LETOPIS NAUČNIH RADOVA / ANNALS OF AGRONOMY
Vol. 45, No 2, 135-142
UDK: 374.136

Poljoprivredni fakultet
Univerzitet u Novom Sadu

Recirculating Aquaculture Systems (RAS) in Serbia: a legislation gap in comparison with European Union

Miroslav I. Urošević[a*], Jasna Grabić[b], Ana Gavrilović[c], Jurica Jug-Dujaković[d]

[a]University of Novi Sad, Faculty of Agriculture, Department of animal science, Novi Sad, Serbia
[b]University of Novi Sad, Faculty of Agriculture, Department of Water Management, Novi Sad, Serbia
[c]University of Zagreb, Faculty of Agriculture, Department of Fisheries, Apiculture, Wildlife management and special Zoology, Zagreb, Croatia
[d]Sustainable Aquaculture Systems Inc., 715 Pittstown Road, Frenchtown, NJ 08825, USA
*Corresponding author: miroslav.urosevic@stocarstvo.edu.rs

ABSTRACT
Recirculating Aquaculture Systems (RAS) reduce water consumption, using recycling technologies thereby producing significantly less wastewater than traditional fish farms The limited use of water makes it much easier and cheaper to remove the nutrients excreted from the fish, as the volume of discharged water is much smaller and solids and diluted waste are more concentrated than in the water discharged from a traditional fish farm and therefore much easier to process. Recirculation aquaculture can therefore be considered as most environmentally friendly way of producing fish at a commercially viable level. In contrast to European Union countries where registration and operation of RAS facilities are strictly regulated by law, Serbian legislation appears to be vague and unspecific about the matter. Serbia is making significant advance to becoming one of the European Union countries so it needs to harmonize its legislation to the one in force in the Union. Accordingly, the purpose of this paper is to provide a review of the existing legislation in the European Union and research papers, making a proposal for future Serbian regulation, concerning the functioning, establishment, and management of this type of most modern aquculture facilities.

Key words: fish production, closed system, EU-regulation, ecology

Introduction

Aquaculture provides about half of the fish for human consumption worldwide (Papacek et al., 2018). The application of new aquaculture technologies and the introduction of technologies known in other industries are one of the ways for developing ecologically, socially, financially and energetically sustainable aquaculture production. Recirculating Aquaculture Systems (RAS) reduce water consumption, using recycling technologies thereby producing significantly less wastewater than traditional fish farms (Gavrilovic and Jug-Dujakovic, 2019).

Recirculation aquaculture is essentially a technology for farming fish, or other aquatic organisms by reusing the water in the production. The technology is based on the use of mechanical and biological filters, and the method can in principle be used for any species grown in aquaculture such as fish, shrimps, clams, etc. The limited use of water makes it much easier and cheaper to remove the nutrients excreted from the fish, as the volume of discharged water is much smaller and solids and diluted waste are more concentrated than in the water discharged from a traditional fish farm and therefore much easier to process. Recirculation aquaculture can therefore be considered as most environmentally friendly way of producing fish at a commercially viable level. Controlling parameters such as water temperature, oxygen levels, or photoperiod for that matter, give stable and optimal conditions for the fish, which again gives less stress and better growth. However, one major aspect to be mentioned right away is the health status of the breeding population. The impact of pathogens is considerably lowered in a recirculation system as invasive diseases from the outside environment are minimised by the limited use of water and by the constant cleaning and sterilizing the water. Only dry feed can be recommended for use in a recirculation system. The use of dry feed is safe and also has the advantage of being designed to meet the exact biological needs of the fish (Bregnballe, 2015).

The implementation of strict environmental legislation, e.g. in northern Europe, to minimise pollution from hatcheries and aquaculture plants has promoted rapid technological development of RAS (Martins et al., 2010; Bregnballe, 2015). Such systems are frequently referred to as “environmentally friendly”, due to e.g. lower water requirements, lower nutrient and carbon discharge, better hygiene and disease management, better biological pollution control (with no escapees) etc. (Martins et al.,

2010; Rijn, 2013; Bregnballe, 2015; Heldbo and Meyer, 2016). However, RAS cannot eliminate effluent and waste discharge completely. Particulate matter, such as fish faeces, uneaten food, bioflocs (from biofilters used in for breakdown of ammonia and organic matter) etc. must be separated from the recirculating water (Badiola et al., 2012; Bregnballe, 2015). These particles are usually removed from the culture tanks via sedimentation and filtration, in the form of sludge (diluted mixture of solids and water from e.g. filter backwash, culture tank cleaning etc.). In general, RAS sludge has low solids content (bellow 2%) but can fluctuate in volume due to changes in feeding and cleaning regime (Mirzoyan et al., 2008, Heiderscheidt et al., 2020).

To the best of our knowledge, currently there are no registered RAS facilities in Serbia ("De jure"), in the sence of European Union (EU) regulatory framework. Contrary, there are "De facto" present a few facilities in Serbia which operation is not in line with the EU legislation. This was the motivation to conduct an analysis of regulations in the field of RAS.

In this study, we provide a short analysis of the existing legislation in the European Union, making a comparison with the Serbian regulation concerning the establishment, functioning and management of RAS. In fact, despite the current situation of symbolic presence of RAS facilities in the country, the entry into force of the existing set of European laws may represent for Serbia a keystone in the process of accession to the EU in the field of fisheries.

The definition of RAS in the frame of EU legislation

The most important issue EU legislation is addressing, concerning aquaculture production, is environmental protection, which is ensured in three ways:

(1) prevention of pollution generated from aquaculture/fish breading facilities,
(2) water saving and
(3) protection from escaping of breeded organisms (which might be alien specimen) into environment.

To ensure satisfying all requests it is adopted that systems are "closed aquaculture facility" and this is the official term for RAS in the EU legislation. According to the Regulation (EU) No 304/2011 (EU-Regulation, 2011) this definition is clarified by amending of the previous Council Regulation (EC) No 708/2007 (EU-Regulation, 2007). Reaching the first the two goals – prevention of polluting environment and water saving, are ensured by requiring that facilities are closed systems. In such systems water recirculates and only a small amount of additional water (10 to 20%) in necessary to provide during breading period, while the rest of the water from culture tanks is filtered and returned into the system.

Furthermore, special attention was pay to defining "alien species". The Community-funded concerted action, a project entitled "Environmental impacts of alien species in aquaculture" (IMPASSE), has delivered a new operational definition of "closed aquaculture facility". For facilities, according to that definition, the degree of risk associated with alien and locally absent species can be reduced to an acceptable level if the potential for escaping of the organisms to be farmed and of non-target organisms is addressed during transportation and if well-defined protocols are applied at the receiving facility (EU-Regulation, 2011). The regulation (Council Regulation EC, No 708/2007) defines alien species as:

(a) A species or subspecies of an aquatic organism occurring outside its known natural range and the area of its natural dispersal potential;

(b) Polyploid organisms, and fertile artificially hybridised species irrespective of their natural range or dispersal potential, where polyploid organisms' refers to artificially induced tetraploid organisms (4N).

These are aquatic organisms in which the number of chromosomes in the cells has been doubled through cell manipulation techniques. Furthermore, locally absent species refers to a species, or subspecies of an aquatic organism which is locally absent from a zone within its natural range of distribution for biogeographical reasons.

It was therefore necessary to amend the definition of 'closed aquaculture facility' in Regulation (EC) No 708/2007 by adding specific features intended to ensure the biosecurity of those facilities.

In the Regulation (EU) No 304/2011 (Regulation, 2011) there is the following definition: "Closed aquaculture facility" means a land-based facility (Article 3, point 3), where it is emphasized that "Aquaculture is conducted in an aquatic medium which involves recirculation of water", while "discharges do not connect in any way to open waters before screening and filtering or percolation and treatment to prevent the release of solid waste into the aquatic environment and the escape from the facility of farmed species and non-target species that might survive and subsequently reproduce". In this way it prevents "losses of reared specimens, or non- target" (Council Regulation EC, No 708/2007). While non-target organisms are defined as "any aquatic organism likely to be detrimental to

the aquatic environment that is moved accidentally together with an aquatic organism that is being introduced, or translocated not including disease-causing organisms which are covered by Directive 2006/88/EC". The same regulation states also that prevention is necessary in case of "losses of reared specimens, or non-target species and other biological material, including pathogens, due to theft and vandalism" as well as to " ensures appropriate disposal of dead organisms".

In order to comply with the EU legislation EU countries have adopted regulations on national level covering specific issues. A good example represents regulating the field of aquaculture in Croatia. Namely, in line to the EU Regulation (2011) Aquaculture Law in Croatia (Croatian regulation, 2017) was written. In this act states that the closed aquaculture facility is the facility referred to in Article 3 point 3 of the Council Regulation (EC) No. 708/2007.

Similarly in Austria, a more clarified definition of RAS is provided. There is a Law about the Amendment of the Water Law Act in Austria (Austrian regulation, 2004). By this Low Recirculation system is defined as: Aquaculture system, in which the water is circulated and the daily fresh water supply is not greater than 20% of the system volume used for animal husbandry (tank volume).

The transparency of RAS facilities registration in EU

Member States are oblidged to list all closed aquaculture facilities located in their territory. For reasons of transparency, that list should be published and regularly updated on a website set up in accordance with Commission Regulation (EC) No 535/2008 of 13 June 2008 (EU-Regulation, 2008) laying down detailed rules for the implementation of Council Regulation (EC) No 708/2007 concerning the use of alien and locally absent species in aquaculture (EU-Regulation, 2007). Each list shall be complent with the definition in Article 3 (point 3) and regularly updated.

In the legislative frame there is also the Article 17 of the Aquaculture Law in Croatia (Croatian regulation, 2017) entitled: The list of closed aquaculture facilities, Register of licenses for the use of foreign and local of absent species in aquaculture and Registry entries and transfers, which states:

The Ministry responsible for aquculture production shall maintain a list of closed aquaculture facilities for the growing of foreign and local of absent species in accordance with Article 2, paragraph 7 of Council Regulation (EC) No. 708/2007, which is published on the Ministry's website.

The disposal of wastewater from RAS (aqueous emissions)

The last but not least is the rule about the waste water produced in RAS during the fish rearing. It is well described by the Law about the Amendment of the Water Law Act in Austria (Austrian regulation, 2004).

Annual production capacity: mass gain of fish, crustaceans or molluscs (expressed in tonnes) of Recirculation system, Flow system and fish ponds due to the action of the Aquaculture facility within a period of twelve months in a plant according to the annual production capacity is determined:

(1) In a circulatory system by multiplying the specific annual production capacity (expressed in tons per cubic meter of system volume) by the size of the part of the system used for animal husbandry (in cubic meters) and
(2) In the case of a permit pursuant to Section 32 (Protection of water supply systems /water protection areas) of Water Law Act (2003) for discharging aqueous emissions from a system in accordance with Annual production capacity into a river, the emission limits specified in Annex A must be prescribed. The following substances may not be discharged: Chloramphenicol; Furazolidone; Dimetridazole; Malachite green - oxalate; and Nitrofurans.

Other substances contained in pharmaceutical specialities for which there is no authorization according to § 11 of the Medicinal Products Act, Federal Law Gazette No. 185/1983, last amended by Federal Law Gazette I No. 12/ 2003.

Paragraph 2 applies to aqueous emissions from a plant with the following activities:

(1) Keep fish, crustaceans or molluscs in a recirculation system;
(2) Fishing, emptying, cleaning or disinfecting a circulatory system.

The use should be considered (state of the avoidance, retention and cleaning technology):

(1) The use of recirculation systems, to the extent due to the or masses to be held fish, crustaceans or molluscs or is possible to be achieved, fish, crustaceans or shellfish qualities;
(2) Use of physicochemical (sedimentation, screening, filtration, liming), and biological circulatory systems purification process of the total waste water or partial streams;

Attachment:
The emission limit refers to the ton of installed annual production capacity for fish, crustaceans and molluscs and day.

Table 1.
Emission limits in accordance with Section 1 (2) for recirculation systems
Requirements for discharges into a flowing water (Austrian regulation, 2004)
Tabela 1.
Granične emisione vrednosti u skladu sa odeljkom 1 (2) za recirkulacione sisteme
Uslovi za izbacivanje u tekuće vode (Austrijska regulativa, 2004)

No.	Parameter	Emission Control limits
1	Toxicity[a)]	
1.1	Algae toxicity GA	2
1.2	Bacterial toxicity GL	2
1.3	Daphnia toxicity GD	2
3	pH – value	6,5- 8,5
4	Total Nitrogen bound TN_b, to qualify as N [b), c)]	150g/(t*d)
5	total Phosphor, to qualify as P [c)]	2g/(t*d)
6	Biochemical Oxygen Demand, BOD to qualify as O_2 [c), d)]	20g/(t*d)
7	Total Organic Carbon TOC, to qualify as C [c), d), e)]	60g/(t*d)

a) The toxicity parameter is only to be used in the case of combating epidemics or parasites on the waste water stream from animal treatment and from cleaning and disinfecting the containers and devices used for this purpose. The test is to be used with the test organism that reacts most sensitively to the substances used. The use of the parameter GA, GL or GD eliminates the need to use the parameter fish toxicity GF, egg;b) The sum of organically bound nitrogen, ammonium nitrogen, nitrite nitrogen and nitrate nitrogen; c) The emission limit refers to the ton of installed annual production capacity for fish, crustaceans or molluscs and day.; d) The specifications for the parameters BOD5 and TOC make specifications for the parameters settable substances and filterable substances superfluous; e) The specification for the parameter TOC does not require a specification for the parameter chemical oxygen demand.

The emission limits of nitrogen, phosphorus and organic compounds (BOD5, TOC) in g/(t*d) are production-specific loads and reflect per ton of installed annual production capacity for aquatic animals and day, or in other words are daily loads (g/d) per ton of annual production capacity.

Overview of legislation in Serbia relating to RAS
Until now, in Serbia exist only restrictive regulations about RAS: The Law on animal husbandry (Serbian regulation 2009a); Rulebook about the organizations with special authorizations (Serbian regulation, 2009b) and Rulebook on incentives for investments in aquaculture (Serbian regulation, 2019). In the following chapter there will be shown the present provisions relating to RAS: official definition in the area of aquculture and

The Law on animal Husbandry (Serbian regulation 2009a)
explains the main definitions according to the all activities in animal production but also the aquaculture.
This legislation describes some important definitions of aquaculture terms and conditions:
Aquaculture means the growing of fish and other aquatic organisms (hereinafter referred to as: fish) in aquaculture facilities.

Some connection with RAS belongs to the Chapter Aquaculture where there are listed the requirements for conducting aquaculture production. Beside the explained aquaculture facilities, it is mentioned that other fish farms are fish thanks/ ponds/ pools built of different materials, of different shapes used for fish farming.

Interestingly it stayed that The Minister (responsible for agriculture) shall prescribe more closely the conditions regarding facilities, equipment and professional staff referred to aquaculture facilities.
According to the fish health conditions, an aquaculture breeder may bring fish into the facility if he / she has a certificate of health, in accordance with the veterinary regulations.

In order to make a control of above mentioned conditions there are responsible agricultural inspectors and border veterinary inspectors.
The facilities which use RAS are mentioned as breeding farm for broodstock, fingerlings and fertilized eggs and belong to organizations with special authorizations. The detailed explanation about these organizations is in the Rulebook about the organizations with special authorizations (Serbian regulation, 2009B)

Rulebook about the organizations with special authorizations (Serbian regulation, 2009B)
The Rulebook (Serbian regulation, 2009B) addresses to some extent to "closed aquaculture systems". Namely, when defining conditions of fish farm for broodstock, juvenile fish and fertilized eggs, it lists necessary facilities for:

(1) Broodstock by species of fish;
(2) Artificial fish spawning - hatchery (built-in or prefabricated building); and
(3) Grow out husbandry by fish species.

Besides, necessary equipment of fish farm for broodstock, young and fertilized eggs must have on disposal following equipment for:

(1) preparation of water for controlled entry and discharge of water from the facility;
(2) preventing the passage of fish, fish fry and eggs into the hatchery, as well as from the hatchery to the recipient;
(3) spawning (tables for spawning);
(4) incubation of eggs (incubators); and
(5) growing the youngest age categories of fish in the hatching system (egg tray system).
(6) Of which under 1) and 2) are enlisted needs/prerequisite also required by the "closed aquaculture facilities".

Rulebook on incentives for investments in aquaculture (Serbian regulation, 2019)
Although in aforementioned Serbian regulations there is a lack of main definition and function of RAS facilities, in Serbia also exists the Rulebook on incentives for investments in aquaculture (Serbian regulation, 2019). In this regulatory document within the Appendix three is a table on the subsidy and eligible investment for the construction and equipment of facilities for improving agricultural primary production and the chapter: Purchase of new equipment for the facility for aquaculture. This chapter consist the list of aquaculture tanks (pools) for recirculation systems with associated equipment: Tubs (pools); Pumps for water recirculation; Devices for treatment with filters for water purification; Water heaters; Machine for separating gases; Machine for UV water filtration and Devices for determining water quality.

Discussion and Results

Although, the field of fisheries is up to some point regulated by contemporary regulatory framework in Serbia, still with respect to RAS or "closed aquaculture facilities" in comparison to EU regulations there is no equally precise act. Additionally, from the above-mentioned documents concerning Serbian regulations, the lack of many important provisions, present in EU legislation, is obvious.

Therefore, contemporary legal documents need to be amended and supplemented. In the Animal Husbandry Law (Serbian regulation 2009a), RAS or "closed aquaculture facilities" are not precisely defined, nor mentioned, but only can be subjected as "other facilities". In the light of modern requirements towards fish production and environmental protection, defining and incorporation of RAS into the regulatory framework represents necessity. This should be also clearly defined in the Rulebook about the organizations with special authorizations (Serbian regulation, 2009b).

In contrast to EU countries where registration and operation of RAS facilities are strictly regulated by law, Serbian legislation appears to be vague and unspecific about the matter.

Especially because some of provisions about RAS already exist in Serbian legislation, i.e. in the Rulebook on incentives for investments in aquaculture (Serbian regulation, 2019). That means, it should be rewrite the chapter of a.m. Rulebook in order to clear description of RAS in further Serbian legislation. There is a list of aquaculture tanks (pools) for recirculation systems with associated equipment: Tubs (pools); Pumps for water recirculation; Devices for treatment with filters for water purification; Water heaters; Machine for separating gases; Machine for UV water filtration and Devices for determining water quality.

In the frame of environmental protection area there is also space for amendments according to the existing regulation in Serbia. More precisely, it doesn't exist the prescriptions about the disposal of wastewater from RAS (aqueous emissions). The good example how to solve this legal shortcoming is Law about the Amendment of the Water Law Act in Austria (Austrian regulation, 2004). I.e. in this Law it was given the complete List of substances, which may not be discharged: Chloramphenicol; Furazolidone; Dimetridazole; Malachite green - oxalate; and Nitrofurans.

In this article we compared the two sets of laws (European and Serbian) in order to highlight inadequacies in the latter and suggested possible improvements. We advise harmonization of the Serbian legislation to the European standards regarding the precise definition of RAS in the frame of animal production, veterinary and health issue, as well as conditions connected with strict environmental protection rules.

Conclusion

On the base of the accession of Serbia to the European Union and being committed to the harmonization of the regulations related to fishery and aquaculture, as well as environmental protection, there is a big space for the correction and supplement of the legislation related to the organization and functioning of RAS. The existing legislation about fishery in Serbia should be fully harmonized with those submitted by the European Union, especially regarding the "closed aquaculture systems", i.e. RAS. However, this should be tailored to suit needs and necessities of the country, determining a transitional period before fully compliance with the EU regulation, and entry into force for the territory of Serbia

Acknowledgement

This research was funded by the Ministry of Education, Science and Technological Development of Serbia on the basis of the contracts for the realization and financing of scientific research work in 2020 (the contract No. 451-03-9/2021-14/200117)

References

Austrian regulation (2003) Änderung des Wasserrechtsgesetzes 1959 und des Wasserbautenförderungsgesetzes 1985 sowie Aufhebung des Hydrografiegesetzes. https://www.ris.bka.gv.at/Dokumente/BgblPdf/2003_82_1/2003_82_1.pdf

Badiola, M., Mendiola, D., Bostock, J. (2012) Recirculating Aquaculture Systems (RAS) analysis: main issues on management and future challenges. Aquac. Eng. 51, 26–35, https://www.sciencedirect.com/science/article/pii/S014486091200060X Last accessed: 14. May 2021.

Bregnballe, J. (2015) A guide to recirculation aquaculture: an introduction to the new environmentally friendly and highly productive closed fish farming systems. FAO and EUROFISH International Organization, Copenhagenhttp://www.fao.org/3/i4626e/i4626e.pdf Last accessed: 14. May 2021.

Croatian regulation (2017) Aquaculture Law. Official Gazette of Croatia 130/17, 111/18 (Effective from 01.01.2019) https://narodne-novine.nn.hr/clanci/sluzbeni/2017_12_130_2983.html Last accessed: 14. May 2021.

EU Regulation (2007) Council Regulation (EC) No 708/2007 of 11 June 2007 concerning use of alien and locally absent species in aquaculture https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32007R0708,Last accessed: 14. May 2021.

EU Regulation (2008) Commission Regulation (EC) No 535/2008 of 13 June 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 708/2007 concerning use of alien and locally absent species in aquaculture https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32008R0535&from=EN Last accessed: 14. May 2021.

EU Regulation (2011) Regulation (EU) No 304/2011 of the European Parliament and of the Council of 9 March 2011 amending Council Regulation (EC) No 708/2007 concerning use of alien and locally absent species in aquaculture https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32011R0304 Last accessed: 14. May 2021.

Gavrilović, A., Jug-Dujaković, J. 2019. Challenges of sustainable aquaculture development: the use of new technologies. 54th Croatian and 14th International Symposium on Agriculture, 17th – 22th February, 2019, Vodice

Heldbo, J., Meyer, S. (2016) Comparison of Legal Regulation and Technology Level Requirements, for Aquaculture Facilities Producing Rainbow Trout in Freshwater, in Selected European Countries. Danish Environmental Protection Agency https://mst.dk/service/publikationer/publikationsarkiv/2016/okt/comparison-of-legal-regulation-and-technology-level-requirements-for-aquaculture-facilities-producing-rainbow-trout-in-freshwater-in-selected-european-countries/ Last accessed: 14. May 2021.

Heiderscheidt, E., Tesfamariam, A., Pulkkinen, J., Vielma, J., Ronkanen, A.K. (2020) Solids management in freshwater-recirculating aquaculture systems: Effectivity of inorganic and organic coagulants and the impact of

operating parameters. Science of The Total Environment, 742, 140398,https://www.sciencedirect.com/science/article/pii/S0048969720339206 Last accessed: 14. May 2021

Martins, C.I.M., Eding, E.H., Verdegem, M.C.J., Heinsbroek, L.T.N., Schneider, O., Blancheton, J.P., Roque d'Orbcastel, E., Verreth, J.A.J. (2010) New developments in recirculating aquaculture systems in Europe: a perspective on environmental sustainability. Aquac. Eng. 43 (3), 83–93,https://www.sciencedirect.com/science/article/pii/S0144860910000671 Last accessed: 14. May 2021.

Mirzoyan, N., Parnes, S., Singer, A., Tal, Y., Sowers, K., Gross, A. (2008) Quality of brackish aquaculture sludge and its suitability for anaerobic digestion and methane production in an upflow anaerobic sludge blanket (UASB) reactor. Aquaculture 279, 35–41, https://www.sciencedirect.com/science/article/pii/S004484860800286X Last accessed: 14. May 2021.

Papacek, S., Petera, K., Masalo, I., Oca, J. 2018. On the optimization of recirculated aquaculture systems. EngOpt 2018 Proceedings of the 6th International Conference on Engineering Optimization Springer, Cham., 17. Sept. 2018.

Rijn, J.V. (2013) Waste treatment in recirculating aquaculture systems. Aquac. Eng. 53, 49–56, https://www.sciencedirect.com/science/article/pii/S0144860912000945 Last accessed: 14. May 2021.

Serbian regulation (2009a) Law on Animal Husbandry. "Official Gazette of R. Serbia" No. 41/2009, 93/2012 and 14/2016. https://www.vet.minpolj.gov.rs/legislativa/zakoni/Zakon%20o%20sto%C4%8Darstvu.pdf Last accessed: 14. May 2021.

Serbian regulation (2009b) Rulebook on the conditions regarding facilities and equipment that must be fulfilled by the breeding organization and organizations with special authorizations, as well as the conditions regarding the professional staff that must be fulfilled by the organization with special authorizations. "RS Official Gazette", No. 103/2009; 104/2018; 04/2019. http://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/sgrs/ministarstva/pravilnik/2019/4/2 Last accessed: 14. May 2021.

Serbian regulation (2019) Rulebook on incentives for investments in physical assets of agricultural holdings for construction and equipment of facilities for improvement of primary agricultural production. "Official Gazette of the R. Serbia", No 29/2018, 30/2018, 27/2019 и 40/2019.http://uap.gov.rs/pravilnici/arhiva-2013/pravilnik-o-podsticajima-za-podrsku-investicijama-u- primarnu-poljoprivrednu-proizvodnju/ Last accessed: 14. May 2021.

Recirkulacioni Akvatični Sistemi (RAS) u Srbiji: nedostaci zakonskih propisa u poređenju sa Evropskom Unijom

Miroslav I. Urošević[a*], Jasna Grabić[b], Ana Gavrilović[c], Jurica Jug-Dujaković[d]

[a]Univerzitet u Novom Sadu, Poljoprivredni Fakultet, Departman za stočarstvo, Novi Sad, Srbija
[b] Univerzitet u Novom Sadu, Poljoprivredni Fakultet, Departman za uređenje voda, Novi Sad, Srbija
[c] Univerzitet u Zagrebu, Agronomski Fakultet, Zavod za ribarstvo, pčelarstvo, lovstvo i specijalnu zoologiju, Zagreb, R. Hrvatska,
[d]Sustainable Aquaculture Systems Inc., 715 Pittstown Road, Frenchtown, NJ 08825, SAD
*Autor za kontakt: miroslav.urosevic@stocarstvo.edu.rs

SAŽETAK
Recirkulacioni akvatični sistemi (RAS) smanjuju potrošnju vode tako što je posebnom tehnologijom ponovo prerade, čime se proizvodi znatno manje otpadnih voda od tradicionalnih uzgajališta riba. Ograničena upotreba vode doprinosi tome da se mnogo lakše i jeftinije uklone izlučevine od riba, jer je količina ispuštene vode znatno manja, a čvrsti i tečni otpad su koncentrovaniji nego u vodi koja se ispušta iz tradicionalnih uzgajališta riba i zato su mnogo lakši za preradu. Tako se recirkulacioni sistemi mogu posmatrati kao ekološki najprihvatljiviji i ujedno održivi način proizvodnje ribe u komercijalno smislu. Za razliku od zemalja Evropske Unije u kojima su registracija i rad RAS objekata strogo regulisani zakonom, srpsko zakonodavstvo izgleda nejasno i nespecifično po tom pitanju. Srbija je značajno napredovala u tome što je postala zemlja kandidat za članstvo u Evropskoj Uni, ali mora da uskladi i svoje zakonodavstvo sa onim koje važi u Uniji. Shodno tome, svrha ovog rada je da pruži pregled postojećeg zakonodavstva u Evropskoj uniji i u naučnim radovima, dajući predlog budućih srpskih propisa koji obuhvataju funkcionisanje, osnivanje i upravljanje ovom vrstom najsavremenijih objekata u akvakulturi.

KLJUČNE REČI: proizvodnja ribe, zatvoreni sistemi, EU-regulativa, ekologija

PRIMLJEN: 27.07.2021.

PRIHVAĆEN: 16.11.2021.