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Uses of Natural additives in seafood

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Abstracts

Due to the health challenge in association with chemical additives in food, this has led to its rejection as preservation by the consumer, demand for Natural processed seafood with good nutritional properties and sensory quality increased, Fish and shell-fish spoils faster immediately after harvesting and the quality together with the nutrients are lost during processing and preservation period, because of their high level of polyunsaturated fatty acids (PUFAs,) the high moisture contents, free amino acids and the presence of autolytic enzymes, bacteria contamination and loss of protein functionality. To retain these qualities, Natural additives have been widely employed in the seafood industry in order to maintain the seafood quality Natural antimicrobial systems found in plants, animals and microorganisms can be used with developing technology. natural antimicrobials that reinforce food safety and preservation by inhibiting bacteria, fungi, and viruses are being deeply evaluated and studied. Foods such as celery, thyme, oregano, clove, bay, almond, coffee, and cranberry contain natural antimicrobials with the ability to inhibit the growth of several microorganisms Natural additives frequently applied Include lysozome, Lactoperoxidase system, Lactoferrin, Chitosan, Spices and their essential oils, Olives, Nisin and bacteriocins .In this review, we will examine the natural antimicrobial, antioxidant, and antibacterial effects on preservation of shelf life of seafood products.

Keywords: Natural antimicrobials, antioxidant, antibacterial, seafood quality and seafood shelf-life.

Review article

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INTRODUCTION

Fish and shellfish are highly perishable as a result of non-protein nitrogen substances they contained such as Lipid content, ph level and high moisture content which makes them be easily prone to microbial growth (Miraglia et al., 2016). Also, Seafood contains a high concentration of lipid as a result of high percentage of Polyunsaturated fatty acids (PUFAs) especially eicosapentaenoic acid, (EPA) and docosahexanoic acid (DHA) which caused off-flavor formation, alteration of color, texture and nutritional level (Secci & Parisi, 2016). Microbial spoilage agents microorganism type, number, harvesting area, type, capture method and handling operations are effective. Typical fish odor comes from TMA. The TMA microbial activity results from trimethylamine oxide (TMA-O). TMA-O is specific to fish meat, other meat is either absent or very small in quantity. Therefore, other meats do not smell like fish. Some additives could be incorporated intentionally to preserve and/or enhance food characteristics, an example would be antimicrobial agents (Wang et al., 2011).Many foods contain natural compounds with antimicrobial activity; these compounds may play a significant role in prolonging food shelf-life. Many of them have been studied for their potential as direct antimicrobials added to food. Their usage has been gaining popularity throughout the globe, natural antimicrobials that reinforce food safety and preservation by inhibiting bacteria, fungi, and viruses are being deeply evaluated and studied. Foods such as celery, thyme, oregano, clove, bay, almond, coffee, and cranberry contain natural antimicrobials with the ability to inhibit the growth of several microorganisms (Sono-chilaca et al., 2016).Antimicrobials are chemical compounds that are naturally present in or added to foods, food packaging, food contact surfaces, or food processing environments to inhibit microbial growth or kill microorganisms (Davidson et al., 2003).

Preservatives are added to food in order to control the growth of microorganisms (bacteria and fungi). Although the most utilized are synthetic preservatives, there are a number of natural products obtained from plants that can be used as food preservatives. Food antimicrobials remain among the most important food additives, they can be synthetic compounds (intentionally added to foods) or from natural origin (Vigil et al., 2005). Phenolics antioxidant in food as well as being important in terms of microbial safety. Natural antimicrobial systems present in plants, animals, or microorganisms are gaining popularity for their potential usage in minimally processed foods. Natural antimicrobial systems can be classified by origin (Soto-chilaca, 2016).

Animal source

Animal is one of the major source of antimicrobial agent that can be consumed safely, chitosan have been applied broadly in the food processing industry (Sharif et al., 2017). Chitosan are low acetyl replaced forms of chitin, it’s identified as resourceful biopolymers widely use in food industry (Shahidi et al., 1999). Chitosan can also be applied for the preparation of several polyelectrolytes complex products with natural polyanions like alginate (Alishali et al., 2012). Chitosan can be extracted from exoskeleton of chitin (arthropods) like crabs, shrimps, and lobsters.it is rich in metal binding capacity with metal iron like chromium, zinc, lead, and iron . (Peng et al.,1998). Now a days, chitosan and its derivatives has showed positive effects as antimicrobial agents, against several microorganisms like bacterial, fungi, yeast (Cao et al., 2009) reported that 5 g/L of chitosan prolong the shelf –life of oyster (*Crassosttrea gigas*) from 8 to 9 days to 14 to 15 days. They further explained that *pseudomonas* and *shewanella* reproduce faster than other in production of toxins and microbial growth. Ye et al., (2008) also reported that chitosan possesses an antibacterial activity that effectively showed in aqueos system, wherefore, its antibacterial characteristics against *L. monocytogenes* in cold-smoked salmon was insignificant. When chitosan is applied in Insoluble film, the growth of *L. monocytogenes* in salmon samples covered with chitosan-coated film and plain film showed similar result (Alishali et al., 2012).

Antioxidant activity of chitosan on different level of viscousities (360.57 and 14cp) having molecular weight of 1800,960 and 660.was applied on commuinuted flesh of herring (*Clupea harengus*) was studied by (Kamil et al ., 2002). The oxidative stability of fish flesh applied with chitosan (50, 100 and 200 pmm) was compared with synthethic antioxidant such as butylated hydroxyanisole added with butylated hydroxytoluene (BHA+BHT, 200ppm) were stored at 4 degree celcius, the best result was from the 14cp chitosan, it inhibit lipid oxidation and TBARS formation in herring sample with 200ppm of 14cp chitosan was slowed down for 8 days of storage period by 52% when in comparism with the other treatment. Lopez-caballero et al. (2005a, b) applied chitosan as a base material to produce a chitosan-gelatin coating for cod patties, the result showed that chitosan applied as powdered or coating do not have any positive effects on the product at the end of the study, but rather, it led to an increase in the yellow color of the product, the elasticity of the patty was also increased. The coating with chitosan inhibit the spoilage of cod patties which was seen in the reduction in Total basic volatile Nitrogen(TVBN).there was no serious effects seen on bacterial spoilage, an excellent sensory properties was observed. (Rong et al., 2010) reported that chitosan coating could significantly increase the shelf-life of pacific oyster with high level of perishability *C. gigas*.

Lactoferrin belongs to the family of iron-binding glycoprotein which closely resemble the plasma iron-transport, it aids in the movement of protein into the body and its made up of a single chain peptides having a molecular weight of 87KDa (Weinberg, 2003). Lactoferrin is a natural origin antimicrobial agent, available in human secretion like milk, tears and saliva. It has potential to reduce the number of Iron available in the environment, as a result of this its very strong potential to retard the activity of microorganisms like Esterichia coli and L. monocytogenes (Sharif et al., 2017). The functionality of lactoferrin as an antimicrobial is as a result of its protein structural conformation (Roller et al., 2003). Its Iron-binding potential and polycatonic nature makes it to be against broad range of bacteria which include food-borne pathogens such as *carnobacterium, Listeria monocytogenes, Esterichia coli, Klebsiella* and *viruses* (Gyawali & Ibrahim, 2014). Lactoferrin functions also depend on its Isolation from the milk source without destruction of the protein conformation of the molecule present in it, Lactoferrin is applied widely in commercial industries for food packaging as antimicrobial edible coating with combination of polypeptides like lactoferrin, lysosome and peroxides(Juneja, et al., 2012).The edible coating from polyptides could help to prolong shelf-life of food and render them safe for human being consumption (Fransen & Krochta, 2003). Lactoferrin was carried out in an In vitro study by Del Olmo et al. (2011) to test its bacterial efficacy with the use of amidated and pepsin-digested derivateives an their contents, it was reported that lactoferrin have potential to be used as antimicrobial against *Esterichia coli* 0157:H7. In another study by (Rollini et al., 2016) salmon fillets was coverered with different packagings film and was also treated with combination of lysosome and lactoferrin (LZ/LF), the result showed that LZ/LF coated PET film lowered the population of mesophiles and psycotrophs bacteria down to 4.5 and 3.8 log/CFU/g, It was observed that sample treated with LZ/LF coated with PET inhibit the growth of H2S- producing bacterial to 2.7 of 4.7 log CFU/g which was seen in control sample.

Lactoperoxidase system

Due to the fact that the use of chemical preservatives in food protection is not required by the consumer, attention has been directed towards natural antimicrobial systems and the lactoperoxidase system (LP), which is one of these systems, has started to gain importance for this purpose (Yıldız, 2008). Lactoperoxidase (LP) system; lactoperoxidase, thiocyanate ion (SCN-) and hydrogen peroxide (H2O2) consists of three components (Nicholette, 1999; Seifu, 2005). Lactoperoxidase (LP), one of these components, is a member of the peroxidase family which is a natural enzyme group (Yıldız, 2008). LP is an oxidoreductase found in milk and has an important role in protecting the newborn baby's gut systems and mammary glands against pathogenic microorganisms (Seifu, 2005). LP contains a single polypeptide chain containing 608 amino acid residues and has a molecular weight of 78 KDa (Boots, 2006). The antimicrobial properties of LP against microorganisms, as well as the cleavage of different carcinogens and the protection of animal cells against peroxidative effects, indicate its biological importance (Yıldız, 2008). It has also been reported that the LP system plays an antioxidant role and therefore protects mammalian cells (Seifu, 2005). As a result, LP system can be used as a preservative in both food and pharmacological applications and it is very important for it to exhibit synergistic effect with other preservatives.

Lysozyme

Lysozyme, also known as muramidase or N-acetylated glycan hydrolase, is an antimicrobial enzyme produced by animals that form part of the natural immune system. Lysozyme is a glycoside hydrolase which catalyzes the hydrolysis of the 1.4-beta-bonds between the N-acetyl-methamic acid and the N-acetyl-D-glucosamine residues in the peptidoglycan, the major component of the gram-positive bacterial cell wall (Manchenko, 1994). This hydrolysis compromises the integrity of the bacterial cell walls that cause bacterial breakdown. Lysozyme is abundant in secretions such as tears, saliva, breast milk and mucus. It is also found in cytoplasmic granules of macrophages and polymorphonuclear neutrophils (PMNs). In humans, the lysozyme enzyme is encoded by the LYZ gene (Yoshimura, 1989; Peters, 1989). These polypeptides inhibit the development of food spoilage and foodborne disease-causing bacteria and are of great importance in the food industry due to these properties (Akkoç et al., 2009). In addition, the increasing interest in bio-preservation methods, especially in the food industry, in which natural antimicrobial components are used, increases the potential of bacteriocin (nisin) and natural enzymes (lysozyme) in foods (Davidson & Harrison, 2002). Lysozyme is known as the only antimicrobial enzyme that has a commercial use. Especially in Gram-positive bacteria, it causes the structural integrity of the cell membrane to hydrolyze the P-1, 4-glucosidic linkages in the peptidoglycan layer, the most important structure of the cell membrane (Gill & Holley, 2000). As a result, Lysozyme is one of the most important bio-protective agents used in the food industry against food pathogens.

Microbial source

Bacteriocins

Bacteriocins are group of Gram- negative and Gram-positive bacteria developed from proteins or polypeptides with resourceful antimicrobial properties (Zacharof & lovith, 2012). Bacteriocins are generally known as primary metabolites produced in the ribosome during the primary process of lower growth of bacteria and the bacteria possesses a slim antimicrobial spectrum. The production of bacteriocins in lactic acid bacteria (LAB) fermentation process are produced in large quantities (Bali et al., 2011). Its production Involves enzymatic process to change the inert substance into active bacteriocins and this process is referred to as Bacteriocin maturation (Rilley &Wertz, 2002). Bacteriocins have strong potential to destroy bacteria bound to the inner membrane of the cell (Garcia-Bayona et al., 2017). The antimicrobial effects of bacteriocins showed positive effects against several strains of pathogen and spoilage microorganism through different level of class and type of bacteriocins (Perez et al., 2015). Application of bacteriocins with other preservatives has extended the shelf-life of fish products. Bacteriocins produced from *Bacillus sp.* extracted from curd possess excellent bactericidal potency against *salmonella sp* and *vibrio sp*. Salt water fish infected with *parastromateus niger* and squid *loligo duvauceli* (Ashwitha et al., 2017).The reduction of bacteriocin in the total count is of the infected fish in storage at -4 and -20 shows to be significantly different.

Nisin

Nisin is a bacteriocin produced by Lactococcus lactic from lactic acid bacteria, called antibiotics and included in first class bacteriocins. Nisin was first discovered in 1928 by Rogers. The investigator has discovered that several species of Streptococcus produce metabolites that inhibit other lactic acid bacteria (Hampikyan, 2007). In 1944, nisin name was used for this substance and it was started commercially in 1950s. Nisin (E234) was first accepted as a food additive in the UK 30 years ago, and was later used in 50 countries in Europe, America and China (Koponen, 2004). Since then, nisin has taken its place among the protective food additives that are used safely in the food Industry (Luck, 1995; Wessels, 1998). It has been adopted by the United Nations Food and Drug Administration as a “GRAS ler (Generally Safe Acceptable Product) and also World Health (WHO) is the only bacteriocin approved as a food additive (Bouttefroy, 2000; Nel, 2004). As a result, important food such as *Bacillus cereus*, *E.coli*, *Salmonella spp.*, *Listeria monocytogenes* and *Clostridium perfringens,* which seriously threaten consumer and public health. To eliminate pathogens, various antimicrobial agents are currently used. In the Investigation of (Gogus et al., 2006). In Comparative effects combination of lactic acid, nisin, coating some postmortem quality criteria of refrigerated *Sardina pilchardus*. The author reported significant difference in the reduction of Mesophilic aerobic bacteria, the growth of MAB was inhibited to 1.54 log/CFU/g. Also another study by (Lakshmanan et al., 2002) Reported 1 log/CFU of Mesophilic aerobic bacteria, Nisin with other treatment reduced the bacterial load of fish.

Plant origin

Olive is an agri-food originally owned by the Spanish and a symbol of rich cuisine (Millan et al., 2002).There is increased attention in the application of polyphenols obtained from Agricultural food products from by-products (Servili et al., 2015). Olive mill wastewater obtained from the mechanical compression of olives during the oil extraction process. The oil is reported to have a higher level of polyphenols, polyphenols from several studies are confirmed to be high in antioxidant properties (Servili et al., 2011, Benedetto et al., 2006). Application of bioactive compound in food Industry led to retardation growth of bacterial strains (Fasolato et al.,2015)Especially, oleuropein, hydroxytyrosel and aliphatic aldehydes which can be found in olive products showed to retard the growth rate of several bacteria and microfungi (Furneri et al.,2002). In a study by (Miraglia et al ., 2016)applied extract of olive water on salmon streaks, they reported that salmon sample with highest percentage olive water extract has lowest value of TVC than the second treatment with a reduced percentage, they stated that the amount of extract absorbed by the salmon was low and the author suggested this may be caused by the high hydrophilic nature of the compound that caused reduced adsorption of the salmon streaks treated with olive water extract, alteration in the color of the salmon was also observed, the author suggested it could be as a result of oxidation of the polyphenols which occurred in the muscle enzymatic activity that altered the yellow color of the sample, Erikson & Misimi (2008) also reported an increased in the level of yellow and redness of the salmon fillet during storage.

Spices and their essential oils

Plant essential oils have been used for many purposes for many years, especially in scientific and commercial fields (Ebru, 2007). Cosmetics, pharmaceuticals, food industry, aromatherapy and phytotherapy are among the top uses (Hammer, 1999). Since the essential oils have a wide range of use, many scientists have recently attracted the attention of many scientists and the biological activities of these essential oils have been investigated. As a result of these researches, the properties of natural products were put into practice (Mouhssen, 2004). Nowadays, obtaining and evaluating pure and especially main active substances of medicinal plants and essential oils of these plants is very important both scientifically and economically (Kırbağ, 2000). The results show that the essential oils of these plants have antimicrobial activity (Ebru, 2007). It is stated that the pharmacological properties of essential oil and its components can be examined and it can be useful to be used in medicine, cosmetics and industrial fields (Kırbağ, 2000). Essential oils can be found in certain organs of the plant, such as petals, leaves, fruit, bark, fruit stalk, woody texture, or in all organs of the plant, and sometimes also in specific tissues of an organ (Ebru, 2007). These oils are found in secretory hairs, secretory pockets, secretory channels or secretory cells according to the families where the plants are connected (Ceylan, 1987). To date, it has been shown that more than 2000 chemical components are present in essential oils, the most important of which are terpenes, phenylpropanoids, and the like. Because of their physiological effects, these substances are sometimes used individually or sometimes as a mixture therapy (Ceylan, 1987). As is known, volatile oils have special properties such as volatility, hydrophobicity and having special odors acting on the respiratory system. These last characteristics reveal that they can be biologically active (Ebru, 2007). The most frequently reported features are that they are antimicrobial and the tests in which these properties are revealed do not depend on a certain standardization and can be performed in appropriate laboratories (Anssen, 1987

Antimicrobial Properties of Plant Essential Oils

Antimicrobial effects of plant essential oils have been extensively studied to date (Leal, 1999) Nostro et al, in their study of some plant extracts used as test microorganism Gram (+), Gram (-) bacteria and yeast showed that inhibitory effect against the strain (Nostro, 2000). In another study using disk diffusion method, it was observed that antimicrobial activity was more effective against Gram (+) bacteria and yeast strains than Gram (-) bacteria (Dağcı, 2002).

Spices

Spices are used for flavor, color, perfume and preserving food and beverages. Spices are extracted from many parts of the plant: skin, buds, flowers, fruits, leaves, rhizomes, roots, seeds, vegetables and styles, or whole plants. The term 'herb' is used as a subset of spice and refers to plants with aromatic leaves. Spices are often dried and used in a processed but complete state. Another option is to prepare extracts such as essential oils by distilling the raw spice material (wet or dry), or to use solvents to extract oleoresins and other standardized products (Weiss, 1997; Anon, 1999; Weiss, 2002; De Silva, 1995).In a study by (Cai et al., 2015) three different spices were investigated for their essential oil , clove, cumin, and spearmints was evaluated for their essential oil efficacy in Inhibiting quality degradation and extending of shelf-life of drum (*Scianops ocellatus*) fillets during 20days of storage at 4 degree celcius, The authour reported that spearmint significantly reduced biogenic amines and microflora counts was reduced to lowest level.

CONCLUSION

Recently, several techniques have been employed in the food processing industry in other to preserve food, Fish and seafood products as the demand for healthy food is on the increase, based on this quest, the techniques to be selected for seafood preservation must have some important characteristics such as maintaining seafood freshness, preserve the quality and give good sensory properties, Natural preservatives have been found to possess these characteristics , so, it can be applied as alternatives to synthethic additives, natural additives have promising functions and potential quality, such as chitosan, lysosome, bacteriocins, spices and herbs, all these have been studied and positive effects have been observed , they can be incorporated successfully as food additive to function as antimicrobial, antibacterial and antioxidant.

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