

IMPLEMENTATION OF BIOTECHNOLOGY IN INCREASING THE ENVIRONMENTAL SUPPORTING CAPACITY OF EX-COAL MINING SOIL

Admizal Nazki*, Nasfryzal Carlo, Abdul Razak

Doctoral Program of Environmental Sciences, Universitas Negeri Padang – Indonesia

*admizalnazki04@gmail.com

ABSTRACT

Indonesia is a country that is rich in minerals and coal. Its management must provide real added value to the national economy to achieve prosperity and welfare of the people in a just manner. In this mineral and coal management, it is necessary to have supervisory authority to achieve the management objectives. Supervision of environmental management, reclamation, and post-mining must be carried out with the principles of good mining techniques to create a sustainable life for the environment. The purpose of this research is to apply appropriate and effective biotechnology methods in increasing the carrying capacity of the environment based on parameters of soil fertility, green plant growth, review of biotic and abiotic environmental influences and their effects on the social environment, cultural life of the community which in this case refers to economic factors. Based on the results of the research, it can be concluded that Cattle Rumen Microorganisms increase the carrying capacity of the soil of ex-coal mining land by improving soil nutrients with evidence from the research results, namely: increased plant height, increased number of plant leaves, and development of root nodules *Tarum* Nuts (*Indigofera sp.*)

Keywords: Application of Biotechnology, Ex-Coal Mining Land, Capacity, Ex-Coal Mining Soil.

INTRODUCTION

Indonesia is a country that is rich in minerals and coal. Minerals and coal play an important role in meeting the various needs of the people, therefore their management must be controlled by the State, and their management must provide real added value to the national economy to achieve prosperity and welfare of the people in a just manner.

¹explains the supervisory authority needs to be regulated as outlined in Government Regulation of the Republic of Indonesia No 55/2010 concerning "Guidance and Supervision of the Management of Mineral and Coal Mining Business" which in Article 28 paragraphs 1 and 2 reads "Supervision of environmental management, reclamation, and post-mining" as referred to in Article 16 and the Principles of Reclamation and Post-mining follow the Decree of the Minister of Energy and Mineral Resources of the Republic of Indonesia No. 1827 K/30/MEM/2018 concerning guidelines for implementing good mining engineering principles.

Environmentally sustainable mining companies are required to carry out reclamation and post-mining repairs. The selection of methods for implementing ex-mining land restoration which refers to ecological aspects and the application of biotechnology is indeed very minimal in Indonesia, so there are many mistakes in rehabilitating ex-mining land, especially the wrong

choice of plants. The plants that will be planted for reforestation do not think about the ecological aspects of the environment^{2 3}.

The problem that often arises in the management of coal mines is the reclamation of coal mines⁴. Where^{5 6} describe mining activities are temporary land use activities and will end when mining is no longer economical or after mining materials are no longer available at the local location. After mining activities are completed, the land becomes very infertile from the chemical, physical and biological aspects of the soil, so its use for various agricultural activities requires a rehabilitation process. It is important to understand the conditions before and after the mine (reclamation) later it is highly recommended to research it first with an ecological perspective based on biotechnology and the environment so that the results of reforestation, economy, humans, and the environment can be created. The purpose of this research was to reveal the effect of microorganism application on nutrient improvement in soil by looking at growth indicators of *Tarum* bean (*Indigofera sp.*) planted on ex-mining land and revealing the results of the soil test of ex-coal land.

METHODS

This type of research is experimental research. Samples from the research were 30 stems of the *Tarum* Nut Plant (*Indigofera sp.*) which were planted in the Wire House area of the Biology Department, Universitas Negeri Padang (UNP), and were given several treatments. The location where the research sample is located in West Sumatra Province is PT. Sinamarinda Lintas Nusantara (PT. SLN) coal production operations with a working area of 481.22 Ha. Administratively, the location of the activity is in the Nagari Sinamar area, Asam Jujuhan sub-district, Dharmasraya Regency. The independent variable in this research was the concentration of liquid cow rumen solution, and the dependent variable in this research was the growth of the *Tarum* Bean plant (*Indigofera sp.*) with the plant growth indicators being root length, number of root nodules, stem length, number of leave and plant biomass.

Observations made in this research aim to get an overview of reclamation activities, general conditions of the location, and current conditions. Interviews to explore information related to the potential problems of the research area are very necessary. Interviews were aimed at mining workers, entrepreneurs, government agencies, and local governments (districts) preparing land for reclamation, types of soil treatment, mechanisms for handling reclaimed land, and places where Microbes (Bacteria) will be spread in handling reclaimed land.

The implementation of this research is a series of laboratory-scale test activities by applying the stages of implementing microbial biotechnology methods and seeing their effects on environmental objects. After the implementation activities, it is continued with monitoring and evaluation of the work results of the implementation of microbial biotechnology methods on soil quality and plant growth. If an error occurs or the results are not optimal, it will be re-implemented following the implementation stage.

RESULTS

The plant used for this research is *Indigofera sp.* The *Indigofera* genus has a stature of trees, shrubs, or herbs. Some species have root nodules⁷. These nodules on the roots cause the soil around the roots of *Indigofera* plants to become rich in nitrogen and contribute to sufficient soil nutrients⁸. Soil productivity can be increased by adding various natural amendments such as

sawdust, wood residue, sewage sludge, and animal manure because these amendments stimulate microbial activity that provides nutrients (N, P) and organic carbon to the soil⁹. ¹⁰ explains the characteristic of leguminous plants is the presence of nodules in their roots. Inside the root, nodules live *Rhizobium* bacteria in symbiosis with the host plant. These bacteria function to bind nitrogen (N) from the air, so it is very beneficial, both in the accumulation of nitrogen in the soil and in increasing the nitrogen content for plant growth.

The effect obtained from the research is the addition of plant height, the addition of the number of plant leaves, and plant-soil nutrient levels. It is influenced by microorganisms from the rumen of cattle. The largest biomass in the rumen is bacteria, where about 50% of the total rumen bacteria live in the fluid and 30-40% adhere to food particles¹¹. Cow rumen is known as the best compost for the community. Compost is useful for soil bioremediation. The compost used is made of cow dung, water hyacinth, and sawdust for twelve weeks¹². In this research, researchers used cow Rumen as a bioindicator of soil fertility in the former coal mining area. The rumen is an ecosystem in which there are biotic and abiotic components. The abiotic components of the rumen consist of gas, CO², and water. While the biotic components consist of bacteria, protozoa, yeasts, and molds.

A. The increase in plant height of *Indigofera sp.*

Based on the data analysis that has been carried out, it was found that treatment 5 (P5), or administration of 40 ml of Rumen fluid, was the best result obtained to give a real effect on the increase in plant height of *Indigofera sp.* ¹³ in his research stated that the administration of various doses of rumen fluid on green bean plants affected plant height. The addition of plant height can be seen in Table 1 below.

Table 1. Results of indigofera plant height increase

Test (r)	Treatment (P)/t				
	P1(Control)	P2	P3	P4	P5
r1	20	18,5	14	27,5	28
r2	13,5	26	17,5	20,5	27,5
r3	8	20	21	24	29,5
r4	16,5	20	19	33	24,5
r5	11,5	21	27	16	23,5
r6	14	25	21,5	24	19,5
Total	83,5	130,5	120	145	152,5
Average	13,91667	21,75	20,00	24,17	25,42

B. Increase in the number of leaves of *Indigofera sp.*

Based on the data analysis that has been done, it was found that treatment 5 (P5) or administration of 40 ml of Rumin fluid was the best result obtained to give a real effect on the addition of *Indigofera sp.* Cow rumen has the potential as a biomineral supplement and has a lot of content, and is very potential as an activator for making organic fertilizers¹⁴. The dosage of cow's rumen affects the number of leaves¹⁵. Not only the number of leaves is affected by the dose of cow's rumen, but the leaf area is also affected¹⁶. The following Table 2 shows the addition of the number of leaves of *Indigofera sp.*

Table 2. Addition of number of leaves of indofera plants per treatment

Test (r)	Treatment (P)/t				
	P1(Control)	P2	P3	P4	P5
r1	4	7	5	8	7
r2	6	6	5	6	6
r3	2	6	6	6	6
r4	5	6	6	10	8
r5	5	6	7	6	7
r6	5	7	7	5	7
Total	27	38	36	41	41
Average	4,5	6,33	6,00	6,83	6,83

C. Soil nutrient content and number of root nodules

Soil Nutrient Level

Based on the results of soil tests that have been carried out, it was found that the nutrient levels contained in Treatment 5 (40 ml) which were the results of the best research ranged in values: Carbon content (C) (%) 7.4234 %, Nitrogen content (N) (%) 0.2914%, and phosphorus content (P) (%) 6.317 %. Nutrient levels in treatment 5 (40 ml) were inversely proportional to control (Treatment 1). Control (Treatment 1) had an average nutrient content higher than Treatment 5 but had the lowest plant growth yield. The following is Table 3 soil nutrient levels.

Table 3. Soil test results (1 March 2022)

No	Parameter	Sample Code					Method
		P1	P2	P3	P4	P5	
1	Carbon content (C) (%)	7,0535	11,7975	8,5604	10,6587	7,4234	Spektrofotometer UV-Vis
2	Nitrogen content (N) (%)	1,6857	0,1291	0,1761	0,4817	0,2914	Kjehdahl
3	Posfor content (P) (%)	6,3170	8,0900	5,3040	5,7230	6,3170	XRF

Table 4. Soil test results (6 April 2021)

No	Parameter	Sample Code			Method
		Mining Land	Mining Land (+Chalk)	Mining Land (+Chalk + Rumen)	
1	Nitrogen content (N) (%)	0,081	0,088	0,094	Trimetri
2	Nitrogen content (K) (%)	0,038	0,070	0,083	AAS
3	Posfor content (P) (%)	2,838	1,388	1,800	XRF

Number of Nodules per Treatment

Table 5. Comparison of the number of root nodules in each treatment and the diameter of the root nodules in each treatment

Treatment (P)	P1	P2	P3	P4	P5
Number of Nodules	269	1456	1527	1739	2016
Average Diameter	3.162	3.068	3.153	3.174	3.211

Note: Treatment Five (P5) had the highest average addition of the number of root nodules, P5 was the best treatment and control had the least average addition of the number of nodules.

D. Biotechnology *Indigofera sp.* with Beef Rumen

Biotechnology in the mining world is known as bioremediation. This bioremediation is known as the process of reducing levels of toxins in the soil with the help of microbes. Based on data analysis, the results of the research showed that the combination of microbes in Rumin Cattle and *Indigofera sp.* produce: 1) *Tarum* plant height increased compared to the control without the addition of cow rumen in the growth medium; 2) The number of leaves of *Tarum* plants increased compared to the control; and 3) Root nodules (nodules) are more developed and more numerous than the control without the addition of rumen.

From the results of the data analysis, it can be revealed that the combination of microbes in Rumin Cattle and *Indigofera sp.* This can improve the Nutrients in the soil. Research results from¹⁷ revealed that the combination of bioremediation with phytoremediation has been proven to be able to grow plants on ex-mining land. ¹⁸in his research revealed that Cattle Rumen Microorganisms can reduce Pollutants in the soil. As a leguminous plant that will be developed as a source of forage, *Indigofera sp.* also contributes positively to the stability of soil fertility.

CONCLUSIONS

Based on the research that has been done, the implementation of Biotechnology of Cattle Rumen Microorganisms provides support for the growth of *Tarum* Plants (*Indigofera sp.*) and improves soil nutrients with evidence that there is an increase in plant height, an increase in the number of plant leaves, and the development of plant nodules (root nodules). The development of *Indigofera sp.* starting from the addition of height, increasing the number of leaves, and the development of the best root nodules was found in the treatment given cow rumen fluid with the appropriate amount.

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