110

DEVELOPMENT OFBIOTECHNOLOGY TEACHING MATERIALS WITH ENVIRONMENTAL BIOTECHNOLOGY CONCEPT BASED ON BIOLOGICAL EDUCATION FKIP UR STUDENT RESEARCH

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Abstract

This research aims to determine the application of various bio-activator to the vegetable and leaf waste to produce compost anddeveloping the biotechnology teaching materials with environmental biotechnology concept based on biological education FKIP UR student research.The research was conducted from April to November 2014. This study consisted of two stages, namely composting stage of vegetable waste and leaves with a bio-activator EM-4, Orgadec and Acticomp and material development stage from the research results. Composting stage using the True-Experimental Research with the RAL that consisting of 4 treatments and 3 replications. Research procedure consisted of four stages, namely preparation of tools and materials, the implementation of composting stage, observation of the composting process and the completion stage. Parameters in this research is the texture, length of composting, C/N ratio of compost. Data were analyzed quantitatively and qualitatively. The second stage, development of teaching materials referring to the R & D research approaches by using model ADDIE. The instrument that used for data collection are sheets of validation. Data were analyzed descriptively. The results showed that Acticomp bio-activator is the best bio-activator to produce compost from vegetable waste and leaves. Results of the research can be developed as a teaching material on the concept of environmental biotechnology in Biotechnology subjects.

Keywords: teaching material, environmental biotechnology , based on research

INTRODUCTION

Biotechnology is one of the subjects that are presented to the students of Biology Education FKIP UR at six semester with total three SKS credits semester that consisting of 2 credits of theory and 1 credit practicum. This course examines the concept of biotechnology, genetic engineering, cloning, health biotechnology, agricultural biotechnology, bio fuels and chemicals, environmental biotechnology, industrial biotechnology and bioethics in food biotechnology. General competence that want to be achieved upon completion of this course is the student able to understand the processes of biotechnology and its application in life (Zulfarina et al., 2007). Especially for environmental biotechnology material which became one of the study subjects discussed biotechnology composting by utilizing waste that are easily foundin the neigh borhood.

Waste is the things that wasted or discarded material from human activity or natural process that does not have economic value, but it has negative impact on the environment.The negative impact is the process of disposal and cleanup need costs as well as its effect can pollute the environment. Waste can from human activity such as agriculture waste like rice straw, corn stover, garbage such as vegetable scraps and waste that does not originate from human activities like foliage.

Waste such as vegetable scraps and foliage are the example of Natural organic waste. Therefore, composting is the proper alternative to handle it. Composting is the process in which organic materials biological decomposition especially by microbes that utilize organic materials as an energy source. Composting can preserve the advantages of the elements contained in a waste such as Nitrogen (N), Phosporus (P) and Potassium (K) (Isroi, 2008).

Composting canoccur naturally or with the addition ofbio-activator. Composting naturally takes quite a long around 6 months but with the addition of bio-activator marketed, composting can happen for 2-3 weeks. In this research, bio-activatorused is EM4, Orgadec and Acticomp. The use of EM-4 bio-activat or because it containsap proximately 80 genera of micro organisms fermentati on while the use of Orgadec because it contains microbial Tricho dermap seudo koningii and Cythophagasp to accelerate the wea the ring (outlining the components become moresimple, soeasily absorbedby plants) andthe use ofbio-activator Acticomp because it contains microbial Tricho dermahar zianum (stimulating growth plant), Aspergillussp (solvent phosphorus) and PGR (plant Growth Promoting Rhizo bacteria). Micro besare able to accelerate the composting process to around 2-3 week sand it will remain alive and active in the compost. When the compost is given to the soil, the microbes will act to control plant disease-causing pathogenic organisms (Manurung, 2011).

Utilizati on of wasteinto compostis closely related to the concept of biotechnology that is one of the subjects presented in particular on material environmental biotechnology to learning objectives: "describing four stages of composting and practicehow to make compost".

Bio-activatoris one of the main compositions of compostingused by the student susually only usebio-activator EM-4 with foliage waste, but there are manyo the ravailablebio-activators and a variety of wastes that can be used with a variety of advantages, such as Acticompand Orgadec. One of the advantages Acticompand Orgadecbio-activator is more economical because it does not requireany other additional materialso that thecost required for composting isfewer(BPBPI, 2009). Therefore, researchers wanted to make the results of this research to develop a theory or practical in environmental biotechnology concept biotechnology subject in Biology Education Studies Program. This is in accordance with the Operational Guidelines Increase Credit Score Assessment of Functional Lecturer to Associate Professor and Professor of that faculty are required to develop teaching material which is one of the activities of implementing education and teaching as well as included in one of the main elements Tridharma. Instructional materials, among others in the form: diktat, modules, models, tools, audio-visual, text tutorials and includes teaching materials to be developed 1 piece / semester (Directorate Direktorat Jenderal Pendidikan Tinggi, 2009). Especially teaching materials that will be developed in this studyis the teaching

materials to the concept of environmental biotechnology. Based on the above, research is conducted with the title Biotechnology Course Teaching Material Development Concept Based on Environmental Biotechnology Researchin Biology Education Student FKIP UR. The purpose of this study was to determine the application of variousbio-activatorsto the vegetable and leaf was teto produce compost and develop instructional material ssubject-based environmental biotechnology concept biotechnology researchin biology education students FKIP UR.

RESEARCH METHODS

This research was conducted in Natural Laboratory Biology Program (implementation stage composting) and the Laboratory of Chemistry Program (implementation of the nutrient analysis of C and N) University of Riau, from April to November 2014. The tools that used in the implementation These studies including: a plastic basin with diameter of 16 cm by 12 pieces, hoes, scales, a machete, a stirrer, tarpaulins, raffia rope, rubber gloves, paper label, permanent marker and clear duct tape. Materials used are vegetable waste, leaves, Manure, Orgadec, EM-4, Acticomp, Brown sugar and water.

This study uses a completely randomized design (CRD), which consists of 4 treatments and 3 replications, namely:

B_0 = 1 kg of vegetable waste + 1kg of leaf + 1 kg of manure
B_1 = 15 g of EM-4 + 1 kg of vegetablewaste + 1 kg of leaf + 1 kg of manure
B_2 = 15 g of Orgadec + 1 kg of vegetable waste + 1 kg of leaf + 1 kg of manure
B_3 = 15 g of Acticomp + 1 kg of vegetablewaste + 1 kg of leaf + 1 kg of manure

There search procedure consisted of;

a. The Preparation tools and materials to be used
b. The implementation stage of composting
c. The Observations composting process
d. The Completion Stage

Parameterstudy:

1.Texture By organoleptic test using the sense of touch and vision in each treatmen tat the end of the observation, It will be rough compost texture if the compostis still asbasic materialsandstill has little degradation by micro organisms. Criteria were meant hereis the texture of compost between crude and refined criteria. To smooth criteria known if the was tehasdecomposedintogranules crumb, such as land, but has not decompose evenly, while the high lyrefined criteria can be said if the compost has the texture of the crumb like soil and decompose evenly over all (Endah Sulistyawati, et al,. 2008).
2.The length of time the composting The determination of the length of time the composting is assessed from the heavy depreciationof compost that has reached 60% (Nurul lita and Budiyono, 2012).

$$\text{The percentageshrinkage} = \frac{\text{initial weight} - \text{final weight}}{\text{initial weight}} \text{ x } 100\ \%$$

3. C / N ratio

C N data retrievalis done after the material has underg one fermentation and the results of the C/N is obtainedby analyzing thematerialsor samplesin the laboratory. (Soil Research Institute, 2005). The data is obtained and analyzed by quantitatively and qualitatively. Quantitative analysisis conducted on C / N ratioand the length of time the compos ting by usinganalysis of variance Anava and continued with a sign if icantly different when DMRT at α level of 5%, while the composttexture data, analyzed qualitatively. The result of researchis madefor teaching materialson Biotechnology subjects. The development follows the ADDIE model development by Dickand Carry (2006). ADDIE Model consists of 5 stages, namely Analysis, Design, Development, Implementation and Evaluation. Implementation and Evaluation for the stage has not been implemented in this study.

RESULTS AND DISCUSSION

The Texture of Compost

The mean of the textureof compost from vegetable wasteand leaves can be see nin Table1.

Table 1.The Results of The Mean Organo leptic Vegetable Wasteand leaves Compost Texture.

Treatment	The Mean of Compost Texture
Control	Medium
EM-4	Medium
Orgadec	Medium
Acticomp	Medium

Organoleptic results showed that of the four treatments does not affect the texture of the compost because of good compost or compost produced on the control resulting from treatment with the addition of three bio-activators does not show a different texture. Although the texture of the parameters did not show the effect of adding bio-activator, does not mean that the compost produced is not mature due to determine the maturity of the compost needs to pay attention to other characteristics, especially the C / N ratio of the compost. This is consistent with the statement Sudradjat in MarliaPangestuti (2008) which states that the characteristic visual of the compost has matured is odorless, black, easily destroyed when crushed hand, does not mix with insects, worms, caterpillars or fungi in the compost, but in laboratories C / N ratio below 20 is an indication that the composting process has ended. Compost texture can be seen in Picture 1.

a. b.

c. d.

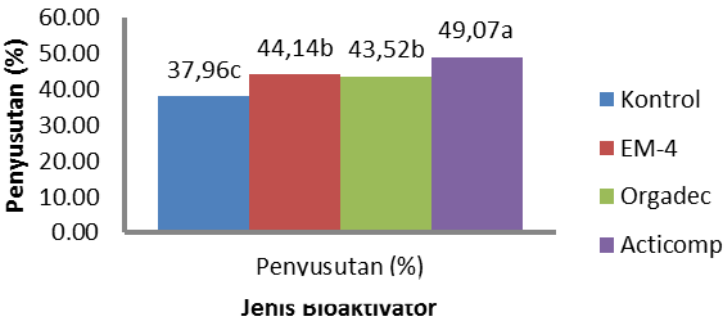
Picture 1. CompostTexture that Produced for 8 weeks a. control. b. EM4 treatment. c. Orgadec treatment d. Acticomptreatment

The Results of composition showed characteristic yet mature compost. By compost produced showed moderate criteria, which still contained the majority of waste that still resembles its original form or not decompose evenly as soil. This is due to the high percentage of lignin content owned by waste in the form of leaf litter leaf that has been dried, mainly from the type Accasia sp. This condition is consistent with the statement YeniAprianis, et al., 2010, which states that the lignin content A. crassicarpa age of 3 years at 27.22% while the lignin A. crassicarpa age of 4 years at 28.48%. The amount of lignin content will inhibit the decomposition process because lignin is a complex compound so difficult decomposed by microorganisms. When compared with the lignin content of one of the waste rice straw by 4-10%, of course, the lignin content in the leaf litter of the garden waste can be quite high. By contrast, if the organic matter content is high is dominated by carbohydrates or cellulose. Cellulose is normally easily digested by bacteria, but the cellulose of some crops will be more difficult to degrade when combined with lignin. Lignin is a complex molecule that has a shape rigid and woody structure of plants and bacteria can hardly digest (Meynel in Syahputra Ari, 2009).

Duration of Composting.

The mean value of the heavy depreciation of compost can be seen in Picture 2 below.

Picture2.



Depreciation percentage the weight of compost from vegetable waste and leaves.

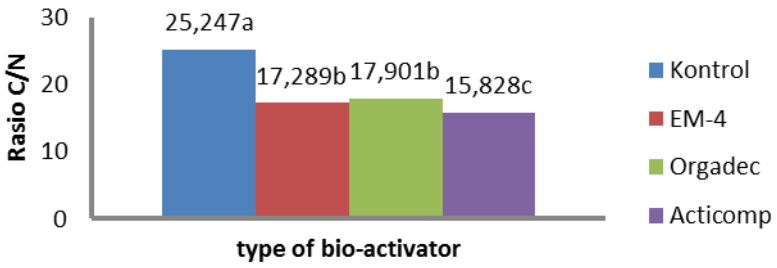
The compost weight shrinkage value in treatment using a bio-activator Acticomp (49.07%) and lowest in controls (37.96%). Depreciation compost weight was higher in the three treatments using bio-activator compared to control treatment. This is because no additional bio-activator in the control treatment, the waste materials are shrinking

weight very slowly, while the treatment using bio-activator, microbes such as methanogenic bacteria actively decompose organic matter into CO2, H2O, humus, nutrient and energy causing loss of CO2 and H2O are quite a lot during the composting process so that the shrinkage of compost (Soepardi in LarasatiPrawitaLauria, 2011).

If the comparison between the three treatments using bio-activator can be seen that treatment with the use of bio-activator Acticomp show shrinkage weight compost higher than the bio-activator others This is because bio-activator Acticomp is designed specifically as degrading lignin and cellulose that high and can lower the C / N ratio of waste high organic microbial which is enriched with Trichodermaharzianum (plant growth stimulants), Aspergillussp (solvent phosphorus) and PGR (plant growth Promoting Rhizobacteria) (IBRIEC, 2009). Trichoderma has the highest potential in the reform of lignocellulosic compared with other decomposer fungi. This is because Tricoderma able to produce cellulase enzyme capable of hydrolyzing materials containing high levels of lignoselulase (Makarim, et al., 2007).

C / N ratio Compost

The mean C / N ratio of compost can be seen in Picture 3.



Picture 3. The ratio of C / N compost from vegetable waste and leaves

Treatment with the use of bio-activator Acticomp shows the C / N ratio of compost that the lowest compared to other bio-activator. This is because bio-activator Acticomp is designed specifically as degrading lignin and cellulose that high and can lower the C / N ratio of organic waste that high which is enriched with microbe Trichodermaharzianum (stimulating the growth of plants), Aspergillussp (solvent phosphorus) and PGR (Plant Growth Promoting Rhizobacteria) (IBRIEC, 2009). Trichoderma has the highest potential in the reform of lignocellulosic compared with other decomposer fungi. This is because Tricoderma able to produce cellulase enzyme capable of hydrolyzing materials containing high levels of lignoselulase (Makarim, et al., 2007). As for the treatment of EM-4 and Orgadec

According to Susanto (2002), C / N ratio with respect to the indication of the intensity of the process of decomposition of organic matter. C / N ratio shows a fairly large hard material decomposes, while the C / N ratio is too low indicates easily decomposed material. In the composting if the C / N ratio is high then less good compost is used as fertilizer plants, otherwise if the C / N ratio is low, the absorption of nutrients can be used by plants for organic matter has been decomposed by microbes into elements that can be absorbed by plants. This is in accordance with the opinion of

Hanafi (2005), stating that compost with C / N ratio is not good for the plant high and when the application directly to the plant will be competition between the plants with microbes in the absorption of nutrients available in the soil. Conversely, if the C / N ratio of compost low means nutrients that are bound to the compost has been released through the mineralization process that can be used by plants. Then treated EM-4 provides C / N ratio of the lowest, so the most excellent as compost for plants compared with other treatments.

Development of Teaching Material of Research Results

Research results obtained teaching materials developed into the concept of environmental biotechnology. Development of teaching materials from the research refers to the stage of development of a simplified model of ADDIE into 3 stages: analysis, development and design. The stages are used as a basis in designing and developing modules.

Phase analysis is done by analyzing instructional Competency Standards (SK) and the Basic Competency (KD) that are listed in the Action Plan Learning Program (RKPP) and Lesson Plan (RP) in the course of Biotechnology. Based on the analysis instructional course on Biotechnology, the research bio-activator application of EM-4, Acticomp and Orgadec in residual waste composting vegetable and leaf litter can be used as teaching material Biotechnology course on the concept of composting. Instructional that can be integrated include: (a) the standard of competence that students are able to understand the processes in biotechnology and its application in life, and (b) the basic competencies that describe the process and the results of the branch Biotechnology Environmental Biotechnology.

The design phase is to design the concept of materials related to the data and facts found during the study, designing indicators and learning objectives to be achieved and designing items both objective and essay as an instrument of evaluation of students referring to the learning objectives in the design of teaching materials. Teaching materials compiled equipped with materials, exercises, summaries, formative test, answer key formative tests, feedback and follow-up are attributed based on research results.

After the design of teaching materials, the next step is the development the instructional materials based on a design that has been created. Stage of development of teaching materials in the form of realization of the design of the product.

To assess the validity of the teaching materials have been developed, conducted by a validator validity matter experts and educational specialists. Validator educational experts assessing the structure of materials, distribution of cognitive levels in the formative tests, and issues related to other teaching materials. While validator material experts assess the compatibility between the results of the research with general competencies, special competencies, learning objectives, and the material presented in teaching materials. Validation of teaching materials was carried out by three lecturers consisting of one educational expert lecturers and 2 lecturers Biotechnology matter experts. Assessment validation results are presented in Table 2.

Table 2. Average validity of teaching material that has been developed.

Observed Components	Mean Ratings			Average of Three Validator
	V1	V2	V3	
Views	4,25	3,33	3,00	3,53
Content	4,50	4,00	3,43	3,98
Practicality	4,50	4,00	4,00	4,17
Language	4,00	3,67	3,33	3,67
Suitability	4,00	4,00	3,50	3,83
Mean Each Validator	4,25	3,80	3,45	3,8
Category validity				valid

Description: V: Validator

Table 2 based on the average of the results of the third rating validator of the five components were observed ranged from 3.45 to 4.17 in the range 1-5. This shows that the results of the rating of teaching materials that have been developed are in the 3.8 category valid. The highest rating is the aspect of practicality is 4.17 which is the category of very valid and the lowest score is the aspect of the display that is 3.53 which is the valid category. High on the aspects of practicality shows that the material is a result of the development of the research contained in teaching materials is considered to greatly help students learn independently and allows students to be actively involved in finding a concept. However, the low on the aspects of the display by the validator, although still in a valid category because of the layout of images, graphs and tables that need to be fixed on the advice of the validator so that the view of teaching materials can be even more interesting.

The other aspect is the aspect of content, language and suitability is considered good enough by the validator where all three are at a valid category. In the aspect of contents, the validator judging that the contents of teaching materials in accordance with the Standards of Competence, Competency Basic, indicator and learning objectives as well as having linkage between matter and environmental conditions. In the aspect of language, teaching materials have been assessed using the sentence in accordance with the rules of Indonesian and easily understood by the cognitive level of the student. The latter aspect, the aspect of suitability rated superbly in accordance with the purpose of learning. In addition, the use of images in the module rated in accordance with the material presented.

Results of the assessment of teaching materials in general by the three validators is valid with a mean of 3.8 (> 3.4 to 4.2). Based on an assessment validator, both material and educational experts stated that the teaching materials developed can be used with little revision as in terms of appearance, the title of the picture (photograph) should be made more proportionate, added flow charts and in terms of its contentsmore focus to the manufacture of compost.

Based on the suggestions that have been given validator, the researcher's revision of teaching materials for improving teaching materials that have been designed. Thus, teaching materials that have been developed can be used and implemented in the learning process of courses in Biotechnology.

Conclusion

1. Applications Acticomp bio-activator is the best bio-activator to produce compost from vegetable waste and leaves.

2. The results can be developed as a teaching material on the concept of environmental biotechnology in Biotechnology courses.

Recommendation

1. Note the elements potassium and phosphorus in compost and planting test to see growth and development of plants after composting.

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