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THE IMPACT OF ENVIRONMENTAL FACTORS ON THE METABOLIC RATE IN FISH: INTEGRATION OF EXISTING DATA

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Abstract

As far as we known there are many scientists doing a lot of researches about animal physiologic regarding the influence and the result of different factors on fish metabolic rate. We can mention as an example: mass, temperature or chemical pollutants on metabolic rate. Regarding intraspecific variation, the reasons why it isn't very well known less about factors causing. It is well known that feeding control influences the metabolism, they interlinked each other. During the last years we have been seeing a lot of climate changes which affect also the fish. Many areas like ecological niches, metabolic performance is definitively influenced by two very important factors like oxygen or temperature. Sometimes, when we have most important environmental variables, the answer for these variables is the temperature of the water and as an effect of this environmental variables we could see the metabolic rates of ectotherms. For this reason, wise minds studied besides water temperature the also the effects of this factor on fish metabolic rate. The also concluded that other environmental factors like oxygen and salinity play very important role as potential determinations of the fish metabolic rate. This review aims to integrate the currently existing data regarding the influence of environmental factors on metabolic rate in fish.

Key words: *environmental factors, impact, fish, metabolic rate.*

INTRODUCTION

Fishes have evolved physiologically to live within a specific range of environmental variation and existence outside of that range can be stressful or fatal (Jahan, 2018).
Metabolic rate is a very important point for keeping fish alive that determines survival in the field because behavior such as providing their food escape from other strong animals and rivals, and also other important physiological process, that require oxygen (Eliason & Farrell, 2016). Metabolic rate, the amount of energy consumed per unit of time, for an organism to sustain life, is influenced by both intrinsic and extrinsic factors (Tanaka et al., 2023). There are a lot of factors in our environmental, like: temperature, oxygen concentration, and pH levels (Campos et al., 2018) with important influences on each metabolize. In conclusion, all these factors affect also the fish metabolism. To some up, we conclude that the issue of this overview is to gather the literature study about those factors which affect the metabolic rate in fish.

MATERIALS AND METHODS

For realising this overview were consulted a number of speciality articles from this domain which approaches the mentioned subject. The most studies are recent, but there are a few older ones that are representative in this domain. The scientific papers we spoke about are indexed in GS data based, a percentage of 58.06% of all these papers are, as well, indexed in the Web of Science (WOS) database and another percentage of 48,38 % are indexed in Scopus. We have red zone, yellow zone and white zone in the WOS database. According to our scientifical studies, our percentages are: 35,48% in the red area, 16,12% in yellow one and 48,4 % in the white area.

After Simionov et al. (2019), the best results can be obtained when multiple research methods electronic and manual compete at the wishing result. To be in the position to given a complete response, we taken to considers o large a period between 1965 and 2023. They were prior the published papers those three zone (red, yellow and white) having a good visibility. The searching of the articles was done using keywords for the approached subject.

RESULTS AND DISCUSSIONS

1. The influence of temperature on the metabolic rate in fish

Under a global warming system, extreme variation in environmental temperature could cause significant stress to aquatic species. The most important effect on fish metabolism, on all its levels, those levels being between the standard metabolic rate and maximus, is temperature (Brett, 1965; Norin & Clark, 2016).

Fish have the capacity of acclimating to temperature changes when are exposed for longer periods. This factor es a key one with an important impact on the metabolic processes. The clownfish was exposed to a rapid increase in temperature combined with limited food availability (one meal after fasting) by Pham et al. (2022) in a study regarding metabolic rate food intake and intestinal transit. The conclusion shows up that less forage combined with more degrees led to assessed he stimulation of anorexigenic metabolically ways for clownfish. The meaning of this action is that: a bit of food steel goes to a higher metabolic rate steel having an induced temperature.

These results show up those small quantities availability and elevated temperature excites anorexigenic steps in, resulting in significantly lower feed intake despite the temperature-induced increase in metabolic rate.

The thermal curve includes the metabolism effects.

This shows up an increasing of temperatures followed by a value's constancy and severe drop (Rezende & Bozinovic, 2019).

Another study made by Liang et al. (2022) aimed to determine whether water temperature played a role in regulating the growth and nutritional metabolism of juvenile grass carp. He is mentioning that *Grass carp* reared at different temperatures seem to show different metabolic patterns.

Kuhn et al. (2023) were exanimating the effects of temperature on feeding actions, food eating and the expression of this in three characid fish (black tetra, neon tetra and cavefish) by submitting them to four different temperatures and showed that temperature influences feeding in *Characidae* fish and induces species-specific changes in the expression of appetite regulators. It is well known that the fish are ectotherms and because of that they have fluctuations of their body's temperature in the same time with the environmental temperature (Haesemeyer, 2020). The increasing temperature is direct proportional with the increasing of biochemical reaction rates, with the metabolic rate, energy balance subsequently increasing energetic demands (Johansen et al., 2021).

Another study observed that when repeatedly exposed to warm water temperatures daily for 53 days, juvenile lake trout had higher maximum metabolic rates compared to those that stayed at cool temperatures, offering the capacity of adapting to thermal exposure (Guzzo et al., 2019).

Moore et al. (2023) investigated how temperatures associated with future warming and present-day marine heatwaves (+3°C) impact the growth, metabolic rate, and more aspects regarding developmental steps of clownfish larvae (*Amphitryon ocellaris*). There results indicate that clownfish development could be altered under future warming, with developmental rate, metabolic rate, and gene expression all affected.

The importance of temperature results also comes out of the researches Grimmelpont et al. (2023). They focused on golden grey mullet

Chelon auratus which they expose to marine heatwaves getting the conclusion that increasing temperature and increasing metabolism are direct proportional.

When Beuvard et al. (2022) concentrated on examining on the effect of different temperatures regarding survival, the growth rate metabolism, and physiological indices of juvenile *Arctic charr* underlined that over optimal temperature growth rate leads to: a decrease of energy intake, a higher demand of the metabolic system and changes in the ability cardiovascular system in sustaining the fish mechanism at higher degrees.

Another effect of water temperature is of about the fluctuations of chemical reactions, physiological processes, and metabolic steps. According Volkoff & Rønnestad' studies (2020), we can declare temperature as being very important because the affects the minimum and maximum metabolic rates and thereby the aerobic scope.

2. The influence of oxygen on the metabolic rate in fish

The most important process on Earth, photosynthesis, has as a result the diffusion of the oxygen from atmosphere, say Singh & Kumar, 2014. It also depends on chemical composition of water body which is very variable, depending on season, time of day, place and depth (Nimesh & Jain, 2016).

The main factor for keeping fish alive, for maintaining them a good health and keeping up the bacteria which decompose the waste produced by the fish, and to meet the biological oxygen demand within culture system is oxygen.

For assuring a fast oxygen intake from water into fish's blood, supposed to have an important availability of oxygen in water. This fact can be held by partial pressure gradient of oxygen, according to Mallya (2007).

The concentration of oxygen in the growth environment has a significant impact on the metabolic rate of fish (Tom, 1998; Ali et al., 2022). Through metabolism, food or stored energy is transformed into the energy needed to perform daily tasks.

Nimesh & Jain (2016) got to the conclusion that.

Many activities body (respiration, feeding) are slower when the availability of dissolved the oxygen is lower.

Other researches (Norin & Clark, 2016) entrechats the above idee that some fish can responded to hypoxia with a decrease in maximal metabolic rate, while individuals may differ greatly regarding their metabolic response.

Moss & Scott underlined through their study from 2011 standard metabolic rates for the bluegill, *Lepomis macrochirus*; largemouth bass, *Micropterus salmoides*; and the channel catfish, *Ictalurus punctatus*, at different degrees. These compared with other species was lower at the same temperature. But we have other two species like: bluegill and perch weighing more 15 grams than which responded indirectly proportion.

3. The impact of pollutants on the metabolic rate in fish

A team, Makiguchi et al. (2023) worked on the idea of comparing the metabolism and swimming performance of semi-wild and farmed fish (*Oncorhynchus masou*). There results were that semi-wild fish have a higher metabolic activity. Oher researches made by He et al., in 2023, was about the evaluate the different effect were regarding: growth's indicators, digestive catalysts, biochemical composition, metabolic factors and antioxidant activities of juvenile Yangtze sturgeon (*Acipenser dabryanus*). They conclusive that the with increasing levels activities feeding levels, higher amylase and lipase, and fish fed with 3% body weight day^{-1} led to a more intense trypsin activity.

Fish would be on the point to create a balance between their metabolism and growth by optimizing nutrient absorption and utilization when fed at different dietary levels.

Zhang et al. (2023) could demonstrate that damaged mitochondrial membrane potential and respiratory chain function through the exposer of female zebrafish to 0.05 mg/L and 0.5 mg/L florfenicol for 28 days. All this prove that toxicity and perturbed metabolic signaling in the F1 generation were related to the mitochondrial injury after exposing F0 female zebrafish to florfenicol.

A comparation upon metabolic effects caused by using copper oxide particles with two distinct structures: nanorods and nanosphere was done by Oliveira et al. (2022). They used the closed respirometry technique for analyses the metabolic rate, specific ammonia excretion, and swimming ability as biomarkers, the physiological effects on *Danio rerio.* This study showed that the metabolism of fish was affected by different morphological structures of the same copper oxide nanoparticle.

It is concluded that the characterization of nanoparticles is essential to understand their effects on fish, since their structural forms can cause different toxic effects on *D. rerio*.

Santos et al. (2023) in their study were investigated a non-target metabolomic vision to investigate changes in the metabolome of juvenile meagre (*Argyrosomus regius*) exposed to venlafaxine (20 μg/L). Venlafaxine conducted to significant alteration of endogenous metabolites tentatively identified in liver, brain and plasma, respectively, also variation metabolic profile where underlined.

Santos et al. (2023) discovered that another substance methamphetamine disturbance metabolism, physiology, behavior.

4. The influence of salinity on the metabolic rate in fish

The development, survival and the welfare condition of animals in general is influenced by several factors, one of the most important for fish being salinity. In terms of growth performance, each species has an optimal salinity range. This fact can be exemplified by the study carried out by Boeuf and Payan (2001) on the rohu species.

Thus, a temporary increase in salinity with a long acclimatization period has a minimal impact on growth and other physiological parameters.

CONCLUSIONS

This paper summarizes the most important effects of temperature, salinity, oxygen and pollutants on the metabolic rate of fish. Among them, temperature decreases the ability of fish to respond to chemical stress factors, through profound metabolic changes.

Thus, it reinforces the idea that temperature has a general effect on all levels of metabolism.

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