolved protein, and PO_4-P in the rearing water are measured chemically using an auto-analyzer (Type San autoanalyzer adapted with flow through cuvettes, Skalar, Breda, The Netherlands).



Air. The metabolic chambers allow the measurement of cumulative airflow across each metabolic chamber and on line measurement of O_2 and CO_2 concentration in in and out going air of each metabolic chamber for air breathing fish *species like African catfish and pangasius.*

Photoperiod. The photoperiod can be adjusted.

Measurement of behavior. Mobile webcams (N=16) and imaging analysis software are available to record and analyze behavioral data. The MRU can be equipped with a mobile feeding registration system.

Measerement of digestibility. Mobile faecal collection units (one can choose 12 Choubert faeces collectors or 12 sedimentation funnels or a combination) can be used to study the digestibility of feed nutrients.

Control over environmental factors.

Water temperature. Water temperature can be controlled between 15 and 30℃.The MRU is designed to enable measurements for for cool- and warm water fish.

Salinity. Salinity can be varied from 0 to 35ppt for research with fresh water and marine organisms.

Gasses. All supply water to the metabolic chambers can degassed (< 1 mg O_2/L) where after 4 new, oxygen influent concentrations can be chosen and controlled supplying each 3 metabolic chambers. This enables studies on the response of fish to various O_2/CO_2 ratios in the environment.

pH, salinity, water exchange rate, phosphorus nitrate. The unit can be connected to two identical RAS differing in these water quality parameters to study the effects of these factors on the response of fish.

Data storage. The MRU is equipped with a data acquisition system in which all data can be stored and made available in excel spreadsheets for later analysis. The unit can be connected to two identical RAS differing in water quality (pH, salinity, water exchange rate, nitrate level) to study the effects of these factors on the response of fish.

***Services currently offered by the WU-MRU infrastructure*:** The metabolic research unit offers a research environment for studies on nutrient and energy balances and metabolism in fish (both over a production cycle and for within-day variations). The research questions in the metabolic research unit relate to how animal factors (genetics, phenotypic differences and health status) nutritional factors and environmental factors (temperature, oxygen concentration, carbon dioxide concentration, stocking density, sex ratio and housing conditions) affect responses of animals. Research has focused on adaptive physiological responses of fish to various husbandry conditions, such as the changes in feed intake behaviour and nutrient utilization when ambient oxygen conditions are pre-set at different levels (tilapia) or carbon dioxide levels are pre-set at different levels (seabass). Studies were combined with changes in feed composition (substitution of animal by plant proteins and different levels of non-starch polysaccharides, affecting the viscosity of the chyme and other intestinal ecological parameters), chronic (density; light

conditions) and acute (netting) stress conditions. Measured responses in the metabolic research unit strongly depend on the research questions involved, but generally, feed efficiency, feeding behavior (latency and feeding time), digestibility, heat production and behavior are among the measurements performed. In addition, these measurements may be combined with blood parameters and anything you can measure at slaughter. Studies were partly conducted through EU funded research (for example, the WEALTH project (SSP8-CT-2003-501984) investigating the metabolic effects of rearing European Seabass in extreme high densities, and at high CO_2, low O_2 levels in RAS). Visiting scientists and PhD's were using the metabolic research unit. Currently the unit is in use in PhD studies and national projects.

The metabolic research unit is advanced in*:* (1) its water degassing possibility and capacity. All supply water to the metabolic chambers can degassed (< 1 mg O_2/L) where after 4 new, oxygen influent concentrations can be chosen and controlled supplying each 3 metabolic chambers, (2) measurement of O_2 consumption and CO_2 production in water and air (unique), (3) high accuracy and stability of the online water flow measurement across the metabolism chambers, in combination with mobile webcams per chamber for behavioral studies and on line water quality measurements , (4) it can be operated in fresh and salt water, cold and warm water (flexibility, rare), (5) measurement of within days variation by concomitant determination of O_2 consumption (from water and air), CO_2 production (in water and air), TAN, Urea, Orthophosphate, temperature and pH.