

TRACK 2B – FISHERIES AND RELATED SCIENCES

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2.	Bioaccumulation of Heavy Metals in Aquatic Organisms from the Estuarine Sites of Butuan Bay, Philippines	Emilie G. Tubio* ¹ , Ruth D. Gaid ¹ , Amy J. Laurden ¹ , Ma. Lyn Jaca ¹ , Ruby C. Gonzales ¹ and Michael Van Panerio ² ¹ Mindanao State University at Naawan, Naawan, Misamis Oriental, Philippines ² Department of Environment and Natural Resources, Region X, Cagayan de Oro City, Philippines *emilie_egt@yahoo.co.uk
3.	Effects of Conservation on the Community Structure of Coral Reef Macrophytes in Cuatro Islas, Leyte, Philippines	Eliza Dadole-Espinosa* ¹ and Ephrime B. Metillo ² ¹ Institute of Tropical Ecology and Environmental Management, Visayas State University, Visca, Baybay City, Leyte, Philippines ² Department of Biological Sciences, Mindanao State University-Iligan Institute of Technology, Iligan City, Philippines *lizadadole@yahoo.com
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	Strontium-Contaminated Soil Using Indian Mustard (<i>Brassica juncea</i>) with Ethylene Diamine Tetra Acetic Acid (EDTA)	Coral*, and Rhaj Jefayne M. Nortiza Philippine Science High School – Central Mindanao Campus, Nangka, Balo-I, Lanao del Norte, Philippines *mcoral23.cmh@gmail.com
7.	Production and Acceptability of Sea Urchin <i>Tripneustes gratilla</i> Chilli Sauce	Jurma A. Tikmasan, Ramadani A. Nambi, Sitti Nur-Radzna G. A-Shamie, Aida A. Hassan, Fathma S. Abduhasa and Rosalinda P. Shariff Mindanao State University Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi, Philippines, 7500
8.	Quantification of Paralytic Shellfish Poisoning Toxins in <i>Anadara granosa</i> (Blood Cockle), <i>Venerupis philippinarum</i> (Manila Clam), and <i>Perna viridis</i> (Green Mussel) from Baroy, Lanao del Norte and Tubod, Lanao del Norte	Kenneth Christopher L. Albaran*, Kayla Marie M. Banaag, and Ayesha Elianne A. Razuman Philippine Science High School - Central Mindanao Campus, Nangka, Balo-i, Lanao del Norte, 9200 Philippines *britrazman@gmail.com
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10.	Spatio-Temporal Profile of Water Quality of Lake Mainit, Northeastern Mindanao, Philippines	Elnor C. Roa*, Sonnie A. Vedra, Ruth D. Gaid, Rey L. Roa, Rustan C. Eballe, Geralyn D. Dela Peña, Marissa Y Salarda, Jeanette J. Samson, Michael James O. Baclayon, and Melchor R. Rigor Institute of Fisheries Research and Development Mindanao State University at Naawan, Naawan, Misamis Oriental, Philippines *elnorcroa@gmail.com
11.	Status of Sea Cucumber Fisheries in Tawi-Tawi	Nikky Merzen A. Maratas ¹ , Jenelyn P. Alingas ¹ , Dahlia P. Burias ² , Nurizna T. Jumaide ² , Aldimar

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12.	Tawi-Tawi as the Heart of the Coral Triangle for Commercially Important Coral Reef Fishes	<p>Richard N. Muallil*, Ahalnida M. Tambihasan, Marylyn S. Enojario and Yunadzmal Ong,</p> <p>Mindanao State University Tawi-Tawi College of Technology and Oceanography, Sanga-Sanga, Bongao, Tawi-Tawi, Philippines, 7500. *Rnmualil2017@gmail.com</p>
13.	Unsustainable Fishing Practices and Its Impact on the Biology and Fishery of <i>Scylla</i> spp. in Selected Areas of the Philippines	<p>Ruby Castrence-Gonzales^{1*}, Jessie G. Gorospe¹, Mark Anthonny J. Torres², Helen J. Vicente¹, Elnor C. Roa¹ and Cesar G. Demayo², David Stern³, Francesca Leasi⁴, and Keith A. Crandall³</p> <p>¹Research Division, Mindanao State University Naawan, 9023 Naawan, Misamis Oriental, Philippines ²Department of Biological Sciences, College of Science and Mathematics, Mindanao State University - Iligan Institute of Technology, 9200 Andres Bonifacio, Iligan City, Philippines. ³Computational Biology Institute, George Washington University, Ashburn, Virginia, USA ⁴Smithsonian Institution National Museum of Natural History Laboratories of Analytical Biology, Washington D.C. USA *rubycastrencegonzales@gmail.com</p>
14.	Utilization of Ensiled Pineapple Leaves (<i>Ananas comosus</i>) for the Production of Lactic Acid using <i>Lactobacillus casei</i>	<p>Maria Sheila K. Ramos*¹ Marie Angelie O. Cabatingan², Hope Marie N. Gocotano², and Druanne N. Pepito²</p> <p>¹Faculty, Department of Chemical Engineering & Technology, College of Engineering & Technology, ²BS Chemical Engineering, College of Engineering & Technology Mindanao State University-Iligan Institute of Technology, Iligan City, Philippines *mariashela.ramos@g.msuiit.edu.ph</p>

ABSTRACTS

AQUATIC RESOURCES INVENTORY AND WATER QUALITY ASSESSMENT IN LAKE BULUAN (MAGUINDANAO AND SULTAN KUDARAT), PHILIPPINES

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Lake Buluan is a very productive lake and is among the important major lakes in the Philippines. However, the lake is also among the least studied freshwater ecosystem in the country. A limnological survey was conducted in Lake Buluan in order to determine its current ecological status which includes survey of limno-plankton, macrophytes, macro-invertebrates, fish species as well as assessment of water quality. The study shows high phytoplankton density of 13,056 indivL⁻¹ which is dominated by greens and blue-greens while small rotifers dominated the zooplankton group. For the aquatic macrophytes, *Eichorrnia crasippes* is the most abundant with a frequency of 81% and a estimated total bed area of 496 hectares. Gastropods dominated the macroinvertebrates with 7 species and with a relative abundance of 92.17%. Fourteen fish species belonging to nine families were also collected from the lake which includes five native and nine introduced species and is dominated by the Nile tilapia *Oreochromis niloticus*. Two newly introduced Cichlid fish species were also reported – the Trimac cichlid *Cichlasoma trimaculatum* and Midas cichlid *Amphilopus* spp. Overall, the result of the study shows evidences of ecological stress and disturbance which include high phosphate level (0.224-0.727 mgL⁻¹), high total coliform content (up to 1600 MPNL⁻¹), low water transparency ($SD_v = 30-33$ cm) and the proliferation of water hyacinth and the decline of native macrophytes and fish species. Based on the current study, it is recommended that management and conservation efforts must be re-enforced to prevent further deterioration and to maintain a good overall health status of the lake and consequently of the nearby communities.

Keywords: *Lake Buluan, Limnological Survey, Aquatic Resources, Diversity, Water Quality*

BIOACCUMULATION OF HEAVY METALS IN AQUATIC ORGANISMS FROM THE ESTUARINE SITES OF BUTUAN BAY, PHILIPPINES

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Butuan Bay supports diverse ecosystems and is home to important marine resources in the region. While industrial, agricultural and mining activities along the bay area and hinterlands increased, pollutants such as heavy metals find their way into the Bay. Heavy metal pollution is a major environmental problem as these pollutants bioaccumulate. Mercury, cadmium, nickel, lead concentrations in select finfish, shellfishes and aquatic plants from estuarine habitats of Butuan Bay was determined following the standard methods of APHA and AOAC International and final determination using microwave plasma atomic emission spectrometry. Findings showed that mercury was below detection level for all organisms sampled. Lead concentration in finfish ranged from 25.6 to 34.82 mg/kg which exceeded 0.2 mg/kg FAO maximum permissible limit. In shellfishes, it ranged from 16.85 to 30.38 mg/kg, exceeding 1 mg/kg FAO permissible limit. Cadmium (Ca) accumulated in finfishes ranged from 2.34 to 2.66 mg/kg which were above the FAO standard at 0.05 mg/kg. For shellfishes, the concentrations at 1.793 to 4.15 mg/kg were above the FAO permissible limit at 1 mg/kg. Ca was also detected in plant samples at 0.06 to 5.64 mg/kg. The nickel (Ni) concentrations were 1.26 to 3.23 mg/kg and 9.43 to 40.67 mg/kg for finfish and shellfishes, respectively. In plants, Ni concentrations were 9.43 to 32.25 mg/kg. Data revealed that except for mercury, heavy metal concentrations in the tissues of marine organisms were above the permissible limits for human consumption. This is indicative of persistent input of said pollutants in the bay area which need to be addressed.

Keywords: *Butuan Bay, Heavy Metals, Bioaccumulation, Microwave Plasma Atomic Emission Spectrometry*

EFFECTS OF CONSERVATION ON THE COMMUNITY STRUCTURE OF CORAL REEF MACROPHYTES IN CUATRO ISLAS, LEYTE, PHILIPPINES

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The study was conducted to determine the seagrass and seaweed community structure inside and outside marine sanctuaries and to assess the impact of coral reef management efforts at Apid, Mahaba, Digyo and Himokilan Islands Protected Landscape Seascape (CIPLS) in Leyte, Philippines. Transect-quadrat method was used to collect data in 2015 and 2016. A total of 71 species were recorded in Cuatro Islas inside and outside marine sanctuaries, of which 61 species were seaweeds and 10 species were seagrasses. In both years of assessment, seagrasses and seaweeds inside marine sanctuaries were less abundant with very poor condition, than those outside which were in fair condition. Shannon diversity index (H') values indicated lower diversity inside than outside marine sanctuaries. However, for both macrophytes we found significant increase in percent cover and H' within sites through time, and no marked differences between inside and outside marine sanctuaries in terms of species composition and diversity. Low abundance inside marine sanctuaries compared to outside marine sanctuaries could be attributed to the reef structure, substrate type, and important ecological interactions within sampling stations. On the other hand, increased cover and diversity of seagrass and seaweed inside and outside marine sanctuaries could be due to effective management and protection through time.

Keywords: *Seagrass-Seaweed, Species Composition, Diversity, Abundance, Marine Sanctuaries, Cuatro Islas*

INVESTIGATING DEVELOPMENTAL INSTABILITY VIA FLUCTUATING ASYMMETRY IN THE SHELL SHAPE OF *Polymesoda erosa* (MUD CLAM)

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Mud clam (*Polymesoda erosa*), an edible species of clam which is widely considered as one of the most abundant and important shellfishes in Butuan City is investigated in this exploratory study. Developmental instability can be estimated using genetically identical or similar individuals in the same environment and assessing fluctuating asymmetry. Fluctuating asymmetry (FA) is a common tool used in estimating the health and quality of individuals and populations and is also utilized to measure the organism's ability to buffer genetic and environmental perturbations. A total of 30 individuals of mud clam were examined. Thirteen (13) anatomical landmarks were subjected to Procrustes ANOVA and Principal Component Analysis (PCA) and was done using "Symmetry and Asymmetry in Geometric Data" (SAGE) software. Results showed a high level of FA in both Procrustes ANOVA ($p < 0.0001^*$) and principal component scores (91.9296%). Principal component (PC) 1 yielded the highest FA percentile (80.1635%). Landmarks 8, 12, and 13 were the most commonly affected landmarks. Results revealed that *P. erosa* has poor developmental homeostasis indicating its inability to buffer the presence of genetic and environmental stress during development.

Keywords: *Polymesoda erosa*, *Developmental Instability*, *Fluctuating asymmetry*, *Procrustes ANOVA* *Principal, Component Analysis*, *SAGE*

**MORPHOLOGY OF *GLOSSOGOBIOUS GIURIS* (HAMILTON 1882) IN LAKE MAINIT,
NORTHEASTERN MINDANAO: WAY FORWARD TO BIODIVERSITY
CONSERVATION AND CLIMATIC VARIABILITY CONCERNS**

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This study is conducted to determine the morphological (i.e. sexual dimorphism and body proportionality) aspects of *Glossogobius giuris* or *pijanga* in Lake Mainit Northeastern Mindanao as presumed to be affected by environmental and anthropogenic stressors. Collection of specimens was conducted in four municipalities of Jabonga and Kitcharao in Agusan del Norte, and in Mainit and Alegria in Surigao del Norte using *laya/laja* and other fishing gears like traps and spear guns. Results showed that male *pijanga* (mean TL 147.99±10.67 to 149.30±7.93 mm) were relatively bigger in Lake Mainit than females (mean TL 144.33±14.62 to 145.92±18.18 mm). Morphometric and meristic characters measured were not significantly different (p value > 0.05), in turn, signified a relatively similar stock of *pijanga* inhabiting the Lake. Male and female *pijanga* did not exhibit sexual dimorphism (p value > 0.05) that signified no signs of habitat restrictions and geographic isolation. Males and females had well-proportioned body structures (p value < 0.05) that assumed to be a function of food availability and favourable habitat. *Pijanga* are observed to be present in all parts of the Lake either in shallow or in deep portions. Therefore, the presumed adverse impacts of environmental and anthropogenic stressors did not mainly influence the biology and ecology of *pijanga* as justified by having no sexual dimorphism and well-proportioned body structure. The relatively good condition of *pijanga* in Lake Mainit should command proactive participatory initiatives on conservation and management to prevent further issues on overfishing and exploitation of *pijanga*.

Keywords: *Lake Mainit, Pijanga, Morphology, Sexual Dimorphism, Body Proportionality*

PHYTOEXTRACTION OF HEAVY METALS IN STRONTIUM-CONTAMINATED SOIL USING INDIAN MUSTARD (*Brassica juncea*) WITH ETHYLENE DIAMINE TETRA ACETIC ACID (EDTA)

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Soil contamination has now become a serious concern worldwide, and multiple methods are conducted to remediate the soil. Phytoremediation is a process wherein bioaccumulator plants, such as the Indian mustard, extract heavy metals from contaminated soil. This method has proven to be a cost-effective alternative to more expensive and conventional methods. Heavy metals like strontium have limited bioavailability in soil, and methods to facilitate its transport to the plants are required for efficient extraction – one way is by using chelating agents such as EDTA. There are two treatments applied, one with EDTA, and one without. The results from both treatments, 0.6173g and 0.5999g respectively, indicate that the two treatments are effective in extracting strontium from contaminated soil with or without EDTA. In a significance level of 0.05, it can be inferred that the effect of EDTA is insignificant with regards to its limited data set. It is recommended that the study be conducted again using a larger data set and factors such as application amount, time, and method of EDTA be considered as to determine the optimal factors in extracting strontium using Indian mustard.

Keywords: *EDTA, Contaminated Soil, Indian Mustard, Phytoextraction, Strontium*

QUANTIFICATION OF PARALYTIC SHELLFISH POISONING TOXINS IN *Anadara granosa* (BLOOD COCKLE), *Venerupis philippinarum* (MANILA CLAM), AND *Perna viridis* (GREEN MUSSEL) FROM BAROY, LANA O DEL NORTE AND TUBOD, LANA O DEL NORTE

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Paralytic shellfish poison (PSP) is a biotoxin produced by microscopic algae and accumulated mostly in molluscan and bivalves (clams, mussels, oysters, and scallops). The paralytic shellfish toxin is a common seafood toxicity problem with worldwide distribution. These shellfish may cause detrimental effects to the consumers' health due to the accumulation of the toxin in the body. Symptoms of poisoning include nausea, paresthesia, muscle paralysis and respiratory failure. Poisoning incidences were recorded in some communities, thus local government units developed methods on how to monitor the toxicity level of the organisms. This study aims to assess the toxicity level of the three selected shellfish species gathered from Baroy and Tubod, Lanao del Norte. To do this, 100 grams of meat from each sample were obtained and processed for analysis using the mouse bioassay method. Results of the study clearly showed that the quantified samples for saxitoxin concentration did not exceed the Philippine Regulatory limit, 60 µg/100 g of shellfish meat for PSP contamination. It can be concluded from this study that, consuming more than 200 grams of shellfish is not advisable because contamination of the toxin might accumulate in the body which may cause direct effects to the consumers.

Keywords: *Paralytic Shellfish Toxins, Saxitoxin, Contamination, Mouse Bioassay Method*

SIMULATIONS ON EFFECTS OF INCREASED AMBIENT TEMPERATURES ON *Aedes aegypti* DEVELOPMENT AND BEHAVIOR: POTENTIAL CORRELATE FOR DENGUE FEVER OUTBREAKS

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Dengue fever remains as one of the leading causes of morbidity in the Philippines. It's hemorrhagic sequel, dengue hemorrhagic fever, has also claimed the lives of a number of people, mainly children. Several studies have examined the possible effects of climatic conditions on the outbreaks of dengue fever. We examined retrospectively such correlations inclusive of the years 2005-2009 because of availability of both medical and meteorological data. We have also simulated increases in ambient temperatures in the laboratory to determine their developmental and behavioral effects on the larvae of *A. aegypti*. While temperature and rainfall are the most likely factors influencing outbreaks, our laboratory results provided additional information on possible mechanisms. Survival rates remain high for larvae exposed to temperatures of 36°C and 38°C for four hours. Results also show a deviation from the reported thermal death point of 41°C for one hour for *A. aegypti* aquatic stages because larvae survived at 42°C for 72 hours, and at 44°C and 48°C for two hours. We have seen a potential adaptive strategy to survival at higher temperatures by a shorter life cycle. This could lead to a concomitant explosion of mosquito population given that an adult female can lay from 100 to 200 eggs per batch and up to five batches in its lifetime. This in turn could possibly contribute to dengue outbreaks. It would be more prudent to address the perennial dengue problem by controlling the population of the mosquito vector rather than addressing the virus itself.

Keywords: *Dengue Fever, Climatic Conditions, Aedes Aegypti, Thermal Death Point, Survival*

SPATIO-TEMPORAL PROFILE OF WATER QUALITY OF LAKE MAINIT, NORTHEASTERN MINDANAO, PHILIPPINES

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Lake Mainit is one of the deepest and most productive lakes in the country. Lake Mainit Development Alliance reported a fish kill in the area that urges the local government to check the quality of the water as it is cited as the cause for the incident. Thus, this study was undertaken to answer the call. Collection of data for temperature ($^{\circ}\text{C}$), Dissolved Oxygen (ppm), pH, nitrate ($\text{NO}_3\text{-N}$, ppm), ammonia ($\text{NH}_3\text{-N}$, ppm), nitrite ($\text{NO}_2\text{-N}$, ppm), phosphate ($\text{PO}_4\text{-N}$, ppm) and light intensity (Lum/ft^2), were done monthly from December 2016 to March 2018 from the seven (7) established sampling stations within the lake. Results were then compared to the DENR standards for freshwater water bodies. Results showed that the water quality of the lake were still within the desirable range for Class A and Class C waters signifying that the occurrence of fish kills was due to other factors. Notable increase of 0.9°C of surface and vertical temperatures in Lake Mainit over a decade showed an alarming state of global warming. Based on the 16 months monitoring, turnover occurred once in the lake particularly during northeast monsoon, indicating that Lake Mainit is a “monomictic lake.”

Keywords: *Lake Mainit, Water Quality, Season, Monomictic Lake*

STATUS OF SEA CUCUMBER FISHERIES IN TAWI-TAWI

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Sea cucumbers are one of the important fishery commodities in Tawi-Tawi. The coastal communities are highly dependent on coastal and marine resources for food and livelihood. This study documented the current status of sea cucumber fisheries in Tawi-Tawi. Initial results show that Sitangkai is the major supplier of sea cucumbers in the Province. Seventeen (17) species of sea cucumbers were harvested commercially. *Actinopyga lecanora*, *Holothuria Lessoni* and *Actinopyga echinites* were collected in high volume. *A. lecanora* commands the highest price at P5, 000/kg. *Telenota ananas* has the highest average size in terms of length 13.48 cm, width 17.77 cm and dry weight (701. 28 g). The supply of the commercially important *Holothuria scabra* has declined because of over-exploitation. The results of this study suggest that there is a need to develop a practical management framework to sustain the sea cucumber fisheries industry in Tawi-Tawi.

Keywords: *Sea cucumbers, Tawi-Tawi, Holothuria sp., Actinopyga spp.*

TAWI-TAWI AS THE HEART OF THE CORAL TRIANGLE FOR COMMERCIALY IMPORTANT CORAL REEF FISHES

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The Coral Triangle is considered as the center of coral reef biodiversity. The Philippines, which is located at the apex of the triangle was shown to have the highest coral reef diversity than the rest of the five Southeast Asian countries (i.e. Indonesia, Malaysia, Papua New Guinea, Timor Leste, Solomon Islands) which make up the Coral Triangle. Experts suggested that the highest fish diversity is located along the Verde Island Passage between Batangas and Mindoro provinces. A study based on very comprehensive underwater fish visual census data all over the country, later revealed that coral reef fish diversity was the highest in the Sulu Sea and they attributed it to the exploitation-related extirpation of reef fishes in the internal seas due to historical overfishing and habitat destruction. In this study, we conducted an inventory of commercially important coral reef fishes (e.g. Serranidae, Acanthuridae, Lethrinidae, Lutjanidae, Scaridae, Mullidae, Haemulidae and Balistidae) from the markets of Tawi-Tawi. We then compared the results of our study with available similar studies conducted in Palawan and Panay Island and found out that Tawi-Tawi has more species recorded for all the fish families/groups considered than any of the two studies. In addition, Tawi-Tawi has the highest proportion of unique species than Palawan and Panay island. These findings suggest that Tawi-Tawi could be considered as the Heart of the Coral Triangle in addition to the fact the it is geographically locally right in the middle of the Coral Triangle. Management options to address the rampant anthropogenic disturbances on these valuable resource swill be discussed.

Keywords: *Coral Triangle, Coral Reef, Conservation, Fish, Tawi-Tawi*

UNSUSTAINABLE FISHING PRACTICES AND ITS IMPACT ON THE BIOLOGY AND FISHERY OF *SCYLLA* SPP IN SELECTED AREAS OF THE PHILIPPINES

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Unregulated fishing may affect not only the abundance of catch but also the size, shape and genetic diversity of organisms and populations. In the Philippines, there is a dearth of information on the fishing practices of the crab fishery as well as using the total evidence approach to fully understand the plight of the *Scylla* spp. This research was conducted to determine the crab fishing practices, abundance, size, phenotypic and genetic diversity of the three species of crabs, *S. serrata*, *S. tranquebarica* and *S. olivacea* from Panguil Bay, Bislig Bay, Sibuyan Sea (Roxas City) and Lingayen Gulf, Philippines using a combination of approaches: collection of empirical data, secondary data, geometric morphometrics and genetics. Among the three species, *S. serrata* is highly selected because of its high demand in the local and export market due to its distinct taste and larger size compared to the other two species. Consequently, *S. serrata* is highly exploited and subjected to non-stop, unregulated fishing pressure collecting even the small, immature and berried crabs. The volume of catch and size of *S. serrata* in Bislig Bay has declined in a span of ten years. Among the three species, *S. serrata* had the least carapace shape variation and the lowest haplotype and nucleotide diversities. This implies that unsustainable crab fishing practices might have caused the decreasing size, declining volume of catch, less carapace shape variation and low haplotype and nucleotide diversities of *S. serrata*. Further investigation and implementation of management intervention is imperative to conserve *S. serrata*.

Keywords: *Geometric Morphometrics, Cytochrome Oxidase I, Haplotype Diversity, Nucleotide Diversity*

UTILIZATION OF ENSILED PINEAPPLE LEAVES (*ANANAS COMOSUS*) FOR THE PRODUCTION OF LACTIC ACID USING *LACTOBACILLUS CASEI*

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This study looked into the production of lactic acid from pineapple leaves with ensiling as a pre-treatment method which is non-energy intensive. Lactic acid is a precursor to produce polylactic acid which is the major raw material for the production of biodegradable plastic. Pineapple leaves were anaerobically ensiled in glass jars with ensiling additives such as molasses, lactic acid bacteria and a combination of both. The ensiled leaves were subsequently hydrolyzed in a two-stage process by the addition of 1% and 3% (w/w) H₂SO₄. The samples underwent fermentation by addition of lactic acid bacteria and varying nitrogen sources (10, 20, and 30 g/L of yeast extract) and then purified through centrifugation, vacuum filtration and distillation to extract the desired product. The highest yield of lactic acid (12.67 %) was obtained through the addition of both lactic acid bacteria (LAB) and molasses during the ensiling process and with addition of 30% of yeast extract while the lowest yield (2.31%) was obtained with LAB only as additive and with 1% of yeast added. This suggests that while ensiling is dependent on the activity of the microbes during silage fermentation, the availability of initial food source such as molasses does affect the glucose yield which subsequently affect the yield of lactic acid. Lactic acid yield is low which might not be economically feasible for large scale production. Exploring other factors to optimize lactic acid yield is recommended.

Keywords: *Ensiling, Lactic Acid, Two-Stage Dilute Acid Hydrolysis, Fermentation*

