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The Use of Egg Color of Rainbow Trout (*Oncorhynchus mykiss*) as a Quality Criterion

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ABSTRACT
The study investigates the use of egg color as a quality criterion by determining the colors of the eggs obtained from different rainbow trout (*Oncorhynchus mykiss*) hatcheries. The study was carried out between 20 December 2017 and 3 January 2018 during which egg stripping was carried out in five different fish hatcheries. The samples were collected during the egg stripping period. The selection of the broodstock and collection of the egg samples were carried out using random sampling. The L*, a* and b* values of egg color were measured using the Minolta Chroma Meter after standardization with a white tile as the reference color before each measurement. The measurements revealed that the L*, a* and b* values between 51.42-70.58; -4.59-15.26 and 24.76-56.75, respectively and the differences between the hatcheries were not statistically significant in terms of the L* values ($p>0.05$), while the hatcheries were significantly different in terms of the a* and b* values ($p<0.05$). The best a * and b * values determined in the study were close to the wild trout egg color. It is thought that the L*, a* and b* values of rainbow trout eggs can be used as egg quality criteria.
Keywords - Rainbow trout, *Oncorhynchus mykiss*, Egg, Color, Egg Quality

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I. INTRODUCTION

The main goal of fry production is to obtain large numbers of high-quality eggs and larvae. The determination of the yield properties (sperm and egg quality) and quality criteria of fish used in egg production is of great importance. Egg quality parameters play a determining role in egg fertilization, embryonal development and larval survival rate under appropriate conditions. Also, the production of large numbers of high-quality eggs is an issue to which importance is attached for various farmed fish species.

In recent years, the studies on the improvement of yield have gained significant importance with the technological developments worldwide. The biotechnological studies pursuing the same goal have a great potential [1].

The fecundity of different fish species greatly varies. While marine fish give millions of eggs, salmon species are giving approximatly 2000-3000 eggs. Moreover, although most marine fish give eggs weekly during the 2-3-month-long spawning season, salmon only give eggs one time a year.

The management and planning of broodstocks, such as salmon, are highly important in the fish species with a low fecundity [2]. The size of the brood fish affects fecundity, while the diameter, number and weight of the eggs are used to determine quality [3, 4]. Egg quality is affected by fish genotypes, stocking amount, stress, feed quality, nutrition amount and properties of the water [2, 4].

The egg quality parameters that are defined as egg properties play a determining role in egg fertilization, embryonal development and larval survival rate [5].

Varying egg quality is one of the limiting factors for successful mass production of fish fry. In the literature, the term egg quality has been defined and used in various ways by different authors. The only definition of egg quality that has general validity is probably the egg's potential to produce viable fry. The egg's potential to produce viable fry is determined by several physical, genetic, and chemical parameters, as well as the initial physiological processes occurring in the egg. Good practical criteria for the determination of egg quality should be both identifiable early in development and simple to use [6].

From the reproduction point of view, good quality eggs are usually marked by their excellent survival rates during incubation and the quantity of hatched fry [6]. Different studies have reported that there was a high correlation between egg color and survival rate [7] and concluded that egg color should be included among quality criteria [8]. The study

investigates the use of the color properties of the eggs obtained from different rainbow trout hatcheries (*Oncorhynchus mykiss*) as quality criteria.

II. MATERIALS AND METHOD

The study was carried out between 20 December 2017 and 3 January 2018 during which stripping was carried out in five different fish hatcheries.

Attention was paid to select broodstocks that move rapidly and do not have abnormal physical appearance and show signs of disease. The samples were collected during the egg stripping period. The selection of the broodstock and collection of the egg samples were carried out using random sampling.

The L*, a* and b* values of egg color were measured using the Minolta Chroma Meter (Model CR-400, Konica Minolta, Tokyo, Japan) after standardization with a white tile as the reference color before each measurement (Commission Internationale de l´Eclairage, CIE, 1976). L* represents the brightness (lightness-darkness), a* represents the redness-greenness, b* represents the yellowness-blueness values [9].

The results were given as mean±standard error. The statistical analyses were carried out using the IBM SPSS 21 statistical package program. The differences between the values were tested using one-way variance analysis (ANOVA) and the results were compared using the Tukey test. The significance level was taken as $p<0.05$.

III. RESULTS

In the study, the L*, a* and b* values of the eggs from the hatcheries were determined and given in Table 1, Figure 1, Figure 2 and Figure 3.

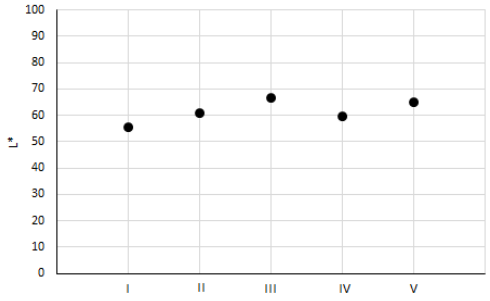

Fig 1. L* values

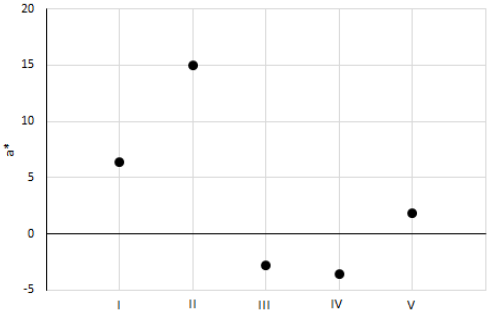

Fig 2. a* values

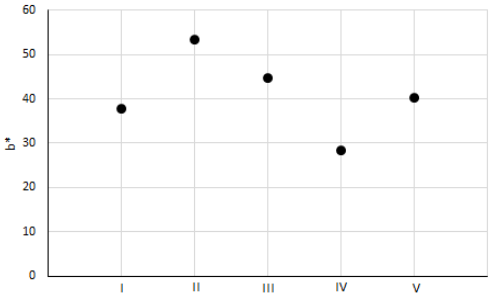

Fig 3. b* values

Table 1. L*, a*, b* values

Hatchery	L*	a*	b*
I	55.59 ± 2.20^{a}	6.40 ± 0.60^{c}	37.83 ± 2.63^{ab}
II	61.04 ± 1.82^{a}	14.99 ± 0.15^{d}	53.30 ± 1.81^{c}
III	66.50 ± 3.60^{a}	-2.77 ± 1.22^{a}	44.60 ± 2.50^{bc}
IV	59.74 ± 2.04^{a}	-3.60 ± 0.35^{a}	28.39 ± 2.53^{a}
V	64.87 ± 2.42^{a}	1.81 ± 1.09^{b}	40.29 ± 4.39^{ab}

Values in the same row with different superscripts are significantly different ($p<0.05$).

The measurements of the eggs showed that the differences in the mean L* values were not statistically significant ($p>0.05$) and the highest L* value was obtained in hatchery III, while hatchery I had the lowest value. The hatcheries were significantly different in terms of the a* values ($p<0.05$). The highest a* value was obtained in hatchery II, while the lowest a* values were obtained in hatcheries III and IV. The highest b* value was obtained in hatchery II, while hatchery IV had the lowest value ($p<0.05$).

IV. DISCUSSION AND CONCLUSION

Accurate information on fish egg quality is important in fishery management and aquaculture and in experimental fish development studies [5, 6, 10, 11]. Fish egg quality is determined by morphological, physiological and biochemical assessments; however, assessments-based analysis of microscopic images is typical [12, 13, 14, 15].

A number of studies have been carried out on other farmed fish species and numerous parameters have been reported to influence egg quality, such as broodstock nutrition, environmental conditions and husbandry practices [16, 17]. The egg quality of rainbow trout is evaluated considering the properties of the broodstock, certain properties of the eggs (egg diameter, absolute and relative egg number), egg fertilization rate, eyeing rate and larval survival rate.

In addition to their other functions, carotenoids are the source of pigmentation in embryos [18].

It has been reported in different studies that carotenoids in eggs affect the larval survival rate as well as provide embryonic development [19, 20, 21]. Dietary carotenoid supplements were also shown to have a positive relationship with egg pigmentation and fertilization as well as the survival of rainbow trout eggs [20, 22], while Svensson et al. [23] found that the coloration of female *G. flavescens* was strongly related to the carotenoid content of the eggs.

In the study, the color characteristics of the eggs are thought to be used as quality criteria that the L* (brightness) values of the hatcheries were not significantly different, while the hatcheries were significantly different in terms of the a* (redness) and b* (yellowness) values.

It stated that the eggs of wild fish were of a higher quality than that of farmed fish, which was attributed to the carotenoid content that also give the eggs their color [20]. The results of this study revealed that the color of the egg samples from the hatchery that yielded the best a* and b* values was close to that of the eggs of wild trout.

Other studies indicated that the relationship between the carotenoid content of eggs and egg quality and color [24, 25, 26, 27]. When the results of these studies evaluated, it is thought that the L*, a*, b* values of rainbow trout eggs can be used as quality criteria for eggs.

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