


## Food Processing Technology as a Means for Developing Scientific Literacy and Awareness of Sustainable Food Consumption

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**Abstract:** The development of science and technology in the food sector requires people to have the ability to understand scientific food processing processes and implement sustainable consumption patterns. Scientific literacy is one of the important competencies that needs to be developed to help individuals understand the relationship between science, technology, the environment and everyday life. Food processing technology not only functions to improve the quality, safety and shelf life of food products, but can also be used as a contextual learning medium in developing students' scientific literacy. Through food processing technology-based learning, students can understand scientific concepts such as physical and chemical changes in food ingredients, the influence of microorganisms, preservation principles, and food safety aspects. Apart from that, this learning is able to raise awareness about the importance of responsible, efficient and environmentally friendly food consumption. This article aims to examine the role of food processing technology as a means of developing scientific literacy and forming awareness of sustainable food consumption. The study was carried out through analysis of various relevant literature sources regarding science education, food technology, and sustainable development. The results of the study show that the integration of food processing technology in learning is able to increase understanding of scientific concepts, critical thinking skills, problem-solving abilities, and students' awareness of the importance of sustainable food systems in supporting food security and environmental preservation.

**Keywords:** food processing technology, scientific literacy, science education, sustainable consumption, food security

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### Introduction

Food is a fundamental human necessity that plays a crucial role in supporting survival, health, and community productivity. Along with the continuous growth of the global population, the increasing demand for food has become an increasingly complex challenge. This challenge is not only related to food availability but also encompasses aspects of quality, safety, nutritional value, and the sustainability of food systems. In this context, food processing technology emerges as an important solution that can enhance the added value of food products, extend shelf life, reduce post-harvest losses, and improve the safety and quality of food consumed by society.

Food processing technology refers to the application of scientific and technological principles in transforming raw food materials into products with improved quality, enhanced safety, and higher economic value. Various food processing methods, including fermentation, drying, freezing, pasteurization, sterilization, canning, and modern packaging technologies, have developed rapidly alongside advancements in science and technology. These processes involve a wide range of scientific concepts from biology, chemistry, physics, and environmental science. Therefore, food processing technology has considerable potential to be utilized as a contextual learning medium in science education.

In the twenty-first century, the development of scientific literacy has become one of the primary objectives of education. Scientific literacy is not merely defined as the ability to understand scientific concepts but also as the capacity to use scientific knowledge to identify problems, make evidence-based decisions, and understand the impacts of technological developments on society and the environment. Individuals with strong scientific literacy are better equipped to address various life challenges, including making informed decisions regarding healthy, safe, and sustainable food choices.

Numerous international studies indicate that the level of scientific literacy among students in several developing countries still requires significant improvement. One of the contributing factors is that learning processes often remain focused on theoretical concept mastery and insufficiently connect scientific knowledge with real-life phenomena. Consequently, students frequently experience difficulties in understanding the relevance of science to the challenges they encounter in everyday life. Therefore, educational approaches that effectively link scientific concepts with real-world contexts are needed to create more meaningful learning experiences.

Food processing technology can serve as an effective learning context for developing scientific literacy. Through observation, experimentation, and analysis of food processing activities, students can directly explore various scientific concepts. For example, fermentation processes can be used to explain microbial activity, metabolism, and biochemical reactions. Drying and freezing processes can help students understand heat transfer and moisture content changes, while pasteurization can illustrate the effects of temperature on microbial growth. Thus, students not only learn scientific theories but also recognize their practical applications in everyday life.

In addition to contributing to scientific literacy development, food processing technology plays an important role in fostering awareness of sustainable food consumption. Currently, the world faces numerous challenges related to food systems, including increasing food waste, excessive exploitation of natural resources, climate change, and unequal food distribution. These issues demand changes in food production and consumption patterns to ensure greater responsibility toward the environment and future generations.

Awareness of sustainable food consumption involves understanding the importance of selecting, processing, and consuming food while considering health, economic, social, and environmental dimensions. Individuals with such awareness tend to use food resources more wisely, reduce food waste, choose local products, and support environmentally friendly food production practices. Through learning about food processing technology, students can gain insights into how food products are produced, their environmental impacts, and strategies for reducing waste and improving the efficiency of food resource utilization.

Previous studies have shown that learning approaches based on real-life contexts can improve students' understanding of scientific concepts and enhance their critical thinking skills. However, studies specifically integrating food processing technology with the development of scientific literacy and awareness of sustainable food consumption remain relatively limited. Most existing research focuses either on food technology or science education separately, highlighting the need for comprehensive studies that connect these two fields.

Based on the above considerations, this article aims to examine the role of food processing technology as a means of developing scientific literacy and awareness of sustainable food consumption. This study is expected to contribute to the development of more contextual, relevant, and meaningful science learning approaches while supporting the achievement of sustainable development goals through improved educational quality and greater public awareness of sustainable food systems.

## Methods

This study employed a literature review method using a qualitative descriptive approach. A literature review was considered appropriate because the objective of the study was not to generate primary data through experimentation or field observation, but rather to synthesize and analyze existing scientific knowledge regarding food processing technology, scientific literacy, and sustainable food consumption. Through this method, the study aimed to identify relationships among these concepts, examine current research trends, and provide a comprehensive understanding of the role of food processing technology in science education and sustainability awareness.

The data used in this study consisted entirely of secondary data obtained from various scientific and academic sources. These sources included peer-reviewed journal articles, scholarly books, conference proceedings, research reports, international organization publications, and policy documents related to food technology, science education, environmental sustainability, and food systems. To ensure the relevance and accuracy of the information, priority was given to literature published within the last ten years. Nevertheless, several classical references were also incorporated to strengthen the theoretical foundation of the discussion and provide historical perspectives on the development of scientific literacy and food processing technology.

Data collection was conducted through a systematic literature search using several reputable academic databases, including Google Scholar, Scopus, ScienceDirect, SpringerLink, and ERIC. These databases were selected because they provide extensive access to high-quality scientific publications in the fields of education, food science, and sustainability studies. The search process utilized a combination of keywords and search phrases, including food processing technology, scientific literacy, science education, sustainable food consumption, food sustainability, food technology education, contextual learning, and sustainability awareness. The use of multiple keywords was intended to broaden the scope of the search and ensure the inclusion of relevant studies from various disciplinary perspectives.

Following the identification stage, the collected literature underwent a screening process to determine its suitability for inclusion in the study. Several inclusion criteria were established, namely: (1) the publication discussed food processing technology, scientific literacy, sustainable food consumption, or related topics; (2) the source was published in a reputable academic outlet; (3) the study provided empirical findings, theoretical frameworks, or conceptual discussions relevant to the objectives of this review; and (4) the full text was accessible for detailed examination. Publications that were duplicated, lacked scientific credibility, or showed limited relevance to the research focus were excluded from further analysis.

The selected literature was then analyzed using a thematic analysis approach. This process involved several stages. First, the researcher carefully read and reviewed each selected publication to identify key concepts and findings. Second, the literature was categorized into several major themes, including the concept and development of food processing technology, scientific literacy in science education, sustainable food consumption behavior, and the integration of food processing technology into learning activities. Third, information from the various sources was compared and synthesized to identify similarities, differences, patterns, and emerging trends. This synthesis process enabled a deeper understanding of how food processing technology can function as a contextual learning medium for promoting scientific literacy and sustainability awareness.

The final stage involved interpreting the findings and constructing a comprehensive narrative based on the synthesized information. The interpretation process focused on explaining the educational value of food processing technology, its contribution to the development of scientific literacy competencies, and its potential role in fostering responsible and sustainable food consumption practices among students. The results of the analysis were presented descriptively to provide a clear and systematic explanation of the relationships among the variables discussed in this study.

To enhance the credibility of the review, the researcher compared findings from multiple sources and considered diverse perspectives from the fields of food science, science education, environmental education, and sustainability studies. This triangulation of literature helped ensure that the conclusions were supported by a broad range of scientific evidence and reflected current developments in both educational and food sustainability research.

## Results

### *Strengthening Scientific Literacy Through Food Processing Technology-Based Learning*

Scientific literacy is recognized as one of the essential competencies required in the twenty-first century. It encompasses not only students' ability to understand scientific concepts and principles but also their capacity to apply scientific knowledge to explain natural phenomena, evaluate information critically, and make informed decisions related to everyday life. Therefore, science learning should not merely emphasize conceptual understanding but also provide meaningful experiences that enable students to connect scientific knowledge with real-world contexts. In this regard, food processing technology offers a highly relevant and effective context for strengthening scientific literacy because it presents authentic phenomena that students encounter in their daily lives.

Food processing technology-based learning allows students to engage directly with scientific processes through observation, experimentation, investigation, and problem-solving activities. Various food processing techniques such as fermentation, drying, freezing, pasteurization, and food preservation can be utilized as learning resources to explain scientific concepts from biology, chemistry, physics, and environmental science. Through these activities, students gain opportunities to observe how scientific principles operate in real situations, making learning more meaningful and easier to understand.

For instance, during a fermentation practicum involving the production of tempeh, yogurt, or fermented beverages, students do not simply focus on the final products obtained. Instead, they explore the biological roles of microorganisms, the metabolic processes occurring during fermentation, and the chemical transformations that affect the nutritional value, texture, flavor, and safety of food products. Students can investigate factors influencing fermentation success, such as temperature, pH, oxygen availability, and microbial activity. Such experiences encourage learners to formulate scientific questions, develop hypotheses, conduct observations, collect and analyze data, and draw conclusions based on empirical evidence. These activities reflect the core dimensions of scientific literacy, including scientific inquiry skills and evidence-based reasoning.

Moreover, food processing technology-based learning provides opportunities for students to develop critical thinking and analytical skills. Students can be encouraged to examine various food-related issues that frequently arise in society, such as food spoilage, foodborne diseases, excessive use of food additives, contamination during food processing, and environmental pollution resulting from food industry waste. Through discussions, case studies, and project-based learning activities, students learn to evaluate scientific information from multiple sources, identify reliable evidence, compare alternative solutions, and formulate reasoned arguments. This process helps students become more discerning consumers and responsible citizens who are capable of making informed decisions regarding food and health.

Another important contribution of food processing technology to scientific literacy development is its ability to integrate science learning with social and environmental issues. Students can analyze how technological innovations in food processing contribute to food security, reduce post-harvest losses, improve food quality, and support sustainable resource utilization. At the same time, they can investigate the environmental consequences of food production and processing activities, including energy consumption, waste generation, and greenhouse gas emissions. Such discussions

broaden students' perspectives regarding the interconnectedness of science, technology, society, and the environment, which is a fundamental component of scientific literacy.

The contextual nature of food processing technology-based learning also increases student motivation and engagement. Since food is closely related to students' daily experiences, learning activities become more relevant and meaningful. Students are more likely to participate actively in investigations, ask questions, and seek explanations when they can relate scientific concepts to familiar situations. Increased engagement contributes positively to knowledge retention and deeper conceptual understanding, which are important outcomes of effective science education.

Furthermore, integrating food processing technology into science learning supports the development of problem-solving skills. Students are challenged to identify practical problems associated with food processing and propose solutions based on scientific principles. For example, they may design strategies to reduce food waste, improve food preservation methods, or develop environmentally friendly food packaging. Such activities encourage creativity, innovation, and the application of interdisciplinary knowledge, all of which are important competencies in modern education.

Overall, food processing technology serves as a powerful educational context for strengthening scientific literacy. By engaging students in authentic scientific investigations and connecting classroom learning with real-world food-related issues, this approach promotes not only conceptual understanding but also critical thinking, problem-solving abilities, and evidence-based decision-making skills. Consequently, students become active learners who are capable of applying scientific knowledge to address various challenges encountered in everyday life, thereby fulfilling the broader objectives of scientific literacy development in contemporary education.

**Table 1.** Contributions of Food Processing Technology-Based Learning to Scientific Literacy Development

Food Processing Activity	Scientific Concepts Learned	Scientific Literacy Components Developed	Expected Learning Outcomes
Fermentation (tempeh, yogurt, bread)	Microorganisms, metabolism, biochemical reactions	Scientific explanation of phenomena, inquiry skills	Students understand microbial roles and explain fermentation processes scientifically
Drying and Dehydration	Water content, evaporation, heat transfer	Data interpretation, observation skills	Students analyze factors affecting food preservation and quality
Freezing and Refrigeration	Temperature effects, microbial growth, physical changes in food	Evidence-based reasoning, problem-solving skills	Students evaluate preservation methods and food safety practices
Pasteurization	Thermal processing, microbial control	Scientific investigation and analytical thinking	Students explain the relationship between temperature and food safety
Food Packaging Technology	Material science, food preservation, environmental impact	Critical thinking and decision-making skills	Students assess packaging effectiveness and environmental sustainability
Food Additives Analysis	Food chemistry, preservatives, colorants, flavor enhancers	Evaluation of scientific information	Students critically examine the benefits and risks of food additives
Food Waste Management	Biodegradation, recycling, environmental science	Socio-scientific reasoning and sustainability awareness	Students develop responsible attitudes toward food consumption and waste reduction
Food Product Development Projects	Integrated concepts of biology, chemistry, and technology	Creativity, scientific communication, problem-solving	Students apply scientific knowledge to design innovative food products

### *Food Processing Technology as a Contextual Learning Medium*

One of the fundamental characteristics of effective learning is its connection to students' real-life experiences. Learning becomes more meaningful when students are able to relate academic concepts to situations they encounter in their daily lives. In this regard, food processing technology provides a highly relevant and accessible context for science learning because food is an essential part of everyday human activities. Nearly all students interact with various food products on a daily basis, whether through consumption, preparation, storage, or observation of food processing practices within their households and communities. This close relationship between food and everyday life makes food processing technology an effective medium for contextual learning.

Contextual learning emphasizes the integration of theoretical knowledge with real-world applications, enabling students to understand the practical significance of scientific concepts. Through food processing technology-based learning, students can recognize that science is not merely a collection of abstract theories presented in textbooks but a body of knowledge that plays an important role in solving practical problems and improving human well-being. The

application of food processing technology allows learners to observe scientific principles operating directly in real situations, thereby enhancing their understanding of the relevance and usefulness of science in everyday life.

Various scientific concepts can be effectively taught through food processing activities. For example, the concept of heat transfer can be explored through food drying, cooking, pasteurization, and sterilization processes. During these activities, students can investigate how heat energy is transferred and how temperature affects the physical and chemical properties of food materials. Similarly, biotechnology concepts can be introduced through fermentation processes such as the production of tempeh, yogurt, cheese, and fermented beverages. These activities provide opportunities for students to examine microbial metabolism, enzyme activity, and biochemical transformations that occur during food processing. Furthermore, concepts related to food chemistry, nutrition, food preservation, and environmental sustainability can also be integrated into learning activities, creating a multidisciplinary learning experience.

The contextual nature of food processing technology-based learning contributes positively to students' motivation and engagement. Students are generally more interested in learning scientific concepts when they can directly observe their applications and understand their benefits in everyday life. Learning activities that involve practical experiences, experimentation, and problem-solving tend to stimulate curiosity and encourage active participation. This condition contrasts with traditional learning approaches that focus primarily on memorization of concepts without providing authentic experiences or opportunities for real-world application. When students perceive learning as relevant to their lives, they become more motivated to explore scientific ideas and develop a deeper interest in science-related subjects.

In addition to increasing learning motivation, contextual learning through food processing technology enhances students' conceptual understanding. Direct involvement in food processing activities enables learners to observe scientific phenomena firsthand and construct knowledge through experience. Rather than receiving information passively, students actively engage in inquiry, experimentation, observation, and reflection. Such experiences facilitate meaningful learning because students are able to connect theoretical concepts with observable outcomes. Consequently, the knowledge acquired becomes more comprehensive and easier to apply in different contexts.

Another significant advantage of contextual learning is its contribution to knowledge retention. Educational research has shown that students are more likely to remember information when it is associated with meaningful experiences and practical applications. Through food processing technology-based learning, students gain hands-on experiences that strengthen the connection between theory and practice. These experiences help learners develop mental models that support long-term understanding and recall of scientific concepts. As a result, learning outcomes are not limited to short-term memorization but extend to deeper conceptual comprehension that can be retained and applied over time.

Furthermore, food processing technology-based contextual learning supports the development of essential twenty-first-century skills, including critical thinking, problem-solving, collaboration, and communication. Students may be challenged to identify food-related problems, evaluate alternative processing methods, assess food safety issues, or design innovative food products. Such activities require learners to apply scientific reasoning, analyze evidence, and communicate their findings effectively. Therefore, food processing technology serves not only as a medium for teaching scientific concepts but also as a platform for developing broader competencies that are essential for lifelong learning and responsible citizenship.

Overall, food processing technology represents a powerful contextual learning medium that bridges the gap between scientific theory and real-world practice. By connecting classroom learning with everyday food-related experiences, it promotes student engagement, enhances conceptual understanding, improves knowledge retention, and supports the development of scientific literacy and other essential skills. Consequently, integrating food processing technology into science education can contribute significantly to creating more meaningful, relevant, and effective learning experiences for students.

### ***Food Processing Technology in Supporting Food Security***

Food security is defined as a condition in which all individuals have physical, social, and economic access to sufficient, safe, nutritious, and high-quality food to meet their dietary needs and support an active and healthy life. Ensuring food security has become one of the major global challenges in the twenty-first century due to rapid population growth, climate change, environmental degradation, and increasing pressure on natural resources. Consequently, efforts to strengthen food security require not only improvements in agricultural production but also the application of effective food processing technologies that can enhance the availability, accessibility, quality, and sustainability of food resources. In this regard, food processing technology plays a strategic role in supporting food security at local, national, and global levels.

One of the most significant contributions of food processing technology is its ability to reduce post-harvest losses. Many agricultural commodities, including fruits, vegetables, grains, fish, and livestock products, are highly perishable and susceptible to physical damage, microbial contamination, and quality deterioration after harvest. Without proper

handling and processing, a substantial proportion of food production may be lost before reaching consumers. Food processing technologies provide practical solutions to this problem by extending the shelf life of food products and maintaining their quality during storage and distribution.

Various preservation techniques have been developed to minimize food losses and improve food availability. Drying technologies reduce moisture content and inhibit microbial growth, thereby extending the storage life of agricultural products. Freezing technologies slow down enzymatic and microbial activities that contribute to food spoilage. Canning and sterilization methods allow food products to remain safe and consumable for extended periods, while fermentation processes not only preserve food but also improve flavor, texture, digestibility, and nutritional value. Through these technologies, food products can be distributed over greater distances and stored for longer durations, contributing to a more stable and reliable food supply system.

Beyond reducing post-harvest losses, food processing technology also contributes to increasing the added value of local food resources. Many agricultural commodities that traditionally possess limited economic value can be transformed into innovative products with higher market competitiveness through appropriate processing techniques. For example, cassava can be processed into flour, chips, or fermented products, while soybeans can be transformed into tempeh, tofu, and various protein-rich foods. Similarly, fruits and vegetables can be converted into juices, jams, dried products, or functional foods with extended shelf life and enhanced consumer appeal. Such value-added processing not only increases product diversity but also creates new economic opportunities for farmers, small-scale industries, and local communities.

The development of value-added food products has important implications for economic sustainability and rural development. Increased demand for processed food products can generate employment opportunities, improve household incomes, and strengthen local food industries. Furthermore, the utilization of locally available food resources reduces dependence on imported products and contributes to the resilience of national food systems. Therefore, food processing technology serves not only as a tool for food preservation but also as a catalyst for economic growth and community empowerment.

Food processing technology also plays an important role in promoting food diversification. Excessive dependence on a limited number of staple foods may increase vulnerability to supply disruptions and nutritional deficiencies. By utilizing processing technologies, a wider variety of local food resources can be developed into attractive, nutritious, and marketable products. Food diversification contributes to dietary diversity, improves nutritional intake, and enhances the resilience of food systems against environmental and economic uncertainties.

From an educational perspective, understanding food security is an important component of science education and sustainability education. Students need to recognize that food security is not solely related to food production but also involves food processing, distribution, accessibility, utilization, and sustainability. Integrating food processing technology into learning activities provides opportunities for students to explore real-world challenges associated with food systems while applying scientific concepts to practical situations. Through observations, experiments, case studies, and project-based learning activities, students can develop a deeper understanding of how science and technology contribute to addressing food-related issues.

Furthermore, learning about food processing technology can foster students' awareness of the importance of innovation in achieving sustainable food systems. Students gain insights into how scientific knowledge and technological advancements can be used to improve food quality, reduce waste, optimize resource utilization, and enhance food security. Such understanding encourages learners to become more responsible consumers and future innovators who are capable of contributing to sustainable development goals.

Overall, food processing technology plays a vital role in supporting food security by reducing post-harvest losses, extending food shelf life, enhancing the value of local food resources, promoting food diversification, and strengthening economic resilience. In the context of education, integrating food processing technology into science learning can help students understand the importance of scientific innovation in ensuring sustainable food systems and addressing the complex food challenges faced by contemporary society. Consequently, food processing technology serves as both a practical solution for food security and an effective educational tool for preparing future generations to participate in building a more sustainable and resilient food future.

### ***The Relationship Between Food Processing Technology and Sustainable Food Consumption***

Sustainable food consumption is an essential component of sustainable development, as it emphasizes the responsible use of food resources while considering their environmental, economic, and social impacts. As global concerns regarding food insecurity, resource depletion, environmental degradation, and climate change continue to increase, the promotion of sustainable food consumption has become a priority for governments, educators, industries, and communities worldwide. Sustainable food consumption encourages individuals to make informed choices about food production, processing, distribution, and consumption in ways that support both present and future generations.

Food processing technology contributes significantly to the development of more sustainable food consumption patterns. Through various preservation and processing techniques, food products can be stored for longer periods while maintaining their quality, safety, and nutritional value. Technologies such as drying, freezing, canning, fermentation, vacuum packaging, and modified atmosphere packaging help reduce food spoilage and extend shelf life. As a result, these technologies minimize food losses throughout the supply chain and decrease the likelihood of food being discarded before consumption. Reducing food waste is one of the most important strategies for improving the sustainability of food systems because a substantial amount of resources, including water, energy, labor, and raw materials, are invested in food production.

In addition to extending shelf life, food processing technology facilitates the efficient utilization of food resources by transforming materials that were previously considered waste into valuable products. This approach helps maximize resource efficiency and reduces the environmental burden associated with waste disposal. For example, fruit peels, seeds, and pulp can be processed into pectin, dietary fiber supplements, natural food colorants, antioxidants, or ingredients for functional foods. Similarly, agricultural by-products such as rice husks, corn residues, and vegetable waste can be converted into animal feed, organic fertilizers, compost, or bioenergy resources. These practices demonstrate how technological innovation can support more efficient and sustainable resource management.

The ability of food processing technology to convert waste into useful products aligns closely with the principles of the circular economy. Unlike the traditional linear economic model, which follows a “take–make–dispose” approach, the circular economy seeks to minimize waste and maximize resource utilization through reuse, recycling, and recovery processes. Within food systems, food processing technologies enable the continuous circulation of materials and resources, thereby reducing environmental impacts and promoting long-term sustainability. By supporting circular economy practices, food processing technology contributes to reducing greenhouse gas emissions, conserving natural resources, and improving overall environmental performance.

Furthermore, sustainable food consumption is not solely influenced by technological advancements but also by consumer knowledge and awareness. In this regard, education plays a critical role in shaping responsible consumption behaviors. Integrating food processing technology into educational activities provides students with opportunities to understand how food products are produced, preserved, distributed, and utilized. Through practical experiences and contextual learning activities, students can develop a greater appreciation for food resources and recognize the importance of reducing unnecessary waste.

Learning about food processing technology can also enhance students’ understanding of the environmental consequences of food consumption choices. Students can explore topics such as food waste management, sustainable packaging, local food utilization, resource conservation, and environmentally friendly food production practices. These learning experiences encourage students to critically evaluate their consumption habits and adopt behaviors that contribute to sustainability. For example, students may become more aware of the importance of purchasing food responsibly, storing food properly, utilizing leftovers efficiently, and supporting local food products with lower environmental footprints.

Moreover, food processing technology-based learning helps students recognize the interconnectedness between science, technology, society, and the environment. They learn that scientific innovations in food processing are not only designed to improve food quality and safety but also to address broader challenges related to sustainability and resource management. Such understanding fosters systems thinking, which is essential for addressing complex sustainability issues in modern society.

Ultimately, the integration of food processing technology and sustainable food consumption education can contribute to the development of responsible and environmentally conscious citizens. By understanding the role of food processing technologies in reducing waste, improving resource efficiency, and supporting circular economy practices, students are better prepared to make informed food choices and adopt sustainable lifestyles. Therefore, food processing technology serves not only as a scientific and technological innovation but also as a valuable educational tool for promoting sustainable food consumption and supporting the broader goals of sustainable development.

### ***Implications for Biology Education and Learning***

In biology learning, food processing technology can be used as a learning context that is able to integrate various scientific concepts in an integrated manner. Materials such as microorganisms, metabolism, enzymes, biotechnology, ecology, and environmental pollution can be studied through food technology studies.

This approach is in line with the demands of the Independent Curriculum which emphasizes project-based learning, strengthening the Pancasila student profile, and developing 21st century competencies. Through food processing projects, students can develop critical thinking, creativity, collaboration and communication skills while increasing understanding of biological concepts.

Apart from improving the quality of learning, the integration of food processing technology also has the potential to grow students' interest in the fields of science and technology. Students can see firsthand how science contributes to solving various life problems, especially those related to food and the environment.

Thus, food processing technology not only functions as learning material, but also as a means of forming a generation that has high scientific literacy, good environmental awareness, and the ability to make responsible decisions in facing various challenges of sustainable development in the future.

## Conclusion

Food processing technology plays a significant role not only in improving food quality, safety, and availability but also in supporting science education and sustainable development. The findings of this literature review indicate that food processing technology provides an effective contextual learning medium that enables students to connect scientific concepts with real-life experiences. Through food processing activities, students can develop scientific literacy skills, including scientific inquiry, critical thinking, problem-solving, evidence-based reasoning, and informed decision-making. Furthermore, the integration of food processing technology into science learning enhances students' motivation, conceptual understanding, knowledge retention, and twenty-first-century competencies. Beyond its educational value, food processing technology contributes to food security by reducing post-harvest losses, extending food shelf life, increasing the value of local food resources, and promoting food diversification. It also supports sustainable food consumption through waste reduction, efficient resource utilization, and the implementation of circular economy principles. Therefore, integrating food processing technology into biology and science education can serve as an effective strategy for developing scientifically literate, environmentally responsible, and sustainability-conscious citizens who are capable of addressing future food and environmental challenges.

## AI Declaration Guidelines

The author declares that Artificial Intelligence (AI) tools were used in the preparation of this manuscript. Specifically, ChatGPT (OpenAI) was utilized to assist with language editing, grammar improvement, content organization, paraphrasing, and academic writing refinement. All AI-generated outputs were carefully reviewed, verified, and revised by the author to ensure accuracy, relevance, originality, and compliance with academic standards. The author takes full responsibility for the content, interpretation, and conclusions presented in this manuscript. AI tools were not used to generate research data, fabricate results, or conduct data analysis. The final version of the manuscript reflects the author's critical evaluation and intellectual contribution.

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