



Editorial: Sustainable Production of Ethnic Alcoholic Beverages

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Editorial on the Research Topic

Sustainable Production of Ethnic Alcoholic Beverages

Scientific and technological research around ethnic alcoholic beverages (EAB) has experienced different degrees of progress. Almost all human cultures have EABs, which are distinctive of their food heritage, traditions, and, in many cases, of ritualistic significance. Many EABs are for local consumption, and their economic impact may be limited. However, they can probably increase their contribution to the local economy. On the other hand, some EABs have achieved international relevance, and their commercialization has grown. However, there are two general problems. First, in the case of beverages for local consumption, it is essential to preserve the knowledge and tradition of their production as a part of cultural heritage and ethnic identity.

Nevertheless, producing these beverages could benefit the economy and quality of life of the producing communities. The problem is different for beverages that have reached increasing production and marketing. In these cases, increased production may be causing problems in the supply of raw materials, endangering biodiversity and even the survival of the species used. Depending on the industries' size and degree of development, there may be other environmental problems derived from the generation and disposal of waste from the production process. All the cases require planning for sustainable production in the long term.

This Research Topic includes five reviews and four original research articles analyzing aspects related to EAB from different geographic origins. First, Sawadogo-Lingani et al. reviewed the production of dolo, an African traditional sorghum beer, finding that production remains artisanal and faces many sustainability challenges. They suggest that strategies must focus on sustainability challenges such as assuring the supply of quality raw materials, and optimizing and standardizing processing techniques for malting and brewing, among others. There is also the need to control fermentation using starters formulated with selected strains while preserving the biodiversity of the fermenting microorganisms associated with African sorghum beers.

Rawat et al. revised EABs from Indian Himalayan Region. Their work highlights that this geographic region has alcoholic beverages enriched with nutritional components such as vitamins and proteins. They concluded that traditional alcoholic beverages play a significant role in preserving the ancient traditions of the tribes. Therefore, it is necessary to preserve the ancestral heritage of traditional alcoholic beverages for the future. Likewise, research is needed to add value to these ethnic beverages to enhance the economic sustainability of tribal communities. Nath et al. discuss the diversity and interactive association of yeasts to produce EAB by indigenous communities of northeast India. It is underscored the relevance of studying yeast-yeast association and the role of chemical communication by quorum-sensing molecules like tyrosol in controlling the quality of fermented products. The commercial potential of these products could

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benefit indigenous people through the commercialization of these alcoholic beverages to impart sustainable livelihood options.

The subject of the review done by Valdivieso Solís et al. is the production of pulque, a non-distilled EAB obtained by fermentation of the agave sap called aguamiel in Mexico. It emphasizes the disappearance of large agave plantations and the long time required (at least 5 years) to reach the plant maturation for pulque production. Then, the authors also underscored the relevance of sustainable plantation models to ensure the raw material supply. They describe successful examples of beverage industrialization and potential applications of several microorganisms isolated from this production system to produce high-value bioactive products. On the other hand, Arellano-Plaza et al. argue that the substantial production increase of mezcal, a distilled EAB from Mexico, is pressing on resources for its production, particularly agaves. The manuscript reviews the current state of mezcal production, the sustainability aspects in a very artisanal process, and the challenges of the production chain in the context of increasing demand.

One of the original research articles was written by Ghosh et al. It reports the physicochemical characteristics and diversity of lactic acid bacteria of haria, a rice fermented alcoholic beverage from India. Molecular techniques allowed them to identify four species of *Lactobacillus* and uncultured *Bacillus* sp. The bacteria activity enriched the beverage with lactic and acetic acids and some vitamins and essential minerals, enhancing the nutritional characteristics of the beverage. On the other hand, Núñez Caraballo et al. investigated the interaction between yeast cells and nanostructures of chitosan-coated manganese ferrite during ethanol production by *Saccharomyces cerevisiae*. They found that biomass immobilization on nanoparticles benefited ethanol production since fermentation time was reduced, and higher ethanol yield and productivity were obtained. Larralde-Corona et al. made a yeast selection based on a characterization protocol to identify strains with good sugar consumption and ethanol productivity, but also a good profile of esters production. Their results allowed them to propose a rational methodology to select strains for starting agave fermentations during tequila and mezcal production. Finally, Ambrocio-Ríos et al. investigated the elaboration of the beverage called taberna (Chiapas, Mexico) from a social and cultural perspective. They applied semi-structured interviews to the producers, identifying the biocultural importance for the communities and the families involved in the beverage production.

Several manuscripts included in this compilation coincide with the importance of preserving ancestral knowledge and the traditions associated with the production of each EAB. Another aspect of coincidence is the need to preserve the raw materials used to produce beverages, considering both their biodiversity and a safe and quality supply for production. Furthermore, improving production methods, ensuring compliance with quality standards, labeling, and marketing of beverages are also considered. Finally, emphasis is placed on ensuring that the production and commercialization of EABs positively impact the economy and standard of living in the producing regions. Therefore, collaborative strategies must be implemented by raw material producers, EAB producers, entrepreneurs, and governments. Those strategies must contemplate a comprehensive approach that considers the social, ecological, technological, and economic dimensions to achieve sustainable production systems.

AUTHOR CONTRIBUTIONS

All authors contributed equally to the article and approved the submitted version.

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