

OPTIMIZING RAINBOW TROUT GROWTH IN A MARINE RECIRCULATING AQUACULTURE SYSTEM

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ABSTRACT

Rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792), one of the most cultured fish species worldwide, has also proved to be suitable for aquaculture in Romanian Black Sea waters during the cold season, recording an optimal growth rate and excellent meat quality. Raising seawater temperatures during summer, however, could be a major drawback for year-round marine farming operations. In this context, this research aimed at testing rainbow trout's growth performance in a recirculating aquaculture system (RAS). Two rainbow trout batches (mean initial biomass 30-40 g/fish, 50 fish/batch) were transferred directly from a mountain farm to seawater in NIMRD's aquaculture laboratory. The fish were placed in two 700-L circular fibre-reinforced plastic tanks, connected to a modern RAS fitted with biological and mechanical filters, a high-capacity protein skimmer, UV and ozone sterilization. Water temperature upon transfer was 15°C and no adjustments were made initially, to allow screening the fish's response to natural variations. After six months of monitoring, encouraging results were obtained: the fish reached impressive biomasses in just six months (mean over 700 g/individual), with no appetite suppression and behaviour changes up to 24.5°C, which indicates that the species can tolerate higher temperatures and be convenient for cage farming at the Romanian coast. No mortalities were recorded, only occasional gastric dilation and air sacculitis (GDAS) occurrences in some individuals.

Keywords: *Oncorhynchus mykiss*, RAS, biomass, seawater, aquaculture

INTRODUCTION

Rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792) is indigenous to cold-water lakes and rivers along the Pacific coasts of Asia and North America. Due to its superior tolerance for a wide range of environmental and production conditions over other trout species, rainbow trout has been introduced to approximately 82 countries around the world - everywhere conditions are favourable for its culture (Woynarovich *et al.*, 2011). It was among the first fish species to have its entire life cycle reproduced for farming purposes. It is one of the species with the longest history in contemporary aquaculture, having been cultivated since the late 19th century (Gall and Candell, 1992). Rainbow trout can live in a variety of environments, from an anadromous life cycle (the "steelhead" strain, which lives in the ocean but spawns in well-oxygenated rivers and streams) to a permanent inhabitation of freshwater lakes (FAO, 2021).

As one of the most widely cultivated species in aquaculture, it is raised in a range of systems, both in fresh and saltwater. Due to its temperate origin and ideal growing temperature of less than 21°C, it is typically grown in mountain areas in lower latitude countries (Sedgwick, 1995). Since the 1950s, rainbow trout production has increased

steadily worldwide, particularly in Europe and more recently in South America and Asia (D'Agaro *et al.*, 2022). Increased inland production in countries like France, Italy, Denmark, Germany, and Spain to serve local markets and mariculture in cages in Norway and Chile to provide the export market are the main drivers of this. The largest producer worldwide is China, with around 200,000 tons per year, followed by Chile, where annual production amounts to approximately 150,000 to 170,000 tons of trout. (FAO, 2021). Moreover, rainbow trout is one of the most important sources of animal protein, and its production effectively supports the growing demand for fish. In certain countries, such as Chile, Norway, and Turkey, trout aquaculture is a significant industry that fosters rural economies, creates a large number of local jobs, and boosts exports (Ceballos *et al.*, 2025).

In the Black Sea region, rainbow trout aquaculture in floating cages began in Turkey in the early 1970s on the east coast between Sinop and Gerze (Şener, 2002) and expanded significantly in the 1990s (Akbulut *et al.*, 2002). In the Black Sea region of Turkey, there are over 300 rainbow trout farms with varying production capacity (FAO, 2022). The fish are moved at sea during the cold season primarily because their production proved higher (by over 10%) than that of farms that only raised rainbow trout in freshwater (Şener, 2002).

Prior to 1989, in Romania the forest management authority and the nationwide network of professional hunters' and fishermen's clubs were in charge of trout aquaculture, including both brown *Salmo trutta* (Linnaeus, 1758) and rainbow trout *O. mykiss*. The state provided subsidies to fish hatcheries, which were part of the fishing organizations run by the two administrations (Bogan and Iamandei, 2016). Trout breeding has grown significantly in freshwater aquaculture systems since 1990 and has been marketed from an economic and touristic perspective and the number of Romanian businesses dedicated to trout farming, either in raceways has increased annually (Nenciu *et al.*, 2022).

Drawing from global experience and research, experiments were conducted between 1981 and 1985 within the Romanian Marine Research Institute (currently the National Institute for Marine Research and Development "Grigore Antipa"/NIMRD), aiming to develop the technology for rearing rainbow trout in Black Sea water under the conditions of the Romanian coast (Zaharia *et al.*, 2017). These first experiments demonstrated that an early switch to sea water causes growth to increase by about 20% when compared to freshwater. The lack of formulated high-quality feed for large-scale cultivation, however, was the primary obstacle to the technology's application. All fish meals were hand-prepared by adding carotenoids from beet and shrimp shells, which resulted in high operating costs (Zaharia *et al.*, 1998). Research on marine water rearing was resumed, and, in 2022, the outcomes were more than encouraging: *O. mykiss* batches were transferred to marine water from a mountain trout farm. Upon completion of the seven-month experiment, growth parameters showed values almost four times higher compared to freshwater culture, the results indicating smaller fish as best fitted for transfer to marine water. The professional carotenoid-enriched feed

provided to the fish resulted in a very nutritious meat, with the highly appreciated pink colorization (Nenciu *et al.*, 2022).

In the context of an increasing interest of economic operators to engage in trout farming in marine water at the Romanian coast, this research aimed at testing the species' growth performances in a recirculating aquaculture system (RAS), under controlled conditions, to determine the optimal parameters for seawater rearing.

MATERIALS AND METHODS

Fish transfer and husbandry

The trial covered six months, from November 2024 to May 2025. The rainbow trout specimens were transferred from a mountain hatchery in Prahova County ("Păstrăvăria Valea Stânii Zăganu"), 300 km away from the Black Sea coast, and transported by car using a live fish fiberglass reinforced transport container provided with oxygen supply (Fig. 1 left). The two rainbow trout batches (mean initial biomass 30-40 g/fish, N = 50 fish/batch) were transferred directly from freshwater to seawater in NIMRD's aquaculture laboratory (Fig.1 right). The fish were placed in two 700-L circular fibre-reinforced plastic tanks, connected to a modern RAS fitted with biological and mechanical filters, a high-capacity protein skimmer, UV and ozone sterilization (model MAT-RAS CPT 10) (Fig. 2). Temperature (°C), salinity (PSU), pH and dissolved oxygen (DO) (%) in both experimental tanks were measured regularly, using a Mettler Toledo Seven Excellence Multiparameter.



Fig. 1. Collection of *O. mykiss* juveniles from the freshwater mountain farm (left) and transfer to NIMRD's aquaculture laboratory directly to marine water (right)
(original photos Magda Nenciu)



Fig. 2. NIMRD's CPT 10 RAS (left) and rainbow trout in experimental fiberglass tanks (right)
(original photos Magda Nenciu)

Feeding protocol

Two types of fish meal were provided during the experimental period, both produced by Skretting. During the first three months, Optiline 2P F 3 mm extruded floating pellets were fed to the fingerlings (crude protein 44%, crude fat 28%, ash 5%, fiber 2%). For the remaining three months, Focus Salmo 3P F 7 mm extruded floating pellets (crude protein 41%, crude fat 24%, ash 8%, fiber 3%), enriched with astaxanthin (90 mg/100 g), were given, at a calculated food ration of 2% of the fish biomass (Zaharia *et al.*, 2017). The Focus Salmo line was created especially to guarantee rainbow trout's optimal fillet colouring. Fish fillet pigmentation is a physiological process in which ambient factors (saltwater), antioxidant nutritional profiles, and feed raw materials all play significant roles (Bjerkeng *et al.*, 1992).

Growth monitoring

The length and weight of each of the 50 fish in each experimental tank were measured on a monthly basis. An ichthyometer was used to measure the specimens' total length (TL) to the nearest 0.5 mm (Fig. 3 left). To find the fish's total weight (TW), a Kern PBJ-N top loading precision balance with readability $d \geq 0.01$ g was utilized (Fig.3 right).

The biometric and gravimetric data collected throughout the six-month study were used to compute the Feed Conversion Ratios (FCR), Specific Growth Rates (SGR%/day), and Fulton's Condition Factor (K). The Length-Weight relationship of the entire rainbow trout lot was also calculated according to Froese (2006):

$$W = a \times L^b$$

Where: W = total weight (g), L = total length (cm), a = intercept, b = slope.

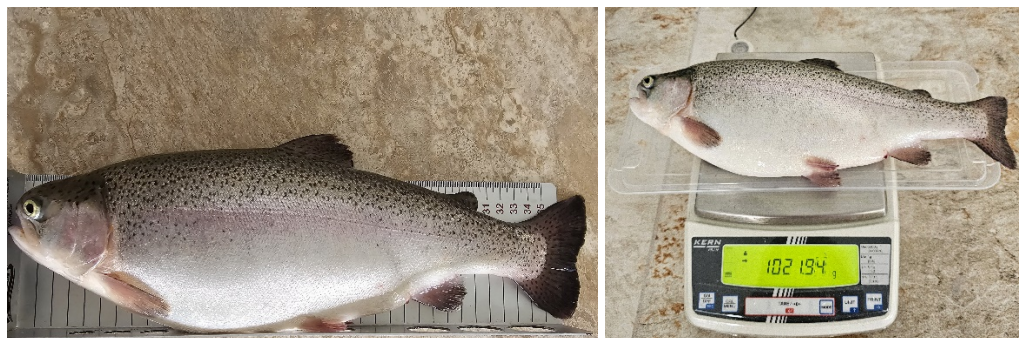


Fig. 3. Length (left) and weight (right) measurements on rainbow trout individuals
(original photos Victor Niță)

The formulas used to determine the Specific Growth Rate (SGR%/day) and the Feed Conversion Ratio (FCR) were the following (Hopkins, 1992):

$$\text{FCR} = \Sigma f_k / W_t - W_0$$

$$\text{SGR} = 100[(\ln W_t - \ln W_0) / t]$$

Where: t = feeding days; W_0 = initial live weight of fish (g); W_t = final live weight of fish (g); L = total length (cm), and f_k = weight of feed consumed by fish at each feeding (feed intake) (g).

Fulton's Condition Factor (K) was calculated using the equation given below (Nash *et al.*, 2006):

$$K = (W / L^3) * 100$$

Where: W = total weight (g), L = total length (cm).

Statistical analysis

For the statistical interpretation of the results, data from the two batches were pooled for a paired T-test analysis and differences at the 5% level ($p < 0.05$) were considered significant (Guy and Grown, 2007).

RESULTS AND DISCUSSION

No mortalities were recorded during transportation from the mountain farm and, after the direct transfer to the experimental tanks, rainbow trout fingerlings were carefully monitored, to document any behavioral change caused by increased salinity (from 0.3‰ measured in freshwater to 16.6‰ in the RAS). Water temperature upon transfer was around 10°C in the transport container and 15°C in the experimental tanks. All specimens in both batches displayed normal swimming behaviour and no stress indications were visible, despite the abrupt salinity change and relatively high difference in temperature. For fish to overcome any negative influence of this switch,

feeding began after 24 hours post-transfer, at the calculated 2% ration, and the full consumption of the pellets was observed.

Temperature, salinity, dissolved oxygen, and pH were regularly measured during the six-month experiment (Table 1), and there were no discernible differences between the two experimental batches ($p \geq 0.05$).

Table 1. Mean monthly values of environmental parameters during the experimental period (NS*).

Month	Temperature (°C)		Salinity (‰)		Dissolved Oxygen (%)		pH	
	Tank 1	Tank 2	Tank 1	Tank 2	Tank 1	Tank 2	Tank 1	Tank 2
Nov.-Dec.	20.35±0.93	19.91±1.08	16.19±0.93	16.81±1.52	72.14±4.35	73.04±3.89	8.15±0.03	8.09±0.03
Dec.-Jan.	17.23±0.61	16.77±0.68	15.32±0.56	15.84±0.62	65.48±3.29	66.72±3.12	8.17±0.07	8.18±0.05
Jan.-Feb.	17.27±1.77	18.05±0.68	15.29±0.15	15.83±0.63	71.21±2.49	71.79±2.27	8.05±0.05	8.03±0.06
Feb.-March	16.96±0.88	16.62±0.97	16.02±0.70	16.56±0.50	68.35±3.62	65.78±3.81	8.02±0.04	8.05±0.07
March-Apr.	17.10±0.84	16.69±0.89	16.77±0.24	16.31±0.15	63.84±3.78	65.17±2.91	8.05±0.08	8.04±0.09
Apr.-May	16.79±0.30	16.25±0.29	15.80±0.48	15.43±0.42	61.70±2.44	62.95±2.63	8.01±0.06	8.13±0.08
Mean values	17.61±0.88	17.36±0.76	15.89±0.51	16.13±0.64	67.12±3.32	67.57±3.10	8.07±0.05	8.08±0.06

* According to statistical analysis (paired t-test), the values among tanks (fish batches) were not significantly different ($p \geq 0.05$).

One of the aims of our study was to test the high temperature tolerance of rainbow trout, in order to determine some thresholds for potential rearing in the Black Sea, under the circumstances of constant warming of seawater in recent years: in 2023, the average temperature of 14.89°C was 2.44°C higher compared to the 1953-2022 annual means (Vlăsceanu-Mateescu and Lazăr, 2024). *O. mykiss* is documented to cope with a wide range of temperatures, starting from 1°C to 27°C, yet steady growth and spawning occur only between 10°C and 20°C (Molony, 2001; Enders and Durhack, 2022).

During the first month of testing, temperature in the experimental tanks was not altered and all fish were carefully observed. When values surpassed 21°C, behavioral changes started to occur in both batches: swimming became less active and the amount of ingested food gradually reduced, as uneaten pellets were noticed floating. The maximum temperature recorded during our test was 24.5°C (in late November, indoor RAS), at which point fish completely refused feeding. In order not to compromise the experimental batches, a chiller was turned-on, and water temperature dropped to 17°C within 24 hours. All *O. mykiss* individuals immediately resumed their normal behaviour.

Our findings are in line with several literature references which indicate that the critical thermal maxima (CTM) for rainbow trout are around 24-26°C (Bidgood, 1980; Bowlby and Roff, 1986; Currie *et al.*, 1998), even up to 29°C (Rodnick *et al.*, 2004). These high temperatures are often recorded at the Romanian Black Sea coast during summer (Vlăsceanu-Mateescu and Lazăr, 2024), thus the transfer to marine water should occur from autumn to spring, so as to benefit from the ideal temperature for biomass gain

and to steer clear of high temperatures that could jeopardize the batch (Nenciu *et al.*, 2022).

Regarding salinity, this parameter was constant during the 6-month experimental trial, around a mean value of 15-16‰ (Table 1). Even though a gradual adaptation to salinity is recommended before full exposure to marine water (Landless, 1976; Guner *et al.*, 2006), simulating the “natural” movement of some trout species into saltwater, an immediate movement of fish from freshwater to marine water was performed, in order to imitate a direct commercial transfer of rainbow trout fingerlings for biomass gain purposes, time efficiency and economic profit. The direct transfer to marine water did not cause any osmotic shock, nor any ethological changes in both replicates. Even more so, it seemed to stimulate fish appetite, which was reflected in the growth performance detailed below. Previous studies concluded that salinity may influence fish appetite and, consequently, biomass gain (McKay and Gjerde, 1985; Nenciu *et al.*, 2022), and food intake was reported to be highest in the intermediate salinities of 15 to 28‰, and much lower in freshwater and at salinities above 30‰ (MacLeod, 1977). Brackish water, as is the case of the Black Sea, is documented to enhance the survival and weight gain of rainbow trout (Tatum, 1976).

Throughout the experiment, dissolved oxygen concentrations ranged between 61% and 73% (Table 1), slightly decreasing as the biomass of the fish increased. Considering that the solubility of oxygen differs, with seawater’s levels being significantly lower than those of freshwater (Molony, 2001), the risk of low DO levels was mitigated by perpetually guaranteeing adequate water circulation and supplementary aeration within the tanks. DO concentration is considered as the critical factor for the survival of *O. mykiss* from spawning to hatching (Rubin, 1998). The species is known to be highly sensitive to oxygen depletion, even as adults, the optimal range being between 60% to 80% (Molony, 2001; Uiuu *et al.*, 2020). Extended exposure to low DO conditions or concentrations below the minimum tolerable level can lead to increased stress and reductions in feed intake, growth, and feed conversion - none of these negative events occurred during our trial. The specific concentration of dissolved oxygen that causes acute adverse health effects, including death, can vary based on multiple factors, including rising feed loads and high stocking density (Welker *et al.*, 2019). Nevertheless, asphyxiation-related deaths have been documented in *O. mykiss* in water where the DO concentration was below 50% (Mathias and Barica, 1985).

Throughout the experiment, stable pH values of approximately 8 in both tanks were recorded (Table 1). This is suitable for the development of rainbow trout. Because of the acidification of aquatic environments as a consequence of climate change, the pH tolerance of rainbow trout has been thoroughly examined (Molony, 2001). The overall results indicated that trout can survive at pH values below 5 (McDonald *et al.*, 1991). Edwards (1978) noted in one of the limited studies investigating the impact of elevated pH on trout that a pH greater than 9 can be lethal for salmonids, particularly during the vulnerable egg and early fry phases.

The evolution of the four parameters monitored in NIMRD’s RAS (temperature, salinity, DO and pH), with no major variations potentially threatening the experimental

batches, strongly suggests that recirculating systems are safe for fish aquaculture. Globally, rainbow trout culture has been traditionally practiced in concrete raceways (on land, in freshwater) and in floating cages (at sea), yet the recent popularity of RAS systems, with high stocking density, has made its culture more profitable with huge potential of expansion (Mehran *et al.*, 2023).

Recirculating aquaculture systems are advanced fish farming systems that use water recirculation to maintain high water quality and reduce environmental impacts. In RAS, water is continuously recycled within the system, minimizing the need for large volumes and preventing the release of waste into the surrounding environment, which makes them more sustainable and compared to traditional open-net systems. They provide a high degree of environmental control, allowing to mitigate the risks of natural hazards, pollution, predation and disease, and also foster optimized species growth on a year-round basis (Cocan *et al.*, 2008). However, when considering the use of such a system, economic performance must also be considered, as it employs high operational and maintenance costs - regardless of the optimal biomass yield, the market value should be thoroughly surveyed.

Growth and biomass gain of rainbow trout reared in a Black Sea water RAS were another keystone aim of our research. Table 2 below summarizes the average values of the growth parameters recorded over the experimental period.

Table 2. Growth parameters recorded by rainbow trout in the marine water RAS during the experimental period (mean values and standard deviation).

Parameter	Tank 1	Tank 2	Paired t-test
Initial length (cm)	15.3±1.34	15.4±2.33	NS
Final length (cm)	39.8±2.23	39.00±1.87	NS
Initial weight (g)	39.74±1.98	41.43±2.43	NS
Final weight (g)	725.76±45.65	720.32±42.34	NS
K	1.27±0.17	1.30±0.20	NS
FCR	1.26±0.79	1.25±0.75	NS
SGR (%/day)	1.62±0.74	1.58±0.68	NS

NS = statistically non-significant ($p \geq 0.05$)

Length evolution was steady and linear throughout the experiment, all fish in both batches reaching around 39 cm after six months, with no significant differences among batches ($p \geq 0.05$) (Fig. 4). These values are comparable to rainbow trout reared in cages in seawater (Akbulut *et al.*, 2002), but higher than those recorded in a freshwater RAS using fingerlings of the same initial size (Cocan *et al.*, 2008).

As far as the rainbow trout biomass evolution during the experimental rearing in the marine RAS, the fish in both batches grew extensively from month to month, at a rather constant rate ($p \geq 0.05$) (Fig.5). During the six-month trial, the mean starting weight around 40 g multiplied 18 times, *O. mykiss* reaching an impressive mean biomass over 700 g, overcoming significantly the reported biomass growth of rainbow trout cultured exclusively in freshwater either in classical raceways (Ihuț *et al.*, 2014) or in

RAS (Cocan *et al.*, 2008). The maximum weight of some individuals in both batches surpassed 1,000 g, which is an impressive value even for marine water in such a short time frame (Woynarovich *et al.*, 2011).

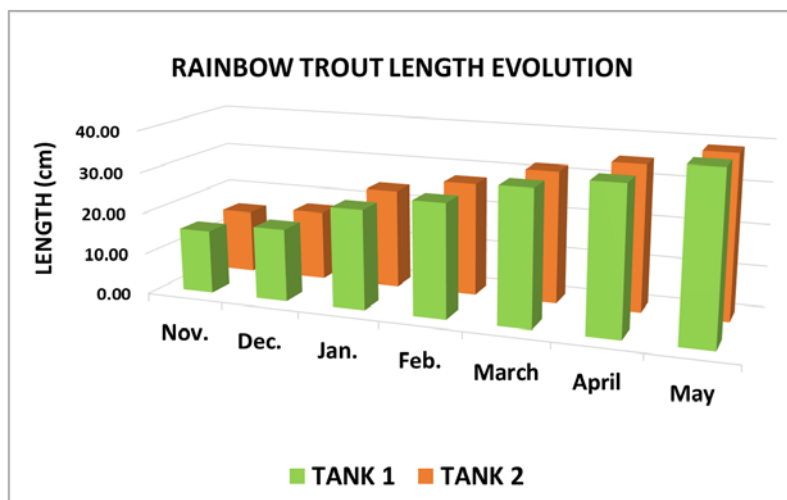


Fig. 4. Evolution of mean rainbow trout length (monthly means)

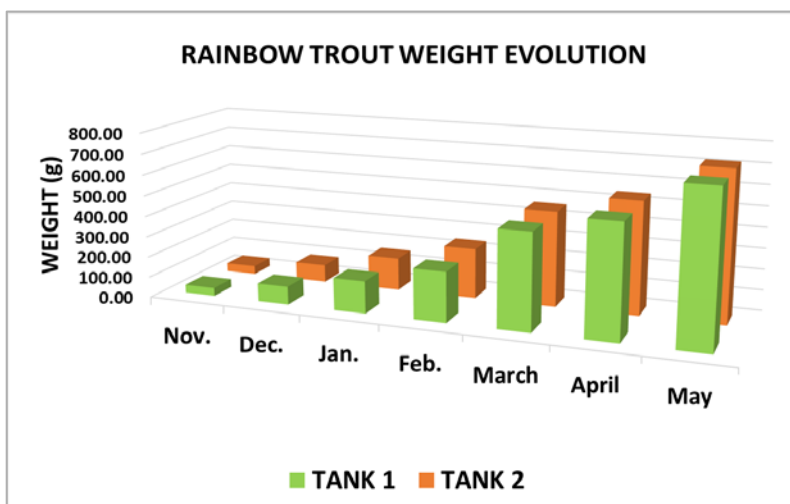


Fig. 5. Evolution of mean rainbow trout weight (monthly means)

This optimal increase is also supported by Fulton's Condition Factor (K) for the two batches, which recorded mean values of 1.27 (Tank 1) and 1.30 (Tank 2), respectively (Fig.6), thus indicating a good condition of the specimens ($K = 1.30$ describes a good, well-proportioned fish) (Barnham and Baxter, 1998). The value of K, which indicates the physical state of the fish (it should be more than 1.0 for rainbow trout), was within the typical limits during our investigation and was in line with K values found in cage-cultured *O. mykiss* in Turkish Black Sea waters (Akbulut *et al.*, 2002) and

in a marine flow-through system previously tested in our laboratory (Nenciu *et al.*, 2022).

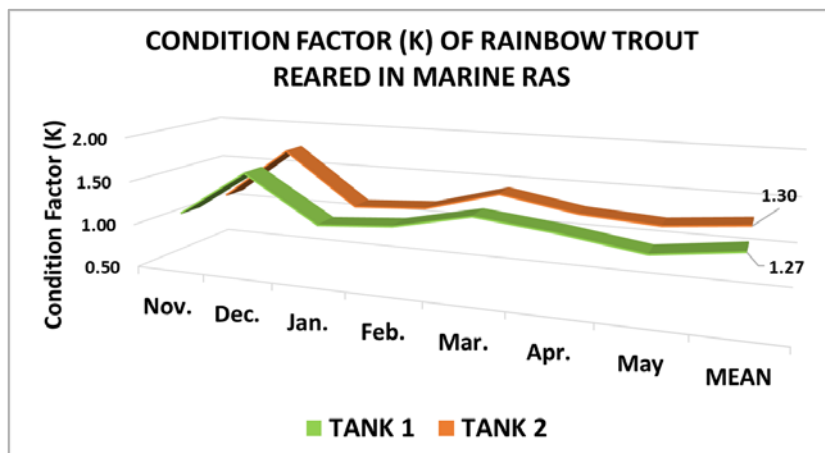


Fig. 6. Monthly means of the Condition Factor (K) of rainbow trout reared in NIMRD's RAS

The Length-Weight relationship also indicated a steady and linear increase (Fig. 7), the values of the coefficient of correlation ($R = 0.9454$) and slope ($b = 3.125$) being in line with the ones reported for the species (Moutopoulos and Stergiou, 2002; Sharma and Bhat, 2015; Dürrani, 2023).

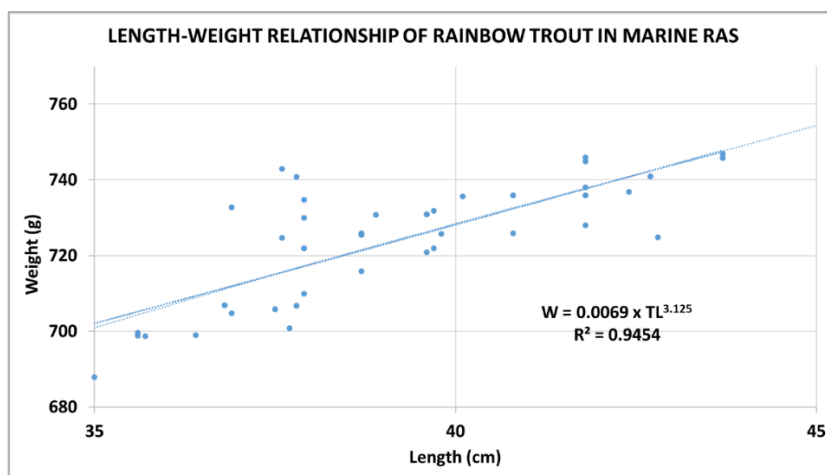


Fig. 7. Length-Weight relationship of rainbow trout reared in NIMRD's marine RAS (trial period November 2024 to May 2025)

The excellent intake of the fish meal provided resulted in mean Food Conversion Ratios (FCR) close to 1, namely 1.26 for Tank 1 and 1.25 for Tank 2 (Fig. 8), which indicates a good efficiency of the Skretting pellets. The FCR values were higher compared to the ones recorded in our previous study in a flow-through system (Nenciu *et al.*, 2022), most likely due to the smaller initial size of the fish and the faster growth

rate. The current FCR results are in line with comparable values reported for rainbow trout raised in seawater (Akbulut *et al.*, 2002). *O. mykiss* specimens reared in freshwater, on the other hand, exhibited higher FCR values (up to 2) (Hosseinzadeh and Nafari, 2014; Pirali *et al.*, 2014), indicating that the species' food conversion efficiency is enhanced by marine water culture.

The high Specific Growth Rates - SGR (%/day) of rainbow trout reared in the marine RAS (1.62 in Tank 1 and 1.58 in Tank 2, respectively) confirm, once again, that the combination of saltwater with a recirculating system contributes to an optimized biomass gain, these values being higher than those of *O. mykiss* reared in open sea cages, which were reported around 1 (Akbulut *et al.*, 2002).

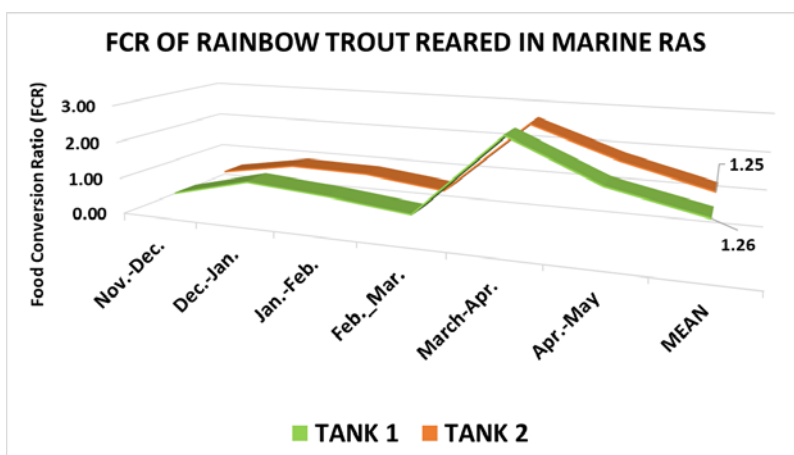


Fig. 8. Monthly means of the FCR (Food Conversion Ratio) of rainbow trout reared in NIMRD's RAS

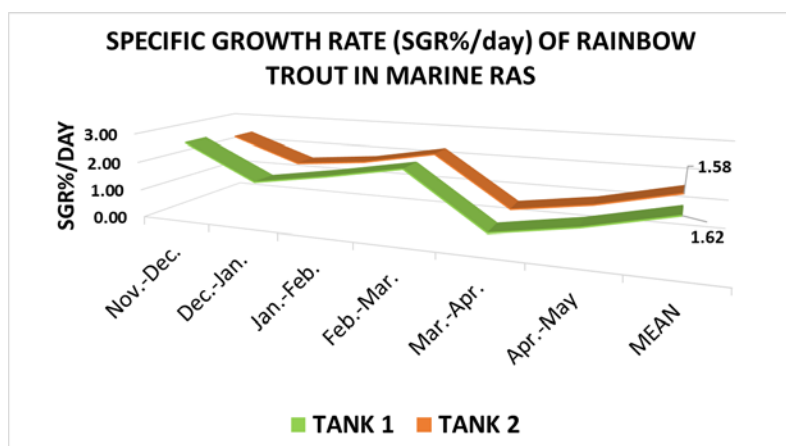


Fig. 9. Monthly means of the Specific Growth Rate (SGR%/day) of rainbow trout reared in NIMRD's RAS

No mortalities were recorded during the experimental period, only occasional gastric dilation and air sacculitis (GDAS) occurrences in some individuals (two specimens per batch). In order to accurately document this event, one individual was sacrificed and subsequently dissected (Fig. 10), being excluded from growth parameter calculation and statistical analysis.



Fig. 10. Gastric dilation and air sacculitis (GDAS), also known as “water belly”, documented in rainbow trout reared in NIMRD’s RAS (*original photos Magda Nenciu*)

The affected specimens exhibited abnormally bloated bellies, which otherwise did not seem to alter their overall behaviour. Upon dissection, it was concluded that the stomach was filled 90% with water and 10% with food. GDAS or “water belly” is a non-infectious condition where the abdomen of salmonids is abnormally distended by an enlarged, water-filled stomach. The condition is most often seen in salmonids reared in marine water (Anderson, 2006). Abdominal distension syndrome appears to be more common when the salinity of the water rises and when the water temperature falls. Rainbow trout are known to experience osmoregulatory failure due to low water temperatures and excessive salinity levels (Finstad *et al.*, 1988).

Although the exact etiology of this illness is unknown, possible contributing factors include increased lipid intake, temperature, stress, and osmotic control failure; increased consumption of seawater; and nutritional overloading brought on by overfeeding (Staurnes *et al.*, 1990). Despite the possibility of death, afflicted fish can live for weeks (Forgan and Forster, 2007) and it can be reversed by altering the food’s composition or reducing the feeding schedule after the fish have been hungry for a few days (Densmore, 2019). Even though it was definitely not a case of overfeeding, as the ration was calculated at 2% of the fish biomass, feeding was stopped for one day and, subsequently, the bloating decreased and ultimately disappeared, the affected fish fully recovering after this event.

CONCLUSIONS

The research aimed at investigating rainbow trout's growth performance in a marine RAS after direct transfer from freshwater to seawater. No mortalities were recorded during transportation from the mountain farm, nor during the trial covering six months (November 2024 to May 2025). Notwithstanding the sudden change in salinity (from freshwater to 16‰) and the relatively large temperature difference (from 10°C to 15°C), all individuals in both batches exhibited typical swimming behaviour and showed no signs of stress. Feeding started 24 hours following the transfer, at the calculated 2% of fish biomass ration. The use of the modern RAS system ensured an optimal control of environmental parameters. From the health and welfare point of view, no mortalities were recorded during the experiment, only occasional gastric dilation and air sacculitis (GDAS) occurrences in some individuals.

Temperature tolerance testing revealed that *O. mykiss* individuals start modifying their behaviour beyond 21°C, with a complete refusal of feeding at 24.5°C. Salinity, on the other hand, was not problematic at all, the constant value around 15‰ being optimal for a sustained growth, with no osmotic shock as a follow-up of the rapid transfer. Dissolved oxygen (mean around 65%) and pH values (mean around 8) recorded during the trial were optimal for rainbow trout aquaculture.

The biomass gain recorded in the marine RAS was excellent, the fingerlings multiplying their initial 40 g weight 18 times, obtaining values three-four times higher compared to rainbow trout aquaculture in freshwater. The maximum weight of some individuals in both batches surpassed 1,000 g, which is an impressive value even for marine water in such a short time frame. The Condition Factor (K), Length-Weight Relationship (LWR), Food Conversion Ratio (FCR) and Specific Growth Rates - SGR (%/day) recorded values that confirm that the combination of saltwater with a recirculating system contributes to an optimized biomass gain. However, because such a system has substantial operating and maintenance expenses, economic performance must also be taken into account when considering its use. Regardless of the ideal biomass production, a full market value survey should be conducted.

Future research endeavours envisage monitoring the growth performance of rainbow trout *in situ* - in sea cages under actual Black Sea conditions.

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