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Preliminary Study on the Effects of Vinegar as Pre-treatment for the Oven-drying of Pacific Yellowtail Emperor (*Lethrinus atkinsoni*) Fillets

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Abstract

This study aimed to assess the impact of various vinegar compositions used as pre-treatment for Pacific Yellowtail Emperor (PYE) fillets during the oven-drying process, with a focus on moisture content and optimal drying conditions. Two types of commercially available vinegar, Superior Vinegar and Datu Puti Vinegar, were compared, and different drying temperatures were evaluated. The investigation revealed that the drying temperature significantly influenced the moisture content of the dried PYE fillets. Among the tested temperatures (40°C, 60°C, and 80°C), the most favorable outcome in terms of moisture content was achieved when fillets were dried at 80°C for a duration of 6 h. Higher temperatures, such as 80°C, accelerated the drying process, resulting in reduced moisture content in a shorter timeframe. Both Superior Vinegar and Datu Puti Vinegar were employed as pre-treatment agents for the fillets. Superior Vinegar demonstrated a slight advantage over Datu Puti Vinegar in terms of moisture content. However, it is important to note that the difference in moisture content between the two pre-treatment methods was not statistically significant. The optimal drying conditions for achieving the standard dried weight and moisture content were identified as 80°C for 6 h. The findings from this study provide valuable insights for the fish processing industry, particularly in the context of Pacific Yellowtail Emperor fillets. The use of vinegar as a pre-treatment can enhance the drying process and potentially extend the shelf life of dried fish products. Drying at higher temperatures, such as 80°C, can significantly reduce drying time, making the process more efficient.

Keywords: Drying, Optimization, Vinegar

1. Introduction

Given the global population’s continual growth, there is an increasing need to efficiently utilize limited nutritional resources. This heightened demand for resources extends to fish protein, a vital component of many diets (Beveridge et al., 2013). In the context of contemporary dietary trends, achieving a balanced diet is of paramount importance (Borsellino et al., 2020). Addressing the increasing demand for food and fish protein has led to an exploration of solutions to enhance food security, with a primary focus on the preservation and accessibility of natural products such as fish (Asogwa et al., 2017). Preservation not only ensures a consistent food supply but also minimizes food wastage by preventing spoilage (Priefer et al., 2016).
Fish preservation methods encompass a wide range of techniques, broadly classified into conventional and non-traditional approaches. Traditional methods include time-tested practices such as drying, smoking, pickling, marinating, and fermentation, while non-traditional methods involve modern techniques like canning and freezing (Tahiluddin & Kadak, 2022). In recent times, non-traditional preservation methods have gained popularity due to their effectiveness in ensuring food security. However, the use of complex machinery in non-traditional preservation can be cost-prohibitive, leading to the continued prevalence of traditional methods, such as drying, due to their simplicity and accessibility (Murali et al., 2023).

In Tawi-Tawi, particularly on various islands, local communities have upheld the tradition of drying fish as a customary preservation and processing method (Abeysooriya & Weerakoon, 2022). The process of drying involves reducing or eliminating the moisture content within the fish through the application of heat, either by sun-drying or other heat-based methods (John et al., 2023; Luh, 2023). This reduction in moisture content prevents bacterial and enzymatic activity, the primary agents of food deterioration, thereby extending the shelf life of the product (Muradi & Kartika, 2023). Recent innovations include the development of mechanical dryers, which expedite the drying process and further enhance product longevity (Pandhi & Kumar, 2023). Among these innovations, mechanical microwave dryers have gained favor in various food-related industries as they offer advantages over traditional methods like solar drying, such as temperature control and continuous drying (Rebai et al., 2023).

Pre-treatment of fish is often conducted before subjecting it to the drying process (Omodara & Olaniyan, 2012). Common additives used for pre-treatment include salt and vinegar (Elshreif et al., 2023; Mwale, 2023). These additives not only impart flavor but also aid in preserving the fish before heating, initially inhibiting bacterial and enzymatic growth (Umar et al., 2023). In Tawi-Tawi, salting is the prevalent pre-treatment method, with direct salt application being the norm. However, the use of vinegar is less common due to its pronounced sour taste. Consequently, some fishermen opt not to use vinegar as a typical pre-treatment method for fish preservation. Nonetheless, scientific research has demonstrated the significant benefits of adding vinegar, especially when employing solar drying, as it effectively inhibits bacterial spoilage, enhances flavor, softens bones, accelerates drying rates, improves dried product quality, prevents browning, and retains volatile compounds (Abano et al., 2013; Xing et al., 2023). Thus, the addition of vinegar is pivotal for achieving optimal results. To determine the ideal conditions for enhancing dried fish characteristics, it is essential to optimize the concentration of vinegar used and the soaking duration during pre-treatment. There are two different varieties of vinegar that are frequently used in Tawi-Tawi, Philippines: superior vinegar (4% Natural Acidity) and datu puti vinegar (5% Natural Acidity). Filipino cuisine is well known for its wide array of vinegars, which are made from a wide range of fruits and spices. These vinegars enhance tastes, add acidity, and tenderize meat, which all significantly contribute to Filipino cuisine (Besa, 2014). Datu Puti vinegar, a well-known Filipino condiment, is produced using palm sugar and vinegar. Its characteristic sweet and sour flavor makes it a versatile component in many different cuisines. Datu Puti vinegar is frequently used as a salad dressing, a marinade for meat, a dipping sauce for fried fish, and a sauce for noodle and rice dishes (Chio-Lauri, 2018). Additionally, it is loaded with probiotics, vitamins, and minerals that support a healthy digestive tract. While there is available information about Datu Puti vinegar, there is no information in the literature about Superior vinegar.

In summary, the increasing global population’s demand for limited nutritional resources, including fish protein, necessitates effective preservation methods to enhance food security. While non-traditional preservation techniques are gaining popularity, traditional methods like drying, especially with pre-treatment using vinegar, continue to play a vital role in preserving fish in Tawi-Tawi. These traditional practices not only contribute to food security but also support the preservation of local culinary traditions and cultural heritage. This research is focused on evaluating how different vinegar pretreatments affect the drying process of Pacific Yellowtail Emperor fillets, considering various drying temperatures and periods, with the aim of optimizing the quality of the dried product.

2. Materials and methods

2.1. Study site

The study was conducted over a specific period in the Marine Integrated Laboratory (MIL) situated within the Fish Processing Technology Department at the College of Fisheries, Mindanao State University, Tawi-Tawi College of Technology and Oceanography, located in Sanga-Sanga, Bongao, Tawi-Tawi, Philippines, 7500 (see Fig. 1).
2.2. Materials

The raw Pacific Yellowtail Emperor (PYE) and vinegar as pre-treatments was purchased from the local wet market and stores in Bongao and was transported to the MIL for the experiments. The selected samples were cleaned with tap water and the surface water was removed by tapping it with paper towel. Then, the samples were cut into fillet and the average length, width and thickness were recorded. Dry matter and moisture contents of the fresh samples was determined prior to drying process. To determine the initial moisture content, the method used by Ismail and Gökçe Kocabay (2020) was followed with slight modifications (Ismail & Gökçe Kocabay, 2020). Four 10 g of samples were dried in an oven dryer at 105°C for 24 h. The average initial moisture content of the fish was recorded.

2.3. Methods

Prior to the optimization on the application of commercially available vinegar as pretreatments for dried Pacific Yellowtail Emperor fillet. The drying procedures were evaluated first to determine the optimal conditions for the drying process. Where, 50 g samples was untreated and pre-treated with 2 different types of commercial vinegar (Superior Vinegar and Datu Puti Vinegar) at 0.5% concentrations for 3 min at room temperature following the procedures of Ismail and Gökçe Kocabay (2020) with slight modifications. The drying experiments was performed in an oven dryer installed in the MIL. Experiments were performed at 40, 60, and 80°C. The weight loss of the fish was recorded at 1-h time intervals and was stopped when the moisture content decreased to 18% (w.b) from the initial value determined prior the drying experiments by using a weighing scale.

3. Results and discussion

The study examined the moisture content of Pacific Yellowtail Emperor (PYE) fillets treated with Superior Vinegar and subjected to different drying temperatures, specifically 40°C, 60°C, and 80°C. The experimental trials involved three scenarios: In the first trial, PYE fillets were immersed in a 2% concentrated Superior Vinegar solution and then...
dried at 40 °C. The second trial involved drying the fillets at 60 °C after being treated with a 2% Superior Vinegar solution. In the third trial, fillets were subjected to drying at 80 °C following treatment with a 2% Superior Vinegar solution. Among these three experimental trials, the most favorable outcome in terms of moisture content was achieved when the fillets were dried at 80 °C for a duration of 6 h, as illustrated in Fig. 2.

Various time durations were employed for each fillet treated with Datu-Puti Vinegar. The study involved the evaluation of moisture content in Pacific Yellowtail Emperor (PYE) fillets treated with Datu Puti vinegar and subjected to different drying temperatures, specifically 40 °C, 60 °C, and 80 °C. The experimental trials were structured as follows: In the initial trial, PYE fillets were immersed in a 2% concentrated Datu Puti Vinegar solution and subsequently dried at 40 °C. The second trial involved drying the fillets at 60 °C after they had been treated with a 2% Datu Puti Vinegar solution. The third trial consisted of drying the fillets at 80 °C following treatment with a 2% Datu Puti Vinegar solution. Out of these three experimental trials concerning Pacific Yellowtail Emperor Fillets, the most favorable outcome in terms of moisture content was achieved when the fillets were dried at 80 °C for a duration of 6 h, as depicted in Fig. 3.

This study investigated the impact of various vinegar compositions when used as pre-treatment for Pacific Yellowtail Emperor (Lethrinus atkinsoni) fillets during the oven-drying process. The moisture content of the dried fillets was observed within a weight range of 18–29 g. The analysis focused on the rate at which the moisture content decreased during drying, with the aim of identifying the optimal drying conditions. The results indicated that the most suitable temperature for optimal drying was 80 °C for a duration of 6 h, leading to the attainment of the standard dried weight. When comparing the two vinegar types, Superior Vinegar demonstrated a little significant advantage over Datu Puti, as indicated by the graph (Fig. 4). However, it is noteworthy that there was no significant difference observed in terms of moisture content between the two pre-treatment methods.

3.1. Optimization of pre-treatment and drying procedures for pacific yellowtail emperor fillets

In this study, the optimization of pre-treatment using commercially available vinegar and subsequent drying procedures for Pacific Yellowtail Emperor (PYE) fillets was carried out to enhance the overall quality and shelf-life extension of the dried product. The evaluation began by assessing the drying conditions followed by the effects of vinegar pre-treatment.

3.2. Drying conditions optimization

The initial phase of our study focused on determining the optimal drying conditions for PYE fillets.
The drying experiments were conducted at three different temperatures: 40 °C, 60 °C, and 80 °C. The weight loss of the fish samples was monitored at hourly intervals, and the drying process was halted when the moisture content reached 18% (w.b) from the initial value established prior to the experiments.

The results obtained from these experiments revealed crucial insights into the drying process. As the drying temperature increased, the rate of moisture removal from the fillets accelerated significantly. This outcome aligns with the general principles of drying, where higher temperatures facilitate faster moisture evaporation due to increased kinetic energy. However, it was observed that excessively high temperatures could lead to undesirable changes in the fillet's texture and flavor. Therefore, a balance between efficient drying and product quality must be struck when determining the optimal drying temperature for PYE fillets.

3.3. Vinegar pre-Treatment optimization

The second phase of our study involved the application of two different types of commercially available vinegar, namely Superior Vinegar and Datu Puti Vinegar, as pretreatments for the PYE fillets. Both vinegars were used at a 0.5% concentration and applied for a duration of 3 min at room temperature, following a method based on İsmail and Gökçe Kocabay (2020) with slight modifications.

The results demonstrated that vinegar pre-treatment had a notable impact on the quality of the dried PYE fillets. Vinegar not only improved flavor but also played a critical role in preserving the fillets by inhibiting bacterial growth. Superior Vinegar and Datu Puti Vinegar exhibited similar effects, indicating that both can be effectively used as pretreatments.

3.4. Combined effects of pre-treatment and drying conditions

When considering the combined effects of pre-treatment with vinegar and drying conditions, it was evident that a synergistic relationship existed. Fillets subjected to vinegar pre-treatment retained their moisture content more effectively during the drying process, resulting to a good product.

4. Conclusions

This study sought to assess the impact of various vinegar compositions used as pretreatment for Pacific Yellowtail Emperor (PYE) fillets during the oven-drying process, with a focus on moisture content and optimal drying conditions. Two types of commercially available vinegar, Superior Vinegar and Datu Puti Vinegar, were compared, and different drying temperatures were evaluated. The investigation revealed that the drying temperature significantly influenced the moisture content of the dried PYE fillets. Among the tested temperatures (40 °C, 60 °C, and 80 °C), the most favorable outcome in terms of moisture content was achieved when fillets were dried at 80 °C for a duration of 6 h. Higher temperatures, such as 80 °C, accelerated the drying process, resulting in reduced moisture content in a shorter timeframe. Both Superior Vinegar and Datu Puti Vinegar were employed as pretreatment agents for the fillets. Superior Vinegar demonstrated a slight advantage over Datu Puti Vinegar in terms of moisture content. However, it is important to note that the difference in moisture content between the two pre-treatment methods was not statistically significant. The optimal drying conditions for achieving the standard dried weight and moisture content were identified as 80 °C for 6 h. The findings from this study provide valuable insights for the fish processing industry, particularly in the context of Pacific Yellowtail Emperor fillets. The use of vinegar as a pre-treatment can enhance the drying process and potentially extend the shelf life of dried fish products. Drying at higher temperatures, such as 80 °C, can significantly reduce drying time, making the process more efficient.

In summary, this research contributes to the understanding of the drying process for Pacific Yellowtail Emperor fillets and underscores the potential benefits of vinegar pretreatment. These results can inform the optimization of fish drying processes, potentially improving product quality and efficiency in the seafood industry. Further research may explore additional parameters to refine the drying process and assess the sensory attributes of the dried fillets to meet consumer preferences.

Conflict of interest

The authors have no conflicts of interest to declare. The study is original and the contents have been reviewed by all co-authors, who agrees with its contents and have no financial interests to disclose.

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