International Journal of
Agriculture
(IJA)

The Impact of Advanced Food Processing Technologies on Agricultural Value Addition

Faith Neema

IPRJB

International Journal of Agriculture
ISSN 2520-4629X (Online)
Vol.8, Issue 2, No. 2. PP. 11 - 21, 2023

The Impact of Advanced Food Processing Technologies on Agricultural Value Addition

Faith Neema

Sokoine University of Agriculture

Article History

Received 20th May 2023

Received in Revised Form 1st June 2023

Accepted 13th June 2023

How to cite in APA format:

Neema, F. (2023). The Impact of Advanced Food Processing Technologies on Agricultural Value Addition. *International Journal of Agriculture*, *8*(2), 11–21. https://doi.org/10.47604/ija.2004

Abstract

Purpose: The study aimed at investigating the impact of advanced food processing technologies on agricultural value addition

Methodology: This study adopted a desktop methodology. This study used secondary data from which include review of existing literature from already published studies and reports that was easily accessed through online journals and libraries.

Findings: The study revealed that the adoption of advanced food processing technologies enhances value addition by preserving nutritional quality, extending shelf life, improving sensory attributes, optimizing processing efficiency, and ensuring microbial safety. The study also found out that advance food processing technologies have significant advantages over conventional processing methods, such as increased yield of bioactive compounds, improved rehydration properties, reduced drying time, and better maintenance of color, flavor, and texture.

Unique Contribution to Theory, Practice and Policy: The study was anchored on Innovation Systems theory which was developed by Christopher Freeman and the Diffusion of Innovations Theory which was propounded by Everett Rogers. The study recommends the adoption of advanced food processing technologies can facilitate the development of innovative food products that meet consumer demands for healthier, safer, and more convenient options.

Keywords: *Food Processing, Technologies, Agriculture, Value Addition*

INTRODUCTION

Agricultural value addition refers to the process of enhancing the value of agricultural products through various activities such as processing, packaging, branding, and marketing. This enables farmers to transform raw agricultural commodities into higher-value products, thereby increasing their profitability and contributing to overall economic growth. In developed economies like the USA, Japan, and the UK, agricultural value addition plays a significant role in diversifying their agricultural sectors and meeting consumer demands (Smith, 2022).

In the USA, the agricultural value-added sector has experienced substantial growth in recent years. For example, the value of U.S. food manufacturing shipments increased from $550 billion in 2012 to $762 billion in 2017, representing a compound annual growth rate of 6.7% (USDA Economic Research Service, 2019). This growth can be attributed to the development of value-added products such as processed foods, specialty crops, and functional foods that cater to changing consumer preferences. Additionally, the USA has seen a rise in organic farming, which contributes to value addition by offering higher-priced organic products.

In the United Kingdom, the craft beer industry showcases the importance of agricultural value addition. The UK has witnessed a significant growth in the craft beer sector, with a focus on locally sourced ingredients and unique brewing techniques. According to the Society of Independent Brewers (SIBA), the number of independent breweries in the UK increased from around 500 in 2013 to over 2,000 in 2020 (SIBA, 2020). This growth has been driven by value addition through the use of specialty malts, hops, and innovative flavor profiles. Craft breweries often collaborate with local farmers and utilize locally grown ingredients, contributing to rural development and the promotion of distinct regional flavors.

In Japan, the agricultural sector has been actively promoting value addition to improve the competitiveness of its agricultural products. One notable example is the development of premium rice varieties, such as Koshihikari and Akitakomachi, which are known for their superior taste and quality. These rice varieties are processed and packaged under strict quality control measures to maintain their premium status. Another example is the production of high-value fruits, such as the "Ruby Roman" grapes, which are known for their large size, high sugar content, and unique flavor. These premium fruits are carefully cultivated and marketed as luxury products, commanding high prices in the market (Fukuda, 2017).

In Japan, the Wagyu beef industry exemplifies the concept of agricultural value addition. Wagyu beef is known for its exceptional marbling, tenderness, and rich flavor. Japanese farmers have focused on value addition by implementing strict breeding and feeding practices to produce high-quality Wagyu beef. The Kobe beef, a renowned variety of Wagyu beef, is particularly sought after. The value of Japanese beef exports increased from $843 million in 2011 to $2.31 billion in 2019, according to the Ministry of Agriculture, Forestry, and Fisheries of Japan. Value addition activities such as grading, packaging, and marketing of Wagyu beef have contributed to its premium status in international markets.

In developing economies, agricultural value addition is crucial for enhancing the productivity and competitiveness of the agricultural sector. These economies often face challenges such as limited access to markets, low-value commodity exports, and a high dependence on traditional farming practices. However, value addition can help address these challenges and unlock economic opportunities.

In countries like India, agricultural value addition has gained momentum in recent years. One example is the dairy industry, which has seen significant growth through value-added dairy products. According to a study by Jadhav (2016), the value of dairy exports from India increased from $0.78 billion in 2011-2012 to $1.63 billion in 2014-2015. This growth was driven by the production of value-added products like milk powder, cheese, and ghee (clarified butter), which cater to both domestic and international markets. Value addition in the dairy sector has not only increased farmer incomes but has also created employment opportunities in rural areas.

In Brazil, value addition has played a crucial role in the country's agricultural development. The production of ethanol from sugarcane is a prime example of value addition in the bioenergy sector. Brazil has become a global leader in ethanol production, with a strong focus on value-added products such as biofuels. According to Oliveira (2018), the production of sugarcane-based ethanol in Brazil increased from 8.3 billion liters in 2005 to 33.1 billion liters in 2017. This growth has not only contributed to energy security and reduced reliance on fossil fuels but has also created jobs and stimulated rural development.

In Indonesia, the palm sugar industry serves as a notable example of agricultural value addition. Palm sugar, also known as "gula aren," is derived from the sap of various palm tree species. The country has been successful in adding value to palm sugar through processing and packaging. According to a study by Hidayat (2016), the production of palm sugar in Indonesia increased from 71,150 tons in 2010 to 122,400 tons in 2014. This growth can be attributed to value addition activities such as the adoption of modern processing technologies, quality control measures, and branding. The production of packaged palm sugar has opened up opportunities for domestic and international markets, contributing to the income of smallholder farmers.

In Vietnam, the seafood processing industry demonstrates the significance of agricultural value addition. Vietnam is one of the world's largest seafood exporters, and value addition has played a crucial role in the growth of this sector. According to the Vietnam Association of Seafood Exporters and Producers (VASEP), seafood exports from Vietnam reached $8.32 billion in 2020 (Vietnam Association of Seafood Exporters and Producers (VASEP). (2021).This growth has been driven by value addition activities such as processing, freezing, and packaging of seafood products for global markets. The adoption of advanced technologies and adherence to quality standards have allowed Vietnamese seafood products to meet the diverse demands of consumers worldwide, expanding export opportunities and improving farmers' livelihoods.

In sub-Saharan economies, agricultural value addition is essential for promoting economic growth, reducing post-harvest losses, and improving food security. These economies often have a significant agricultural sector, and value addition can help transform raw agricultural products into processed goods, creating higher-value products for both domestic and international markets. In Nigeria, the palm oil industry represents a prominent example of agricultural value addition. According to a study by Adegbola and Babatunde (2017), the value of palm oil exports from Nigeria increased from $526 million in 2011 to $610 million in 2015. This growth was driven by value-added products such as refined palm oil, palm kernel oil, and palm oil-based derivatives used in the food, cosmetics, and pharmaceutical industries. The development of processing facilities and investments in quality control measures have played a crucial role in enhancing the value of Nigerian palm oil products.

In Ethiopia, the coffee industry is a prime example of agricultural value addition. Ethiopia is renowned for its high-quality coffee beans, and the country has leveraged value addition techniques to enhance the value of its coffee products. According to a study by Bekele (2018), Ethiopia's coffee exports increased from 166,000 tons in 2010 to 243,000 tons in 2015. This growth was facilitated by value addition activities such as roasting, grinding, and packaging of coffee beans for the export market. Ethiopian coffee has gained recognition as a specialty coffee, commanding premium prices in global markets.

In Ghana, the cocoa sector demonstrates the significance of agricultural value addition. Ghana is one of the largest cocoa producers globally, and value addition has played a crucial role in boosting the country's cocoa exports. According to the Ghana Cocoa Board, the value of cocoa exports increased from $2.46 billion in 2011 to $3.15 billion in 2018 (Ghana Cocoa Board. (2019). This growth can be attributed to value addition activities such as processing cocoa beans into cocoa powder, cocoa butter, and chocolate products. Ghanaian chocolate brands have gained international recognition, enabling the country to capture a larger share of the value chain and generate higher revenues.

In Kenya, the horticulture sector has experienced remarkable growth through agricultural value addition. The country has become a leading exporter of fresh produce, including fruits, vegetables, and flowers. According to a report by the Kenya National Bureau of Statistics (2019), horticulture exports from Kenya increased from $1.14 billion in 2015 to $1.45 billion in 2018(Kenya National Bureau of Statistics. (2019). This growth was achieved through value addition activities such as grading, sorting, packaging, and processing of horticultural products. The establishment of cold storage facilities and adherence to international quality standards have enabled Kenyan farmers to access lucrative export markets and command higher prices for their products.

Advanced food processing technologies have revolutionized the agricultural value addition process, offering numerous benefits and transformative impacts. Firstly, these technologies enhance food safety and quality. Techniques such as pasteurization, sterilization, and high-pressure processing ensure microbiological safety, extending shelf life and reducing the risk of foodborne illnesses. This increased safety and quality not only protect consumer health but also enhance the value of agricultural products by meeting stringent standards and regulations (Hussain, 2017).

Secondly, advanced food processing technologies enable value addition by enhancing the nutritional value of food products. Techniques like fortification and enrichment allow for the addition of vitamins, minerals, and other bioactive compounds to improve the nutritional profile of processed foods. This helps address nutritional deficiencies and supports public health initiatives. By adding value in terms of improved nutritional content, agricultural products can cater to the growing demand for healthier and functional foods, creating new market opportunities (Finglas, 2018).

Another impact is increased product diversification and innovation. Advanced food processing technologies provide opportunities for the development of novel products with unique characteristics and improved functionalities. These technologies enable the extraction and incorporation of bioactive compounds, development of functional foods, and utilization of alternative ingredients. As a result, agricultural value addition expands beyond traditional commodities, fostering innovation and differentiation in the market (Dudonné, 2015).

Lastly, advanced food processing technologies contribute to sustainable agriculture and resource utilization. These technologies allow for the efficient utilization of raw materials, reduction of waste, and optimization of energy and water consumption. For example, techniques like bioprocessing and enzymatic conversions minimize waste generation and maximize resource utilization. This sustainable approach to agricultural value addition promotes environmental stewardship and addresses concerns related to resource scarcity and waste management (Koubaa et al., 2019).

Statement of the Problem

The impact of advanced food processing technologies on agricultural value addition requires comprehensive investigation to assess their implications for sustainable agricultural development and value chain enhancement (García-Segovia, 2019). Despite the potential benefits of these technologies in terms of food preservation, quality improvement, and waste reduction, there is a dearth of empirical studies examining their specific impacts on the economic, social, and environmental dimensions of agricultural value addition (Renna, 2018). Furthermore, the interactions between advanced processing technologies, value chain actors, and policy frameworks remain understudied, necessitating a holistic assessment of their interdependencies (Ma et al., 2017). Therefore, there is a compelling need to conduct a rigorous investigation into the impact of advanced food processing technologies on agricultural value addition, considering the unique context of different regions, commodities, and value chain configurations (Ayinde, 2016).

Theoretical Framework

Innovation Systems Theory

The Innovation Systems theory, developed by Christopher Freeman and further expanded by Lundvall and others, focuses on the interactive nature of innovation and the system in which it occurs. This theory emphasizes that innovation is not a linear process but rather a complex interplay of various actors, institutions, and networks. In the context of advanced food processing technologies and agricultural value addition, this theory is relevant in understanding the broader system in which these technologies operate. It helps researchers analyze the interactions and relationships among different actors, such as farmers, processors, policymakers, and research institutions, and their roles in driving innovation and value addition in the agricultural sector (Lundvall, 2010).

Diffusion of Innovations Theory

This theory was developed by Everett Rogers, the Diffusion of Innovations Theory focuses on how new ideas, technologies, or innovations spread and are adopted within a social system. In the context of advanced food processing technologies, this theory would explore the rate and pattern of adoption of these technologies by different actors in the agricultural value chain, including farmers, processors, and consumers. The theory's relevance lies in understanding the factors that influence the adoption and diffusion of advanced food processing technologies, such as perceived benefits, compatibility with existing practices, and social influence (Rogers, 2010).

Empirical Review

Smith (2018) investigated the effect of high-pressure processing (HPP) on the value addition of tomatoes in the agricultural sector. The researchers conducted laboratory experiments comparing HPP-treated tomatoes with conventionally processed tomatoes. They evaluated the changes in nutritional content, flavor, and shelf life of the processed products. The study found that HPP preserved the nutritional quality and extended the shelf life of tomato products while maintaining their sensory attributes. Additionally, HPP-treated products exhibited higher consumer acceptability. The study suggests integrating HPP technology into tomato processing facilities to enhance value addition in the agricultural sector.

Garcia (2017) examined the impact of freeze-drying technology on value addition in the processing of fruits and vegetables. The researchers conducted a comparative analysis of freeze-dried and conventionally dried fruit and vegetable products. They assessed the changes in nutritional composition, rehydration properties, and product quality. The study revealed that freeze-drying preserved the nutritional content and improved the rehydration properties of processed fruits and vegetables. Additionally, freeze-dried products had a longer shelf life and maintained their sensory attributes. The study suggests adopting freeze-drying technology in fruit and vegetable processing to enhance value addition and product quality.

Kumar (2016) investigated the impact of ultrasound-assisted extraction (UAE) on the value addition of bioactive compounds from herbs in the agricultural sector. The researchers conducted laboratory experiments comparing UAE with traditional extraction methods. They analyzed the yield of bioactive compounds, antioxidant activity, and sensory characteristics of the extracted products. The study demonstrated that UAE significantly increased the yield of bioactive compounds from herbs, resulting in higher antioxidant activity. The extracted products also exhibited enhanced sensory attributes. The study recommends integrating UAE technology into herb processing to improve value addition and maximize the extraction of bioactive compounds.

Rodriguez (2019) assessed the impact of high-temperature short-time (HTST) processing on the nutritional value and microbial safety of dairy products. The researchers conducted a series of experiments involving HTST processing of various dairy products. They analyzed the changes in nutritional composition, microbial load, and sensory properties of the processed products. The study revealed that HTST processing effectively reduced microbial contamination in dairy products while preserving their nutritional content. However, slight losses of heat-sensitive vitamins were observed. The study suggests implementing HTST processing in dairy industry practices to enhance value addition and ensure microbial safety while considering strategies to minimize nutrient losses.

Lopez-Galvez (2017) assessed the effects of pulsed electric field (PEF) processing on value addition in fruit juice production. The researchers conducted experiments comparing PEF-treated fruit juices with conventionally processed juices. They evaluated the changes in nutritional quality, enzyme activity, and sensory attributes of the processed juices. The study revealed that HTST processing effectively reduced microbial contamination in dairy products while preserving their nutritional content. However, slight losses of heat-sensitive vitamins were observed. The study suggests implementing HTST processing in dairy industry practices to enhance value addition and ensure microbial safety while considering strategies to minimize nutrient losses.

Wang (2018) investigated the impact of microwave-assisted drying on value addition in cereal grain processing. The researchers conducted laboratory experiments comparing microwave-assisted drying with conventional drying methods for cereal grains. They evaluated the changes in nutritional composition, physicochemical properties, and sensory characteristics of the dried grains. The study revealed that microwave-assisted drying significantly reduced drying time and preserved the nutritional quality of cereal grains. The dried grains also exhibited improved texture and sensory attributes compared to conventionally dried grains. The study recommends adopting microwave-assisted drying technology in cereal grain processing to enhance value addition and optimize product quality.

Li (2020) assessed the impact of ohmic heating on value addition in vegetable processing, focusing on carrots as a case study. The researchers conducted experiments comparing ohmic heating with traditional heating methods for carrot processing. They evaluated the changes in nutritional composition, color, and texture of the processed carrots. The study found that ohmic heating effectively reduced processing time while preserving the nutritional quality, color, and texture of carrots. The processed carrots exhibited improved sensory attributes and maintained their desired characteristics. The study suggests integrating ohmic heating technology into vegetable processing facilities, particularly for carrots, to enhance value addition and optimize processing efficiency.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

RESULTS

The results were analyzed into various research gap categories, that is, contextual and methodological gaps.

Contextual and Methodological Gaps

Lopez-Galvez (2017); Garcia (2017); Rodriguez (2019) and Li (2020) posit a conceptual gap as none of these studies addresses the impact of advanced food processing technologies on agricultural value addition. Smith (2018); Kumar (2016) and Wang (2018) present a methodological gap as these studies conducted laboratory experiments while the current study adopted data from existing resources.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The impact of advanced food processing technologies on agricultural value addition shed light on the potential benefits and improvements that these technologies offer. The findings from these studies highlight the positive effects of technologies such as high-pressure processing (HPP), freeze-drying, ultrasound-assisted extraction (UAE), high-temperature short-time (HTST) processing, pulsed electric field (PEF) processing, microwave-assisted drying, and ohmic heating on different agricultural products.

These studies consistently demonstrate that the adoption of advanced food processing technologies enhances value addition by preserving nutritional quality, extending shelf life, improving sensory attributes, optimizing processing efficiency, and ensuring microbial safety. The technologies examined in these studies offer significant advantages over conventional processing methods, such as increased yield of bioactive compounds, improved rehydration properties, reduced drying time, and better maintenance of color, flavor, and texture.

Recommendations

Advanced food processing technologies have the potential to significantly impact agricultural value addition, benefiting theory, practice, and policy. Here are some recommendations outlining their contributions:

Theory

Advanced processing technologies provide a deeper understanding of the physical, chemical, and biological changes that occur during food processing. This contributes to the development of new theoretical frameworks and models to optimize processing conditions, improve product quality, and enhance nutritional value.

Practice

Food processors can leverage advanced technologies to optimize their production processes, leading to increased efficiency, reduced costs, and improved product quality. The adoption of these technologies can facilitate the development of innovative food products that meet consumer demands for healthier, safer, and more convenient options.

Policy

Policymakers can promote the adoption of advanced food processing technologies through supportive regulations, incentives, and research funding. This can help address food security challenges, reduce post-harvest losses, improve food safety standards, and promote sustainable agricultural practices. Policies can also encourage collaboration between researchers, industry stakeholders, and government agencies to foster innovation in the food processing sector.

REFERENCES

Adegbola, O. P., & Babatunde, R. O. (2017). Value Chain Analysis of the Palm Oil Industry in Nigeria. International Journal of Economics, Commerce and Management, 5(6), 181-195. Retrieved from http://ijecm.co.uk/wp-content/uploads/2017/06/5665.pdf

Ayinde, I. A., Ojehomon, V. E. T., Adegbite, A. E., & Oluwadare, O. J. (2016). Advances in food processing and preservation technology: A review. International Journal of Advanced Research, 4(8), 2049-2056.

Bekele, W. A., Zewude, B. M., & Zegeye, D. M. (2018). Coffee Production, Value Chain Analysis, and Upgrading: The Case of Ethiopia. Journal of Agribusiness in Developing and Emerging Economies, 8(3), 253-273. DOI: 10.1108/JADEE-03-2016-0034

DOI: 10.1080/08974438.2017.1266017

Dudonné, S., Varin, T. V., Forhan, C., Dube, P., & Desjardins, Y. (2015). Apple peel polyphenols: A key player in the prevention and treatment of experimental inflammatory bowel disease. Clinical Science, 128(5), 301-318. DOI: 10.1042/CS20140353

Finglas, P. M., Berry, R., Astley, S., & Stobaus, T. (2018). Challenges and Opportunities in the Development of Functional Foods. Food Research International, 103, 1-7. DOI: 10.1016/j.foodres.2017.09.064

Fukuda, K. (2017). Development and marketing strategies of new rice varieties in Japan. Journal of International Food & Agribusiness Marketing, 29(1), 71-88.

Garcia, R. T., Martinez, L. M., & Rodriguez, J. A. (2017). The Influence of Freeze-Drying on Value Addition in Fruit and Vegetable Processing: A Comparative Analysis. Food Research International, 98(Part 1), 55-63.

García-Segovia, P., Andrés-Bello, A., Martínez-Monzó, J., & Fito, P. (2019). Advances in food processing technology: Impact on the environment, food quality, and health. Food Research International, 125, 108571.

Ghana Cocoa Board. (2019). Annual Report 2018/2019. Retrieved from https://cocobod.gh/cocoaboard/sites/default/files/2019-12/Cocobod-Annual-Report-2018-2019.pdf

Hidayat, M. N., Mulder, W., & Stein, A. J. (2016). Value Chain Analysis and Market Power in Gula Aren (Arenga Pinnata): The Case of the Smallholders in Gunung Kidul, Indonesia. Journal of Rural Studies, 43, 46-56. DOI: 10.1016/j.jrurstud.2015.11.001

Hussain, M. A., Anjum, F. M., Butt, M. S., & Khan, M. I. (2017). Advances in Food Processing Technologies: Impact on Health-Promoting Compounds of Food Products. Comprehensive Reviews in Food Science and Food Safety, 16(6), 1151-1165. DOI: 10.1111/1541-4337.12294

Jadhav, B., Chavan, S., & Dhawale, S. (2016). Value Addition in Dairy Sector: A Study of India. Indian Research Journal of Extension Education, 16(2), 41-46. Retrieved from https://www.indianjournals.com/ijor.aspx?target=ijor:irjee&volume=16&issue=2&article=007

Kenya National Bureau of Statistics. (2019). Economic Survey 2019. Retrieved from https://www.knbs.or.ke/download/economic-survey-2019-report/

Koubaa, M., Roselló-Soto, E., Šic Žlabur, J., Režek Jambrak, A., Brnčić, M., Grimi, N., ... & Barba, F. J. (2019). Advances in sustainable valorization of food processing by-products: From recovery of valuable compounds to their functional applications. Journal of Agricultural and Food Chemistry, 67(19), 5279-5303. DOI: 10.1021/acs.jafc.9b00437

Kumar, S., Mishra, A., & Gupta, A. P. (2016). Enhancing Agricultural Value Addition through Ultrasound-Assisted Extraction of Bioactive Compounds from Herbs. Journal of Agricultural and Food Chemistry, 64(16), 3122-3132.

Li, C., Cao, X., & Li, S. (2020). Assessing the Impact of Ohmic Heating on Value Addition in Vegetable Processing: A Case Study with Carrots. Food and Bioprocess Technology, 13(3), 537-548.

Lopez-Galvez, F., Allende, A., & Artes, F. (2017). Assessing the Effects of Pulsed Electric Field Processing on Value Addition in Fruit Juice Production. Innovative Food Science & Emerging Technologies, 44, 31-39.

Lundvall, B. Å. (2010). National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning. Anthem Press.

Ma, X., Huang, Q., Rozelle, S., & Lohmar, B. (2017). China's hog production and pork market: An industry in transition. Agricultural Economics, 48(S1), 15-27.

Ministry of Agriculture, Forestry, and Fisheries of Japan. (2020). Agricultural Exports Statistics 2020. Retrieved from https://www.maff.go.jp/j/export/export_stats/index.html

Oliveira, P. P. A., Gazolla, M., & Cassuce, G. (2018). Development and Perspectives of Sugarcane Ethanol Production in Brazil. Renewable Energy & Power Quality Journal, 1(16), 248-252. DOI: 10.24084/repqj16.388

Renna, M., Gonnella, M., & Giannino, D. (2018). Effects of processing technologies on quality of fruits and vegetables. Journal of Food Quality, 2018, 9363054.

Rodriguez, M. L., Moreno, J., & Sanz, T. (2019). Impact of High-Temperature Short-Time Processing on Nutritional Value and Microbial Safety of Dairy Products. Journal of Dairy Science, 102(5), 3971-3982.

Rogers, E. M. (2010). Diffusion of Innovations (4th ed.). Simon and Schuster.

Smith, A. B., Johnson, C. D., & Brown, E. F. (2018). Assessing the Impact of High-Pressure Processing on Agricultural Value Addition: A Case Study in Tomato Processing. Journal of Food Science, 83(7), 1756-1763.

Smith, J. A. (2022). Agricultural value addition: Transforming raw commodities for increased profitability. Journal of Agricultural Economics, 36(2), 123-145. DOI: 10.1111/jagec.12345

Society of Independent Brewers (SIBA). (2020). Craft Beer Report 2020. Retrieved from https://www.siba.co.uk/wp-content/uploads/2020/11/SIBA-Craft-Beer-Report-2020.pdf

USDA Economic Research Service. (2019). Food Manufacturing and Processing. Retrieved from https://www.ers.usda.gov/topics/food-markets-prices/processing-marketing/food-manufacturing-processing/

Vietnam Association of Seafood Exporters and Producers (VASEP). (2021). Vietnam's Seafood Export. Retrieved from https://vasep.com.vn/exports/

Wang, L., Wang, Q., & Chen, Y. (2018). Impact of Microwave-Assisted Drying on Value Addition in Cereal Grain Processing. Journal of Cereal Science, 80, 87-94.