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Studying the Effect of the Alcoholic Extract of Date Pits Powder on the Chemical and Physical Properties of Fish Products

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Abstract

This study aimed to evaluate the effect of the alcoholic extract of date seed powder on the chemical and physical properties of refrigerated fish products during storage (1−12 days) and to compare its effectiveness as a natural preservative with the control treatment (T1). Processed fingerlings of mullet fish were used in five treatments: a control (T1) and four treatments with increasing concentrations of the extract, reaching 1.5% in treatment T5. Samples were stored at 4 ± 1°C and periodically analyzed for chemical spoilage indicators (PV, TBA, FFA, TVN) and physical properties such as moisture, fat, protein, and water-holding capacity. Results showed that prolonged storage caused gradual quality deterioration, especially in the control treatment. In contrast, treatments containing the extract—particularly T5—reduced the rate of chemical degradation and preserved product quality. GC-MS analysis identified bioactive compounds such as palmitic acid, oleic acid, vitamin E, and beta-sitosterol, enhancing the extract's antioxidant activity. These findings confirm the effectiveness of the extract as a natural, safe preservative for improving the shelf life and quality of fish products.

Keywords:

Date seeds, alcoholic extract, fish products, physical properties.

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Introduction

The world is more and more concerned with food products including high nutritional values, like fish meat (1, 14), as the consumers grow concerned about healthy food and marine proteins preventive role in the case of chronic diseases development (1, 15). In this regard, the possible benefit of using phenolic extracts which are single-celled organisms can be utilized as a source of plant-derived compounds to address this issue by studying their antioxidant property, and thus its capability of food protection against oxidation-related deterioration (5, 8). Antioxidants are those compounds that can alter the rate of oxidation in foods through inhibition of free radicals. Alterations of the food habits, convenience of preparation, and long shelf life have all contributed to the increment in the consumption of these processed fish products that increased their vulnerability to oxidative reactions and to the modification of their sensory and chemical properties during storage (11, 39).

In order to alleviate these effects, the food industry has resorted to the use of natural antioxidants that are obtained out of plants and not synthetic additives that have long been revealed to have the potential of harming the health of the masses (Al-Farsi, 2005; Zhou & Xie, 2021). The date seeds, the by-product of date palm (Phoenix dactylifera L.) of the Arecaceae family, are a good source of biologically active substances e.g., phenols, flavonoids, tannins, plant sterols, phenolic acids, and tocopherols.

Research has revealed that alcoholic extraction of date seeds is very efficient in inhibiting free radicals and the rancidity of fats in food products such as fish products (Fisheries, 2018). This beneficial influence of such extracts has been attributed to the synergetic effect of active plant constituents i.e. polyphenols and tocopherol in inhibiting active food against oxidation and improvement of the chemical stability against food degradation during storage (Niazi, 2017; Nair & Reddy, 2024). Present research has tried to enhance the chemical and physical properties of perceived frozen fish stick products by inserting the alcoholic extract of date seed powder and testing the effectiveness of each of these extracts as a natural additive in increasing the shelf life of the product by lessening the oxidation process and in keeping up the quality of the product throughout its storage period (Issa & Abdulrahem, 2019; Amaral et al., 2021).

Materials and Methods

Preparation of Date Seed Powder

The date seeds were gathered locally in the sacred city of Karbala, where they were carefully purified of any contamination or the residues of date flesh. They were then washed thoroughly in distilled and sterilized water, and then allowed to dry in the sun for 3-4 days so that the moisture could be removed. The seeds were allowed to dry, after which a fine and homogeneous powder was obtained by grinding the seeds using an electric grinder (Moulinex, model LM 207, 500 watts, France) and stored in airtight containers until needed.

Preparation of Alcoholic Extract from Date Seeds

One hundred grams of dry date seed powder was weighed, and 500 mL of ethanol with a concentration of 98% was added to it (P-DES date seed extract–tilapia study, 2024). The mixture was placed in a magnetic stirrer for 24 hours at room temperature (25 degrees Celsius) with continuous stirring. After the extraction process was completed, the mixture was filtered using Whatman No.1 filter paper, then the filtrate was concentrated using a rotary evaporator at a temperature of 40 degrees Celsius to remove the alcohol and obtain the concentrated extract. The extract was then left at room temperature and stored in sterilized, opaque bottles under refrigeration conditions until use.

Preparation of Fish Sticks

Fresh fish meat was obtained from the local market in the holy city of Karbala, where it was carefully cleaned, and the skin and bones were removed (Zhang et al., 2010). It was then minced directly using an electric grinder to obtain a homogeneous texture. After mincing, the meat was divided into four equal batches, and each batch was stored in airtight containers at a temperature of 4°C. These batches were used to prepare fish sticks on the first, fourth, eighth, and twelfth days of refrigerated storage, aiming to study the effect of storage duration on the chemical and physical properties of the product (Shettima, 2019; Sayre et al., 1964). In all the treatments, the minced pieces of fish meat were added with various percentages of the alcoholic extract of the date seeds (0% Control, 1%, 1.5%) in which the water or addition of any other components is avoided, so in this way the natural properties of the fish meat were not altered (Anderson, 2007; Vera et al., 2021).

The mixture was thereafter handled by hand to form uniformly weighted sticks (50 to 50 grams) using special moulds and the moulds were covered with thick polyethene paper which helps ease the process of making the sticks and also to avoid the molten mixture which sticks easily.

The fish sticks were packed airtight in polypropylene bag and refrigerated at a constant temperature of 4 degree overnight to the time of the beginning of the study (Jamal et al., 2021; Ismail et al., 2018). A 1, 4, 8, and 12-day refrigerated keeping was set to carry out chemical and physical analyzes.

Chemical Composition of Fish Sticks

Estimation of Moisture Percentage

The moisture content in the fish sticks was calculated by measuring the difference in the dry samples weight with the ones that were already dried (Yan et al., 2025). A piece of the sample was initially weighed with the exactness of about 5 grams and then put in the weighing dishes that were prepared in advance. The samples were dried in an electric oven at 105 degrees Celsius until the attainment of a constant weight of the samples in 16 hours. The given method (44), can also be referred to as a standard method to be employed during the analysis of the fish products.

Then the moisture percentage was obtained using the formula below:

Moisture Percentage= (Weight of sample before drying Weight of sample after drying) Weight of sample after drying × 100

Estimation of Fat Percentage

The amount of fat in the samples was also estimated on the grounds of a Soxhlet extractor as per the method (Narayan & Balasubramanian, 2024). Sample then was accurately weighed and put in filter bags and extracted with an organic solvent diethyl ether. When the extraction ended the flask was dried and the fat extracted weighed.

Chemical Tests for Fish Fingers

Peroxide Value

The value of peroxide in the samples of fish finger was measured in line with method used (ISO 3960:2017) as stated in (Agarwal & Yadhav, 2023). 2 grams of the sample were weighed accurately and 30 ml of mixture of glacial acetic acid and 20ml isooctane weighted in a (60:40) (volume/volume) to the mixture. This, thereafter, was poured into 5 ml of saturated potassium iodide and reaction aided by the addition of 30-50 ml of distilled water, with the purpose of dissolving the saturated iodine.

The resulting iodine was titrated with sodium thiosulfate 0.01 to the point where no more blue color was observed and endpoint was made clear by means of starch as the indicator. The resulting peroxide value was then determined as in the equation below:

Peroxide value (milli-equivalent) = (The amount of milliliters of the sodium thiosulfate / 1000) x 0.01 x Weight of the sample

Thiobarbituric Acid Value

The authors estimate the thiobarbituric acid (TBA) content in fish fingers through the method included in. The extract was placed into the sample and absorbance read at the wavelength of 532 nanometers on a UV-Vis spectrophotometer. This outcome was determined as micromoles/kg of the samples and the TBA result was recorded according to the following forms: TBA value = absorbance x the constant 5.2 mg malondialdehyde (MDA) per kg = absorbance x 5.2 mg/kg.

TBA value mg/MDA kg = 5.2 x 530 A

Free Fatty Acids

The procurement of free fatty acids in the samples of fish fingers fortified with date pit extract was performed with the consideration of the common method outlined by the American Oil Chemists Society (Simunović et al., 2023). Some amount of the sample (2-10 grams) was weighed and 25 ml of 95% ethanol and 25 ml of ether and 1ml of phenolphthalein reagent was added. The titration was performed in 0.1 M sodium hydroxide till the attainment of a stable pink colour as follows in the equation:

Free fatty acid percentage = Number of milliliters of NaOH × Concentration × 0.028 / Weight of the sample × 100

Estimation of Total Volatile Nitrogen

The nitrogen value in the samples of fish fingers was determined based on the method. A precise weight of 2.0 grams of the sample was spread on an aluminum dish measuring 50 mm in diameter and 40 mm in depth. The sample was dried in an air oven at a temperature of 100-102 degrees Celsius for a period ranging from 16 to 18 hours until a constant weight was achieved, and the sample was cooled in a desiccator at room temperature for no less than 30 minutes.

Total volatile nitrogen% % = (Weight of the sample before drying - Weight of the sample after drying) / Weight of the sample before drying × 100

Statistical Analysis: The statistical software SAS-Statistical Analysis System, User's Guide (2018) was used to analyze the data to study the effect of different treatments on the studied traits, following a completely randomized design (CRD). Significant differences between means were compared using the Least Significant Difference (LSD) test.

Results and Discussion

Effect of Treatment and Time on Chemical Components

This study investigated the effect of alcoholic extracts of date pits (Phoenix dactylifera) at concentrations of 1% and 1.5% on the chemical and physical properties of refrigerated stored fish fingers. The study included the preparation of extracts, identification of active compounds, and estimation of chemical quality indicators (moisture, protein, fat, ash, fiber, carbohydrates, PV, TVN, TBA, FFA), and physical properties (pH, solubility) (Rasul et al., 2021).

The results shown in Table (1)indicated that the peroxide value (PV) increased progressively during the storage period, reaching its highest levels in the control treatment (T1), which reflects an acceleration in lipid oxidation over time (Rizzo, 2024). In contrast, the treatments involving date seed extracts (T2–T3) contributed significantly to reducing oxidation, with clear statistical differences ($P<0.05$). The T3 treatment, which contained 1.5% alcoholic extract, was the most effective in lowering the PV throughout the storage period, consistently recording the lowest values on all days, followed by the T4 treatment.

Overall, these results confirm the effectiveness of date seed extract, particularly the alcoholic extract at a concentration of 1.5%, in significantly reducing peroxide values during refrigerated storage compared to the control sample. This demonstrates the efficacy of date seed extract as a natural antioxidant in limiting lipid deterioration in refrigerated fish, thereby helping to maintain the quality and safety of fish products for a longer period (Foods Review, 2021).

These findings are supported by previous studies published on PubMed concerning tilapia fish, as well as other research in the journal Foods (2021), where plant extracts exhibited similar effectiveness in inhibiting oxidation and preserving fish quality.

Table 1. The effect of different treatments and refrigeration storage periods on chemical spoilage indicators (PV, FFA, TBA, TVN) in fish fingers on day one and day twelve

Treatment	PV (meq/kg)		FFA (%)		TBA (mg MDA/kg)		TVN (mg/100g)	
	1 day	12 day	1 day	12 day	1 day	12 day	1 day	12 day
T1 control	6.89	16.32	1.31	2.43	0.79	1.94	10.98	63.00
T2	4.21	8.11	0.86	1.33	0.44	0.78	9.12	23.98
T3	3.67	5.89	0.61	1.18	0.39	0.76	7.87	17.25

It is evident from the data in Table 1 that there is a gradual increase in the concentration of free fatty acids (FFA) as storage periods progress, with this increase being more pronounced in the control treatment (T1), reflecting accelerated lipid degradation in the absence of any treatments. In contrast, treatment T3 recorded the lowest FFA values on all days, starting from 0.61 mg/g on day one to 1.18 mg/g on day twelve, followed by T2. The significant differences (LSD) indicated the superiority of these treatments, as the alcoholic extract of date seeds is rich in phenolic compounds and flavonoids that possess strong antioxidant properties, inhibiting lipase enzyme activity at a significance level of 0.05. Adding the extract to fish fingers, especially at a concentration of 1.5%, led to a clear reduction in free fatty acid concentrations during refrigeration storage (Zamanpoore et al., 2024). These results support previous studies, such as the study by (Ali et al. 2019), which demonstrated the role of polyphenolic plant extracts in reducing FFA accumulation in fish meat (Zangana & Al-Shamery, 2016). Other studies have also reported similar improvements using natural extracts such as Pitaya fruit or rosemary. Based on this, the effectiveness of date seed extract as a natural anti-lipid degradation agent can be confirmed, enhancing fat stability and prolonging the shelf life of refrigerated fish products (Harmantepe & Yılmaz, 2025).

According to the data in table (1) and figure 1, there was a gradual increase in TBA values as storage progressed, reflecting the escalation of secondary lipid oxidation, especially in the control treatment (T1), which recorded the highest values throughout the study period, starting from 0.79 mg MDA/kg on day one to 1.94 on day twelve. In contrast, treatments T3 and T2 recorded the lowest values, indicating their effectiveness in reducing oxidation. In the later days (from day four onwards), statistically significant differences ($P \leq 0.05$) appeared between the treatments, with T3 remaining the lowest in TBA (0.32–0.76), followed by T2, while the other treatments recorded intermediate values. These outcome shows that there is effectiveness of date seed extract (T5) that is able to prevent free radicals and formation of other secondary oxidation products like malondialdehyde (MDA), to extend the shelf life than in the control sample (Mahomoodally et al., 2024). This validates the utility of alcoholic extract of date seeds as an agent of lowering secondary oxidation of refrigerated preserved fish products as illustrated in research undertaken by (Afrin et al., 2023) which has indicated a decrease in TBARS values by significant percent compared to the control sample.

Table 1 values signify that the total nitrogen (TVN) had a steady increase in TVN values with respect to the storage period in all the treatments. Nevertheless, the growth in control treatment was far higher (T1), which means that the sample rapidly degraded and spoiled due to more protein undergoing degradation (Kristinsson & Rasco, 2000). T1 recorded a significant increase from 10.98 to 63.0 mg/100g over 12 days, while T5 showed the lowest values (from 7.87 to 17.25), followed by T4, reflecting the efficiency of these treatments. The differences between the treatments showed significant statistical significance ($P \leq 0.05$) starting from day four. The results showed that using the alcoholic extract of date seeds at a concentration of 1.5% in the fish finger product led to a reduction in the chemical changes associated with protein degradation, thereby preserving the physical properties and maintaining the quality of refrigerated stored fish (Shaviklo, 2015). These results are consistent with what (Mehrabi et al.,2024) reported.

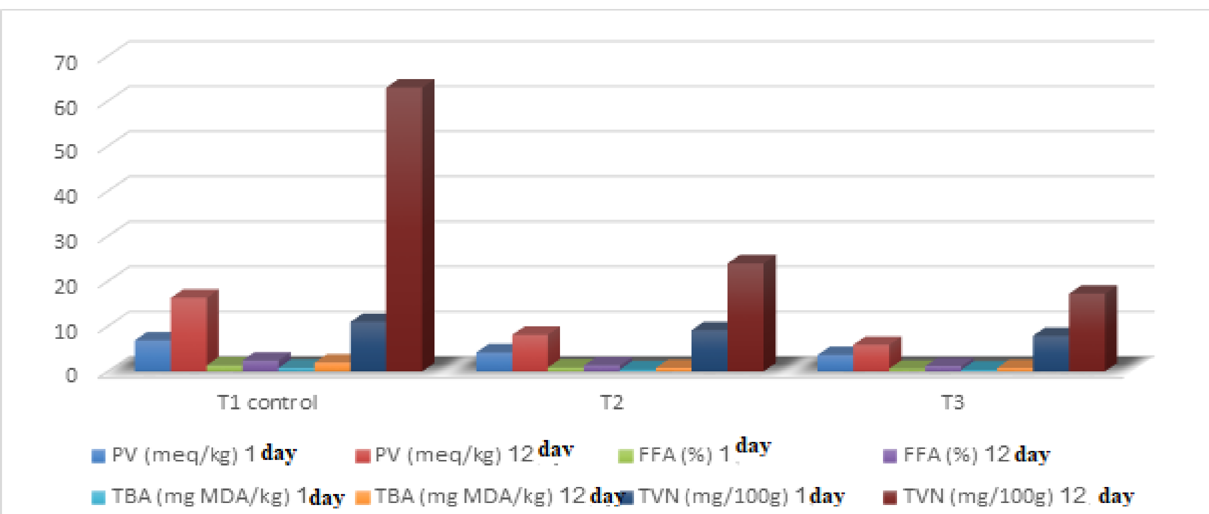

Figure 1. The effect of different treatments and refrigeration storage period on chemical spoilage indicators (PV, FFA, TBA, TVN) in fish fingers on day one and day twelve.

Analysis of Basic Chemical Indicators

The values observed in Table 2 indicated that the moisture content reduced gradually in all the treatments in the course of refrigerated storage, with the loss of natural water. However, this change was not significant throughout the study. On the first day, the moisture level varied between 75.2% (T1) and but as the storage proceeded, the result further reduced until it was and 67.1% (T3) in the twelfth day, with T3 recording the highest level of relative moisture content. Although the levels of little variation existed among treatments, the LSD value was non- significant in all days, which means that treatments containing alcoholic extract of the date seeds, especially with concentration of 1.5%, would help alleviate the loss of moisture during refrigerated storage due to prevention of the adverse chemical and physical alterations as well as maintenance of the texture of the product. A study by (Jeon et al., 2002) indicated an increase in moisture content for herring and cod during their storage for 12 days, recording a decrease in water loss ranging from 29–40% compared to the control These findings suggest that the application of specific treatments or additives enhanced the water-holding capacity of fish products during storage, thereby preserving tissue integrity and minimizing dehydration.

According to Table 2, there was a gradual increase in fat content as storage progressed in all treatments. However, all differences were statistically non-significant, suggesting that this increase was likely due to moisture loss rather than an actual change in fat content. On day one, values ranged from T4 76.0-66.6.T5 75.3 - 67.1% (T2–T3), and gradually increased to 7.3% (T1) and 7.7% (T3) on day twelve. Despite this trend, there were no statistically significant differences. With the progression of the storage period, the apparent fat percentage increased in all treatments, attributed to the concentration of fats due to water evaporation and protein breakdown, rather than the formation of new fats, as the alcoholic extract is rich in antioxidants that oxidize fats and prevent rancidity rather than reduce total fats (Nawaz et al., 2024). This interpretation was supported by (Chavan et al.,2022) in a study on refrigerated storage of salmon, where a gradual increase in total fat percentage was recorded during the storage period due to water and protein loss, and the researchers confirmed that fats become more concentrated rather than in greater actual quantity (Johnny et al., 2020).

The study utilized natural packaging techniques that affected oxidation rates but did not reduce the increased fat concentration either. The protein percentage gradually decreased during storage across all treatments, with the decline being more pronounced in the control treatment (T1), while the other treatments especially T3 maintained relatively higher levels. Despite this trend, all differences were statistically non-significant, as the LSD values did not exceed the significance limits in any of the periods. Overall, this indicates that the treatments helped to limit protein degradation relatively, but without producing a clear statistical effect during the storage period.

This thesis investigated the antioxidant effects of astaxanthin and allyl isothiocyanate on fresh refrigerated minced beef (Ajeena et al., 2024). The study aimed to reduce lipid oxidation, which negatively impacts meat quality during storage (Domínguez et al., 2019).

The additives were evaluated for their influence on chemical, physical, and sensory properties over the storage period. Results showed that these compounds effectively inhibited oxidation and helped maintain the quality of the meat, especially in terms of color and flavor, compared to untreated samples.

These findings were supported by a study by (Soyer et al., 2010) which concluded that coating trout fillets with chitosan and essential oils helped prevent protein loss that occurs during refrigerated storage as it was attributed to the inhibition of protein degrading enzymes and the bacteria that produce said enzymes in a recent study, where the extracts of brown seaweeds such as Padina tetrastromatica was used to coat Nile tilapia (Oreochromis niloticus) fillets during its refrigerated storage period. Besides, (Chebaane et al., 2020) mentioned the influence of organic and biological nutrient transmission on several growth characteristics and the yield of date palm leaflets (Phoenix) (Li et al., 2018).

Table 2. Effect of treatment and refrigeration storage period on the chemical composition (moisture, fat, protein, ash, fiber, carbohydrates) of sliding fish fingers on day one and day twelve

Treat.	Moisture (%)		Ash (%)		Fat (%)		Protein (%)		Fibre (%)		Carb (%)	
	Day 1	Day 12	Day 1	Day 12	Day 1	Day 12	Day 1	Day 12	Day 1	Day 12	Day 1	Day 12
T1 control	75.2	66.6	1.8	2.3	5.9	7.3	18.8	16.9	0.2	0,2	1.4	4.6
T2	76.0	66.6	1.9	2.5	6.1	7.6	18.7	17.1	0,2	0,2	1.6	4.8
T3	75.3	67.1	2.00	2.5	6.1	7.7	18.8	17.2	0,2	0,2	1.7	4.8

As shown in Table 2, there was complete stability in the fiber content (0.2%) across all treatments (T1–T3) throughout the various storage periods, with no significant changes, as dietary fibers are indigestible in the human body (Krogdahl et al., 2005). Despite the presence of an LSD value (0.04), the differences were not statistically significant. This preservation is explained by explaining that fibers are composed of stable chemical properties that are not easily subjected to degradation or oxidation, thus they cannot easily show an indication that the products stored in fish have spoiled and it is not easily altered even in refrigerated storage.

This finding was similar to those of (Mehri et al., 2022) which suggested that the fibers in the fish were stable when they were refrigerated or frozen because this component was not chemically prone to alteration in the same magnitude as other components such as proteins or fats (Abdel Fattah et al.,2020). Also enhanced that the fiber content in the fish product of tilapia did not reveal any changes and was stable during the storage period, be it the refrigerated state, or the frozen state, which suggests that it is a rather easy-to-stabilize welfare component of fish products (Klinmalai et al., 2021).

Table 2 results depict that the content of carbo-hydrates increased gradually in all the treatment as the storage dates went by with control treatment (T1) increasing its contents to 1.4 per cent on the first day, up to 4.6 per cent on the twelfth day. Comparatively, in treatment T3 (4.8%) the value was registered as the highest, at the end of storage. This possible addition is caused either by the decomposition of some of the complex compounds like proteins or fats in more simple parts regarded as carbohydrates or because of concentration of solids as a result of moisture loss. Though the treatment disparities were not significant as of the first day of storage, they turned out to be significant after the fourth day meaning that the influence of the treatment type on the rate of carbohydrate accumulation was limited. The findings indicate that therapies i.e. such as T3 and T2 also facilitated elevation of the carbohydrate levels probably by suppressing processes of degradation or by protecting the carbohydrates soluble materials.

A study by (Mphande et al., 2021) on the effect of preservation methods on sagan fish indicates that total carbohydrates may slightly increase during storage due to moisture loss, but they are not a primary indicator of spoilage or degradation; rather, they reflect relative changes in body composition (Pratama et al., 2023; Duru et al., 2012) in a study on frozen fish preservation noted that any change in carbohydrates is often associated with changes in other more active components (such as proteins and moisture), and does not represent chemical degradation by itself (Mascheroni et al., 1981; Mphande & Chama, 2015). The results indicate that the gradual increase in carbohydrate content during refrigerated storage is primarily due to the loss of other components rather than an actual change in carbohydrate content (Ismail, 2024). Additionally, treatments with date seed extract did not significantly affect this indicator, reinforcing its role as a natural substance that does not disrupt the nutritional balance of fish while maintaining the quality of proteins and moisture (Al-Farsi & Lee, 2008; Himanshu et al., 2024).

The ash content, as shown in Table 2 and Figure 2, exhibited a slight gradual increase during the storage periods across all treatments; however, this increase was not statistically significant, indicating that refrigerated storage did not markedly affect the mineral content of the sample. On the first day, values ranged between 1.8% (T1 and T2) and 2.0% (T3), and continued to rise gradually to reach 2.3–2.5% on the twelfth day. The ash content showed higher percentages as the storage period progressed compared to the control sample, and this increase may be attributed to the minerals present in the meat.

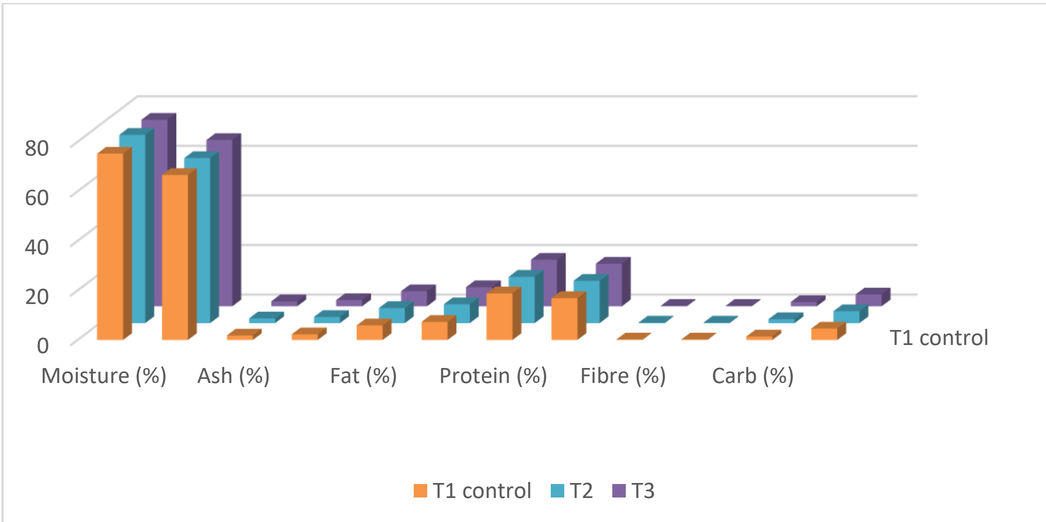

Figure 2. The effect of treatment and refrigeration storage period on the chemical composition (moisture, fat, protein, ash, fibre, carbohydrates) of the slippery fish fingers on day one and day twelve

Analysis of Physical Tests

The results in Table 3 and Figure 3 indicated that the water holding capacity (WHC%) gradually decreased over the storage period in all treatments, due to structural changes occurring in the proteins that negatively affect their ability to retain moisture. The control treatment (T1) recorded the lowest WHC percentages across all periods, decreasing from 73.3% on day one to 66.1% on day twelve. In contrast, treatment T3 demonstrated high efficiency in water retention, starting at 78.4% and remaining the highest until the end of storage (72.8%). Treatments T2, also outperformed the control treatment, with significant differences observed between the treatments across all periods (LSD significant at $P \leq 0.05$).These results confirm the effectiveness of some treatments, particularly the addition of alcoholic extract T3 of date seeds to slippery fish fingers, especially at a concentration of 1.5%, which led to a noticeable improvement during cold storage and the role of the extract in protecting the protein structure and reducing water loss, contributing to the enhancement of the quality of the stored product.

Moreover, a study by (Abou-Taleb, 2022) showed that edible coatings enhanced with plant extracts such as pomegranate peel or date extracts can improve the properties of fish during storage, including WHC, due to their antibacterial effects and protein-stabilizing properties (Ibrahim, 2023). These results indicate that the use of date seed extract is an effective means of preserving the functional properties of fish muscle tissues, such as WHC, during refrigerated storage, which contributes to improving the texture of the final product, enhancing consumer acceptance and extending the shelf life of the product without resorting to artificial additives.

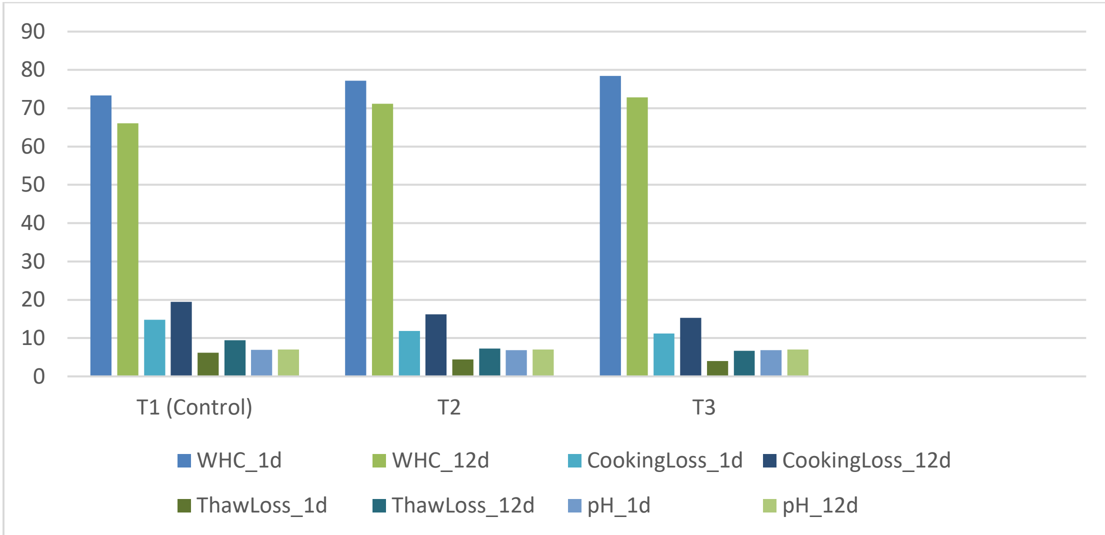

Figure 3. Effect of treatment and refrigeration storage period (WHC, cooking loss, thawing loss, pH) for sliding fish fingers on day one and day twelve

The values presented in Table 3 also showed that the cooking loss percentage gradually increased with the advancement of storage periods in all treatments, due to structural changes in the proteins and the loss of the tissues' ability to retain water and fat. The control treatment (T1) had the highest loss, increasing from 14.8% to 19.5% during the storage period. In contrast, treatment T5 recorded the lowest loss percentage (from 11.2% to 15.3%), followed by T2 (from 11.9% to 16.2%), indicating their efficiency in retaining juiciness during cooking (Cyril et al., 1996). The results showed significant differences between the treatments (LSD between 2.30 and 2.96), confirming the positive impact of the treatments—especially T3 and T2—and that the addition of the alcoholic extract of date seeds to slippery fish fingers, particularly at a concentration of 1.5%, led to a significant reduction in cooking loss during refrigerated storage compared to the control sample. This improvement is attributed to the extract's role in protecting proteins and fats from deterioration, thereby maintaining the product's structure, texture, and final Weight after cooking, and prolonging its shelf life, thus enhancing the quality of the product after storage.

There's a steady rise in oxidative rancidity, microbial and pH with the increasing time of storage (El-Sherif et al., 2021; Al-Zaid et al., 2023). Also, a significant reduction in TBA, microbial and pH was observed in patties treated with clove, thyme, mentha and BHT as compared with untreated samples (Nielsen & Ismail, 2017). It was found that adding natural extracts is more effective in inhibiting microbial count than did BHT (Li et al., 2018). The highest score of overall acceptability was noticed in patties blended with thyme and mentha, and the lowest was recorded in control samples.

(Wangang et al., 2010) indicated in a study on meat treated with natural extracts that water loss during cooking is directly related to the integrity of the protein bonds within the tissues, and that natural treatments that reduce oxidation significantly contribute to reducing cooking loss (Abou-Taleb et al., 2021). The results of this table confirm that the date seed extract significantly contributed to lowering the cooking loss percentage, which is a positive indicator of maintaining the structural and functional quality of muscle tissues, and is considered a crucial factor in increasing consumer acceptance.

GC-MS analysis of the ethanoic date extract revealed a variety of active chemical compounds (Figure 4). Among the most notable are fatty acids such as palmitic acid (n-Hexadecanoic acid) at a high percentage of 18.19%, and its derivatives such as methyl palmitate (Hexadecanoic acid, methyl ester) at 9.77%, in addition to oleic acid (Oleic acid) and its derivatives, indicating an abundance of fatty compounds with biological benefits. Aromatic compounds, phosphonate-type compounds, and sulfur and phenolic compounds were also detected, along with a notable concentration of the compound Supraene. These results show that the extract is rich in components with potential antimicrobial and antioxidant properties, enhancing its potential use in pharmaceutical or cosmetic applications.

Table 3: Effect of treatment and refrigeration storage period (WHC, cooking loss, thawing loss, pH) for sliding fish fingers on day one and day twelve

Treat.	WHC	Cooking Loss	Thaw Loss	Ph
	1d / 12d	**1d / 12d**	**1d / 12d**	**1d / 12d**
T1 (Control)	73.3 - 66.1	14.8 - 19.5	6.2 - 9.4	6.96 - 7.01
T2	77.2 - 71.2	11.9 - 16.2	4.4 - 7.3	6.89 - 7.04
T3	78.4 - 72.8	11.2 - 15.3	4.0 - 6.7	6.87 - 7.02

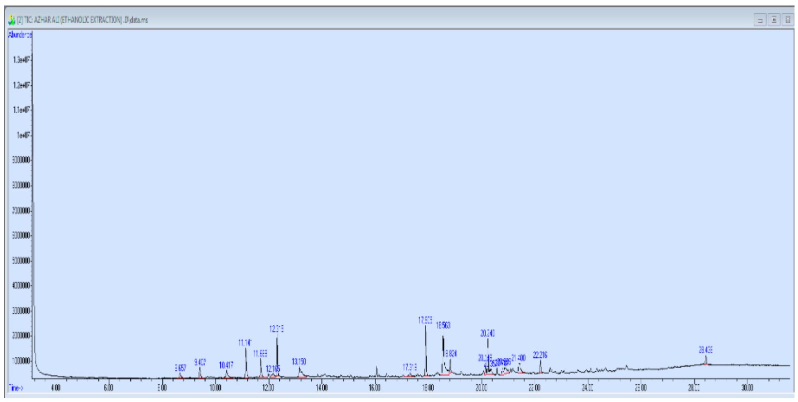

Figure 4. GC-MS of the alcoholic extract of date seed

Conclusion

The study demonstrated that incorporating alcoholic extract of date pits at concentrations up to 1.5% significantly improved the chemical and physical stability of refrigerated fish fingers during a 12-day storage period. Compared to the control, treated samples—especially T3 (1.5%)—exhibited reduced lipid oxidation (as evidenced by lower PV, FFA, TBA, and TVN values), better retention of moisture and protein, enhanced water-holding capacity, and reduced cooking and thawing losses. GC-MS analysis confirmed the presence of potent antioxidant compounds such as palmitic acid, oleic acid, and vitamin E in the extract. These findings confirm that date pit extract is an effective, natural preservative that prolongs shelf life and maintains the quality of fish products, offering a safe alternative to synthetic additives.

Author Contributions

All Authors contributed equally.

Conflict of Interest

The authors declared that no conflict of interest.

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