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Review on Edible Film as Food Preservatives Agent

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ABSTRACT

Fish product is highly perishable and has a short shelf-life. During storage, many reactions occur leading to changes in quality such as endogenous chemical and enzymatic reactions. Safety and shelf-life are related to the presence of food spoilage and pathogenic microorganisms. Spoilage of food products is due to chemical, enzymatic, or microbial activities One-fourth of the world's food supply and 30% of landed fish are lost through microbial activity alone. With the ever-growing world population and the need to store and transport the food from one place to another where it is needed, food preservation becomes necessary in order to increase its shelf life and maintain its nutritional value, texture, and flavor. Edible films are thin films prepared from materials, which act as a barrier to external factors and thus protect the food product, extend their shelf life and improve its quality. Proper handling, pre-treatment, and preservation techniques can improve the quality of fish and fish products and increase their shelf life. Therefore, the objective of this paper reviews was to observed the food preservative and edible film on the extended shelf life of Tilapia (Oreochromis niloticus) fillets under refrigerated storage conditions against fish food spoilage-causing microorganisms

Keywords: *Oreochromis niloticus; Edible film; Shelf life; Refrigeration; Preservation; Spoilage*

INTRODUCTION

Tilapia is a freshwater fish species which has broadly been cultured on a global scale. It is extensively farmed in China and sold in supermarkets and food chain stores, but there have long been issues regarding its storage due to the short shelf-life. Therefore, it is essential to growing effective methods for extending the shelf-life of Tilapia (Cao et al. 2012). Nile tilapia (Oreochromis niloticus) is from the most prosperous fish that lives in tropical and subtropical waters; tilapia could grow in a wide range of salinity, temperature, and oxygen concentration. The global production of tilapia was tripled through the last decade due to its importance and quality that increased the acceptance and preference of human consumers to the whole fish or its products (Alsaggaf et al. 2017).Fish food preservation technique was different used method such as freezing, chemical preservation, salting, and modified atmosphere packaging have been employed to recover the microbial safety and prolong the shelf-life of aquatic products. However, low-temperature storage and chemical techniques for controlling water activity, enzymatic, oxidative and microbial spoilage are the most common in the industry today (VIP 2010 and Cao et al. 2012). In spite of the convenient and widespread use of preservatives, food processors and consumers have both wanted to decrease the use of synthetic chemicals in food preservation. Consequently, there have been increasing interests in the application of natural agents as bio-preservatives (Cao et al. 2012).

Edible films are thin films prepared from materials, which act as a barrier to external factors and thus protect the food product, extend its shelf life and improve its quality (Vodnar et al.2015).An edible film is defined as a performed thin layer or solid sheets of material placed on or between food components (Galus and Kadzińska 2015). The edible films could be applied to food products as film wraps or pouches for food. The use of edible films in food protection and preservation has increased in the last decade since they can offer several advantages (high antimicrobial effect with minimum sight effects, increasing the trust of the consumer, reducing the economic costs, etc.) over synthetic materials, such as being biodegradable and environmentally friendly (Dehghani, 2018). The first edible film used for food preservation was made in the 15th century from soymilk (Yuba) in Japan (Sánchez-Ortega et al. 2014).

There has been much research to determine the shelf life of aquacultured sea bass during refrigeration or ice storage (Poli et al. 2006 ; Taliadourou et al. 2003; and (Limbo et al. 2009). For instance, (Poli et al. 2006) concluded that the shelf life of seafood was 7 days on the ice. In the additional quality assessment of iced sea bass fillets, the shelf life of 8 – 9 days was reported on the basis of microbiological and sensory analyses (Taliadourou et al. 2003). In further authors have reported differences in the shelf life of sea bass stored at 4 °C, ranging from 4 (Arfat and Benjakul 2015; and (Limbo et al. 2009) to 5 – 6 days (Kostaki et al. 2009).Packaging plays a serious role in the fish supply chain and is part of the answer to challenge food waste (Vodnar et al. 2015). For instance, Vacuum packaging (VP) and modified atmosphere packaging (MAP) are actual ordinarily used as a supplement to ice or refrigeration to inhibit the normal spoilage flora and prolong the shelf-life of fresh fish products (Velu et al. 2013;and (Cyprian et al. 2013).MAP technology has, however, some difficulties, such as added costs for packaging equipment, gases, and packaging materials; it also needs special training for food operators (Grujić et al. 2017).

Packaging innovation and new technologies are essential for the fishing industry. In current years, a variety of active packaging systems have been developed to extend storage life and increase the safety of fish products. These have a variety of benefits such as biodegradability, edibility, biocompatibility, and aesthetic appearance ,respectively, barrier properties against oxygen and physical stress (Socaciu et al. 2018). Therefore, the objective of this reviews paper was to examine food preservative and edible film on the extended shelf life of Tilapia fish (Oreochromis niloticus) fillets under 4 0C storage conditions against fish food spoilage-causing microorganisms.

Extended Shelf Life of Tilapia Fish (Oreochromis Niloticus) Fillets

Shelf existence of food is defined because of the most period of time a given product of fish for human consumption. Fish shelf life is the time from when it's a taken from the Water until it is now not fit to consume. In advertising, the shelf life of clean or fresh and frozen fish is a completely important consideration understanding the remaining shelf life lets in the processor and retailer to plan the period of time a product may be held permitting manipulate in their market place. Adding one or two days to the shelf lifestyles allows the marketplace to get pinnacle dollar and assure repeat income (Dolye, 1995 and Elzbeer 2017).

Different species of fish have an extraordinary shelf life, which also varies depending at the oil ranges, catch location, season length of rigor mortis, intrinsic situation of fish and how it changed into captured (Chuma, et al, 2010). Temperature and managing practices are the most important component in deciding the shelf life of all species of fish; if the fish product is treated cautiously, the temperature at which it is held controls its beneficial life. The temperature will control the rate of bacteria spoilage and enzyme breakdown an undeniable truth is that the higher the temperature the faster fish spoilage (Dolye, 1995).

Food Spoilage Microorganisms

Fish and their product are very perishable food product and are especially prone to each chemical and microbiological spoilage throughout processing or storage (Serio et al. 2014). For that reason, one or extra adequate preservation systems are required so as to keep the safety and quality and extend the shelf life of such products. Diverse conventional processing methods which include drying, salting, smoking, marinating, fermentation and so forth have been broadly used when you consider that historical time to preserve fish high-quality or upload more cost to the product. Furthermore, low-temperature storage and chemical preservatives used for controlling water activity, enzymatic, oxidative, and microbial spoilage are substantially utilized in the food industry (Alsaggaf et al. 2017).

Chemical reactions that reason offensive sensory modifications in foods are mediated with the aid of a selection of microbes that use food as a carbon and energy supply. These organisms encompass prokaryotes (bacteria), single-celled organisms lacking described nuclei and other organelles, and eukaryotes, single-celled (yeasts) and multi cellular (molds) organisms with nuclei and different organelles. some microbes are typically discovered in many forms of spoiled foods whilst others are extra selective inside the ingredients they devour; multiple species are regularly recognized in a single spoiled food object but there may be one species (a particular spoilage organism, SSO) typically answerable for the production of the compounds causing of odors and flavors. Within a spoiling food, there is usually a succession of various populations that rise and fall as exceptional nutrients grow to be to be had or are exhausted. A few microbes, consisting of lactic acid bacteria and molds, secrete compounds that inhibit competitors(Gram et al. 2002).

Spoilage microbes are frequently common population of soil, water, or the intestinal tracts of animals and can be dispersed via the air and water and by means of the activities of small animals, especially insects. It should be mentioned that with the development of latest molecular typing techniques, the scientific names of some spoilage organisms, particularly the bacteria, have changed in recent years and a few older names are no longer in use. Many insects and small mammals also purpose deterioration of food; however, those will no longer be taken into consideration right here. Food loss, from farm to fork, reasons massive environmental and financial outcomes.

The USDA economic research provider envisioned that more than ninety-six billion pounds of food within the U.S. were lost with the aid of retailer, food service, and consumers in 1995. Fresh produce and fluid milk each accounted for nearly 20% of this loss whilst decrease possibilities have been accounted for via grain product (15.2%), caloric sweeteners (12.4%), processed fruits and veggies (8.6%), meat, poultry and fish (8.5%), and fats and oils (7.1%) (Rawat 2015).

Spoilage of food products can be due to chemical, enzymatic, or microbial activities. Chemical deterioration and microbial spoilage are liable for lack of 25% of gross primary agricultural and fishery products each every year. One-fourth of the world food delivers and 30% of landed fish (VIP 2010) are misplaced via microbial activity alone. Around 4-5 million tons of trawled and shrimp fish are misplaced each year because of enzymatic and microbial spoilage because of the flawed onsite garage.

Clean fish spoilage can be very rapid after it's far caught. The spoilage method (Rigor mortis) will start within 12 h of their capture in the excessive ambient temperatures of the tropics. Rigor mortis is the procedure through which fish loses its flexibility due to stiffening of fish mussels after a few hours of its loss of life (Adebowale et al. 2008). Most fish species degrade as a result of digestive enzymes and lipases, microbial spoilage from floor micro organism and oxidation. At some stage in fish spoilage, there is a breakdown of diverse components and the formation of the latest compounds. These new compounds are answerable for the changes in odor, flavor, and texture of the fish meat.

This represents a major issue of the freshness of the saleable product and the breakdown of proteins and lipids. Better energy demanding freeze-storage maintenance can be altered by synthetic or natural preservatives for manipulating of lipid oxidation and microbial growth in fish at some point of storage (VIP 2010). Capsulated or wrapped with a rice-based edible film of those preservatives and refrigeration diminishes the process of spoilage.

Compositional changes at some point of fish spoilage result in lipid oxidation and protein degradation in addition to the lack of different treasured molecules. If you want to expand superior maintenance techniques for these value delivered product inactive forms, information of the mechanism chargeable for their degradation is essential (Olatunde and Benjakul 2018).

Autolytic Enzymatic Spoilage

The procedure of degrading proteins through indigenous enzymes, called autolysis, starts immediately after the final of rigor mortis. This method creates a favorable environment for bacterial growth (Kuley et al. 2017). Alteration within the sensory properties of seafood may be attributed to proteases and lipases (Lund and Nielsen 2001).

Even for the duration of refrigeration and frozen storage, autolysis happens in seafood at a very gradual charge (VIP 2010). However, at some point of mistaken storage, protein is unexpectedly degraded, through a procedure mediated by means of indigenous and microbial proteases.

Chymotrypsin, cathepsins, tryps in, lipase, and phospholipase are reportedly located within the hepatopancreas, spleen, and pyloric ceca of seafood, whereas pepsin is positioned inside the belly (Odedeyi and Fagbenro 2010). Belly burst, which generally takes place in fish, is a characteristic of the enzymes inside the fish intestine or gut, causing fast protein decomposition. Textural adjustments (meat toughening) at the side of the production of formaldehyde, for the duration of the storage and processing of seafood, are also results of enzyme activities (Olatunde and Benjakul 2018).

Trimethylamine oxide demethylase, found in some fish, induces the formation of formaldehyde through demethylation of TMAO to dimethylamine (DMA) and formaldehyde (Gonçalves and de Oliveira 2016; and Leelapongwattana et al. 2005).Formaldehyde cross-links proteins through methylene bridging, which makes fish muscle hard and with the low water-preserving ability(Immaculate and Jamila 2018). Melanosis (black pigment formation) in shrimp is also a result of tyrosinase or polyphenol oxidase present in the shrimps (Sae-leaw, Benjakul, and Simpson 2017). The product of proteolysis (free amino acids and peptides) can serve as the nutrients for microbial growth, main to spoilage, together with the formation of biogenic amines (Fraser and Sumar 1998).

Temperature and pH are elements affecting protease pastime. Most efficient pH values for most proteases are within alkaline and neutral variety (Olatunde and Benjakul 2018). The reduction of TMAO to TMA and other basic volatiles through the action and metabolism of the endogenous or microbial enzymes increases the pH of stored seafood (Leelapongwattana et al. 2008) fats in seafood can also be hydrolyzed through lipase or phospholipase (Aryee et al. 2007 and Kaneniwa et al. 2004).

Hydrolysis of mono-, di-, and triglycerides to glycerol and fatty acids is induced on by using triacylglycerol acyl hydrolases(EC three.1 .1.three) within the presence of water (Fernandes 2016). FFAs liberated in seafood can simply go through oxidation, which contributes to the formation of off-odor, in particular, fishy odor.

The fishy smell is related to aldehydes, especially polyunsaturated aldehydes and the fishy smell depth in fish with bleeding turned into decrease than that of unbled fish (Maqsood and Benjakul 2010). Moreover, lipoxygenase positioned in particular in gill or pores and skin can induce oxidation in stored fish, in particular, whilst the fish is stored for an extended time (Sae-Leaw et al. 2013).

Oxidative Spoilage

In well known, seafood is rich in lipids, particularly fat containing long-chain PUFAs (Gudipati 2017). Lipids play a main position in off-flavor and off-smell development and loss in the dietary value of seafood (Mariutti and Bragagnolo 2017). Depletion of fat-soluble vitamins and different compounds is likewise an effect of lipid oxidation (Mariutti and Bragagnolo 2017; Souza and Bragagnolo 2013).Lipid oxidation includes numerous levels. An abstracted labile hydrogen atom from a fatty acyl chain can initiate lipid oxidation, with free radical production. Metals, ions, irradiation, and warmth are catalysts for the free-radical formation.

Free radicals react expeditiously with oxygen to form the peroxyl radical, that could further abstract a hydrogen atom from another fatty acyl chain, thereby producing a new unfastened radical, and hydroperoxides. The new free radical can then preserve the chain response (Ladikos and Lougovois 1990; and Waraho et al. 2011).

Lipid oxidation is terminated when there is a construct-up of free radicals with the formation of non-radical products (Schneider 2009). The rate of oxidation is ruled by way of oxygen availability, mild, the presence of metals, and moisture, temperature, and degree of unsaturation of the lipid (Maqsood and Benjakul 2010). Nevertheless, the number one products, especially hydroperoxides, are not stable. Secondary products of lipid oxidation are formed because of the decomposition of primary products. Hence, each primary (unfastened fatty acids [FFAs], dienes, and peroxides) and secondary (aldehydes, trienes, and carbonyls) product are generated from the lipid oxidation manner.

Average, the amounts, and forms of oxidation product rely on the quantity of the oxidation reaction and fatty acid composition (Berton-Carabin et al. 2014). (Mariutti and Bragagnolo 2017) stated that pre-slaughter action (physical accidents and stress), post-slaughter activities (cold shortening and tenderization techniques, temperature, and pH), and processing parameters (raw substances first-class, processing temperature, size reduction, additives, form of packaging, and distribution and storage situations), had been factors influencing the depth and rate of oxidation.

Lipid oxidation can be induced via several prooxidant (hemoglobin, myoglobin, and cytochrome c) Ghaly et al., 2010). Deoxygenated or oxidized hemoglobin, that is prooxidant often observed within the blood of fish, are answerable for accelerated lipid oxidation (Undeland et al. 2005)Bleeding could decrease lipid oxidation, related to the decreased prooxidant present in the blood (Undeland et al. 2005, Secci and Parisi 2016).Apart from the off-flavor development in seafood, loss of functionality, due to protein oxidation, happens when secondary oxidation products react with proteins, amines, and peptides (Mariutti and Bragagnolo 2017). Denaturation of myofibrillar and sarcoplasmic proteins is likewise an end result of interaction among the one's proteins and FFAs shaped all through hydrolysis of lipids (Horne 2008).

Microbial Spoilage

Seafood is exceptionally vulnerable to invasion through opportunistic and pathogenic micro organisms. Habitat, that is microbe-rich surroundings, commonly determines the microbial load of seafood (Olatunde and Benjakul 2018; and Kuley et al. 2017). Generally, spoilage in seafood is especially caused by the growth and metabolism of microorganisms related to the manufacturing of biogenic amines, alcohols, histamine, putrescine, sulfides, natural acids, aldehydes, and ketones (Kuley et al. 2017). Psychrophilic bacteria are the primary organization of microorganisms responsible for spoilage in chilled or refrigerated seafood. Identified aerobic or facultative anaerobic psychrotrophic gram-negative bacteria, inclusive of Moraxella, Shewanella putrefaciens, Acinetobacter, Pseudomonas, Photobacterium, Aeromonas, Flavobacterium, and Vibrio, as fundamental spoilage organisms in seafood (Sivertsvik et al. 2002).

Unique spoilage organisms consisting of Shewanella, Photo bacterium phosphoreum, and Pseudomonas are considered the main causes of seafood spoilage (Gram and Dalgaard 2002). Gram-negative bacteria are the major contributors to spoilage in seafood. But, continuous processing or prolonged storage/ transportation offer opportunities for Gram-positive bacteria to additionally dominate and reason spoilage (Al Bulushi et al. 2010). Arafat and Benjakul 2015 reported both Gram-bacteria (P. phosphoreum) and lactic acid bacteria (LAB) because of the major spoilage microorganism in fish. Gram-positive microorganism bacteria Coryne bacterium, Bacillus, Staphylococcus, Clostridium, Streptococcus (Al Bulushi et al. 2010), and Brochothrix thermosphacta (Fall et al. 2010; and Lalitha et al. 2005) have been also recognized as spoilage microorganisms in seafood.

It can, consequently, be deduced that each Gram-negative and Gram-positive bacteria are responsible for the spoilage of seafood. However, the sampling area, geographic area, and method of fishing are factors determining the sort and wide variety of microorganisms (Kuley et al. 2017).The low-molecular molecular weight substances, including small peptides, carbohydrates, and free amino acids in the tissue, are used by microorganisms as an energy supply for increase and production of several by-products, such as biogenic amines (Masniyom 2011), histamine (Visciano et al. 2012),sulphur-containing compounds (Varlet and Fernandez 2010), and other additives. The enzymatic activity of a few different bacteria, consisting of psychrotolerant Enterobacteria, Vibrio spp, Aeromonas spp, and S. putrefaciens have been mentioned to lessen trimethylamine oxide (TMAO) in seafood to trimethylamine (TMA), which is chargeable for the fishy odor (Arfat and Benjakul 2015&Yarnpakdee et al. 2015; Lidbury, Murrell, and Chen 2014). TMA production is followed by means of the improvement of hypoxanthine, which reasons a sour flavor in seafood (Tikk et al. 2006). Production of hypoxanthine is induced by indigenous enzymes or, enormously more fast, by means of bacteria via decomposition of nucleotides (inosine or inosine monophosphate (Masniyom 2011; Varlet and Fernandez 2010; and Visciano et al. 2012).

Fish Quality Improvements

Fish quality is very subjective in nature and is a very complicated concept, which includes nutritional (Pietrowski, Tahergorabi, and Jaczynski 2012),microbiological, biochemical and physiochemical attributes. Fish is a more perishable product than other muscle foods and its freshness degrades after death due to various biochemical reactions (e.g., changes in protein and lipid content, and the formation of biogenic amines and hypoxanthine) and microbiological spoilage (Matak et al. 2015).

This results in the deterioration of sensory quality and nutritional value of fish. Preservation of fish is important to prevent the loss of this nutritionally rich natural resource (Mohan et al. 2012). Edible films and coatings can be used to provide physical protection (Ocht 2005) to protect food products from mechanical damage, and from physical, chemical, and microbiological activities.

They also can be edible, biocompatible, non-toxic, and serve as both a barrier and a carrier of food additives (e.g., antioxidants and antimicrobials). Biodegradable edible films may be categorized according to the type of material from which they are derived. Each chemical class has its inherent advantages and limitations when used for films. Polysaccharides, proteins, and lipids are the three main materials used for this purpose. Polysaccharides are widely available and usually cost-effective. Most of them are neutral, although some gums are negatively charged. Due to the presence of a large number of hydroxyl and other polar groups in their structure, hydrogen bonds have a crucial function in film formation and final characteristics (Dehghani et al. 2018).

The determination of fish quality is assessed by three methods included under the sensory evaluation, microbial analysis, and chemical analysis.

Sensory Evaluation

Sensory evaluation is defined as the scientific means of quantifying and interpreting the variations in food characteristics (odor, taste, tactile, appearance by using the human sense of sight, smell, taste, touch, and hearing(Cao et al. 2012). Sensory methods are divided into two groups' discrimination and descriptive tests however the most commonly used is the descriptive test which measures the difference or absolute value indicating the different quantitative level (Abbas et al. 2008).The sensory general is known to be irrationally expensive due to the high training requirement of the panel, cost of running, need for the individual scheme for individual fish species given the different spoilage patterns and physiological and psychological limitation of the analyst (Li et al. 2012).

Microbial Analysis

The major change in fish freshness, for instance, unattractive change in food characteristic such as flavors, odor, colors are largely due to bacterial growth and activity (Cao et al. 2012).Microbiological methods are used to estimate the bacterial number in order to determine fish freshness, hygiene and or evaluate the possible presence of bacterial or organisms of public health importance (Obemeata 2011).

The various way used to determine bacteriological contamination in food fish include Total Plate Count, Total Viable Count, Aerobic Plate Count and Standard Plate Count (TPC, TVC, APC, and SPC) and other instrumental methods. All mean number of bacteria (Colony forming unit CFU/ ml) in food product under the specified and uniform condition of culturing. In general, these methods rely on the estimation of the fraction of the microflora able to produce colonies in the medium used under specified incubation condition (Elhadi 2017).

Chemical Analysis

Fish death is subjected to a series of changes a result of bacterial and enzymatic activities, which will result in the breakdown of the storage material and degradation of energy-rich compounds these analytic and bacterial changes during fish spoilage are accompanied by the accumulation of a certain constituent and degradation of others (Immaculate and Jamila 2018).With regard to the evaluation of fish quality using chemical methods, the total volatile basic nitrogen (TVBN) constitute the commonly measured chemical indicators. TVB-N is a general phrase used to include volatile amines such as ammonia and trim ethylamine produce by spoilage bacteria, dim ethylamine produce by the autolytic enzyme (Cyprian et al. 2013).

Total Volatile Nitrogen

Volatile amines are the characteristic molecules responsible for the fishy odor and flavor present in fish several days after the catch(Monique and Ifremer, 2005). Total volatile nitrogen is a group of biogenic amine formed in non-formed food products during storage, the combined total amount of ammonia (NH3), dim ethylamine DMA and trim ethylamine TMA in fish is called the total volatile base (TVB) nitrogen content of the fish and is commonly used as an estimate of spoilage and has been widely used as an index for freshness of fish (Limbo et al. 2009).

The increase in the amount of TVN parallel with the increase in the TMA during spoilage. At the activity of spoilage bacteria increases after the death of fish, and subsequent in the reduction of TMAO to TMA (Silva and Franco 2014).

CONCLUSION

Edible film encapsulated Tilapia fish fillets exhibited enhanced shelf life under refrigerated conditions. This is because an edible film is available with a wide range of properties that can help to alleviate many problems encountered with foods. Biodegradability, barrier properties, biocompatibility, and edibility as well as being non-toxic and non-polluting are a few advantages of edible films for food packages. It has been shown that edible coatings improve the quality and increase the shelf-life of Tilapia fish fillets. The improvement in the quality of the fish products is achieved through inhibition of microbial growth, reduction of lipid oxidation-reduction and enhancement of sensorial attributes. To provide safe foods and to protect natural sources, further studies are recommended.

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