A quick and simple color determination method with free, online software, for rainbow trout *Oncorhynchus mykiss* (Walbaum 1792) meat

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Abstract. The flesh color is the second characteristic when consumers make a buying choice regarding rainbow trout (*Oncorhynchus mykiss*) fillet, after freshness. Thus, many trout farmers color the flesh of rainbow trout using feeds containing carotenoid supplements. However, the coloration does not depend only on the existence of carotenoids in the feed. It depends on a number of different factors, including the quantity of carotenoids, their type (synthetic or natural), the feed consumption, the period of administration, the specific carotenoid used, the physiological status of the fish, etc. Color determinations are usually made with the help of the SalmoFan scale, a simple instrument that codes orange-reddish color. With a simple visual comparison between the sample and the scale, the sample can be color-coded, and it can be concluded if the sample is marketable or not. Even though this is a widely applied instrument, which is simple to use, quick and cheap, it does have some small disadvantages, such as absent colors or nuances. For a laboratory scenario, a slight change in color that would be disregarded on such scales may be important. Thus, different software are used for determining the exact color. The aim of this study is to use 2 such software for determining the color of rainbow trout flesh. The selected software are free and available online, being also easy to use and time-saving: redketchup.io and colordesigner.io/. Rainbow trout flesh from a previous experiment with carotenoid supplementation were used, and color was determined with the two software. Although there were no visible observable differences, the software determined that some fillets were more reddish or orange than others.
Key Words: carotenoids, fish fillets, flesh color, red fillet.

Introduction. Rainbow trout (*Oncorhynchus mykiss*) aquaculture is a very important component of the global aquaculture industry due to the species' fast growth, better adaptability to various environmental parameters compared to other salmonids, and strong consumer demand (Fornshell 2002; D’Agaro et al 2022). In addition, the farming technology is widely studied and known, offering more know-how than for other species (Singh 2020). As one of the most widely farmed freshwater fish, rainbow trout supports food security, is a high-quality protein source, and contributes to the economic stability of different communities (Kankainen et al 2012; Aloo et al 2017).

The color of rainbow trout fillets plays a great role in consumer appeal and sales. The red or orange color is associated with freshness, high quality, and a healthy diet, making it more attractive to buyers (Rosenau et al 2023; Sun et al 2023). This visual cue can influence purchasing decisions more than taste or nutritional value alone, especially as the visual aspect comes before organoleptic properties. Producers often manage feed and farming conditions to enhance fillet pigmentation, knowing that a more desirable color can lead to higher market prices and increased consumer demand. Usually, synthetic astaxanthin is used in the feed, but more and more natural sources are researched and utilized, as consumers become more aware about the ingredients used in the feed, the welfare of fish and, ultimately, their own health (Xie et al 2022; Păpuc et al 2024).

The aim of this study was to use two software for determining the color or rainbow trout flesh, and to determine whether or not there are color differences in the flesh of rainbow trout fed different experimental feeds supplemented with natural carotenoid sources.

Material and Method. This study used rainbow trout flesh from a previous experiment (Păpuc et al 2025), where rainbow trout were fed diets with 2% addition of carrot meal, tomato meal and spinach meal, in addition to the control group with standard feed, *ad libitum*, for 90 days. The flesh was maintained at -18^{o}C, in a freezer, until color analyses were performed. Color analysis is important for rainbow trout fillets for marketing and sales reasons (Ljungqvist et al 2012).

The carcasses were thawed and portioned. Thus, from each group, one set of five samples was selected for color analyses. The sets consisted of fillets. The samples were photographed under controlled light conditions, in the same position, to avoid differences in the images.

A comparison with the SalmoFan scale was performed. There are many methods of colorimetric assays that can be employed in this area (Yeşilayer 2020). In this study, two free software available online were used for further image analysis. First, the "redketchup color picker" (https://redketchup.io/) was used to determine the RGB (red, green, blue) values of different points on the image. Five points were selected from each sample. The values obtained were averaged. Secondly, the software colordesigner.io (https://colordesigner.io/) was used to convert the RGB values in HSV (hue, saturation, value) values. The HSV model classifies colors better for our purpose than the RGB model. The "hue" component of the HSV code offers the possibility to determine which color is closer to red, orange, or other colors.

RedKetchup.io is a free, web-based suite of tools that can be used for quick and easy digital tasks. It offers a wide range of features including image editing, color tools, data formatting, text utilities, and developer tools. All tools are accessible online without the need for installation, making it a convenient and versatile platform. ColorDesigner.io is a comprehensive, web-based platform designed to assist in working with color. It offers a suite of tools, including a Color Palette Builder, a Gradient Generator, and a Color Mixer for blending hues. Users can extract color palettes from images, identify colors using the Image Color Picker, and convert colors between formats like HEX, RGB, HSL, LAB, HSV and more.

Results and Discussion. Generally, the color difference between the four groups was not visually observable with the naked eye. This means that the carotenoid sources used were either not efficient in changing the color, or other factors interfered. The color remained whiteish, in some parts reaching 17-18 on the SalmoFan scale, much under the market requirements (Gümüş et al 2023) (Figure 1).

However, the SalmoFan scale is mostly used to evaluate salmonid color after astaxanthin is used, emphasizing the reddish color. As the diets used for the rainbow trout that provided the fillets did not contain astaxanthin, the digital method of analysis was also proposed.

Thus, an average of RGB value for the rainbow trout fillet from the control group was 140 for red, 128 for green and 126 for blue. When converted to HSV, the values correspond to 8.57, 10% and 54.9%. For the rainbow trout fed the experimental diet with carrot meal addition, the average was 154 for red, 129 for green and 130 for blue, corresponding to 357.6, 16.23% and 60.39% in HSV. For the rainbow trout fed with a diet containing tomato meal, the average RGB values were 147 for red, 130 for green and 122 for blue, corresponding to 19.2, 17.01% and 57.65% in HSV. In the last group, with spinach meal added to the diet, the RGB averages were 132, 117 and 119, respectively, corresponding to 352, 11.36%, and 51.76% in HSV.

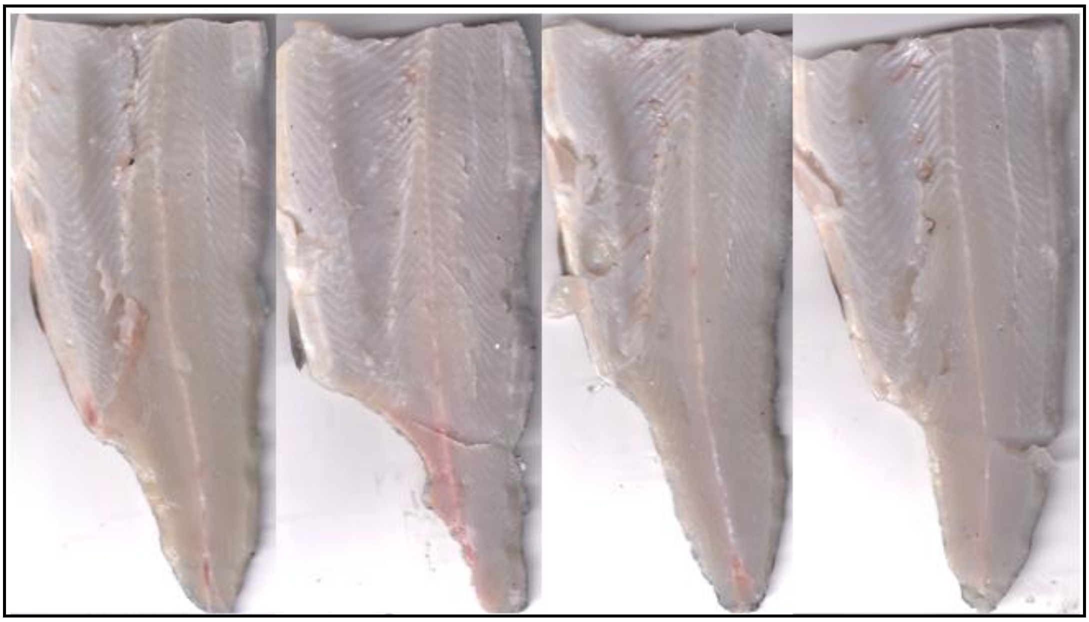

Figure 1. Fillet color of rainbow trout (*Oncorhynchus mykiss*); from left to right: control group, rainbow trout fed with a 2% addition of carrot meal, rainbow trout fed with a 2% addition of tomato meal, and rainbow trout fed with a 2% addition of spinach meal.

The RGB values were obtained with the "redketchup color picker" software (https://redketchup.io/). The software "colordesigner.io" (https://colordesigner.io/) was used to convert the RGB values in HSV values. For a visual representation, the colors corresponding to the averages in RGB are presented in Figure 2. However, as the differences remained relatively low, there were a light filter (+40%) and contrast filter (-20%) applied to distinguish better among colors.

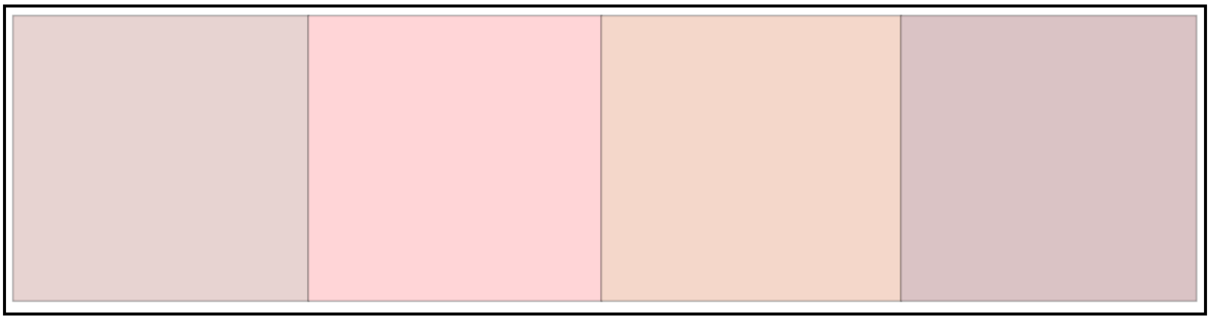

Figure 2. Color of rainbow trout (*Oncorhynchus mykiss*) fillet, according to RGB averages in the "redketchup color picker" software; from left to right: control group, rainbow trout fed with a 2% addition of carrot meal, rainbow trout fed with a 2% addition of tomato meal, and rainbow trout fed with a 2% addition of spinach meal.

According to HSV values interpretation, the color of fillets from rainbow trout fed a diet supplemented with carrot meal was the closest to the red color, followed by the color of fillet from rainbow trout fed diets supplemented with spinach, control and tomato. Surprisingly, the fish fed tomato meal supplemented diets had the farthest color from red, but, according to the same interpretation, their color was closest to orange, another color desired in rainbow trout aquaculture. On the orange color scale, in order after the fish from the group with tomato meal supplemented diets were rainbow trout from the control group, from the group with a carrot meal supplemented diet, and from the group with a spinach supplemented diet.

Thus, adding 2% carrot meal in the diet of rainbow trout slightly changed the fillet color towards red, while the supplementation with cu 2% tomato meal produced a slight color modification towards orange. However, as said before, the color changes were minimal, not visually observable with the naked eye. The weak coloration might be attributed to various factors, such as differences in feed consumption, differences in carotenoid content of the meals, or changes in fish metabolism. Nevertheless, as the color was not observable with the naked eye, the quick and easy method presented for color determination proved to identify differences in fillet color, making it a valuable resource in such situations.

Conclusions. The software used in this study determined some color changes in rainbow trout fillet where the naked eye could not. Carrot meal in the diet produced a slightly more reddish color, while dietary tomato meal produced a more orange color. Although the color remained mostly the same, the marginal changes do support the continuation of studying different natural sources of carotenoids for use in the aquaculture of rainbow trout.

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Conflict of Interest. The authors declare that there is no conflict of interest.

References

Aloo P. A., Charo-Karisa H., Munguti J., Nyonje B., 2017 A review on the potential of aquaculture development in Kenya for poverty alleviation and food security. African Journal of Food, Agriculture, Nutrition and Development 17(1):11832-11847.

D’Agaro E., Gibertoni P., Esposito S., 2022 Recent trends and economic aspects in the rainbow trout (*Oncorhynchus mykiss*) sector. Applied Sciences 12(17):8773.

Fornshell G., 2002 Rainbow trout – challenges and solutions. Reviews in Fisheries Science 10(3-4):545-557.

Gümüş B., Gümüş E., Balaban M. O., 2023 Color of rainbow trout (*Oncorhynchus mykiss*) fillets by image and sensory analysis, and correlation with SalmoFan numbers. Journal of Food Science 88(1):430-446.

Kankainen M., Berrill I. K., Noble C., Ruohonen K., Setälä J., Kole A. P. W., et al, 2012 Modeling the economic impact of welfare interventions in fish farming - a case study from the U.K. rainbow trout industry. Aquaculture Economics & Management 16(4):315-340.

Ljungqvist M. G., Dissing B. S., Nielsen M. E., Ersbøll B. K., Clemmensen L. H., Frosch S., 2012 Classification of astaxanthin colouration of salmonid fish using spectral imaging and tricolour measurement. IMM-Technical Report, Technical University of Denmark.

Păpuc T., Cocan D., Constantinescu R., Răducu C., Ladoși D., Ladoși I., et al, 2024 Carotenoids in salmonid aquafeeds: A review of use and effects. Scientific Papers. Series D. Animal Science 67(1):764-775.

Păpuc T., Cocan D., Constantinescu R., Răducu C., Lațiu C., Uiuiu P., et al, 2025 Blood parameters of rainbow trout (Oncorhynchus mykiss) fed diets supplemented with natural phytoadditives during the cold season. Scientific Papers. Series D. Animal Science LXVIII(1). (In Press).

Rosenau S., Wolgast T., Altmann B., Risius A., 2023 Consumer preference for altered color of rainbow trout (*Oncorhynchus mykiss*) fillet induced by Spirulina (*Arthrospira platensis*). Aquaculture 572:739522.

Singh A. K., 2020 Emerging scope, technological up-scaling, challenges and governance of rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792) production in Himalayan region. Aquaculture 518:734826.

Sun L., Engle C. R., Kumar G., van Senten J., 2023 Supermarket trends for rainbow and steelhead trout products: Evidence from scanner data. Aquaculture Reports 30:101579.

Xie W., Deng H., Li K., Ma Y., Gao M., Duan H., et al, 2022 Dietary supplementation of archaeal carotenoids improved antioxidative capacity and regulated immune-related gene expression of golden trout *Oncorhynchus mykiss* against challenge. Aquaculture Research 53(14).
Yeşilayer N., 2020 Comparison of flesh colour assessment methods for wild brown trout (*Salmo trutta macrostigma*), farmed rainbow trout (*Oncorhynchus mykiss*) and farmed Atlantic salmon (*Salmo salar*). Pakistan Journal of Zoology 52(3):1007-1014.
*** https://colordesigner.io/
*** https://redketchup.io/

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