Getting to Know Local Tubers from the School Environment: An Analysis of Elementary School Students' Recognition and Appreciation in Malang City

Nurinda Zulinar Rahmawati
Department of Biology, Mathematics And Natural Sciences, Universitas Brawijaya, East Java, Indonesia

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ABSTRACT

Purpose of the study: This study aimed to analyze the influence of school location on elementary students' recognition of local tuber diversity and to evaluate the appreciation of 117 elementary school students in Malang City toward processed local tuber products as an effort to strengthen local food literacy among young learners.

Methodology: Descriptive research design involving 117 fourth- and fifth-grade elementary students from three schools in Malang City. Data were collected using Questionnaire I and Questionnaire II, direct tuber observation, organoleptic testing, product demonstrations, Likert scale assessment, Kruskal-Wallis test, Mann-Whitney test, descriptive statistical analysis, and Statistical Package for the Social Sciences version 16.00 for Windows.

Main Findings: School location influenced students' direct recognition of local tubers, with students near traditional markets showing higher familiarity. Pocket money profiles did not significantly affect recognition or consumption experience. Consumption of processed local tuber products was relatively equal across schools. Students' acceptance levels varied, with generally moderate appreciation, indicating that product appearance, taste, and innovation remain important factors affecting acceptance.

Novelty/Originality of this study: This study integrates assessment of elementary students' recognition of twelve local tuber varieties with evaluation of appreciation toward processed products across different school locations. It provides new evidence that geographical school context has greater influence than economic indicators on local food recognition, offering practical insights for strengthening food education and local biodiversity conservation strategies.

Corresponding Author:
Nurinda Zulinar Rahmawati
Department of Biology, Mathematics And Natural Sciences, Universitas Brawijaya, Veteran Street, Malang 65145, East Java, Indonesia
Email: ndazuilmawatii@gmail.com

1. INTRODUCTION

Indonesia's biodiversity is a national treasure with significant potential to support community food security [1], [2]. One abundant local food resource is the various types of tubers found throughout the region. Local tubers such as cassava, sweet potato, taro, ganyong, arrowroot, and suweg (suweg) are nutritious and can be processed into a variety of food products [3], [4]. The presence of local tubers is not only economically valuable but also holds cultural significance, having long been part of Indonesian consumption [5], [6].

However, amidst the flow of food modernization, the existence of local tubers is beginning to face challenges in terms of their recognition and utilization by the younger generation.

Current changes in consumer behavior indicate a growing preference for instant foods and wheat-based products [7][8]. This situation has indirectly displaced local foods, including tubers, from people's daily lives. Elementary school-aged children are a group that is particularly vulnerable to the influence of modern consumption trends [9], [10]. Exposure to fast food, packaged snacks, and imported food products further alienates them from local foods. As a result, many elementary school students are unfamiliar with the diversity of local tubers or their benefits as alternative food sources [6], [11].

Elementary education plays a strategic role in instilling knowledge and an appreciation for local resources from an early age. Schools can be effective educational spaces for introducing students to local food diversity through various learning approaches [12], [13]. Introducing students to local tubers not only fosters knowledge but also fosters awareness of the importance of preserving local wisdom [14], [15]. Furthermore, an appreciation for locally processed tuber products can foster interest in consuming foods based on local resources. Therefore, strengthening local food literacy at the elementary school level is a crucial step in supporting sustainable food security [16], [17].

Malang City is an urban area with diverse social and educational characteristics. The diversity of school locations, both in the city center and in the suburbs, has the potential to influence students' access to information about local foods. Family environments, household consumption habits, and exposure to modern food products also shape students' understanding of local tubers. Differences in the geographic context of schools allow for variations in students' knowledge and appreciation of local tuber diversity. Therefore, Malang City is a relevant location to examine how school location influences students' understanding of local foods.

Processed products made from locally processed tubers offer significant potential for development as attractive food alternatives for children [18], [19]. Processing innovations, such as chips, brownies, donuts, ice cream, and cookies made from local tubers, can increase consumer appeal. The appearance, taste, texture, and packaging of processed products are important factors influencing elementary school students' acceptance [20], [21]. Students' appreciation of locally processed tuber products can be a potential indicator of opportunities for developing local food consumption in the future [6], [22]. A positive student response can serve as a foundation for developing education and diversifying local tuber-based food products.

Research on local food literacy among school-aged children has been conducted in several regions in Indonesia, but most have focused on nutritional education or general consumption behavior [23], [24]. Studies specifically evaluating elementary school students' level of awareness of local tuber diversity are still relatively limited. Even fewer studies link this awareness to school location. Furthermore, research on students' appreciation of processed local tuber products generally has not integrated preference analysis as part of efforts to strengthen local food security [25], [26]. This situation indicates the need for more comprehensive research to understand the relationship between knowledge, school context, and students' appreciation of local tubers.

A gap analysis shows that few studies have explored variations in elementary school students' appreciation of local tuber diversity and processed tuber products in an urban context like Malang City. The novelty of this research lies in the integration of an evaluation of students' awareness of local tuber varieties, an analysis of the influence of school location on this awareness, and a simultaneous measurement of students' appreciation of processed local tuber products.

The urgency of this research is based on the importance of building awareness of local food from an early age as part of a strategy to maintain food security and conserve regional biodiversity. The findings of this study are expected to provide a basis for developing more effective local food education programs in elementary schools. Therefore, the primary objective of this study was to analyze the influence of school location on elementary school students' level of familiarity with local tuber diversity and to assess 117 elementary school students' appreciation of locally processed tuber products.

2. RESEARCH METHOD

2.1. Time and Place

The research took place at several elementary schools in Malang City, namely Dinoyo State Elementary School, Jodipan State Elementary School, and Kauman State Elementary School. The research locations were selected based on the differences in the geographical characteristics of each school. These differences in location were deemed essential to support the analysis of the influence of the school environment on the research results [27], [28].

2.2. Research Object

This study involved 117 elementary school students from fourth and fifth grades across all elementary schools designated as research locations. Subjects were selected based on student representation at each school. School selection was based on the varying geographic locations of each school. These differences in location are important considerations in assessing the potential influence of the school environment on students' understanding of local tuber diversity. Therefore, the research subjects were selected to provide a comprehensive overview of the variations in students' appreciation of local tubers and their processed products.

2.3. Initial Evaluation of the Introduction of Local Tubers' Diversity
An initial evaluation was conducted to determine elementary school students' level of familiarity with the diversity of local tubers in their local environment [6], [29]. This activity used a first questionnaire administered once to half of the fourth and fifth grade students in each school. The questionnaire included questions about students' familiarity with local tubers, including through listening, direct observation, reading, and consumption experiences. Information was also collected on family consumption habits, pocket money profiles, and student snack preferences. In this evaluation, students were introduced to twelve local tuber species: cassava, purple sweet potato, yellow sweet potato, taro, bentul, mbothe, gadung, suweg, gembili, porang, sente, and uwi. The tubers were shown directly, accompanied by visual documentation to help students recognize their shapes and characteristics. Students then observed each tuber type and answered questions according to the provided guidelines. This approach was used to obtain more accurate data on students' level of familiarity with local tuber diversity.

2.4. Processed Tubers
The processed tuber products developed in this research are sweet and savory snacks tailored to the tastes of elementary school students. The products are made with energy efficiency in mind, without the use of synthetic additives, have attractive shapes and colors, and are affordable [30]. The main ingredients used are local tubers with the addition of natural ingredients for flavor and coloring. The types of tubers used include uwi, purple sweet potato, gembili, suweg, and mbothe. These tubers are processed into Uwi Cake, Suweg Ice Cream, Gembili Croquettes, and Taro Chips, which are then introduced to students at three elementary schools as part of an evaluation of the appreciation of local tuber processed products.

2.5. Promotion and Evaluation of Consumption of Locally Processed Tuber Products
Promotional activities were conducted through interactive demonstrations using media and language easily understood by fourth and fifth grade elementary school students. Students were given the opportunity to observe the appearance of the processed products and taste them directly through organoleptic testing. Afterward, students were asked to complete a second questionnaire to gauge their responses to the local tuber products introduced. Assessments covered aspects of taste, appearance, and product acceptability. The questionnaire used a five-level rating scale, ranging from strongly disagree to strongly agree.

2.6. Determining Elementary School Students' Appreciation of Locally Processed Tuber Products
Elementary school students' appreciation of locally processed tuber products was determined by completing a second questionnaire. Assessment was based on several aspects of appreciation, including students' willingness to share, gift, and recommend the products to others. The questionnaire included questions describing students' level of acceptance of the processed products they had tasted. Appreciation was determined using a five-level rating scale, ranging from strongly disagree to strongly agree. The results of this assessment were used to determine students' level of appreciation for locally processed tuber products.

2.7. Research Design
This study used a descriptive design with the economic status of the students' families as the independent variable. The dependent variables in this study included the level of recognition of local tuber diversity and the appreciation of local tuber products among elementary school students. The research data were obtained by distributing questionnaires to elementary school students. Data collection was conducted once without repetition, with half of the total number of fourth and fifth grade students. This design was used to illustrate the relationship between family economic conditions and students' level of recognition and appreciation of local tubers.

2.8. Data Analysis
The data obtained in this study were ordinal, which were then tabulated to facilitate analysis. Data analysis was conducted using a nonparametric statistical approach. The Kruskal-Wallis test, followed by the Mann-Whitney test, was used to determine the effect of school differences based on economic level on the level of recognition of local tuber diversity among elementary school students. Meanwhile, data from the evaluation of consumption and appreciation of processed local tuber products were analyzed descriptively. The entire data analysis process was conducted using statistical software.

3. RESULTS AND DISCUSSION

Based on observations of the three schools, an initial suspicion arose that Jodipan Public Elementary School was located in an area with lower economic conditions, followed by Dinoyo Public Elementary School and Kauman Public Elementary School. However, the results of the pocket money profile evaluation obtained through the first questionnaire in Figure 1 showed findings slightly different from this suspicion. As many as 53% of Jodipan Public Elementary School students received pocket money of more than Rp3,000.00 per day, which is included in the high pocket money profile category. This percentage is the same as the number of students at Kauman Public Elementary School, which is 53%. Meanwhile, Dinoyo Public Elementary School has the lowest number of students from families with moderate economic conditions, at 32%.

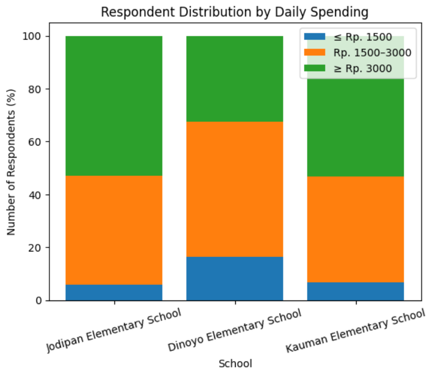

Figure 1. Elementary school students' pocket money profile

The moderate pocket money profile category is indicated by an allowance range of Rp1,500.00 to Rp3,000.00. Dinoyo Public Elementary School had the highest percentage of students with a moderate pocket money profile, at 51%, while Jodipan Public Elementary School and Kauman Public Elementary School had 41% and 40%, respectively. Furthermore, the percentage of students with a low pocket money profile at Dinoyo Public Elementary School reached 15%, higher than Jodipan Public Elementary School (6% and Kauman Public Elementary School (7%). These data indicate that differences in schools do not always directly reflect the economic conditions of students' families. This is due to policies in some schools that limit the amount of pocket money, making it impossible to use the amount as the sole indicator of a family's economic situation.

Regarding the pocket money profile, there was initial suspicion that students with low pocket money tended to be more familiar with local tuber varieties because this factor is often associated with family economic conditions. However, the results showed that the level of recognition of local tuber diversity through listening was relatively similar across the three schools. The percentage of students who had heard of local tubers was recorded at 48% at Jodipan State Elementary School, 48% at Dinoyo State Elementary School, and 50% at Kauman State Elementary School. This finding indicates that the pocket money profile does not directly correlate with students' level of familiarity with local tubers.

Differences between schools are also influenced by their geographic location. Jodipan State Elementary School is located in a suburban area close to a traditional market, Dinoyo State Elementary School is located on a main road with relatively good residential access, while Kauman State Elementary School is located in the city center. These location conditions have the potential to influence the intensity of students' interaction with local tubers and their processed products. This is evident in the highest percentage of students at Jodipan State Elementary School who have directly experienced local tubers, at 41% of the total respondents. Thus, school location appears to have a greater influence on students' exposure to local tubers than their pocket money profile.

This percentage is significantly higher than at Dinoyo State Elementary School (35% at both schools) and Kauman State Elementary School (33%). This situation is thought to be due to the majority of Jodipan State Elementary School students living near a local traditional market, thus having greater opportunities to directly encounter various types of local tubers. Proximity to the traditional market provides students with greater access to the role of tubers in everyday life. In terms of information acquisition through reading media, Dinoyo State Elementary School showed the lowest percentage, at only 4.2% of total respondents. This figure is significantly lower than Kauman State Elementary School (20.7%) and Jodipan State Elementary School (26.2%). This finding indicates that students' access to or interest in written information about local tubers remains relatively low, especially at Dinoyo State Elementary School.

The study also showed that family economic conditions had no significant impact on their experience consuming local tuber products. The percentage of students who had consumed local tuber products did not exceed 50%: 42% at Jodipan State Elementary School, 41% at Dinoyo State Elementary School, and 44% at Kauman State Elementary School. This indicates that the opportunity to consume local tuber products was relatively equal across the three schools. This is possible because processed products made from local tubers are relatively readily available and affordable.

However, not all students who had consumed local tuber products enjoyed the taste. The preference rating for this product was lowest at 24% at Kauman State Elementary School, compared to 34% at Jodipan State Elementary School and 32% at Dinoyo State Elementary School. This is likely because Kauman State Elementary School students generally have access to a wider variety of appealing snack options. Furthermore, most locally processed tuber products available do not fully meet children's preferences, both in terms of appearance and taste. Therefore, exploration and innovation in processing local tubers into more appealing snacks is crucial. Developing products that suit elementary school students' tastes is expected to increase their acceptance of local foods. This effort also has the potential to encourage students to favor locally processed tuber products over other snacks available in their environment. Therefore, product innovation is a strategic step in strengthening the presence of local tubers as a desirable food alternative for the younger generation.

The synthesis of pyrimidinone derivatives from bis-chalcone analogs demonstrated that the cyclocondensation approach is an effective method for forming complex heterocyclic frameworks with high biological potential. The successful formation of the target structure indicates that the bis-chalcone analogs used possess the appropriate reactivity to undergo transformation into pyrimidinone ring systems. This is consistent with the electrophilic nature of the α,β-unsaturated carbonyl group in bis-chalcones, which readily reacts with nucleophilic reagents to form new heterocyclic rings. The formation of pyrimidinone derivatives in this study also demonstrated the importance of methoxy substituents on the aromatic ring. Methoxy groups are known to act as electron donors, increasing the distribution of electron density in conjugated systems [31], [32]. This contributes to the stability of intermediates during cyclization and potentially influences the electronic properties of the final compounds. From a medicinal chemical perspective, this type of electronic modification is crucial because it can increase the affinity of compounds for specific biological targets, including enzymes involved in cancer cell proliferation.

The anticancer activity of the synthesized compound can be explained by a possible inhibitory mechanism against the enzyme dihydrofolate reductase. This enzyme plays a crucial role in the biosynthesis of tetrahydrofolate, which is required for DNA nucleotide synthesis. Inhibition of this enzyme activity will disrupt DNA replication and cell division, particularly in cancer cells with high proliferation rates [33], [34]. The structure of the resulting pyrimidinone derivative shares pharmacophore similarities with several previously known inhibitors of the enzyme dihydrofolate reductase, thus supporting the potential for competitive interactions at the enzyme's active site. The effective bioactivity of the resulting compound can also be attributed to the combination of the pyrimidinone skeleton and its methoxy aromatic fragment. This combination allows for hydrophobic interactions and other noncovalent bonds with amino acid residues on the biological target [35], [36]. Furthermore, the presence of a broad conjugation system allows for better cell membrane penetration, thereby increasing the compound's bioavailability at the cellular level. These factors are among the reasons why heterocyclic derivatives are often developed as next-generation anticancer drug candidates.

These research results strengthen the concept of structure-activity relationships in the development of heterocyclic-based anticancer compounds. Molecular structure modification through the transformation of bis-chalcone analogs into pyrimidinone derivatives has been shown to significantly improve bioactive characteristics. This approach demonstrates that molecular design based on chalcone precursors remains highly relevant for producing new compounds with enhanced pharmacological potential compared to their original structures [37], [38]. However, the bioactivity evaluation in this study was limited to in vitro enzyme inhibition assays. To gain a more comprehensive understanding of the compound's anticancer mechanism, further testing using specific cancer cell cultures, toxicity studies on normal cells, and molecular docking analysis to predict molecular interaction patterns are needed. These steps are crucial for confirming the compound's selectivity and safety before further development.

Overall, this research makes a significant contribution to the development of medicinal chemistry, particularly in the exploration of pyrimidinone derivatives as anticancer candidates. These findings open up opportunities for the development of a series of new analogs through variations in substituents on the aromatic ring or modification of the heterocyclic framework [39], [40]. With appropriate structure optimization strategies, pyrimidinone derivatives have the potential to become the basis for the development of more selective and effective anticancer agents in the future.

This research has significant scientific implications for the development of heterocyclic anticancer compounds, particularly pyrimidinone derivatives synthesized from bis-chalcone analogs. The results provide insight into the potential of molecular structure modification to enhance a compound's biological activity [41], [42]. Furthermore, these findings can serve as a foundation for further research in medicinal chemistry to design new anticancer compounds that are more selective, effective, and have lower toxicity than conventional chemotherapeutic agents. Practically, this research opens up opportunities for the development of organic synthesis-based drug candidates that can be directed toward pharmacological optimization and therapeutic formulation.

However, this study has several limitations. The evaluation of the compound's bioactivity is limited to in vitro dihydrofolate reductase inhibition assays, thus not fully reflecting the compound's biological effectiveness in cellular systems or living organisms. This study also does not include cytotoxicity testing against various cancer cell lines or selectivity against normal cells, so the compound's safety profile cannot be fully determined. Furthermore, computational analyses such as molecular docking or molecular dynamics simulations have not been performed, which could provide a more detailed picture of the compound's interaction mechanism with its biological target. These limitations indicate the need for further research to confirm the potential of the synthesized compounds as anticancer candidates worthy of further development.

4. CONCLUSION

Based on the research results, it can be concluded that differences in schools do not directly reflect the economic conditions of students' families, as the amount of pocket money is influenced by school policy and cannot be used as a sole indicator. The pocket money profile also did not show a significant relationship with students' level of familiarity with local tuber diversity. Conversely, school location had a more significant influence on their experience of familiarizing themselves with local tubers, particularly among students at Jodipan State Elementary School, who had more direct experience with local tubers due to their proximity to traditional markets. Furthermore, experience with consuming processed local tuber products was relatively even across the three schools, indicating that these products are relatively accessible to all students regardless of family economic circumstances.

However, student preference for processed local tuber products was still relatively low and varied across schools, indicating that currently available products do not fully meet children's preferences. Therefore, innovation in local tuber processing, both in terms of taste, appearance, and product variety, is needed to make them more attractive to elementary school students. These efforts are crucial for increasing the younger generation's appreciation of local foods and strengthening the potential of local tubers as a valuable and sustainable food alternative. Further research is recommended to conduct cytotoxicity tests on various cancer cell lines and evaluate selectivity against normal cells to obtain a more comprehensive picture of the effectiveness and safety of the synthesized compounds. Furthermore, molecular docking studies, structure-activity relationship analysis, and development of substituent variations on the pyrimidinone skeleton are needed to optimize anticancer potential and better understand the compound's mechanism of action.

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AUTHOR CONTRIBUTIONS

Conceptualization, N.Z.R.; Methodology, N.Z.R.; Software, N.Z.R.; Validation, N.Z.R.; Formal Analysis, N.Z.R.; Investigation, N.Z.R.; Resources, N.Z.R.; Data Curation, N.Z.R.; Writing – Original Draft Preparation, N.Z.R.; Writing – Review and Editing, N.Z.R.; Visualization, N.Z.R.; Supervision, N.Z.R.; Project Administration, N.Z.R.; Funding Acquisition, N.Z.R. The author has read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

Not applicable.

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