Development of Laboratory Module of Isolation Trimyristin from Nutmeg (*Garcinia mangostana)* to Support Meaningful Learning in Natural Product Chemistry Course

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Aliefman Hakim[1*], Jamaluddin Jamaluddin[2], Abdul Wahab Jufri[2], I Nyoman Loka[1], Sukib Sukib[1], Saripatul Mahmudah[1]

[1]Chemistry Education Program, Faculty of Teacher Training and Education,
University of Mataram, Mataram, Indonesia
Corresponding Author: *aliefman@unram.ac.id

[2]Biology Education Program, Faculty of Teacher Training and Education,
University of Mataram, Mataram, Indonesia

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Abstract

This research aimed to develop laboratory module of isolation trimyristin from nutmeg (*Garcinia mangostana)* to support natural product chemistry course. The research design used 4D model (Define, Design, Develop, and Disseminate). The population in this study covers all students of Chemistry Education Program, University of Mataram who took natural product course. Meanwhile there were four students who became the sample in this study. The four students were taken randomly and became respondents for a limited trial. The results showed that the validity of three validators obtained by using Aiken index was V = 0.7 indicated that the natural chemistry laboratory module about trimyristin isolation from nutmeg was valid and feasible to use. Practicality can be seen from the responses of students and lecturers who showed a positive response with the average of all module component practicability of 83%. Based on the data, it can be concluded that the natural chemistry labortory module of isolation trimyristin from nutmeg was feasible and practical, so it can be used in the learning process.

Keywords: Laboratory Module, Natural Product Chemistry, Trimyristin

INTRODUCTION

Education is a process that every individual uses to gain knowledge, insight and develop attitudes and skills. In this case education can be gotten anywhere and anytime as well as in laboratory activity. Laboratory activity is one of the learning processes which is being implemented in the laboratory. Laboratory activity is usually done in order to prove the theory obtained (Fajriyani, 2017). Laboratory activity at college can be said as part of a course. Laboratory activity is a form of learning which is conducted at a certain place that students play an active role in solving problem given through the use of certain tools, materials, and methods. One of the practices that are carried out in college is a practicum in the subject of the natural product chemistry.

Natural product chemistry is a course that studies the understanding of natural product compounds, classification, structure, nature, biogenesis, biosynthesis, isolation, and identification of terpenoid, steroids, flavonoids, polyphenols, phenylpropanoids, and alkaloids (Hakim *et al.*, 2016; Hakim & Jufri, 2017; Hakim, et al., 2018; Hakim & Jufri, 2018). Natural product chemistry courses need laboratory activity (Griffin, 1976; Doyle *et al.*, 2004; Douglas, *et al.*, 2007; Halpin *et al.*, 2010; Walsh, *et al.*, 2011; Nazri *et al.*, 2012; Carroll *et al.*, 2012). Secondary metabolite compounds can be obtained from various plants in Indonesia. Data from the Indonesian Biodiversity Strategy and Action Plan (IBSAP), Indonesia is a country that has abundant biodiversity. Those diversity is in the form of animals and plants diversity. The diversity of plants is a source of secondary metabolite compounds that have been known to have many benefits, one of them are as drugs. Indonesian people also have known that some plants are can be processed into herbal medicine that is used as a traditional medicine from generation to generation as an inheritance (Raharjo, 2013). Students can obtain secondary metabolite compounds from some plants that have been known to be useful as a drug. This can be done in the natural product chemistry by isolation of secondary metabolite compounds comprising extraction, fractionation, purification, and identification.

Laboratory activity will be done well if it uses a laboratory module which serves as a guide in carrying out the practicum *(*Qodar, *et al.*, 2018; Yunita, 2017; Rakhmawan *et al.*, 2016; Aldilla *et al.*, 2016). Module, in general, can be interpreted as the unit of the smallest learning program, which can be studied by the students themselves individually

(self-instructional) after students complete one unit in the module, then students can step forward and learn the next module unit (Prastowo, 2012). Learning by using modules, is a specific strategy for organizing individual learning. The learning module, as developed in Indonesia, is a package of learning materials that contains descriptions of learning objectives, instruction manuals that explain how to teach efficiently, reading material for students, answer key sheets on student paper sheets, and evaluation tools of learning.

Based on the explanation, the laboratory module can also be said as almost similar as the learning module. The module contains the titles of laboratory work, the purpose, theoretical base, tools and materials, and procedures. Isolation of secondary metabolite that are often done in university's chemistry courses at the university level is isolation curcumin from turmeric. This causes the students to have lack knowledge about major compounds in other plants. Meanwhile, there are many plants with the content of major compounds that can be isolated as well as curcumin one of which is a trimyristin compound from nutmeg seed.

Trimyristin compounds contained in nutmeg seed is very important to be isolated because it has various benefits. Trimyristin, along with myristic acid, myristicin and elemicin have antioxidant, anticonvulsant, analgesic, anti-inflammatory, antidiabetic, antibacterial and anti-fungal activity. Trimyristin can also be processed into its derivatives, ie, myristic and myristyl alcohol. These materials are widely used in the manufacture of soaps, detergents, and other cosmetic ingredients, such as shampoos, lipsticks, and lotions (Asgarpanah and Kazemiyas, 2012). In addition, Ma'mun (2013) explains that trimyristin nutmeg is superior to trimyristin from coconut oil, palm kernel oil, and babassu oil. This is because at the nutmeg fat is not required fractionation process, which is a relatively expensive component separation process, and also yields a higher purity yield. Trimyristin in oil other than nutmeg is also mixed with other fatty acids, such as lauric acid and palmitic acid.

Isolation trimyristin requires a laboratory module containing theoretically and procedurally materials so the isolation process runs more efficiently and students isolate the trimyristin compound properly. However, the laboratory module on the isolation of trimyristin compounds is very difficult to be found, so it takes an innovation to create a practical module

that will be used as a reference in isolating the trimyristin compound.

METHOD

This research was conducted at FKIP University of Mataram. This research includes the type of research development (Research and Development). Sugiyono (2014) stated that the research development method is a research method used to produce a particular product, and test the effectiveness of the product. This research developed a module of the natural product chemistry of isolation trimyristin from nutmeg. The research design was 4D model which consists of four stages, namely define, design, development, and dissemination. However, this study is limited only to the development stage with a sample of 4 people (limited trial). Variables in this research were the feasibility and practicality of the practicum module. The population in this research was all students of the chemistry education program at the sixth semester who took Natural Product Chemistry class at FKIP Universitas of Mataram. The sample used was four 6^{th}-semester students of chemistry education program.

This research used validation sheet instrument of laboratory module and questionnaire of student and lecturer response. The validation sheet of the laboratory module was analyzed using Aiken's V statistic. The student's response questionnaire was analyzed using the practice index, while the lecturer's response questionnaire was analyzed descriptively. Procedural stages in this study are explained in the discussion.

RESULTS AND DISCUSSION

This research aimed to produce laboratory module that was valid and practical criteria through feasibility and practicality tests. Development process includes three stages that presented based on the development model used, namely (1) defining (define), (2) design, (3) development (development). Each of these development stages described as follows.

1. Definition Stage (Define)

At the define stage, the steps taken were to define and limit within the scope of the developed labortory module. This step is divided into two stages: (a) performing the final preliminary analysis and (b) performing the material analysis. In the final analysis, the researchers analyzed several journals on trimyristin isolation from nutmeg, the analysis of the RPS and RTM. Based on the analysis of those, the researcher made the trimyristin compound isolation work scheme consisting of main work scheme and modification work scheme. The modification work scheme that was

made by the researcher in conducting an experiment on the isolation of trimyristin from nutmeg carried out by using two extraction methods namely maceration and reflux. The purified was tested by TLC plate (Thin Layer Chromatography) and melting point. Identification of the trimyristin compound used IR and UV-Vis spectroscopy test to match the structure of the trimyristin compound obtained in the experiment with the structure present at literature. From the two methods used in the experimental isolation of trimyristin compounds, the researchers chose one method with the best isolation results to be used in the developed practicum module.

Based on the results of the laboratory activity, the researchers chose reflux method with n-hexane solvent to be applied to the developed laboratory module. This is because the result of trimyristin obtained in reflux method was 6,0904 gram with a yield 84,35%. While on the maceration method, trimyristin obtained 4.7224 g with a yield 80.69%. The most significant effect on the extraction using reflux was the addition of heating process and the solvent used will remain in a fresh state due to the re-vaporization of the solvent submerged in the material, so the solvent used is not much wasted and more efficient.

The result of trimyristin isolation obtained was better than Ma'mun (2013) with a yield 79,55%. While Pratiwi et al (2009) using the reflux method (ethanol) yielded trimyristin with a yield 59,17%. According to the Food and Agriculture Organization (FAO) nutmeg oil contains more than 84% trimyristin. The result of the IR and UV-Vis spectroscopy test showed that the trimyristin obtained by the researcher. Therefore, based on the results of the experiment, the researchers made a laboratory module by reflux extraction method followed recristalization.

The analysis of the material consisted of theoretical and procedural material that was adapted to the purpose of the laboratory in the module developed was to make the students understand of isolation trimyristin compound from nutmeg. The theoretical material consists of the purpose of isolation, equipment and insulating, extraction, solvent polarity, and solvent selection, the factors that influence the extraction and the determination of the structure of secondary metabolite compounds. In addition, it also gave the exposure to the characteristics of trimyristin to be isolated from the nutmeg. While the procedural material gave exposure of extraction process using reflux method and purify used recristalization. Identification of

trimyristin compound used Thin Layer Chromatography, melting point, IR and UV-Vis spectroscopy.

2. Design Stage (Design)

The design stage was done based on some findings or identification results in the definition or analysis phase. At this stage the preparation of the module begins with the design of the cover, the preparation of the module component (1) the introduction, the table of contents, the practice of laboratory, and the introduction of chemical laboratory, (2) the practicum process, contains the title laboratory, work procedures, observation results, data processing, question and discussion. After doing the design of the module, the results obtained from the design stage or design is in the form of prototype 1.

3. Development Stage (Development)

Developed learning devices can be said to be qualified if it meets several criteria, namely: 1) validity (validity) and 2) practicality. This study aims to produce products in the form of practical and feasible practical modules for use in the learning process. At this stage, the generated initial product (prototype 1) were then being then tested to test its validity in order to get inputs and suggestions, so the module is developed better and feasible to be used as a practicum media. The validity test used an expert validation sheet instrument that contains the components of the graphics, presentation components, content feasibility components, and language components. During the process of developing laboratory module some notes from the validator must be considered, such as the image on the module should be made more focused, the image on the header, the image resolution should be improved, the writing on the module, and instructions on the module.

The analysis for determining the level of validity was the Aiken index where the three validators provide valid judgments to the module and can be used after making a few revisions. After validating the module, the prototype 2 was obtained. The next prototype 2 was tested to the test subjects, i.e. students and lecturers of Chemistry Education program, Faculty of Teacher Training and Education, University of Mataram. The experiments conducted are a limited-scale trial that is on four students at the sixth semester of chemistry education program who took natural chemistry course and only one lecturer who teaches the class. At this stage, trials were conducted to obtain student and lecturer responses to the practicum modules that have been developed. Questionnaire responses of students and lecturers used consisted of 21 items

statement in which ten statements for the module attractiveness component, seven statements for the module ease component, two statements for the module time component, and two statements for the module benefit component. After analyzing the questionnaire from the students 'and lecturers' responses, it is obtained that the average of students and lecturers showed a good response to the module that has been developed.

The feasibility of natural product chemistry laboratory module about trimyristin isolation based on the aspect of graffiti which is analyzed with Aiken's V obtained the value which equals to 0,7 with the category of eligibility, at presentation aspect obtained equal to 0,7 with eligible category, at expediency contents aspect obtained equal to 0.7 and on the language aspect was obtained at 0.7 with the appropriate category. So that the result of a feasibility test of the experiment module which has been developed based on four aspects have been obtained average equal to 0,7 with category worth to test.

The natural product chemistry laboratory isolation trimyristin developed based on practical index obtained by 75% percentage for respondent 1 with practical category, 89% for respondent 2 with very practical category, 79% for respondent 3 with practical category and 89% for respondents 4 with very practical category. So that the average practicability of practical modules that have been developed for 83% with the category very practical for use in the learning process. This is supported also by the results of descriptive analysis of response questionnaires by lecturers who showed a positive response to the natural chemistry practicum module on trimyristin isolation developed. Where, of the 21 statements in the questionnaire, the lecturer assigns a score of 2 (less agree) to a statement, 3 (agree) to fourteen statements, and 4 (strongly agree) to six statements.

CONCLUSION

Based on the data of research and discussion, it can be concluded that the natural product chemistry laboratory module about trimyristin isolation from nutmeg which has been developed using 4D model (Define, design, development, and dissemination) was in the category of feasible and practical, so it can be used in the learning process of natural product chemistry course.

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