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From Bananas to Chips: A STEM Journey to Explore Food Processing Concept

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Abstract

Banana chips become a famous snack and provide an effetely sustainable solution to promote community environment and economic sustainability. However, key knowledge and application in applying in student teachers' context is not well familiar. This study aims to explore the bananas transformation into banana chips as a snack based on the STEM education and introduce in student teachers' context of teaching and learning. The study has designed regarding Sutaphan and Yuenyong (2019) context-based STEM education learning approach that providing 7 stages such (1) Identification of social issues, (2) Identification of potential solutions, (3) Need for knowledge, (4) Decision-making, (5) Development of prototype or product, (6) Test and evaluation of the solution, and (7) Socialization and completion decision stage. This study reveals critical thinking skill, creativity skill, and sustainability in food practices for daily life, particularly in life science subject. It also shows the significant of incorporation STEM education into real world projects for scientific practices in the future career and advanced technology. Thus, it is significant for teachers to promote STEM education in their classroom activities.

Keywords: STEM Education, Banana Chip, Food Processing, 7 stages STEM model

1. Introduction

Food processing works a necessary role in current society, making food safety, strengthening life's shelf, and empowering value of nutrition. One common technique of food procedure was dehydration, that had been global applied to many fruits such bananas to decrease spoilage and enlarge availability (Razavi et al., 2019). Bananas are extremely spoilable fruits, producing into effective banana chips that meaning concept of preservation while also making a famous snack product (Emaga et al., 2007). The banana chip production relevant with scientific concept like banana's moisture removal, reaction of enzymatic, and transfer of heat, creating a wonderful STEM education's case study (Fellows, 2022).

Bananas become the most worldwide fruit consumption in over the world, supporting initiate nutrients like fiber, potassium, and vitamins (Emaga et al., 2007). Otherwise, their extreme perishability revealed some challenges in distribution and storage, causing to post-harvest significantly losses (FAO, 2019). Another method of the banana chip production is slicing, heating (drying), and baking or frying the fruit to make a nice crispy, and snack shelf-stable.

Furthermore, technology cooperation in the production of banana chips could improve sustainable products by using efficient energy techniques of drying and reducing waste of food (Singh & Heldman, 2014). The implementation of STEM education in processing of food projects motivate students with hands on activities in learning experiences, enhance problem-solving skills, promote critical thinking and innovation (Kolb, 2014).

2. Developing STEM Education Learning Activities

Educational STEM (Science, Technology, Engineering, and Mathematics) in classrooms plays an essential role in providing students capacity through problem-solving skills and developing innovative thinking for advancement scientific within modern era (Baharin et al., 2017). One effectively conducted approach to enhance educational STEM is through learning hands-on activities, practical with real-world issues which empower students in scientific critical thinking and processes of engineering applied (Kolb, 2014). Food processing activities, exceptionally the bananas transformed into banana chips snack, performed as useful context for improving STEM education hand-on activities for learning that involved concept process of food science integration, technology connection, and sustainability achievement (Fellows, 2022).

Banana chips become a famous snack produced by dehydrating or frying fresh banana slices (Abd Elmoneim et al., 2014). The production flow consists some main steps to guarantee high-quality and crispy chip products (Ravli et al., 2013). The key process involves banana selection step, peeling step, slicing step, treatment step, drying or frying step, seasoning step, and packaging step (Picouet et al., 2019). The First process is to select proper variety of banana fruits. Usually, people preferred Nendran bananas, Cavendish bananas, and Saba bananas, because of firm texture of bananas and slight sweetness were adopted from many people (Martínez et al., 2024). The banana fruits should prioritize mature; however, they are not overripe to make sure appropriate slicing step and crispiness process. After selected, bananas are mechanically or manually peeled. Traditional manual peeling is generally worked in small-scale production, while industrial or large-scale setups employed automated peeler machines (Sa'adah et al., 2024). Then, peeled bananas need to slice into mixture thickness and uniform, commonly ranging from 1.5 to 3 mm, putting stainless steel slicers to make sure stable frying and drying steps (Adrika, 2011). The shape of chips can be oval or round based on the technique of slicing process. To better texture and avoid browning, sometimes the slices of banana would add solution of sodium metabisulfite (about 0.5%) or soaked into saltwater for a while (Martínez et al., 2024). This process supports retain color and promotes the crispiness product (Kunyanee et al., 2024).

There are two common methods to produce banana chips: i) Deep Frying Method: banana slices have been fried in hot oil made by vegetable (palm or coconut oil) at temperatures ranging from 160-180°C for 3-5 minutes (Borah & Nayak, 2013; Udomkun et al.,2021). Frying step removed moisture content in bananas, resulting chips a crispy texture (Udomkun & Innawong, 2018). Using an oil extractor or paper towels to excess oil by drained. ii) Drying (Dehydration) Method: producing healthier alternative, slices of banana could be dried by having sun-dried or a food dehydrator (Abd El-Wahhab et al., 2023). Putting in oven with 60°C around 6-8 hours can also commonly practiced (Pan et al., 2018). This method mostly practiced in banana chip rather than result in crispy ones

(El-Wahhab et al., 2023). After drying or frying, banana chips, commonly, flavored with spices, salt, sugar, or honey, regarding consumer needs (Deori., 2018). When they were cooled, the banana chips have packed in packaging materials that consisted moisture-proof like vacuum-sealed or polyethylene bags to provide shelf life extending (Khanvilkar et al., 2016). Proper and appropriate storage helps to prevent rancidness and provides crispiness (Ammawath et al., 2002).

Therefore, integrating STEM education in school is crucial because it has the potential to encourage students to apply scientific and relevant knowledge to designing effective solutions to real-world problems (Kelley & Knowles, 2016). Theerasan & Yuenyong, (2019) has developed a theoretical framework for STEM teaching strategies in school. Moreover, Sutaphan & Yuenyoug (2019) has also designed STEM teaching approach consisted 7 stages such as 1). Identification of social issues, 2). Identification of potential solution, 3). Need for the knowledge, 4). Decision-making, 5). Development of prototype or product, 6). Test and evaluate the solution, and 7). Socialization and completion decision stage. The implementation the 7 stages of STEM in education has been promoted and enhanced environmental sustainability (Srieng et al., 2024; Sav et al., 2025). Thus, the 7 stages of STEM education were applied in this STEM project.

2.1 Purpose of study

This study aims to explore the bananas transformation into chips regarding the STEM education, integrated science, technology, engineering, and mathematics subjects in teaching and learning. The processing engages students' understanding on the chemistry concept in food processing, enormously the part of browning enzymatic, reduction moisture of banana chips, and transferring heat during frying and drying processes.

2.2 The activities of recycling banana stem with STEM education

The study activities of banana chip project conducted according to the 7 stages of the STEM education learning approach from Sutaphan and Yuenyoug (2019). This study tries to address the problems of banana remaining farms or markets and in communities. The potential solution was processing banana into snacks. The decision-making was regarding the product processing, cost-effectiveness, environmental influence, and communities benefit. The prototype flow was designed by hand-made. Final products were promoted during the school event. Additionally, the products have evaluated on taste, quality, attractiveness, cost-effectiveness, and environmental issues.

Table 1: Summarize 7 stages of the STEM education learning approach "From Bananas to Chips".

Stage	Activity
(1) Identification of social issues	▪ Bananas provide many benefits such as fruit, leaves, and stems. However, banana become waste remaining from farms and market that lead to have no economic value. The remaining banana waste has polluted to the environment. ▪ In communities, most people likely has less awareness and less practical knowledge of making or transforming the raw materials into food, ornamental, eco-friendly products, and homemade souvenirs.
(2) Identification of potential solutions	After figuring out the issues, the team has decided to make banana into food, food proccessing into snacks. The team discussed on alternatives and the potentail design of food proccessing according to these aspects were drafted: ▪ STEM (science, technology, engineering, and mathematics) ▪ Raw materials: the sources (bananas) and cost of raw materials

	▪ Social: seeking and try an appropriate potential solution for critical thinking and problem-solving to align with 21st century skill. ▪ People: it is relevant to their level of satisfaction with products and also think about the health and diseases from having additional taste (more sugar). ▪ Product's cost-effectiveness: Acceptable and possible for people by comparing with the existing products. ▪ Environmental issues: The product of food proccessing promotes environmental sustainability that support to SDGs and ESD.
(3) Need for knowledge	This study explores how to making banana into banana chips via food processing. Thus, the team needs to study and gather information from Google scholar, research gate, YouTube, and previous articles related concept topic on STEM approach. ▪ Science: prototype the banana into food. ▪ Technology: researching the concept of food processing. ▪ Engineering: construct the product model of food processing (handmade). ▪ Mathematic: calculate the size, length, wide, and thickness of products. ▪ Economic: the effective cost of the product.
(4) Decision-making	▪ After our team gathered the related information, team presented project plan to the lecturers in the classroom. ▪ Our team designed the processing model and drafted size and shape of banana chips.
(5) Development of prototype or product	Processing of making banana chip: ▪ Selection of Bananas: selecting the appropriate variety of bananas. The bananas should be mature but not overripe to ensure proper slicing and crispiness. ▪ Peeling: bananas are manually peeled. ▪ Slicing: then sliced into uniform thickness, typically the size is between 1.5 mm to 3mm.  ▪ Treatment: banana slices are dipped in saltwater for a while. ▪ Deep Frying: The slices are fried in hot vegetable oil for 3-5 minutes. ▪ Seasoning: After frying, banana chips has flavored with salt and sugar.  ▪ Packaging and Storage: when it is cooled, the banana chips were packed in moisture-proof packaging. Proper storage prevents rancidity and maintains crispiness.

	
(6) Test and evaluation of the solution	These indications were used in the testing and evaluation of the banana chips ▪ Tasting: The degree of sweetness, crunchiness, and flavor profile (salty, caramelized, plain, and spiced, for instance). ▪ Quality: Freshness (ripeness, storage, and circumstances), technique, lack of additives or preservatives (natural versus artificial), and hygienic standards are all factors that affect quality. ▪ Attractiveness: Shape and size are appealing (consistent slicing). ▪ environmental Issue: the raw material is biodegradable (no harm to the environment). ▪ Cost-Effectiveness: reasonable raw material costs and manufacturing efficiency
(7) Socialization and completion decision stage.	▪ At the STEM fair, these products were showcased. The poster and explanation were shown to described the items' benefits and how they are processed. ▪ These baskets were purchased by interested participants. ▪ The social media was used to spread information to public about lesson learned and improving our critical thinking skills so that we can create environmentally friendly products.

3. Conclusion

The processing of banana transformation into banana chips display the practical knowledge and skills of food processing concept of science, technology integration, and sustainability solutions, providing with an effectiveness of STEM education approach. This model not only provides the life skills and knowledge of banana fruit but it also decreases food waste through sharing hands-on activities in learning opportunities to students. The producing banana chips process integrates the concept of scientific principles like reaction enzymatic step, removal moisture step, and heat transferring step, involves with concept of engineering relevant to food equipment processing technique. Regarding the implementation of the STEM education approach of Sutaphan and Yuenyong (2019), students involve in problem-solving skill, innovation practice, and application to real-world regarding mathematical and scientific concepts. The key knowledge and application in applying in student teachers' context were well familiar by address the problems of banana farms or markets and in communities with potential solution was processing banana into snacks.

This study enhances critical thinking skill, creativity skill, and sustainability in producing food practices in daily life. It reveals the significant of incorporation STEM education into real world projects to promote student involvement and improve initiated skills for scientific in the future and advanced technology. Moreover, transforming bananas into chips provide an effetely sustainable solution to promote environmental and economic sustainability. In addition, the knowledge and skills gained through decision-making regarding the product processing, cost-effectiveness, environmental influence, and communities' benefit were enhanced via the prototype flow designed by hand-made, communication, and socialization events.

The assessment of the process stages, students' knowledge and skills was made through reflection of a notable panel of assessment. The framework of assessment of the learning process was provided through designed questions. These included where and how

the information was acknowledge and to what extend the critical thinking skill, creativity skill, and sustainability in producing food practices in daily life were ensured on knowledge developed.

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