Degradation Of Organic Kitchen Food Wastes Enhanced with Probiotics

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Abstract — The proper degradation of food waste is one of the environmental issues that need to be addressed. This present study aimed to help the community in degrading their food waste. It uses homemade probiotics as enhancers to make the food waste degradation fast, odorless, and beneficial as the food waste can be used as soil fertilizer with experimental methods. The ways of degrading the food waste are (a)collection of food waste, (b) placing the six(6) drums in the sample site, (c) Labeling the six drums with and without probiotics, and (d)mixing probiotics with chlorine-free water. After the step-by-step procedure, observation for 14 days must be followed. In just 5 days, the color of the food waste changed. The odor was slowly gone in just 3 days and the physical appearance of the food wastes became watery during the 5th day of observation. Additionally, the food wastes have been analyzed by the Department of Science and Technology (DOST) with the test parameters of Nitrogen, Moisture, and Potassium (K) to see if there are differences between the sample food wastes with and without probiotics. The result shows that Nitrogen, Moisture, and Potassium (K) are present with closer percentages in both food waste. Statistically treated, there is no significant difference in the physico-chemical composition/level of compost with probiotics (treated) and without probiotics (untreated). In conclusion, the degradation of organic kitchen food wastes with probiotics can be fast, odorless, and beneficial to soil with the presence of Nitrogen, Moisture, and Potassium.

Keywords — Degradation, Organic Food Waste, And Probiotics

I. Introduction

Probiotics are known by society as good bacteria which help your body to be healthy. They came as fermented foods like yogurts and pickles and in other drinks. But, there's more to it. As people normalize throwing their foods from their kitchen food waste like meat and vegetables, raw or matured vegetables, fruit peelings or fruit alone, bones, and oils, without considering its effect to the environment, probiotics can be a great help in helping them degrade these wastes.

According to the United Nations Environment Programme (1972) one-third of the food produced in the world for human consumption every year is approximately 1.3 billion tonnes - gets lost or wasted. Additionally, United Nations Environment Programme (1972) also states that food losses and waste amount to roughly 680 billion US dollars in industrialized countries and 310 billion US dollars in developing countries. When we waste food, we also waste all the energy and water it takes to grow, harvest, transport, and package it. Expressed by World Fun (2022) that if food goes to a landfill and rots, it produces methane—a greenhouse gas even more potent than carbon dioxide. The food waste problem indeed is dangerous especially when neglected.

Food and Nutrition Research Institute of the Department of Science and Technology (Dela Peńa, 2021) states that in the Philippines, 1,717 metric tons of food is wasted each day. Likewise, the International Rice Research Institute (Dela Peńa, 2021) said that 23 million pesos worth of rice is wasted daily, enough to feed 4.3 million. Our locality, Dipolog City as part of the Philippines is not exempt from this. Recently, one of the newspapers in our city named Tingog PENINSULA released a news last August 7, 2022. It was written that the City Environment and Natural Resources(CENRO) set new schedules and rules for the segregation of our waste. This is based on the Republic Act No. 9003 and City Ordinance No. 123 along with the Solid Waste Management System in our locality. To strengthen this program, the city is requesting all the households, offices, and establishments within Dipolog City to respond appropriately by segregating wastes in "color-coded" garbage cans or bags effective August 15 of the year 2022. The researchers' concern is when food waste is mixed with others, it will be thrown into landfills and as it rots in the landfill, it produces a greenhouse gas called methane which causes our environment to be destroyed.

The researchers came up with the idea that instead of throwing away our food waste, we must take responsibility for degrading it and enjoy its potential benefits. This study will conduct step-by-step degradation of kitchen food waste to help the community lessen kitchen food waste issues slowly and also wanted to try making a soil fertilizer or soil conditioner.

This is based on the study by Hong et.al entitled Food Waste Composting: Natural Fermentation Method published in the International Journal of Recent and Engineering(IJRTE) (2019) illustrated that in Malaysia, they use Ooomi probiotics to make their food waste useful in farming as a soil fertilizer. In our locality, Barangay Minaog, Dipolog City there is no method like that.

That is why researchers are inspired to inform the community of the methods of degrading their kitchen food waste and could make soil conditioners instead of throwing them anywhere with the use of probiotics.

THEORETICAL AND CONCEPTUAL FRAMEWORK

This study is anchored by the Probiotic theory of Qomarudin et.al in their study Probiotics and Bioremediation last 2019. Which stated that probiotics can play a role as remediation agents which are expected to be able to help the host in responding to environmental changes. Certain types of probiotics act as bioremediation or decomposing agents of hazardous substances. Bacteria are often associated with diseases or with something that is frightening and disgusting. But along with advances in technology, bacteria today are not considered only as an enemy but can also be friends.

STATEMENT OF THE PROBLEM

The study aims to degrade kitchen food wastes with probiotics as an enhancer to make the wastes degrade faster, odorless, and useful. Specifically, this study sought to answer the following problems:

1. What are the steps in degrading kitchen food wastes with probiotics and without probiotics in terms of?

    1.1 Volume of collection wastes

    1.2 Water

    1.3 Physico-chemical properties such as temperature and moisture.

2. Determine the physico-chemical properties of the compost between samples with probiotics (treated) and without probiotics (untreated) in terms of:

    2.1 Odor

    2.2 Color

    2.3 Nitrogen (N)

    2.4 Potassium (K)

3. Is there a significant difference in the physico-chemical composition/level of compost with probiotics (treated) and without probiotics (untreated)?

Literature Review

Food Waste

Wasted food is a major global environmental, social, and economic challenge. According to scientific research, approximately one-third of the food produced in the U.S. is never eaten. When food is produced but unnecessarily wasted, all the resources used to grow the food – water, energy, fertilizers – and the resources used to transport it from farms to our tables, are wasted as well the United States Environmental Protection Agency (2021). Most of the resource inputs and environmental impacts of food waste occur during production, processing, and delivery to our kitchens.

Probiotics

In the present work, a novel treatment method of kitchen waste for the economic production of probiotics was investigated. This required the selection of suitable probiotic microorganisms. Based on the pure cultures of probiotic strains for the fermentation of kitchen waste, 5 strains of microorganisms including 1 strain of Lactobacillus, 2 strains of Bacillus, and 2 strains of yeast were selected, respectively. These probiotic microorganisms were mixed at the same ratio and cultured using the kitchen waste as a culture medium at a pH of 7.2 and temperature of 37°C. After 24 h, the total count of the viable cells reached 2.24 ×1010 CFU/g, which was higher than that obtained in any single probiotic strain pure culture. It was found that the presence of yeasts and Bacillus species enhanced the growth of the Lactobacillus strain. Bench scale experiments were also done in a self-designed rotating drum-type bioreactor. The experimental results indicate that there is a good possibility of utilizing kitchen waste for the economic production of probiotics.(Dong Y, et. al, 2013). Food waste and municipal sludge were used as the substrates for the biosynthesis of lactic acid in a batch fermentor.

Temperature

Yang et.al studied Lactic acid production from mesophilic and thermophilic fermentation of food waste at different pH wherein pH and temperatures were investigated comprehensively to find their effects on LA fermentation, and microbial analyses were used to take insight to the variation of LA production. The results showed that mesophilic fermentation benefited hydrolysis and acidification, leading to a high yield of LA, while thermophilic conditions restricted other producers at low pH, leading to a high purity of LA. *Lactobacillus amylolyticus* was the main LA producer under thermophilic conditions, but *Thermoanaerobacterium thermosaccharolyticum* boomed at pH 5.0–6.0 and it converted LA partly to butyric acid. Simultaneously, *Bacillus coagulans* also increased and improved the optical purity (OP) of L-LA. From a series of this study, an operational condition of pH 5.5 and temperature of 52 °C would be potentially suitable for lactate fermentation of FW with high purity of 89%, while a stable LA production with an OP of 68% was achieved at 55 °C and pH 6.0.

Time and Texture

Physicochemical analyses and viability of probiotics were investigated after yogurt formation and for 3 weeks under refrigerated storage. Results showed that adding AF decreased syneresis and increased water holding capacity during storage. Both AF and VO had a beneficial effect on hardness, the most important textural property of yogurt. Confocal laser scanning microscopy revealed that the added in- gradients played a major role in the formation of the gel network structure of the yogurt. Both Streptococcus thermophilus and Lactobacillus bulgaricus remained at ac-ceptable levels > 8.28 Log CFU/g and > 5.79 Log CFU/g after 3 weeks at 4°C regardless of the added ingredients according to the study of Vassilios Raikos, Lina Juskaite, Frazer Vas, and Helen E. Hayes(2020). .Probiotic viability was significantly increased by the addition of aquafaba and remained at therapeutic levels (>7 log cfu/g) during the storage period for all treatments. Aquafaba can be used as a gelling agent to improve consistency of nondairy fermented products. The main limitation of the study was the batch variability between samples which reduced the statistical power of the data. Further work needs to be conducted to standardize the process and optimize yogurt formulations.

Moisture Content

The study of Li et.al (2020) aimed to analyze the relationship between food components and food waste aerobic fermentation efficiency. Different food wastes were designed to be reflective of different dietary regimes, including formulated (R1), high oil/fat and salt (R2), high oil/fat and sugar (R3), and vegetarian (R4) diets, after which the physicochemical properties, enzyme activity, and structural characteristics of food waste microbial communities were examined to explore the potential mechanisms of food waste degradation under different dietary regimes. The main results of the study demonstrated that the physicochemical properties and hydrolase activity of different food waste were significantly different.

Odor

A major problem for composting plants is odor emission. Slow decomposition during prolonged low-pH conditions is a frequent process problem in food waste composting. The aim was to investigate correlations between low pH, odor and microbial composition during food waste composting. Samples from laboratory composting experiments and two large-scale composting plants were analyzed for odor by olfactometry, as well as physico-chemical and microbial composition. There was a large variation in odor, and samples clustered in two groups, one with low odor and high pH (above 6.5), the other with high odor and low pH (below 6.0). The low-odour samples were significantly drier, had lower nitrate and TVOC concentrations, and no detectable organic acids. Samples of both groups were dominated by Bacillales or Actinobacteria, organisms which are often indicative of well-functioning composting processes, but the high-odor group DNA sequences were similar to those of anaerobic or facultatively anaerobic species, not to typical thermophilic composting species. High-odour samples also contained Lactobacteria and Clostridia, known to produce odorous substances. A proposed odor reduction strategy is to rapidly overcome the low pH phase, through high initial aeration rates and the use of additives such as recycled compost (Cecilia Sundberg, et. al., 2013).

Nitrogen

The study of Saray et.al (2014) emphasized that *L. acidophilus* has more proteolytic activity compared with the other Lactobacilli. Due to this feature, it can produce more nitrogenous compounds which are necessary ingredients for bacterial growth. Availability of free nitrogen through proteolysis can enhance bacterial population by producing more *Bacteriocin* and increasing the number of S-layers. These phenomena can increase the protein content of the processed feed. Therefore, the higher CP content of RW was processed by *L. acidophilus*.

Potassium

Probiotic Microbiome: Potassium Solubilization and Plant Productivity was the study of Kumar et.al (2017) illustrated that the mechanism of K solubilization signifies the means through which the insoluble K and structural inaccessible forms of K complexes are mobilized and solubilized due to the excretion of a wide range of organic acids by microbes. These acids undergo a sequence of exchange reactions like acid lysis and complex lysis. In addition, these reactions are input processes that cause the alteration of insoluble forms of K into soluble forms. During the period of bacterium inoculation, there was no decrease in the pH of the medium, implying that Bacillus sp. did not excrete organic or inorganic acids, and slime formation by bacterium could possibly be responsible for K solubilization. The soil microbiome involved in mineral weathering produces organic and inorganic acids, protons, chelates, siderophores, and ligands.

II. Methodology

The researchers follow the method of decomposing kitchen wastes through the study entitled “Food Waste Composting: Natural Fermentation Method” by Hong et.al this study was published in the International Journal of Recent and Engineering (IJRTE) last 2019. First, the kitchen food waste was collected from 10 houses. The kitchen food wastes were screened to eliminate any plastic, wood, glass, paper, and bones because these are hard to decompose. The screened kitchen food was then mixed with homemade probiotics. In every 10 kg of food waste, there is 2L chlorine-free water mixed with 10 ml probiotics. Then it will be sprayed with probiotics mixed with chlorine-free water for 14 days alternately.

Research Environment

This study will be conducted at Minaog, Purok Nipa Dipolog City in the province of Zamboanga del Norte which comprised of 9,402 household population based on Census of Phil Atlast 2020. This represented 6.81% of the total population of entire Dipolog City. The researchers will collect food wastes in selected 10 household at Purok Nipa for thorough experimentation and observation. The process of observation and experimentation will also be done at the exact place where the food wastes are collected.

Figure 1. The Actual Sample Site at Purok Nipa, Minaog, Dipolog City

III. Results and Discussion

This method is based on the study of Hong et.al which entitled Food Waste Composting: Natural Fermentation Method published in International Journal of Recent and Engineering(IJRTE) (2019) illustrated that in Malaysia, they use Ooomi probiotics to make their food waste useful in farming as soil fertilizer.

Table 1 shows the effectivity of probiotics to the kitchen food waste. The checklist identified the kitchen food wastes as having the most days of odor alterations that have been seen, which emphasized that odor is more quickly noticed than other factors. Color and odor of wastes has noticeable changes along the observation process of the study. This is based on the study of Sannikova and Kovaleva(2019) on their study Use of Probiotic Preparations in Waste Waters Cleaning of Agricultural Enterprises which they also observed that probiotic preparation intensifies the processes of biological wastewater treatment, which allows significantly reducing the intensity of odor and color of wastewater.

No. of days	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Day 8		Day 9		Day 10		Day 11		Day 12		Day 13		Day 14		Remarks
Is there any changes in the color of the compost kitchen food wastes?	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	
		/		/		/		/	/		/		/		/		/		/		/		/		/		/		4 days not observed 10 days observed
Is there any changes in the odor of the compost kitchen food wastes?	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	
		/		/	/		/		/		/		/		/		/		/		/		/		/		/		2 days not observed 12 days observed
Is there any changes in the texture of the compost kitchen food waste?	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	
		/		/		/		/	/		/		/		/		/		/		/		/		/		/		4 days not observed 10 days observed

Table 1. Effectivity of probiotics on the kitchen food waste.

No. of days	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		Day 8		Day 9		Day 10		Day 11		Day 12		Day 13		Day 14		Remarks
Is there any changes in the color of the compost kitchen food wastes?	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	
		/		/		/		/		/		/		/		/		/		/	/		/		/		/		10 days not observed 4 days observed
Is there any changes in the odor of the compost kitchen food wastes?	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	
		/		/		/		/		/		/		/	/		/		/		/		/		/		/		7 days not observed 12 days observed
Is there any changes in the texture of the compost kitchen food waste?	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	
		/		/		/		/		/		/		/		/		/		/		/		/		/		/	14 days not observed

Table 2 shows the physico-chemical properties result of the compost kitchen food wastes with probiotics. Nitrogen with 26. 3℃ temperature and relative humidity of 54.2 % has 1.20 % result. Moisture with 24.6 ℃ temperature and relative humidity of 53.7 % has 69.9 % result. Potassium with 23.9℃ temperature and relative humidity of 51.9 % has 2966 mg/kg result. This is based on the study of Sakthika and Sornalaksm (2019) on their study about Nutrients Analysis of Vermicompost of Water Hyacinth Supplemented with Probiotics which the aquatic weed supplemented with probiotic bacteria Lactobacillus sporogens showed 18.03% nitrogen and 26.86% potassium. The moisture content of produced probiotic powder for all the treatments based on the study of Arepally et.,al (2020) showed the range of 4.59%–9.05%.

Test Parameter	**Date Tested (MM.DD.YYYY)**	**Environmental Condition**		**Method**	**Results**	**Unit**
		Temp. (℃)	Relative Humidity (%)			
Nitrogen	October 04, 2022	26.3	54.2	NMKL No.6, 4th ed., 2003	1.20	%
Moisture	August 23-31, 2022	24.6	53.7	NMKL No. 169, 2022	69.9	%
Potassium	October 12, 2022	23.9	51.9	AAS-Emission Mode	2966	mg/kg

Table 2. Physico-chemical properties result of the compost kitchen food waste with probiotics.

Table 3 shows the physico-chemical properties result of the compost kitchen food waste without probiotics. In the table 3 nitrogen has 23.7℃ temperature and relative humidity of 58.3 % and has 1.32 % result. This means that kitchen food wastes without probiotics still consist the organic matter Nitrogen. This is also stated by the study of Jones (2017) that nitrogen is generally present in only low concentrations in immature composts, although it may increase as the compost matures. Nitrogen levels may be high during initial stages of the composting process, but decrease as maturity increases. Moisture has the highest percentage in the analysis result with 24.3℃ temperature and relative humidity of 54.3 % and has 74.1% result. In the study of Zaman (2016) he says that moisture plays a critical role by supporting microbial activities. Dry waste takes longer time to decompose compared to moist waste. Potassium also present with 23.7℃ temperature and relative humidity of 56.2% has 4699 mg/kg result.

Test Parameter	**Date Tested (MM.DD.YYYY)**	**Environmental Condition**		**Method**	**Results**	**Unit**
		Temp. (℃)	Relative Humidity (%)			
Nitrogen	November 16,2022	23.7	58.3	NMKL No.6, 4th ed., 2003	1.32	%
Moisture	November 03-04,2022	24.3	54.3	NMKL No. 169, 2022	74.1	%
Potassium	Octoberb27, 2022	23.7	56.2	AAS-Emission Mode	4699	mg/kg

Table 3.Physico-chemical properties result of the compost kitchen food waste without probiotics.

This implies that Nitrogen is both present in organic food wastes with probiotics (treated) and without probiotics (untreated) with little amount difference. Moisture is also present in both samples but has highest percentage in food wastes with probiotics. And Potassium can also be found in both samples but the one contains with probiotics has high percentage in result. This means that organic food wastes with or without probiotics has the presence of Nitrogen, Moisture, and Potassium.

Summary of Findings

The study revealed the following results:

1. Steps in degradation of kitchen food wastes. First collecting of food wastes, placing the six drums in the sample site, labelling the six drums "with probiotics" and "without probiotics", mixing the probiotics with chlourine-free water, spraying the kitchen food wastes with probiotics in two (2) times a day, then observe it for fourteen (14) days.

2. Volume of collected food wastes. The six drums must contained ten (10) kilograms of food wastes from selected household.

3. Water. The water must be chlourine-free and it will be mixed with probiotics in 100 ml sprayer.

4. Temperature. The temperature must not exceed between 65 to 75 degrees Fahrenheit or 15 to 24 degrees Celsius.

5. Moisture. The food waste with probiotics has 69.9 % result based on Department of Science and Technology (DOST) while the food waste without probiotics has 74.1 % result.

6. Odor. The food wastes with probiotics become odorless in just 2 days while the food wastes without probiotics took 1 week to become odorless.

7. Color. The food wastes with probiotics changes its color during 5th day of observation while the food wastes without probiotics changes its color during 10th day of observation.

8. Texture. The appearance of the food wastes with probiotics during the 10th day has changed from solid to liquid while food wastes without probiotics never changed.

9. Nitrogen (N). The food wastes with probiotics has nitrogen with 1.20 % while the food wastes without probiotics has 1.32 % based on the analysis of DOST.

10. Potassium (K). The food wastes with probiotics has 2966 mg/kg while the food wastes without probiotics has 4699 mg/kg based on the result from DOST.

11. Difference on the physico-chemical composition/level of compost with probiotics (treated) and without probiotics (untreated). There is no significant difference on the physico-chemical composition/level of compost with probiotics (treated) and without probiotics (untreated) which led to the acceptance of the null hypothesis.

IV. Conclusion

Based on the result of the study, the probiotics can be useful in degradation of kitchen food wastes in terms of color, odor, texture and time of degradation. Nitrogen (N), Moisture and Potassium (K) are present in both food wastes with and without probiotics. Therefore, it can beneficial as soil fertilizer.

However, there is no significant difference on the physico-chemical composition/level of compost with probiotics (treated) and without probiotics (untreated).

V. Recommendations

Based in the findings and conclusions the following recommendations were hereby offered:

1. Future researchers must include in testing parameter the presence of pH.
2. The presence of Phosphorus must be included in testing parameters for the next studies.
3. Financial aspect should be considered first during the study.
4. Food waste must be placed in proper place just like what the researchers did during the study.
5. Due to the complexity of the process involved in degrading food waste, researchers must be properly oriented with the community.

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