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Estimation of Impact of Natural Oils on Sensory and Chemical Activity of Tilapia Fish

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ABSTRACT

Background: The chemical and sensory acceptability of Tilapia (*Oreochromis Niloticus*) fish fillets coating containing oregano, ginger and cinnamon essential oils (EOs) were evaluated after vacuum packing. **Methods:** The antimicrobial activity of fish was also investigated. The proximate composition (moisture content, crude protein, crude fat and total ash) of collected fish fillets was determined following the procedure of AOAC (2012). Results: Concerning protein and fat content, essential oil helps in maintaining the protein and fat value as compared to the controlled group in which the protein and fat decreased. The essential oil shows the strongest antimicrobial properties; ginger, oregano, and cinnamon oil reduce microbial growth as compared to the control group. Loss in color and weight were significantly lower with coating. Fish with coating-maintained firmness whereas fish without coating became softer. Fish with an edible coating of ginger, oregano, and cinnamon essential oils showed higher sensory acceptability regarding to odor, evaluated by consumers. The concentration of ginger, oregano, and cinnamon oil is recommended best as compared to the control samples. The sensory attributes of all formulas treated with natural extracts were acceptable as compared to the controlled sample. **Conclusion:** Therefore, the natural additives could be safely used by fish processors to improve the quality and sensory acceptability and also extend the shelf life of fish products.

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INTRODUCTION

Parts of aromatic plants i.e., flowers, buds, leaves, twigs, bark, herbs, seeds, wood, fruits and roots contain volatile natural fluids, called natural oils or Essential oils (Guerra-Rosas et al., 2017). EOs have a significant role to play in the defense of plant against microbes, parasites, fungi and viruses (Amorati et al., 2013). Furthermore, the advantages of EOs have been utilized in the industry in cosmetics, perfumery and medicine. In addition to the above-mentioned usages, nature of EOs as food preservatives has also been acknowledged and EOs are increasingly incorporated as flavor-enhancer and as an antioxidant (Muriel-Galet et al., 2012).

Services of EOs in fish industry to increase shelf life have been widely utilized (Harpaz *et al.*, 2003; Giatrakou et al., 2008; Quitral et al., 2009). Examples of the EOs that extend shelf life and improve secondary characteristics of the food are oregano, cinnamon and ginger (Tsigarida et al., 2000; Burt 2004; Hernández-Ochoa et al., 2011; Makhal et al., 2012). EOs are considered natural preservatives or food additives with strong, antifungal, and antibacterial activities, used in the food industry for

raw and processed food preservation (Atarés and Chiralt, 2016).

Physical changes in the food are accompanied by chemical alterations in the food constituents mainly, sugars, lipids and proteins. Different aromatic EOs are present in meats of different kind (pork, beef, mutton and fish) in water soluble and lipid fractions. The sensory characteristics of the foods are bound to be altered through physiochemical changes that occur as a result of chilling. Other variations in sensory characteristics are a result of ATP degradation as a result of product conditioning. Essential oils can be incorporated into the food products for preservation. The sensory changes ultimately cause a differentiated profile of aromatic oils in the food products, which can be measured and thus sensory changes can be checked (Bermúdez-Aguirre et al., 2016).

Oreochromis niloticus (Nile Tilapia), an important and wildly cultured fish species, occupy a significant share of the global fish market, accounting for 8% of the global fish production (Penarubia et al., 2020). Nutritional value of Nile tilapia is unparalleled as it contains important minerals and vitamins including B vitamins, Potassium, Phosphorous, and Selenium.

An increased market share based on market desirability further provides an incentive for Nile tilapia's aquaculture. Owing to the ease of culture and high growth rate, the culturing of tilapia in the province of Punjab and particularly southern Punjab is gaining popularity. Despite the various mentioned advantages, farmers often state the issues of fish health, processing, marketing, expensive feed and low fry survival, among others (Iqbal, 2018).

The main objective of the food handling and processing industry is the provision of safe and wholesome food to the costumers (Pal and Mahendra, 2015). These objectives are met through physically controlling hygienic conditions, which in turn ensure antimicrobial atmosphere, furthermore, chemical disinfection is also applied to preserve foods. Nonetheless, the latent bacteria and microorganisms in preserved food, spoil the freshness of preserved foods (e.g., fish). The spoilage and deteriorated food content are assessed successfully through sensory methods. These methods include the usage of senses (namely; vision, smell, taste, touch) to evaluate the physical characteristics of the food (such as, odor, flavor, texture, appearance and taste) (Paul, 2010).

Advances in information technology have been coupled with an increased awareness and consciousness of consumers about the harms and ills of chemical preservatives. Researchers have thus, started to look for natural and organic alternative preservation means to the already existing chemical ones. These natural preservatives exist in various living organic bodies, e.g., bacteria, fungi, algae, plants and animals (Ghanbari et al., 2013; Hassoun et al., 2017). Various antimicrobial and antioxidant activities have been reported for natural preservatives derived from bacteria (e.g., bacteriocin) and plants (thyme essential oil, tea polyphenols, rosemary extract, etc.). Furthermore, the antimicrobial compounds present in fungi (mushrooms) and algae could also prove to be a source of discovery of novel compounds with antimicrobial properties.

Increasing demand of the valuable products such as tilapia, for natural preservatives such as essential oils, forces the need for an evaluation of the effect of Eos on the preservation status of tilapia. Thus, the current study was designed to obtain the objective of evaluating the effect of EOs on the preservation status of tilapia. The preservation status was gauged by evaluating physical, biochemical, and microbiological changes of tilapia fillets stored on ice to increase its shelf life.

MATERIALS AND METHODS

Sample collection

The study was carried out at the laboratory of the PCSIR Lahore. Experimental fish was collected from fish pond complex of the fisheries Research and Training Institute Lahore, Tilapia (*Oreochromis niloticus)* were selected as experimental fish for" study".

Sample preparation

The fillets were divided into twelve pieces. The fillets were immersed for 15 min into the ginger oil, oregano oil, cinnamon oil. Tilapia fillets which had been stored in laboratory refrigerator of the Lahore Garrison University. After that fillets were vacuum-packed and stored in refrigerator.

Proximate analysis

The proximate composition (moisture content, crude protein, crude fat and total ash) of collected

fish fillet was determined following the procedure of Horwitz, (2000).

Determination of moisture

Three crucibles were taken, washed carefully, and dried in electric oven. The crucibles were shifted in desiccator with the help of tongs for 10 – 15 minutes for cooling purpose. The 2g fish meat samples in each crucible were placed in electric oven at 130°C for 1 -2 hours. The crucibles were placed in desiccator and weighed (Horwitz, 2000).

Determination of crude ash

The crucibles removed from oven in moisture test were used further, and then charred the dehydrated sample and put them into muffle furnace at 550C for 4-6 hours. The crucibles were removed from furnace when white colored material (ash) appeared in the crucibles. Then the crucibles were put in desiccator for 10-15 minutes and weighed (Horwitz, 2000).

Determination of fat content

The hot extraction method was used for the estimation of fat. 2g fish meat sample was taken in the thimble and placed in oven for 1 hour to remove extra moisture. The thimbles were placed in Soxhlet apparatus for 4-16 hours. n- hexane was poured in Soxhlet apparatus. The thimble was removed, air dried, and then dried in oven for 1 hour. After 1 hour the thimbles were placed in desiccator and weighed (Horwitz, 2000).

Determination of crude protein

The method used for the determination of protein is Kjeldhal method.

Microbial analysis

Microbial analysis of all samples was performed according to the method described in the mannual of food quality control, FAO of the united nation 1992 (Penarubia et al., 2020). The fish sample were tested for variouus food borne pathogens of public health concern including total plate count (TPC), Escherchia coli (EC) , Salmonella (SS).

Sensory evaluation

For sensory analysis, the Quality Index Method (QIM) Scheme developed by Bonilla et al (2007) was used with modification. The Scheme consisted of four quality Parameter (odor, texture, flavor, whiteness). The Scheme had four sample descriptors, scoring demerit points from 0 to a maximum of 3, where 0 represented the best quality assessment before the experiment. triplicate samples were taken at regular intervals for sensory analysis. The panel members were asked to state whether the fish fillet was acceptable or not for the visual qualitative determination of shelf life of fish.

Tilapia fillets were treated with different essential oils. In this study, a microwave was used for cooking fish. Fillets were cooked in a microwave at 600 w for 2 minutes, and then evaluated by seven trained assessors in terms of appearance, discoloration, texture, and odor and scored on a 5- point scale: 5 like very much, 4 like, 3 neither like or dislike, 2 dislike, and 1 dislike very shown in table 1.

RESULTS

Moisture content of fish meat sample

The moisture content of tilapia fish after treatment with 3 different essential oils comparison to control group was determined. The ginger oil treatment showed a moisture content 5.7%, 6.2% as compared to the control group having 8.4% and oregano oil also reduced the moisture content 5.5%, 6.1% as compared to the control group having 8.5% cinnamon oil treatment showed 6.2%,6.3% value as compared to control group having 8.4%. So, the natural oil showed positive results by reducing moisture as compared to control group.

Ash content of fish meat sample

The results show the crude ash content of tilapia fish after edible coatings and control groups. The ginger oil treatment showed the ash content 10.2%, 10.8% as compared to control group having 6.2% and oregano oil also higher values the ash content 10.3%, 10.4% as compared to the control group having 6.5% another cinnamon oil treatment showed 10.4%, 10.9% value as compared to control group having 6.2%.

Crude protein of fish meat sample

The crude protein in the ginger oil treatment was 44.5%,45.6%; in oregano oil treatment 42.6%, 45.6%; and in cinnamon oil treatment it was 55.5%, 57.6% as compared to the control group in which the crude protein decreased by 42.6%, 42.5%, 42.6%.

Crude Fat of fish meat sample

The ginger oil treatment showed 18.8%, and 18.6% crude fat, oregano oil treatment showed 15.7%, and 16.1% crude fat while cinnamon oil treatment showed 15.4%, and 16.2% crude fat as compared to the control group in which fat content decreased by 14.4%, 13.3%, 14.4%.

Antimicrobial Analysis of fish sample

The total plate count analysis of Salmonella, E. coli was decreased in the ginger, oregano, and cinnamon oils.

Sensory evaluation

The result of this study suggests that treating tilapia fillets with ginger, oregano, cinnamon oil 20% before storing them in the refrigerator may preserve the sensory attributes up to 15 days longer after vacuum packing. The concentration of ginger and oregano oil is recommended best as compared to the cinnamon oil. The sensory attributes of all formulas treated with natural extracts were acceptable as compared to the control sample (Figure 1).

DISCUSSION

Modern food processing technologies are primarily targeted and tailored to costumer demands. An awareness of natural and organic preservatives as alternative to the chemical preservatives has triggered scientists to look for natural ways to preserve foods. One natural way to preserve food and add life to it is the addition of natural essential oils. These EOs have been applauded for their antimicrobial and antifungal properties.

The natural oils (Essential oil) are extracted from plants and are attracting interest as natural additives due to antimicrobial and antioxidant properties (Atarés and Chiralt 2015). EOs are considered natural preservatives or food additives with strong, antifungal, and antibacterial activities, used in the food industry for raw and processed food preservation.

The importance of tilapia in aquaculture prompted the usage of tilapia as sample in the current study. These samples or fillets were divided into twelve pieces. The fillets were immersed for 15 min in to the ginger oil, oregano oil, cinnamon oil. After that fillet were vacuum-packed and stored in refrigerator for 30 days. Then proximate composition (moisture content, crude protein, crude fat and total ash) of collected fish fillet was determined following the procedure of Horwitz, (2000).

In current study, an application of EO coating containing cinnamon, ginger and oregano oils before refrigeration, was successful in the preservation of sensory and chemical attributes of tilapia fillets, it further extended the shelf life for up to 15 days after vacuum packing. The current study also recommends the usage of ginger and oregano oils as these were found to be better preservatives than the cinnamon oil. All samples preserved with EOs were observed to have the same sensory attributes as that of the controls. Shelf life of the fish meat was extended due to the antimicrobial properties of EOs. Hence, the usage of natural oils as food preservatives could be employed safely to enhance quality and add life to shelf products such as fish.

In a study Acevedo-Fani et al. (2015) conducted on Tilapia (Oreochromis niloticus), alginate- based coatings containing oregano and ginger Eos were applied as preservatives. Following the application, sensory and quality suitability of the fish fillets were gauged, furthermore, fish and EO coatings were also checked for antioxidant activity. Although lipid oxidation reduction was seen after the application of edible EO coatings, consumers were satisfied with the products and rated EO-coated fish as having higher sensory appeal. Even though the coating caused a reduction in weight of the fish and a dullness of the color, the overall performance of EOs as natural preservatives and flavor enhancers was well-established.

Khalafall et al. (2015) studied Thymus vulgaris (thyme) and Rosmarinus officinalis (rosemary) extracts (0.5% and 1.5% respectively) were employed as preservatives through dripping and the subsequent effect on the shelf life of Orechromis niloticus was observed during refrigerated storage at 2 ± 1 °C. Periodic sensory, biochemical and microbiological methods were used for examination of samples and controls after every three days, starting from day zero. This pattern was continued till the decomposition in each group. Results showed that the antioxidant and antimicrobial properties of thyme extracts preserved the tilapia fish far better than the control preservatives. The effectiveness of thyme extract was evident from the extended shelf life of tilapia fish that outperformed the controls by 9 days. Similarly, rosemary extract showed strong antioxidant properties while its antimicrobial properties were lagging behind that of the thyme extract.

The current study however, employed three oils namely; ginger, oregano and cinnamon to preserve refrigerated tilapia fillets. The results showed that the natural oil inhibit the microbial growth in fish sample meat. Ginger, oregano, cinnamon oils effectively

curtail the growth of bacteria and thus add life to the preserved food (tilapia fish).

Ginger extracts obtained by supercritical CO2 extraction (SCE) and ginger essential oil were employed by Mattje et al. (2019) to preserve tilapia fish burgers and notice the quality changes in the food. These extracts were examined against controls that had no antioxidant added and against those samples that had sodium erythorbate (SE) as preservative. Results of the study showed that SCE successfully curtailed the lipid oxidation and enhanced shelf life of the fish burgers from 6 to 8 days (according to TBARS data). The study however showed that a strong ginger taste was actually a deterrent and consumers based low feedbacks on this distaste. SCE-obtained ginger extracts thus prove to be an efficient and natural way to preserve tilapia as compared to the chemicals available commercially.

The result of this study suggests that treating tilapia fillets with ginger, oregano, cinnamon oil before storing them in the refrigerator may preserve the sensory attributes up to 15 days longer after vacuum packing. The concentration of ginger, oregano and cinnamon oil is recommended best as compared to control sample. The sensory attributes of all formulas treated with natural extracts were acceptable as compared to the controlled sample. Therefore, the natural additives could be safely used by fish processors to improve the quality and extend the shelf life of fish products.

Mincemeat of Mozambique tilapia and burger patties were analyzed for chemical, sensory and microbial activities by Lithi et al. (2020) for 75 days. Mincemeat and patties were stored at -18 ºC. Detection of moisture and lipid contents of mincemeat and patties was performed. It was found that moisture and lipid content of burgers was higher than that of the mincemeat. Furthermore, the microbial contents of burgers were found to be higher than that of mincemeat. The overall microbial load of both samples (mincemeat and burgers) was found to be lower than that of the maximum possible counts at the conclusion of the study. Towards the end of the experiment, there was a reduction in the sensory measurements of the burgers which included taste, color and texture. This significant reduction ($P<0.05$) was however were not enough to overshadow the overall acceptability of the burgers.

In present study proximate analysis of tilapia fish sample after applying different essential oil treatment. Significant ($p <0.05$) results in moisture, Ash, fat, protein in oil coating samples and show insignificant ($p>0.05$) results in controlled sample of fish meat sample. Essential Oil Coating sample reduce the microbial growth as compared to the controlled sample. Essential oil treated sample showed maximum sensory acceptability as compared to control sample.

In another study conducted by Vital et al. (2018) the fish fillet of Nile tilapia was coated with alginate-based different EOs (ginger and oregano). Quality of the preserved fillet, sensory parameters and antioxidant activities were checked. The coating of oregano essential oil was found to have the maximum number of antioxidants. However, a reduction in lipid oxidation in samples as compared to the controls was observed. The oregano coating was also successful in preserving the color of preserved food along with resisting a reduction in weight. Texture of the preserved fish was maintained in EOs' coating and samples were stiff compared to the soft fillets of uncoated fish.

In addition to this, consumers assessed the preserved fish for odor and the fish coated with edible essential oil coating was found to be the most acceptable. Thus, the study has concluded the EO edible coating to be a potent tool to maximize preservation along with antioxidant, sensory and quality enhancement.

CONCLUSION

In conclusion, the results obtained in this study showed the tested essential oils (EOs) ginger, oregano and cinnamon possess antimicrobial properties that enhance the physicochemical, microbiological and sensory quality attributes of tilapia fish fillets during cold storage. Thus, extending the shelf life and also inhibit the microbial growth thereby preventing from spoilage and also extend the shelf life in oil treated sample as compared to the control sample. Then proximate composition (moisture content, crude protein, crude fat and total ash) of collected fish fillet was determined by following the procedure of Horwitz, (2000). Therefore, the natural additives could be safely used by fish processors to improve the quality and extend the shelf life for fish products.

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Statement of conflict of interest

None to declare.

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Table 1: Sensory analysis of fish sample Quality index scheme

Properties	5	4	3	2	1
Odor	Fresh	Slightly loosen fresh odor	Slightly stale and bad	Stale and bad	Rotten and Ammonia odor
Texture	Tight, hard elasticity	Slightly loosen tight texture	Slightly soft, suitable elasticity	Texture is soft, week suitable	Evidently soft and with no elasticity
Flavor	Pleasant	Slightly loosen	Spoil slightly	Spoil	Evidently spoiled, not eatable
Whiteness	Color is white	Color is near to white	Color is near to white	Color is dark yellow, gray, blackish	Color is indistinct

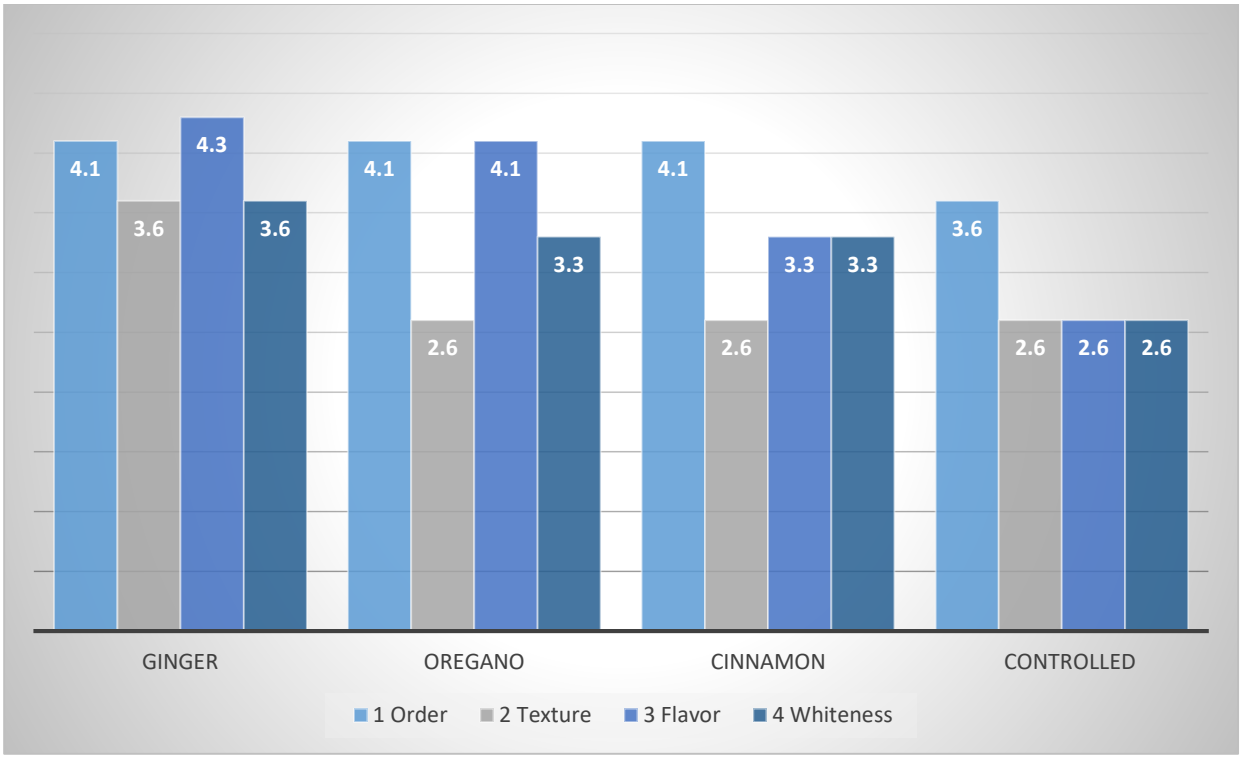

Figure 1: Sensory evaluation of tilapia fish meat sample after applying different oil treatment. On X axis shows about the order, texture, flavor, whitness parameters and on Y axis shows different sensory evaluation values treated with different essential oil compared with control sample.