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COMPETITIVE ECONOMIC TRENDS OF STEELHEAD FARMING IN TÜRKİYE AND NORWAY

Ümüt YIGIT[1], Murat YIGIT[2], Sebahattin ERGÜN[3], Feyza SANVER[4], Nic TAYLOR[5*]

[1] Program of Underwater Technologies, School of Marine Technologies, Canakkale Onsekiz Mart University, 17020-Çanakkale, Türkiye
[2] Department of Aquaculture Industry Engineering, Faculty of Marine Science and Technology, Canakkale Onsekiz Mart University, 17020-Canakkale, Türkiye
[3] Department of Aquaculture, Faculty of Marine Science and Technology, Canakkale Onsekiz Mart University, 17020-Canakkale, Türkiye
[4] Lallemand UK, Edinburgh, Scotland, United Kingdom, UK
[5] SS Snow-Leopard Research Vessel, Multihull Centre, Foss Quay, Millbrook, Cornwall, PL10 1EN - United Kingdom, UK

Ümüt Yigit: umutyigit@comu.edu.tr, https://orcid.org/*0000-0002-1378-2422*
Murat Yigit: muratyigit@comu.edu.tr, https://orcid.org/0000-0001-8086-9125
Sebahattin Ergün: sergun@comu.edu.tr, https://orcid.org/0000-0002-9077-9438
Feyza Sanver: sanverfeyza@yahoo.com, https://orcid.org/0009-0005-2442-8129
Nic Taylor: nic@nictaylor.net, https://orcid.org/0000-0001-8034-5815

**Corresponding author: Nic TAYLOR, nic@nictaylor.net, +44-737-6027737*

Abstract

This study evaluates the competitive economic trends in respect to the production growth of Steelhead in the Norwegian and Turkish aquaculture sectors. These two countries are the leading key fish producers who supply remarkable volumes of farmed fish to satisfy the growing demand worldwide. The main two producers in this study were identified by annual production yields based on FAO statistics. Growth trends and economic performance of the key players were comparatively evaluated and superimposed with population growth from 1994 to 2021. Harvested steelhead in the Norwegian aquaculture increased 6.6-fold from 14,367 to 94,660 tons between 1994 and 2021, whereas Turkish steelhead production increased from 14,367 to 165,687 tons with nearly 23.8-fold improvement over the last 27 years. Despite superior yields achieved by Norwegian producers, which was 51.4% more than the Turkish harvest in 1994, Turkish production succeeded in catch-up in 2009, and exceeded Norwegian steelhead production by 42.9% in 2021. Nonetheless both countries attained similar economic return, Norwegian production profiting slightly higher by 1.43%. Turkish steelhead farming reaped larger volumes. Nevertheless, Norwegian yield clinched clienteles with higher price in the market, and achieved 43.7% more monetary value compared to Turkish production in 2021. This was, however, in contrary to what Turkish industry has performed in 1994, 39.2% higher

profits compared to Norwegian production. A strong correlation has been noted between production and population increase in the case of Türkiye (R= 0.9577436) compared to Norway with a considerably lower correlation of R= 0.7099250 for the past 27 years. The results of this study corroborate, factors such as operational, marketing, and branding strategies other than production volume capacity play part in generating high economic value from aquaculture production as it's been shown in this study with steelhead production, however further exploration is essential.

Keywords: High volume farming, High value farming, Pacific salmon, Rainbow trout, Steelhead, Norwegian aquaculture, Turkish aquaculture

Introduction

Over the last decade cage farms have been moved from sheltered marine locations to offshore sites in deeper waters, where caged aquaculture facilities operate in severe exposed marine sites with challenging strong currents, wind and wave impacts. Hence, more and more innovative equipment with stronger resistance has been introduced in facilities both in Norway and Türkiye for open ocean aquaculture. In Norwegian waters, current velocities over 0.5 m s-1 have been reported as common at exposed locations (Bergheim, 2012), and considering the conditions set for granting permission to cage aquaculture facilities in Turkish waters, the environmental law in force since 2006, underlines application basics of 30 m depth, 0.1 m s-1 current velocity and 0.6 miles distance from the shore, are the minimum limitations. Most of the cage farms in the Turkish aquaculture sector are operating at the far-edge of the limits due to an increased production capacity, in order to meet the increasing market demand for salmon. The size of aquaculture cage constructions expanded to 100 m diameter and to over 600 m circumference. There is a need for technological innovations not only in terms of structural features to accommodate this, but also electronic-based applications, such as visual technologies for monitoring fish behavior in order to ensure welfare and feed efficiency optimization. For example, Blaalid (2008) noted that the visual control of caged fish from surface is a problematic issue in caged systems with large volumes and only 0.2% of the entire volume could be possible with eye-vision in a cage with around 160 m circumference. The use of more sophisticated systems drives farmers into international competition. The use of more comprehensive systems forces farms in international competition. There are several factors affecting fish price in the market, which may vary depending on the level of development of the relevant countries, and can be more complex for the international market. However, among a wide range of factors such as fish size, quality, consumer's preference, seasonal effects, packing, labelling, nutritional value etc., the main factors affecting market price have been reported as product quality, fish size (Maciel et al., 2013; Alapan et al., 2016; Ike-Obasi, 2021), packaging and nutritional value attributes, as well as product availability in the market (Maciel et al., 2013). Notably, aquaculture enterprises may gain higher sales benefits by eco-labeling, branding and the use of quality packaging, that can extend the freshness and shelf life of the produce, which can influence consumers with regard to confidence (Olawunmi & Clarke, 2022). Consequently, producing high volume or high-quality products not always assure superior market price. With targeted marketing, producing high quality products combined with assuring consumer confidence may generate higher value with higher profits. Norway and Türkiye, the two key producers, provide high quality steelhead (*Oncorhynchus mykiss*), a Pacific salmon species (Laird, 2001), for the international market and are in competition, with efforts being invested to protect their existing market position while striving to reach new market opportunities.

This present study aims to evaluate production growth with sales values and economic returns from steelhead aquaculture in Norway and Türkiye, with a special emphasis on "high volume" versus "high value" product, that in turn might provide useful indications for marketing strategies for steelhead farming with boosted competitive power.

Materials and Methods

Collecting data and analyses

All variables measured in this study are given in means ± SD. The production in quantity was back dated 27 years with harvest data as well as sales values between 1994 and 2021 for steelhead production in both the Norwegian and Turkish aquaculture sectors have been collected from statistical query panels provided by FAO (2023a, b). The increase of harvest yields in percent over 27 years has been assessed as "production growth", which was calculated by the formulae given below, according to Yigit and Kusku (2022);

$$PG = \frac{(FFH - IFH)}{IFH}\ x\ 100$$

where, PG represents "production growth of steelhead in tons", FFH "final year fish harvest in tons" and IFH "initial year fish harvest in tons".

The unit sales price for each target country was calculated by dividing the production values by production quantity using following equation:

$$USP = \frac{PV}{PQ}$$

where, USP represents "unit sales price", while PV and PQ stand for "production value" and "production quantity", respectively.

The relative population growth was evaluated by using following equation:

$$RPG = \frac{(P\ fin - P\ ini)}{P\ ini}\ x\ 100$$

where, RPG expresses "relative population growth", whereas "P ini" is for "initial population", and "P fin" for "final population".

Statistical analyses

The correlation between population growth and the increase of harvest yields for steelhead for the target countries evaluated in this study, has been assessed using MacBook Pro, macOS Big Sur (11.7.3) and running a Microsoft Excel program for Mac, based on the following formulae:

$$Correl\ (X,Y) = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2\ \sum\ (y - \bar{y})^2}}$$

where, $\bar{x}$ and $\bar{y}$ show the sample mean values for the two different series, that was set as annual growth in steelhead production for Serie 1, and annual population growth for both countries for Serie 2.

Results and Discussion

The rainbow trout (*Oncorhynchus mykiss*), formerly known as *Salmo gairdneri* was reclassified as a Pacific salmon species after investigations on its genetic and native distribution according to Laird (2001), who listed the rainbow trout among the three widely farmed Pacific salmons in significant quantities, together with the chinook (king) salmon (*Oncorhynchus tshawytscha*), and the coho (silver) salmon (*Oncorhynchus kisutch*). The rainbow trout (also known as steelhead) has been reported as the most widely cultured salmonid species in the world (Candiotto et al., 2011; Stanković et al., 2015), and today it is the most farmed species in Türkiye (Yoğurtçuoğlu et al., 2021) comprising nearly 27% of the European production with more than 140 thousand tons (FAO, 2023c).

Turkish steelhead farming in net cages dates back to early 1990's when Yigit (1996) and Yigit and Aral (1999) investigated the growth differences of rainbow trout in freshwater versus seawater conditions in the Black Sea, which was followed by investments into rainbow trout farming, and thereafter in several years, it has become a major industry, destined for international markets. With hopes to gain higher profits in the Turkish aquaculture sector, the search for new marketing strategies brought farmers to the production of fish with larger size. Supportive of the new marketing strategy, fish with over 2.5 kg in weight are sold as "Turkish Salmon" (TMAF, 2020). This strategy is in line with Fernández-Sánchez et al. (2022), who reported that better profits were obtained with larger fish size for seabass in Mediterranean aquaculture. And indeed, the new farming strategy of the Turkish cage aquaculture business, with harvesting larger size rainbow trout (also known as steelhead) in offshore conditions, lead to competition between Türkiye and Norway, two leading producers.

The production of steelhead showed a gradual increase over the years and it has reached a good reputation and position in the world market. Steelhead production in Norway increased 6.6-fold from 14,367 to 94,660 tons over the last 27 years (1994-2021), while the Turkish aquaculture sector harvested 165,687 tons of steelhead in 2021 (FAO, 2023a) with around 23.8-fold increase from the annual harvest yield of 6,977 tons in year 1994. Norway presented 51.4% higher production compared to the Turkish harvest in 1994, however Turkish steelhead farms demonstrated a catch-up in 2009 with an extraordinary breakthrough and reached 42.9% higher harvest yields from steelhead aquaculture compared to Norwegian farms in 2021 (Figure 1).

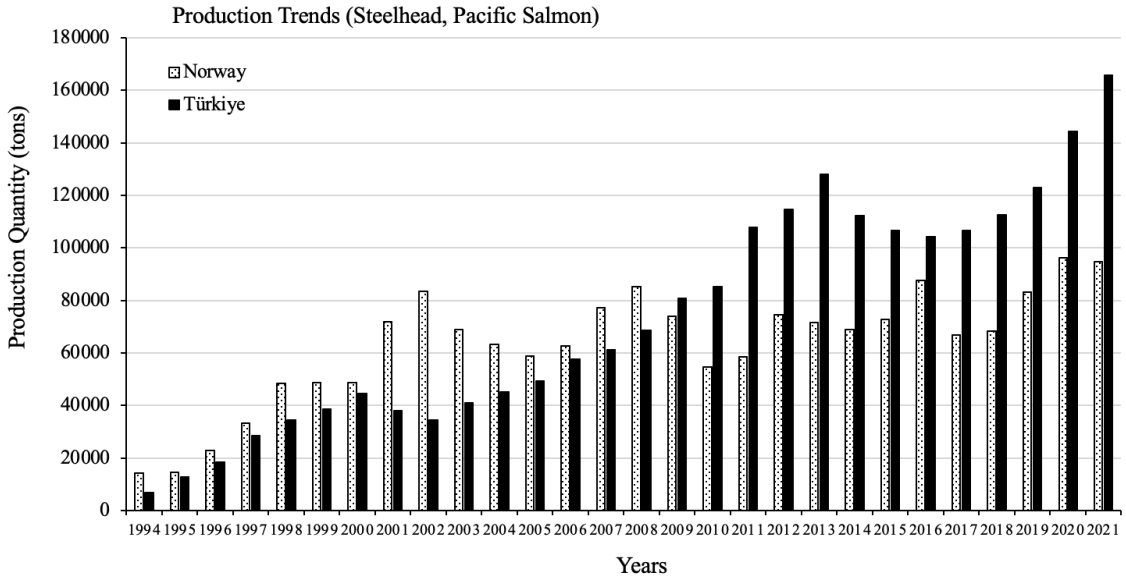

Figure 1. Production trend of steelhead between 1994 and 2011 (FAO, 2023a).

The economic profits however, were very similar for both countries with only 1.43% higher earnings for Norwegian enterprises. The production value for the Norwegian and Turkish steelhead increased from 48,477,157 to 489,828,392 $, and 38,722,350 to 482,847,914 $ between 1994-2021, respectively (FAO, 2023b). The increase over the past 27 years was 10.1-fold for the Norwegian production and 12.5-fold for the Turkish aquaculture business. The fact that Turkish steelhead business obtained higher production volumes did not make any difference in financial earning compared to the Norwegian with less production volumes. This demonstrates that Norwegian steelhead received higher price in the market with 43.7% better achievement in terms of price value compared to Turkish business of steelhead trading in 2021. In the early 1990's however, when Turkish cage aquaculture sector has initiated steelhead farming, the conditions were in opposite and 39.2% higher profits were noted for the Turkish business compared to Norwegian in year 1994 (Figure 2).

In the early 1990s, Norwegian steelhead production was 2-fold higher than the Turkish harvest, but with lower unit sales value (3.37 $ per kg fish) compared to the Turkish steelhead (5.55 $ per kg fish), which dropped to 1.48 $ per kg by 2001 and relapsed into recovery thereafter and reached 2.91 $ per kg fish in 2021. The new production and marketing strategy of the Turkish steelhead business, in terms of producing fish of over 2 kg seems to be exceptional move for the improvement of sales value which hit 7 $ per kg fish in 2022 (personal communications: Mr. Bilal Dülger, Farm Manager Forza Aquaculture Co., Trabzon-Turkiye). However, this can be clarified in future statistics when available in the following years.

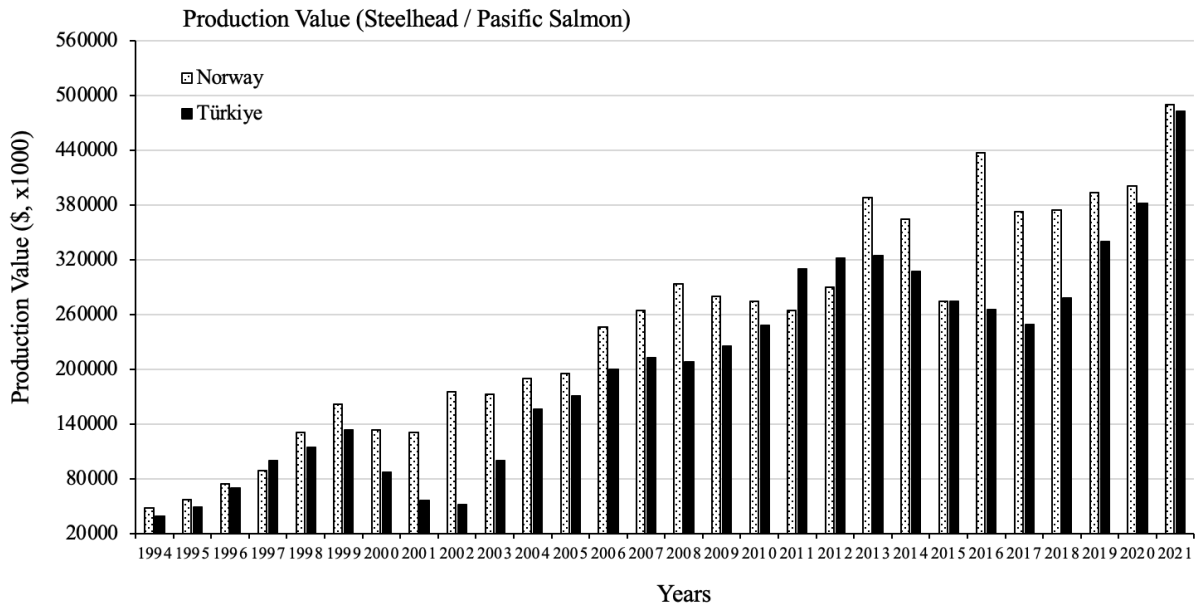

Figure 2. Production value of steelhead between 1994 and 2011 (FAO, 2023b).

The unit sales price for steelhead delivered to the market from Turkish farms in 1994 was 39.2% higher than the Norwegian steelhead, which in the following years increased for the Norwegian steelhead which reached a 43.7% superior value (5.17$ per kg fish) in 2021 compared to the Turkish sales price (2.91 $ per kg fish). With some fluctuations, the overall increase for sales price during the past 27 years was 1.53-fold for the Norwegian production and 0.53-fold for the Turkish aquaculture farms. The average unit sales price for Norwegian and Turkish steelhead between 1994 and 2021 presented mean values of 3.83±1.07 and 2.95±0.78, respectively. Despite the lowered unit sales price in Turkish steelhead farming, it has been noted that the production has been in an increasing trend, continuously over the years, which can be explained

by the increased competitiveness in international market. In the present study, the 23.8-fold increase of production quantity with only 12.5-fold increased production value, resulted in a decline of unit sales value of steelhead harvested from Turkish farms. Despite the lowered sales price for steelhead in the Turkish aquaculture market compared to 27 years ago, the steady increase of production in large volumes can be a sign of profitable expansion, this might be attributed to lower production cost, improved production technologies, and lower distribution and logistics costs as earlier reported by Asche (2015), who also noted this phenomenon for the successful aquaculture species of salmon and shrimp, with the actual prices presently lower than one-third compared to 25 years ago. This phenomenon however was not seen in the Norwegian steelhead business, which conversely to the Turkish sector, had a higher value increase (10-fold) with lower quantity growth (6.6-fold) was noted over the past 27 years (Figure 3).

The higher sales price for Norwegian steelhead, compared to the Turkish production might be explained by an increase in the confidence of consumers for the Norwegian product, following the reports of Mutambuki (2014), who underlined that the high-market-share of a known brand plays an important role for consumers' preferences as an indication of superior quality. This in turn may increase profitability, as the high-market-share brands may regulate their price at a premium level, the so-called price commanding ability. Further, Feucht and Zander (2017) evidenced that consumers' preferences and "willingness to pay" for premium fish are closely linked to farm conditions with certain sustainability standards in European society.

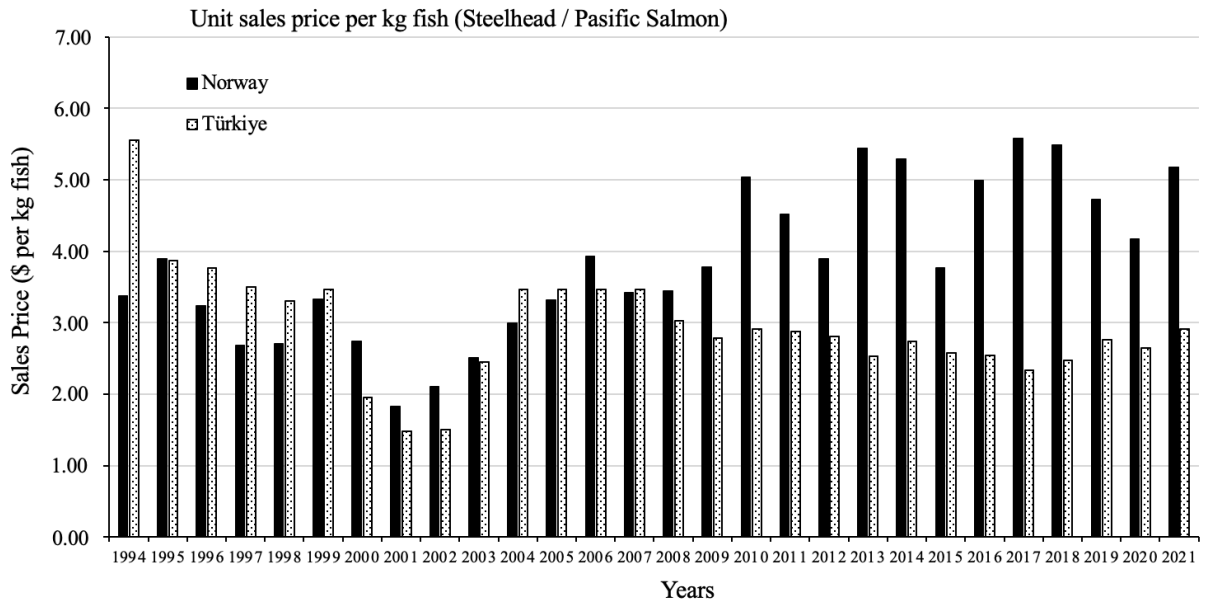

Figure 3. Unit sales price of steelhead between 1994 and 2011 (figure produced by calculation of data in Figure 1 and 2.

Over the last 27 years, the Norwegian population reached 5,543,193 with 1.3-fold increase from 1994 to 2023, whereas Turkish population hit 86,970,930 in 2023 which growth was 1.5-fold over the 1994 values. The relative population growth rates for the last 27 years were estimated as 51.09% and 27.68% for Türkiye and Norway, respectively. The median age in Türkiye is 31.5 years while in Norway the median age is reported as 39.8 years, which shows younger generation for the Turkish society compared to the Norwegian (Worldometer, 2023a, b) (Figure 4).

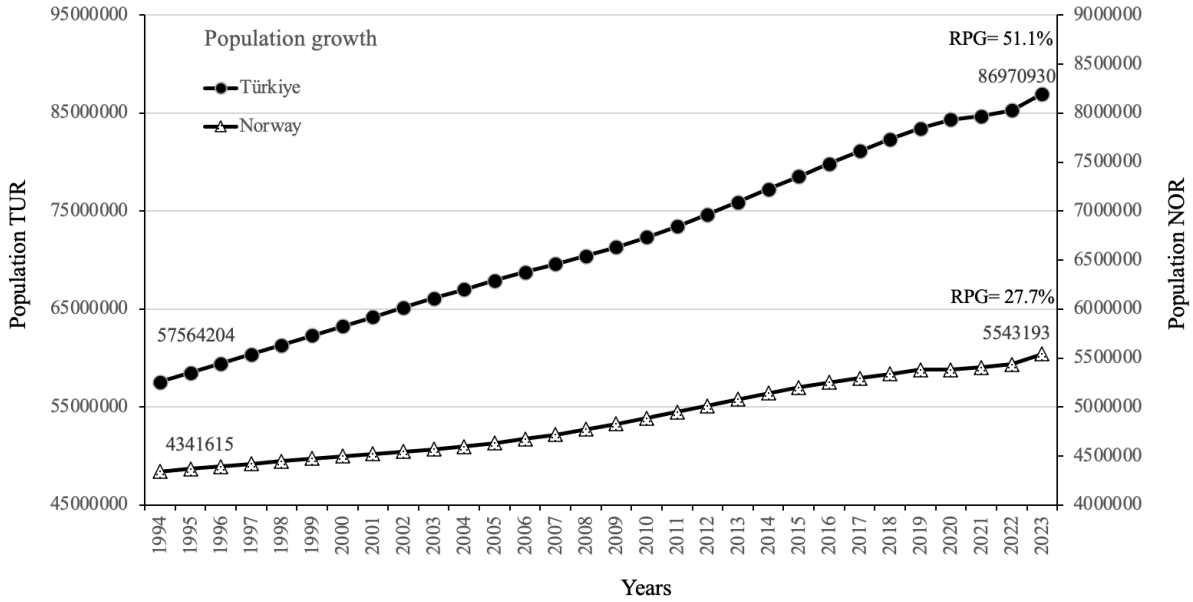

Figure 4. Population growth in Norway and Turkiye between 1994 and 2021 (figure produced by data retrieved from Worldometer, 2023a, b). RPG represents relative population growth.

Overall, the population of Türkiye is 15.7 times higher than the Norwegian population, that could be assigned as an advantage for the selection of well-trained personnel from a wider population range with more opportunities for the employment of younger personnel. A strong correlation has been found between production quantity trends and population growth in the case of Türkiye (R= 0.9577436), while the same correlation set was remarkably lower (R= 0.7099250) for Norway, when the last 27 years of time span was analyzed (Figure 4), showing that the production growth is strongly related to the increase of production volumes in the Turkish aquaculture, which is in line with earlier report of Yigit and Kusku (2022), whereas lower relation was noted for the same set of data in the Norwegian aquaculture development.

Erwin and Richard (2002) reported that in highly industrialized countries, a society with an older population can lose enthusiasm and excitement for nature-related work environments. Considering that 4,521,838 people in the Norwegian society (83.4% of the total population) live in urban areas, whereas 63,803,445 people representing 75.7% of the Turkish population in total are distributed in urbanized locations, according to 2020 estimations by Worldometer (2023a, b), there are more opportunities for the employment of younger people in nature-linked works such as aquaculture business as also underlined earlier by Yigit and Kusku (2022), that may support the rapid development of the Turkish aquaculture industry in the near future.

Conclusions

The long history of fisheries and aquaculture of Norway might be an advantage for its steelhead business with its well-stablished infrastructure. The high-market-share brand factor seems to be another advantage for the Norwegian steelhead farms with the capability to command a premium price. Norway's greater economic gain with less volume production may be due to its accomplishment in marketing and branding strategies. Türkiye, on the other hand, has steelhead production volumes competitive to Norway, but with lower sales price. As an important point, however, the supply of larger size steelhead in recent years increased sales value for the Turkish production, showing that the new marketing strategy of harvesting large fish was a positive move ahead in the competition with Norwegian production. The integration of high technology systems with its younger population in workforce, Türkiye seems have another advantage,

along with its lower production costs. It can be anticipated that Turkish steelhead product might be able to compete with Norwegian steelhead not only in terms of a lower production cost and market availability but also in price indices and sales revenues, provided that product availability in the market has been assured with quality standards. In view of comparable production volumes of both Türkiye and Norway, leading players in steelhead aquaculture, higher sales price and production value of the Norwegian steelhead farming confirms that not only production volume but also other factors such as marketing or branding strategies are of importance for generating high value aquaculture revenues, that is a theme unfolded to carry out further analysis in future investigations.

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Ethical approval
No ethical approval needed for this study since no living organisms were used.

Informed consent
Informed consent has been obtained from all individual participants involved in the study.

Data availability statement
The authors declare that data can be provided by corresponding author upon reasonable request.

Conflicts of interest
There is no conflict of interests for publishing this study.

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Contribution of authors
Ümüt Yigit: Conceptualization, Methodology, Data curation, Formal analysis, Writing original draft
Murat Yigit: Conceptualization, Methodology, Data curation, Validation, Writing original draft
Sebahattin Ergün: Methodology, Data curation, Validation, Writing original draft
Feyza Sanver: Resources, Supervision, Validation, Visualization, Review, Editing.
Nic Taylor: Resources, Supervision, Validation, Visualization, Review, Editing.
All authors have read and agreed to the final version of the manuscript.

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