Annals of Studies in Science and Humanities

A Scientific Journal of Caraga State University

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Online Edition: E-ISSN 2408-3631 available at www.journal.carsu.edu.ph/index.php/assh
Print Edition: ISSN 2408-3623

Annals of Studies in Science and Humanities. Volume 5, Number 1, June 2024.

Editorial correspondence should be addressed to: The Editor-in-Chief, Annals of Studies in Science and Humanities, Caraga State University, Ampayon, Butuan City, 8600 Philippines, or e-mail at jassh@carsu.edu.ph.

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Annals of Studies in Science and Humanities

Volume 5 | Issue 1 | June 2024

PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408-3631 | www.journal.carsu.edu.ph/index.php/assh

Published in 2024 by the

Research and Development Publication Office
Office of the Vice President for Research, Innovation and Extension Caraga State University
Ampayon, Butuan City 8600, Philippines

Annals of Studies in Science and Humanities
Volume 5 | Issue 1 | June 2024

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Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

Biochemical Characterization and Bioactivity of Red Alga, *Ceratodictyon spongiosum* (Zanardini) from Goso-on, Carmen, Agusan Del Norte, Philippines

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ABSTRACT

Rhodophyta, present in marine and freshwater habitats, are the most varied group of seaweeds and an essential source of biochemical compounds. This study aimed to analyze the bioactive properties and composition of Rhodophyta *Ceratodictyon spongiosum* (Zanardini). The species was subjected to FTIR, antibacterial, cytotoxic, and proximate analyses. The proximate composition of ethanolic extract *C. Spongiosum* included 10.28±0.04% moisture, 41.09±0.09% ash, 36.00±0.38% crude protein, 2.63±0.02% crude fat, 1.21±0.02% crude fiber, and 0.65±0.02% total sugar. The FTIR spectrum subsequently reveals the presence of numerous functional groups, including alcohol, amine salt, carboxylic acid, alkene, amine, alkane, conjugated alkene, ester, primary amine, aromatic group, ether, and oxy. The species also demonstrated highly potent antibacterial activity against *S. aureus* (24.67±0.58) and *E. coli* (22.67±0.58). Moreover, after 6 hours in BSLT, the extracted sample resulted in a 3% mortality rate at just 100 ppm, yielding an LC_{50} of 928.86 ppm. Nevertheless, at 24 hours, the extracts sample produced high percentage mortality of 45.56 percent, 96.6 percent, and 100 percent at 1, 10, and 100 ppm, respectively, and acquired an LC_{50} of 0.96 ppm, which was extremely poisonous to brine shrimp nauplii. Additional research on *Ceratodictyon spongiosum* in Mindanao is recommended because it contains biological components that might lead to the discovery of novel medications and food products for industrial and medicinal uses.

Keywords: *Ceratodictyon, proximate composition, cytotoxicity, antibacterial, functional group*

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Received: September 9, 2022
Revised: November 17, 2022
Accepted: June 7, 2023
Released Online: June 30, 2024

Cite this article: Buyog, C. C., Magdugo, R. P., & Won, M. E. Q. (2024). Biochemical Characterization and Bioactivity of Red Alga, *Ceratodictyon spongiosum* (Zanardini) from Goso-on, Carmen, Agusan Del Norte, Philippines, *Annals of Studies in Science and Humanities,* **5**(1):1-9.

1 Introduction

Rhodophyta, also known as red algae, is the most diverse group of seaweed (Ismail et al. 2020). It is multicellular and found in marine and freshwater ecosystems. Found in-depth intertidal zones and a few terrestrial or subaerial representatives (Gurgel et al. 2007). The species is rich in polysaccharides and floridean starch (Khotimchenko et al. 2002). It also contains sulfated galactans such as carrageenans and agars (Ismail et al. 2015). As evidence shows, Rhodophyta macroalgae contain numerous biochemical constituents, mainly lipids, proteins, and carbohydrates (Ismail et al. 2015). This species is a critical source and has been found to contain high amounts of macronutrients, such as pigments, minerals, and vitamins (Sudhakar et al. 2018). Compounds related to antimicrobial, antiviral, anti-inflammatory, and other viral diseases (Pérez et al. 2016), as well as human food production and cosmetics (McHugh 2003).

In the Philippines, active searches for the biological properties of Rhodophyta have

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

become widespread. Goso-on, Carmen, Philippines' marine environment is home to a great diversity of marine organisms (Walag & Rosario 2018; Walag et al. 2019), including *Ceratodictyon spongiosum* (Zanardini). This species, which belongs to the division Rhodophyta, is a filamentous red alga that lives in symbiosis and has a sponge-like appearance. It was first explored in Mahatao, Batanes, Philippines, from 1999 to 2002, with its assemblage. *Ceratodictyon spongiosum* and *Haliclona cymaeformis* exhibited a compound known as p-sulfooxyphenylpyruvic acid (Bugni et al. 2002). However, the current literature on the biochemical components of *C. spongiosum* might potentially have is lacking, despite its wide occurrence in Mindanao (Baleta & Nalleb 2016). Further research is needed to determine the applications of this biological species. This study evaluates the biochemical composition of the Rhodophyta *Ceratodictyon spongiosum* (Zanardini) found in Gosoon, Carmen, Agusan del Norte, Mindanao, Philippines. Additionally, it investigates the bioactivity and cytotoxicity of this species.

2 Materials and Methods

Locale of the Study

Samples were collected during partly cloudy weather on the 27th day of August 2021 in the specific coastal area of Goso-on, Carmen, Agusan del Norte, Philippines (09º 04' 41.3" N and 125º 13' 17.2" E ArcGis- Software) (Figure 1). Water quality parameters were determined in the following areas: pH, temperature (°C), salinity (ppt), conductivity (mS/cm), and Oxidation-reduction potential (mV) using an OAKTON PC 450 waterproof portable meter.

Sample Collection and Extraction

Approximately 1800 g of wet samples were collected in shallow water, placed in a polythene bag, transported, cleaned, sterilized with distilled water, and air-dried for 14 days in a warm, closed environment. The red seaweed *Ceratodictyon spongiosum* has been documented. They were categorized at the species level using the Seaweeds Guide Publication, an online resource that facilitates species identification. Voucher specimens were prepared for the herbarium.

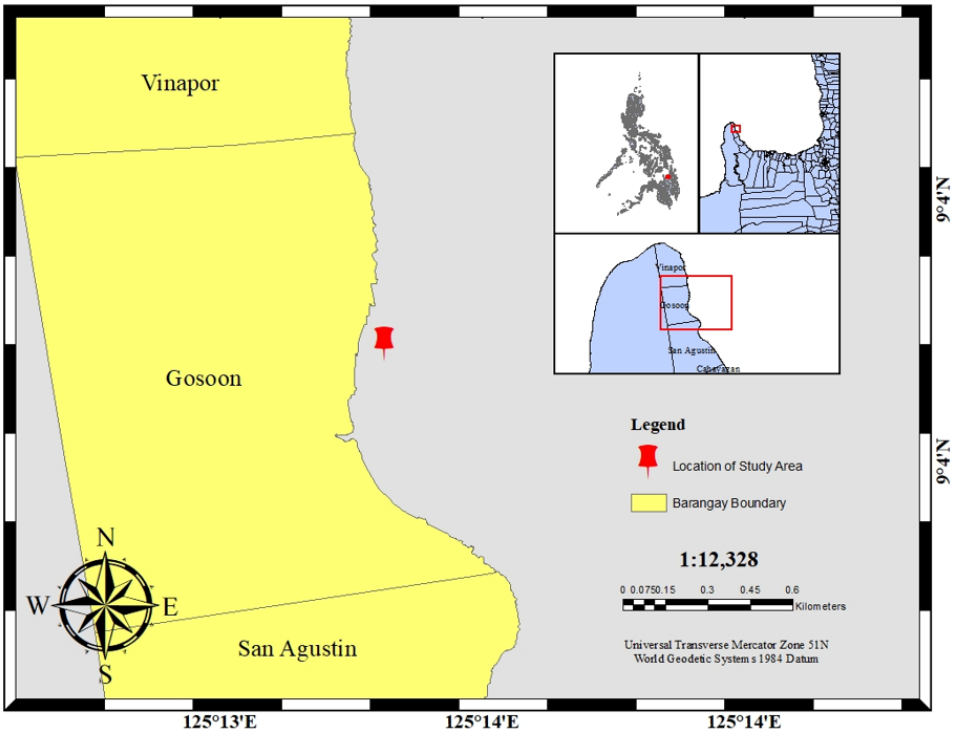

Figure 1. Map showing the location of the sampling area at Gosoon, Carmen, Agusan del Norte, Philippines

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

C. spongiosum was wholly dried, coarsely processed in an electric grinder, and weighed 63.0 g. The CUP Series Ethanol Alcohol Extraction System (patented, certified UL 1389 ISO 9001, and PSI) was used to prepare finely powdered material for ethanolic extraction according to the guidelines of Guevara et al. (2005) in DOST Caraga RSTL.

Proximate Analysis

The nutrient composition of raw *C. spongiosum* was analyzed using the Association of Official Analytical Chemists (AOAC) method (2005) at UP Los Banos, BIOTECH, using an oven, muffle (hobersal) furnace, Soxhlet extractor, Kjeldahl apparatus, refluxing apparatus, and etch. The test was to determine the proximate composition of the following: moisture using AOAC 925.45 B, ash using AOAC 923.03, crude fat using AOAC 2003.05, crude fiber using AOAC 978.10, crude protein using AOAC 981.10 (modified) 20th ed., and total sugar using the Phenol Sulfuric Acid Method (Dubois et al. 1956).

Fourier Transform Infrared Spectroscopy (FTIR) Analysis

The ethanolic extract of *C. spongiosum* was used to determine the presence of characteristic peaks and their functional groups using FTIR spectroscopy (Perkin Elmer- Attenuated Total Reflectance (ATR)) at the Caraga State University (CSU), Chemistry Laboratory.

Antibacterial Assay

The disk diffusion method (Guevara et al. 2005) was used for the antibacterial assay in DOST Caraga RSTL. Approximately 15 mL of sterile Muller-Hinton's agar was poured into sterile Petri dishes and reconstituted bacterial culture, with adjusted $1.5x10^8$ CFU/mL concentration. Standardized saline suspensions of bacteria were inoculated using sterile cotton swabs into Petri dishes, dried for 15 min, and punched with sterile 6 mm paper discs impregnated with the crude extracts (10 µL). The plates were allowed to stand under aerobic conditions at 37°C for 24 h. The experiment was performed in triplicate. The diameter of the zone of inhibition (ZOI) was evaluated using a Vernier scale millimeter after incubation.

Cytotoxicity Test (Brine Shrimp Lethality Test)

The BSLT assay followed the method described by Guevara et al. (2005) and was performed in the CSU Biology Laboratory. The hatching of Artemia salina Leach eggs was processed using prepared culture media: artificial seawater with 72 g of rock salt in 2 L of distilled water, mild aeration, and under constant illumination (light intensity: 3 watts).

The experimental procedure was performed with five dose treatment groups and three replicates per dose. Each dose consisted of a control group (positive control: potassium dichromate; negative control: 4.5 mL seawater), dose group 1 (100 ppm), dose 2 (10 ppm), and dose 3 (1 ppm).

In 0.5 mL of 80% ethanol (10000 ppm), 0.071 g evaporated plant extract was dissolved. Each concentration (0.5 mL) was diluted to 4.5 mL of 80% ethanol until 100, 10, and 1 ppm (doses) were obtained. Three replicates were performed for each dose. Each replicate contained 4.5 mL of seawater and 0.5 mL of each dose. Ten Artemia salina leach larvae were inserted afterward. A magnifying lens was used to observe and count the number of survivors and larvae deaths (% mortality) after 6 h and 24 h. The LC_{50} value was determined using probit analysis (Finney 1952).

Statistical Analysis

Variations in the bioactivity of the extract on the test bacteria, proximate analysis, and water parameters were analyzed using descriptive statistics in IBM SPSS Statistical Analysis Software. Values were reported as mean±SD. The probit analysis (Finney 1952) was calculated through statistical data with Microsoft Excel to determine LC_{50} in BSLT.

3 Results and Discussion

Classification and Identification of Species

The collected species belong to the class *Florideophyceae* and family *Lomentariaceae*, characterized by creeping axes with erect branches forming turf-like small patches. They grow on rocks or epiphytic, in lower intertidal to upper subtidal (Titlyanov et al. 2017).

Ceratodictyon spongiosum was identified by its form and structure (Figure 2). It was structurally branched with small holes along the branches. It appears sponge-like algae with green-red-purple

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

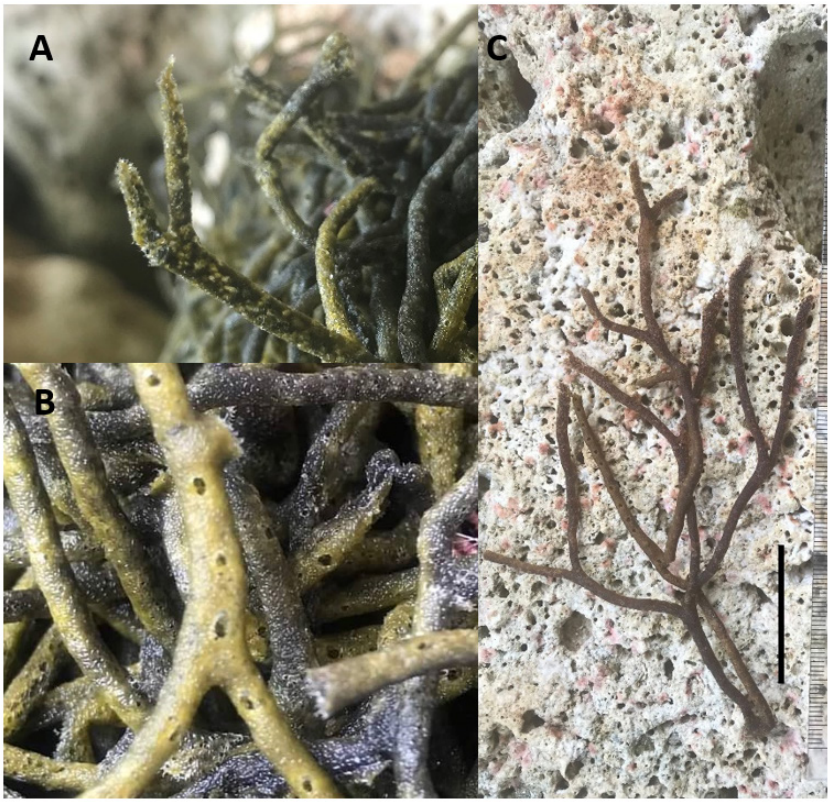

Figure 2. *Ceratodictyon spongiosum* with (A) v-shaped tip, (B) green-red-purple color and branch holes and (C) structural branching. Scale Bar=3cm

in color and a v-shaped tip on its branches. The species measured 3 cm high and 1.0–1.5 cm broad.

Sampling Conditions

Goso-on, Vinapor, Carmen, Agusan del Norte showed standard parameters ideal for the growth and nutritional composition of *Ceratodictyon spongiosum.* The seawater temperature was 34.6°C, with a pH of 7.6, a salinity of 38.3 ppt, a conductivity of 7.6 mS/cm, and an oxidation-reduction potential of 69.5 mV.

Predicting the water quality parameters is a crucial factor in the water quality management of marine waters, which impacts the environment and the species living in it (Ranković et al. 2010). Red algae (*Ceratodictyon spongiosum* Zanardini) in Goso-on, Vinapor, Carmen, Agusan del Norte are ideally related to the obtained water quality parameters that caused the species' inhabitation. It is well known that differences in physical and biological factors may influence seaweed populations' spatial and temporal variations (Schiel & Foster 2006; Wichachucherd et al. 2010). The ideal water temperature for seaweed is between 29°C and 34°C in the wet and dry seasons. Along with the temperature, the pH range (6.5-8.5) (Hidayat et al. 2015) also affects the red seaweed's *C. spongiosum* nutrient composition. Furthermore, Rhodophyta can grow in salinity ranging from 32 to 37 ppt, influencing seaweed reproduction (Ding et al. 2013). Conductivity (5 mS/cm) values depend significantly on temperature and salinity (Ding et al. 2013). The ORP (500–650 mV) is influenced by the water's dissolved oxygen content, which is measured to understand water sanitation levels (Suslow 2004).

Proximate Composition of C. spongiosum

Proximate composition of *Ceratodictyon spongiosum* was expressed as a mean value±SD (Table 1). The moisture content of *C. spongiosum* was 10.28%. The percentage of ash content in *C. spongiosum* was 41.09%, which showed a higher value than other reported Rhodophyta species,

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

Table 1. Proximate composition (%) of *Ceratodictyon spongiosum.*

Proximate Composition	Mean ± SD (%)
Moisture	10.28 ± 0.04
Ash	41.09 ± 0.09
Crude Fiber	1.21 ± 0.02
Crude Protein	36.00 ± 0.38
Crude Fat	2.63 ± 0.01
Total Sugar	0.65 ± 0.02

i.e., *Hypnea japonica* (22.10%) (Siddique 2013). Crude protein in *C. spongiosum* displayed a high content of 36%, along with other researched red seaweed, dulse, *Palmaria palmata* (35%), nori algae, *Porphyra umbilicalis* (40%) (Mouritsen et al. 2013; Gamero-Vega et al. 2020). Meanwhile, the crude fat content of the studied red algae was considerably high, at 2.63% relative to the available literature reported by Wong et al. (2000), i.e., *Porphyra umbilicalis* (3.4%). However, the crude fiber of 1.21% and total sugar content of 0.65% of *C. spongiosum* were obtained with a minimal amount compared to the other reported crude fiber of *Tricleocarpa fragilis* (12.05%) and total sugar (24.05%) (Banu & Mishra 2018).

Typically, red algae provide higher-than-average amounts of these constituents (Fleurence et al. 2012; Pereira et al. 2012). Moisture content is an essential standard for identifying the quality of processed seaweed meals, which *C. spongiosum* considers to be quality seaweed. In general, increased ash levels, in turn, indicated a higher mineral content (Gamero-Vega et al. 2020), which was also influenced by the average water salinity relative to the studied results. Moreover, proteins have crucial functions in all biological processes. Because of its excellent nutritional profile, *C. spongiosum's* high content value (36%) would benefit aquaculture and animals as supplemental food (Becker 2004). High-level crude fat contains quality fatty acids such as unsaturated fatty acids (UFA) (Pereira et al. 2012). Subsequently, high amounts of crude fiber are associated with increased satiety, easier digestion, and decreased glucose levels (Brownlee et al. 2005; Mohammed et al. 2021); however, *C. spongiosum* exhibited a low amount of fiber, proving a lack of digestion aid. Total sugar is regarded as the most significant component of metabolism because it provides the essential energy for respiration and other metabolic activities (Alwaleed 2019); otherwise, there is a low amount of total sugar in *C. spongiosum*. Generally, these content values vary by cultivation environment, location, and the sample's age (Sánchez et al. 2007; Siddique 2013).

Ceratodictyon spongiosum, an understudied red alga, was strongly suggested in this study for its promising proximate composition (%). Compared to other species of seaweed, red seaweed, or Rhodophyta, is thought to be a considerably more significant source of biologically active metabolites (Mouritsen et al. 2013; Shannon & Abu-Ghannam 2019; Naseri et al. 2019; Gamero-Vega et al. 2020). This emergence is subject to novel products in the health food industry, as it is one of the primary producers of organisms in various habitats (Saranraj 2014).

FTIR Spectra of C. spongiosum

The obtained analysis showed the IR spectrum of the C. spongiosum extract peaking at wavenumbers 3339, 2997, 2910, 1640, 1453, 1043, and 880 cm^{-1}, which exhibited seventeen functional groups (Table 2). The sample's strong bands at around 3339 cm^{-1} may be attributed to the O–H and N–H stretching, indicative of amino acids (Kannan 2014; Anjali et al. 2019). Kalasariya (2020) stated that peaks at 2997 cm^{-1} are formed due to the O-H stretch of alcohol and the C-H stretch of alkene. The N-H stretch of amine salt, the O-H stretch of carboxylic acid, and the C-H stretch of alkane can be found at the peak of 2910 cm^{-1}. The peak at 1640 cm^{-1} is attributed to the N-H bending of amine, representing the C=C stretch of alkene, conjugated alkene, and cyclic alkene. It is also owed to the C=O, which indicates the presence of the ester group. Additionally, peak 1453 cm^{-1} is formed due to the C-H stretch of alkane. Peak 1043 cm^{-1} indicates the C-N stretch of primary amine, and peak 880 cm^{-1} represents the C-H bend and C-O-O stretch of the aromatic ring and ether oxy, respectively.

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

Table 2. FTIR peak values and functional group for sample *Ceratodictyon spongiosum*

Absorption peak (cm^{-1})	Peak appearance	Functional Group	Class	References
3339	Strong, Broad Strong, Broad	O-H Stretching N-H stretching	Alcohol Amino acid	Kannan (2014); Anjali et al. (2019)
2977	Strong, Broad Medium	O-H Stretching C-H Stretching	Alcohol Alkane	
2910	Strong Strong Medium	N-H Stretching O-H Stretching C-H Stretching	Amine salt Carboxylic acid Alkane	Kalasariya (2020)
1640	Medium Medium Medium Medium Strong	N-H bending C=C Stretching C=C Stretching C=C Stretching C=C Stretching C=O stretching	Amine Alkene Conjugated alkene Cyclic alkene Alkene Ester	
1453	Medium	C-H stretching	Alkane	
1043	Strong	C-N stretch	Primary amine	Nandiyanto et al. (2019)
880	Medium	C-H bending C-O-O stretch	Aromatic ring Ether, oxy	

The functional group, distinguished by FTIR spectrum analysis, might confirm the potential antioxidant activity to fight against various diseases and free radical scavenging properties—the Gracilaria dura (Kalasariya 2020) correlated with the functional group present in *C. spongiosum.*

Antibacterial Activity of C. spongiosum

The diameter of antibacterial for each triplicate in different bacteria showed a relatively high percentage of inhibition (Table 3). The *C. spongiosum* extract against *S. aureus* displayed a 24.67±0.58 mm zone of inhibition (ZOI) and against *E. coli* with 22.67±0.58 mm ZOI. The extract showed high-level susceptibility to antibacterial activity. A diameter <10 mm is expressed as inactive, 10-13 is partially active, 14-19 is active, and a diameter >19 mm exhibits a very functional outcome for the zone of inhibition (Guevara et al. 2005).

It was indicated (Table 3) that gram-positive *S. aureus* provides the highest zone of inhibition. Suggesting that ethanol extracts of red alga *C. spongiosum* are more efficiently bioactive against Gram-positive bacteria. Similar to a study presented by Kolanjinathan et al. (2009) and Karabay-Yavasoglu et al. (2007).

This study also suggests that 80% ethanol is a better solvent for consistently extracting bioactive compounds from red seaweeds. It might be due to the capacity of ethanol to elute compounds responsible for their activity. However, the efficacy of ethanol depends on the biochemical composition of red algae. The bioassay methods, geographical distribution of seaweeds, and seasonal production of bioactive compounds also contribute to the efficient bioactive properties of seaweeds (Salvador et al. 2007).

Cytotoxic Activity

The study determined the extent of lethality corresponding to the concentration of the *Ceratodictyon spongiosum* ethanolic extract (Table 4). After 6 h of observation, all shrimps survived in negative and positive control from concentrations 100, 10, and 1 ppm (ug/mL). The highest mortality in *A. salina* was observed in 100 ppm negative and positive control after 24 h. At 6 h, the extract of *C. spongiosum* caused the lowest mortality in all concentrations; 1 ppm, 10 ppm, and 100 ppm with 0%, 1.11%, and 3.33% mortality, respectively. However, at 24 h, extracts caused average mortality in 1 ppm and 10 ppm with 45.56% and 96.67% mortality, respectively, and a higher lethality percentage in 100 ppm with 100% mortality. The 24 h assay showed more significant mortality than 6 h.

The LC_{50} value obtained after 6 h of exposure was 928.86 ppm, which displayed the sample extract as slightly toxic to nauplii. An LC_{50} value obtained after 24 hours was 0.96 ppm which is highly toxic to nauplii. An extract is considered highly toxic if the LC_{50} value is <100 ppm, moderately toxic when the LC_{50} value is 101-500 ppm, slightly toxic when the value is 501-1000 ppm, and non-toxic when LC_{50}> 1000 ppm. The LC_{50} is inversely proportional to toxicity (Meyer et al. 1982; Clarkson et al. 2004).

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

Table 3. Zone of inhibition (mm) of seaweed extract against *E. coli* and *S. aureus*

Treatment	Bacteria	(mean ± SD)	Remarks
Extract *Ceratodictyon spongiosum*	*Escherichia coli*	22.67 ± 0.58	Very active
	Staphylococcus aureus	24.67 ± 0.58	Very active

Table 4. Cytotoxic activity of Ethanolic extract *C. spongiosum* evaluated after 6 and 24 hours.

Hours	Concentration (mg/L/ppm)	No. of Survivor			% Mortality	LC50 (ug/mL)	Toxicity Criterion
		R1	R2	R3			
6 h	1	30	30	30	0.00	928.86	Slightly toxic
	10	30	29	30	1.11		
	100	29	29	29	3.33		
24 h	1	0	0	0	45.56	0.96	Highly toxic
	10	0	2	1	96.67		
	100	22	19	8	100.00		

The findings showed that *C. spongiosum* contains cytotoxic substances which could be explored further to be used therapeutically. Manilal et al. (2009) suggested that secondary metabolites extracted and the polarity of the different compounds may influence the cytotoxic activity of the red seaweed species. Alencar et al. (2014) also showed a lethality test of red seaweeds, which suggested that lethality against *Artemia* sp. was dose-dependent.

4 Conclusions and Recommendations

Typically, red seaweeds provide higher-than-average amounts of biochemical compositions than brown and green seaweeds. The findings of our study demonstrate that water parameters significantly impact the biochemical makeup of red seaweed. It showed that the amounts of protein, ash, moisture, crude fat, crude fiber, and total sugar in *Ceratodictyon spongiosum* were high to average. These could be used as food and feed resources for human and animal consumption, with high-quality nutritional content. Additionally, these seaweeds could be rich sources of natural antioxidants because of the functional group's presence. Findings on the antibacterial and cytotoxic activity can be a basis for more advanced research on red seaweed's capabilities, enriching the national pharmaceutical industry for nutritional, medical, and industrial aspects.

Acknowledgement

The authors would like to thank Meljan Demetillo, Ph.D., for his research suggestion. The authors would also like to thank the Municipality of Carmen for the sampling activity, BIOTECH UP Los Baños, DOST-CARAGA RSTL, CSU-Chemistry Department, and Biology Laboratory for conducting the experiments of this research.

5 Statement of Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

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Volume 5 | Issue 1 | June 2024
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Annals of Studies in Science and Humanities

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

Detection of *Neoechinorhynchus* sp. (Acanthocephala: Neoechinorhynchidae) in the Gut of Wild Nile Tilapia (*Oreochromis niloticus*, L.) from Lake Mainit, Caraga, Philippines

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ABSTRACT

Wild-caught freshwater Nile tilapia is potentially carrying parasites. Acanthocephalan parasites occur in almost market-sized tilapia, which frequently infect its gut. This infection presents a compelling subject for study, as it gains insights that extend beyond mere public health concerns to encompass broader environmental health implications. This study aimed to detect acanthocephalan parasites from the gut of wild Nile tilapia from Lake Mainit, Philippines. A total of 60 randomly sampled fishes were collected and examined for acanthocephalan parasites under the compound microscope. The results of the study revealed that 40% of the fish sampled were infected with *Neoechinorhynchus* sp. (Acanthocephala: Neoechinorhynchidae). *Neoechinorhynchus* sp. primarily infects fish and other aquatic organisms but does not pose a significant risk to human health. There is no significant correlation between *Neoechinorhynchus* sp. intensity and fish length and weight, suggesting that the morphology of tilapia, specifically its length and weight, is not influenced by the parasite's low intensity. This indicates that while the fish may harbor these parasites, their growth and physical development remain largely unaffected under low parasitic loads. Such findings are important for aquaculture practices, implying that a low-intensity of *Neoechinorhynchus* sp. infections might not impact the overall fish productivity and market value. Nonetheless, ongoing monitoring and management of parasite levels are recommended to ensure the continued health of the fish populations. While not a major public health threat, awareness and education on prevention can help reduce the risk of zoonotic infections, especially in regions where people consume raw or undercooked fish.

Keywords: *: fish parasites, bioindicator, prevalence, parasitic helminths*

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*Email: rapaylangco@carsu.edu.ph
Received: November 18, 2022
Revised: June 19, 2024
Accepted: June 25, 2024
Released Online: June 30, 2024

Cite this article: Aniñon, A. K. T. & Paylangco, R. A. (2024). Detection of *Neoechinorhynchus* sp. (Acanthocephala: Neoechinorhynchidae) in the Gut of Wild Nile Tilapia (*Oreochromis niloticus*, L.) from Lake Mainit, Caraga, Philippines, *Annals of Studies in Science and Humanities*, **5**(1):10-17.

1 Introduction

Acanthocephalan parasites are known as spiny-headed worms due to the presence of eversible proboscis, armed with spines that are mainly for piercing and anchorage to the host gut wall (Taraschewski 2000). Several studies have shown the susceptibility of fish as hosts to acanthocephalan parasites however they are of little importance as an agent of disease but their role in the determination of the environment health specifically as biomonitors of heavy metals is promising, as acanthocephalan parasites were found to be accumulated more heavy metals than its fish host and sediments (Thielen et al. 2004; De la Cruz et al. 2013; Paller et al. 2022). The acanthocephalan parasites isolated from the gut of Nile tilapia in Laguna Lake, Philippines,

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

exhibit significantly higher levels of lead (Pb) compared to fish tissues and ambient waters (Paller et al. 2016). Additionally, recent research has documented acanthocephalan parasites infecting fish in various aquatic systems in Mindanao, Philippines (Munda & Estaño 2020; Ali 2021; Villahermosa et al. 2022). These findings provide valuable insights and present an excellent opportunity for conducting ecological studies related to environmental health.

Lake Mainit in the Caraga Region, Mindanao was declared with exceptional biodiversity resources such as fish and shellfish (LMDA 2007). The lake was considered one of the Key Biodiversity Areas (KBA) in the Philippines but was recently reported as at risk due to some anthropogenic activities which include forest degradation, conversion of forested land to agriculture, shifting cultivation, and small-scale mining operated near the lake (Paylangco et al. 2020; Demetillo et al. 2016). Moreover, zoonotic parasites were also documented in the surrounding ricefield of the lake such as from the wild rats (Abao-Paylangco & Nepa 2021), *Oncomelania hupensis quadrasi* snail (Abao-Paylangco et al. 2019), and bovines as a reservoir host (Jumawan et al. 2020; Estaño & Jumawan 2023;). Lake Mainit produces the edible fish tilapia both wild and cultured. Due to its abundance, it served as a food source and livelihood for some residents living near Lake Mainit. Hence, this study aims to detect acanthocephalan parasites in the gut of wild Nile tilapia from Lake Mainit and its association with fish weight and length.

2 Materials and Methods

Study site and fish collection

The wild Nile tilapia was collected and purchased from Lake Mainit, Barangay Beltran, Jabonga, Agusan del Norte, Philippines (Figure 1). The lake is the fourth largest and the deepest lake in the country and is located between 9°15' and 9°35' North Latitude and 125°28' and 125°35' East Latitude (Tumanda et al. 2003; LMDA 2007), and is considered one of the Key Biodiversity Areas in the Philippines (Seronay et al. 2020). The study was also conducted due to the presence of other intestinal parasites found in other commercially produced fish, *Channa striata* in Lake Mainit (Paglinawan et al. 2022). The fish sample collection took place in a more accessible barangay during the months of October (N=30 fishes) and November (N=30 fishes) and was chosen due to the reported high likelihood of capturing market-sized tilapia in the lake during this period,

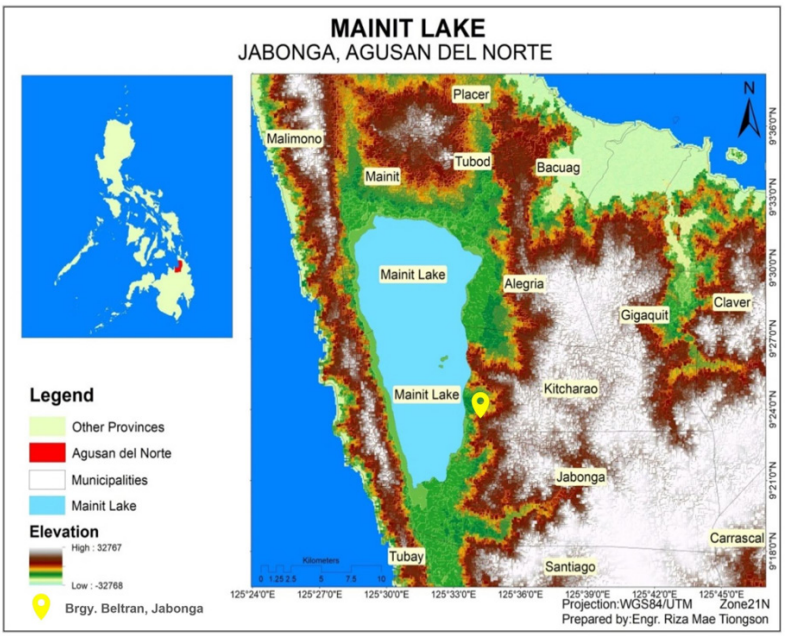

Figure 1. Map showing the source of the wild Nile Tilapia, in Brgy. Beltran, Jabonga, in Lake Mainit, Agusan del Norte, Philippines

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

as indicated by local knowledge and experience. Limited resources and the large size of the fish, coupled with their high market price, constrained the ability to examine larger sample sizes. Consequently, the fish collection was restricted to only 30 fish samples, each month. Inside the plastic coolers with ice blocks, fresh fish samples were then transported immediately to the Laboratory for acanthocephalan parasite examination.

Isolation and identification of acanthocephalan parasites

Before parasite examination, the fish weight and body length were measured using triple beam balance (g) and ruler (cm), respectively. Identification of juvenile and adult fishes was not assessed, instead, a relative market-sized fish was only taken for parasite examination. The isolation and preservation methods of the fish parasites were adopted by Paller et al. (2016). The fish was laid on the dissecting board on one side and was opened from the mouth to the anal region. The gut was removed and placed in a petri dish with saline solution. The gut was then stretched out in the petri dish and cut longitudinally to expose the gut contents. The contents in the gut were then examined for the presence of an acanthocephalan adult or juvenile stage under a stereo microscope (Motic, China), then photomicrograph at 100x and 200x and further confirmed under compound microscope (Motic, China). Identification of isolated acanthocephalan was based on its morphological characteristics and locating its reported geographical distribution as tilapia fish as their host (De la Cruz & Paller 2012; De la Cruz et al. 2013; Briones et al. 2015). The isolated acanthocephalan parasites were stored in a clean glass vial containing distilled water and then refrigerated for up to two hours for the eversion of proboscis then later transferred to 10% formalin for longer storage. Voucher specimens were kept and deposited in the Biology Laboratory at the Caraga State University, Ampayon, Butuan City, Philippines.

Data Analyses

The acanthocephalan parasite infection rate was computed as the total number of infected fish over the total number of fish examined and then multiplied by 100 to get the prevalence percentage (de la Cruz et al. 2013). The total number of acanthocephalan parasites recovered over the total number of infected tilapia was also obtained for the mean intensity. To determine the relationship between the intensity of acanthocephalan infection and the fish length-weight measurement, spearman correlation analysis was used (Carpio-Hernández et al. 2020). A normality test was obtained before Spearman correlation analysis. Statistical analysis was done through the use of IBM SPSS version 20 and performed at a 5% level of significance.

3 Results and Discussion

Acanthocephalan parasite in wild Nile tilapia

The acanthocephala parasites were carefully isolated from the fish samples and identified as *Neoechinorhynchus* species of the Neoechinorhynchidae family (Briones et al. 2015; De la Cruz et al. 2013; De la Cruz & Paller 2012). These parasites are characterized by their distinct morphology, including a cylindrical body and a retractile proboscis armed with hooks used for attachment to the host's intestinal wall. This holdfast organ is one of the key structures in distinguishing acanthocephalan worms from other parasitic organisms and is unique to every species of acanthocephalans. The attachment of the spiny proboscis to the intestine can cause irreversible mechanical damage in the architecture of the intestinal tissues leading to pathological changes (Herlyn 2021). These changes include deterioration and or damage of the intestinal villi, formation of granular tissues, and capsule formation. Upon these changes, the response of the host's immune system seriously affects the digestive and absorptive efficacy of the animal. When heavy infections occur in the organism they can result in intestinal obstruction and migration of the parasites into infrequent locations has also been recounted (Nickol 2006). The body of the isolated worms in the study is composed of major parts: Figure 2A: everted proboscis (P) and neck (N); Figure 2B: trunk (T); Figure 2C: everted bursa (B) of the male worm is visible; Figure 2D: whole mount of the acanthocephalan parasite with a scale bar of 100 μm.

Acanthocephalan parasites have a unique morphology that aids in the specialized absorption of nutrients from their fish hosts. The trunk which is the main body of the acanthocephalan is generally cylindrical in shape which became

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

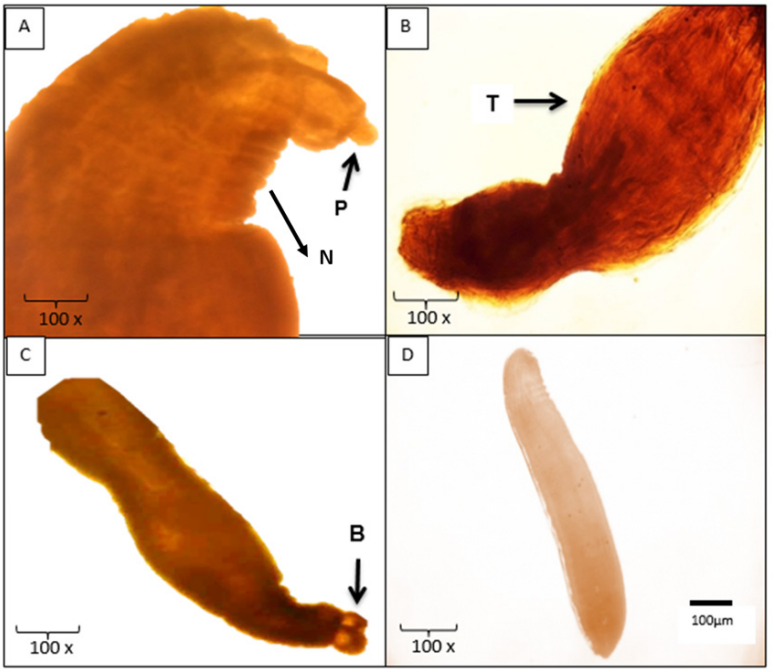

Figure 2. The recovered Acanthocephalan parasites from the gut of wild Nile tilapia from Lake Mainit, Jabonga, Agusan del Norte, Philippines. A: everted proboscis (P) and neck (N); B: trunk (T); C: everted bursa (B) of the male worm; D: whole mount of the acanthocephalan parasite. Scale bar=100um

an interest of many scientists due to its unique function. One of them is the absorption of nutrients to its body wall as acanthocephalan parasites have no known gut (Klimpel et al. 2019; Cheng et al. 2022). Their teguments consist of various pores, canals, and several structurally distinct layers, which perform both a protective and absorptive function (Nabi et al. 2016). Acanthocephalans are dioecious and it is in the trunk where most of the reproductive organs are found, while mating in acanthocephalans happens in the vertebrate host's intestine. Acanthocephalan parasites of fishes are found either as adults in the intestine or as larvae (post-cystacanths) in fish tissues. The male acanthocephalans are distinguished from females because of the presence of copulatory bursa. A fluid-filled called Saefftigen's pouch is connected to the bursa and is responsible for the eversion of the bursa (Nickol 2006; Kimpel et al. 2019).

The study recorded positive samples of fish infected with Acanthocephala. Out of 60 fish samples examined, a total of 42 *Neoechinorhynchus* sp. worms were isolated from the fish guts, resulting in a 40% infection prevalence. The distribution and infection rate of *Neoechinorhynchus* sp. in freshwater fish like Nile tilapia, are influenced by several factors. The host species diversity, as this parasite infects a wide range of fish species, both marine and freshwater. An inventory of aquatic organisms was recorded in Lake Mainit. A total of 41 fish species and several invertebrate species were listed in the Lake (Uy et al. 2015). This parasite was also recorded infecting a diverse range of fish hosts including the commercially important species in the Philippines (Gustillo et al. 2022). Additionally, a higher intestinal infection rate (72%) of *Neoechinorhynchus* sp. was recorded in tuna fish in Indonesia (Uliya & Yushi 2020).

Environmental conditions can also significantly impact the life cycle and distribution of *Neoechinorhynchus* sp. Optimal environmental conditions can enhance the development and survival of both the parasites and their intermediate hosts such as the crustaceans. However, previous studies have shown that crustacean distribution is likely influenced by the soil substrate and

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

riparian vegetation in Lake Mainit, resulting in low diversity (Paylangco et al. 2020). Moreover, a distinct seasonal fluctuation also influences *Neoechinorhynchus* sp. high prevalence rate (71.7%) in freshwater fishes (Okoye et al. 2014) and even in marine water fishes as well (Chine et al. 2020).

Ecological interactions, such as the presence of predators and competitors can affect the population dynamics of both the fish hosts and the intermediate hosts, indirectly influencing the infection rates of *Neoechinorhynchus* sp. (Thomas 2002). Anthropogenic factors can also alter the aquatic environment, affecting both the hosts and the parasites. Declining water quality, open-access fisheries, and the introduction of exotic species are among the most pressing environmental issues jeopardizing the sustainability of Lake Mainit's biodiversity (Uy et al. 2015). Pollution can impact the health of fish, making them more susceptible to infections, while habitat modification can influence the distribution and abundance of both the fish hosts and the intermediate hosts. A high susceptibility of fish with recorded prevalence of 83.3% and histopathological analysis of *Neoechinorhynchus* to fishes was observed and showed complete desquamation of the intestinal epithelium with severe evidence of inflammatory reaction associated with fish host immune response (Martins et al. 2001). Similar results revealed a substantial mucus production in the fish intestine indicating a tissue inflammation. Moreover, microscopic examinations revealed that *Neoechinorhynchus* sp. induced disruption, necrosis, and degeneration of the host epithelial cells (Chine et al. 2020). Understanding these factors is crucial for managing the spread of *Neoechinorhynchus* sp. and mitigating its impact on fish populations, particularly in aquaculture settings where the health of fish is directly linked to economic outcomes. Effective monitoring and management strategies should consider these variables to control the distribution and infection rates of this parasite.

Acanthocephalan parasite infecting tilapia has an ecological impact as this was known to bio-accumulate more heavy metals than its fish host tissues (Paller et al. 2016). Interestingly, their abundance and distribution among fishes could serve as bioindicators for a healthier animal and environment. The intensity of parasite infection is crucial in assessing animal health because it might relate to fish morphology and physiology. However, some instances could be due to the interactions between conspecific parasites that act as regulators on the number of parasites per host (Barber 2007). In many acanthocephalan parasites infecting fish, studies have shown that the number of acanthocephalan worms declines when a certain number of host parasitic load is reached (Labaude et al. 2020). Although the hosts are of the same species and live in the same habitat, the variation in number of accumulations of parasitic organisms can still be observed. Furthermore, it was stated that parasitic infections are more common in the wild where ecological requirements for intermediate hosts and parasite transmission are met.

Correlation between the fish weight and length and intensity of Neoechinorhynchus sp.

The fish length and weight were recorded to determine its association with the intensity of *Neoechinorhynchus* sp. Correlation analysis (Figure 3) showed no significant relationship between the intensity and length ($r= -2.53$, $p= 0.177$) as well as the weight ($r= -2.42$, $p= 0.198$). This suggests that the fish morphology such as the length and weight are not affected or altered by the low intensity of acanthocephalan parasites. Similar results reported that *Neoechinorhynchus* sp. has no relationship between its intensity and fish host length and weight (Olurin et al. 2012). However, some studies showed that more parasite burden can be seen in larger fishes due to the larger surface area available for attachment (Akinsanya & Otubanjo 2006).

Parasitic infection tends to increase with the size and age of the fish. Larger fish provide more space for parasites, have a greater food supply, and live longer, which increases their exposure to parasitic infections over time (Brickle et al. 2005). The smaller/younger fish on the other hand had a high incidence of parasitic infection and this is mainly due to the less developed immunity against parasitic infection (Emde et al. 2012). Moreover, a significant relationship between the fish sex and size to the parasitic helminth infections in fishes was also recorded (Koyun 2012). However, in some instances, the zooplankton copepod, *Lernaeenicus sprattae* did not establish a host-size preference

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

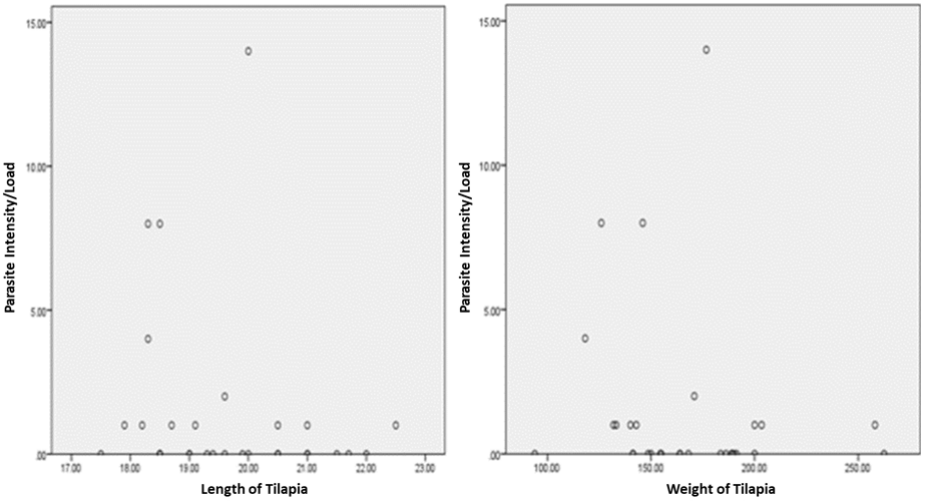

Figure 3. Plot graphs showing the relationship of parasite intensity/load and the length and weight of wild Nile tilapia from Lake Mainit, Agusan del Norte, Philippines

hence there is always a negative correlation of parasitic load to the fish size because of this shifting feeding habits in fish (Pulkkinen et al. 2000; Otachi 2009).

4 Conclusions and Recommendations

The wild Nile tilapia in Lake Mainit showed susceptibility to acanthocephalan parasites, particularly to *Neoechinorhynchus* sp. The presence of these parasites has significant implications for consumers and environmental health, particularly when the host fish are exposed to contaminated water. Parasites do not necessarily have a host-size preference, as several factors might influence their distribution. Future studies are highly recommended to adopt a more holistic approach, including socio-economic aspects, assessment of heavy metal contamination in the study area, and electron microscopy photomicrography for the isolated parasites.

Acknowledgement

The authors would like to thank the local fishermen and the Barangay Captain for their cooperation during the sampling process. Additionally, we extend our gratitude to the Biology Laboratory at Caraga State University for providing space and assistance during the parasite examination.

5 Statement of Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Volume 5 | Issue 1 | June 2024
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Annals of Studies in Science and Humanities

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

The Influence of Self-Efficacy on Career Decision of Teenage Mothers in Butuan City Amidst Covid-19 Pandemic

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ABSTRACT

This study aims to investigate the influence of self-efficacy, including demographic information, such as the educational attainment of parents and family income, on the career decision-making of 124 teenage mothers who were identified through stratified proportionate sampling in the center region of Caraga. The data was collected through an online survey and was analyzed through descriptive and multiple linear regression analysis. The study findings show that teenage mothers' self-efficacy is at an average level and high level in career decision-making. Self-efficacy also affirms that it significantly influences the level of career decision-making of teenage mothers, giving us a nuanced understanding of its vital role in career decision-making. Further results also show that the educational background of mothers mostly influences career decision-making compared to the educational background of fathers of teenage mothers, while family income appears to have no significant influence on teenage mothers in their career decision-making. The insights from the results of this study have inferences for the design of targeted interventions and support programs intended to nurture and empower the self-efficacy of teenage mothers, thereby helping them to be more informed and confident as they take their challenges in their career decision-making for a clearer career path.

Keywords: *: Influence, Self-efficacy, Career decision-making, Teenage Mothers*

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*Email: charinamaylagunde@gmail.com
Received: October 7, 2022
Revised: November 21, 2023
Accepted: June 25, 2024
Released Online: June 30, 2024

Cite this article: Lagunde, C. M., & Badiang, S. S. (2024). The Influence of Self-Efficacy on Career Decision of Teenage Mothers in Butuan City Amidst Covid-19 Pandemic, *Annals of Studies in Science and Humanities,* **5**(1):18-28.

1 Introduction

Adolescent pregnancy is a global public health problem. It is a pregnancy in girls between the ages of 10 and 19. Some 21 million girls aged 15–19 experience pregnancy in developing regions, and an estimated 12 million of them give birth. The adolescent birth rate (ABR) has experienced a drop, decreasing from 64.5 births per 1000 women (15–19 years) in 2000 to 41.3 births per 1000 women in 2023 on a global scale. Nevertheless, the pace of this decline varies across different regions, with the most significant reduction observed in Southern Asia (SA) and slower declines in sub-Saharan Africa (SSA) and the Latin American and Caribbean (LAC). Despite improvements in all regions, LAC and SSA persist with the highest global rates, standing at 99.4 and 52.1 births per 1000 women, respectively, in 2022 (WHO, 2023). In the Philippines, 5.4 percent of women 15 to 19 years old have ever been pregnant, 0.4% have had a pregnancy loss, and about 1.6 percent of them are currently pregnant. In terms of area residence, the percentage of women 15 to 19 years old who have experienced pregnancy was slightly lower in urban areas (4.8%) compared to rural areas (6.1%). When considering different regions, Northern Mindanao had the highest prevalence of pregnancies among women aged 15 to 19 years (10.9%), with Davao Region (8.2%), Central

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

Luzon (8.0%), and Caraga (7.7%) following the list. Conversely, the lowest percentages of teenage pregnancies were observed in the Ilocos Region (2.4%) and Bicol Region (Philippine Statistics Authority 2023).

The period of young adolescence, from 12 to 18 years, is crucial in the journey to construct their identity development (Erikson 1958, 1963). Adolescence is usually identified as the period when the process and development of career identity formation begin (Morsunbul & Meeus 2015). Navigating career decision-making is a complicated process that requires students to gain a deep understanding of themselves (Azhenov et al. 2023). Sampson et al. (2004), career decision-making involves a sequential and interconnected process that encompasses activities like gathering relevant information, choosing a career, pursuing education, and looking for employment after finishing an educational program (cited in Duro 2022). Choosing a career can pose one of life's most daunting challenges. Individuals frequently find themselves overwhelmed with information as they consider the myriad career paths available to them (Gati et al. 2019).

Cultivating a sense of ability in career decision-making is important to successfully engage in occupational and educational planning and decision-making (Chiesa et al. 2016). Self-efficacy plays a substantial positive role in career decision-making (Sandra & Mularsih 2021). Self-efficacy is people's belief in their capability to exercise some measure of control over their functioning and environmental events (Bandura 2001, as cited in Feist et al. 2018). Self-efficacy has a vital role in career decision-making since it denotes belief in oneself in engaging in activities related to career decisions (Duru 2022; Crişan & Turda 2015). Other than self-efficacy, the educational background of parents significantly impacts teenagers' career decisions. Parents who have higher educational backgrounds tend to demonstrate greater consistency and encounter fewer difficulties when making career choices (Mbagwu & Ajaegbu 2016). The study by Adikwu and Ereka (2022) also revealed that parental educational background and socioeconomic status influenced the students' career choices.

Previous research indicates that self-efficacy has garnered significant attention in the literature on career-related concerns, particularly among college and university populations. Still, there is not so much emphasis on teenage mothers. Hence, this paper focused on determining the level of self-efficacy and career decision-making of teenage mothers and examined the extent of influence of self-efficacy and demographic profile (parents' educational attainment and family income) on career decision-making.

The study findings could have a potentially significant impact, providing valuable insights into the factors that influence the career decision-making processes of teenage mothers. Understanding the roles of self-efficacy may empower teenage mothers by providing them with a clearer understanding of their capabilities in navigating career choices despite their unique challenges. This knowledge could contribute to developing targeted interventions and support systems, nurturing greater self-reliance and self-belief among teenage mothers. Additionally, by exploring these dynamics within the specific context of teenage motherhood, the study enhances the broader body of knowledge in career psychology and career guidance. It improves understanding of how personal factors like self-efficacy can influence career decisions. This can guide future research in developing more effective interventions to support career development in diverse populations, especially those with additional challenges in life. Limitations of this study are also recognized, where various psychological factors like personality traits, intrinsic and extrinsic motivations, and other psychological resources of teenage mothers are yet to be explored associated with career decision-making.

2 Materials and Methods

Research Design

The study employed a quantitative research design, particularly a descriptive-causal design, which further aided the researchers in collecting the data through a survey questionnaire of the identified sample size.

Sample and Sampling Design

Out of 178 teenage mothers, the sample size was determined through stratified proportionate sampling from the identified barangays. This

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

process yielded a sample of n=124 teenage mothers in the central region of Caraga.

Instruments Used

The first research instrument was the General Efficacy Scale (GSES), which comprises 10 questions, ranging from "not true at all" to "exactly true," using the 4-point Likert scale (1= Not all true, 2 = Hardly true, 3 = Moderately true, 4 = Exactly true). It assesses individuals' general beliefs about coping with life's challenges. It has no subscales and reverse-coded items, so the automatic score is a simple sum of ten answers. Its Cronbach's alpha is between .76 and .90 (Schwarzer & Jerusalem 1995).

The second research instrument was the Career Decision-Making Self-Efficacy Scale - Short Form (CDMSES-SF). It aims to assess the confidence of an individual in making career-related decisions. The items measure accurate self-appraisal or assessment, gather professional information, select objectives, prepare decision-making plans, and solve problems (Betz et al. 1996). The results are measured by calculating the average number of its 25 items with a 5-point Likert scale, 1 = no confidence and 5 = complete confidence. Its Cronbach's alpha is .94 (Betz et al. 1996).

The range and descriptive equivalent or remark assigned on the level of self-efficacy and the level of career decision-making are shown below:

Range	Descriptive Equivalent or Remark
1.00-1.49	Very Low
1.50-2.249	Low
2.50-3.49	Average
3.50-4.49	High
4.50-5.00	Very High

Data Gathering Procedure

The researchers first secured the approved letter from the City Population Office (CPO) of the center region of Caraga for the study to be conducted and the list of teenage mothers per barangay. A formal letter was also sent to the identified barangays to request the assistance of their respective barangay health workers in tracing the target teenage mothers. The data was collected online due to the stringent local health restrictions imposed by the Inter-Agency Task Force (IATF) during the height of the COVID-19 pandemic. Embedded in the link for the online survey were the formal letter and informed consent and/or assent for their voluntary participation. The scales of self-efficacy and career decision-making followed this.

Data Analysis

The data were tallied, tabulated, processed, and analyzed using frequency counts, percentages, and weighted mean to determine the level of self-efficacy and career decision-making. The study used multiple linear regression in examining the extent of influence of self-efficacy and demographic profile on the career decisions of teenage mothers.

3 Results and Discussion

Most of the participants were aged between 17–19-year-olds, and 14-year-old were the youngest (Figure 1). Most participants were still in high school with 59.68%, while others were high school graduates and college level with 20.16% and 20.16%, respectively. Most of their parents were not college graduates, and most were classified as poor and low-income (not poor) as their social status according to their income cluster, with P5,000-P10,000 having 30.64% as the highest percentage. P10,000-15,000 follows this with 21.77% and P1,000-5,000 with 20.16%.

The Level of Self-Efficacy of Teenage Mothers

The overall weighted mean of self-efficacy among teenage mothers was average (M = 3.15, SD = 0.633) (Table 1). Similar results among Filipino adolescent mothers also demonstrated a moderate level of self-efficacy (Mira et al. 2017). This means that teenage mothers have a fair set of beliefs that they could averagely and passably perform their tasks and plans of action related to career decision-making in prospective situations. Hence, it is crucial to nurture the self-efficacy of teenage mothers to increase their self-efficacy from an average level to a high level so that they can thrive better and succeed when pursuing any career-related decision-making.

The study by Valizadeh (2021) showed that students with good-to-high levels of self-efficacy beliefs demonstrate confidence and assertiveness in their academic achievements and performance. Career indecision and career uncertainty are linked to individuals' low self-efficacy, accentuating the crucial role of self-efficacy in shaping career decision-making (Sandra & Mularsih 2021). The

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

self-efficacy of students correlates significantly with their academic motivation, thereby enhancing the academic achievement of graduating Filipino college students (Yapo et al. 2021).

The Level of Career Decision-Making of Teenage Mothers

The overall career decision-making among teenage mothers yielded a high-level result (M=3.60, SD = 1.015). A high level of career decision-making suggests that individuals possess a substantial level of confidence in managing tasks related to career decision-making, particularly in self-appraisal for identifying influential resources and planning for their careers (Xing & Rojewski 2018). Individuals with higher scores in career decision-making are more adept at handling challenges and are less prone to encountering psychological barriers when making career decisions. It is associated with positive career attitudes, high self-esteem, and distinct vocational identity (Jiang & Jiang 2015). Meanwhile, low levels of career decision-making are usually associated with difficulties in career decision-making, often leading to career indecision (Gati et al. 2011). In this study, the high level of career decision-making of teenage mothers indicates that they exhibit enhanced abilities to navigate challenges and reduce the likelihood of encountering difficulties when making career decisions.

For each subscale of career decision-making, occupational informational gathering showed a high-level remark (M= 3.92, SD = 0.607) (Table 2). Occupational information gathering involves collecting important details about occupational and educational opportunities. Comprehensive occupational or career information encompasses details, including information in practice resources, career news, career policy, and career evaluation.

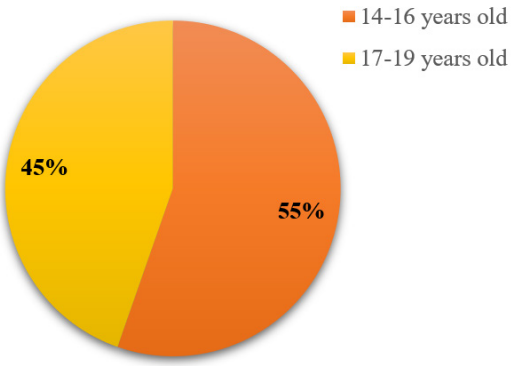

Figure 1. Age Distribution of Teenage Mothers

Table 1. Level of Self-Efficacy of Teenage Mothers

Indicators	Mean Score	Standard Dev	Remark
I can always manage to solve difficult problems if I try hard enough.	3.25	0.833	Average
If someone opposes me, I can find the means and ways to get what I want.	2.79	1.142	Average
It is easy for me to stick to my aims and accomplish my goals.	3.02	0.937	Average
I am confident that I can deal efficiently with unexpected events.	3.25	0.772	Average
Thanks to my resourcefulness, I know how to handle unforeseen situations.	3.50	0.577	High
I can solve most problems if I invest the necessary effort.	3.34	0.731	Average
I can remain calm when facing difficulties because I can rely on my coping abilities.	2.62	0.976	Average
When I am confronted with a problem, I can usually find several solutions.	3.20	0.732	Average
If I am in trouble, I can usually think of a solution.	3.12	0.728	Average
I can usually handle whatever comes my way.	3.40	0.583	Average
Over-all Self-Efficacy	**3.15**	0.633	**Average**

1.00-1.49= Very Low; 1.50-2.249= Low; 2.50-3.49= Average; 3.50-4.49= High

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

Table 2. Level of Career-Decision of Teenage Mothers

Indicators	Mean Score	Standard Dev	Remark
Occupational Information Gathering	**3.92**	0.607	**High**
• Find Information about occupations you are interested in.	4.69	0.691	Very High
• Find out the employment trends for an occupation over the next ten years.	2.61	1.287	Average
• Find out about the average yearly earnings of people in an occupation.	4.61	0.708	Very High
• Talk with a person already employed in a field you are interested in joining or switching.	4.05	0.863	High
• Find information about graduate or professional schools in line with your career goals.	3.63	1.032	High
Goal Selection	**3.51**	0.795	**High**
• Select one major from a list of potential majors you are considering.	3.56	1.092	High
• Select one occupation from a list of potential occupations you are considering joining or switching.	3.50	1.016	High
• Choose a career that will fit your preferred lifestyle.	2.57	1.191	Average
• Make a career decision, and then do not worry about whether it was wrong or right.	4.73	0.543	Very High
• Choose a major or career that will fit your interests.	3.19	1.194	Average
Planning	**3.82**	0.753	**High**
• Make a plan of your goals for the next five years.	4.02	1.000	High
• Determine the steps you need to take to complete your chosen major successfully.	4.33	0.762	High
• Prepare a good resume.	3.85	0.837	High
• Identify employers, firms, and institutions relevant to your career possibilities/progression.	3.01	1.158	Average
• Successfully manage the job interview process.	3.90	0.932	High
Problem-Solving	**3.33**	0.901	**Average**
• Determine the steps you take if you are having academic trouble with an aspect of your chosen major.	3.77	1.081	High
• Persistently work at your major or career goal even when you get frustrated.	3.80	0.937	High
• Change majors if you do not like your first choice.	2.49	1.165	Low
• Identify employers, firms, and institutions relevant to your career possibilities/progression.	3.92	0.889	High
• Identify some reasonable major or career alternatives if you are unable to get your first choice.	2.67	1.261	Average
Self-Appraisal	**3.40**	0.868	**Average**
• Accurately assess your abilities.	3.23	1.188	Average
• Determine what your ideal job would be.	3.82	0.914	High
• Decide what you value most in an occupation.	3.11	1.042	Average
• Figure out what you are and are not ready to sacrifice to achieve your career goals.	3.23	1.045	Average
• Define the type of lifestyle you would like to live.	3.64		High
Over-all Self-Efficacy	**3.60**	1.015	**High**

1.00-1.49= Very Low; 1.50-2.249= Low; 2.50-3.49= Average; 3.50-4.49= High; 4.50-5.00= Very High

In the development of the internet and global communication in a modern technology-driven world, occupational or career information is crucial as it helps individuals navigate the rapidly changing job market, understand emerging career opportunities, and acquire the necessary skills and education. It empowers informed decision-making, increases employability, and supports continuous professional development in an evolving digital landscape. Hence, it is important in the career guidance process (Cai 2020). The goal selection subscale yielded a high-level remark (M = 3.51, SD = 0.795). The selection of career goals is rudimentary, directly controls and guides individuals' behavior goals, and serves as a foundational motivational mechanism for explaining individual behavior. Through the specific mechanism of setting career goals, the focus on personal competence and the direction of action becomes clear and defined (Jung 2022). The planning subscale also showed a high-level remark (M = 3.51, SD = 0.753). Career planning is preparing career development direction, reflecting the potential to predict the future, real-world conditions, and the capacity to influence factors. It encompasses activities and strategies individuals

Volume 5 | Issue 1 | June 2024
PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

undertake to achieve practical goals related to their career aspirations (Song 2015). Meanwhile, problem-solving yielded an average level remark (M = 3.33, SD = 0.901). Problem-solving involves the cognitive process of identifying ways to achieve specific targets and intentions (Mefoh et al. 2017); it is an advanced cognitive skill that involves identifying the nature of a problem, breaking it down, and devising an effective set of actions to tackle its associated challenges (Abazov 2016; Oliveri et al. 2017). Self-appraisal also showed an average remark (M = 3.40, SD = 0.868). Self-appraisal or self-evaluation is critical to career decision-making (Jiang & Jiang 2015) and highlighted its significance in the process of career decision-making (Udayar et al. 2020).

The Influence of Self-Efficacy and Demographic Characteristics on Career Decision-Making of Teenage Mothers

The findings revealed that in terms of demographic characteristics such as age and educational attainment of teenage mothers generated VIFs greater than 5 and tolerance less than .02, which suggests that these variables add multicollinearity. They are highly correlated to the other independent variables used in the model. In modeling, the condition of independent variables should be highly correlated. Thus, these variables should be removed from the model.

Further, it also revealed that self-efficacy consistently had a significant influence on career decision-making across all five subscales, along with the mothers' level of educational attainment. Self-efficacy ($\beta = 0.635$, $p < 0.001$) and mothers' educational attainment - college level ($\beta = 0.517$, $p = 0.046$) demonstrating significant influences on occupational information gathering. These independent variables (self-efficacy and mothers' educational attainment - college level) contributed to 60.7% of the variations of the dependent variable (occupational information gathering) based on the generated $R^2 = 0.607$ of the model.

Self-efficacy ($\beta = 0.736$, $p < 0.001$) and all levels of mothers' educational attainment ($\beta = 0.613$, $p = 0.006$; $\beta = 0.682$, $p = 0.003$; $\beta = 0.939$, $p = <.001$; $\beta = 1.223$, $p = <.001$) demonstrating significant influences on goal selection. These independent variables (self-efficacy and various levels of mothers' educational attainment) collectively accounted for a significant portion of the variance in the dependent variable (goal selection), explaining 70.5% of the variability based on the generated $R^2 = 0.795$ of the model.

Self-efficacy ($\beta = 0.799$, $p < 0.001$) and all levels of mothers' educational attainment ($\beta = 0.666$, $p = <.001$; $\beta = 0.907$, $p = <0.001$; $\beta = 1.114$, $p = <.001$; $\beta = 1.211$, $p = <.001$), which also includes the fathers' educational attainment in terms of HS graduate and college level ($\beta = -.765$, $p = 0.040$; $\beta = -0.903$, $p = 0.021$) respectively demonstrating significant influences on planning. These independent variables (self-efficacy and various mothers' educational attainment and some levels of the father's educational attainment) contributed to 75.3% of the variations of the dependent variable (planning) based on the generated $R^2 = 0.753$ of the model.

Self-efficacy ($\beta = 1.042$, $p < 0.001$) and all levels of mothers' educational attainment ($\beta = 0.915$, $p = <0.001$, $\beta = 0.656$, $p = 0.005$; $\beta = 0.871$, $p = .002$; $\beta = 1.065$, $p = .002$) demonstrating significant influences on goal selection. These independent variables (self-efficacy and various levels of mothers' educational attainment) collectively accounted for a significant portion of the variance in the dependent variable (problem-solving), explaining 79.5% of the variability based on the generated $R^2 = 0.795$ of the model.

Self-efficacy ($\beta = .955$, $p < 0.001$) and all levels of mothers' educational attainment ($\beta = 0.740$, $p = <0.001$; $\beta = 0.595$, $p = .006$; $\beta = 0.932$, $p = <0.00$; $\beta = 1.097$, $p = <.001$) are also demonstrating significant influences on self-appraisal. These independent variables (self-efficacy and various levels of mothers' educational attainment) collectively accounted for a significant portion of the variance in the dependent variable (self-appraisal), explaining 86.8% of the variability based on the generated $R^2 = 0.868$ of the model.

These results imply that self-efficacy played a predictive factor in shaping the career decision-making process among teenage mothers. In support, Ogutu et al. (2017) examined the impact of self-efficacy on career decision-making among secondary school students. Their findings indicated that factors within the self-efficacy variable played a significant role in shaping the connection between self-efficacy and career decision-making. Hence, self-efficacy influences career decision-making. As highlighted by Rodinda and Eva

(2023), there is a significant favorable influence between self-efficacy and career decision-making. Higher levels of self-efficacy correspond to greater certainty in the career decision-making process among students. Additionally, self-efficacy influences career choices among undergraduate students (Njiku et al. 2022).

The study by Fouad et al. (2015) and Humayon et al. (2018) presented that family influence is a key factor in career-related decisions. These influences could be in different forms like family structural variables that reflected family members' socioeconomic status and family process-oriented variables, especially parental career-related behaviors (Xing & Rojewski 2018), including parents' educational and occupational attainment, family income, and finances-related concerns (Adikwu & Ereka 2022). However, in this study, family income consistently demonstrated no significant influence on career decision-making among teenage mothers, which reverses some research literature that indicates that family income or socioeconomic status significantly influences career decision-making and choice among students (Adikwu & Ereka 2022).

4 Conclusions and Recommendations

Based on the study findings, teenage mothers possess an average level of self-efficacy. This indicates that they only have adequate confidence in their ability to exert a degree of influence over their environmental occurrences and functioning, but it still significantly affects their career decision-making. Thus, the study concluded that it is vital to strengthen and cultivate their self-efficacy beyond the typical level so that teenage mothers would not execute their tasks and plans in a mediocre manner but teach a great sense of certainty, confidence, and assurance, particularly regarding life challenges and career decision-making.

To enhance the self-efficacy of teenage mothers, it is recommended that this be achieved through targeted interventions aimed at bolstering self-efficacy among teenage mothers, like mentorship programs and self-management, to be integrated into career guidance programs in schools and the community. These programs should provide information about the importance of self-efficacy, various career paths, educational opportunities, and skill development, empowering teenage mothers to be informed about their future career decisions.

Acknowledgement

The authors deeply appreciate the City Population Office (CPO) approving this study. To the barangay officials and health care workers for their assistance, which made data gathering more feasible. Further, the researchers are immensely thankful to the teenage mothers who participated in this study. This would not have been possible and successful without the people who showed their support and shared their expertise to refine this study.

5 Statement of Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

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PRINT ISSN: 2408-3623 | ONLINE ISSN: 2408 3631

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The journal, Annals of Studies in Science and Humanities would like to thank the following reviewers who were instrumental in ensuring quality, clarity and consistency among papers included in this issue:

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The main text should include the introduction, materials and methods, results and discussion, and conclusion. (Exception to this are researches that are theoretical in nature). They may be written as headings of separates sections or as an integrated text with appropriate headings suitable to the discipline. Headings and subheadings should be aligned to the left side of the page and set in bold face and italics. The main text of the manuscript should be written in this order:

•Introduction
•Materials and Methods
•Results and Discussion
•Conclusion
•Acknowledgement (if necesssary)
•Statement of No Conflict of Interest

All literature citations will follow the APA format.

Annals of Studies in Science and Humanities

Volume 5 | Issue 1 | June 2024

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CARAGA STATE UNIVERSITY
Ampayon, Butuan City, Agusan del Norte, 8600
Published in June 2024