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Garlic (*Allium sativum*) as a Preservative Agent in Fresh Nile Tilapia (*Oreochromis niloticus*) from Laguna De Bay, Philippines

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Abstract:- Every household experiences food spoilage or simply a change of appearance different from the food in its fresh form, a change in color, a change in texture, an unpleasant odor, or an undesirable taste, and that adds up to the amount of food waste, especially from the community to the whole country.

This research was conducted using garlic (*Allium sativum*) as a preservative agent for Nile tilapia (*Oreochromis niloticus*) from Laguna de bay, Philippines. Nile tilapia (*Oreochromis niloticus*) begins to decay or deteriorate immediately after capture and cleaning; it also requires proper handling and preservation to increase its shelf life and retain its quality.

This study addresses the use of an experimental research design in which garlic (*Allium sativum*) was extracted using the process of maceration or an extraction procedure that uses a mortar and pestle to pound the garlic cloves into smaller pieces to obtain its extract quickly. The product, which is Nile tilapia in garlic extract, was observed during the preservation period for three days, and after that, it was subjected tomicrobiological analysis. Simultaneously, the researchers also observed the untreated tilapia for comparison. The product given to the Food Development Center for microbiological analysis was negative for Escherichia coli and Salmonella, which are the main reasons for spoilage of tilapia. In conclusion, this study shows that based on observation and microbiological analysis, garlic (*Allium sativum*) extract was effective as a preservative agent for Nile tilapia (*Oreochromis niloticus*) from Laguna de Bay.

Keywords:- *Nile Tilapia, Garlic Extract, Preservative Agent.*

I. INTRODUCTION

Every Filipino chooses fresh tilapia as a dish because of the different ways to cook it and because it is cheap, depending on the season. According to Mason (2022), it is generally acceptable to consume tilapia that has been at room temperature for up to 2 hours; however, there is a danger of food poisoning after this period. Bacteria that can cause food poisoning, such as *salmonella*, can proliferate on fish left at temperatures ranging from 35°C to 37°C.

The researchers are conducting a study to determine the possible solution for this which is preservation. The organic preservative that can help eradicate this problem is garlic (*Allium sativum*) extracts, which are also abundant in the Philippines. It is available for each season in dry and moist markets, retail and wholesale. Some studies have shown that garlic (*Allium sativum*) is an effective preservative. In accordance with Sarma (2004), garlic could be an effective meat preservative for preventing meat spoilage due to bacterial growth. Garlic keeps killing bacteria when *Salmonella* and *E. coli*are present - as stated by Taski (2015). Garlic can be used as a food preservative to inhibit the growth of pathogens and as a remedy for treating or preventing several diseases.

The study intends to experimentally show the efficacy of garlic (*Allium sativum*) extracts as a preservative for fresh Nile tilapia (*Oreochromis niloticus*). During the academic year 2022-2023, the researchers seek to determine if the shelf life of fresh Nile tilapia (*Oreochromis niloticus*) will be prolonged and similar to the day the fish was purchased.

This proposed study is expected to tackle the effectiveness ofgarlic (*Allium sativum*) extracts as a preservative agent in fresh Nile tilapia (*Oreochromis niloticus*). The objectives of our study are as follows:

- To assess the garlic (*Allium sativum*) extracts' ability to prolong the shelf life of fresh tilapia (*Oreochromis niloticus*).
- Evaluate whether fresh tilapia (*Oreochromis niloticus*) can be consumed or cooked with the same quality from the day it was bought.
- Observe if there was a difference betweengarlic (*Allium sativum*) treated fresh tilapia and untreated (no preservatives added) fresh tilapia.

This study aimed to use garlic (*Allium sativum*) extracts as a preservative agent for Nile tilapia (*Oreochromis niloticus*) from Laguna de Bay to increase its shelf life. Specifically, this study aims to answer the following questions:

- *What is the effectiveness of using garlic (Allium sativum) extracts as a preservative agent in fresh Nile tilapia (Oreochromis niloticus) in terms of*

- *Appearance*;
- *Smell;*
- *Texture and*
- *Taste (Cooked)?*

- *Is there a significant difference betweengarlic (Allium sativum) treated fresh tilapia and untreated (no preservatives added) fresh tilapia in terms of the variable mentioned above?*
- *What are the bioactive components of garlic (Allium sativum) that make it a preservative agent for fresh Nile tilapia (Oreochromis niloticus)?*

- *Theoretical Framework*

According to Sadat Kamal Amit et al. (2017), "A review on mechanisms and commercial aspects of food preservation and processing," foods is an organic substance consumed for nutritional purposes. Foods are of plant or animal origin and contain moisture, protein, lipid, carbohydrate, minerals, and other organic substances. Foods undergo spoilage because microbial, chemical, or physical actions. The nutritional values, color, texture, and edibility of foods are susceptible to spoilage. Therefore, foods must be preserved to retain their quality for extended periods. Food preservation is the process of maintaining internal and external factors that may cause food spoilage. The principal objective of food preservation is to increase its shelf life while, retaining its original nutritional values, color, texture, and flavor.

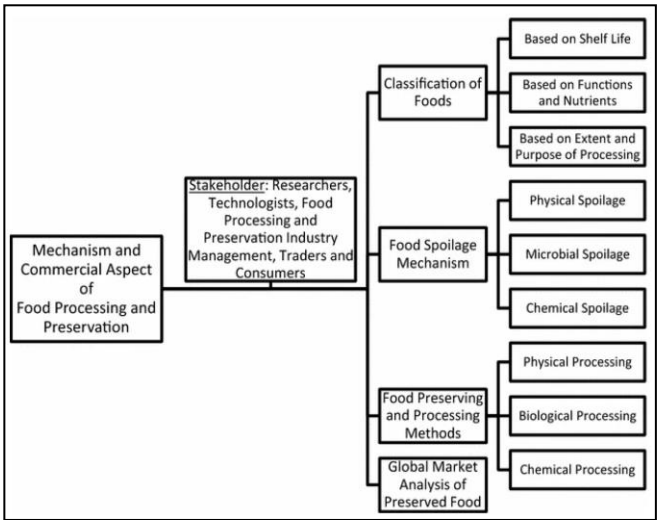

Fig 1 Flow Diagram of Various Categories of Foods

According to Martindale et al. (2017), food waste behaviors connect many sustainability issues across consumers' complex food choices when meals are prepared. Our research shows that food manufacturers and retailers occupy critical supply points that can determine how these food consumption behaviors can be transformed into more sustainable ones. An important way of achieving this is by reducing the food waste associated with every meal.

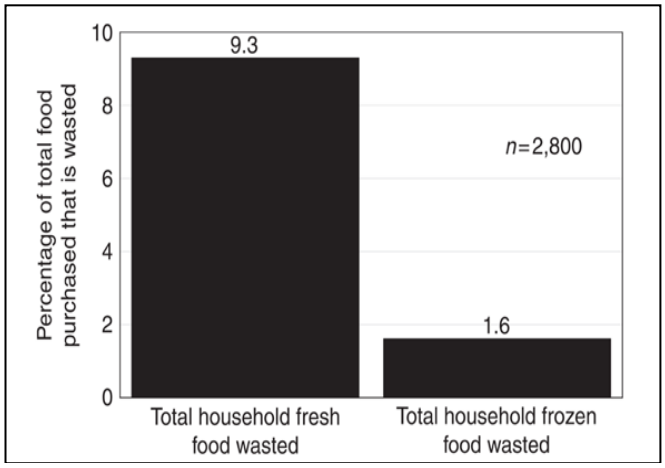

Fig 2 Amount of Food Waste Associated with Total Purchases of Fresh and Frozen Foods in Austrian Households

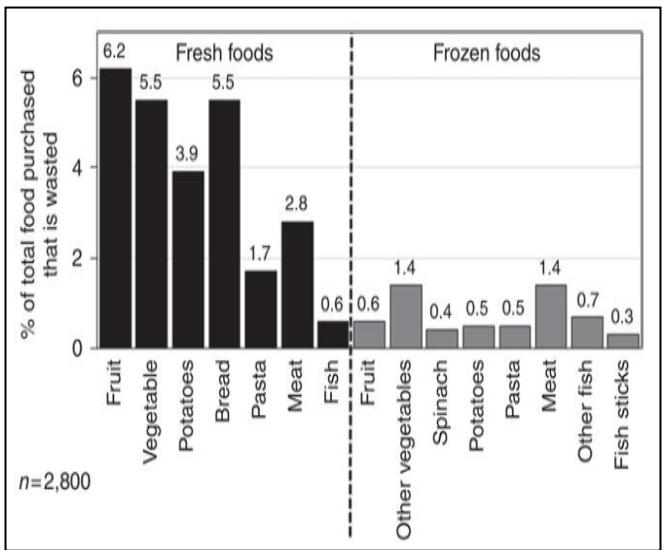

Fig 3 Percentage of Food Purchases Wasted forFresh and Frozen Food Product Categories Assessed

Food spoilage is a problem of every home in the Philippines, and that is how it was explicitly explained in this framework. The researchers showed how to eradicate food spoilage using garlic (*Allium sativ*um) extract as a preservative agent for fresh Nile tilapia (*Oreochromis niloticus)* from Laguna de Bay. The researchers used the capabilities and bioactive components of garlic (*Allium sativum*) extract to slow down the build-up of pathogens that cause food spoilage.

II. METHODOLOGY

This study addresses the use of an experimental research design to assess the effectiveness of garlic (*Allium sativum*) extracts as a preservative agent for fresh Nile tilapia (*Oreochromis niloticus*). The extract was collected through the collection and maceration of garlic (*Allium sativum*), which means that the researchers extracted garlic (*Allium sativum*)using a mortar and pestle and pounding it into smaller pieces. The researchers observedchanges in physical appearance, taste, odor, and texture for three consecutive days after the applying garlic (*Allium sativum*) extract to fresh Nile tilapia (*Oreochromis niloticus*).

The studyexpands the abilities of garlic (*Allium sativum*) not just as a flavorful and healthy ingredient in a dish but alsoas a preservative agent in a tilapia (*Oreochromis niloticus*) from Laguna de Bay. The study observed the characteristics of tilapia (*Oreochromis niloticus*) to compare the changes after it was preserved, and it was analyzed by the Food Development Center - Department of Agriculture foraccuracy.

The scope of the study will revolve around preserving fresh tilapia (*Oreochromis niloticus*) to avoid food spoilage by using garlic (*Allium sativum*) extracts. There are so many kinds of fish that the researcher will encounter, but the study only focuses on one species: Nile tilapia (*Oreochromis niloticus*) from Laguna de Bay. During the study, researchers might encounter problems that could harm the study. The abovementioned problems could benatural calamities that could affect the supply of Nile tilapia (*Oreochromis niloticus*), the aquaculture farm in Laguna de Bay.

The method is used to observe how long garlic extract prolongs the shelf life of fresh tilapia until the researchers see the difference when fresh tilapia with garlic that has been extracted and untreated tilapia are tested. There is a definite quantity of ingredients and procedures that the researchers should follow to prove that preservation using garlic extract on tilapia is successful. The procedures that researchers would implement are as follows:

➢ *Procedures*

- *Choosing Fresh Nile Tilapia (Oreochromis niloticus)*

✓ Purchasing Nile tilapia (*Oreochromis niloticus*) from Barangay Bagumbayan in Taguig City nearLaguna de Bay.
✓ Meticulously check the eye, gills, body, smell, and scale of Nile tilapia (*Oreochromis niloticus*) to determine if it is fresh.

- *Purchase of Garlic (Allium sativum)*

✓ Acquiring approximately 1 kg of garlic (*Allium sativum*).

- *Cleaning of Nile Tilapia (Oreochromis niloticus)*

✓ Rinse with tap running water to remove debris andslimy liquid surrounding the fish.
✓ Using the scraper-style scaler, remove the scale in a direction from tail to head.
✓ Remove the gills with a knife and scoop out with a spoon orfinger.
✓ Using a kitchen knife, carefully cut the fins on both sides of the fish and trim the tail.
✓ To remove the gutinnards, use a knife to open the bottom part of the fish and remove it with a spoon or your finger.
✓ Rinsewith tap running water thoroughly, and then tap dry with a paper towel.

- *Extraction of Garlic (Allium sativum)*

✓ Remove every clove one by one.
✓ To easily remove the skin of the garlic, the researchers will use a knife to press the garlic using the flat surface of the knife.
✓ Using a mortar and pestle, pound the garlic like a paste.
✓ Place the pounded garlic in a fine mesh strainer and forcefully push it to extract it.

- *Coating Nile Tilapia (Oreochromis niloticus) with garlic (Allium sativum) extract.*

✓ Place the Nile tilapia (*Oreochromis niloticus*) in a plastic container to ensure that it is clear and has enough space.
✓ Spread the garlic (*Allium sativum*) extract thoroughly in every part of Nile tilapia (*Oreochromis niloticus*) using a clean spoon.
✓ Leave in a dry place and at room temperature.

The data gathered and shown in this study were taken from observations made during the study. The researchers observed the changes in Nile tilapia for about three consecutive days. This table serves as a criterion for obtaining the scores of each characteristic observed from the first day (Day 1) to the last day (Day 3).

Table 1 Criteria of Characteristics Observation

Criteria	Characteristics	Score
Appearance	Red gills	5
	Pink gills	4
	Pale gills	3
	Gray gills	2
	Black gills	1
Smell/Odor	No Smell	5
	Garlic smell	4
	Fishy smell	3
	Bad smell	2
	Rotting smell	1
Texture	Firm Texture	5
	Soft Texture	4
	Dry Texture	3
	Shaggy Texture	2
	Decomposing Texture	1
Taste	Strong garlic taste	5
	A bit garlic taste	4
	salty	3
	Undesirable taste	2
	Not Edible	1

Legends: 5- Very good, 4-Good, 3-Acceptable, 2-Poor, 1-Very poor

➢ *Microbiological Analysis at the Food Development Center (FDC)*

In preserving Nile tilapia (*Oreochromis niloticus*) using garlic extract (*Allium sativum*), the researchers aimed to slow down the zero build-up of pathogens such as *Salmonella* and *Escherichia coli* to zero.

On May 2, 2023, the researchers submitted a sample containing one (1) piece of tilapia with garlic extract packed in an unlabeled plastic container in the Food Development Center. The report of microbiological analysis was done on May 09, 2023 (7 days after the sample was submitted).

The researcher's sample was analyzed by Ms. Gracielle B. Brizuela, Senior Science Research Specialist from the Microbiology Section in FDC, and certified as correct by Ms. Rachel R. Elano, Smicro Supervising Science Research Specialist from the Microbiology Section in FDC.

The result was given on the date of May 15, 2023, and it says that the 3-tube MPN (most probable number technique) showed growth and gas formation; this it means that upon the consecutive days of waiting for the product to be analyzed, the product releases a gas that causes the container's lid to be moist, but was negative in the confirmatory tests.

For the researcher's product result to be accurate and more effective, it must be tested at local and legal food testing centers such as the Food Development Center. The researchers, therefore, conclude through the help of FDC that preserving Nile tilapia (*Oreochromis niloticus*) through the extract of garlic (*Allium sativum*) can help eradicate food spoilage due to the build-up of pathogens.

- *Statistical Treatment Data*

The mean was obtained from the scores gathered from the first day (day 1) of preservation up to the last day (day 3). The mean will be used for the two independent sample t-tests to determine if there is a significant difference between the garlic treated and untreated tilapia. The mean will be determined using the following formula:

$$\overline{X} = \frac{\sum X}{N}$$

x = mean
∑x =sum of observations
n = number of observations

Two independent sample t-tests were used to measure the difference between the two samples. It will determine if there is a significant difference between the garlic-treated and untreated tilapia in terms of appearance, smell, and texture using the following formula:

$$t = \frac{\left(\overline{X}_1 - \overline{X}_2\right)}{\sqrt{\left[\frac{SS_1 + SS_2}{N_1 + N_2 - 2}\right]\left[\frac{1}{N_1} + \frac{1}{N_2}\right]}}$$

t = t-test
$\bar{x}$ = the mean of group 1
x = mean of group 2
SS_1= sum of squares of group 1
SS_2= sum of squares of group 2
n_1 = number of observations in group 1
n_2 = number of observations in group 2

- *Ethical Considerations*

In this study, for the researchers to continue without any harm in the community where it will be done and for the researcher's safety and avoidance of any harmful effect of materials and ingredients that the researchers needed first, gathering and acquiring such ingredients needed in this study and it is from the aquaculture farms in Laguna de Bay (City of Taguig) where we got the Nile tilapia (*Oreochromis niloticus*) and Barangay Upper Bicutan wet market where we got the garlic (*Allium sativum*).

Next, in the process of cleaning Nile tilapia (*Oreochromis niloticus*), the researchers wore gloves, aprons, hair nets, and clean kitchen tools to avoid the harmful effect of garlic (*Allium sativum*) while extracting it and strictly followed the correct personal protective equipment (PPE) needed such as lab coats, gloves, hair nets, and face mask.

Finally, the researchers guaranteed thatNile tilapia (*Oreochromis niloticus*) with garlic (*Allium sativu*m) extract was free of any substances that would harm the people and environment where it was produced.

III. RESULTS AND DISCUSSIONS

Table 2 Result on the Effectiveness of Garlic (*Alliums sativum*) Extract in terms of Appearance, Smell, Texture, and Taste

Criteria		Treated		Untreated	
		Score	Description	Score	Description
Appearance	Day 1	5	Red	3	Pale
	Day 2	4	Pink	2	Gray
	Day 3	4	Pink	1	Black
Smell	Day 1	4	Garlic	3	Fishy
	Day 2	4	Garlic	2	Bad
	Day 3	4	Garlic	1	Rotting
Texture	Day 1	5	Firm	3	Dry
	Day 2	5	Firm	2	Shaggy
	Day 3	3	Dry	1	Decomposing
Taste	Day 1	4	A bit garlic	1	Not edible
	Day 2	4	A bit garlic	1	Not edible
	Day 3	4	A bit garlic	1	Not edible

Table 2 shows the comparison between the treated and untreated samples in terms of appearance, smell, texture, and taste. All the scores of garlic-treated tilapia were greater than the scores of untreated tilapia. Therefore, garlic extract prevents the microorganisms that cause spoilage, resulting in changes in its appearance, smell, texture, and taste, such as *Salmonella* and *Escherichia coli*.

According to Kombat etal. (2017), as soon as it is caught or it dies, fish loses its natural resistance to microbial attack and starts to undergo spoilage due to intrinsic enzymes, bacteria, and fat oxidation. The spoilage is easily noticed because it consists of changes in taste, smell, appearance, and texture.

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Table 3 Result if there is a Significant Difference between the Garlic-Treated and Untreated-Tilapia in terms of Appearance, Smell, and Texture

Criteria	T-test		DF	P-value	Decision	Interpretation
	Computed	Critical				
Appearance	3.5	2.776	4	0.02	Reject Ho	Significant
Smell	3.46	2.776	4	0.03	Reject Ho	Significant
Texture	2.65	2.776	4	0.06	Accept Ho	Not Significant

If t-computed value>=t-critical value, reject Ho.

Table 3 shows the result of the t-test in the significant difference between the garlic-treated and untreated tilapia in terms of appearance, smell, texture, and taste at 0.05 level of significance. The computedt-value, of 3.5 and, 3.46 are both greater than the critical value of 2.7764; thus the null hypothesis is rejected. There was is a significant difference between garlic-treated and untreated tilapia in terms of appearance and smell. However, if the value of 2.65 is less than the critical value of 2.7764, then the null hypothesis is accepted; therefore, there is no significant difference in texture between the garlic-treated and untreated tilapia.

Table 4 Report of the Microbial Analysis

Analysis	Result	Method
Escherichia coli Count as MPN Most Probable number per gram (MPN/g)	<3.0	Enumeration by MPN
Salmonella	Not Detected in 25 grams	Detection

Table 7 shows the results of microbial analysis. Through the use of MPN or most probable number method, it was discovered that the presence of *Escherichia coli* is less than the which is considered to be present in the sample, while the detection method used to determine if there is a presence of *Salmonella* in the fish indicates that the said bacteria is not detected in 25 grams. This implies that garlic extract can eliminatebacteria that cause spoilage, such as *Escherichia coli* and *Salmonella.*

According to Ahmad Reynaldi et. al. (2019), garlic contains allicin compounds that are bactericidal and can inhibit the growth of bacteria such as *Escherichia coli* and *Staphylococcus aureus.* These two (2) bacteria can causedifferent types of illnesses if consumed, and also it is also the main reason why fish canspoil.

IV. CONCLUSION

There can be no doubt that the effectiveness of garlic (*Allium sativum*) extracts is proved by comparing the treated and untreated Nile tilapia and showing that they have a significant difference in appearance based on the observed characteristics of treated tilapia since it has a higher scores than those of untreated fish tilapia from day 1 to day 3. Beside appearance, there is the smell, texture, and taste. In terms of smell, there is a significant difference between treated and untreated tilapia because of the potential reduction in fishyodor - the preserved tilapia may have a milder or less pronounced fishy odorthan untreated fish tilapia. Moreover, the texture of treated tilapia may exhibit a firmer texture compared to the untreated fish tilapia, where it affects its texture because of being spoiled. However, the taste of treated tilapia is likely to have a distinct garlic flavor because of the use of garlic extract for preservation. While the untreated Nile tilapia had already rotted and did not last a day, and it was impossible to tell if it was still edible.

The results of comparing the garlic-treated tilapia from untreated (no preservatives added) tilapia have shown that there is a significant difference between them in terms of appearance, smell, texture, and taste. This implies that the garlic-treated tilapia have performed better than the untreated tilapia, considering that table 6 shows that there is a significant difference between the two aforementioned samples. In addition, the result of microbial analysis shows that the garlic-treated tilapia is negative from the bacteria that could cause food spoilage; hence, it proves that the garlic extract is effective as a preservative agent for Nile tilapia.

In the use of preservation, garlic extract primarily acts as a natural antimicrobial agent because of compounds such as allicin, which inhibit the growth of microorganisms. Salt, on the other hand, works as a preservative by drawing out moisture from the cells of microorganisms, thereby inhibiting their growth. The choice between garlic extract and salt depends on the specific microorganisms targeted and the preservation method employed. Garlic extract has broad-spectrum antimicrobial activity against various pathogens, including bacteria, fungi, and some viruses. Salt, however, primarily inhibits the growth of bacteria. If the preservation goal is to target a wider range of microorganisms, garlic extract may be the preferred choice. With regards, to taste and flavor, garlic extract can add a distinct flavor and aroma to preserved foods, which may be desirable in certain culinary applications. Salt,a common ingredient in many foods, has a more neutral taste. The choice between garlic extract and salt may depend on the desired flavor profile of the preserved product. Garlic extract is a natural ingredient derived from garlic bulbs, and salt can be either natural or synthetic. For individuals seeking natural or organic preservatives, garlic extract may be a preferable option for food preservation.

This research contributes to the understanding of natural preservatives and their potential application in the preservation of fresh Nile tilapia. The findings highlight the significance of garlic extract in maintaining the freshness, quality, and shelf life offish, offering a sustainable and safer alternative to synthetic preservatives. In addition, future research might expand on these results to improve the use of garlic extract, investigatepossible combinations with other natural preservatives, and evaluate the practicality and consumer acceptance of its use in fish preservation.

RECOMMENDATIONS

This study illuminates the promising potential of garlic extract as a preservative for Nile tilapia from Laguna de Bay, showcasing its societal impact by curbing food waste and enhancing livelihoods. The recommendations stemming from this research advocate for widespread adoption:

Firstly, local government units and non-governmental organizations should integrate garlic extract as a viable preservative option, recognizing its efficacy in combating food spoilage at the household level, thereby empowering citizens to employ it in their homes.

Additionally, suggesting that household parents incorporate garlic extract into fish marination to prevent bacterial growth and enhance flavors when cooked presents a practical application in everyday cooking routines.

For future researchers, the recommendation emphasizes applying this study within communities to raise awareness of garlic extract's preservative capabilities. Key considerations for subsequent investigations include evaluating its effectiveness under varying climatic conditions, maintaining room temperatures between 20 and 23 degrees Celsius to optimize preservation, exploring its application on diverse meat products such as pork, chicken, and beef, and prescribing the ideal garlic quantity for preservation purposes—1kg to produce ¼ pint of garlic extract suitable for preserving 1kg-2kg of tilapia. These strategic guidelines serve as pillars for further exploration and implementation of garlic extract as a sustainable preservative in food management practices.

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