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DESIGN OF A MICROPLASTIC AND WATER TURBIDITY REDUCTION DEVICE FOR AQUACULTURE BASED ON ELECTROCOAGULATION WITH IOT INTEGRATION DESIGN OF A MICROPLASTIC AND WATER TURBIDITY REDUCTION DEVICE FOR AQUACULTURE BASED ON ELECTROCOAGULATION WITH IOT INTEGRATION

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ABSTRACT

Human behavior that threatens the natural environment has been evidenced by the deteriorating state of the world's ecosystems, particularly in aquatic environments. The factor that has a significant impact on pollution is plastic. Plastic that spreads can break down into fragments known as microplastics. Microplastics are speculated to pose higher risks and can easily be released into water bodies. Then, due to the absence of biodegradable plastics in nature, plastics in the water will tend to be carried by currents and accumulate in convergence zones, areas where these plastics will gather and be swept along by other currents. At a time when many researchers have found plastic levels in fish bodies of various sizes, ranging from micro to even nano. Thus, the researchers are trying to reduce the levels of toxic substances in fish by taking samples of the milkfish species. (Chanos chanos). The method used is quantitative experimental with electrocoagulation techniques focusing on water turbidity and microplastic reduction in fish bodies. Electrocoagulation involves the use of a rapid mixing system to evenly distribute coagulants throughout the wastewater in the tank, forming larger flocs or particles that can be settled. With this, the researchers have developed this method into a tool named TM-Cycle (turbidity microplastic cycle) that is designed to be practical and can be applied in minimal spaces due to its relatively small size. The main objective of this research is to determine the differences in the quality of fish in electrocoagulated water compared to those in regular water, as well as the differences in water turbidity.

Keywords*: *abstract, bold, italic

A. INTRODUCTION

Seafood has increasingly emerged as a preferred alimentary resource across numerous nations, most notably Indonesia, owing to its omega-3 fatty acid composition, which is known to mitigate inflammation, safeguard cardiovascular health, and avert chronic illnesses. (Pahrurodji & Purwanti, 2021). Nevertheless, the prevailing pollution levels in aquatic environments exacerbate the likelihood of seafood being tainted by microplastics. Indonesia has been documented as the second-largest contributor to marine plastic pollution subsequent to China, with such waste ultimately degrading into microplastics that significantly affect both the aquatic milieu and the marine organisms inhabiting it. (Syifa & Novian, 2019). The infiltration of microplastics into biological systems is detrimental and has the potential to inflict cellular damage. (L.M & Chrysentia, 2020). In efforts to mitigate microplastic contamination, one viable technique that can be implemented is electrocoagulation. Electrocoagulation is a process that employs electrical current to induce the precipitation of particles suspended in water. (Wulan Sari, 2020). This technique involves the utilization of a pair of electrodes configured in parallel to act as a conduit for electrical energy directed towards the coagulant. (Wiyanto, et al., 2015).

This approach can be applied within the domain of aquaculture entrepreneurship. Aquaculture represents a commercial endeavor that is predominantly centered on trade within coastal regions. The Gresik District, distinguished by its strategic geographic

position, constitutes a significant contributor to the aquaculture industry, encompassing approximately 556 enterprises. (Mahfudlotul'ula & Kusnadi, 2015). However, it is imperative to note that the geographical attributes of Gresik have been characterized as a slum area due to the high urban density. The resultant pollution has facilitated the influx of waste containing toxic substances, which ultimately permeates the cultivated biota, including the milkfish (Chanos chanos) (Leny Agustin Maharani, 2014), thereby leading to an elevation in the turbidity of pond water. (Diliana, 2014). The milkfish identified as containing microplastics will subsequently be disseminated through the food web, with humans occupying the apex position as consumers. A study published in a journal revealed that out of 22 human blood samples analyzed, microplastic particles were detected in nearly 80% of the blood cells of the individuals assessed. Consequently, it is essential to initiate measures aimed at reducing the prevalence of microplastics. (Auta, et al., 2011).

The investigators proffered a solution through the development of a compact electrocoagulation apparatus that interfaces with a mobile device utilizing an Arduino Uno sensor via an Android application. (Susanto & Jauhari, 2019). This apparatus is outfitted with a turbidity sensor that quantifies the turbidity levels in the aquatic environment of shrimps that will undergo coagulation and subsequently be transferred to the prototype aquaculture pond. The architectural design and fabrication of this instrument predominantly utilize energy sourced from a rechargeable battery, which can be recharged through a charger (Farina, et al., 2019) connected via a USB interface. The microplastic remediation procedure within this apparatus occurs via a power source that supplies energy to the anode-type aluminum electrode, thereby facilitating the aggregation and amalgamation of hazardous substances present within the aquatic medium. (P & Harsanti, 2010). The water that has been subjected to the electrocoagulation process will be directed to a pond or aquarium through a hose that is integrated with a turbidity sensor, which will establish a feedback mechanism for the electrocoagulation operation of the water within the device. This innovative design is designated as TM-Cycle. (turbidity microplastic cycle).

The writing system consists of an introduction, methods, results, discussion, and conclusion. The introduction contains the reasons for conducting the research supported by a literature review. (theoretical). The introduction section is written to be about 20% of the body of the article. Then, the methods section contains a brief description of the research methods used (approximately 10% of the body of the article). The next section is very important, namely regarding the results and discussion. This section is written to comprise about 65% of the overall article, and the discussion of the research results must refer to previous research findings. The conclusion is written concisely (about 5% of the body of the article) to provide a brief answer to the research problem. Meanwhile, the bibliography is written according to the guidelines issued by the American Psychological Association (APA) Sixth Edition published in 2010.

In light of the various challenges and concerns articulated in the preceding sections of this discourse, the overarching aim of the present research endeavor is fundamentally centered around two primary objectives, which are delineated as follows:

1. To meticulously evaluate and ascertain the degree of effectiveness exhibited by the TM-Cycle methodology in the process of elucidating and subsequently diminishing the

turbidity levels present within the aquatic habitat specifically designated for the rearing of milkfish (Chanos chanos) within controlled pond environments, thereby facilitating a clearer understanding of its implications for aquaculture practices.

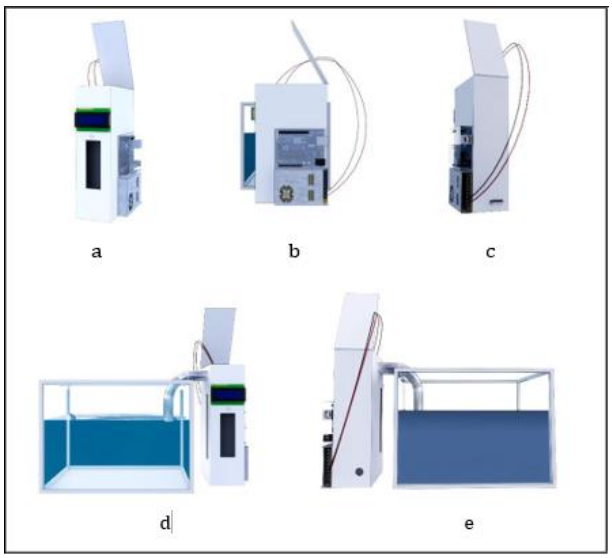
2. To comprehensively investigate and analyze the efficacy of the TM-Cycle approach in mitigating and reducing the presence of microplastic contaminants that may be found within the physiological structures of milkfish (Chanos chanos) in pond ecosystems, aiming to contribute valuable insights into the broader environmental impacts on marine life and food safety.

B. RESEARCH METHOD

After conducting a comprehensive and meticulous review of existing scholarly literature pertaining to various human food sources, particularly focusing on shrimp, a contemporary and portable electrocoagulation device was meticulously designed, utilizing the findings from pre-field tests carried out in both the Physical Chemistry Laboratory within the Faculty of Mathematics and Natural Sciences (FMIPA) and the Manufacturing Automation Laboratory located in the Faculty of Technology (FT) at the esteemed Brawijaya University. The subsequent testing phase for this innovative device was executed at one of the coastal aquaculture ponds situated in Gresik, which is located in the province of East Java, thereby ensuring that the device could be evaluated in a real-world environment representative of its intended application.

The individual components and materials that comprise this sophisticated tool were meticulously designed utilizing advanced software, specifically Blender, which facilitated the initial creation of a two-dimensional design that was then expertly transformed into a highly detailed three-dimensional illustration, incorporating intricate details pertaining to the sensors that are integral to its operation. Following the completion of the design phase, significant efforts will be directed towards adapting this innovative design for integration with mobile technology, specifically through the development of an application that is based on the widely-used Android operating system. This adaptation is crucial as it will enable users to conveniently operate the electrocoagulation device through their mobile phones, thereby enhancing accessibility and functionality in various practical scenarios. Ultimately, this project represents a significant advancement in the field of food safety and processing technology, demonstrating the potential for innovative solutions to address contemporary challenges in the aquaculture industry.

Figure 1. a device seen from the front, b device seen from the side, c device seen from the back, d device with aquarium seen from the front, e device with aquarium seen from the back.



From the image, data can be obtained through sensors connected to a mobile phone, presenting data in the form of turbidity based on Arduino Uno. Thus, data can be collected on the turbidity level of water. TM-Cycle uses a system that can detect turbidity values and employs an Arduino Uno programming drive system in real-time. After both sensors have completed the detection process on the object, the quantity concentration results will be displayed on the mobile phone screen.

Data Sources, Tools, and Materials

This research involved 6 milkfish with 3 repetitions for each object over the course of 1 week. This research was conducted using an experimental quantitative method. By analyzing the differences in the results between the electrocoagulated and non-electrocoagulated samples regarding the quality of milkfish and turbidity in water, the variables in this study are as follows:

- Independent Variable : Electrocoagulation on the object
- Dependent Variables : Turbidity concentration in water and the quantity of microplastics in fish
- Control Variables: Water volume, fish species

The tools and materials needed for this research are:

1. Tools

Tool	Brand/Type
Adapter	Power
Aluminum Electrode	-
Crocodile cable	-
Container	-
Beaker glass	Iwaki
Measuring pipette	Pyrex
Bulb pipette	D&N
Turbidity sensor	-
Arduino Uno sensor type 12V	El - Tech
LCD display	-

Glass	-
Stainless steel pipe	Clamp
Battery charger and USB port	SMARTOOLS

2. Materials

Materials	Brand/Type
Water (fish habitat)	-
Milkfish (Chanos chanos)	-
Litmus paper	Merck

C. RESULTS AND DISCUSSION

Based on the comprehensive literature review that has been meticulously conducted, it can be interpreted that:

1. Previous Research on Electrocoagulation In light of the extensive body of previous research undertaken in the field of electrocoagulation, it has become evident that this particular method was systematically applied to electrochemistry, grounded in well-defined design and construction principles, with the fundamental mechanism involving oxidation reactions that transpire at the anode due to the continuous flow of electric current, which consequently leads to the generation of aluminum ions (Al ions) and the subsequent reaction of these ions with hydroxide ions (OH-) to form aluminum hydroxide (Al(OH)3). This compound then plays a pivotal role in capturing chromium ions (Cr ions) present in wastewater, whereby the formation of Al(OH)3 is observed to increase in proportion to the concentration of dissolved metals that are being effectively removed from the water. This removal process is followed by the extraction of Cr ions until a significant accumulation of Al3+ ions occurs, which ultimately facilitates the flocculation of Al(OH)3, essential for the coagulation process aimed at purifying the water. The resulting flocculation of Al(OH)3 is particularly noteworthy as it has the capacity to entrap and immobilize harmful insoluble substances that are present within the aqueous solution, thereby enhancing the overall purification process (Amri, et al., 2020). The electrocoagulation process is fundamentally based on the principle of utilizing electrolysis cells, which are sophisticated devices designed to convert direct current (DC) electricity into various electrochemical reactions that are instrumental in the treatment of wastewater (Hanum, et al., 2015). Nevertheless, it is imperative to acknowledge that this method does possess certain limitations, particularly its inability to effectively electrocoagulate substances that exhibit excessively high electrolyte content, a situation that can lead to short-circuiting between the anodes, thus adversely affecting the percentage reduction of pollutants present in the waste stream (Takwanto, et al., 2018). In response to these challenges, the proposed tool innovation demonstrates significant advantages, particularly in terms of work automation, as it is seamlessly integrated with Internet of Things (IoT) technology and is capable of connecting directly to mobile devices. This integration is strategically intended to enhance time efficiency while simultaneously mitigating the risk of human error, which can often occur in the monitoring process, largely due to the implementation of advanced turbidity sensors. Furthermore, this innovative tool is designed to transmit turbidity data directly to the user's mobile phone, thereby eliminating the necessity for continuous and real-time monitoring of the process, which can be both labor-intensive and time-consuming. Additionally, the compact packaging of this tool

contributes to its portability, rendering it usable in a variety of locations, thereby extending its practical applications in the field of water treatment.

2. Previous Research on Microplastic Management Microplastics, which are classified as debris with a size larger than 4 mm, are derived from an array of sources, including but not limited to rivers, as elucidated by Javier Castro-Jiménez et al. (2019), where illegal waste disposal practices frequently occur, resulting in significant environmental repercussions. The detrimental effects of such waste on aquatic animals are profound, as the ingestion of microplastics can lead to severe health complications and, in many instances, premature death among these organisms (Wegorzewski et al., 2015). In response to the growing concern surrounding microplastic pollution, various technologies have been developed to effectively manage and mitigate the impacts of these pollutants. These technologies encompass the replacement of conventional fossil plastic materials with biodegradable alternatives, which can be synthesized from renewable sources such as plant starch, vegetable oils, and biodegradable polymers, thereby promoting sustainability (Oktavianti, 2020). Furthermore, the purification process for microplastics can be executed through the application of enzymes, which involves a series of three critical steps: extraction, precipitation, and the purification of proteins via chromatography techniques. Other strategies for managing microplastics include the installation of trash traps in water bodies, the deployment of micron filtration units in ponds, and the innovative utilization of microplastic-degrading bacteria, all of which collectively contribute to the reduction of microplastic contamination in aquatic environments.
3. Previous Research on Water Turbidity Water turbidity is defined as the quality of water that contains various compounds and solid substances, which contribute to the total suspended solids (TSS) present in the water (R. Maturbongs, 2015). To facilitate the reduction of turbidity in water, a systematic approach is employed, which involves the utilization of simple coagulants. This process begins with allowing the turbid water to settle for a duration of 24 hours, after which a stock solution of a natural coagulant, specifically derived from Moringa oleifera, is introduced to the water. Subsequently, this mixture undergoes a thorough examination through a jar test operation, which is conducted until the desired concentration of the coagulant is achieved, thereby optimizing the coagulation process. Following this step, a detailed analysis is conducted using a pH meter to assess the chemical properties of the treated water (Asrafuzzaman et al., 2011). Through these methodologies, it is possible to significantly improve the quality of water by reducing turbidity levels, thereby enhancing its overall suitability for various applications, including drinking and irrigation.

D. CONCLUSION

The actions and decisions of humans that endanger the delicate balance of the natural environment have become increasingly apparent, as evidenced by the alarming and ongoing deterioration of the various ecosystems that comprise our planet, with a particular emphasis on the increasingly compromised state of aquatic environments which are vital to global biodiversity. One of the most critical contributing factors that has been shown to have a remarkably significant impact on the pervasive issue of pollution in these environments is the widespread use and subsequent disposal of plastic materials, which, due to their ubiquitous presence in modern society, have become an indelible part of the pollution crisis. When plastic waste is introduced into ecosystems, it can undergo a process of degradation that results in the formation of tiny particles, commonly referred to as microplastics, which

are characterized by their exceedingly small size and ability to infiltrate various environmental compartments. There is a growing body of speculation and scientific inquiry suggesting that these microplastics may pose substantial and multifaceted risks to marine life and ecosystems, as they can be easily and readily released into water bodies, where they may be ingested by organisms or otherwise disrupt ecological processes. Furthermore, the current environmental landscape is exacerbated by the unfortunate reality that biodegradable alternatives to conventional plastics are largely absent from natural ecosystems, leading to a situation whereby plastics introduced into aquatic environments are prone to being transported by water currents. As a result, these plastics tend to accumulate in specific convergence zones, which are defined as areas where different currents converge and facilitate the gathering and entrapment of plastic debris, effectively creating hotspots of pollution that can have dire consequences for marine ecosystems. In summary, the intersection of human activity, plastic pollution, and the unique dynamics of aquatic environments is a complex and urgent issue that necessitates comprehensive research and concerted efforts to mitigate its profound impacts on the natural world.

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