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Food Microbiology Handout Evaluation about Banana Preservation Through Drying: Analysis of Validity, Practicality, and Handout Effectiveness

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ABSTRACT
This study aims to evaluate a Food Microbiology handout by analyzing its validity, practicality, and effectiveness for undergraduate Biology students at Malang State University. The research method used is Research and Development (R&D) with the ADDIE developmental model. The subjects of this study were undergraduate students in the Biology Education program. Research instruments consist of: expert validation sheets, practicality questionnaires, and pretest-posttest questions. Validation was done by a material expert, a learning practitioner, and a learning media expert. The results indicated that the handout was valid with an average percentage score of 100%. The practicality test results showed that students think the handout is practical, easy to understand, and supports the learning process, with an average score of 85%. The pretest and posttest analysis proved an improvement in learning outcomes, with a moderate increase according to N-Gain scores: 41% for critical thinking skills and 38% for cognitive knowledge. Based on these results, the handout is worthy of being used as teaching material in Food Microbiology courses.

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1. INTRODUCTION

One of the goals of higher education in Indonesia is to produce graduates capable of solving problems in their lives. A common issue encountered in everyday life in the field of Biology is the rapid decay of fruits, particularly bananas (Alegbeleye et al., 2022; Kesumawati et al., 2020; Wardani & Sutopo, 2021; Uebersax & Siddiq, 2020; Putri et al., 2015; Kuyu & Tola, 2018; Zhao et al., 2020; Pathare & Al-Dairi, 2022). This phenomenon can be studied in the Food Microbiology course, especially the positive and negative roles of microorganisms in food, particularly in processing, storage, and food safety. Therefore, food preservation material, especially about bananas, is an important topic in this course.

Problem-solving skills can be developed through critical thinking and students' cognitive understanding of the topics studied (Fatmawati et al., 2019; Tuaputty et al., 2021; Rosy & Pahlevi, 2015). This material can be studied using a handout, which functions as a teaching medium. A handout is an alternative resource that presents content concisely, clearly, and systematically, enriches the main teaching materials, and can direct students in the learning process (Kosasih, 2020). Based on a needs analysis conducted in the Food Microbiology course at the Biology Department of Malang State University using a Google Form, involving 36 students and one lecturer, it was found that teaching materials on banana preservation, specifically on “Banana Preservation through Drying”, have not yet been developed. The analysis revealed that 72% of students had never practiced this topic and the lecturer confirmed that it had not yet been included in the course content. All respondents (100%) agreed on the need for a handout equipped with illustrations to support better understanding. Additionally, students’ average critical thinking score related to the topic was low, at 65. These findings indicate a clear need for teaching materials focused on banana preservation to support learning in the Food Microbiology course. Therefore, it is necessary to develop a handout on banana preservation through drying to enhance students' critical thinking skills and cognitive understanding.

Previous studies have proved that handouts based on the teaching materials with the criteria of: validity, practicality, and effectiveness can improve student learning outcomes (Rahman et al. 2019; Riefani et al. 2020;

Khotimah et al. 2021). These improvements are often influenced by factors such as alignment with learning objectives, ease of use, student engagement, and the ability to support independent learning. Therefore, the developed handout needs to be evaluated to assess its feasibility for use in learning activities. Based on this background, this study aims to evaluate the Food Microbiology handout, especially its validity, practicality, and effectiveness by implementing it with Biology students enrolled in the Food Microbiology course.

2. RESEARCH METHODS

This study used a Research and Development (R&D) approach based on the ADDIE development model, which consists of five stages: Analyze, Design, Develop, Implement, and Evaluate (Branch, 2009). The subjects were 36 undergraduate students in the Biology Education program at Malang State University who had previously enrolled in the Food Microbiology course. They were selected using purposive sampling, as they had already completed relevant course content. The validators who validated the handout were a material expert, a learning practitioner, and a learning media expert.

The instruments used in this study included: (a) validation sheets completed by a Microbiology content expert and a learning practitioner to assess aspects such as relevance, conceptual clarity, presentation systematics, and alignment with learning objectives; (b) validation sheets completed by learning media experts to evaluate the design quality and visual aspects of the handout, including layout, the color choice, and illustrations; (c) practicality questionnaires to get student feedback on the developed handout, particularly regarding the material clarity, ease of use, and its impact on the learning process; and (d) pretest-posttest questions to measure the effectiveness of the handout based on the improvements in student learning outcomes. The test consisted of 15 multiple-choice questions that covered key concepts related to banana preservation through drying. The items were developed based on the learning objectives of the Food Microbiology course and reviewed by a subject matter expert in Food Microbiology, an educational media expert, and a Food Microbiology instructional practitioner to ensure content validity.

The purpose of this study is to evaluate the developed handout, with a particular focus on the Develop, Implement, and Evaluate stages of the ADDIE development model. The application of these stages is described as follows: (a) Develop, which involves developing the handout teaching material and conducting expert validation based on the validity criteria presented in Table 1;

Table 1. Handout Validity Criteria

Validity Test Score (%)	Information
>85	Highly valid
70.01-85.00	Moderately valid
50.01-70.00	Less valid
≤50.00	Invalid

Source: modified from Akbar (2022:41)

(b) Implement, which involves applying the handout in the learning process, and conducting practicality tests based on the criteria in Table 2.

Table 2. Handout Practicality Criteria

Practicality Test Score (%)	Information
>85	Highly practical
70.01-85.00	Moderately practical
50.01-70.00	Less practical
≤50.00	Not practical

Source: modified from Akbar (2022:41)

Student learning outcomes are also measured through pretest and posttest, which are then converted into N-Gain scores; and (c) Evaluate, which involves evaluating the feasibility of the handout based on the results of the validity, practicality, and effectiveness analysis according to the effectiveness criteria shown on Table 3.

Table 3. N-Gain Effectiveness Criteria

N-Gain Score (%)	Information
<30	Low
31-70	Moderate
>71	High

Source: modified from Hake (1999:1)

3. RESULTS AND DISCUSSION

At the Develop stage, the handout was validated by three validators: a Microbiology lecturer serving as a material expert, a Microbiology lecturer as a learning practitioner, and a learning media lecturer as a learning

media expert. The assessment conducted by the material expert and learning practitioner covered aspects of relevance, conceptual clarity, presentation systematics, and alignment with learning objectives. The relevance aspect refers to the alignment between the material descriptions and the assignments or questions in the handout with the learning outcomes of the Food Microbiology course. The conceptual clarity aspect assesses how clearly each subtopic is explained in the "Banana Preservation Through Drying" handout teaching material. The systematic presentation includes the logical sequencing of material from simple to complex. The alignment with learning objectives assesses the ability of the material presentation to improve students' critical thinking skills and cognitive knowledge. The assessment by a learning media expert focused on handout size, cover design, and content design, which includes: layout, color scheme, illustrations, and the use of font size and type. The results of the handout validation by the material expert, learning practitioners, and the learning media expert are presented in Table 4, all gave a score of 100%, indicating that the handout is highly valid. However, despite the perfect score, the validators also provided reinforcement notes and minor suggestions for improvement, such as refining the layout and enhancing the clarity of some illustrations, which were then incorporated into the final version of the handout.

Table 4. Results of Handout Validation by Material Experts, Learning Practitioners, and Learning Media Experts

Validation by	Validated Aspects	Average Score (%)	Category
1. Material expert	Relevance, conceptual clarity, presentation systematics, alignment with learning objectives	100	Highly valid
2. Learning practitioner	Relevance, conceptual clarity, presentation systematics, alignment with learning objectives	100	Highly valid
3. Learning media expert	Handout size, cover design, content design	100	Highly valid

The handout that has been validated then proceeded to the next stage: Implement, which involves testing its practicality with students who are currently enrolled in the Food Microbiology course. The practicality test is conducted in three phases: individual trials, small group trials, and field trials. The primary difference among these stages lies in the number of student respondents who carry out the assessment. The individual trial consisted of three respondents, the small group trial consisted of eight respondents, and the field trial consisted of 20 respondents. The evaluated aspects include clarity, impact, and feasibility. The clarity aspect assesses sentence length, language clarity, content clarity, and visual presentation. The impact aspect evaluates the handout's ability to support knowledge development and critical thinking skills. The feasibility aspect considers the overall visual design, clarity of the material, and ease of use.

The practicality test result, presented in Table 5, indicates that the handout was considered moderately practical in the individual trial, with a score of 75%. In both the small group and field trials, the handout received a score of 90%, demonstrating that it was consistently rated as highly practical. Based on the practicality results across all three stages, the overall practicality level of the handout ranges from good to very good, with an average score of 85%. This is reflected in the high ratings for the clarity, impact, and feasibility aspects at each testing stage. Therefore, it can be concluded that the handout is practical and suitable for use in the learning process.

Table 5. The Handout Practicality Test Result

Practicality Test	Average Score (%)	Category
1. Individual Trial	75	Moderately practical
2. Small Group Trial	90	Highly practical
3. Field Test	90	Highly practical
Overall average score	85	Moderately practical

After completing the Develop and Implement stages, the handout was evaluated during the Evaluate stage. The effectiveness of the handout was assessed by analyzing the N-Gain obtained through a comparison of students' pretest and posttest scores. The pretest was conducted before the learning activity to assess students' initial understanding of the "Banana Preservation Through Drying" material. The posttest was given after the learning process to measure the knowledge gained. The purpose of the N-Gain analysis was to determine whether there was an improvement in student learning outcomes based on the difference between pretest and posttest scores.

The results of the N-Gain analysis of pretest and posttest scores, presented in Table 6, indicate an increase in students' critical thinking skills with a moderate category score of 41%, and in their cognitive knowledge with a moderate category score of 38%. The average N-Gain score from both aspects of learning outcomes suggests a meaningful increase in students' critical thinking skills and cognitive knowledge related to

the "Banana Preservation Through Drying" material after using the handout. Based on these results, it can be concluded that the handout used improves student learning outcomes.

Table 6. Average N-Gain Score of Students on Learning Outcomes

Learning outcomes	Average N-Gain (%)	Criteria
Cognitive Knowledge	38	Moderate
Critical Thinking Skills	41	Moderate

4. CONCLUSION

Based on the results of the validity, practicality, and effectiveness analysis, it can be concluded that the Food Microbiology handout entitled *"Banana Preservation Through Drying"* is valid based on expert assessments, practical according to field test results, and effective because it improved students' cognitive knowledge and critical thinking skills, as shown by increased posttest scores. Therefore, the handout is suitable for further use in Food Microbiology learning activities.

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