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FROM FARM TO CLASSROOM: TUBERS AS KEY RESOURCES IN DEVELOPING BIOLOGY LEARNING MEDIA ROOTED IN BANTEN'S LOCAL CULTURE

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ABSTRACT

This study aims to investigate the diversity of tuber plants used as food by Banten locals, which are then used as learning content based on local potential. To achieve this goal, we conducted research and development (R&D) to create various media using the information on tuber diversity in Banten. In the first stage, we collected data on the diversity of tuber plants cultivated by Banten locals and their uses. In the second stage, we developed various forms of learning media from the diversity data and the status of plant utilization. Data on diversity was obtained by conducting field observation and interviews with 373 respondents: tuber farmers, traders, intermediaries, processed makers, souvenir shop owners, and homemakers in Banten. Data were analyzed using the descriptive-qualitative method. Information about the diversity of types of tubers, their use for food, and their processing techniques was then used as the content on learning media of Biology subject for senior high school on biodiversity, ecosystems, and biotechnology concepts. We customize content development to support biology classes with Kurikulum Merdeka. The results showed that 16 tubers belonging to 11 families, such as Dioscoreaceae, Euphorbiaceae, and Convolvulaceae, were used as food. The media development analysis results show that diversity data can be applied to various types of multimedia learning media in biology. While these materials may complement the learning of biology, careful consideration must be given to the advantages and disadvantages of each medium to ensure that they are appropriate to the learners' learning goals and circumstances.

Keywords: Biology education; local food; tubers diversity

INTRODUCTION

The locals of Banten have a close relationship with the various types of tubers that grow there. Many generally use these tubers as the most essential raw material for local food recipes. On the other hand, Banten's abundance of tuber diversity and its use has not been the subject of research or information to the younger generation, especially in written information. It can be a source of vulnerability for the diversity itself, where the reduction of tuber utilization, the population will reduce the amount of planting. Furthermore, it can drastically decrease the diversity of potential food sources in Banten.

The decline in the use of tubers as food, the reduction in the number of known traditional recipes, and the change in diet to one rich in fast food are issues highlighted by many experts (Khastini et al., 2023). The dramatic decline in

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the consumption of local tubers is influenced by many aspects, including a lack of information, a disjointed flow of information about local foods to the younger generation, and dietary habits that depend only on a few core crops. It can be risky, as the reduction of cultural wealth and food security is threatened when we rely on only one type of food. For this reason, we must try to include information about tubers in local foods in classroom learning.

The learning at school must be comprehensively intended using a contextual approach to ensure that learning objectives are met (Johnson, 2002; Hudson & Whisler, 2007). Contextual learning encourages students to think critically, logically, systematically, creatively, and innovatively to ensure they can relate content gained in school to contexts applicable to daily life (Lotulung et al., 2018; Dewi & Primayana, 2019; Sarwinda et al., 2020). Contextual learning adheres to the fundamental principles of the *Kurikulum Merdeka*, pointing out the teacher's ability to implement a learning process that can be meaningful, authentic, and challenging, influences students' skills, and enhances critical students' thinking skills and participation in their daily activities (Zakiyyah et al., 2021; Purnomo et al., 2023). Contextual learning will also make students more conscious of their environment.

The most important part of contextual learning is using local resources and the setting in which one is learning. Connecting new information and the previous understanding is the core of contextual learning. Here are a few examples of how teachers might tap into local resources to improve the quality of students' contextual understanding (Andriana et al., 2023). This makes it easier for students to find concrete applications for abstract ideas and enhances the significance of their learning.

Integrating cultural learning by studying regional customs and history is essential for the school biology curriculum. Students may develop a stronger sense of belonging and identity through exposure to local literature, art, music, and traditions. Also, community-based problem-solving involves creating hypothetical situations where problems of interest to the neighborhood may be addressed. Students are pushed to use what they have learned in a manner that has real-world consequences. It allows students to get practical experience and make connections in the professional world.

Integrating local food into school subjects is essential to educating students about food literacy (Cullen, 2015; Nanayakkara et al., 2017). Food literacy is essential to learn in formal education since it can enhance a person's understanding, abilities, mindsets, and behaviors when deciding which foods they will consume (Vidgen & Gallegos, 2014; Truman et al., 2017; Truman & Elliott, 2019). This thing has a connection with health; therefore, this literacy is critical. The mistake of choosing a food pattern will lead to malnutrition and stunting (Gartaula et al., 2020; Stjernqvist et al., 2021).

However, the application of local culture-integrated contextual learning is minimal, especially in Banten. According to Leksono et al. (2015), the lack of evident biodiversity and local wisdom research data in Banten makes it difficult for teachers to develop teaching materials based on local wisdom. Preliminary studies to determine the application of contextual learning based on local wisdom in 10 high schools in three districts of Banten also showed that 85% of biology teachers in these schools had not developed local wisdom-based learning media, and 15% had tried to apply it once or twice. It shows the lack of enthusiasm of the teachers in linking biology learning through contextual approach and local wisdom.

Contextual learning can be accomplished by utilizing local potential in the students' immediate surroundings (Nesterova, 2020; Singh et al., 2020). The natives of Banten consume tuber crops because they contain many carbohydrates and can be used as an alternative to rice to boost dietary variety (Leidi et al., 2018; Maretta et al., 2021). Tubers are inflated, swelling, spherical plant components that are adaptations of leaves, stems, or roots. Tubers are plant portions that have evolved to act as food reserves that generally occur below the soil surface (Zierer et al., 2021).

Tubers are classified as stem tubers, root tubers, rhizome tubers, corms, and bulbils based on their form and function. Taro (*Colocasia esculenta*) and potato (*Solanum tuberosum*) are examples of plant stem tubers. Meanwhile, root tubers are root modifications for plants like carrots (*Daucus carota*) and cassava (*Manihot esculenta*) (Lende et al., 2019; Zierer et al., 2021). The natives of Banten are familiar with all varieties of tubers. Investigation and inventory must be conducted to determine which tubers are often utilized as local food. The exploration aims to learn more about the many varieties of tubers used as local food and how to prepare them. This information is crucial for students to comprehend, especially when highlighting the local potential of the area where they currently live.

However, getting students to pay attention to this important information requires an unusual effort, more than ever before (Sulistyaningsih, 2016). Students in the post-pandemic era tend to be exposed to audio-visual media from various types of social media, characterized by a lower willingness to explore written sources and drastically reduced focus time (Mukhtar et al., 2020). The fact is that concentration is a prerequisite for children to have a secure understanding and internalization of information. This deficiency can be overcome by providing information through audio-visual media for a certain period (Azlan et al., 2020). Many previous studies have been conducted on using learning media to integrate local food information into school materials. The study of learning media of local food is considered effective to use as learning media (Nikmawati, 2018), improving learning competencies (Priyatna et al., 2019) and developing students' character (Arsih et al., 2023). Another study on using spice research data in Maluku also showed effectiveness in improving students' science literacy (Hasan et al., 2021). Furthermore, based on these previous studies, using local food as material can improve students' learning outcomes, food literacy, behaviors, and understanding.

In Kurikulum Merdeka, integrating learning media necessitates meticulous alignment with the academic content's intrinsic attributes, the students' requisites, and varied learning preferences. Effective educational media should transcend mere information dissemination, actively prompting students to delve independently into the subject. The imperative for educators lies in fortifying the capacity of instructional media to fulfill these multifaceted demands. Consequently, a concerted and sustained endeavor from diverse educational stakeholders is imperative to bridge this gap. The reshaping of students' perspectives, influenced by their surroundings, plays a pivotal role in their comprehension of academic content. This phenomenon gains additional support from research findings that highlight students' heightened ability to recognize and understand the diversity of plants when connected to real-life experiences. However, further exploration is warranted to elucidate the specific mechanisms through which environmental factors impact students' cognitive processes. Investigating these intricate connections could offer valuable insights into the interplay between external stimuli and cognitive development, thereby informing more nuanced and effective educational strategies. This might be regarded as learning based on ordinary experiences enhancing students' knowledge of the subjects of their studies. Therefore, to enhance food literacy in Banten, local food from plants must suit the people's dietary demands. Based on this context, this study aims to describe the diversity of tuber crops and their application as local food in Banten that has not been explored yet and assess them as biology learning content based on local potential.

METHODS

The Reseach and Development method is used in this study (Creswell, 2016). We modified the steps from Hidayah et al. (2018). The steps are divided into preliminary study, product development planning, and product prototyping. The first steps are focused on gaining data on the tuber diversity and its utilization in Banten, which covers all districts/cities, including Pandeglang District, Lebak District, Serang District, Tangerang Regency, Serang City, Cilegon City, Tangerang City, and South Tangerang City (Figure 1). Field observations and interviews obtained data on tuber diversity and its utilization.

Figure 1. Map of Diversity Tuber Exploration, Colored Area is Where the Data Gained in This Research

Data on tuber diversity and its utilization were obtained utilizing field observations and interviews. Field observations were carried out in tuber farms, traditional wholesale markets, tuber processing plants, and typical gift shops in each district/city in Banten. Interviews were conducted face-to-face and through the Google Form involving 373 respondents: tuber farmers, traders, wholesalers, homemakers, souvenir shop owners, and housewives in Banten (Table 1).

Table 1. Characteristics and Categories of Respondents

Respondent categories	Frequency	Percentage (%)
Tubers traders	38	10,2
Tubers stockbroker	17	4,5
Tubers farmers	18	4,8
Homemakers	37	9,9
Gift shop owners	21	5,6
Housewives	242	64,9
Total	373	100

Table 1 explains the number of respondents in each category. The number of respondents from each group is different, which is very dependent on the form of data and the data collection techniques used. Details regarding the sampling technique in this study are contained in Table 2.

Table 2. Data Type and Data Collection Techniques

No	Data	Data Collection Techniques	Sampling Techniques
1.	Tubers inventory	Observations on farming land and interviews with the owners/farmers of the land	Purposive sampling and snowball sampling
		Observations on traditional markets and interviews with traders	Purposive sampling
		Interviews to stockbroker	Snowball sampling
2.	Utilization of tubers as Banten local food	Observations and interviews with homemakers	Purposive sampling
		Observations and interviews in a gift shop	Purposive sampling
		Interviews of housewives	Purposive sampling

Tuber species were identified directly in the field and the Department of Biology Education laboratory at a public University in Banten, Indonesia. The utilization of tubers as local food was analyzed using interactive data analysis proposed by Saldana et al. (2014), which consists of data reduction, data presentation, and data inference. The flow of data analysis is presented in Figure 2.

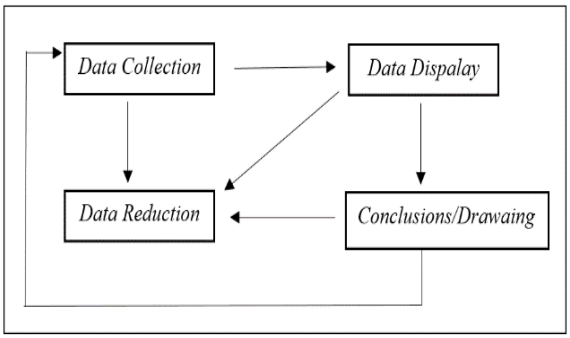

Figure 2. Interactive Model Data Analysis

The analysis result of tuber diversity and its utilization is then implemented in learning material based on local potential. We planned the product based on the content developed following the Kurikulum Merdeka and the demands of the 21st century, including critical thinking, creative, collaborative, and communicative skills. This local potential-based learning content aims to help students understand biodiversity, ecosystems, and biotechnology materials and their benefits in the surrounding environment.

We continue the research phase to product development planning by analyzing and compiling diverse content according to the learning outcomes required by the Kurikulum Merdeka. Students are expected to know the wealth of local potential in Banten Province. Content analysis is carried out by analyzing the learning objectives in biology.

The final stage is the development of product prototypes into different types of learning media from the product development plan developed. The form of the developed media is adapted to the learning design and related learning models. The developed prototype is then tested by reviewing teacher responses to the developed media. Teacher responses were collected through an open-ended questionnaire and analyzed qualitatively to describe the experience, advantages, and disadvantages of using the media in learning. To understand the effectiveness of the various media we developed, we identified teachers' responses to each media component, its shortcomings, and advantages.

Then, by analyzing the facts and data from observations of root crops in Banten, local food was found in the field, furthermore, by analyzing the learning materials and linking the material to the results of facts and field data.

RESULTS AND DISCUSSION

Researchers conducted an extensive examination of tuber diversity across all districts within Banten Province. Subsequently, collected samples underwent identification based on the morphological characteristics of the plants, utilizing a taxonomic key to discern the respective species. Following this, a comprehensive literature review was undertaken to establish comparative insights. The findings show that 11 tuber families are used as food by banten people, consisting of 17 species and 25 varieties (Table 3).

Table 3. Diversity of Tuber Used as Banten Local Food

No.	Family Name	Scientific Name	Local Name		Variety	Tubers Type
			Banten	Indonesia		
1.	Dioscoreaceae	*Dioscorea bulbifera*	Kentang *gantung/leweng*	Gembolo		Bulbils
		Dioscorea esculenta	*Hui teropong*	Gembili		Root
		Dioscorea rotundata	*Hui gede*	Uwi Putih		Root
		Dioscorea hipsida	Gadung	Gadung		Root
2.	Araceae	*Colocasia esculenta*	*Tales* bogor	Talas bogor	*Colocasia esculenta* var. *bentul*	Corms
					Colocasia esculenta var. *antiquorum*	Corms
		Xanthosoma sagittifolium	*Tales sente*	Talas belitung		Corms
		Xanthosoma undipes	*Tales* beneng	Talas beneng		Corms

No.	Family Name	Scientific Name	Local Name		Variety	Tubers Type
			Banten	Indonesia		
3.	Convolvulaceae	*Ipomoea batatas*	*Mantang*	Ubi jalar	*Ipomoea batatas* var. *antin 2*	Root
					Ipomoea batatas var. *Manohara*	Root
					Ipomoea batatas var. *ac kuning*	Root
					Ipomoea batatas var. *beta 1*	Root
					Ipomoea batatas var. *cangkuang*	Root
4.	Euphorbiaceae	*Manihot esculenta*	*Dangder/sampeu*	Singkong	*Manihot esculenta* var. *mentega*	Root
					Manihot esculenta var. *roti*	Root
					Manihot esculenta var. *manggis*	Root
5.	Lamiaceae	*Plectranthus rotundifolius*	*Kumili/kumbili*	Kentang hitam	*Plectranthus rotundifolius* var. *rubra*	Stem
					Plectranthus rotundifolius var. *nigra*	Stem
6.	Cannaceae	*Canna edulis*	*Ganyol*	Ganyong	*Canna edulis* var. *verdos*	Rhizome
7.	Fabaceae	*Pachyrhizuz erosus*	*Bengkoang*	Bengkuang		Root
8.	Saolanaceae	*Solanum tubersoum*	Kentang	Kentang		Stem
9.	Apiaceae	*Daucus carota*	Wortel	Wortel		Root
10.	Marantaceae	*Maranta arundinaceae*	*Tarigu*	Garut		Root
11.	Cyperaceae	*Eleocharis dulcis*	Rumput *tike*	Rumput purun		Rhizome

Based on the results of interviews, tubers are used as a staple food and additional food ingredients in the form of snacks and vegetables. Here are 17 types of tubers and their utilization in Banten:

1. *Gembili* (*Dioscorea esculenta*)

Banten people call *gembili* as *hui teropong* (Figure 3). The common name for gembili is Asiatic yam, and its international name is Chinese yam or lesser yam. Gembili is a Southeast Asian plant (Andres et al., 2017). Wild plants are found in New Guinea, India, and Burma. Banted people eat gembili as a snack. Gembili is processed simply by steaming it. The steamed gembili is *sepan hui teropong*. Gembili is not cultivated massively. It is usually planted in gardens as a distraction.

Figure 3. Gembili (*Dioscorea esculenta*) Source: Research documentation

2. *Gembolo* (*Dioscorea bulbifera*)

Banten people call *gembolo* tubers *kentang gantung* or *kentang leweng* because they resemble potatoes (*Solanum tuberosum)* hanging in their stems. The plant is usually found in forests or uncultivated fields. The common name for gembolo is air potato, and the international name is *aerial yam* or *air yam*.

Banten people use the aerial part of the gembolo tuber that hangs on the stem. They process gembolo by sautéing it as a side dish to rice called *kentang gantung tumis/ kentang leweung tumis.*

3. *Uwi Putih* (*Dioscorea rotundata*)

Banten people call the tuber of *uwi putih* by the name *hui gede* (Figure 4). The international name for uwi putih is white guinea yam. Banten people eat uwi putih as food and as a snack. Uwi putih is processed by steaming, which is called *sepan hui gede*.

Figure 4. Uwi Putih (*Dioscorea rotundata*). Source: Research documentation

4. *Gadung* (*Dioscorea hipsida*)

Banten people call this tuber *gadung* (Figure 5). The common name of gadung is ascitic bitter yam, and the international name is intoxicating yam. Gadung is a plant that originated in western India and then spread to Southeast Asia.

This tuber has a cyanide poison, so not everyone can process it into food. Banten people usually remove the poison by washing it clean, slicing it thinly, stirring it with firewood ashes, soaking it in running water for two days, then steaming it and drying it in the sun. Adding firewood ashes and soaking them in running water aims to dissolve the cyanide in the tuber. *Keripik Gadung* is the most common snack known by Banten people.

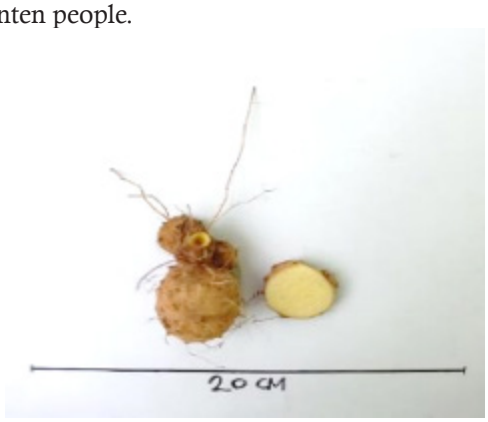

Figure 5. Gadung (*Dioscorea hipsida)* Source: Research documentation

5. Cassava (*Manihot esculenta*)

Banten people call cassava by the name *Dangder* or *Sampeu*. Several regions in Indonesia call cassava by the name *ubi* or *singkong*. The common name for cassava is Asiatic cassava and the international name is Brazilian arrowroot or tapioca.

Three varieties of cassava were found in Banten: the mangosteen (*Manihot esculenta var.* mangosteen), butter (*Manihot esculenta* var. butter), and roti variety (*Manihot esculenta* var. roti). Cassava is easy to cultivate because it is highly tolerant to drought. It is one of the most widely used tubers by Banten people. Cassava is processed into various snacks: *gegetuk dangder*, cake *beam, putri noong cake, dodongkal, papais, katimus, gogonyol, undal share, jajalon, combro, misro, gabin tapai, dangder balls, bangkerok, cassava compote/ dangder kolek, cassava gipang, dangder sepan, dangder fry, dangder belem, enye-enye, opak, dangder chips, slondok, dangder tapai, rangining, nasi inter,* and *dangder petis*. Cassava can also be used as a basic ingredient to make flour for making food (Abass et al., 2018). Cassava can be processed into natural, attractive, hygienic, nutritious dishes such as instant noodles, *gori, kharina,* pastries and cakes, *tiwul,* and various traditional cakes. Along with the development of the culinary world, many types of food are developed with cassava as the

basic ingredient, such as mashed cassava, fried cassava with cheese, and steamed cassava with flavor. Cassava can also be used as mocaf flour, which is used to make noodles and pastries.

6. Sweet Potato (*Ipomoea batatas*)

Banten people call sweet potato by the name of *mantang* or *ubi*. Some regions in Indonesia call sweet potatoes *hui boled, ketela rambat,* or *ubi jalar.* The common name for sweet potato is Asiatic sweet potato. Sweet potato originated in Central America but is now widely grown in several tropical and subtropical countries.

Five sweet potato varieties were found in Banten: yellow sweet potato (*Ipomoea batatas* var. ac kuning), manohara (*Ipomoea batatas* var. manohara) cangkuang (*Ipomoea batatas* var. cangkuang), beta 1 (*Ipomoea batatas* var. beta 1), antin 2 (*Ipomoea batatas* var. antin 2)

Sweet potato is one of the most preferred tubers by Banten people, so the community widely cultivates it. Sweet tubers are processed into sweet potato chips, sweet potato sticks, balls, trays, *klepon*, *kembang goyang, biji salak*, steamed sweet potato/*sepapan*, fried sweet potato, *petis kacang*, and crispy chips.

7. Taro (*Colocasia esculenta*)

Banten people call *talas bogor* by the name *talas ronyok*. There are two varieties of talas bogor: talas bentul (*Colocasia esculenta* var. bentul) and talas santoimo (*Colocasia esculenta* var. anti quorum). The common name for bogor taro is asitic taro. It originates from India and Southeast Asia and is a staple food for many islands in the South Pacific, such as Tonga, West Samoa, and Papua New Guinea. This taro is widely cultivated in Africa, the Pacific, and the Caribbean Islands (Chandrasekara & Josheph Kumar, 2016). The largest taro production is in Africa, Asia, and Oceania. The dominant producing regions in Africa are Nigeria, Ivory Coast, Ghana, Zaire, and Kamreun (Rashmi et al., 2018). The main producers in Asia are China, the Philippines, Japan, and Thailand. Meanwhile, in Oceani, production is dominated by Papua New Guinea, Samoa, Solomon Islands, Tong, and Afiji (Temesgen & Retta, 2015). Banten people process Bogor taro into fried tales and *sepan* tales.

8. *Talas Belitung* (*Xanthosoma sagittifolium)*

Banten people call it *tales sente* or *tales kimpul*. In Indonesia, *talas belitung* is called as it is or talas kimpul. Its common name is elephant ear or cocoyam. Taro belitung was first domesticated in Tropical America and has been cultivated since ancient times. Banten people process Belitungg taro into a variety of foods.

9. *Talas Beneng* (Xanthosoma undipes)

Banten people know the name *talas beneng,* which stands for *beuneur* (big or full) and *koneng* (yellow). The name is based on the tree and tubers of *talas beneng,* which are large and yellow (Figure 6).

Banten people process this tuber into brownies, *nastar*, *kastangel*, arben noodles, arben macaroni, and arben rice.

Figure 6. Talas Beneng (*Xanthosoma undipes)* Source: Research documentation

10. *Bengkuang* (*Pachyrhizus erosus)*

In Indonesia, *Pachyrhizus erosus* is also known as *Bangkowang* or *Besusu.* Its common name is yam bean, and its international name is *chop suey bean*, jícama, Mexican yam bean, and turnip bean. Bengkuang originates from the tropics in Central America, *Pachyrhizus tuberosus* from the lowlands on the slopes of the Andes mountains, and *Pachyrhizus ahipa* from the Andes highlands. Bengkuang is widely cultivated in several countries in Southeast Asia, including Indonesia.

Banten people consume bengkuang as a salad. It is usually dipped in rujak sauce combined with sweet yam to produce a delicious taste. Bengkuang can also be used as an additional ingredient for wheat flour in making bread.

11. Water Chestnut (*Eleocharis dulcis*)

Banten people call water chestnuts by the name *tikè* (Figure 7). Several regions in Indonesia refer to water chestnuts as *babawangan*, *peperetan*, or *teki*. The common name is Chinese water chestnut, and the Spanish is *cabezas de nergito*. It originates from Southeast Asia and has spread to the tropics of West Africa, China, Thailand, Madagascar, India, northern Australia, Japan, and the Pacific islands. Banten people process water chestnuts as a raw material for making chips or crackers.

Figure 7. Water Chestnut (*Eleocharis dulcis*) Source: Research documentation

12. *Garut* (*Maranta arundinacea*)

Garut can be found in various regions in Indonesia with different local names such as *labia walanta* (Gorontalo), *patat* (Sunda), *hudasula (Ternate), rare sago (Minangkabau), sago banban* (Batak Karo), *arut/ jesoluble/irut /soluble/arrowroot* (East Java), andrawa sago (Nias), or sago (Palembang) (Djaafar & Pustika, 2010). Garut comes from Central America, South America, the West Indies, and Mexico (Chandrasekara & Josheph Kumar, 2016). This plant has been widely cultivated in tropical countries and naturalized in countries such as Bermuda, Jamaica, China, Sri Lanka, Equatorial Guinea, Bahamas, India, Netherlands, Florida, Gabon, Cambodia, Philippines, and Indonesia (Chandrasekara & Josheph Kumar, 2016).

Banten uses *garut* to make flour as a basic ingredient for traditional cakes such as *pais kusruk, layer cakes, banana cakes, chips, prawn gabes, syringe cakes, siomai, cendol,* and *ongol-ongol*. Garut can also be processed into hunkwe, biscuits, wet cakes, porridge, pudding, sponge mix, and a mixture of chocolate.

13. Potato (*Solanum tuberosum)*

Potatoes originate from the highlands and have been domesticated in the Andean highlands of South America. It is the main food in the highlands of South America, Asia, and Central and East Africa (Chandrasekara & Josheph Kumar, 2016).

Potatoes are in great demand from people because they taste delicious and soft. They are fritters, chips, crackers, stir fry, and salad.

14. *Kentang Hitam* (*Plectrathus rotundifolius*)

Banten people call *kentang hitam* by the name *kumili* or *kumbili.* Its common name is *hausa potato,* and international names in English are black potato, country potato, Chinese potato, coleus potato, frafta potato, zulu potato, or sudan potato. It is a plant from tropical Africa widely cultivated in East Africa. However, several countries worldwide have cultivated it, such as Sri Lanka, India, Indonesia, Thailand and Malaysia.

There are two varieties of *kentang hitam* found in Banten: purple (Plectranthus rotundifolius var. nigra) and white (Plectranthus rotundifolius var. rubra).

Banten people process kumili by steaming; the processed name is sepan kumili/sepan kumbili. Besides that, kumili is also processed with vegetables. According to Cicilia et al. (2018), kumili flour can be used to make bread and cookies.

15. Carrots (*Daucus carota)*

Local names for carrots in Indonesia vary, such as *ortel* (Madura), *wertol/wortel (*Java), or *wortol* (Sunda). Banten people use carrots as a mixture of vegetables for cooking. Banten people usually make stir-fried carrots. Carrots can also be made as a snack called carrot sticks.

16. Canna (*Canna edulis*)

Banten people call canna by the name *ganyong* (Figure 8). Several regions in Indonesia call canna by the names pikul yam (Sumatra), *banyar manyor* (Madura), *laos jambe, senitra, tasbeh fruit, lumbong, nyindro, laos mecca, midro, or ganyong* (Java) (Suhartini, 2010). This plant is cultivated commercially in Australia for its starch (Chandrasekara & Josheph Kumar, 2016). Banten people process ganyong as flour for various processed foods such as *dodol ganyong* and *goyobod*.

Figure 8. White Ganyong (*Canna edulis* var. verdos) Source: Research documentation

Implementation of Tuber Diversity Data as Biology's Learning Media in the Kurikulum Merdeka

Diversity tubers and their benefits for local food can be implemented in the learning material of biodiversity and the use, ecosystems, and biotechnology taught in Phase E (commonly used for class X at a National High School Equivalency Program) in the Kurikulum Merdeka.

At the end of phase E, participants should create a solution to problems based on local, national, or global issues related to biodiversity concepts, ecosystem components, their interactions,

and biotechnology. On the elements of participants' process skills, they can observe, question and predict, plan and inquire, process and analyze data and information, evaluate and reflect, and communicate results investigation related to biodiversity and its use, ecosystem components and interactions, and biotechnology. Material analysis in the biodiversity of tubers and their use in Local Banten food can be explained in Table 4.

In the process skills aspect, students can observe, question, predict, plan and carry out investigations, process and analyze data and information, evaluate, reflect, and communicate the results of investigations related to the material diversity of living things and their roles, ecosystem components and interactions between components and biotechnology.

The biodiversity of tubers and their utilization of local food can be content in achieving biology learning objectives. Students will be more able to explore the local potential around them, be able to see real problems in the field, and be able to make the solutions offered (Jesus-Leibovitz et al., 2017; Raymond et al., 2019; Fiedler et al., 2020; Gass et al., 2021).

Students can better understand and apply food diversification to fulfill nutrition needs. Students are invited to think that the nutritional content of food is more important, as well as the variations of food resources. Students are also expected to be able to solve the phenomenon of food consumption that occurs in communities that still depend on rice so that rice consumption continues to increase as the population increases. Population dependence on rice leads to food insecurity. The solution offered is the implementation of food consumption diversification by optimizing local potential. Local food diversification will allow households to have more than one type of food choice to fulfill family nutrition needs (Waha et al., 2018; Narciso & Nyström, 2020). More choices will create opportunities for all income groups to fulfill balanced nutrition in household consumption.

Table 4. Analysis of Material Diversity Tubers in Food Local Banten on Kurikulum Merdeka

Phase	Concept	Subconcept and Indicator	Learning achievement	Materials
E	Biodiversity	Flora Diversity Identify biodiversity of tubers Classify the biodiversity of tubers Organism-level Biodiversity Analyze the utilization of tubers in Banten by local communities	Students can analyze the biodiversity of tubers used in local food in Banten. Students can inform the utilization of tubers. Students can create a local food innovation from tubers.	Tuber diversity and identification Diversity of Tuber in Banten in three biodiversity levels Utilization of Tubers in Local Food in Banten
	Ecosystem	Ecosystem Biodiversity Identify ecosystem biodiversity of tuber Analyze the optimum ecosystem of tuber	Students can analyze the suitable ecosystem for the optimum growth of tuber species.	Growth conditions of plant tubers based on ecosystem
	Biotechnology	Food Biotechnology Evaluate application biotechnology conventional on utilization plant tubers Create innovations of tuber utilization for local community	Student able to evaluate the use of tubers in Banten's Local Food Students can create an innovation by using tubers, by biotechnology technique	Biotechnology application in local food Banten

Researchers developed the concept based on the following principles of learning media to teach the concept of biodiversity based on local potential, which holds significant importance in educational settings. Some principles of local potential-based learning media can be summarized as follows.

Enhancing Relevance: Local potential refers to the unique biodiversity found in a specific region or locality. By incorporating learning media that showcase the local biodiversity, educators can make the concept of biodiversity more relevant and relatable to students. It helps them connect with their immediate environment and understand the importance of preserving and conserving local biodiversity (Mehmeti & Çakmak, 2019).

Promoting Active Engagement: Learning media, such as videos, images, interactive simulations, and hands-on activities, can actively engage students in the learning process. When students have access to visual representations and tangible experiences related to local biodiversity, they are more likely to be actively involved in exploring, observing, and analyzing the subject matter. This active engagement can enhance their understanding and retention of biodiversity concepts.

Fostering Appreciation and Conservation: Local biodiversity is often underappreciated or overlooked. By using learning media that highlight the richness and uniqueness of local biodiversity, educators can help students develop a sense of appreciation and admiration for their natural surroundings. This, in turn, can inspire students to become responsible stewards of the environment and actively contribute to biodiversity conservation efforts.

Connecting Community and Culture: Biodiversity is deeply intertwined with local communities and cultures. Learning media incorporating local potential can highlight the interconnections between biodiversity and various aspects of community life, such as traditional practices, indigenous knowledge, and local economies. By emphasizing these connections, educators can help students recognize the cultural significance of biodiversity and its importance in sustaining local communities.

Providing Real-World Examples: Local biodiversity offers real-world examples and case studies that can enrich the learning experience. Educators can use learning media based on local potential to present concrete examples and stories that illustrate biodiversity concepts in action. This approach helps students see biodiversity's practical applications and implications in their lives and communities.

Based on the point described, we consider it essential for educators to develop contextual learning media in biology education. Improving the learning process to assist the students in increasing their ability to master the concept of biodiversity, ecosystem components, and biotechnology can be done by involving various learning media and using the current technology. Previous research has shown that using various learning media like the "ALPA" application, *E-Magazine*, *TikTok video*, *E- Photonovela,* and Encyclopedia could significantly improve students' ability to accept the learning content.

The prototype media draft was considered capable of presenting learning materials in an engaging, effective, and efficient way in the target group of the younger generation, which is audio-visual media. It is known that the most suitable media are those that are application-based and store little information but are frequently exposed to students with short attention spans, are technology freaks, and are exposed to fast-moving media that can be accessed quickly. The media described above are media that can meet these needs.

In order to understand the effectiveness of the various media we developed, we identified teachers' responses to each media component, its shortcomings, and advantages (Table 5). Teachers responded differently to each type of media, ranging from aspects of usefulness and shortcomings. It shows that the material component is not the only determinant of media use, but the appropriate form of media is very subjective and specific to certain classes.

Table 5. Draft of Application Uses in Serving Content Material in Biology Education

No.	Media	Content / Topic	Advantage	Disadvantage
1	"ALPA" Application Literacy Food (Robust Plants in Food Banten Local)	Biodiversity of tuber root in Banten Local food Plant morphology and biodiversity Utilization and innovation of local food in Banten	It increases creativity with various stimulations during the learning process. Easy access It supports any digital literacy program.	It takes time and external applications to create the content. It must be connected to the internet and require minimum specification of digital devices.

2.	E - M a g a - zines	Biodiversity of tuber root in Banten Local food Plant morphology and biodiversity Utilization and innovation of local food in Banten	It has abundant resources and tools It can present complex material and forms of learning media It helps students in new learning experiences.	It needs more time to develop. It requires individual devices for optimum learning experiences.
3.	Tiktok Video	Utilization and innovation of tubers local food in Banten	It is easy to create, even for students. It does not need any external application to create and watch. Short and direct content	The duration is short, and it is tricky to create learning content. Too many distractions in the apps
4.	E- Photonovela	Biodiversity of tuber root in Banten Local food Plant morphology and biodiversity Utilization and innovation of local food in Banten	The development process is easier than any form of comics Dialog-based, suitable for teens	Teacher must collaborate with content creator. Need individual devices for optimum learning experience.
5.	Encyclopedia	Biodiversity of tuber root in Banten Local food Plant morphology and biodiversity Utilization and innovation of local food in Banten	It does not need the internet to access and operate It accommodates content with an extensive database Suitable for providing detailed information to students.	Teachers must have considerable, detailed information. Students have to access it from school devices.

Using learning media in teaching biodiversity offers several benefits in enhancing students' understanding and engagement with the subject. However, with the development of technology, both hardware and software, educators have a wide variety of media at their disposal for creating learning materials in biodiversity and biotechnology that can be tailored to students' requirements and classroom settings (Wahyuni et al., 2022).

Teachers should consider the essential benefit of developing educational content based on local food diversity by incorporating local diversity into biodiversity education. Teachers can make the topic more meaningful, relatable, and actionable for students (Smith & Justine, 2018; Nuangchalerm et al., 2022). This approach fosters a deeper understanding of the value and importance of biodiversity conservation and encourages students to become active participants in protecting the environment (Parmin et al., 2019).

However, by the result of teachers' response to the developed media, we understand that the media's novelty and variation do not mean it is suitable to deliver the content as it best helps students improve in understanding. Teachers must consider many aspects before adopting the media itself. The instructional strategies for promoting local knowledge can be multimedia tools to share films, photos, and other stuff created in Banten. Multimedia presentations that emphasize the local context might include virtual tours, interviews with local experts, and other forms of media.

The advantage of local resources like libraries, archives, and museums is to enrich biodiversity lessons. It provides students access to various data directly relevant to where they live. By tapping into local resources, teachers may provide their students with a more personalized education that helps them connect the dots between classroom concepts and real-world applications.

With this intention, the abundance of tuber biodiversity diversity owned by the province of Banten, as well as various processing, the potential for using this information is crucial and significant in efforts to use tuber biodiversity as a teaching material. Educators can effectively engage students in biodiversity, highlighting the importance of plant diversity, food security, cultural connections, and conservation efforts.

CONCLUSION

Banten has diverse types of tubers used in various types of processed food, both traditional and modern. There are 17 tubers used extensively by Banten locals, including root, stem tuber, corms, and rhizome groups. This content can be applied to at least five forms of integrative learning media in class implementation at Kurikulum Merdeka. However, precision in media selection requires thoughtful consideration of both the nature of the material and the intended objectives to ensure accurate alignment.

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