

**EFFICIENCY OF EFFECTIVE MICROORGANISMS (EM) IN MUDBALLS AS  
BIOREMEDIATOR OF WASTEWATER**

**BY**

**NORIELLE C. DE OLON**

An undergraduate thesis presented to the faculty of the College of Fisheries in partial  
fulfilment of the requirements for the degree of

**BACHELOR OF SCIENCE IN FISHERIES**

**Department of Aquatic Resources, Ecology and Management  
COLLEGE OF FISHERIES  
CENTRAL LUZON STATE UNIVERSITY  
Science City of Muñoz, Nueva Ecija  
Philippines**

**2018**



**COLLEGE OF FISHERIES**  
**CENTRAL LUZON STATE UNIVERSITY**  
Science City of Muñoz, Nueva Ecija

**EFFICIENCY OF EFFECTIVE MICROORGANISMS (EM) IN MUDBALLS AS  
BIOREMEDIATOR OF WASTEWATER**

by

**NORIELLE C. DE OLON**

is an Undergraduate Thesis presented to the Faculty of the  
College of Fisheries in partial fulfilment of the  
requirements for the degree of

**BACHELOR OF SCIENCE IN FISHERIES**

**APPROVED:**

  
**JOSE S. ABUCAY**

Adviser

07-09-18

Date


  
**KARL MARX A. QUIAZON**

Critic

07-09-18

Date

**NOTED:**

  
**REMEDIOS B. BOLIVAR**

Department Chair

07-09-18

Date

**RECORDED:**

  
**REMEDIOS B. BOLIVAR**

College Research Coordinator

07-09-18

Date

**ACCEPTED:**

  
**RAVELINA R. VELASCO**

Dean

07-09-18

Date

## BIOGRAPHICAL DATA



### Personal Data

Name	Norielle C. De Olon
Birthday	November 15, 1994
Birth Place	Banengbeng, Sablan, Benguet
Address	Banengbeng, Sablan, Benguet
Parents	Leonila C. De Olon and Bernardo C. De Olon

### Educational Attainment

Elementary	Ebbes Elementary School Banengbeng, Sablan, Benguet
Secondary	Benguet National High School Bineng-annex Bineng, La Trinidad, Benguet
Tertiary	Central Luzon State University Science City of Muñoz, Nueva Ecija

## ACKNOWLEDGEMENTS

First of all the author would like to thank God who provided strength, protection and guidance all throughout the conduct of the thesis, for the knowledge, wisdom and blessing to complete this paper. He would like also to extend her deepest gratitude and express her sincerest thanks to everyone with grateful heart that made this thesis possible.

The author is sincerely grateful to the following people who have contributed the completion of this paper

To his family for the un-ending support, love and care to the author especially to his brother Leonard for providing all of his financial needs until the completion of his study.

To his adviser, Dr. Jose S. Abucay and his critic, Dr. Karl Marx A. Quiazon for their time, patience, encouragement, knowledge and ideas provided, and the priceless help in making the best outcome of his paper. I thank them for all the ideas and assistance given to the author as well as for giving motivation in finishing this paper. Their assistance and dedicated involvement was the author's guide to accomplish his paper.

To the College Research Coordinator, Dr. Remedios B. Bolivar for the time and patience in checking, editing, giving comments and suggestions and the words of wisdom for the author to improve this paper.

To Sir Alvin T. Reyes for the knowledge he shared, the suggestions and help to improve the paper and making the statistical analysis to be better.

To all of his mentors during his studies: Dr. Emmanuel M. Vera Cruz, Dr. Ravelina R. Velasco, Dr. Karl Marx A. Quiazon, Dr. Jose S. Abucay, Dr. Apolinario V.

Yambot, Prof. Janet O. Saturno, Prof. Rodora M. Bartolome, Dr. Alvin T. Reyes, Ms. Claire Samantha T. Juanico, and Ms. Rea Mae C. Templonuevo for imparting him knowledge and assisting the author while studying at the College of Fisheries.

To his classmates for the unforgettable experiences, encouragement, support, and ideas that they had shared.

To Sarah Joyce Simbulan who always support him on his decision and the love she showed to the author. For always giving/lending him money in times the author is in short. For the encouragement, support and the help she provided to the author during his study.

The author would like to thank his friends: Mark Anthony Ped, Marvin Ronquillo, Carlo Doctolero and especially to John Paulo Juliano and Alexis Duque for their help during the completion of this study, for always being there in times the author needs assistance in his conduct.

To his dorm roommates who always cheering him up and waking him at 12:00 am for the author to continue his writing and also the support and help of his roommates during his study.

With deep respect, he extends his sincere gratitude and humblest apology to all whom he failed to mention. You will always remain on his heart and always be remembered.

All of you will stay in the authors' heart and will not be forgotten. It will remain as a legacy. Your great contribution on the accomplishment of this study are very much appreciated.

**NORIELLE C. DE OLON**

## TABLE OF CONTENTS

	<u>Page</u>
<b>LIST OF TABLES</b>	ix
<b>LIST OF FIGURES</b>	x
<b>LIST OF APPENDIX TABLES</b>	xi
<b>LIST OF APPENDIX FIGURES</b>	xii
<b>ABSTRACT</b>	xiii
<b>INTRODUCTION</b>	
Background of the Study	1
Statement of the Problem	2
Objectives of the Study	3
Significance of the Study	4
Scope and Limitations of the Study	4
Time and Place of the Study	4
<b>REVIEW OF RELATED LITERATURE</b>	
Description of Effective Microorganisms	5
Effective Microorganisms (EM)	5
Effective Microorganism (EM) Concept	7
Principal Microorganisms in Effective Microorganism and their Function (EM)	7
<b>MATERIALS AND METHODS</b>	
Experimental Design	10
Experimental Setup	10
Experimental Lay-out	11
Preparation of EM Liquid Activated Solution	12
Preparation of Mud balls with EM	12
Preparation of Mud balls with no EM	13
Preparation of Experimental Water	13
Data Gathered	13
Statistical Analysis	13

## **RESULTS AND DISCUSSION**

Dissolved Oxygen	14
pH	17
TAN	20
Un-ionized	23
Ionized Ammonia	26
Temperature	29

<b>SUMMARY, CONCLUSION AND RECOMMENDATION</b>	32
---	----

<b>LITERATURE CITED</b>	34
-------------------------	----

<b>APPENDICES</b>	36
-------------------	----

## LIST OF TABLES

<b>Table No.</b>	<b>Title</b>	<b>Page</b>
1	Experimental treatments to be used in the experiment	10
2	Mean ( $\pm$ SD) of Weekly DO readings of surface and bottom	15
3	Mean ( $\pm$ SD) of weekly pH readings of surface and bottom	18
4	Mean ( $\pm$ SD) of weekly TAN readings of surface and bottom	21
5	Mean ( $\pm$ SD) of weekly computed un-ionized ammonia of surface and bottom	24
6	Mean ( $\pm$ SD) of weekly computed ionized ammonia of surface and bottom	27
7	Mean ( $\pm$ SD) of weekly temperature readings of surface and bottom	30

## LIST OF FIGURES

<b>Figure No.</b>	<b>Title</b>	<b>Page</b>
1	Experimental plastic bucket	11
2	Experimental lay-out	11
3	Trend of surface DO readings during the conduct of the study	16
4	Trend of bottom DO readings during the conduct of the study	16
5	Trend of surface pH readings during the conduct of the study	19
6	Trend of bottom pH readings during the conduct of the study	19
7	Trend of TAN in surface area during the conduct of study	22
8	Trend of TAN in bottom area during the conduct of study	22
9	Trend of un-ionized ammonia in surface area	25
10	Trend of un-ionized ammonia in bottom area	25
11	Trend of ionized ammonia on the surface area	28
12	Trend of ionized ammonia on the bottom area	28
13	Trend of Temperature readings in surface area	31
14	Trend of temperature readings in bottom area	31

## LIST OF APPENDIX TABLES

<b>Appendix Table No.</b>	<b>Title</b>	<b>Page</b>
1	Analysis of Variance of surface Dissolved oxygen	37
2	Analysis of Variance of bottom Dissolved oxygen	38
3	Analysis of Variance of surface pH	39
4	Analysis of Variance of bottom pH	40
5	Analysis of Variance of surface TAN	41
6	Analysis of variance of bottom TAN	42
7	Analysis of Variance of surface Un-ionized ammonia	43
8	Analysis of Variance of bottom Un-ionized ammonia	44
9	Analysis of variance of surface Ionized ammonia	45
10	Analysis of variance of bottom Ionized ammonia	46
11	Analysis of variance of surface Temperature	47
12	Analysis of variance of bottom Temperature	48
13	Correlation of water quality parameters in surface water	49
14	Correlation of water quality parameters in bottom water	50

## LIST OF APPENDIX FIGURES

<b>Appendix Figure No.</b>	<b>Title</b>	<b>Page</b>
1	Bacteria and soil use for culturing	51
2	Equipment used for recording data	52

# **EFFICIENCY OF EFFECTIVE MICROORGANISMS (EM) IN MUDBALLS AS BIOREMEDIATOR OF WASTEWATER<sup>1/</sup>**

## **ABSTRACT**

The study focused on the effect of EM mud balls and liquid EM in water quality parameters such as dissolved oxygen, pH and level of ammonia. The study had 4 treatments, each replicated three times. The treatments were: Treatment 1 (control), Treatment 2 (mud ball with no EM), Treatment 3 (mud ball with EM) and treatment 4 (Liquid EM mixture). The experiment has been done in plastic buckets with the area of 0.12 square meter and the volume of 60 liters (Fig. 1). Three inches of the bucket height is filled with pond bottom soil. The plastic buckets is filled with 50 liters of water to artificially create a pond condition and then applied 5 kilograms of chicken manure. The treatments and their replicates will be arranged randomly following a completely randomized design. The experiment lasted for 30 days.

On the mean of the result in all parameters, most of the water parameters have improve in quality however, only pH and Un-ionized ammonia showed a significant difference after the conduct of the experiment.

From this study it can be concluded that EM mud ball and EM in liquid both can enhance some of the water parameters in such exact concentration prior to the toxicity/level of pollutant of the water.

---

<sup>1/</sup>Undergraduate Thesis presented to the faculty of College of Fisheries, Central Luzon State University in partial fulfilment of the requirements for the degree of Bachelor of Science in Fisheries. Prepared at Department of Aquatic Resources, Ecology and Management under the supervision of Dr. Jose S. Abucay

## LITERATURE CITED

- Canadian Council of Ministers of the Environment. 2010. Canadian water quality guidelines for the protection of aquatic life. Retrieved from file:///C:/Users/User/Downloads/Canadian%20Ammonia%20(en).pdf on June 05, 2018.
- Diver, S. 2001. Nature farming and effective microorganisms. Retrieved from <http://ncatark.uark.edu/~steved/Nature-Farm-EM.html> on November 20, 2016.
- Dubon, M. 2014. Promoting Canadian agrifood exports, effective microorganisms (EM) for accelerating composting. Retrieved from file:///E:/thesis%20mudball/newpdfthesis/Dubon-Madeline-.pdf on October 11, 2017.
- EM Technology. 1998. Effective microorganisms for a sustainable agriculture and environment. Retrieved from: <http://emtech.org/prod01.html> on February 8, 2017.
- EMRO. undated. How EM works. Retrieved from <https://emrojapan.com/how/> on November 20, 2016.
- Evans J. and D. Pasnik. 2006. Un-ionized ammonia exposure in Nile tilapia: toxicity, stress response, and susceptibility to *Streptococcus agalactiae*. Retrieved from <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1536&context=usdaarsfacpub> on June 05, 2018.
- da Silva, F.J.R., F.R.S. Lima, D.A. do Vale and M.V. do Carmo e Sá. 2013. High levels of total ammonia nitrogen as  $\text{NH}_4^+$  are stressful and harmful to the growth of Nile tilapia juveniles. *Maringá*, 35(4): 475-481.
- Higa, T. undated. Effective microorganisms for sustainable community. Retrieved from <http://www.envismadrasuniv.org/pdf/Effect%20Microorganisms.pdf> on March 14, 2017.
- Higa, T. and N. Chinen. 1998. EM treatments of odor, waste water, and environment problems. Retrieved from [http://www.scienzaegoverno.org/sites/default/files/file\\_attach/Relazione%20Dr%20Higa.pdf](http://www.scienzaegoverno.org/sites/default/files/file_attach/Relazione%20Dr%20Higa.pdf) on March 14, 2017.
- Rao, S.M. and P. Mamatha. 2004. Water quality in sustainable water management. *Current Science*, 87(7): 942-947. Retrieved from file:///C:/Users/User/Desktop/USBFILES/thesis%20mudball/rao%20and%20mamatha.pdf on September 20, 2017.

- Sekeran, V., C. Balaji and T.B. Pushpa. 2005. Evaluation of effective microorganisms (EM) in solid waste management. Retrieved from <https://escholarship.org/uc/item/56q5g376#page-1> on September 25, 2017.
- Seng, H., S. Dokkratoom and N. Pijarn. 2015. Effect of EM ball on DO, BOD and COD of wastewater treatment plant in Bangkokthonburi University, Thailand. Retrieved from: <http://www.isaet.org/images/extraimages/P615284.pdf> on January 13, 2017.
- Szymanski, N. and R.A. Patterson. undated. Effective microorganisms (EM) and waste water systems. Retrieved from <file:///C:/Users/User/Desktop/USBFILES/thesis%20mudball/P53-03-Szymanski-Patterson.pdf> on September 25, 2017.
- The Goa Foundation/Green Goa Works. Undated. Effective microorganisms brochure. Retrieved from [http://www.goafoundation.org/images/em\\_brochure.pdf](http://www.goafoundation.org/images/em_brochure.pdf) on May 16, 2017.
- The Recycle Works, Ltd. undated. What are effective microorganisms (EM's) and using the EM activator?. Gardening woks in harmony with nature-brochure. Retrieved from [file:///C:/Users/User/Desktop/USBFILES/thesis%20mudball/Using\\_the\\_Garden\\_Yoghurt\\_Maker.pdf](file:///C:/Users/User/Desktop/USBFILES/thesis%20mudball/Using_the_Garden_Yoghurt_Maker.pdf) on October 6, 2017.
- Wahid, W. and S. Azman. 2005. Improvement of water quality using effective microorganisms. Retrieved from <http://civil.utm.my/wp-content/uploads/2016/12/Improvement-of-Water-Quality-using-Effective-Microorganisms.pdf> on November 11, 2017.
- Zacharias, I., E. Dimitriou and T. Koussouris. 2005. Integrated water management scenarios for wetland protection: application in Trichonis Lake. *Environmental Modeling and Softwares*, 20(2): 177–185.
- Zakaria, Z., S.Gairola and N. Mohd.Shariff. 2010. Effective Microorganisms (EM) technology for water quality restoration and potential for sustainable water resources and management. Retrieved from <https://scholarsarchive.byu.edu/cgi/viewcontent.cgi?article=2493&context=iemss> conference on September 20, 2017.
- [http://www.em-la.com/what\\_is\\_the\\_em\\_technologyyy\\_en.php?idioma=2](http://www.em-la.com/what_is_the_em_technologyyy_en.php?idioma=2) Retrieved on February 08, 2017.
- <https://www.yokogawa.com/library/resources/application-notes/ph-in-fish-farming/> Retrieved on June 05, 2018.