Approval

We certify that we have read the thesis submitted by Leyla KaemzadehPournaki titled **"THE EFFECT OF OIL BASED NANOEMULSIONS ON THE QUALITY OF WHITE LEG SHRIMP (*LITOPENAEUS VANNAMEI*) DURING COLD STORAGE"** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Food Engineering.

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NEAR EAST UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

DEPARTMENT OF FOOD ENGINEERING

THE EFFECT OF OIL BASED NANOEMULSIONS ON THE QUALITY OF WHITE LEG SHRIMP *(LITOPENAEUS VANNAMEI)* DURING COLD STORAGE

M.Sc. THESIS

Leyla KAZEMZADEHPOURNAKI

Nicosia

October, 2022

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Declaration

I hereby declare that all information, documents, analysis and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are original to this study.

Leyla KazemzadehPournaki

…../…../…..

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Leyla KazemzadehPournaki

Abstract

The Effect of Vegetable Oil Based Nanoemulsions on the Quality of White leg Shrimp (*Litopenaeus vannamei*) During Cold storage

Kazemzadehpournaki, Leyla

MA. Department of Food Engineering

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This study aimed to assess the effect of oil-in-water (o/w) nanoemulsions based on various oils such as olive, sunflower, and soybean on the quality and shelf-life of White leg shrimp (*Litopenaeus vannamei*) during cold storage. The shrimp samples were divided in to four groups and subjected to the following treatments: olive oil based nanoemulsion, sunflower oil nanoemulsion, soybean oil based nanoemulsion, and control group. Treated samples were stored at 4 ^{0} C. During the storage, various chemical (TVB-N, TBA, WHC, pH) and colour were performed on days 0, 3, 6, 9 and 12. The results indicated that the use of olive oil, sunflower and soybean oil nanoemulsions can maintain better shrimp quality compared to the control treatment. pH, TBA (Thiobarbituric Acid), TVB-N values (volatile nitrogen base complex) and WHC values (water holding capacity) as chemical indicators quality of the shrimps treated with sunflower oil nanoemulsion were better than the other treatments.

Keywords: Nanoemulsion, shrimp, quality, shelf- life, lipid oxidation, edible coating.

Özet

Bitkisel Yağ Bazlı Nanoemülsiyonların Beyaz Bacaklı Karidesin (*Litopenaeus vannamei*) Soğuk Depolama Sırasında Kalitesine Üzerine Etkisi

Kazemzadehpournaki, Leyla

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Bu çalışma, zeytin yağı, ayçiçek yağı ve soya yaği bazlı su içinde yağ tipi nanoemülsiyonların soğuk depolama sırasında Beyaz bacaklı karidesin *(Litopenaeus vannamei*) kalitesi ve raf ömrü üzerindeki etkisini değerlendirmeyi amaçlamıştır. Karides örnekleri dört gruba ayrılmış ve şu işlemlere tabi tutulmuştur: zeytinyağı bazlı nanoemülsiyon, ayçiçeği nanoemülsiyonu, soya nanoemülsiyon ve kontrol grubu. İşlenmiş numuneler 4^0 C'de saklandımiştir. Depolama süresince 0, 3, 6, 9 ve 12. günlerde çeşitli kimyasal (TVB-N, TBA, WHC, pH) ve renk analizi yapılmıştır. Sonuçlar, zeytinyağı, ayçiçeği ve soya yağı nanoemülsiyonlarının kullanımının kontrol uygulamasına kıyasla daha iyi karides kalitesini koruyabildiğini göstermiştir. Ayçiçek yağı nanoemülsiyonu ile muamele edilen karideslerin kalitesinin kimyasal göstergesi olarak pH, TBA (Tiyobarbitürik Asit), TVB-N değerleri (uçucu nitrojen baz kompleksi) ve WHC değerleri (su tutma kapasitesi) diğer nanoemülsiyon uygulamalarına göre daha iyi bulunmuştur.

Anahtar kelimeler: Nanoemülsiyon, karides, kalite, raf ömrü, lipid oksidasyonu, yenilebilir kaplama.

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List of Abbreviations

CEO:	Cinnamon Essential Oil
CH:	Chitosan
EO:	Essential Oils
HLB:	Hydrophilic-Lipophilic Balance
HPP:	High-Pressure Processing
HIPE:	High Internal Phase Emulsion
LBG:	Locust Bean Gum Chitosan
LCTs:	Long-Chain Triglycerides
LDPE:	Low-Density Polyethylene
LPO:	Lacto Peroxidase
MA:	Microwave- Assisted
MAP:	Modified Atmosphere Packaging
MT:	Million Tonnes
O/W:	Oil-In-Water
OTR:	Oxygen Transmission Rate
PPE:	Pomegranate Peel Extract
REO:	Rosemary Essential Oil
RNS:	Reactive Nitrogen Species
RO:	Rosmarinus Officinalis
ROS:	Reactive Oxygen Species
SEM:	Scanning Electron Microscopy
SFF:	Silver Carp Fish Fillet
SSO:	Specific Spoilage Organisms
TBARS:	Thiobarbituric Acid Reactive Substance
TGA:	Thermo Gravimetric Analysis
TS:	Tensile Strength
TVB-N:	Total Volatile Basic Nitrogen
VI:	Vacuum Impregnation
WHC:	Water Holding Capacity
W/O:	Water-In-Oil
WVTR:	water Vapour Transmission Rate

CHAPTER I
Introduction

Shrimp is among the most consumed types of food worldwide, because of its nutritional quality and health benefits. Shrimps are high in omega-3 fatty acids, protein, minerals, astaxanthin antioxidants, and vitamins, among other nutrients. Among these, the significant selenium found in shrimp aids in the maintenance or enhancement of the immune system. Astaxanthin not only protects the brain and heart, lowering the danger of mental weariness and heart attack, but it also aids male fertility. Furthermore, studies have shown that the omega-3 fatty acids found in shrimp are beneficial to the cardiovascular system (X. Dong et al., 2021).

Statement of the problem

Shrimp muscle endures many quality changes during processing, transportation, and frozen storage, including ice-crystal damage, protein denaturation, protein oxidation, and lipid, melanosis, and moisture migration. Off-flavour, texture degradation, Drip loss, discoloration, and rancidity are all major consequences of these alterations in muscle products. Because of their highly unsaturated compositions and textures, Shrimp muscle lipids are vulnerable to degradation in the presence of several promoters during preparation and storage. Although the quantity of lipids in shrimp muscle is normally relatively low, with values ranging from 0.7 to 1.2 percent (w/w) of biological components, oxidation of lipids has a detrimental impact on the regular, Shrimp foods' nutrient benefit and biological hazards. Lipid oxidation is largely achieved by a chemical series of reactions, which is aided by reactive oxygen species (ROS), Secondary oxidation compounds, and/or reactive nitrogen species (RNS) developed in cardiac muscle (Tu et al., 2022).

There are a variety of thermal processing options for white shrimp that can enhance shelf life and improve quality. Heat is normally transmitted from the surface to the inside in traditional heating techniques, resulting in a gradual heating rate, however with microwave heating techniques, heating happens throughout the whole meal, volumetrically and simultaneously. Microwave heating is widely employed in food production, including heating, dehydration, canning, and sterilization. It offers a number of advantages, including a quick cooking time, a rapid temperature rise, and less nutritional and taste damage. Nonetheless, a major drawback of microwave heating is the non-uniformity of temperature distribution, which can result in cold and/or hot areas in food. Cold spots are of special relevance since they can pose major food safety issues. To counter these drawbacks, microwave-assisted (MA) processing methods, which combine traditional and microwave heating processes, are utilized to conserve energy, enhance food quality, and reduce processing time and cost. MA thermal heating, MA pressure heating, MA dry heat, MA freezing drying, MA steam heating, and MA solar water heating are examples of frequently used MA processing processes (Lee et al., 2022).

Different preservation tactics for storage and distribution, including temperature management, humidity control, and activity prevention, have been used to maintain quality and prolong the shelf life of aquatic goods.

Low storage temperature is used to extend the shelf life of aquatic food items by lowering the rates of enzymatic autolysis, lipid oxidation, and microbiological degradation, which has been done for decades. Refrigerated storage between 0 and 4 ∘C, frozen preservation from -18 to -40 degrees Centigrade, and super-chilled preservation between −1 to −4 ∘C are the most prevalent methods for low-temperature preservation. Microbial activity is hindered at low temperatures, and the majority of bacteria have no ability to replicate. Chemical and enzymatic processes, particularly the breakdown of ATP and associated molecules, are also slowed(Pan et al., 2019). Shrimps have a shelf life of 1–2 days at room temperature (25 °C), which can be prolonged to 4–6 days at 4 °C due to the weakening of most bacteria and enzymes' activity at low temperatures (Q. Yu et al., 2022).

Different styles of packaging have been invented more often in recent years all around the world. The use of films and coverings which are edible have attracted considerable consideration among newly created packaging due to its various exceptional benefits, factors as affordability and ecological protection. Edible films and coatings are compounds that can be processed by the internal organs or are sustainable in the ecosystem. Edible materials are divided into films, edible coatings, and sheets based on their usage. Edible coatings are digestible elements in fluid state, and they can incorporate added biological and chemical ingredients, nanoparticles, for instance. The thickness of edible films (0.025 mm) and layers (more than 0.050 mm) is distinguished. It's worth noting that layers covered around foodstuffs are edible films, whereas edible coatings are often sprayed on the top of meals or food is immersed in various edible coatings such as proteinoids compounds. Several investigations on the production of edible coatings based on various fruits, polysaccharides, vegetables, proteinoids composites, antibacterial substances, and essential oils have been done (Paidari et al., 2021).

Waxing was sprayed onto oranges and lemons in the 12th century to decrease moisture loss. In England in the 16th century, fat coating of foods, sometimes known as 'buttering,' was employed to evaluate their moisture - resistant characteristics. Inside the United States, hot heated paraffin coatings have been used to wrap fresh fruit since the 1930s, however since the 1950s, carnauba wax and oil-in-water emulsions have been used to cover fresh fruits and vegetables.

Food products benefit from edible films and coatings because they protect them against physiological, chemical, and biodegradation. Edible coatings offer strong moisture barrier qualities, which reduce weight loss owing to moisture evaporation, preventing moisture loss during storage of fresh or frozen foods. The use of low-oxygen-permeability edible coatings helps to minimize the rate of rancidity and browning in meats, although anaerobic circumstances should be avoided. Pre-heating edible film liquids shortly before application might minimize spoilage and pathogenic germs on the surface of coated foods while also partially inactivating deteriorative proteolytic enzymes. Enrobing with edible coating of food products serves as a transporter for bioactive molecules such as antimicrobials and antioxidants, either synthetic or natural. When antioxidants or antimicrobials are applied to edible coatings, they aid to postpone meat rancidity and discolouration while also lowering microbial burdens. Foods might benefit from edible coatings to reduce colour loss, volatile flavour, and the pick-up of foreign odours. When edible coatings are put to the surface of food before battering in a battered and breaded product, they prevent oil uptake and moisture loss during frying, boosting the nutritional value of the product. The biodegradability and edibility of edible film and coating materials are their biggest advantages (Swain & Mohanty, 2020).

In order to increase digestibility, targeted administration, effective encapsulation, and bioavailability, food-grade nanoemulsions are increasingly being employed. Edible films/coatings are used in the food industry to increase the shelf life of fresh fruits, vegetables, meat, and food owing to the antioxidant and antibacterial qualities of the embedded nanoemulsions.

There are three types of emulsions: macroemulsion, microemulsion and nanoemulsion. Microemulsions and nanoemulsions, on the other hand, have smaller droplets than macroemulsion. Nanoemulsions are created by shattering larger emulsion droplets into Nano-droplets with an external force, such as pressure or energy, resulting in improved physicochemical and sensory qualities. A nanoemulsion with a size range of 50 to 200 nm makes a clear solution, whereas one with a size greater than 500 nm appears milky or foggy (Sneha & Kumar, 2022).

Nanoemulsions are utilized in the food industry for food confinement, processing, preservation, and storage, as well as delivery mechanism for active lipophilic components. Weakly soluble chemicals' targeting, adsorption, encapsulation, solubility, bio accessibility, permeability, and bioavailability are also improved by nanoemulsions. It might be owing to the droplets' Nano-size and huge surface area (Ahari & Naeimabadi, 2021).

Nanoemulsions, for illustration, are a result of food nanotechnology that has improved macroscale qualities such as, texture, taste, process ability, and stability of foods. Nanoemulsions are made up of two immiscible liquids, one of which is scattered as tiny spherical particles in the continuous phase. Oil-in-water (O/W) and water-in-oil (W/O) nanoemulsions are distinguished. Because of its water compatibility, O/W nanoemulsions have become more popular in recent years than W/O nanoemulsions (Pongsumpun et al., 2020).

Nanoemulsions are similar to microemulsions in that they are dispersions of nanoscale particles generated via mechanical force rather than spontaneous formation. Processing methods of nanoemulsions are as following:

- High energy emulsification: homogeneity with high pressure and ultrasonication
- High-Pressure Homogenization: To make Nano-sized particles, a specifically developed high-pressure homogenization device is used. Oil and water phases are permitted to push through a tiny input hole at very high pressures (500 to 5000 psi). As a result of the intense volatility and dynamic tension, very minute particles are formed. However, this process necessitates a high level of temperature and energy. Particle size is determined by pressure and homogenization cycles. Greater the intensity and higher the homogeneity processes, smallest is the particle size. It's simple to expand this strategy.
- Ultrasonication: This approach is based on the idea that when a coarse emulsion is placed in an ultrasonic field and the external pressure is raised, the cavitation threshold rises, limiting the formation of fine nanoparticles.
- Low energy emulsification: The temperature method, the solvent displacement method, and the emulsification component method are all used in phase inversion.
- Microfluidization: A specifically built gadget known as a microfluidizer is also utilized in this technique to achieve high-pressure (500 to 20000psi). To begin, make a coarse emulsion by combining the oil and water phases. This device comprises of a tiny micro channel diffusion of ions through which coarse emulsion is driven to an impingement region to generate nano-size fine particles, which is then filtered to get uniform particles.
- Spontaneous Emulsification: This technique is straightforward and employs a volatile organic solvent system that includes oil, water, and lipophilic and hydrophilic surfactants. Magnetic stirring is used to ensure that this mixture is homogeneous. The water-miscible solvent is then evaporated under vacuum to produce a nanoemulsion.
- Phase inversion: The concept of interfacial temperature, or the temperature at which spontaneous polarization occurs, is used in this method. Low temperatures are better for O/W emulsions, whereas high temperatures are better for W/O emulsions. Fine particles are produced by quick cooling and heating cycles. Polymers dehydration, non-ionic emulsifier like polyoxymethylene become at high temperatures, it is lipid

soluble, whereas at colder concentrations, it is hydro. Solvent Evaporation: To use this procedure, first the medication should be combined with an extraction liquid and an appropriate surfactant, then mix the continuous phase to make an O/W emulsion. Then, using a vacuum, warming, or ambient conditions, organic solvent is evaporated to yield drug-loaded microspheres, which are then centrifuged or filtered.

- Hydrogel: This procedure is similar to that of solvent evaporation. To create a nanoemulsion of drug-solvent that is miscible with the medication anti-solvent, high shear forces are applied.

Advantages of nanoemulsions are:

- Nanoemulsions are kinetically and highly stable, therefore they don't have problems like emulsion formation, coagulants, gelation, or suspension.
- Nanoemulsions have effectively improved stability, allowing them to be used in a wide range of compositions, including sprays, gels, fluids, and aerosols.
- Because nanoemulsions are non-toxic and non-irritating, they may be treated with topical and mucosal with ease.
- Nanoemulsions are made up of plant oils and surfactants that are safe for humans to consume, and they may be taken orally, enterically, topically, transdermal, or intravenously.
- They might be utilized to distribute liposomes and vesicles as an alternate delivery mechanism.
- Because they do not harm human or animal cells, nanoemulsions are safe for human and veterinary pharmacological activities.
- Nanoemulsions have nanoscale droplet size, which increases the surface area, increasing the rate of absorbing and improving the formulation's bioavailability (Sharma et al., 2020).

Disadvantages of nanoemulsion are:

- Nanoemulsion instability was produced by a range of parameters, including individual characteristics including Oswald ripening, creaming, flocculation, and coalescence, as well as external influences like temperature and pH.

- To stabilize the Nano-droplets, a lot of oil or surfactant was used, which may contribute to obesity and cardiovascular disease (Darimont et al., 2020)(J. Chen & Hu, 2020)

Food and beverage sectors could benefit from edible nanoemulsions comprising lipophilic functional substances such as phytosterols, carotenoids, flavonoids, fat-soluble vitamins, and polyunsaturated lipids. The bioavailability and bioaccessibility of bioactive substances in food were increased via nanoemulsification. The vitamin D nanoemulsions created might be used to make useful food and beverage items. The stability and distribution of bioactive chemical nanoemulsion under varied processing and storage conditions were the most important requirements for integration or fortification. Developed self-assembled nanoemulsions for several useful components in beverages, including lutein, phytosterols, coenzyme Q10, carotene, isoflavones, lycopene, and vitamins (E, D3, and A).

Antioxidants, antimicrobials, anti-bleaching substances, nutraceuticals, flavouring agents, or texture enhancers can be added to the edible coating, which improves the nutritional and the layer's functional purpose. Water-soluble substances like pre-/probiotics, proteins and vitamins (B and C) can easily get joined using a biodegradable (biopolymer or peptide) substrate to create an edible covering. Lipid soluble incorporation components such as essential oils or fat-soluble chemicals offered a significant problem in the creation of edible coatings. As a result, extra processes to stabilize this combination are necessary.

The dispersion phase, continuous phase, and emulsifiers are the three main components of oil–water nanoemulsion edible coatings as stabilizers or surface-active compounds. In a polysaccharide-based coating, emulsifiers may be required to stabilize the Nano-sized oil droplets if the polysaccharide is utilized in lacks of surface-active characteristics.

The most basic kind of o/w emulsion used in the nourishment commercial was beverage emulsions, which consisted of tiny oil droplets scattered in an aqueous solution. Flavour and fog emulsification were the two primary categories of beverage emulsions. Flavour emulsions include lipophilic chemicals that are added to give the flavour and scent of beverages, whereas cloud emulsions might change the beverage's refractive appearance via altering its condensation to a suitable level. Cloud emulsions were made with the content of vegetable oils, which are very oil phase chemicals which are insoluble in water and stable. A diameter of both the solvent molecules inside the aerosol suspensions was determined to regulate refraction and aggregation. To disguise the sedimentation and ringing, aerosol suspensions were put to drinks and beverages with a significant fraction of liquor to produce a desired foggy look.

Another one is dairy products that is the emulsions were often utilized in everyday life in the form of margarines, fatty spreads, and homogenized milk. The diminution in size and homogeneous lipid granules diffusion are used to make homogenized milk stable. whey proteins, lipid granules, and Casein micelles are the basic micro- and nano-scale structures used in the dairy industry to make cheese, complicated liquids, foams (whipped cream and ice cream), and layers of hydrogel (yogurt), emulsions (butter).

Next one is confectionery industry, different items such as sweeties, toffies, and cracker and dough products have a large and expanding demand. The confectionery industry may be divided into two types: flour and sugar confectionery. Biscuits and bakery items are made using flour confectionery, whereas chocolate, toffee, sweets, chewing gums, and other sugar confectionery products are made with sugar confectionery. Nanoemulsions are likely to have a wide range of applications in wheat confectionery, while their use in the glucose range could be controlled.

Non-fat particles such as cocoa, glucose, and dairy grains were interrupted in a non-stop lipid segment in chocolate (chocolate buttercream). Substances were used in the preparation of cocoa help prevent the issue of 'full bloom,' that could result of deterioration and extra unpleasant sensory changes. To ensure operational and economic feasibility, the surfactant was also applied to enhance the distribution of the chocolatey. They were also utilized to improve the texture and obtain the desired look. Nanoemulsions were indeed intended to be found in flour and glucose pastry products that need improved foam stability and smooth spray diffusion. An important market for nanoemulsions is the cream used in pastry goods such as pastries and butter cookies. The incorporation of nanoemulsions in patisserie items like cream, that are fat-in-sugar liquid emulsions plus diffused air, seems viable.

The spreading of lipids in a glucose and starch mixture, along with certain compounds and peptides, resulting in soft pastry products. To attain the desired quality, chewy confectionery producers discovered that emulsifiers may be used as a plasticizer and also help with fat dispersion. The manufacture of specified objects, when homogeneous diffusion of aroma compounds is permitted, was another viable market for nanoemulsion use in the confectionery business (Dasgupta et al., 2019).

Edible coatings and films help to maintain raw and dried foods safe while also improving their quality. Because film is extremely permeable to water, it can be used on cooked meat to reduce rancidity and moisture content. It may be used to cover vegetables and fruit, as well as cheeses. It has qualities that help increase the quality and longevity of tomatoes, papayas, and bananas, as well as the texture of green chilies and tomatoes. For reducing surface dehydration, packaging coatings in a variety of applications, including meat, meals oil–based, steady powdered meal, seafood, chicken, and salami (Chhikara & Kumar, 2022).

Purpose of the study

Around the world, new package designs have been created increasingly often in recent years. Due to its several remarkable benefits, including affordability and environmental friendliness, the usage of nanoemulsion for coatings has garnered significant interest among newly developed packaging.

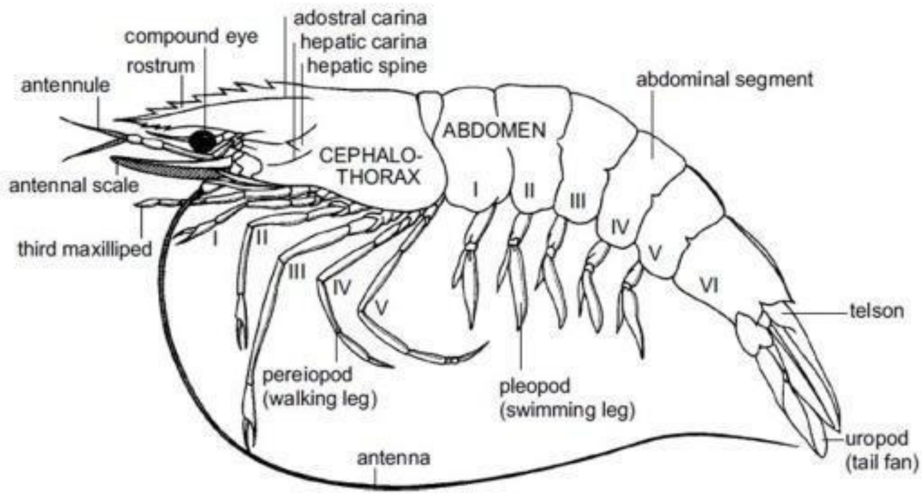
The food sector uses nanoemulsions for food containment, processing, preservation, and storage as well as a means of delivering active lipophilic ingredients. This study set out to find out how white leg shrimp (*Litopenaeus vannamei*) quality and longevity kept in cold storage were affected by an oil-in-water nanoemulsion based on vegetable oils (olive oil, soybean oil and sunflower oil).

CHAPTER II
Literature Review

Theoretical Framework
Shrimps (Litopenaeus vannamei)

Because of the capacity to sustain a different type of heats and salt concentrations, ease of culture under high stocking density, ease of breeding, accelerated extension, improved chances of living, appealing shape, significant industry necessity, and Tolerance to illness, Pacific white shrimp *(Litopenaeus vannamei*) has been identified as the greatest frequently cultivated and financially valuable subspecies in Asia, comprising for 73percent in terms of worldwide production. Other problems, such as illnesses, have resulted in 1.7 million tonnes (MT) of shrimp producing reductions of US $ 3.3 billion, comprising approximately 300,000 T of the lost. Pacific white shrimps, like other, inability to adjust characteristics besides use natural adaptive protection to identify in addition eliminate viruses, which probiotic studies have shown to be effective in combating this threat (Amoah et al., 2019).

Figure 1 *Morphology of Litopenaeus vannamei (C. P. Balasubramanian, 2018)*



These species are more tolerant of high stocking levels, which range from 60 to 150 per m^2 but can reach 400 per m^2. Low protein needs of approximately 20–35 percent crude protein and enhanced feed conversion rates, increased estimated average growth rates of up to 3 g per week^{-1}. Strong tolerance for a wide range of water conditions, involving salt concentrations and temperature, and 50–60% better survival rates during larval feeding. As a result of this increased production, *Litopenaeus vannamei* has been the focus of several scientific research, resulting in significant understanding about the species' biology, genetic, and zootechnics.

Sexual size dimorphism in *Litopenaeus vannamei* begins at 10 g and becomes prominent around 17 g. Females have a bigger cephalothorax and a broader first abdominal segment than males, making them heavier.

Male *Litopenaeus vannamei* were more active swimmers than females, who spent much of their time at the bottom of tanks. When it came to fighting for food, men were more violent than females. Males, despite their lower size, tended to monopolize the food supply for longer periods of time than females. As a result, it is obvious that gender, rather than size, is a more relevant component in explaining differences in eating activity in this species. It indicates that *Litopenaeus vannamei* females do not have a competitive advantage over food, and physiological advantage is one of the likely sources of sexual development dimorphism in this species.

Shrimps are mostly restricted to two-dimensional space rather than three-dimensional volume as benthic creatures, yet when stocked in high densities, the water column becomes more significant since they may graze on suspended food particles. As a result, in an aquaculture scenario, bottom substrate becomes a major problem. Artificial substrates have increased post larvae and juvenile development and/or survival in *Litopenaeus vannamei*, even at high stocking densities. *Litopenaeus vannamei* can grow in a broad range of temperatures, from as low as 15°C to as high as 33°C, albeit at a slower rate and pH levels in the range of 7.4–8.2 (Bardera et al., 2019).

Deterioration of Shrimps

Because of microbiological, chemical, and physical changes that occur during storage, shrimp is a perishable product with a short shelf life. Fresh shrimp has a limited shelf life, which makes distribution and marketing difficult. Fresh shrimp have traditionally been preserved by chilling and freezing. These approaches, on the other hand, are ineffective because they do not address particular components of the enzymatic process (Khaledian et al., 2021).

Shrimp is heavy in water, free amino acids, and unsaturated fatty acids, making it more susceptible to breakdown and the production of off-flavours and aromas than other muscle meals. Enzymatic chemical digestion, microbial degradation, and oxidation reactions are the three principal shrimp degradation processes. Proteolytic enzymes, which take proteins and peptides as substrates and convert them to nitrogenous chemicals that promote tissue softening, are the principal source of autolytic alterations. When no preservation method is used, autolysis changes occur as soon as the animal dies. At 35°C and an acidic pH, white leg shrimp flesh had the highest autolytic activity, with aspartic proteinase dominating shrimp muscle autolysis. When compared to other meat products, seafood is more sensitive to lipid autoxidation due to its high content of unsaturated fatty acids. With increased unsaturation, the production of fatty acid radicals becomes easier, and seafood often contain significant amounts of unsaturated fatty acids. Lipoxygenase, which is found in seafood tissues or derives from microbial presence in the diet, may also accelerate the creation of fatty acid radicals. Hydroperoxides produced by autoxidation do not produce off-aromas, but they rapidly degrade into lower molecular weight volatile chemicals, such as alcohols, aldehydes, and ketones. Bacteria begin to penetrate tissue after the creature dies, and the metabolites and digestive enzymes generated by bacteria considerably speed up the spoiling process.

Specific spoilage organisms (SSOs) are microorganisms that are involved with spoiling processes. In the early stages of spoiling, SSOs are present in modest levels, but by the conclusion of the process, they have taken over the microbial community. The sort of SSOs found in seafood is significantly reliant on the organism's habitat and storage circumstances. *Psychrotrophic* gram-negative bacteria, such as *Aeromonas spp*., *Pseudomonas spp*., *Photobacterium phosphoreum*, and *Shewanella putrefaciens*, are prominent SSOs in cold seafood. These bacteria are responsible for the production of chemicals that have an adverse influence on performance and shrimp protection. Sulfuric acid generation, Ketones and alcohols (3-methyl-1-butanol and 1-penten-3-ol) (2-butanone) by *Pseudomonas spp*. results in stale and rotten aromas. *Shewanella putrefaciens* has the ability to create amines as well as hydrogen sulphide. Biogenic amines are manufactured in deteriorated seafood by microbiological dehydrogenation of free amino acids. Bacterial histamine decarboxylase converts free histidine into histamine, which is the main toxin responsible for shellfish poisoning. Putrescine and cadaverine, which are produced by arginine and lysine carbonization, in both, are key rotting markers of seafood. Thermal gradients, as in 0°C, can hinder the development of histamine-forming bacteria, despite the fact that compound and cadaverine-forming microorganisms may multiply and assist to amine generation at 0°C. Shrimp kept frozen approximately 9-12 days, microorganisms corresponding towards a category negative bacteria filaments that are not oxidative, such as Micrococcus, Photobacterium, and Aeromonas, be shown selected the dominant microorganisms that produce ions (Fan et al., 2022).

Preservation Methods

Shrimp deterioration is temperature-dependent and can be slowed down by lowering the storage temperature. Shrimps have been processed using a variety of drying procedures, including defrost, dehydrating using high-pressure steam, bed dehydration using jets, and heat pump drying. One of most common methods of shrimp treatment are still solar drying and hot air drying. One of the most essential low-cost ways of shrimp preservation is sun drying. Blow flies, on the other hand, infested unsalted dried shrimp in large numbers. Curcumin is already used in traditional system of medicine to suppress the growth of germs and fungi. This has been employed in the preparation of meals (Phuoc Minh et al., 2018).

Vacuum and modified environment packing, high-pressure treatment, gamma irradiation, and the use of plant extracts, organic acids, and essential oils are some of the ways used to extend the storage life of fresh shrimp. The edible coating is a novel strategy for increasing the safety and delaying the spoiling of meat, fish, and other foods by slowing lipid oxidation, preserving protein functioning, reducing off-odours, discoloration, and moisture loss, and decreasing off-odours, discoloration, and moisture loss (Khaledian et al., 2021).

Modified atmosphere packaging (MAP) is recognized as an excellent preservation solution for improving the quality of meat products and increasing their shelf life. The most frequent gases used in MAP are CO2, N2, and O2. However, because the presence of oxygen in MAP may cause quality degradation by encouraging lipid oxidation, it may be preferable to package cooked meat in an oxygen-free environment (X. Chen et al., 2020). The use of ozone and MAP in combination is a potential strategy for extending the shelf life of seafood while maintaining excellent safety and quality. Ozone gas is one of the most powerful oxidants recognized for its bactericidal properties, and it has piqued the processing industry's attention in recent years. The combined effects of ozone and a changed environment increased the shelf life of white shrimp *Litopenaeus vannamei* from 11 to 24 days in cold storage at 4 °C (Gonçalves & Lira Santos, 2019).

In a solid-liquid food system, vacuum impregnation (VI) is a potential approach for increasing the penetration of certain bioactive chemicals into porous tissues at low pressure. Under vacuum, gases or liquids are removed from the pores of solid meals, which are subsequently replaced with VI immersion solutions upon the return to air pressure. On marine species, VI has been combined with antioxidants from natural extracts to prevent chemical degradation and microbiological spoiling during storage (Shiekh et al., 2021).

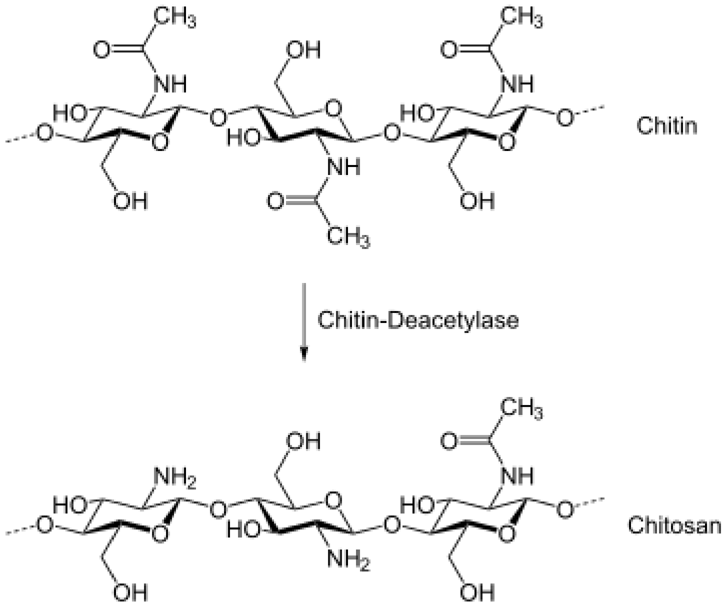
One of the non-thermal food processing methods is high-pressure processing (HPP). It seals the food in a high-pressure-resistant container, then applies and maintains high pressure (≥100 MPa) for a set amount of time. HPP has the ability to suppress or even inactivate bacteria, allowing cold-chain goods to last longer. HPP, on the other hand, has limited influence on low - molecular - weight substances like pigments, vitamins, and aromatic compounds, therefore the product's original quality and flavour may be preserved. HHP kills bacteria by preventing the synthesis of volatile nitrogen and trimethylamine, prolonging the shelf life of shrimp. HPP might be used to change the protein function and potable water of shrimp. Understanding the impact of HPP on water distribution and proteins is crucial to understanding the changes in other physical and chemical characteristics. It may hasten protein breakdown during refrigeration, but by decomposing the initial microbial population during the HPP phase, it improves shrimp physicochemical quality and ensures shrimp preservation in ice for at least 28 days. HPP's effects on water distribution and protein in shrimps may help to keep them from spoiling during refrigeration. The results help researchers better understand the impact of HPP on shrimp water distribution and protein quality during chilled storage (L. Chen et al., 2022).

Ionizing energy irradiation is a successful and environmentally acceptable application, and it is the only procedure that may be used on goods after they have been packaged. As a result, it eliminates all contamination and the risk of food recontamination. For microbial killing, gamma irradiation employs two processes. They're breaking DNA by impacting it directly and breaking DNA by interacting with other molecules, such as water molecules. Food irradiation with gamma rays has been demonstrated to kill *E. coli O157: H7*, *Salmonella spp*. , *Listeria monocytogenes* and *Vibrio spp*. Raw, headless tropical shrimp can be radiated with 1.5-2.0 kGy doses to enhance their storage period to 42 days around3^0c (Marasinghe et al., 2022).

Edible coating has been extensively researched and proven to be an effective and ecologically friendly method of maintaining food value and stability when in chilled conditions. An edible coating created just on interface of products aids in the limitation on water evaporation, lipolysis, biological degradation, and biochemical processes, that are each primary causes of food spoiling. Eatable ingredients, such as whey protein, alginate, chitosan, and gelatine, have been demonstrated to improve agriculture items' longevity whether used individually or in combination through organic additives throughout the last decade.

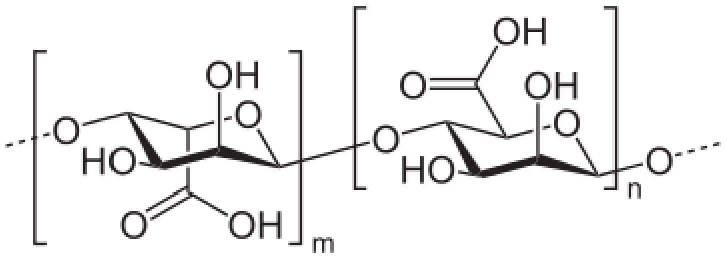
Chitosan is a hydrolysed chitin, a straight polymer made up of b-(1–4)-2-acetamido-D-glucose and b-(1–4)-2-amino-D-glucose elements, the former becoming the most significant part. Chitosan is classified according to its depolymerization rate as well as maximum polymer mass, that are responsible for their antibacterial properties, as well as physical properties such as viscosity, permeability, and film formation. Due to various their bio-activities and provide a gaseous, chitosan-based films decreased microbial numbers and the build-up of toxic metabolites, and improved physical and sensory characteristics.

Figure 2 *Forming chitosan by partial deacetylation of chitin*



Alginate, a natural coating substance derived from brown seaweed, is another attractive natural coating material. Alginate has the capacity to create non-soluble polymeric or powerful liquids by chemically diverse iron ion bridge actions due to its peculiar colloidal properties. Alginate has the capacity to create strong gels or insoluble polymers by bridge actions reactions with polyvalent metal ions, and Ca^{2+} is typically chosen being the best emulsifier due to its unique colloidal features. In general, alginate - based soluble salts (1.5–4%) are applied to fisheries products through immersing or splashing them, then dipping them to promote emulsification in a calcium liquid (2%). By preventing oxidative microorganisms, reducing dehydration, delaying oxidation of lipids, and limiting prevent poisoning, alginate gel films assist to protect the quality of agricultural items. Because alginate has little bioactivity, it also works like a transporter for antibacterial and preservative substances to extend the duration of storage of fisheries products. The development of decomposition and harmful aqua bacteria items, such as *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella anatum*, was likewise inhibited by these alginate composite coatings.

Figure 3 *Structure of Alginic acid*



Collagen, one of most prevalent protein in higher organisms, is largely harmful for environment or hydrolysis to produce gelatine. Through gelatinization properties, in addition from its tolerance to oxygen, drying, and light, gelatine is a promising coating material. Gelatine, like some other coatings, can be utilized as a protective or antimicrobial chemical transport. Coverings derived on gelatine are typically used for brushing, dropping, or scattering with a proportion of a mixture ranging from 1 to 8%.

Based on its bioavailability and oxidant tolerance, scent, and qualities of lipid layer, a by-product of processing of dairy, whey protein, was employed. Whey protein benefits from the presence of lacto peroxidase (LPO), an antibacterial enzyme with a broad spectrum of action.

Coating carriers like chitosan and whey protein help to keep chilled fisheries goods fresh for a while, but their limited antibacterial and antioxidation properties can't totally prevent spoiling and meet customer demands for an extended period of storage and improved acceptable texture. Organic liquid as well as liquor substances were intensively researched as antioxidant and antimicrobial covering boosters to seafoods. In general, plant extracts work in tandem with coated carriers to limit bacterial growth. Bioactive chemicals such as terpenoids and phenolic compounds, which have been regarded antibacterial agents, are abundant in Phenolic acids and flavourings are examples of liquid extraction. Plant extracts have been shown to a positive influence on the antimicrobial characteristics of edible films in vitro employing various techniques, as well as in situ using fishery products.

Coatings for protection might being sprayed explicitly or implicitly. Direct coating is the process of producing an edible layer on a nutrition interface by coating, spaying or dropping (D. Yu et al., 2019).

Spraying can be done using either a traditional or an electro-spraying approach. The droplet size of the solution in the traditional approach is approximately 20 µm, but the droplet size in electro-spraying was around 100 nm. Whenever thinner coatings are needed, the dipping method of edible coating is being used.

The dipping technique is commonly used to improve the physicochemical quality of minimally processed fruits and vegetables, as well as meat products. Various characteristics, including as density, viscosity, and surface tension, can be used to adjust the thickness of the coating. A layer-by-layer electrostatic approach may be used to link two or more layers utilizing physical or chemical interactions, which is a unique variant in dipping procedure. Dipping is now the most researched method for putting coatings on fisheries goods. The dipping coats of chitosan-gelatine solutions reduced the deterioration of chilled shrimp. Electrostatic coating has mostly been employed on confectionery items.

The coating dispersion is brushed on the surface of the food substance in the third approach Indirect coating is the process of using a brush or a spray to apply a covering compound for a nutrition sheet such as polyamide layer to create its double-layer film with specialized functionality (Dhumal & Sarkar, 2018).

Edible coatings have several advantages, including enhancing the external surface of food products, lowering weight loss and oxygen consumption, and thus deformation; restricting microorganism absorption and expansion on the food surface; and delaying the corrupt practices and mechanical deformation of fruits and vegetables throughout storage, inhibiting absorption of water or dryness of low-moisture foods, as well as the negative repercussions; stopping enzymes from browning and food from becoming nonenzymic; decreasing nutritional inadequacies in undesirable processes like oxidation and browning; greatly lowering excessive oil absorption into product tissue and excessive water loss during frying; significantly reducing the usage of synthetic packaging material (Milani & Nemati, 2022).

Edible coatings have several drawbacks, such as preventing oxygen exchange and causing off-flavour development. Some edible coatings are hygroscopic, allowing microbial growth to flourish (Hassan et al., 2018).

Emulsions

Emulsions used in edible coating production, which are made up of two or more immiscible phases, are frequently employed in the pharmaceutical, cosmetics, and food industries. Thermodynamically, traditional emulsions are unsteady. The long-term metastability is caused by surfactants or particles adsorbed at droplet surfaces, which cause repulsion or depletion. Surfactants are used to stabilize emulsions, although they can be allergic and hemolytic, as well as have detrimental environmental consequences. Solid particles are being researched as a way to increase stability between the phases of emulsions as a way to reduce or replace surfactants (Sieben et al., 2022).

Suspensions are frequently used in various farming systems, like crème, dairy, ranch dressing, mustard, drink, milkshakes, and so on, as a significant aspect of the food business. Suspensions are sensitive to spontaneous stratification while storing because they are a non-uniformly distributed liquid solution. The addition of stabilizers to emulsions is an efficient way to increase their stability. Traditional emulsions, for example, were made more stable by adding a considerable number of tiny molecule surfactants. The biosafety of stabilizers is the most important factor in the food sector. However, the majority of tiny molecule detergents are biohazardous data, restricting its usage as emulsified food (Tian et al., 2022).

Emulsions are heterogeneous, thermodynamically unstable systems made up of an emulsifying agent and one phase intimately distributed in another in the form of droplets. Topical administration of emulsions has some advantages, including better medication release and skin permanence. Emulsions are promising formulations for treating skin conditions such as atopic dermatitis and eczema. However, there are worries about the environment and toxicity, namely skin responses such as contact dermatitis or irritation, cell damage, and carcinogenicity. In comparison to nonpolar or anionic surfactants, cationic surfactants have a higher irritating potential, which diminishes as the surfactant concentration decreases. As a result, discovering novel techniques to minimize toxicity and stabilize emulsions is a hot topic in the cosmetic and pharmaceutical sectors. In recent research on "surfactant-free" emulsions, alternative emulsifying agents such as polymers and solid particles have been used to replace surfactants (Peito et al., 2022).

Water-in-oil Emulsions

Water-in-oil emulsions are common in fat processes such as mustard, spreading, spreading, and cream. The subject may as well be employed as an Encapsulation of substances, drug-controlled release, antioxidant protection, micro-reactors, flavour preservation, and other uses. Like a function, it's common mostly in foods, industrial, pharmaceutical, skincare, and polymeric sectors. Furthermore, it's also hard to make a W/O emulsion, as well as no general hypothesis for forecasting the micro emulsion form in a given water, oil, and reagent combination. Surfactants have solubility that are miscible made up of two solvents fluids, usually surfactant, water, and oil, as is well known. Moreover, the function of a Water-in-oil the emulsification factor and droplet consistency have a huge impact upon dispersion, that is a critical stage in their commercial application. Several parameters, considering a structure of a colloid, Particle shape, pH, stage quantities, and fluidity all have an effect on colloid control solution and discharge qualities (Al-Maqtari et al., 2021).

Given a global rise in obesity and food-related cardiovascular disorders, W/O emulsions are attracting more attention for the creation of fat-reduced meals. Water particles in the oil phase give a realistic way of simulating the "cream" and "sweetness" of complete foods. Bioactive chemicals, on the other hand, can be loaded in the water phase or oil phase to fulfil nutritional needs. The interfacial tension of W/O emulsions is considerable, and the high fluidity of water makes phase separation likely during preparation and storage (Zhang et al., 2022).

Because of its excellent motion limitation, (W/O) colloid has a wide variety of uses in heavy oil wells. This efficiently prevents sticky fondling while floods, increasing swept capacity thus improving oils removal rate. Because of its inherent lipid soluble compounds contained with raw oils, W/O emulsions are simple to develop and maintain in the heavy oil water flooding process (Sun et al., 2022).

The high internal phase emulsion (HIPE) is a viscoelastic concentrated emulsion with a high internal phase content of >74 percent. It possesses solid properties and variable viscoelasticity, allowing it to be used in a variety of materials science, culinary, and cosmetic applications. Due to the irreversible adsorption of particles at the interface, Pickering HIPE is a more modern sub-category with stronger stability against coalescence and Ostwald ripening than surfactant-based HIPE. The physicochemical qualities and stability of emulsions are influenced by several processing parameters such as emulsifier type, concentrations, the nature of the oil phase, and emulsion compositions (Liu et al., 2022).

Advantages of emulsion is the flavour and stability of food are influenced by the rheological qualities of the emulsion. The emulsion's apparent viscosity drops when its velocity profile grows, indicating that an emulsion is a pseudoplastic fluid (Xiao et al., 2021).

Explaining rheological methods and concepts would be essential since this enables visitors to develop appropriate analysis devices for probing emulsifying qualities and improving the physical characteristics, textural characteristics, and nutritive quality of emulsifying agent meats such as additives, ranch dressing, milk, marinades, and broths. To something, shape, structure, taste, and longevity are all influenced by the rheological qualities of these compounds. Rheology measurements may be used to characterize the effects of formulating and preparation factors like material content, acidity, type and concentration, or heat on colloid properties and durability. The formation as including size and extent of oil, pattern modals, and absorbers, manufacturing situations like emulsification sort and operational requirements, and surroundings such like acidity, electrical sensitivity, also emulsifying heat`s agent food goods industry each have a significant impact on their rheology, which in turn has a significant impact on their functional features and potential implementation such as process ability, texture, and mouthfeel (Zhang et al., 2021).

Disadvantages are the because of their enormous interfacial areas, these Nano- and micro-emulsions have poor stability in most mediums. Surfactants are commonly used to stabilize systems; due to their amphiphilic qualities, surfactants preferentially adsorb at immiscible liquid/liquid interfaces, and effective surfactant selection leads to an efficient decrease in interfacial energy (Fujisawa et al., 2017).

It is critical that an emulsion maintains its stability over its stated shelf life. Creaming, flocculation, and coalescence are all destabilization mechanisms that can cause emulsions to break down. The emulsifier that surrounds the droplets may have an effect on these instability processes. For starters, the size of the droplets formed during homogenization affects the likelihood of creaming, with smaller droplets moving more slowly (Ozturk & McClements, 2016).

Their downsides include that they must be used in large amounts to be efficient as emulsifiers, and they are susceptible to microbial development, necessitating the use of a preservative in their formulations. The majority of emulsifiers produce hydrated lyophilic colloids, which create multimolecular layers around emulsion droplets. These emulsifiers have a protective colloid effect but have little or no influence on interfacial tension. They lower the chance of coalescence by forming a protective coating surrounding the droplets, charging the dispersed droplets, and expanding the system to improve its viscosity (Udomrati et al., 2020).

Because basic (O/W or W/O) emulsion delivery techniques failed to provide enough protection for encapsulating materials against chemical degradation or controlled release, there is a growing interest in using different delivery systems that have showed greater benefits than simple emulsions. In culinary applications, double emulsions have exhibited benefits such as masking odour, preventing oxidation, improving sensory qualities, and controlling ingredient release. When it comes to fat content in functional meals, double emulsions help to enhance the quality and quantity of fat by lowering fat content and giving better fatty acid profiles (Jamshidi et al., 2020).

Nanoemulsions

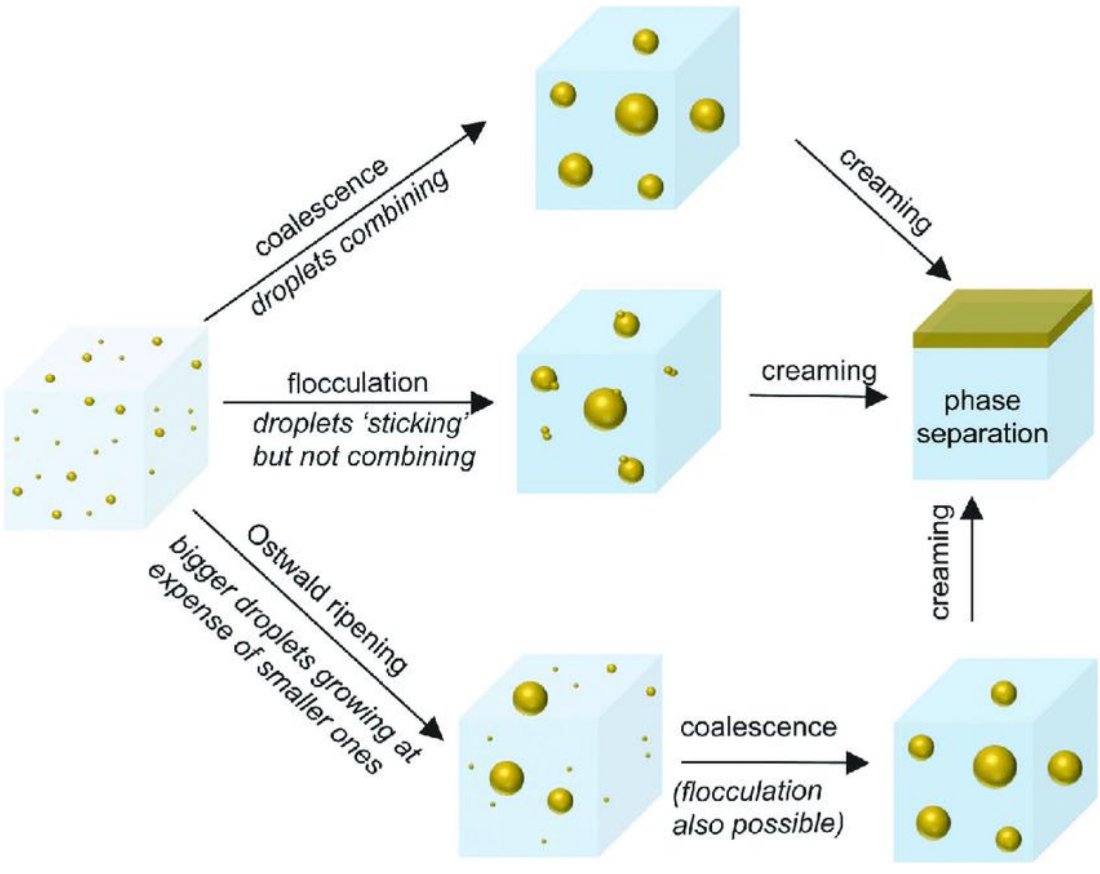
Two liquid solutions plus a surfactant are needed to make a nanoemulsion. The dispersion and liquid phase are comprised of two liquid phases, one of which must be obsequious and the other aquatic in nature. A core–shell structure exists in both the o/w and w/o nanoemulsions. Monoacylglycerols, free fatty acids, triacylglycerols, and diacylglycerols constitute the solvent of a nanoparticles.

This stage of lipids of nanoemulsions can be wholly made up of bioactive lipids like fish, essential, or aromatic oils, or it can be made up of bioactive lipids like vitamins or nutraceuticals solubilized inside an essential oil such as maize oils, soybean, sunflower, or olive oil. Nonpolar substances such as triglycerides, mineral oils, flavour oils, and essential oils could be used to create the oil phase. Lower viscosity droplets require less time within the homogenizer to become distorted and disturbed, making them easier to deteriorate upon solubilization. Smaller surface tension particles require less power to distort and disturbed, making them simpler to break down. So that to its higher surface resistance as well as low permeability, essential oils and flavour oils form nanoemulsions with small droplet sizes, LCTs, on the contrary side, create nanoemulsions with higher globules. Because of destabilizing events such Ostwald ripening or coalescence, including nanoemulsions taste oils might have concentrated lengthy sustainability. To ensure the formation of small nanoparticles upon synthesis which persist throughout preservation and usage, the oils stage must be properly prepared.

The physicochemical characteristics of nanoemulsions are primarily controlled by one's appearance of the water phase. Tastes, bases, minerals, acids, vitamins, surfactants, proteins, preservatives, sugars, and polysaccharides are all water-soluble elements that may be added to the water phase to modify the issue characteristics. The electrostatic interactions among oil droplets are affected by the acidity and electrolytic conductivity of the water phase, which can change the consistency of droplet aggregation. It has been observed that adding viscosity enhancers before homogenization reduces the dimensions of a liquid formed by raising the internal shear forces that cause disruption. By reducing gravity dispersion and droplet collisions, viscosity boosters in the water phase of nanoemulsions change their lengthy sustainability. Including liquid flavonoids to the aqueous phase, such as chelating compounds, reduces the velocity of lipolysis in nanoparticles.

Nanoemulsions are immiscible systems, which need the use of proper stabilizers to generate and maintain them. Emulsifiers are required to aid in the creation of tiny nanoparticles upon mixing and to prevent its accumulation both before and after the procedure. Other forms of stabilizers, including as evaluating method, pattern alterations, and maturation agents, can be added to nanoemulsions to avoid disintegration owing to gravity Ostwald ripening and separated particle accumulation.

Figure 4 *Schematic of various nanoemulsion destabilization mechanisms*



Emulsifiers are amphiphilic compounds with lipophilic and hydrodynamic portions in its chemical composition that serve as surface active agents. As a result, one half prefers nonpolar medium such as oil, whereas the other prefers polar media such as water. The hydrophilic-lipophilic balance (HLB) is the proportion of hydrophobic to lipid soluble compounds on a structure, is a reliable predictor of an emulsifier's relative affinity for the water and oil phases. Emulsifiers with an HLB value over than 10 have such a stronger solubility in water (surfactants), while emulsifiers with an HLB number under 10 have such a greater overall attraction to oils (oleophilic) (lipophilic). Both high and low-energy synthesis methods are used, particles diameter in nanoemulsions decreases as surfactant concentration rises.

When introduced into aqueous solutions, hydrocolloids exhibit thickening or gelling qualities that have been widely employed in food compositions. They can be used in nanoemulsions to change the item's structure or increase its consistency of disconnection due to gravity. The rheological properties of the water phase can be altered the texture and mouthfeel of a nanoemulsion while also slowing droplet mobility.

Application of Nanoemulsions

The methods utilized to create nanoemulsions are typically classed including rising or falling energy. High-energy techniques entail utilizing automatic equipment in a place to break up drops of oil and rising emulating and microfluidizers, for instance, are used to distribute particles into liquid state, and sonicates, to apply high disruptive forces. Low-energy techniques, as well as random emulsifying agent and thermal version procedures, depend on the creation of microscopic drops of oil so when liquid or atmospheric temperatures shift within combined o/w surfactant mixtures. Both techniques may produce tiny globules, but the majority of functional foods, strong techniques are preferable because:

(a) Organic hydrocolloids may be used,

(b) Fewer surfactant concentrations seem to be necessary,

(c) Producing on a high level is simpler, so

(d) Its device has been extensively widely available utilized.

Because of its flexibility and scalability, coagulation under high pressure is frequently utilized in manufacturing to create nanoemulsions and dispersions. High-pressure homogenizers come in a variety of forms, the most popular of which being high-pressure valve homogenizers and microfluidizers. High-pressure valve homogenizers and microfluidizers typically have a cooling coil near the treatment chamber's exit; otherwise, the product can reach temperatures of up to 70°C.

Sonication is segmented a combination of o/w into a nanoemulsion using ultrasonic high-intensity vibrations (regularity generally more than 20 kHz). Sonication has been reported as a technique for microbial inactivation, food extraction, and emulsification of liquid food items. Ultrasonic irradiation techniques generate pressure variations in the liquid, causing air bubbles to form and compress in a cyclical pattern. The air bubbles eventually grow to a certain mass, getting unsustainable, and rapidly collapsing. The cavitation zone is characterized by strong shear forces, hot areas, and instability caused by explosion bubbles implode. Breakup of oil droplets occurs as a result of this action, resulting in elements with nanosized diameters. The length and volume of the therapy that is related to the velocity of the ultrasonic irradiation pulse are the key parameters influencing the ultimate sonicated measured particle diameter produced nanoemulsions. Depending on the architecture of the working chamber, sonication can be done in a batch or continuous manner. There are a number of disadvantages to employing sonication to make nanoemulsions. First, hot spots caused by bubble implosion and high shear rates can produce an emulsion temperature increase (up to 80°C), which can be harmful to heat-sensitive substances. Furthermore, the presence of reactive species in the sonicated fluid has been shown to produce cavitation to trigger the polymerization or degradation of fats, resulting in fat decomposition. Because Metal ions or nanoparticles from the ultrasonic irradiation probes may be injected into the product due to turbulence degradation, some other restriction for industrial flocculation is that metals or fragments from of the ultrasonic probes could be activated into the item (Salvia-Trujillo et al., 2017).

Packaging Films and coatings

Nanoparticles might be used as nanomaterials as potential thin films. This composite material is made up of natural polymers substrate layers and coverings which produce nanoparticles. If a velocity of the flow increases, particle flocculation slows. Making nanoemulsion edible layer includes dispersing the compounds ingredients in a solid that comprises the substrate of the packaging. Nutritional fluids are used, as well as appropriate low- or high- energy synthesis methods. After homogenization, the substance is shaped in evenly coating material and dry. The layers' morphological, physical properties, thermally, kinetic, and insulating properties will also be investigated. The biopolymers utilized in film preparation also help scattered nanoemulsions preserve their functional characteristics.

For prepare food manufacturing most green, nanoemulsions is being used. Heating, oxygen, enzymatic activities, and acidity variations could all have a negative impact on the active constituents. Global Flavours and Aroma Co. has invented a flavour nanoemulsion composed of a hydrodynamic particle comprising flavouring, a liquid, as well as a surfactants solution composed of a polyethoxylated sorbitan esters of fatty acids and protein. The flavour nanoemulsion has been used to process of creating as well as visually clear fluid drinks, such as hard liquor.

Nanoemulsions of natural antioxidants, such as those derived from fruits, vegetables, or grains, have been trademarked for use as food preservatives. Like a thick, nanoparticle coating, a nanocomposite being placed to the food. A nanoparticles coating has also been found to inhibit gaseous and liquid contact with the external environment. Fresh and lightly processed foods with edible nanocoatings have a longer shelf life. It has also been proven that when frozen meals are thawed, it improves their organoleptic quality (McClements et al., 2019).

Related Research

Vegetable oils have been used to produce nanoemulsions as coating material in various investigations. Some of the research that will be summarized are as follows:

Rahnama et al.(2021) using an essential oil-based nanoemulsion as a biodegradable and edible covering can extend the shelf life of shrimp by inhibiting microbial development. Ethanol was used to extract zein from 50 grams of dry milled maize. Tween 80 was used to proper garlic essential oil. Garlic essential oil and nanoemulsion were tested for radical scavenging efficacy and total phenol concentration. Finally, the peroxide value, the thiobarbituric acid reactive substance (TBARS) value, the total volatile basic nitrogen (TVB-N) value, and sensory assessments of several shrimp samples were determined. Corn zein, in combination with garlic-based nanoemulsion, had a significant impact on TVB-N, TBARS, and peroxide value, indicating that the z+24 % garlic nanoemulsion group had the lowest peroxide value among the other groups on days 3, 7, and 14 ($p< 0.05$), as well as microbial properties, indicating that the garlic EO nanoemulsion had significantly better antibacterial effectiveness compared to other groups ($p <0.05$), and sensory evaluation of *Litopenaeus vannamei*. Corn zein nanoemulsion served as an antioxidant and antibacterial agent, extending *Litopenaeus vannamei*'s shelf life at chilled temperatures.

For shrimp preservation, a novel bilayer active packaging film based on low-density polyethylene (LDPE) has been designed and made with rosemary essential oil (REO) and cinnamon essential oil (CEO) in the inner layer by Z. Dong et al. (2018). REO (1% w/w), REO (2% w/w), CEO (1% w/w), CEO (2 % w/w), REO (1% w/w) + CEO (1% w/w) and control film without EO, the blown film extrusion process was used to create these designs. To justify the influence of EOs on film physical functioning, researchers looked at tensile strength (TS), water vapor transmission rate (WVTR), oxygen transmission rate (OTR), thermogravimetric analysis (TGA), and film microstructure. The insertion of REO or CEO into the LDPE matrix resulted in the surface of active films becoming considerably rougher, according to scanning electron microscopy (SEM) results. However, the films with various amounts of EOs showed a modest decrease in TS while improving barrier characteristics. In addition, after storage at 4 C for 10 days, shrimp packaged in active films containing EOs had lower microbial counts, total volatile basic nitrogen (TVB-N) contents, and thiobarbituric acid reactive substances (TBARS) values than those packed in control films. According to the findings, the blended film (REO + CEO) was more successful in preserving freshness and prolonging the shelf life of packed shrimps by up to four days. This novel active packaging film has the potential to improve the quality and stability of aquatic goods during storage.

Edible nanoemulsion coatings containing eugenol as an antioxidant and Aloe vera as a functional component were produced for pink shrimp preservation at 277 ^{0}K for 7 days (Sharifimehr et al. (2019)). Under ultrasonication, nanoemulsion samples were made using 0, 10, and 20 g L^{-1} of Aloe vera, as well as 0, 15, and 30mL L^{-1} of eugenol and Tween 80. The low pH of Aloe vera reduced the particle size and turbidity of the nanoemulsions, while the particle size and turbidity increased with increasing Aloe vera concentration. Furthermore, eugenol and Aloe vera concentrations had a significant impact on the nanoemulsions colour and antioxidant activity ($p < 0.05$). Increased eugenol content resulted in more nano-emulsion pickup but less lightness. Higher Aloe vera concentrations significantly ($p < 0.05$) reduced drip loss, cooking loss, pH increase, and oxidation rates in the shrimp samples while increasing hardness. The nano-emulsion coating with 30mL L^{-1}eugenol and 20 g L^{-1} Aloe vera produced the greatest results. Over the course of seven days in cold storage, the nano-emulsion was able to improve shrimp quality.

In a study by Alak et al. (2019), the goal was to look at the impacts of using quinoa as a carrier polymer in the development of edible film, as well as the value of using essential oils (lemon and sage oil) that have high biological activity as a support in this coating material. The edible film that was created for this study was used to wrap the rainbow trout fillets. The first group received 2 % lemon oil + quinoa edible film, the second group received 2 % sage oil + quinoa edible film, the third group received quinoa edible film alone, and the fourth group received control (untreated). Fillets from all groups were kept in the refrigerator (4 0.5°C) for 15 days before being tested for microbiological parameters such as psychotropic, mesophilic, aerobic, lactic acid bacteria, Enterobacteriaceae, and Pseudomonas counts, as well as chemical parameters such as lipid peroxidation [Thiobarbituric Acid Reactive Substrate], total volatile basic nitrogen, and pH. During the storage period, the difference between the control and application groups was found to be significant for all quality measures ($p < .05$). The combination of lemon oil and quinoa worked best in reducing lipid oxidation in rainbow trout fillets. The sage oil + quinoa combination, on the other hand, has shown to have superior antibacterial properties. As a consequence, it was discovered that a coating made by mixing lemon and sage essential oils into quinoa edible film improved the quality and shelf life of rainbow trout fillets.

Licciardello et al. (2018) wanted to explore if edible coatings made of chitosan (Ch) and locust bean gum (LBG) combined with pomegranate peel extract (PPE) might keep shrimp fresh during cold storage. To begin, the researchers tested different PPE doses on Ch and LBG in vitro against *Pseudomonas putida*. The effect of various coatings during storage on *Pseudomonas spp*., total psychotropic bacteria counts, total volatile basic nitrogen (TVB-N), and visual colour as quality indices were evaluated in vivo on headed and peeled shrimps coated with Ch and LBG integrating the most effective PPE level. The results demonstrated that combining PPE and Ch can effectively minimize microbial deterioration during storage: fact, Ch integrating PPE was able to diminish *Pseudomonas spp.* For 6 days, count by around 2 log units and keep the psychotropic microbial load below 7 CFU/g. Furthermore, TVB-N levels in shrimps coated with Ch containing PPE after 6 days were as low as those seen in control samples after 2 days.

Fish fillet (*Oreochromis niloticus*) with alginate-based coating containing ginger and oregano essential oils (EO) were tested for quality and sensory acceptability in another study by Vital et al., (2018). It was also looked at the antioxidant activity of essential oils, coatings, and seafood. In terms of lipid oxidation, the edible coatings were shown to be less effective than the control, with the coating containing oregano EO being the most effective and having the maximum antioxidant activity. Coating resulted in substantially less colour and weight loss. Fish with a covering kept their hardness, but fish without a coating softened. Fish with an edible coating and oregano essential oils were shown to be effective. Better sensory acceptance in terms of odour as measured by consumers. As a result, edible coatings using essential oils as a natural antioxidant increased product quality and acceptance.

Fish are very perishable meals that decay faster than other meat foods due to their high body water content and neutral pH. The impact of a salep gum coating with concentrations of zero, 0.25 percent, and 0.5 percent orange peel essential oil in reducing microbial flora development and chemical deterioration and improving the shelf life of fish fillets in the refrigerator for 16 days was explored in a study of Agdar GhareAghaji et al. (2021). The number of total aerobic mesophilic, psychrophilic, coliforms, and lactic acid bacteria, pH, total volatile base nitrogen, peroxide value, and thiobarbituric acid increased significantly during storage in all treatments, with the exception of those coated with salep containing orange peel essential oil ($p < .01$). According to their research, covering fillets with a salep containing 0.5 % orange peel essential oil can extend fish shelf life to at least 12 days.

Abdeldaiem et al. (2018) aimed to see how gamma irradiation combined with coatings containing 0.5 % rosemary (Rosmarinus officinalis) essential oil (RO) affected the chemical, microbiological, and silver carp (*Hypophthalmichthys molitrix*) fish fillets (SFF) sensory properties during cold storage (4°C). SFF were separated into three groups: uncoated (control), edible coating (no additives), and -irradiated (0, 1, 3, and 5 kGy) covered with a 0.5 % rosemary coating. The samples' shelf life was extended by gamma irradiation at 1, 3, and 5 kGy with coating, which lowered the initial total bacterial count, psychrophilic bacteria, and lactic acid bacteria. Irradiating coated samples with 1 kGy dose decreased the number of *Enterobacteriaceae, Staphylococcus aureus*, and *Bacillus cereus*, as well as *eradicating Vibrio spp*. and *Salmonella spp.* These bacteria were entirely controlled in coated samples irradiated at 3 and 5 kGy. The combined treatment resulted in a slight increase in thiobarbituric acid-reactive substances post irradiation during cold storage, but had no effect on total volatile basic nitrogen or trimethylamine contents, despite the fact that these chemical quality indices gradually increased during cold storage. The sensory qualities of SFF were unaffected by the combined therapy. Both rosemary oil and irradiation generate an increase in the bacterial inhibitory action.

CHAPTER III

Materials and Methods

Materials

Table 1**.**

Materials used in the thesis

Name Of Consumer	Manufacturer Company
*Vannamei S*hrimps	-----
Sunflower Oil	-----
Soybean Oil	-----
Olive Oil	Virgin- Iran
Tween 80	India
2-Trichloroacetic Acid (TCA)/ ≥ 98%	Merk- Germany
Potassium Carbonate (K_2CO_3)	Merk, Sigma-Aldrich (Germany)
Hydrochloric Acid (HCL)/ 37%	Merk- Germany
Perchloric Acid ($HCLO_4$)/ 70%	Merk- Germany
Thiobarbituric Acid (TBA)	Merk- Germany
Sodium Chloride	------

Shrimps

For this research, fresh *Litopenaeus vannamei* shrimps were bought from the local market then put into the icebox and transferred to the Aquatic Processing Private Laboratory of Tehran. Shrimp`s heads were cut and removed in the presence of a sufficient amount of ice, then thoroughly washed with water.

Figure 5

The size of the shrimps purchased and used

Chemicals

Equipments

Vegetable oils-nanoemulsions (oil-in-water) were mixed with water and homogenized by using an ultrasonic homogenizer (T25D, IKA Co., Germany). The pH values of the solutions were determined by a pH meter (Microprocessor pH meter, HANNA Instrument, USA). Calculate the quantities of compounds, in different samples an Ultraviolet-Visible Spectrophotometer has been employed (Perkin Elmer, USA), the colour of a shrimp was observed by metering device Minolta Chroma (CR-300, Japan). To compute a water holding capacity, used a filter paper and a weight of two kilos.

Methods

Preparation and Application of Nanoemulsions

Nanoemulsions include olive oil (virgin - Iran), sunflower oil, or soybean oil, as well as tween 80 and water. 14% olive oil, sunflower oil and soybean oil were first combined with 3% ethanol and 3% surfactant as Tween 80 and held at 85 ° C for one hour. 80 millilitres of distilled water have been put to the newly formed emulsion also stirred at a temperature of around 35 °C. In order to shrink the soluble particles and turn them into nanoparticles, an ultrasonic device was used and the solution was stirred for 15 minutes at a frequency of 20 kHz and power of 400 watts (Figure 6).

The prepared shrimps were divided into the 4 groups. One group served as a control, while the other three were immersed nanoemulsion treatments for five minutes each.

For the application of nanoemulsion on shrimps, they were dipped into nanoemulsion and waited for five minutes, application was repeated then taken out and dried on a tray for five minutes and then repeat this step two more times, then coated shrimps put into the plastic bags and kept in the refrigerator for 12 days (Figure 7).

All samples were analysed on days 0, 3, 6, 9 and 12 for some chemical indicators such as TVB-N, TBA, WHC, pH and colour.

Figure 6

Preparation of oil based nanoemulsions and coating of shrimps

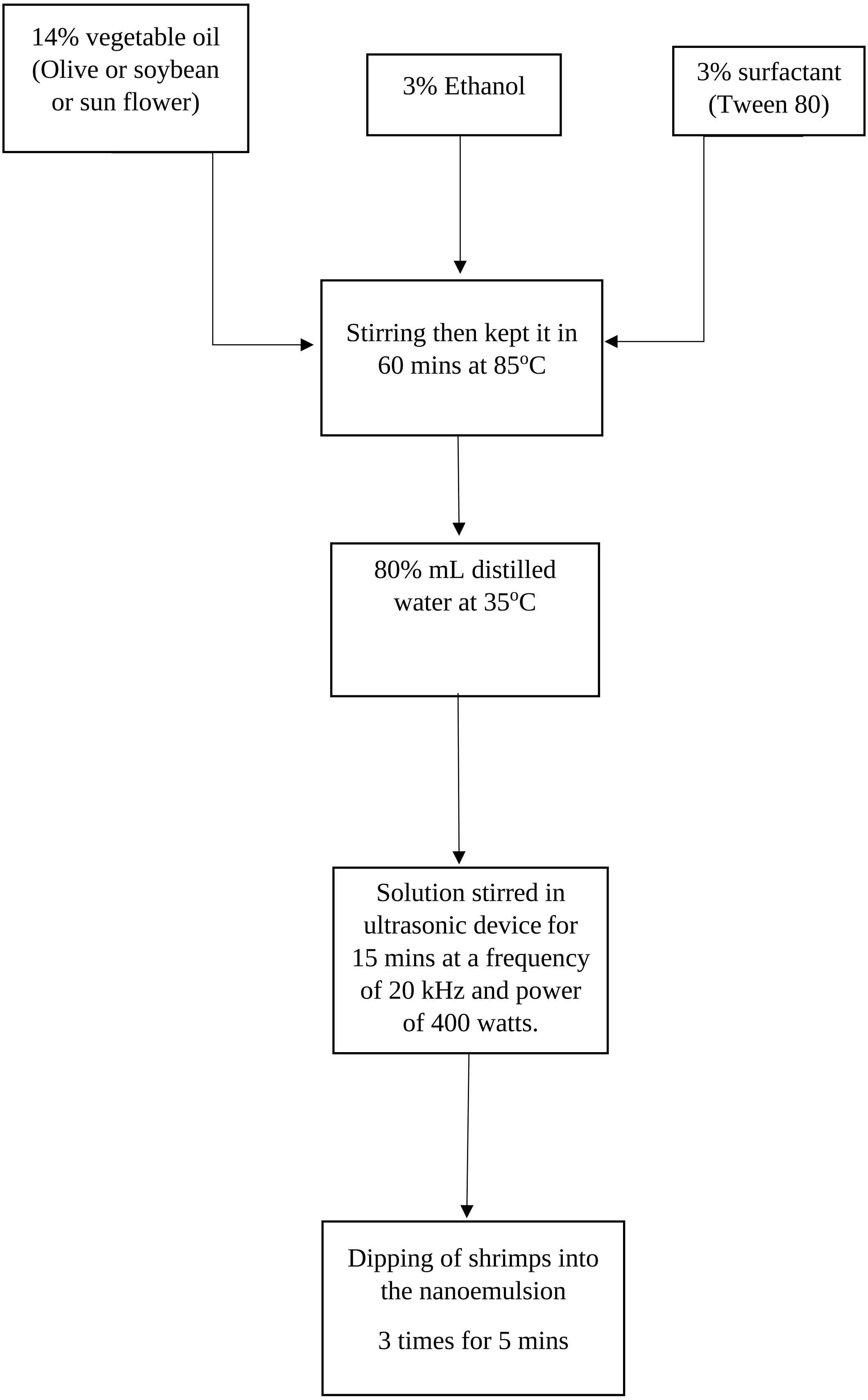


Figure 7

Immersing shrimps in to the nanoemulsion and packaging in the bags for storage

Chemical Analysis

For sample preparation, first, all the necessary laboratory equipment's and surfaces, such as the scalpel, glass plate, and other surfaces were disinfected and then samples were carefully separated in the appropriate amount to minimize contamination, then the other processes outlined in this document were carried out.

pH measurement

The pH was measured using Iran's national standard technique No. 1028. Five grams of shrimp fillet sample from each treatment was combined in such mixture with 50 mL of distilled water. A pH meter (Hanna pH 211 microprocessor) was used to test the pH of the samples.

Total volatile nitrogen bases (TVB-N)

About 2 g of the material was commodified after being combined with 8 ml of a 4percentage TCA mixture well to determine the TVB-N index. The homogenous mixture has been shaken about 4,000 for 30 minutes. After that in an outer layer of the TVB-N test container, 2 ml of the upper solution was separated with 2 ml of supersaturated potassium carbonate solution, and 2 ml of 1 % with a few drops of reagent (mixture of methyl red and bromocresol) in the inner layer. It was poured, and the container containing the sample was put on a shaker (at room temperature) for 3 hours after closing the lid. After that, its interior from this same remedy was titrated through 0.01 N HCl. That titration procedure was ended when the solution's colour changed from green to pink.

Then, using the formula below, the quantity of volatile nitrogen compounds in the sample was calculated:

$$\text{TVB-N (mgN/ 100 g sample)} = \{14 (N)(A-B)(V)(100)\}/ M \qquad (1)$$

-N is the normality of hydrochloric acid used for titration of examples,

- The amounts of acid (in ml) utilized for test neutralization are A & B,

- V, amount (ml) in stage, an amount (ml) the acids for titrating process indicators,

-M represent the initial weight of the liquid sample (g),

After centrifugation the result was expressed as milligrams of nitrogen per 100 grams of shrimp meat.

Thiobarbituric Acid Reactive Substances (TBARS)

Lipid measurement test: A thiobarbituric acid reactant produced from lipid peroxidation was prepared using the solution preparation method.

The first 2 grams of material were homogenized 4% perchloric acids in 8 millilitres to determine the thiobarbituric acid index. Then homogeneous samples have been put inside a darkness cabin approximately 30 mins. Following this, the particles examined to take out of the cabin and filtered using a centrifuge. After that, the test tubes were filled with 5 ml of the cleaned solution and 5 ml of the 0.02% thiobarbituric acid reagent and placed in a 30-minute water bath at 95 °C. Afterwards cooling this same pipes with no external heat source, the amount of solution adsorbed from each sample was determined by the UV-2100 spectrophotometer (Unico, USA) at 530 nm beside the complete solution (5 ml of purified H2O and 5 ml of TBA solution) and the amount of TBARS (Thiobarbituric acid reactive substances) in terms of milligrams of malondialdehyde each kilogram of shrimp was reported.

Water Holding Capacity

Starting these samples, a 2 g piece was selected. This piece was sandwiched between two sheets of paper. The sample's weight was added to the weight of the paper, and the sample was then pressed for 5 minutes with a 2 kg weight. The following formulas were used to compute the water holding capacity:

WHC = 1- The amount of water leaked / Sample initial moisture ×100 (2)

Measurement of water leaked = initial dry weight of filter paper - Secondary weight of filter paper
Sample initial moisture = Wet meat weight - Dry meat weight ×100

Colour

A Minolta chromameter was used to determine the colour of the shrimp and the sample colour was measured triplicate. Before using the instrument, it was calibrated with a white screen. Then about 5 grams of shrimp were transferred to a matte cylindrical container and finally measured by L * (lightness), a * (redness to greenness) and b * (yellowness to blueness) values.

Statistical analysis of the results

The experiment stayed carried out in a completely random manner. The data was statistically analysed using just an examination of variation with the Duncan testing. The investigation was performed in triplicate and the statistical significance at 5% level. IBM® SPSS® software version 23 was used to analyse the data ($P < 0.05$) and draw graphs using Excel software version 2013.

CHAPTER IV

Results and Discussion

Chemical test results

pH Evaluation

Its build-up of acidic chemicals like ammonia as well as ammonia particles, which are mostly caused by microbial activity, is indicated by a rise in pH value. On the whole, these treatment shrimps' pH levels were lower than those of the control group on most days of the storage. This downward tendency might have been caused by antimicrobials (Sharifian et al., 2019).

When looking at the data (table 2 and Figure 8), it can be observed that as time progressed from day 0 to day 12, the pH increased as predicted, but as time progressed and we moved from the control treatment to the olive oil treatment, the quantity of this factor reduced. As least proportion with this increase been noted inside this therapy covered with nanoemulsion of sunflower oil, which indicates the antioxidant and antimicrobial ability of these compounds, which has maintained the quality and freshness of shrimp over time.

Table 2

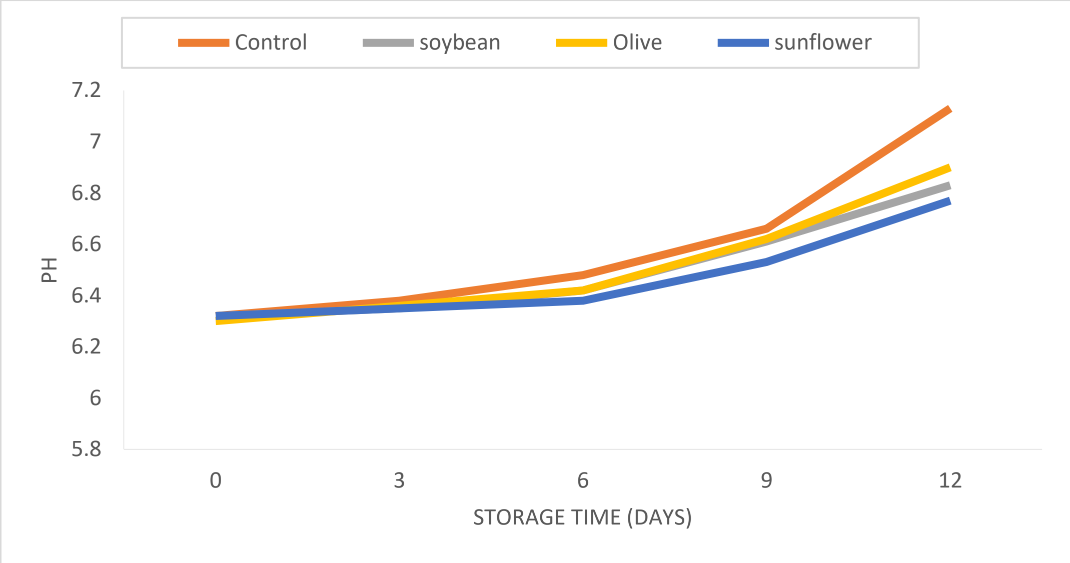
The rate of pH changes of various treatments over a 12-day period

Experimental Treatments				
Storage Time (Day)	Control shrimps	Sunflower oil-NE	Soybean oil- NE	Olive oil- NE
0	6.32±0.00[a]	6.32±0.01[a]	6.32± 0.00[a]	6.30± 0.04[a]
3	6.38± 0.00[c]	6.35± 0.00[a]	6.35± 0.00[a]	6.36± 0.00[b]
6	6.48± 0.01[c]	6.38± 0.00[a]	6.41± 0.01[ab]	6.48± 0.02[b]
9	6.66± 0.01[b]	6.53± 0.01[a]	6.61± 0.05[ab]	6.62± 0.05[b]
12	7.13± 0.01[d]	6.77± 0.03[a]	6.83± 0.02[b]	6.90± 0.00[d]

* *Different uppercase every line of words indicates quantitatively important distinction between the groups (Duncan test at 5% level).*

Figure 8

pH changes of various treatments



The results obtained from the number of changes in pH factor in different treatments during a period of 12 days indicate a significant difference between all treatments compared to the control treatment. So that the highest amount of this factor was observed in all measurement periods related to the control treatment and the lowest amount was observed in the treatment of coating with sunflower oil nanoemulsion.

TVB-N Differences

Nitrogenous compounds in proteins as well as non-proteins decompose due to its resolution by microbes and enzymes that form volatile ammonia and alkaline nitrogenous compounds such as dimethylamine and trimethylamine is one of the most important indications of freshness. The major cause for this is that during storage, bacteria and natural enzymes break down shrimp heads both nitrate as well as proteins compounds like Alkaloids as well as nitrates, leading in a rise in TVB-N content and pH.

Low temperature reduces this same function of internal enzymatic, inhibits microbiological development, slows increasing TVB-N concentration and acidity, as well as lowering their ability of nonprotein nitrogenous compounds to decarboxylate as well as dehydrate, all of which reduces the degree of protein breakdown (Liu et al., 2021). Enzymes and bacteria breakdown carbohydrates, proteins, and lipids, resulting in the creation of volatile nitrogenous chemicals. The degree of protein degradation developed as a result on spoilage bacteria and the activity of endogenous enzymes is measured by (TVB-N) value. TVB-N values of 35 mgN/100g in shrimp muscle may cause an unpleasant taste and odor according to many national and international standarts. According to the results obtained from the analysis of nitrogen volatile (Table 3 and Figure 9) bases of different treatments, the lowest and highest levels of this factor were in the treatment coated with sunflower oil nanoemulsion (13/23, 16/93, 23/06, 27/31, 33/23), and there was a control treatment (13/25, 19/85, 28/16, 36/04, 44/16). In contrast side, this notable distinction observed the differences in TVB-N in all oil-treated treatments compared to the control treatment. As in the previous study, in each time period from the control treatment to the treatment coated with olive oil, the total volatile bases decreased (the lowest amount related to the treatment coated with sunflower oil nanoemulsion) and increased over time in all treatments. The main reason that the amount of this factor in the control treatment has increased faster than other treatments is the antimicrobial properties of soybean oil, sunflower oil, and olive oil, which inhibit the growth of bacteria.

Senapati & Sahu (2020) have also found similar results in a study which the samples' initial TVB-N value was found to be 10–14 mg/100 g. The tests' TVB-N grew significantly ($p < 0.05$) with storage time, and the rate acceleration increased as the temperature increased.

Table 3.

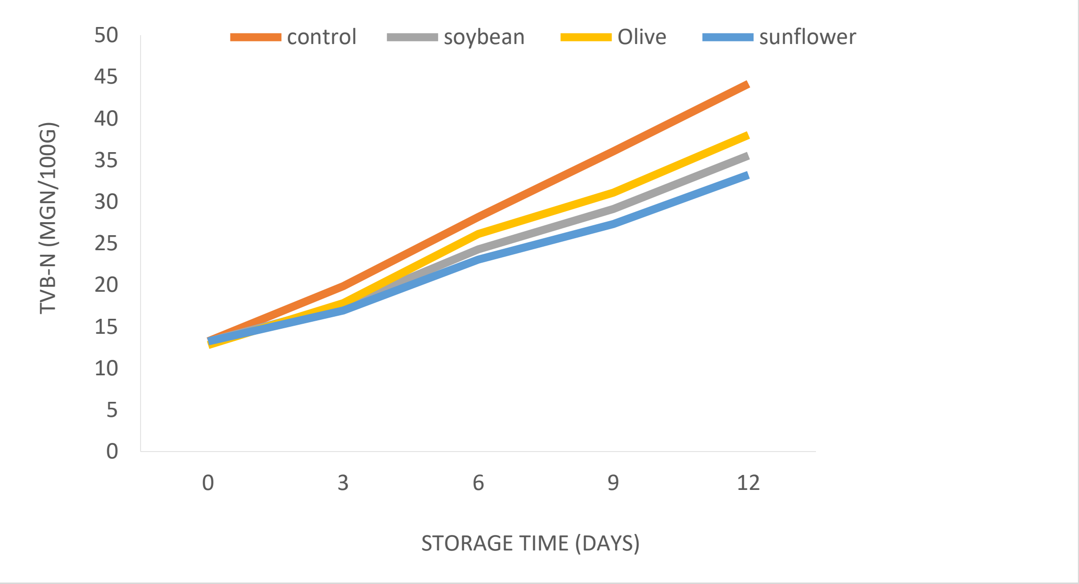
Results of changes in TVB-N (mgN/100g) in different experimental treatments

Experimental Treatments				
Storage Time (Day)	Control shrimps	Sunflower oil-NE	Soybean oil-NE	Olive oil-NE
0	13.25±0.00[a]	13.23±0.02[a]	13.22±0.01[a]	12.79±0.53[a]
3	19.85± 1.13[b]	16.93± 0.25[a]	17.50± 0.02[a]	17.81± 0.06[a]
6	28.16± 0.75[d]	23.06± 0.49[a]	24.28± 0.00[b]	26.13± 0.22[c]
9	36.04± 0.24[d]	27.31± 0.18[a]	29.13± 0.11[b]	31.08± 0.17[c]
12	44.16± 0.02[d]	33.23± 0.30[a]	35.54± 0.52[b]	38.02± 0.32[c]

* *Different uppercase every line of words indicates quantitatively important distinction between the groups (Duncan test at 5% level).*

Figure 9

Changes in TVB-N (mgN/100g) in different experimental treatments



TBARS changes

The worse events that affect its standard for seafood as well as shrimp foods is lipid oxidation. Oxidizing as well as the enzyme process involving peroxidase, lipoxygenase, and organismal proteins can start it. Free radical chain mechanisms promote lipid oxidation, which is a complicated process. The TBARS value represents the proportion of metabolites of terminal peroxidation in shrimp. Permissible limit is determined as 0.4 (G MAD/KG). Phospholipase and lipase are produced by psychotropic bacteria, primarily *Pseudomonas* species, resulting in an increase in free fatty acids. The oxidation of free fatty acids results in the formation of an unstable lipid hydroperoxide. TBARS can be evaluated using the end products (Zouelm et al., 2019).

According to the results of the thiobarbituric acid assay shown in Table 4 and Figure 10, there was a significant difference between all treatments compared to the control treatment, but according to the numerical results, the most suitable treatment was the sunflower oil nanoemulsion coated treatment. On the other hand, the lowest amount of this factor in different time periods can be observed in the sunflower oil nanoemulsion treatment, and the highest amount can be observed in the control treatment, meaning that with increasing shrimp storage time, the amount of this factor has increased in all treatments.

Table 4.

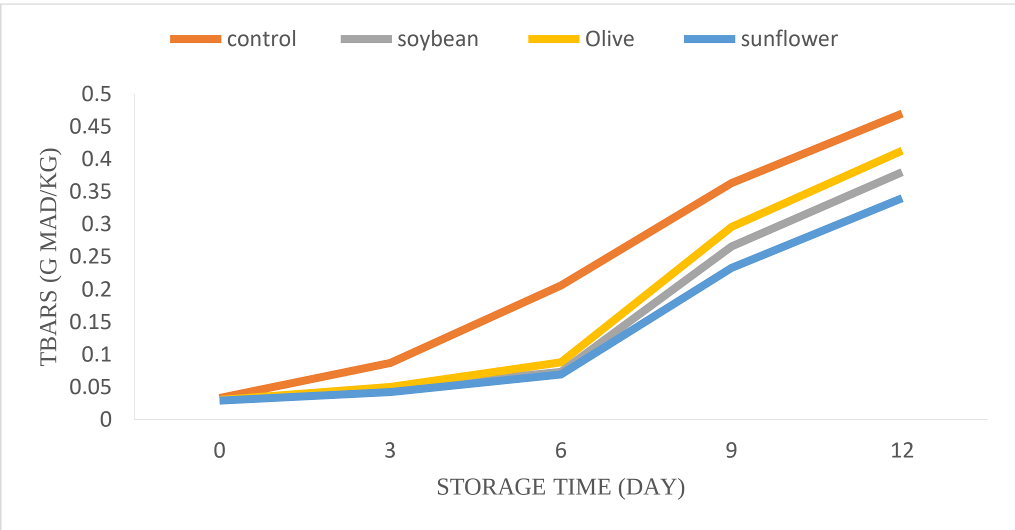
Results of TBARS (G MAD/KG) changes in different experimental treatments

	Experimental Treatments			
Storage Time (Day)	Control shrimps	Sunflower oil-NE	Soybean oil-NE	Olive oil-NE
0	0.033± 0.00[ab]	0.029±0.00[a]	0.030± 0.00[ab]	0.033± 0.00[b]
3	0.087± 0.00[d]	0.042± 0.00[a]	0.047± 0.00[b]	0.050± 0.00[c]
6	0.206± 0.02[b]	0.069± 0.00[a]	0.073± 0.00[a]	0.088± 0.00[a]
9	0.363± 0.02[d]	0.233± 0.01[a]	0.266± 0.01[b]	0.296± 0.00[c]
12	0.470± 0.03[c]	0.340± 0.02[a]	0.380± 0.01[ab]	0.413± 0.01[b]

* *Different uppercase every line of words indicates quantitatively important distinction between the groups (Duncan test at 5% level).*

Figure 10

TBARS changes in different experimental treatments



Water Holding Capacity (WHC)

Water accounts for approximately 75percent of total of overall body mass so has a significant effect on meat quality products. Juiciness, sensitivity, stiffness, and appearance are all closely associated with muscular liquid (myowater). The water-holding capacity (WHC), or ability to retain moisture, has an impact on the value of new meats by influencing their appearance and digestibility. Several studies have shown that the WHC is significantly linked to protein degradation, Muscular polypeptides, for instance, play key roles in matrix and myowater connections (Qian et al., 2020).

Biology, pre-slaughter animal rescue, animal nutrition, ultrasound, and tissue cooling can all impact its water-holding capacity (WHC) of meats. Meat's capacity to retain its intrinsic water under applied load and/or preparation (i.e., grinding, cutting, pressing, thermal processing, packing, curing, etc.) is known as water-holding capacity (WHC). This amount of water a livestock can hold while slicing, steaming, processing, press, packing, storing, and frying is referred to as its water-holding capacity. Dripping, refresh, weeping, effusion, or boil waste are all names for liquid evacuated, and all of them are indirectly correlated to WHC. This amount of water produced from a cooked beef item, that is deeply linked to WHC, is defined as cooked production (Szmańko et al., 2021).

Based on the results, it was found that the amount of water holding capacity in all treatments was associated with an increase, so that the lowest amount of this parameter in all days of the experiment was in the treatment covered with sunflower nanoemulsion, and the highest amount was related to the control treatment.

According to the results of a delicate study of water retention in different treatments of the experiment, it was found that on the third and fifth days of the assessment, there is a significant difference between treatments covered with oil compared to the control treatment. Over time, as a result of bacterial activity, the amount of interstitial water increases, and as a result of centrifugation, more water is removed from the sample, resulting in a more significant weight loss than the initial weight. As a result, water holding capacity will be reduced during the test period.

Table 5.

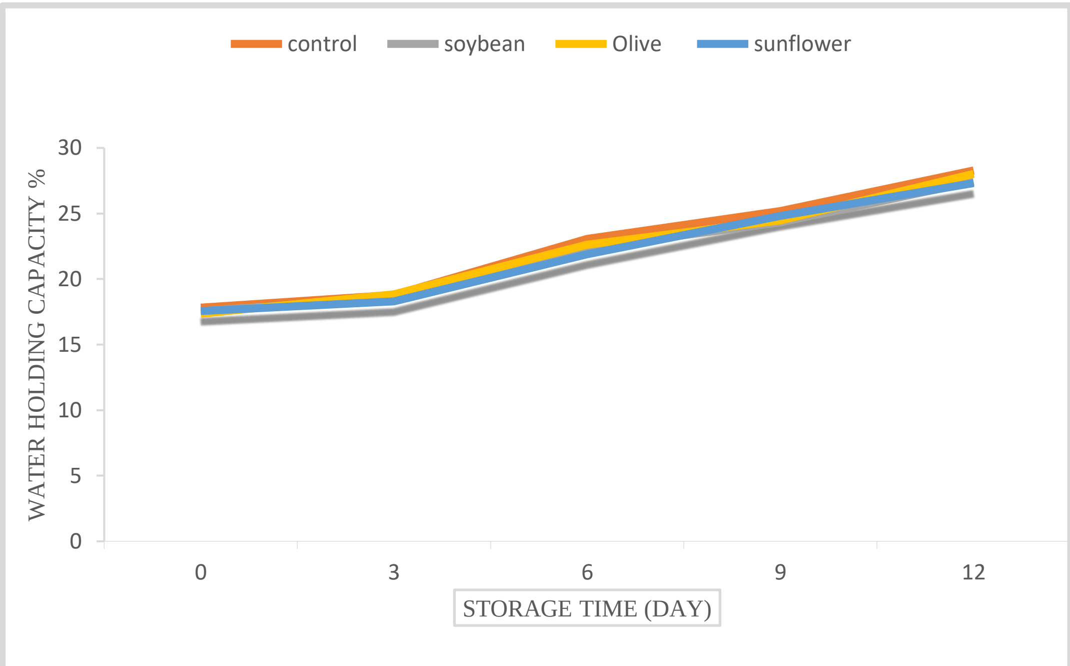
Results of Water holding capacity % in different treatments

	Experimental Treatments			
Storage Time (Day)	Control shrimps	Sunflower oil-NE	Soybean oil-NE	Olive oil-NE
0	17.82±0.51[a]	17.56±1.47[a]	17.56± 0.36[a]	17.36± 0.36[a]
3	18.79±0.21[a]	18.30± 0.23[a]	18.54± 0.01[a]	18.84± 0.47[a]
6	23.06±0.38[c]	21.89± 0.44[a]	22.35± 0.02[b]	22.61± 0.17[bc]
9	25.18±0.17[a]	24.82± 1.16[a]	24.34± 0.06[a]	24.49± 0.34[a]
12	28.28±0.14[c]	27.32± 0.02[a]	27.43±0.06[a]	28.02± 0.08[b]

* *Different uppercase letters in each row indicate a statistically significant difference between the groups (Duncan test at 5% level).*

Figure 11

Water holding capacity in different treatments



Colour Measurements

Lightness (L)

According to the results obtained from the study of the brightness factor in different treatments (Table 6 and Figure 12), it was found that, the brightness of all treatments decreased over time. The highest lightness in each time during the storage period was related to the sunflower treatment, besides the least significant being linked to a standard therapy. that was a witness. On the other hand, only during the experiment's first day. None of the differences were conclusive between the different treatments compared to the control treatment.

Table 6.

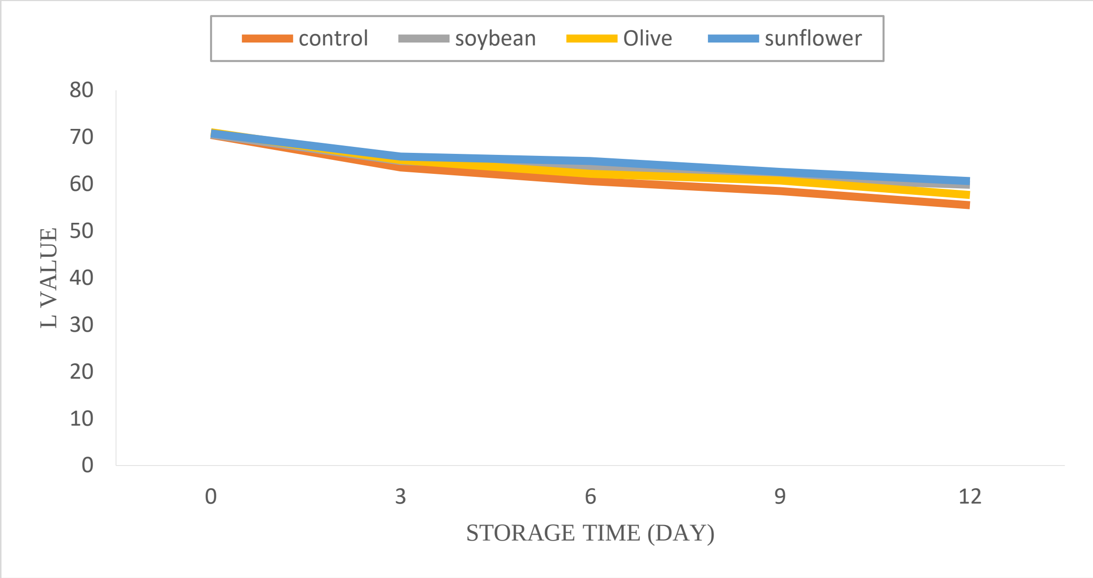
Results of Lightness (L) Measurements in different treatments

	Lightness (L)			
Storage Time (Day)	Control shrimps	Sunflower oil-NE	Soybean oil-NE	Olive oil-NE
0	70.49± 0.50[a]	70.82±0.38[a]	70.58± 0.09[a]	71.06± 0.40[a]
3	63.57± 0.81[a]	65.89± 0.38[b]	64.92± 0.94[b]	65.14± 0.32[b]
6	60.63± 0.33[a]	64.90± 0.16[d]	63.60± 0.51[c]	62.22± 0.24[b]
9	58.49± 0.45[a]	62.63± 0.50[c]	61.23± 0.02[a]	60.75± 0.24[b]
12	55.50± 0.45[a]	60.65± 0.17[d]	59.86± 0.27[c]	57.69± 0.28[b]

* *Different uppercase every line of words indicates quantitatively important distinction between the groups (Duncan test at 5% level).*

Figure 12

Lightness (L) Measurements in different treatments



Examination of the light index, it was observed that the type of nanoemulsion has been one of the factors affecting this property of shrimp during storage. Although there is no significant difference in the lightness of different treatments at the beginning of the test, the lightness of the samples is gradually reduced, and this decrease occurs more severely in uncoated shrimp, until finally the light intensity on day 12 was significantly lower. The control sample was smaller than the samples with nanoemulsion coated. In this regard, several reasons can be mentioned.

1. The surface of shrimp, which reduces the intensity of light by creating a viscous layer.
2. Oxidation of surface pigments occurs faster in uncoated samples.
3. Black spots that do not occur due to the ability to trap oxygen in the samples with the coating and prevent oxygen contact with the finding will have a lighter colour.

Redness Factor (a)

The results related to the redness parameter of different treatments (Table 7 and Figure 13) showed that the amount of redness decreased over time so that the highest and lowest values of this parameter were presented in the sunflower oil-NE and control nanoemulsion treatment on each test day respectively. On the other hand, only on days four and day five of the experiments, there was a statistically significant difference between all three treatments compared to the control.

Table 7.

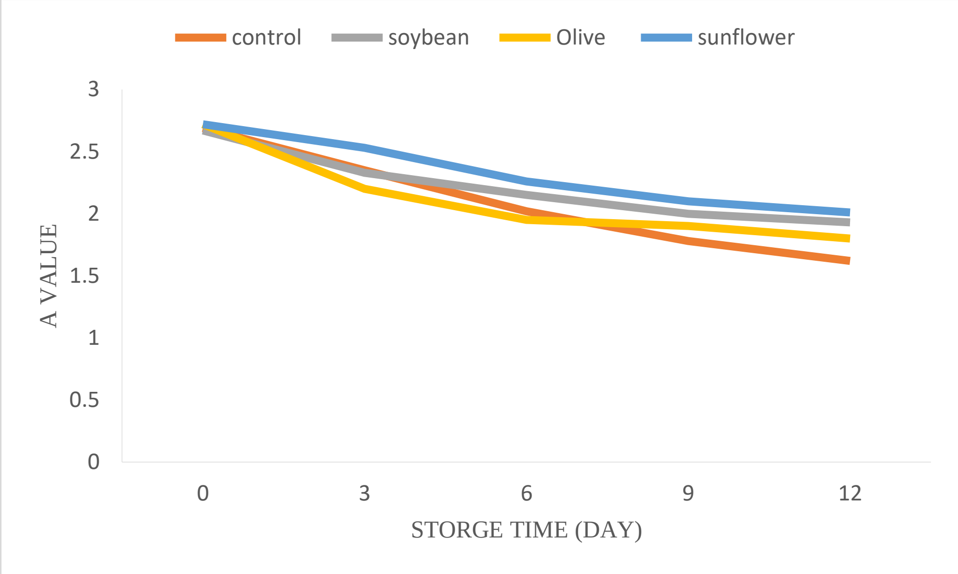
Results of Redness factor (a) Measurements in different treatments

	Redness (a)			
Sampling Time (Day)	Control shrimps	Sunflower oil-NE	Soybean oil-NE	Olive oil-NE
0	2.69± 0.14[a]	2.72±0.15[a]	2.67± 0.24[a]	2.72± 0.14[a]
3	2.35± 0.24[a]	2.53± 0.35[a]	2.33± 0.19[a]	2.20± 0.11[a]
6	2.02± 0.15[a]	2.26± 0.25[a]	2.15± 0.45[a]	1.95± 0.08[a]
9	1.78± 0.09[a]	2.10± 0.01[d]	2.00± 0.02[c]	1.90± 0.01[b]
12	1.62± 0.02[a]	2.01± 0.03[c]	1.93± 0.20[bc]	1.80± 0.02[ab]

* *Different uppercase every line of words indicates quantitatively important distinction between the groups (Duncan test at 5% level).*

Figure 13

Redness factor (a) Measurements in different treatments



Yellowness Factor (b)

The results of the yellowness parameter of different treatments (Table 8 and Figure 14) showed that over time, the amount of this parameter in all treatments was increasing, so that the highest and lowest amount of this parameter were in the control treatment and sunflower nanoemulsion respectively. Also, the experiment's third and fourth days, none of the differences were conclusive was observed around different treatments compared to the control treatment, but on the fifth day, only the second treatment (sunflower nanoemulsion) had a statistically significant difference compared to the control treatment.

Table 8.

Results of yellowness factor (b) Measurements in different treatments

	Yellowness (b)			
Sampling Time (Day)	Control shrimps	Sunflower oil-NE	Soybean oil-NE	Olive oil-NE
0	1.80± 0.08[a]	1.79±0.03[a]	1.77± 0.19[a]	1.80± 0.15[a]
3	2.30± 0.29[a]	1.93± 0.25[a]	2.00± 0.06[a]	2.10± 0.15[a]
6	2.70± 0.05[b]	2.13± 0.07[a]	2.30± 0.35[a]	1.95± 0.08[a]
9	2.90± 0.05[b]	2.26± 0.16[a]	2.50± 0.35[ab]	1.90± 0.01[b]
12	3.20± 0.15[b]	2.60± 0.27[a]	2.92± 0.02[c]	2.98± 0.12[b]

* *Different uppercase every line of words indicates quantitatively important distinction between the groups (Duncan test at 5% level).*

Figure 14

Yellowness factor (b) Measurements in different treatments

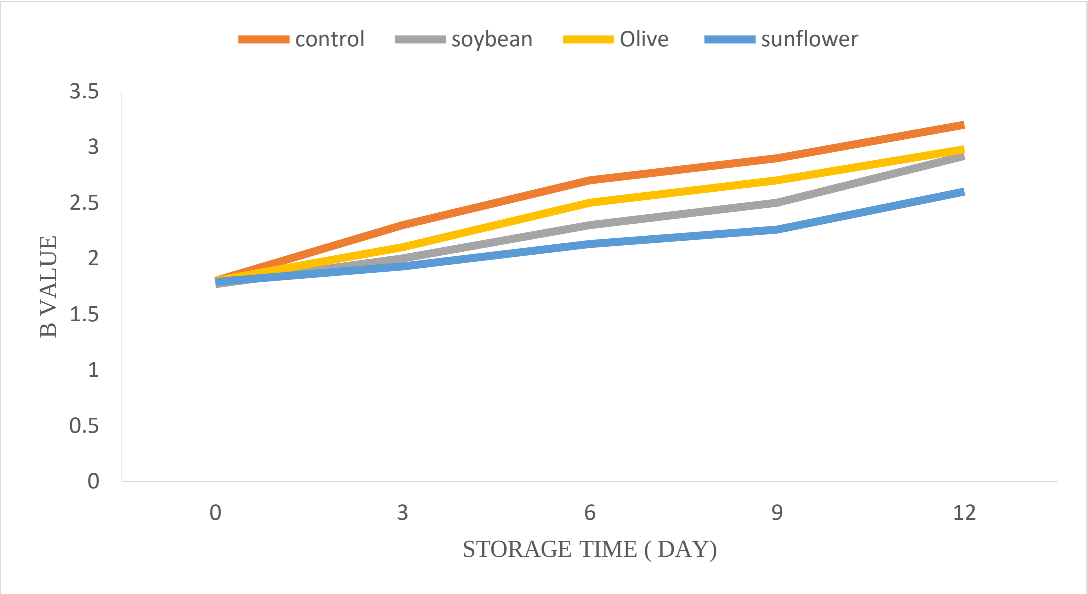


Table 9.

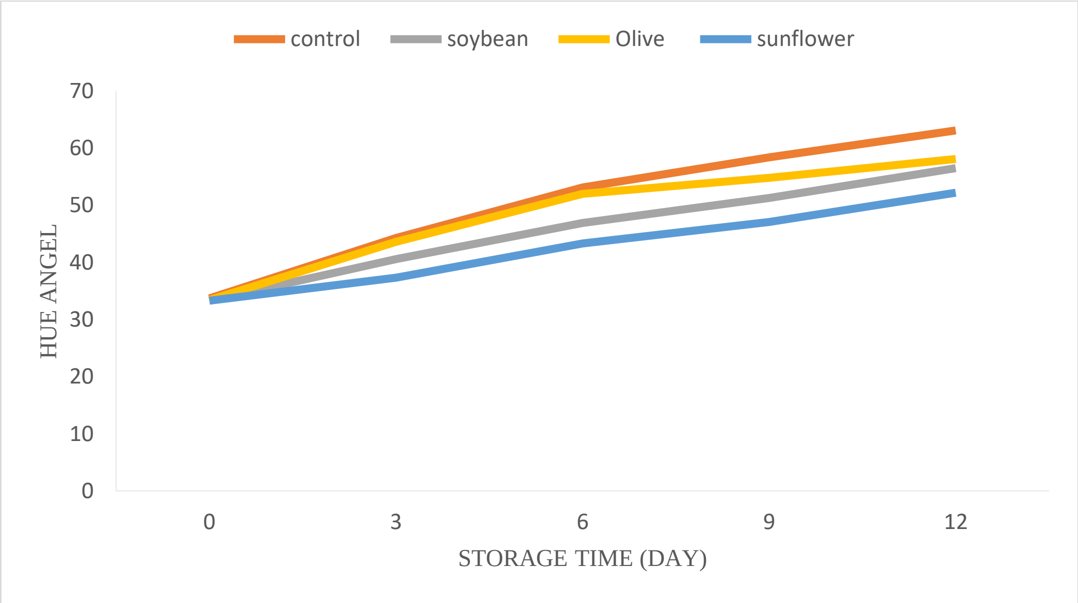
Results of Hue angle changes Measurements in different treatments

Hue Angel				
Sampling Time (Day)	Control shrimps	Sunflower oil-NE	Soybean oil-NE	Olive oil-NE
0	33.78± 0.12[a]	33.34±0.03[a]	33.54± 0.14[a]	33.49± 0.23[a]
3	44.38± 0.11[a]	37.33± 0.19[a]	40.64± 0.10[a]	43.66± 0.23[a]
6	53.19± 0.07[b]	43.30±0.18[a]	46.93±0.21[b]	52.04± 0.17[ab]
9	58.45± 0.17[b]	47.10± 0.16[a]	51.34± 0.13[b]	54.86± 0.31[ab]
12	63.14± 0.05[bc]	52.29± 0.03[a]	56.53± 0.09[b]	58.17± 0.10[c]

* *Different uppercase every line of words indicates quantitatively important distinction between the groups (Duncan test at 5% level).*

Figure 15

Hue angle changes Measurements in different treatments



The hue angle is an indicator of the colour of the food, with an angle of zero or 360 degrees representing red, and angles of 180 green, 90 blue, and 270 degrees representing yellow. In other words, the hue angle indicates the predominant colour of the material. The closer this angle is to zero, the more the sample is red.

CHAPTER V
Conclusion and Recommendation

Conclusion

Shrimps are rich in omega-3 fatty acids, natural resources such as vitamins, protein, and other nutrients and antioxidants such astaxanthin. Hydration diffusion, melanosis, frozen damage, denaturation of proteins, and lipid and protein oxidation are just a few of the quality changes that shrimp muscle experiences throughout preparation, transportation, and frozen storage. Major effects of these changes in muscle products include discoloration, rancidity, off-flavour, texture deterioration, and drip loss. Because of their free unsaturated compositions of texture, lipids in shrimp muscle are subject to degradation while storage and processing inside the presence of various promoters.

The results of chemical and colour measurement confirmed that shrimps covered with sunflower oil nanoemulsion compared to other treatments and control performed better quality. The values of pH, TBA (thiobarbituric acid), and TVB-N (volatile nitrogen bases) as chemical indicators of quality of shrimp treated with sunflower oil nanoemulsion were lower than other treatments. This nanoemulsion used for covering of shrimps, not only extending the shelf-life but also nanoemulsion stability is high, they are not harmful for humans, cost effective and environment friendly type. In general, in all chemical and colorimetric parameters, some of the deterioration indicators increases and becomes undesirable with increasing storage time.

Due to the importance of natural antioxidants in human health, their anti-cancer properties and due to the effects of these substances in reducing oxidation and subsequently reducing spoilage and improving the quality of stored products, their use in preserving aquatic products, is especially fresh and frozen products are suggested, and more research is needed in this area.

Recommendation

1. The use of other oil-based nanoemulsions to maintain quality and extent the shelf life of other high-consumption shrimp species
2. Use of these nanoemulsions in edible films
3. Investigate the release rate of active compounds over time from the coating

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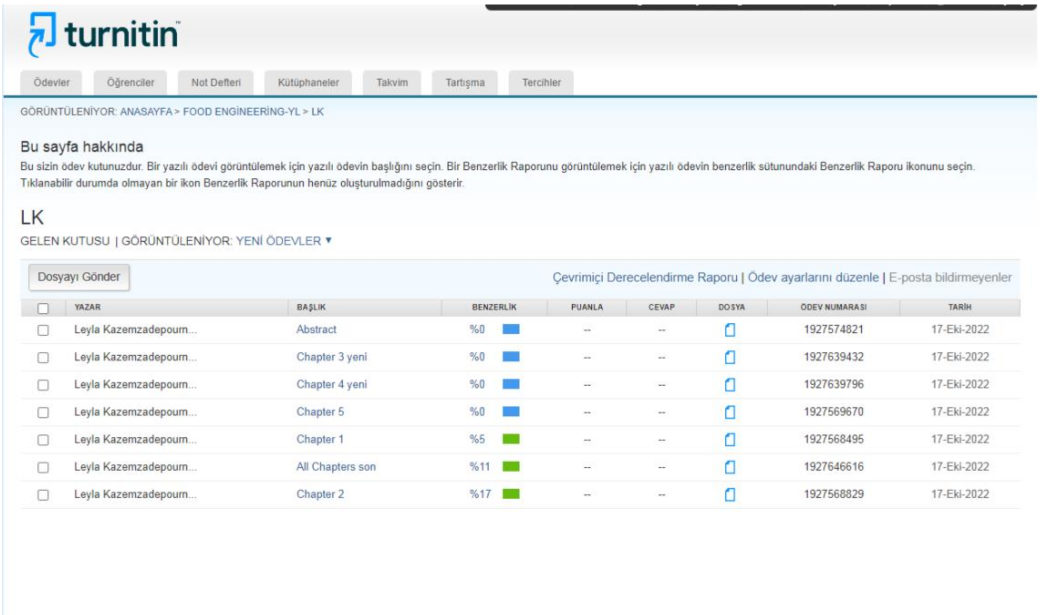
APPENDICE

Appendix A: Thesis Plagiarism Index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Ödevler | Öğrenciler | Not Defteri | Kütüphaneler | Takvim | Tartışma | Tercihler

GÖRÜNTÜLENİYOR: ANASAYFA > FOOD ENGİNEERİNG-YL > LK

Bu sayfa hakkında

Bu sizin ödev kutunuzdur. Bir yazılı ödevi görüntülemek için yazılı ödevin başlığını seçin. Bir Benzerlik Raporunu görüntülemek için yazılı ödevin benzerlik sütunundaki Benzerlik Raporu ikonunu seçin. Tıklanabilir durumda olmayan bir ikon Benzerlik Raporunun henüz oluşturulmadığını gösterir.

LK

GELEN KUTUSU | GÖRÜNTÜLENİYOR: YENİ ÖDEVLER ▾

Dosyayı Gönder

Çevrimiçi Derecelendirme Raporu | Ödev ayarlarını düzenle | E-posta bildirmeyenler

YAZAR	BAŞLIK	BENZERLİK	PUANLA	CEVAP	DOSYA	ÖDEV NUMARASI	TARİH
Leyla Kazemzadepourn...	Abstract	%0	--	--		1927574821	17-Eki-2022
Leyla Kazemzadepourn...	Chapter 3 yeni	%0	--	--		1927639432	17-Eki-2022
Leyla Kazemzadepourn...	Chapter 4 yeni	%0	--	--		1927639796	17-Eki-2022
Leyla Kazemzadepourn...	Chapter 5	%0	--	--		1927569670	17-Eki-2022
Leyla Kazemzadepourn...	Chapter 1	%5	--	--		1927568495	17-Eki-2022
Leyla Kazemzadepourn...	All Chapters son	%11	--	--		1927646616	17-Eki-2022
Leyla Kazemzadepourn...	Chapter 2	%17	--	--		1927568829	17-Eki-2022

Leyla kazemzadehPornaki | **Assist.Dr. Perihan Adun**

………. | …………

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