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A SHORT REVIEW ON THE USE OF NATURAL EXTRACTS FOR FISH AND SHRIMP PRESERVATION

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ABSTRACT

Natural products, such as plant extract, either pure compounds or standardized extracts, provide unlimited opportunities to control microbial growth owing to their chemical diversity. The quality and shelf life of fish products is increased by applying several kinds of natural additives when fish or fish products are handled, processed, and stored. Natural extract can reduce potential health hazards by replacing synthetic additives. Antioxidants can be found in various plant origins, including herbs, spices, fruits and vegetables, seaweed, etc. Antimicrobial activities are also observed in different natural extracts, which are the source of several types of bioactive compounds. As a result, plant extract can be used as an antioxidant or antibacterial agent in the treatment of chilled, frozen, and dried whole fish, fillets, as well as fish mince. Plant extracts have the potential to replace sulfating agents in crustaceans. The primary purpose of this review is to know about the use of different natural extracts as preservatives in different fish and shrimp products.

Keywords: Fish preservation, natural extracts, plant extracts

Introduction

Fish is one of the most highly perishable food products. The shelf life of fish products is bounded by atmospheric oxygen, which causes lipid oxidation and the growth of aerobic spoilage microorganisms. Food antimicrobials, including food preservatives, have been widely used to inhibit the growth of spoilage and food-borne bacteria. The demand for natural food additives increased due to strong awareness for more nutritious, healthy, and safe foods. In traditional centuries plants, herbs, and their extracts have been used for medicines, food flavors, preservatives, or even cosmetic materials. Scientific reports have also shown that various microorganisms, including foodborne pathogens and spoilage bacteria, are reduced by the potential antimicrobial activity of extracts from different herbs and spices. Relevantly, the use of synthetic preservatives and their natural counterparts are restricted to the manufacturers by the stringent laws from legislative bodies combined with the continuous urging of the customer. Exuded that are from plants renowned as safe (GRAS) because there is no harmful effect or document established from different toxicological studies. Additionally, certain herbs and spices fetch some flavor and extend the lifespan of the food product through their bioactive compound. In plants, some preservative effects are found because of certain phytochemicals. These phytochemicals include flavonoids, polyphenols, tannins, lectins, alkaloids, terpenoids, and isothiocyanates. Due to their chemical diversity, plant extracts protect fish products from microbial activity, whether it is a pure compound or standard extract.

Plant extract phenolic compounds revealed essential antioxidants for their redox potential. That permits them to donate hydrogen and act as reducing agents. The dip treatment mainly applies the extract to chilled and frozen stored products. Modified atmospheric packaging with plant extract is a useful preservation method. Plant extract increases fishery products' shelf life (Ucak *et al*. 2011). Fishes' quality will be enhanced during storage by adding plant extracts to ice. The interactions between phenolic compounds and proteins also play a role in certain food products' processing and quality enhancement. Various plant extracts have recently been used for gel enhancement in surimi products from dark fleshed and

lean fish. Furthermore, adding plant extracts to protein-based films has improved their mechanical properties. This review aims to update the natural extracts used as natural preservatives on fish and shrimp preservation to increase the shelf life to maintain quality.

Active Compounds Mechanism in Natural Extracts

Mainly phenolic compounds are extracted from fresh or dried plants such as seeds, leaves, roots, stalks, fruit peel, and bark. Because of their ease of use, efficiency, and broad applicability, solvent extractions are the most commonly used for preparing extracts from plant materials. Different solvents named ethyl acetate, methanol, acetone, ethanol and also their combined solutions have been used to extract phenolics from plant materials (Dai and Mumper 2010). After extraction, remove the solvent and dried the extract using either the conventional drying method with an oven or spray drying. In plants, bioactivity is found due to phytochemicals, mostly polyphenols that vary in diversity and concentration. Quercetin, the most common flavonoids found in onions, apples, broccoli, tea, and some fruits contain catechin and flavanol, grapefruit consists of the main flavanone naringenin. An anthocyanin named cyanidin-glycoside is found in berries (raspberry, black currant, and blackberry); soybean consists of main isoflavones named glycitein, genistein, and daidzen (D'Archivio *et al*. 2007). Phenolic acids are mainly distinguished into two groups: benzoic acid derivatives such as gallic acid and cinnamic acid derivatives such as coumaric, caffeic, and ferulic acid. Caffeic acid is the most abundant phenolic acid in various fruits and vegetables. As in chlorogenic acid, caffeic acid is frequently esterified with quinic acid, the main phenolic compound in coffee. Another common phenolic acid, ferulic acid, found in cereals and citrus fruits are rich in coumaric acid.

Because of their redox potential, polyphenolic compounds are found in plant extracts. They donate hydrogen and act as reducing agents, nascent oxygen quenchers, and metal ion chelators. Polyphenols' active hydroxyl groups interact with free radicals in their molecular structure, reducing lipid oxidation (Mitsumoto *et al*. 2005). Additionally, polyphenols and phenols show scavenging against free and superoxide radicals. Mainly the hydroxyl (OH^-) group is responsible for determining the capacity of antioxidants. Its presence and position in the structure of phenolic molecules determine this.

Microbial cells may lead to toxins by plant phenolics and their constituents, inhibiting secondary metabolite production. The outer cell or cytoplasmic membrane is a major interaction site with a bacterium and disruption of this vital membrane causes bacterium death. This process occurs through (i) destruction of the cell membrane; for this microorganism losses its interior macromolecules, (ii) structural and functional changes occur in the cell for the reason of interaction with protein and (iii) intercession with some functional work like protein synthesis, electron transport, nutrient uptake and enzyme activity (Bajpai *et al*. 2008). The effect of phenolic compounds is concentration-dependent. At low concentrations, phenols affect enzyme activity, particularly in energy production; they cause protein denaturation at high concentrations. The lack of reproducibility of natural antimicrobial activity, despite the wide range of compounds contained in them, is a major barrier to their use in foods. Plant extract efficacy is affected by the quantitative and qualitative differences in the bioactive phytochemicals content.

Application of Natural Extracts

Different natural extracts are used in various fish and shrimp due to their diverse function (Tables 1 and 2)

Fish Preservation

Tea polyphenols

Antioxidant and antimicrobial substances are present in medicinal plants, vegetables, and fruits. These natural preservatives enhance chilled fish products' shelf life. Natural food preservatives named tea polyphenols are rising in popularity among researchers. During ice storage, they immersed in 0.2 % of tea polyphenol of Silver carp for as long as 90 minutes prolonging the life span by seven days (Fan *et al*. 2008). The ATP degradation and lipid oxidation are restricted by tea polyphenol dipping at 0.2% (Li *et al*. 2012). Yi *et al*. (2011) treated crucian carp with 0.2% tea polyphenols, which effectively inhibited microbial growth, delayed chemical deterioration, and extended shelf life by 6-8 days than chill storage. The fish ball's life span increased to six days by assembling

Table 1. Species used for extract treatment

Common name	Scientific name	Extracts
Silver carp	*Hypophthalmichthys molitrix*	Tea polyphenol, citrus and pomegranate peel extract, grape seed extracts and clove bud extracts,
Crucian carp	*Carassius carassius*	Tea polyphenol
Yellow croaker	*Larimichthys polyactis*	Tea polyphenol
Atlantic mackerel	*Scomber scombrus*	Rosemary Extract, Flax seed extract
Anchovies	*Engraulis encrasicolus*	Rosemary Extract
Sardine	*Sardinella longiceps*	Rosemary Extract, Rosemary and sage tea
Sea salmon	*Salmo salar*	Rosemary Extract
Pompano	*Trachinotus carolinus*	Rosemary and sage tea
Rainbow trout	*Oncorhynchus mykiss*	Turmeric and shallot extract
Horse mackerel	*Trachurus trachurus*	Potato peel
Indian mackerel	*Rastrelliger kanagurta*	Citrus peel extract, Mint and citrus extracts, Aloe vera concentrate and crown of God fruit powder
Freshwater barb	*Pethia conchonius*	Thyme hydrosol
Bonito	Sarda sarda	Green tea, Grape seed and Pomegranate peel extract
Freshwater prawn	*Macrobrachium rosenbergii*	Guava leaves extract
Shrimp	*Trachypenaeus curvirostris*	Extracts of grape seed, green tea, lead seed, and pomegranate peel

Table 2. Function of different types of extracts

Natural Extract	Function
Tea polyphenol	Inhibition of lipid oxidation, Retard microbial growth, delayed chemical deterioration; Retained the myofibrillar functional properties
Rosemary Extract	Control bacterial growth and bio-chemical indices; Slowed down lipid oxidation; Improve sensory and chemical quality parameters and shelf life; Reduce oxidation
Rosemary and sage tea	Lowering ammonia and biogenic amine formation; Protein decomposition, lipid oxidation, nucleotide breakdown, and microbial growth are all inhibited.
Turmeric and shallot extract	Source of antibacterial agent
Potato peel	Protective effect on lipid and protein oxidation
Citrus peel extract; Mint and citrus extracts;	Provide antioxidant and antimicrobial activities; Control biochemical and microbiological changes.
Citrus and pomegranate peel extract	Shelf-life extension
Aloe Vera concentrate and crown of God fruit powder	Reduce changes in sensory and microbial quality.
Grape seed extracts and clove bud extracts	lipid and protein oxidation inhibition
Thyme hydrosol	Extended its shelf life
Green tea, Grape seed and Pomegranate peel extract	Reduce muscle structure deformation
Extracts of grape seed, green tea, lead seed, and pomegranate peel	Prevent Melanosis

tea polyphenols in vacuum-packed collichthys fish balls during 0°C storage. Furthermore, tea polyphenols had a large amount of myofibrillar functional substances than the control which had an efficient influence on muscle protein strength during the post-mortem of sizeable yellow croaker (Zhao *et al*. 2013). Lin and Lin (2005) investigated the effect of glazing with three tea extracts on frozen Bonito fillets' storage quality over 16 weeks. Frozen bonito flesh protein and lipid oxidation are reduced using green and pouchong tea.

Rosemary extract

Carnosic acid, carnosol, rosmarinic acid, and others are useful compounds in rosemary (*Rosmarinus officinalis*) extract. In various food items, rosemary extract restricts the oxidation of lipid and microbial growth. In stored brined anchovies at 4°C for 28 days, the excellent antioxidant activity of rosemary extract slows down lipid oxidation (Turhan *et al*. 2009). When the sardine fillet is stored at 31°C, using rosemary and sage tea extract with ethanol extends the life span to about seven days (Kenar *et al*. 2010). During chilled storage, rosemary extract was used at concentrations of 0.4 and 0.8 percent. It has a beneficial effect on regulating bacterial growth and biochemical index in vacuum-packed Atlantic mackerel burgers (Ucak *et al.* 2011). According to Ozogul *et al*. (2011), vacuum-packed sardine fillets stored at 31°C with extract treatment of rosemary and saga tea reduced ammonia and biogenic amine formation. A recent study found that during storage at 4°C, the combined effect of rosemary extract and nisin, restricted decomposition of protein, oxidation of lipid, nucleotide breakdown, and microbial growth in pompano fillet (*Trachinotus ovatus*) (Gao *et al*. 2014).

Similarly, Ice made from rosemary and oregano extract was found to be effective during storage on chemical changes in Chilean jack mackerel. Compared to traditional icing, this system delayed chemical change. Another study found that sensory quality, chemical quality attributes, and the life span of sardines increased by three days more than traditional ice storage using ice at 0.05-0.1% rosemary extract. Furthermore, their study revealed that biogenic amine formation, particularly histamine and putrescine, has been reduced by using rosemary extract ice.

In frozen stored fish and fish products, using antioxidant glazing after freezing and pre-freezing dip treatment slow down the oxidation process. Mackerel, tuna, and bonito are most prone to oxidation and discoloration during frozen storage. To eliminate oxidative rancidity, frozen minced, whole fish, and fish fillet are treated with plant extract. To delay lipid oxidation and produce significantly less malonaldehyde than the control during storage, rosemary extract was applied to filleted and minced frozen horse mackerel (Vareltzis *et al*. 1997). The muscle of the horse mackerel fillet is less prone to oxidation during frozen storage when using rosemary extract (Aubourg *et al.* 2004). Tironi *et al.* (2010) investigated lipid and protein changes at 11° C storage by using rosemary extract in sea salmon mince. Its higher concentrations delayed the onset of oxidation and oxidation and muscle red color were reduced by 50%.

Through coating on smoked sardine, muscle antioxidant properties are increased by the edible film with oregano or rosemary extract use.

Turmeric extract

Turmeric extract (*Curcuma longa*) is an antibacterial agent which holds the quality attributes of vacuum-packaged rainbow trout (*Oncorhynchus mykiss*) used with shallot (*Allium cepa*) extract (1.5 percent each, v/v) or without shallot (*Allium cepa*) extract (1.5 percent each, v/v) during a refrigerated storage period of 20 days (Pezeshk *et al.* 2011).

Fruits and vegetable

The efficacy of fruits and vegetable peel has also been investigated as preservative agents in fish. Potato peel has been applied to refrigerated horse mackerel mince, showing a protective effect on lipid and protein oxidation (Farvin *et al*., 2012). This study reported that extracting potato peel with ethanol was very fruitful in delaying lipid oxidation.

If Indian mackerel is stored at -2°C, the peel extract of citrus (*Citrus aurantium*) gives a good antioxidant and antimicrobial impact that increase the life span by about two days compared to retard spoilage process. The combined effect of pomegranate peel extract with citrus and nanoparticles of chitosan, expanse the life span of silver carp fillets (Zaeri *et al*. 2015). Pomegranate peel extract was significantly more effective than orange extract at delaying lipid oxidation. During storage at -18° C, lipid hydroperoxides and TBARS are reduced considerably by adding 2% commercial pomegranate seed extract (Ozgen *et al*. 2011).

Grape polyphenols extracts have been shown to inhibit oxidation in various food systems. Flavonols found in grape pomace reduce oxidation in the white muscle of Atlantic mackerel in frozen conditions (Pazos *et al.*2005).

When added to minced horse mackerel muscle, the antioxidant dietary fiber of grape attaches a large quantity of dietary fiber and polyphenolic antioxidants. During storage at - 20°C, lipid oxidation is significantly inhibited by using phenolic acids, anthocyanins, catechins, and other flavonoids (Yerlikaya and Gokoglu 2010) stated that green tea, grape seed, and pomegranate peel extract reduces muscle structure deformation by dipping (1 percent w/v) treatment and also showed the sensory and physical properties of frozen bonito fillets.

Thyme/ Herbs/Plants

Compared to the control, during storage at 0°C, sprinkling powdered thyme (*Thymus vulgaris*) with vacuum packaging reduced lipids' auto-oxidation and increased tuna quality *(Thunnus thynnus)* as evidenced by lowering TBARS and increasing PUFA values. During the storage at 0°C of minced yellowfin tuna, the antimicrobial benefit of *Majorana syriaca* plant extract has been attained (Al-Bandak *et al.* 2009). During the storage of Indian mackerel at 4°C, to reduce changes in microbial and sensory quality, concentrated aloe vera and crown of God fruit (*Phaleria macrocarpa*) powder are used. Traditional icing is effective compared to incorporating plant extracts into ice to restrict the spoilage of fresh fish based on microbial and biochemical changes. A new icing procedure has been discovered to improve the quality of fish kept on board and transported to remote locations (Oral *et al*. 2008). The spoilage of a freshwater barb was trying to prevent by ice with wild thyme hydrosol was investigated, and it was unfolding that this modification in the icing system extended its shelf life from 15 to 20 days.

Recently investigated the effect of ice extract contain with thyme (0.04 percent w/v), oregano (0.03 percent w/v), and clove (0.02 percent w/v) on anchovy (*Engraulis encrasicholus*) containing quality parameter using chemical, sensory and microbiological methods (Bensid *et al*. 2014). Compared to the traditional ice batch, using these icing systems resulted in a remarkable antioxidant effect like lowering aerobic mesophile and psychrotrophic bacteria in anchovy muscle. Fillet of Tilapia, when frozen, the effect of rosemary, thyme, and black cumin extract and their combinations had a good impact on the values of TVBN, TMA, TBARS, and moisture loss (Ibrahim and Sherif 2008).

Maqsood and Benjakul (2013) reported on the adjournment of hemoglobin-mediated lipid oxidation in washed Asian sea bass mince using Kiam wood (*Cotyleobium lanceotatum*) extract. Bud of clove (*Syzygium aromaticum*) and grape (*Vitus vinifera*) seed extracts were fruitful in retarding oxidation in silver carp fillets when stored in chilled conditions. Viji *et al.* (2015) recently reported that biochemical and microbiological changes can be controlled in frozen Indian mackerel using mint and citrus extracts. Plant extracts added to smoked products reduce lipid oxidation while inhibiting microbial growth.

Spices

The oldest methods of preserving fish are drying and smoking. Cold smoking is the most common method. Cold smoking temperatures are 25 to 30°C, which are not sufficient to kill microbes. Smoking components can act as antioxidants, but lipid oxidation remains a problem in mildly processed fish. Furthermore, the attack of maggots and dermestids destroys a large proportion of smoked or dried fish; their market value was reduced. The use of plant extract in chilled and frozen fish products has received more attention than in smoked fish products. The fish beetle hatchability and adult emersion are slowed down by piper guineense and *afromomum melegueta* pulverized plant (Fasakin and Aberejo 2002). Klin-Kabari *et al*. (2011) investigated pepper and nutmeg aqueous extracts' effect on smoked catfish. Pepper extract was more effective at diminishing lipid oxidation in dried-smoked catfish when stored at room temperature for six weeks as measured by peroxide and TBARS values.

Application of natural extracts to improve gelling properties

Exogenous agents of chemical and biological origin can improve the textural properties of the fish protein (Chiou *et al*. 2006). Natural phenolic compounds from plants have cross-linking properties, making them potential gel enhancers (Rawel *et al.* 2002). Phenolic compounds combined with proteins change their secondary structure. It results in increased thermal stability. Balange *et al.* (2009) found that ethanolic Kiam wood extract, oxidized

0.15 percent bearing tannic acid, improved mackerel surimi gel's breaking force and deformation. Surimi gels prepared from mackerel require an effective gel-strengthening agent (Balange and Benjakul 2009). To improve gels forming properties of lesser sardine (*Sardinella brachiosoma*), seaweed (*Sargassum tenerrimum*) exudate at various levels (0.5 to 2.5 percent surimi) was used (Shitole *et al*. 2013).

Application of Natural Extracts in Shrimp

In crustaceans, through biochemical procedure blackening is developed; in this procedure polyphenol oxidase (PPO) oxidizes phenols to quinones, known as Melanosis. Black high molecular weight pigments are formed by colorless quinones polymerizing. Sulfite-based formulations delay Melanosis; nevertheless, high additive concentrations are necessary to successfully seize melanosis (Gomez-Guillen *et al.* 2005). Extensive research has been conducted in recent years about controlling the progression of melanosis by using plant extracts. Delaying the formation of melanosis and extending Pacific white shrimp shelf life may be possible when Plant phenolic compounds, such as catechin and ferulic acid are used in ice cream. Melanosis in shrimp is effectively suppressed by grape seed extract, enokitake (*Flammulina velutipes*) extract, green tea extract, lead seed (*Leucaena leucocephala*) extract, and pomegranate peel extract. Shrimp melanosis can be removed by immersing shrimp used per mL of 2.5 g wet enokitake extract for 10 minutes up to 20 hours at 24° C (Jang *et al.* 2003). When stored at 4° C, shrimp (*Parapenaeus longirostris*) treated with 1.5 percent grape seed extract had the least melanosis when differentiated from other treatments (Gokoglu and Yerlikaya 2008). The use of methanolic pomegranate extract in treating Pacific white shrimp for 15 minutes followed by chilled storage will delay the development of melanosis. During the pomegranate extract treatment, using 1.25 % sodium metabisulphite treatment increased the shelf life by six days. The gel strength of fish proteins influences surimi seafood's physical properties and texture.

Limitations in using Natural Extracts and Essential Oils for Fish and other Seafood Preservation

Plant extracts and essential oils have been shown to have excellent antimicrobial and antioxidant activities in vitro, even at deficient concentrations. However, some plant extracts, such as rosemary has been introduced into the market. Applying natural extracts and EOs in food systems, especially fishery products, usually requires a higher concentration than synthetic compounds. These levels are not organoleptically acceptable in terms of appearance and color (Garc´ıa-D´ıez *et al*. 2016). Even at low concentrations, EOs mostly from herbs and spices, have a strong aroma, negatively affecting the smell and taste of the treated seafood. Also, chemical variations in plants due to the age of the plant, ecological and geographical conditions, harvesting time, and method of extraction are factors limiting the applications of their extracts as natural food preservatives (Weerakkody *et al*. 2010).

Conclusion

For food preservation, different kinds of traditional natural or plant extracts have been used for thousands of years. Though, there are international guidelines for safe food additives, it is challenging to monitor the standardization of plant extract. Many factors complicate the safety assessment of natural extracts, like compositional distinction, the absence of checking active ingredients, and many more. Plant extract may increase the quality and life span of the fish product. Different kinds of plant extract inhibit microbial growth, slow lipid oxidation, and improve texture quality. There have also been reports of protein cross-linking and enzyme inhibition activities of various extracts. In fish and fish products, to prevent oxidation and quality deterioration, we can use natural extracts rather than synthetic additives. Plant extracts that serve many valuable functions in the fish processing sector can broaden the scope for multifunctional natural food ingredients. Due to the awareness of the effect of consuming artificial preservatives, natural preservatives have gained interest. Preservatives can extend shelf life and maintain the organoleptic properties of fish and shrimp products. For use as food preservatives, many types of natural sources are still not being studied. The presence of active compounds such as phenolic acids, flavonoids, quinone, tannins, and so forth in natural sources will act as antimicrobial and antioxidant agents.

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