The environmental impact of increased traceability in the value chain of beef within the area of Central Macedonia

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Introduction

Food fraud, a global socio-economic issue, involves intentionally misleading food claims, substituting or tampering with food or its packaging for economic gain, prompting increased consumer demand for accurate labeling and certified genuine products due to associated health and safety risks. Therefore, the certification of food authenticity is a crucial step for protecting consumers and the supply chain which involves a large variety of biochemical identification methods of authentication. At the same time, the global food industry is experiencing a dual trend of continued trade globalization and a strategic shift towards local production and distribution due to climate change and the Covid-19 pandemic, which aims to address rising production costs, transportation barriers, and global uncertainties, while industrial agricultural practices continue to threaten health, food security, and sustainability. Ultimately, the evolution of the agri-food sector is closely linked to consumer preferences, emphasizing quality and sustainability as critical drivers of future growth and development. Food authenticity and identity is even more crucial in beef production considering the significant instances caused by meat consumption (Bovine spongiform encephalopathy, African Swine Fever, etc.). However, food authenticity implication in the environmental performance of beef value chain remains unknown and it can be estimated by using the Life Cycle Analysis methodology.

Material and Methods

Background information: The study is part of the Authenbeef Program, which aims to develop a beef traceability method in Central Macedonia and integrate it into the Authenbeef platform which is based on blockchain technology and securely stores and certifies information about beef, including breeding, production, and packaging details. The environmental analysis concerns data of the Region of Central Macedonia (RCM), which is divided into seven (7) Regional Units (RU): 1) Imathia, 2) Pella, 3) Pieria, 4) Thessaloniki, 5) Kilkis, 6) Serres, and 7) Chalkidiki. Beef consumption in the region of Central Macedonia was 22636 tons, its beef production was 13852 tons while Greece imported 113412.4 tons of beef in 2021 (ELSTAT, 2021).

Goal & Scope: Compare the environmental impacts of beef value chain in RCM before and after introducing Authenbeef platform for food authenticity. Functional unit: 1 (one) kg of beef at the reatiler Boundaries: the stages of beef slaughter to retail positioning in stores of RCM. Comparative analysis will be based on the ISO 14040 Life Cycle Assessment methodology, using SimaPro v3.6 software and the Ecoinvent v3.10 database, along with the ReCiPe Midpoint (H) methodology.

Scenario 1(before Authenbeef platform): Based on 22636 tons of beef consumption in RCM, 60% is produced within the RCM, while the rest is imported from France (~13.5%), Netherlands (5.5%), Spain (7%), Italy (6%), Poland (3%), Germany (2%), and Denmark (1%).

Scenario 2 (after Authenbeef platform): Based on the same consumption, 22636 tons, and the consumer preferences in Greece (80% would prefer local products) local production increase from 60 to 80%, and imported beef is decreased by 20%.

Inventory:

Table 1: The total input in water and transport as well as the output of nutrients (N, P, K) and biogas for the six handlings (H1-H6)

	Scenario 1	Scenario 2
Input		
Transport in refrigeration (kgkm)	921.8	542.5
Transport in freezer (kgkm)	75.93	33
Output		
Production	1 kg beef	1 kg beef

Results and Discussion

The Life Cycle Impact Assessment comparison of Scenarios 1 & 2 was based on 18 environmental indicators related to air, water, and soil pollution, as well as human health. Based on Figure 1, human carcinogenic and non-carcinogenic toxicity are the most affected impact categories by the beef value chain followed by the aquatic ecosystems. Overall, the entry of the platform into the beef value chain in RCM results in improvement in various indicators, with the most significant improvement being in the carcinogenic toxicity indicator. Based on figures 1 & 2, the improvement of the beef value chain through the use of the platform is evident in fourteen out of eighteen indicators. The improvement experienced by the cattle production system is around 2% per indicator. More specifically, improvements greater than 3% are achieved in the indicators of human carcinogenic toxicity, terrestrial ecotoxicity, and mineral resource scarcity.

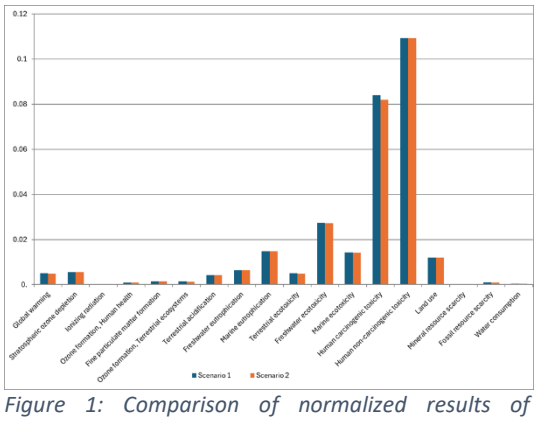

Figure 1: Comparison of normalized results of environmental impacts for scenarios 1 and 2 using the ReCiPe Midpoint method.

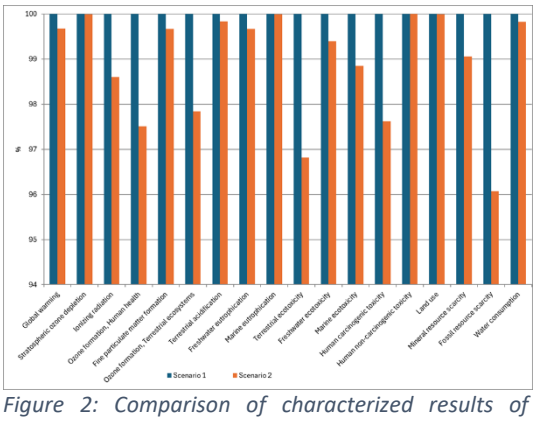

Figure 2: Comparison of characterized results of environmental impacts for scenarios 1 and 2 using the ReCiPe Midpoint method.

Conclusions

The environmental performance of beef production is mostly affected by the stage of cattle raising. More specifically, methane emissions from enteric fermentation and feed production are the most impactful stages. A relocalization of beef production in RCM can improve the environmental impact of the value chain due to the decrease of transportation. As a matter of fact, a cut down in imports can primarily improve the environmental performance of beef production in human health and terrestrial ecotoxicity indicators. Furthermore, quite important is the improvement in the impact on aquatic ecosystems and resources as well as ozone formation. Overall, increased traceability and authenticity can improve the sustainability of the sector. Further research is needed to examine the incentivization of producers to obtain more environmentally sustainable practices when beef value chains increase transparency.

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