WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Oregano (*Origanum Vulgare*) Essential Oil as a Preservative of Fish Meat

Ronalie May M. Bautista[1], Hazel Joys B. Jamilla[2], Alexi Nathalie Jenn M. Mabansag[3], Angela S. Manicdao[4], Jamielle John R. Patron[5]

Divine Word College of Calapan
E-mail: ronaliemay.bautista@dwcc.edu.ph[1] , hazeljoysjamilla@dwcc.edu.ph[2], alexinathaliejenn.mabansag@dwcc.edu.ph[3], angela.manicdao@dwcc.edu.ph[4] jamiellejohn.patron@dwcc.edu.ph[5]

ABSTRACT

Fish meat has been known to deteriorate quickly, affecting the freshness of fish meat and causing spoilage. The quick spoilage of fish meat has been a problem; therefore, preservatives were created to reduce the amount of time of spoilage of fish meat. The Oregano (Origanum Vulgare) essential oil has been shown to have antimicrobial and antioxidant properties responsible for eliminating and depreciation microbes in fish meat. This study was conducted to determine the effect of Oregano (Origanum Vulgare) Essential Oil as a preservative for Fish Meat.

The experiment administered three test methodologies; the methodologies were: Bacterial growth, shelf-life, and pH Level, of fish meat. The pH level was measured quantitatively, while the bacterial growth and shelf-life were measured qualitatively using a survey observing the difference in the physical characteristics of Fish Meat. The study was laid out using a comparison of Fish Meat with and without Oregano (Origanum Vulgare) Essential Oil after 24 hours in a vacuum-sealed container.

This study showed that all of the test methodologies demonstrate that Oregano (Origanum Vulgare) Essential Oil reduces the number of bacteria, characteristics brought upon by shelf life, and acidity. Therefore, Oregano Essential Oil can be used as a preservative for fish meat.

***Keywords*:** *Oregano (Origanum Vulgare) Essential Oil, Fish Meat, Preservative*

1. INTRODUCTION

Human infections in fish and fish products, as well as the production of chemical dangers Fish is an important part of the produced by the growth of spoilage human diet, and the production and microorganisms. Fish are aquatic vertebrates consumption of fish and fish products has and devour animal meat. Fish meat is a highexpanded globally over the years. Major quality, low-fat protein and high in omega-3 issues are the transfer and persistence of fatty acids and vitamins D and B2

(riboflavin). Fish is a good source of calcium, phosphorus, and even minerals like iron, zinc, iodine, magnesium, and potassium (Fish Advisories Program, n. d.).

In addition, one of the foods that spoil faster in our daily living is fish. Fish spoils quicker than meat because psychrophilic bacteria, primarily found in fish skin, can develop on the fish's skin at freezing temperatures, causing the fish to deteriorate. Because meat has a lower pH and is less wet, seafood is more prone to microbial deterioration than meat. Enzymatic and microbiological deterioration restrict the shelf life of the fish under regular refrigerated storage settings. Enzymatic autolysis, oxidation, and microbial growth are the three major processes that cause fish rotting (Ghaly & Dave et al., 2010).

In this regard, to lessen the food spoilage in fish salting and freezing are different preservation techniques. The Romans utilized salting, or salt curing, as one of the first ways of fish preservation to create the salt cod or bacalao. Because salted fish can be preserved for extended periods of time and does not need to be refrigerated, it has made an enormous impact (Peñarubia, 2021). In the modern century, we utilize refrigerators to use the method of freezing. It is one of the most effective practices of processing and preserving seafood. It extends the shelf life of foods by making them more inactive, reducing the adverse reactions that cause food spoiling, and shortening the shelf life of high-quality products. Even though freezing enhances the shelf life, the texture and flavor will deteriorate with time, according to the Food and Agriculture Organization of UN (2021).

On the other hand, Essential Oils are primarily employed in the food sector for food preservation due to their scent, tastes, and natural anti-bacterial content. Different types of EOs, such as tea tree oil, lemon oil, clove oil, cinnamon oil, and thyme oil from various traditional plants, have significantly improved antimicrobial and antioxidant activities, as well as effectively increased the shelf lives of cereal products and increased the quality of food

safety, according to the journal Grain & Oil Science and Technology (2019). This demonstrates that preserving fish may be done in various ways, including freezing and salting and using natural preservatives such as essential oils.

Anti-bacterial and antimicrobial qualities that benefit the health of Filipinos can also be found in a medicinal plant. Oregano (Origanum Vulgare) is a wellknown herbal remedy with potent antioxidant effects. This also includes anti-inflammatory, anti-bacterial, antioxidant, anti-fungal, and anti-viral compounds rosmarinic acid, thymol, and carvacrol, which are responsible for its different activities (López, 2017). Oregano is a herbal medication that may be used for health, but it can also be used for a portion of food. The components and composition of oregano (Origanum Vulgare) demonstrate significance in using natural alternatives to synthetic food additives. According to Aranha and Jorge (2012), the antioxidant potential of oregano extract may be confirmed, indicating that oregano extract possesses antioxidant properties that lower the risk of various illnesses.

Moreover, oregano (Origanum Vulgare) is an excellent natural food preservative because of its antioxidant and antimicrobial properties. Due to widespread concern over synthetic food preservatives, natural alternatives are rapidly being investigated for effective food preservation. Oregano extract (OE) and essential oil (OEO) are two natural food preservatives that have shown potential. Furthermore, oregano is being researched for its health benefits, meaning that utilizing oregano to preserve food offers additional advantages. (Veenstra and Johnson, 2019) cited that Oregano (Origanum Vulgare) might be used as a food preservative in fish meats because of its antimicrobial properties.

Therefore, the researcher aims to investigate the microbiological quality of the oregano as a food preservative in fish meat using the Oregano (Origanum Vulgare) essential oil and Fish meat as a test subject for the study. The researcher targets observing the microbial growth of fish meat and monitoring the total bacteria build up, allowing the researchers to identify the growing bacteria in a test subject of Fish Meat. This study will investigate the microbiological quality shelf-life, and pH level of fish meat, with or without Oregano (Origanum Vulgare) as food additives.

2. METHODS

The study determines the effect of Oregano (Origanum Vulgare) as a preservative in fish meat, considering the three variables; bacterial build-up, Ph level, and shelf-life.

Laboratory experimentation techniques will compare the controlled variables, fish meat with and without Oregano Essential Oil, considering the experimental group of variables. The experimental group of variables of the study is the effect of the constant variables on the bacterial build-up, shelf-life, and Ph level of fish meat.

To determine the effects of the variables of this study, the samples will be tested inside the laboratory in Maria Estrella General Hospital, located at Baranggay Tawiran, Calapan City, Oriental Mindoro. To collect data on the bacterial build-up of fish meat, the indicators used are light growth, moderate growth, and heavy growth. The shelf-life will also be determined by using a survey through an interview with fishers in Brgy Tibag, Calapan City, Oriental Mindoro about the shelf-life of fish. There are five category questions on the shelf-life of fish meat with or without oregano essential oil, which will enable respondents to compare and rate the two samples.

Lastly, the range of the litmus paper to determine the acidity and basicity of fish meat. The indicator of the litmus paper is the color changes of the litmus strip that varied according to the Ph level of the fish meat; each color has its Ph value written in numbers.Overall, the data collected from the administered test methodologies will be used to compare fish meat with and without Oregano (Origanum Vulgare) essential oil.

The study made use of the following materials to make Oregano Essential oil and preparing the Test Subject for the experiment; Oregano, Olive Oil 500ml, Fish Meat 200g & 250g (Galunggong), Vacuum Sealed Container, Chopping Board, Measuring Cup, Large Jars, Small Jars, Strainer, Syringe, Knife, Pot, Water.

To determine the results, the mean will be employed to identify the average of a data set in the survey of Shelf Life with or without Oregano (Origanum Vulgare)

Essential Oil in Fish Meat. The total rating will be transcribed using a 4-point Likert Scale, as shown below (Brown, S. 2020).

Item	ITEM DESRIPTION	Score Rating
4	Excellent	3.40 - 4.00
3	Good	2.60 - 3.30
2	Deteriorating	1.90 - 2.50
1	Spoiled	1.00 - 1.80

The table shows the verbal description of the choices in the survey questionnaire with its corresponding item description from Excellent to Spoiled, which interprets the Shelf Life With or Without Oregano (Origanum Vulgare) Essential Oil in Fish Meat.

Likert Scale will be used to measure the numerical responses in the questionnaire and to sum up all the respondents to get the weighted mean and the average score range or mean in comparing the two shelf-life samples of fish meat with or without Oregano Essential Oil. The following formula will be used:

(a) To determine the respondents weighted mean or score range in each category:

$$\text{Weighted mean/Score Range} = \frac{No.\ Item * No.\ Response}{No.\ of\ Respondent}$$

(b) to measure the average score range of respondents' numerical responses in questionnaire, Mean will be used:

$$\text{Average}_{\text{Score}}\ \text{Range} = \frac{\sum \text{of Score Range}}{No.\ \text{of Categories}}$$

3. RESULTS

Table 1: Bacterial Growth of Fish Meat

Category of Fish Meat	**Bacterial Growth**
100 grams of Fish Meat with 10 ml Oregano (Origanum Vulgare) Essential Oil	Moderately Heavy Growth of *Vibrio Alginolyticus*
100 grams of Fish Meat without Oregano (Origanum Vulgare) Essential Oil	Heavy Growth of *Vibrio Alginolyticus*

The results above show the qualitative amount of bacterial growth of *Vibrio Alginolyticus* in fish meat.

Table 2: Shelf-Life of Fish Meat

Table 2.1 Fish Meat With Oregano (Origanum Vulgare) Essential Oil

Category of Fish Meat	**4**	**3**	**2**	**1**	**Range**
Color	1.00	2.25	0	0	3.25
Odor	1.33	1.75	0.17	0	3.25
Texture	0.67	2.5	0	0	3.17
Color of the Gills	0	3	0	0	3
Softness of the Muscle	0.33	2.75	0	0	3.08
WEIGH MEAN/ AVERAGE					**= 3.29**

Legends

4- Excellent / Highly Acceptable

3- Good / Acceptable

2- Deteriorating / Not Acceptable

1- Spoiled / Rejected

Table No 2.1 represented the shelf life of fish meat with Oregano Essential Oil in observation of color, odor, texture, the color of the gills, and softness of the muscle

Table 2.2 Fish Meat Without Oregano (Origanum Vulgare) Essential Oil

Category of Fish Meat	**4**	**3**	**2**	**1**	**Range**
Color	0	0	0.5	0.75	1.25
Odor	0	0.25	0.5	0.67	1.42
Texture	0	0.5	0	0.83	1.33

Color of the Gills	0	0.25	0.5	0.67	1.42
Softness of the Muscle	0	0	0.5	0.75	1.25
WEIGH MEAN/ AVERAGE					**= 1.33**

Legends

4- Excellent / Highly Acceptable

3- Good / Acceptable

2- Deteriorating / Not Acceptable

1- Spoiled / Rejected

Table No. 2.2 depicted the shelf life of without Oregano Essential Oil based on color, odor, texture, gill color, and muscle softness to establish the characteristics of fish meat infused with Oregano Essential Oil that had been stored for 24 hours prior to the survey.

Table 3: Ph Level of Fish Meat

Category of Fish Meat	**pH Level**
Fish Meat with Oregano (Origanum Vulgare) Essential Oil	5
Fish Meat without Oregano (Origanum Vulgare) Essential Oil	3

The table above shows the categories of fish Meat with and without (Origanum Vulgare) Essential Oil according to their pH level.

4. ANALYSIS Table 1. Bacterial Growth

The results in Table 1 show the qualitative amount of bacterial growth of *Vibrio Alginolyticus* in fish meat. The *Vibrio Alginolyticus* is one of the most common pathogenic bacteria and marine Vibrio species that has been found in fish and is also one of the causes of seafood poisoning. The amount of bacterial growth of *Vibrio Alginolyticus* can vary depending on the amount of time fish meat is exposed outside water.

The first sample is 100 grams of Fish Meat with 10 ml of Oregano (Origanum Vulgare) Essential Oil. The data shows that the bacterial growth of the fish meat with Oregano (Origanum Vulgare) Essential oil has **Moderately Heavy Growth of *Vibrio Alginolyticus*.** The second category is 100 grams of Fish Meat without Oregano (Origanum Vulgare) Essential Oil. The fish meat without Oregano (Origanum Vulgare) Essential Oil displayed a **Heavy Growth of *Vibrio Alginolyticus***.

Table 2. Shelf-Life of Fish Meat

Table 2.1 Fish Meat with Oregano (Origanum Vulgare) Essential Oil

Table No 2.1 represented the shelf life of fish meat with Oregano Essential Oil in observation of color, odor, texture, the color of the gills, and softness of the muscle to determine the characteristic of the Fish Meat with Oregano Essential Oil which is stored for 24 hours before the survey occurred.

In terms of the Color of Fish Meat, as indicated in the table, it results from a high range of 2.25 as Good or Acceptable which corresponds to nine out of 12 respondents observing that it is Acceptable, whereas three respondents that observed the Excellent ranging a 1.00 in the Highly Acceptable table. At the same time, there are no responses in Deteriorating and Spoiled. This results in an overall score of 3.25, bringing a GOOD description in Color.

While in Odor, the respondents notice the fish meat as Good or Acceptable for them summing a 1.75 range or seven respondents, on the other hand, the table for Excellent ranges 1.33, consisting of four out of 12 fishers. Stating that it is Highly Acceptable, one response is Deteriorating, stating it is

Not Acceptable with a 0.17 range. It totals a 3.25 Overall Score Range as a GOOD description in Odor

Next, in Texture, there are no responses in Deteriorating and Spoiled. As indicated in the table, there is two response in the Excellent or 0.67 ranges. At the same time, there is a high range of 2.5 or 10 out of 12 respondents observing that the fish meat is still Good or Acceptable in Texture and an overall score range of 3.17 or GOOD representation.

Describing that the characteristic of fish meat in terms of Color of the Gills with Oregano Essential Oils scores a Good range mentioning 12 out of 12 respondents tells that the Gills of the fish meat is still Acceptable as they observed to the sample.

Lastly, the Softness of the Muscle varies to their ranges of 2.75, which is Good or Acceptable, and 0.33 range as Excellent or Highly Acceptable, stating that there is no respondent for Deteriorating and Spoiled, 3.08 overall scoring range results in a Good illustration in the table.

The overall average observation for table No 2.1, the shelf life of fish meat with Oregano Essential Oil in terms of color, odor, texture, the color of the gills, and muscle softness is **3.29.** Indicating that **Oregano Essential oil in Fish meat is GOOD and ACCEPTABLE** to the fisheries of Brgy Tibag the surveys by the researcher.

Table 2.2 Fish Meat without Oregano (Origanum Vulgare) Essential Oil

Table No. 2.2 depicted the shelf life of fish flesh without Oregano Essential Oil based on color, odor, texture, gill color, and muscle softness to establish the characteristics of fish meat without Oregano Essential Oil stored for 24 hours prior to the survey.

There are no responses in the Color column of Excellent and Good. However, there is one response in the Deteriorating or 0.5 ranges, as shown in the table, which explains that they are not acceptable to their observation. At the same time, there are several ranges of 0.75 or 11 out of 12 respondents observing that the fish meat is Spoiled and Rejected in Color, with an overall score lower range of 1.25 or Spoiled representation that is not good for the color of the fish meat.

In terms of the Odor of fish meat, as shown in the table, it has a range of 0. 67 as Spoiled or Rejected, which corresponds to eight out of twelve respondents observing that it is not acceptable and has a bad odor to the smell. Whereas three respondents observed Deteriorating ranging from 0.5 to a Not Acceptable column, while there are one response in Good ranging 0.25 and no response in Excellent. This yields an overall Odor score range of 1.42, indicating it is Spoiled and does not have a good odor description for the fishers of Tibag.

When it comes to texture, the respondents rate the fish meat without Oregano Essential Oil as Spoiled, with a total of 0.83 respondents believing it is of poor texture and rejecting it. On the other hand, the table for Good ranges 0.5, indicating that two respondents agree that the texture is still Good and Acceptable, and no one claims that the texture is Deteriorating due to the texture of the Fish when they pressed the Sample without Oregano Essential Oil. Totaling a 1.33 Overall Score Range as Spoiled and rejected to the respondents' observation in texture describing the difference of a good quality texture.

In terms of Gill Color, it yields a wide range of 0. 67 as Spoiled or Rejected, with eight out of twelve respondents stating that it is

Spoiled, three replies in Deteriorating, scores 0.5 in the Not Acceptable column, one response in Good range 0.25, and no response in Excellent. It displays the total score range for the Color of Gills of 1.42 as a Spoiled description in the table.

Finally, the Softness of the Muscle varies to their ranges of 0.5 in Deteriorating or Not Acceptable and 0.75 in Spoiled and Rejected to the eye of the fishers in Brgy Tibag stating that there is no respondent for Excellent and Good, a 1.25 overall scoring range results in Spoiled and Rejected illustration in the table, which shows that the muscles of the fish meat did not satisfy the appearance for the fishers to be an Acceptable Softness of the Other Muscle of the fish meat.

The overall average observation for table No 2.2, the shelf life of fish meat without Oregano Essential Oil in terms of color, odor, texture, the color of the gills, and softness of the muscle is **1.33**. Indicating that Samples **Without Oregano Essential oil in Fish meat is SPOILED or REJECTED** to the fisheries of Brgy. Tibag resulting in a low average.

Table 3. pH Level

Table 3 shows the categories of fish Meat with and without (Origanum Vulgare)

Essential Oil according to their pH level. The Fish Meat with Oregano (Origanum Vulgare) Essential Oil has a pH level of 5, while the Fish Meat without Oregano (Origanum

Vulgare) Essential Oil has a pH level of 3.

DISCUSSION

This study is focused on the effect of Oregano (Origanum Vulgare) Essential Oil as a preservative for fish meat by administering three test methodologies to fish meat with and without Oregano Essential Oil after placing it in a vacuum-sealed container for 24 hours.

Table 1. shows that the Fish Meat with Oregano Essential Oil is Moderately Heavy Growth while the Fish Meat without Oregano Essential Oil displays Heavy Growth of Bacteria. The bacterium *Vibrio Alginolyticus* in the two fish meat samples indicates the rapid growth of bacteria within 24 hours. The difference between the two samples was also an indication that the Oregano (Origanum Vulgare) Essential Oil has affected the growth of the quantity of the bacterium since the amount of fish meat with Oregano (Origanum Vulgare) Essential Oil has a lesser growth of bacteria. According to Lopez (2017), Essential oils of oregano are widely recognized for their antimicrobial activity and antiviral and antifungal properties. The data collected supports the idea that Oregano (Origanum Vulgare)

Essential Oil has antimicrobial properties that can reduce spoilage of Fish Meat. Hence, the Oregano (Origanum Vulgare) Essential Oil can be used to preserve fish meat.

The results from Table 2. This shows a significant difference between Fish Meat with and without Oregano Essential Oil. According to Aquafind (n,d.), changes in color, odor, texture, eye color, gills, and muscle softness are some of the characteristics observed in spoiled fish. The fish meat with Oregano Essential Oil in terms of color, odor, texture, the color of the gills, and softness of the muscle got 3.29, indicating that Oregano Essential oil in Fish meat

is GOOD or ACCEPTABLE. The fish meat without Oregano Essential Oil in terms of color, odor, texture, the gills' color, and the muscle's softness got 1.33, indicating that Samples Without Oregano Essential oil in Fish meat are SPOILED or REJECTED. This survey from the fishers only proves that their Oregano (Origanum Vulgare) Essential Oil can prolong the shelf-life of fish meat.

Table 3 shows that Fish Meat with Oregano (Origanum Vulgare) Essential Oil has a pH level of 5, indicating that there must be a presence of the micro-organism. The Fish Meat without Oregano (Origanum Vulgare) Essential Oil has a pH level of 3, indicating that there is already the presence of bacteria. According to the ACS Distance Education n.d.., the pH measures how acidic and alkaline a food is. Micro-organisms thrive at a neutral pH of between 5 and 7.5, whereas most bacteria are inhibited at a pH below 4, although yeast and molds can tolerate lower pH levels. The data collected from the fish meat with and without Oregano (Origanum Vulgare) Essential Oil indicated that the Oregano Essential Oil effectively reduces bacteria in Fish Meat. Hence, the pH level supports the idea of Oregano (Origanum Vulgare) Essential Oil as a preservative for Fish Meat.

Based on the findings obtained, the following are concluded:

1. Oregano Essential Oil is effective in terms of inhibition of bacterial growth.
2. Oregano Essential Oil increases the shelf life of the fish meat by reducing the substandard characterization in terms of physical observation.
3. Oregano Essential Oils have the susceptible pH level to become a food preservative agent.
4. Oregano Essential Oils can be used as a food preservative for fish meat.

Recommendations:

1. Utilize other variants of fish meat in administering test methodologies to give more evidence that Oregano Essential Oil can be used in other varieties of fish meat.
2. Place the fish meat in a vacuum-sealed container in different time frames, shorter and longer than 24 hours, to establish its effectiveness when it comes to shelf-life.
3. Consider testing the flavor of fish meat with Oregano essential oil to ensure taste for consumption.
4. Administer the testing Bacterial Count instead of Bacterial growth for a more accurate Bacterium data in Fish Meat.

References

[1] *AL-HIJAZEEN, M. (2018). Effect of direct adding oregano essential oil (Origanum syriacum L.) on quality and stability of chicken meat patties. Food Science and Technology, 38(suppl 1), 123–130. https://doi.org/10.1590/1678-457x.17117*

[2] *American College of Healthcare Sciences. (2021, April 6). The Amazing Use of Essential Oils as Natural Preservatives. https://achs.edu/blog/2017/04/18/essential oils-as-natural preservatives/?fbclid=IwAR0mIF2g8qqUnNFUJIObU4Js3hDm2x_n7tpTpEOK96fC8rcO7tdRdXEhjI*

[3] *Amit, S. K. (2017, November 21). A review on mechanisms and commercial aspects of food preservation and processing - Agriculture & Food Security. BioMed Central. https://agricultureandfoodsecurity.biomedcentral.com/articles/10.1186/s40066-017-0130-8*

[4] *Antimicrobial effect against different bacterial strains and bacterial adaptation to essential oils used as feed additives. (2017). Natural Library Of Medicine. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4581672/*

[5] *Asensio, C. M., Grosso, N. R., & Rodolfo Juliani, H. (2015). Quality preservation of organic cottage cheese using oregano essential oils. LWT - Food Science and Technology, 60(2), 664– 671. https://doi.org/10.1016/j.lwt.2014.10.054*

[6] *Badekova, K. Z., Atazhanova, G. A., Kacergius, T., Akhmetova, S. B., & Smagulov, M. K. (2021). Formulation of an Origanum vulgare based dental gel with antimicrobial activity. Journal of Taibah University Medical Sciences, 16(5), 712–718. https://doi.org/10.1016/j.jtumed.2021.05.009*

[7] *Boskovic, M., Djordjevic, J., Glisic, M., Ciric, J., Janjic, J., Zdravkovic, N., Krnjaic, D., & Baltic, M. Z. (2019). The effect of oregano (Origanum vulgare) essential oil on four Salmonella serovars and shelf life of refrigerated pork meat packaged under vacuum and modified atmosphere. Journal of Food Processing and Preservation, 44(1). https://doi.org/10.1111/jfpp.14311*

[8] *Boskovic, M., Glisic, M., Djordjevic, J., Vranesevic, J., Djordjevic, V., & Baltic, M. Z. (2019). Preservation of meat and meat products using nanoencapsulated thyme and oregano essential oils. IOP Conference Series: Earth and Environmental Science, 333(1), 012038. https://doi.org/10.1088/1755-1315/333/1/012038*

[9] *Brazier, Y. (2020, January 17). What are the health benefits of oregano? Medical News Today. https://www.medicalnewstoday.com/articles/266259#_noHeaderPrefixedContent* [10] *Chivandi, E., Dangarembizi, R., Nyakudya, T., & Erlwanger, K. (Eds.). (2016). Chapter 8 - Use of Essential Oils as a Preservative of Meat. In Essential Oils in Food Preservation, Flavor and Safety (pp. 85–91). Elsevier Inc. https://doi.org/10.1016/B978-0-12416641-7.00008-0*

[11] *Designs for Health. (2017, December 21). Outstanding Oil of Oregano - A Jack of All Trades.* https://blog.designsforhealth.com/bid/199016/Outstanding-Oil-of-Oregano-A-Jack-ofAll-Trades

[12] *D.J. (2016a). Origanum (PROSEA) - PlantUse English. Origanum (PROSEA).* https://uses.plantnetproject.org/e/index.php?title=Origanum_(PROSEA)&mobileaction=toggl e_view_desktop

[13] *Essential Oils in the Philippines. (n.d.). Filipino Culture by The Pinoy Warrior.* http://www.thepinoywarrior.com/2016/06/essential-oils-in-philippines.html

[14] *Food Spoilage. (n.d.). ACS Distance Education.* https://www.acsedu.co.uk/Info/Alternative-Living/Preventative-Healthcare/FoodSpoilage.aspx

[15] *Hać-Szymańczuk, E., Cegiełka, A., Karkos, M., Gniewosz, M., & Piwowarek, K. (2018, October 16). Evaluation of antioxidant and antimicrobial activity of oregano (Origanum vulgare L.) preparations during storage of low-pressure mechanically separated meat (BAADER meat) from chickens. Food Science and Biotechnology, 28, 449–357.* https://doi.org/10.1007/s10068-018-0491-1

[16] *Health Benefits of Fish | Washington State Department of Health. (n.d.). Fish Advisories Program,.* https://doh.wa.gov/community-and-environment/food/fish/healthbenefits

[17] *Hernández, H., Fraňková, A., Sýkora, T., Klouček, P., Kouřimská, L., Kučerová, I., & Banout, J. (2016). The effect of oregano essential oil on microbial load and sensory attributes of dried meat. Journal of the Science of Food and Agriculture, 97(1), 82–87.* https://doi.org/10.1002/jsfa.7685

[18] *Hao, Y., Li, J., & Shi, L. (2021, November 5). A Carvacrol-Rich Essential Oil Extracted From Oregano (Origanum vulgare "Hot & Spicy") Exerts Potent Antibacterial Effects Against Staphylococcus aureus. Frontiers in Microbiology, 12.* https://doi.org/10.3389/fmicb.2021.741861

[19] *K.E. (2017). The Father of Canning. The Canning Theory. https://www.smithsonianmag.com/smart-news/father-canning-knew-his-process-worked-notwhy-it-worked-180961960/*

[20] *Kovačević, Z., Kladar, N., ČAbarkapa, I., Radinović, M., Maletić, M., Erdeljan, M., & Božin, B. (2021). New Perspective of Origanum vulgare L. and Satureja montana L. Essential Oils as Bovine Mastitis Treatment Alternatives. Antibiotics, 10(12), 1460.* https://doi.org/10.3390/antibiotics10121460

[21] *Kryvtsova, M. (2020). CHEMICAL COMPOSITION AND ANTIMICROBIAL PROPERTIES OF ESSENTIAL OIL FROM Origanum vulgare L. IN DIFFERENT HABITATS. Biotechnologia Acta, 13(3), 64–72.* https://doi.org/10.15407/biotech13.03.064

[22] *L. (2016). Different antimicrobial activity. Oregano (Origanum Vulgare) Is a Well-Known Herbal Remedy. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6152729/*

[23] *Leyva-López, N., Gutiérrez-Grijalva, E., Vazquez-Olivo, G., & Heredia, J. (2017). Essential Oils of Oregano: Biological Activity beyond Their Antimicrobial Properties. Molecules, 22(6), 989.* https://doi.org/10.3390/molecules22060989

[24] *Majid, A., Hashemi, M., Hassan, H. A., & Jalal, H. (2016). The Use of Herbal Extracts and Essential Oils as a Potential Antimicrobial in Meat and Meat Products: A Review. Human Environment and Health Promotion, 1(2), 63–74*http://zums.ac.ir/jhehp/article-1-23-en.pdf

[25] *Maxwell, A. (2015, February 12). Preserving Meat with Essential Oils? Thermo Fisher Scientific.* https://www.thermofisher.com/blog/food/preserving-meat-with-essential-oils/

[26] *Microbial Spoilage of Foods. (2017). The Microbiological Quality of Food. https://doi.org/10.1016/B978-0-08-100502-6.00002-9*

[27] *Mogoşanu, G. D., MihaiGrumezescu, A., Bejenaru, C., & EverardBejenaru, L. (2017). Natural products used for food preservation. Nanotechnology in the Agri-Food Industry, 365–411.* https://doi.org/10.1016/B978-0-12-804303-5.00011-0

[28] *NAKATANI, N., & KIKUZAKI, H. (1987). A new antioxidative glucoside isolated from oregano (Origanum vulgare L.). Agricultural and Biological Chemistry, 51(10), 2727–2732.* https://doi.org/10.1271/bbb1961.51.2727

[29] *Natural antibacterial content. (2019). Grain & Oil Science an Technology.*https://www.sciencedirect.com/science/article/pii/S259025981930007X#:~:text=Different%20 types%20of%20EOs%20such,the%20quality%20of%20food%20safety.

[30] *Natural Medicines Comprehensive Database. (2020a). WebMD.* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC64772/

[31] *Omega-3 in fish: How eating fish helps your heart. (2022, April 19). Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/heart-disease/in-depth/omega-3/art20045614*

[32] *Pandey, A. K., Kumar, P., Singh, P., Tripathi, N. N., & Bajpai, V. K. (2017, January 16). Essential Oils: Sources of Antimicrobials and Food Preservatives. Frontiers in Microbiology.* https://doi.org/10.3389/fmicb.2016.02161

[33] *Pathirana, H. N. K. S., Wimalasena, S. H. M. P., de Silva, B. C. J., Hossain, S., & Heo, G. J. (2017). Antibacterial activity of oregano (Origanum vulgare) essential oil, carvacrol and thymol against fish pathogenic bacteria isolated from cultured olive flounder (Paralichthys olivaceus). Iranian Journal of Fisheries Sciences.* https://doi.org/10.22092/ijfs.2021.125609

[34] *Park, C. (2022). A Dictionary of Environment and Conservation. Oxford Reference. https://www.oxfordreference.com/view/10.1093/acref/9780199641666.001.0001/acref9780199641666?fbclid=IwAR0yecoCptBuFEwO0sHbT6i6NNwvFdcrK2V5ZnIWiuqsFvcOLq5tlRwYl8*

[35] *Pereira Moura Aranha, C., & Jorge, N. (2012). Antioxidant potential of oregano extract (Origanum vulgareL.). British Food Journal, 114(7), 954–965.* https://doi.org/10.1108/00070701211241554

[36] *ResearchGate.(n.d.).AranhaandJorge.https://www.researchgate.net/publication/262848555_Antioxidant_potential_of_oregano_extract_Origanum_vulgare_L*

[37] *Rojo, A. D. A., Vidales, H. J., & Monterrubio, A. R. (March82017). Oregano Essential Oil in Animal Production. IntechOpen.* https://doi.org/10.5772/66703

[38] *Rowles. (2020). Herbal Medicine. Natural Library of edicine.https://www.ncbi.nlm.nih.gov/books/NBK92773/*

[39] *Ruscio, M. D. (2021, June 25). Oil of Oregano Benefits: How It Can Help Your Health. Dr. Michael Ruscio, BCDNM, DC.* https://drruscio.com/oil-of-oregano-benefits/

[40] *Sadiku, M. N., Ashaolu, T., & Musa, S. (2019, August). Food Preservation: An Introduction. International Journal of Trend in Scientific Research and Development, 3(5), 367–369.* https://doi.org/10.31142/ijtsrd25319

[41] *Skandamis, P., & Nychas, G. J. (2001). Effect of oregano essential oil on microbiological and physico-chemical attributes of minced meat stored in air and modified atmospheres. Journal of Applied Microbiology, 91(6), 1011–1022.* https://doi.org/10.1046/j.13652672.2001.01467.x

[42] *Shange, N., Makasi, T., Gouws, P., & Hoffman, L. (2018, October 17). Preservation of previously frozen black wildebeest meat (Connochaetes gnou) using oregano (Oreganum vulgare) essential oil. Meat Science, 10(012), 88–95.* https://doi.org/10.1016/j.meatsci.2018.10.012

[43] *Spoilage of fish-process and its prevention. (n.d.). Aquafind.* http://aquafind.com/articles/spolage.php

[44] *Smirnov, A. I. (2017). Food Spoilage. Science Direct. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/food-spoilage*

[45] *Tariq, S. M. (2021, May 20). Food Preservation Methods. News-Medical.Net.* https://www.azolifesciences.com/article/Food-Preservation-Methods.aspx

[46] *Umaraw, P., Chauhan, G., Mendiratta, S. K., Verma, A. K., & Arya, A. (2020, February 5). Effect of oregano and bay as natural preservatives in meat bread for extension of storage stability at ambient temperature. Journal of Food Processing and Preservation, 44(4).* https://doi.org/10.1111/jfpp.14375

[47] *Veer Pal Signh. (2018, March 27). Recent Approaches in Food Bio-preservation - A Review. Open Veterinary Journal, 8(1), 104–111.* https://doi.org/10.4314/ovj.v8i1.16

[48] *Veenstra, J. P., & Johnson, J. J. (2019). Oregano (Origanium Vulgare) Extract for Food Preservation and Improving Gastrointestinal Health. International Journal of Nutrition, 3(4), 43–52.* https://doi.org/10.14302/issn.2379-7835.ijn-19-2703

[49] *Zhou, R., Wu, J., Lang, X., Liu, L., Casper, D. P., Wang, C., Zhang, L., & Wei, S. (2020a, January 15). Effects of oregano essential oil on in vitro ruminal fermentation, methane production, and ruminal microbial community. Journal of Dairy Science, 103(3), 2303–2314.* https://doi.org/10.3168/jds.2019-16611

[50] *ŽItek, T., Borjan, D., Golle, A., Knez, E., & Knez, M. (2021). Optimization of Extraction of Phenolic Compounds with Antimicrobial Properties from Origanum vulgare. Processes, 9(6), 1032.* https://doi.org/10.3390/pr9061032