CHALLENGES AND OPPORTUNITIES IN CHESTNUT SECTOR

[1]GLYKERIA KARAGOUNI, [2]AGGELIKI TSAMETI

[1,2]University of Thessaly, Greece
E-mail: karagg@uth.gr, tsameti@uth.gr

Abstract - Chestnut production has experienced a decline but is now gaining interest due to its nutritional value and market potential. Challenges include seasonal production, inefficient post-harvest techniques, and technological limitations. Opportunities for innovation in processing, product development, and by-product valorization exist, particularly in polyphenol recovery. Strategies for revitalizing the sector include integrated pest management, improved drying processes, and high-value-added products. Successful revival requires a balance between tradition and innovation, public policies, and private sector engagement. This research aims to provide a SWOT analysis of chestnut flour, enhancing its competitive position in both Greek and international markets.

Keywords - Chestnut Flour, Industry Challenges, SWOT Analysis

I. INTRODUCTION

Chestnut production has faced decline but is experiencing renewed interest due to its nutritional value and market potential (Aglietti et al., 2022; Giovannelli, 2009). The industry faces challenges including seasonal production, inefficient post-harvest techniques, and technological limitations (Giovannelli, 2009). However, opportunities exist for innovation in processing, product development, and by-product valorization, particularly in polyphenol recovery (Aglietti et al., 2022). Strategies for revitalizing the sector include developing integrated pest management, improving drying processes, and creating high value-added products (Aglietti et al., 2022; Bruzzese et al., 2020). Successful revival of the chestnut sector requires a balance between tradition and innovation, supported by coherent public policies and private sector engagement (Bruzzese et al., 2020; Giovannelli, 2009).

Chestnut flour has gained attention in recent years due to its nutritional value and potential for innovation in the food industry. It is rich in carbohydrates, proteins, unsaturated fatty acids, fiber, and polyphenolic compounds (Oniszczuk et al., 2019). Chestnut flour can be used in various products such as puddings, bakery items, bread, breakfast cereals, soups, and sauces (Mete & Altıner, 2017). The chestnut market has been expanding due to increased demand for natural products, advancements in harvesting and processing technologies, and new rural development policies in the European Union (Pettenella, 2001). Additionally, well-structured networks among chestnut growers can enhance the dissemination of information, knowledge, and innovations, leading to better product diversification and market sales (Marco et al., 2018).

This research aims to deliver a thorough SWOT analysis of the chestnut flour. This study seeks to be a valuable guide for industry professionals, producers, processors, and investors interested in the exploitation of chestnut flour, placing the product in a strong competitive position both in the Greek and international markets. The contribution and significance of the research lies in its comprehensive evaluation of the chestnut market in Europe. This research not only enhances understanding of the current market dynamics but also aids stakeholders in making informed decisions that could lead to increased competitiveness and opportunities in both Greek and international markets.

II. RESEARCH METHODOLOGY

Initially, researchers collected data on the chestnut industry using secondary sources available online. This process involved conducting keyword searches and reviewing recent secondary information. The use of the established SWOT methodology, a practice found in various scholarly works will serve as a valuable tool for facilitating decision-making by evaluating the internal strengths and weaknesses of the resource, as well as the external opportunities and threats it faces.

The chestnut sector in Greece: a SWOT analysis

Chestnuts are a crucial component of the Mediterranean diet and an essential economic element of agroforestry systems. Greece has a long history of chestnut cultivation, with significant production areas in many regions. Chestnuts play a vital role in maintaining local economies, contributing to both domestic consumption and export market. Although the industry is in a competitive global market, with growth opportunities in the coming years, it also faces multiple challenges. Indicatively, these include adaptation to changing market dynamics, changes in consumer preferences, environmental conditions and fungal diseases in chestnut trees. In particular, producers face a particular problem with "micro fruit" (small sizes of fruits that cannot be sold or exported - they are not commercially exploitable), as well as with losses from fallen and broken chestnuts, which reduce the

overall volume and value of production. In addition, more specifically, in terms of competition, Greek chestnut producers face intense competitive pressures from international markets, especially from countries such as China and Korea, which can affect prices and market share. The importance of developing a formal strategic marketing planning process has also been highlighted in the context of Greece's agricultural sector, economy and tourism industry, which shares some similarities with the chestnut market in terms of the need to diversify the product and enhance competition.

In addition, chestnuts are traditionally propagated through grafting, which can be unreliable and lead to inconsistency in production. In addition, over time oversized and oversized chestnut trees are likely to become unstable and therefore tend to be uprooted (Vogt et al., 2006). The new chestnut trees that are planted bear fruit in about six years, which means that these years the trees will not give income to the producers. Harvesting chestnuts can be labor-intensive, especially for seedlings that produce fruit unevenly throughout the season. At the same time, the aging of the workforce employed in chestnut cultivation, the great shortage of workers and the effort to keep young people in Greek chestnut villages by providing them with incentives to become new producers of agricultural products and work in the chestnut sector are also some of the challenges. Furthermore, many small-scale producers do not have the modern knowledge to adopt new technologies and innovations or to enter new markets. There is an obvious need for increased investment in research and development to further promote breeding programmes, pest management strategies, post-harvest treatment techniques and commercial practices. The complex and difficult regulatory framework can also be a barrier for producers seeking to innovate or expand their businesses.

Lack of robust infrastructure, insufficient advanced technological machinery and tools, lack of information, insufficient guidance on disease management and innovative agricultural practices, low government support, as well as distribution to specific supply chain networks, hinder producers' ability to effectively manage the production, marketing and distribution of their products, especially in international markets. In addition, chestnuts currently hold a niche position in the market compared to more established nuts such as almonds. The Eurozone crisis has also highlighted the country's lack of a national strategy for exporting agricultural products (Andéhn & Decosta, 2020).

Apart from the difficulties mentioned above, one of the most important challenges of the industry is the prevalence of diseases. Specifically, in Greece, as in many European chestnut producing regions, there has been a general decline in chestnut cultivation due to the aggravating factor of climate change (Aglietti et al., 2022; Pérez-Girón et al., 2020), environmental degradation (Bruzzese et al., 2020) and several stressors, including diseases such as Cryphonectria parasitica (c. parasitica; Diamandis, 2018), Phytophthora cinnamomi (p. cinnamomi; Robin & Heiniger 2001; Turchetti et al. 2008; Vettraino et al. 2005) and insect parasites such as elephas (Coleoptera, Curculionidae) (Paparatti & Speranza, 2005).

These challenges have led to fluctuations in yield, quantity and quality, highlighting the need for alternatives. Several rural development policies have had a significant impact on chestnut initiatives, with the EU prioritizing diversification in agricultural activities and seeking new non-agricultural sources of income (Burgess & Rosati, 2018). Technological development, including forest management techniques, harvest technology, and production chain processing, is a driving force in the industry's performance (Bruzzese et al., 2020; Pettenella, 2001). Several factors are likely to shape farmers' attitudes towards growing Castanea sativa, including the availability of alternative markets and investments in various chestnut applications, both primary and secondary chestnut products, that can provide additional income and enhance the value of the product. The security of land ownership, supportive infrastructure, and capital investments are also critical. However, political and social factors may hinder the adoption of alternative practices. Farmers make decisions by interacting with their environment, striving for rationality and efficiency as they modify or reconsider their initial choices, all while considering ethical, political, cultural, and normative values. Changes in chestnut production practices and applications are influenced and determined by farmers' capabilities, market conditions, know-how, available technology, existing or potential synergies, and policy frameworks. Conservation efforts also play a role in balancing profit maximization with secondary goals (Zafeiriou et al., 2021; Thompson et al., 2015). Considering the cumulative impact of losses from fallen and broken chestnuts, chestnut diseases, environmental challenges, lack of information, insufficient technological infrastructure and limited resources, as well as exclusivity in exports and partnerships, uncertainty is likely to increase, negatively affecting the volume and value of chestnut production. This, in turn, will reduce producers' income. Organized and coordinated efforts are essential for cooperatives. They are more than ever called upon to develop a common vision and explore alternative, innovative solutions to maximize the value of their product, such as promoting the use of chestnut flour (chestnut flour).

Strengths	Weaknesses
A crucial component of the Mediterranean diet Greece has a long history of chestnut cultivation Chestnuts and processed chestnut products (i.e., chestnut flour) have a significant positive impact on human health (Braga et al., 2015), the economy, and waste management (Borrello et al., 2016; Salvador et al., 2021).	Seasonality of production: The chestnut harvest is limited to autumn (September-November), leading to limited availability. Small sizes re not commercially exploitable The cost of production and processing is higher than other flour Chestnut cultivation is vulnerable to extreme weather events, climate changes, and diseases Small-scale producers luck knowledge Harvesting chestnuts can be labor-intensive Lack of robust infrastructure, insufficient advanced technological machinery and tools, lack of information, insufficient guidance on disease management and innovative agricultural practices
Opportunities	**Threats**
The growing demand for gluten free products. Increasing consumer demand for healthier choices Increasing need for sustainability (Knorr & Augustin, 2020). Developed Synergies with existing specialized flour mills and factories for high standards of hygiene and quality(Cappelli et al, 2021). Technological development, including forest management techniques, harvest technology, and production chain processing. EU initiatives	High competition among flours (almond flour, quinoa, oats, rye, chickpeas, buckwheat, millet and coconut which are strong competition in the category of alternative flours). Intense competitive pressures from international markets, especially from countries such as China and Korea Significant shortage of workers The Eurozone crisis, USA tariffs and global vulnerabilities

Table 1. SWOT Analysis for Chestnut Flour

III. CONCLUSIONS

The chestnut flour market has evolved from a small-scale, local activity to an international, growing industry that capitalizes on trends in healthy eating, gluten-free products and more natural choices. Chestnut flour, as a product produced from chestnuts undergoing drying and milling treatment, is considered “superfood” due to its nutrients, such as fiber, antioxidants and vitamins. This makes it ideal for use in bakery and confectionery products, as well as recipes aimed at special nutritional needs. The market for chestnut flour has powerful advantages that make it attractive, such as its unique nutritional benefits and flexibility in use. However, the challenges of seasonality, production costs and competition require strategies of innovation and diversification. The development of new products, the utilization of organic certifications and penetration into international markets are key success factors for the industry. The chestnut market in Europe is a dynamic and growing industry with a focus on quality, innovation and sustainability.

Although there are challenges, such as disease, seasonality and competition, opportunities for exports, the processing and promotion of gluten-free products, current needs and new policies offer opportunities for growth. Mediterranean countries continue to lead the market, offering high-quality chestnuts in high demand both within and outside Europe. More specifically, chestnut producers in Greece understand that investing in alternative uses of chestnut is required to provide additional income and added value to the product. Chestnut flour with its sweet, unique flavor and nutritional benefits, offering flexibility in culinary applications as it can be used as an alternative to wheat flour in many recipes (Aguilar et al., 2016; Bathrellou et al., 2018; Paciulli et al., 2016; Shafi et al., 2017) is one such product – an alternative use of chestnut – . Focusing on high-quality production and leveraging trends that take into account consumer health and sustainability at an economic, social and environmental level, chestnut flour is placed at the heart of the activities of producers, processors, food companies and other stakeholders to meet the growing consumer demand for nutrient products and create a strong market presence.

The chestnut flour market is projected to continue to grow at a steady pace as demand increases and the trend towards improving nutrition and awareness about the nutritional benefits of natural products increases. Consumers are looking for alternatives to traditional flour, and chestnut flour, with its rich nutritional value and gluten-free absence, is able to meet these needs. With the incorporation of chestnut

flour into new recipes and applications, such as biscuits, protein bars and cereal mixes as well as other food products, the market is expected to expand further. Increased availability and improved distribution in new markets will enable the development of chestnut flour in regions outside Europe, such as North America and Asia. Chestnut flour is in seasonal demand, with periods of increased consumption occurring during autumn and winter. This is linked to the chestnut harvest season (mainly September - November) and the increased use in traditional winter recipes and festive products. In summary, the chestnut flour market shows dynamic growth with seasonal demand trends and great prospects for expansion at an international level. Furthermore, the regulatory rules for organic and gluten-free products set labelling requirements, certification procedures and quality specifications, affecting the cost and certification of the chestnut flour. It is important to mention that advances in processing technology can improve the quality of chestnut flour and reduce production costs. The adoption of modern processing methods will allow producers to offer higher quality products and compete more effectively in the market.

In general, it is understood that the market for chestnut flour is significantly influenced by economic and social awareness of healthy eating, the improvement of production and distribution technology, as well as by the legal regulations for food. These external factors largely determine the future course and growth dynamics of chestnut flour in the global market, which seems positive, with many growth opportunities in the field of production, processing and promotion. With the right marketing strategy and the support of the food industry, chestnut flour can establish itself as a popular choice for healthy eating globally.

ACKNOWLEDGMENTS

This research was funded by the Greek Ministry of Rural Development & Food under the operational plan that is being implemented within the framework of Measure 16, particularly the sub-measure 16.1-16.2 – Action 2, with the code of funding body M16SYN2-00412. The title of the project is “Transfer of know-how for the innovative utilization of both sorting and fallen chestnuts, strengthening the competitiveness of the chestnut producers’ cooperatives”. The authors declare no conflicts of interest related to this study

REFERENCES

[1] Andéhn, M., & L’Espoir Decosta, J. N. P. (2021). Authenticity and Product Geography in the Making of the Agritourism Destination. *Journal of Travel Research, 60*(6), 1282-1300. https://doi.org/10.1177/0047287520940796

[2] Bathrellou, E., Kontogianni, M. D., & Panagiotakos, D. B. (2018). Celiac disease and non-celiac gluten or wheat sensitivity and health in later life: A Review. Maturitas, 112, 29–33. https://doi.org/10.1016/j.maturitas.2018.03.014

[3] Barbieri, C., & Mahoney, E. (2009). Why is diversification an attractive farm adjustment strategy? insights from Texas farmers and ranchers. *Journal of Rural Studies, 25*(1), 58–66. https://doi.org/10.1016/j.jrurstud.2008.06.001

[4] Bartlett, L., & Vavrus, F. (2017). Comparative Case Studies: An Innovative Approach. *Nordic Journal of Comparative and International Education (NJCIE), 1*(1). https://doi.org/10.7577/njcie.1929

[5] Beridze, B., & Dering, M. (2021). Problems and threats to the Caucasus forest ecosystems on the example of Castanea sativa. *Kosmos, 70*(1), 19–26. https://doi.org/10.36921/kos.2021_2662

[6] Borrello, M., Lombardi, A., Pascucci, S., & Cembalo, L. (2016). The seven challenges for transitioning into a bio-based circular economy in the Agri-Food Sector. *Recent Patents on Food, Nutrition & Agriculture, 8*(1), 39–47. https://doi.org/10.2174/2212798408011603041439 39

[7] Bruzzese S, Blanc S, Brun F. Strategies for the Valorisation of Chestnut Resources in Italian Mountainous Areas from a Sustainable Development Perspective. Resources. 2020; 9(5):60. https://doi.org/10.3390/resources9050060

[8] Burgess, P.J., & Rosati, A. (2018). Advances in European agroforestry: results from the AGFORWARD project. *Agroforest Systems 92*, 801–810. https://doi.org/10.1007/s10457-018-0261-3

[9] Campos DA, Gómez-García R, Vilas-Boas AA, Madureira AR, Pintado MM. Management of Fruit Industrial By-Products—A Case Study on Circular Economy Approach. Molecules. 2020; 25(2):320. https://doi.org/10.3390/molecules25020320

[10] Cappelli, A., Lupori, L., & Cini, E. (2021). Baking Technology: A systematic review of machines and plants and their effect on final products, including Improvement Strategies. *Trends in Food Science & Technology*, *115*, 275–284. https://doi.org/10.1016/j.tifs.2021.06.048

[11] Che, D., Veeck, A., & Veeck, G. (2005). Sustaining production and strengthening the agritourism product: Linkages among Michigan Agritourism destinations. *Agriculture and Human Values, 22*(2), 225–234. https://doi.org/10.1007/s10460-004-8282-0

[12] Diamandis, S. (2018). Management of Chestnut Blight in Greece using hypovirulence and silvicultural interventions. *Forests*, *9*(8), 492. https://doi.org/10.3390/f9080492

[13] Domi, S., & Belletti, G. (2022). The role of origin products and networking on Agritourism Performance: The case of tuscany. Journal of Rural Studies, 90, 113–123. https://doi.org/10.1016/j.jrurstud.2022.01.013

[14] El Chami, M. A., Tourvas, N., Kazakis, G., Kalaitzis, P., & Aravanopoulos, F. A. (2021). Genetic characterisation of chestnut cultivars in crete. *Forests*, *12*(12), 1659. https://doi.org/10.3390/f12121659

[15] Freitas, T. R., Santos, J. A., Silva, A. P., & Fraga, H. (2021). Influence of climate change on Chestnut Trees: A Review. *Plants*, *10*(7), 1463. https://doi.org/10.3390/plants10071463

[16] Gold, M. A., Godsey, L. D., & Josiah, S. J. (2004). Markets and marketing strategies for Agroforestry Specialty Products in North America. *Agroforestry Systems*, *61–62*(1–3), 371–384. https://doi.org/10.1023/b:agfo.0000029011.42829.83

[17] Guiné, R. (2021). A Review of the Use of Chestnut in Traditional and Innovative Food Products. *Journal of Nuts, (14)*1.

[18] He L, Min Q, Hong C, Zhang Y. Features and Socio-Economic Sustainability of Traditional Chestnut Forestry Landscape in China: A Case of Kuancheng County, Hebei Province. Land. 2021; 10(9):952. https://doi.org/10.3390/land10090952

[19] Knorr, D., & Augustin, M. A. (2021). From value chains to food webs: The quest for lasting food systems. *Trends in Food Science & Technology, 110,* 812–821. https://doi.org/10.1016/j.tifs.2021.02.037

[20] Littardi, P., Paciulli, M., Carini, E., Rinaldi, M., Rodolfi, M., & Chiavaro, E. (2020). Quality Evaluation of chestnut flour addition on fresh pasta. *LWT*, *126*, 109303. https://doi.org/10.1016/j.lwt.2020.109303

[21] Lozano, M.; Vallés, J. An analysis of the implementation of an environmental management system in a local public administration. J. Environ. Manag. 2007, 82, 495–511;

[22] Paciulli, M., Rinaldi, M., Cirlini, M., Scazzina, F., & Chiavaro, E. (2016). Chestnut flour addition in commercial gluten-free bread: A shelf-life study. LWT, 70, 88–95. https://doi.org/10.1016/j.lwt.2016.02.034

[23] Papaioannou, E. A., Stefanou, S., Gakis, S. F., Netsikas, E. N., & Mavridis, A. (2019). Growth, forest floor, and soil chemical analysis comparison between two management practices in chestnut forests of Greece. *Journal of Sustainable Forestry*, *38*(6), 526–541. https://doi.org/10.1080/10549811.2019.1598438

[24] Paparatti, B., & Speranza, S. (2005). Biological control of hazelnut weevil (curculio nucum L., Coleoptera, Curculionidae) using the entomopathogenic fungus Beauveria bassiana (balsamo) vuill. (Deuteromycotina, hyphomycetes). *Acta Horticulturae*, (686), 407–412. https://doi.org/10.17660/actahortic.2005.686.56

[25] Pérez-Girón, J. C., Álvarez-Álvarez, P., Díaz-Varela, E. R., & Mendes Lopes, D. M. (2020). Influence of Climate Variations on primary production indicators and on the resilience of forest ecosystems in a future scenario of climate change: Application to sweet chestnut agroforestry systems in the Iberian Peninsula. *Ecological Indicators*, *113*, 106199. https://doi.org/10.1016/j.ecolind.2020.106199

[26] Pettenella D., 2001. Marketing perspectives and instruments for chestnut products and services. *Forest Snow and Landscape Research, 76*(3), 511-517

[27] Robin, C., & Heiniger, U. (2001). Chestnut blight in Europe: Diversity of Cryphonectria parasitica, hypovirulence and biocontrol. Forest Snow and Landscape Research, 76, 361–367.

[28] Ryu, J. S., L'Espoir Decosta, J. N. P., & Andéhn, M. (2016). From branded exports to traveler imports: Building destination image on the factory floor in South Korea. *Tourism Management*, *52*, 298–309. https://doi.org/10.1016/j.tourman.2015.07.004

[29] Salvador, R., Puglieri, F. N., Halog, A., Andrade, F. G., Piekarski, C. M., & De Francisco, A. C. (2021). Key aspects for designing business models for a circular bioeconomy. *Journal of Cleaner Production*, 278, 124341. https://doi.org/10.1016/j.jclepro.2020.124341

[30] Seijo, F., Millington, J. D. A., Gray, R., Mateo, L. H., Sangüesa-Barreda, G., & Camarero, J. J. (2016). Divergent fire regimes in two contrasting Mediterranean Chestnut Forest Landscapes. *Human Ecology*, *45*(2), 205–219. https://doi.org/10.1007/s10745-016-9879-9

[31] Shafi, M., Baba, W. N., & Masoodi, F. A. (2017). Composite flour blends: Influence of particle size of water chestnut flour on nutraceutical potential and quality of Indian flat breads. Journal of Food Measurement and Characterization, 11(3), 1094–1105. https://doi.org/10.1007/s11694-017-9486-5

[32] Thompson, A. W., Reimer, A., & Prokopy, L. S. (2015). Farmers' views of the environment: The influence of competing attitude frames on landscape conservation efforts. Agriculture and Human Values, 32(3), 385–399. https://doi.org/10.1007/s10460-014-9555-x

[33] Zhou, S., Reddy, C. K., Du, B., & Xu, B. (2021). Pasting, thermal, and functional properties of wheat flour and rice flour formulated with chestnut flour. *Bioactive Carbohydrates and Dietary Fibre*, *26*, 100290. https://doi.org/10.1016/j.bcdf.2021.100290

[34] Vettraino, A. M., Morel, O., Perlerou, C., Robin, C., Diamandis, S., & Vannini, A. (2005). Occurrence and distribution of phytophthora species in European chestnut stands, and their association with ink disease and Crown decline. *European Journal of Plant Pathology*, *111*(2), 169–180. https://doi.org/10.1007/s10658-004-1882-0

[35] Vogt, J., Fonti, P., Conedera, M., & Schröder, B. (2006). Temporal and spatial dynamic of stool uprooting in abandoned chestnut coppice forests. *Forest Ecology and Management*, *235*(1–3), 88–95. https://doi.org/10.1016/j.foreco.2006.08.008

[36] Zafeiriou, E., Chatzissavvidis, C., Antonopoulou, C., & Arabatzis, G. (2021). Sweet Chestnut and agricultural development: A farmers' perspective for Northern Greece. *International Journal of Agricultural Sustainability*, *20*(2), 199–215. https://doi.org/10.1080/14735903.2021.1923912

★★★