

Effects of Bacteriocin Applications For *Clostridium botulinum* and *Listeria monocytogenes* in Seafood Products

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ABSTRACT

Food related diseases are on the rise and the safety of food is still an increasingly important public health issue in worldwide. Seafoods are particularly suitable for both microbiological spoilage and biochemical deterioration so it is essential to develop proper strategies to protect these products' safety, maintain the higher quality and also extend their shelf life. There are number of techniques for protecting the seafoods safety but especially biopreservation is pointed out to maintain the higher quality and minimum effects on nutritional values, extending shelf life and stabilizing the organoleptic properties. With the increasing antibiotic resistance problem and awareness of the risks of chemical preservatives for public health, bacteriocins have attracted a considerable attention. Due to their naturally produced structure, bacteriocins are much more admissible by consumers. The inhibition of the foodborne pathogens by bacteriocins has been studied by several researchers. Eventually, nisin and sakacin P are the most studied bacteriocins, but the other bacteriocins like curvaticin, carnocin, bavaricin, and divergicin also studied for potential applications in seafood products. In this review, it is aimed that to summarize the bacteriocin applications as an antimicrobial agent in seafood products.

Key Words: Bacteriocin, Biopreservation, Foodborne Infections, Nisin, Seafood.

Deniz Ürünlerinde Bakteriyosin Uygulamalarının *Clostridium botulinum* ve *Listeria monocytogenes* Üzerine Etkileri

ÖZ

Günümüzde, gıda kaynaklı hastalıklar artış göstermekte ve güvenilir gıdanın önemi gittikçe daha önemli hale gelen bir halk sağlığı problemi haline gelmektedir. Diğer yandan, deniz ürünleri hem mikrobiyolojik ve hem biyokimyasal bozulma ajanlarına karşı oldukça duyarlı ürünler olmaları nedeniyle deniz ürünlerinin güvenliği ve kalitesini sağlamak, aynı zamanda raf ömrünü uzatmak amacıyla etkin muhafaza teknolojilerinin geliştirilmesi önemlidir. Deniz ürünlerinde kullanılacak alternatif gıda muhafaza yöntemlerini arasında, raf ömrünün uzatılması ve hijyenik kalitenin sağlayan, besinsel ve organoleptik açıdan ürünü en az etkileyen biyolojik muhafaza yöntemleri özellikle ilgi çekmektedir. Antibiyotik dirençliliği endişelerinin yanı sıra, tüketicilerin kimyasal koruyuculardan kaynaklanabilecek potansiyel sağlık risklerine olan duyarlılığı dolayısıyla bakteriyosinlere olan ilgi artış göstermiştir. Bakteriyosinler doğal olarak üretildikleri için tüketiciler tarafından daha kolay kabul edilmektedir. Bakteriyosinlerin gıda kaynaklı patojenleri inhibe edici etkisi birçok araştırmacı tarafından çalışılmaktadır. Sonuç olarak, nisin ve sakacin P üzerinde en fazla çalışılan bakteriyosinler olmakla birlikte, curvaticin, carnocin, bavaricin ve divergicin bakteriyosinlerinin de deniz ürünlerinde potansiyel uygulamaları üzerinde çalışılmaktadır. Bu derlemede, bakteriyosinlerin antimikrobiyal ajan olarak deniz ürünleri üzerine uygulamalarının özetlenmesi amaçlanmıştır.

Anahtar Kelimeler: Bakteriyosin, Biyokoruma, Gıda Kaynaklı Enfeksiyonlar, Nisin, Deniz Ürünleri.

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INTRODUCTION

The growing interest for advanced product quality and longer shelf life of seafoods and products has led the consumers consume safer and higher qualified foods (Cortesi et al. 2009). In this review, it is aimed that to summarize the bacteriocin applications as an antimicrobial agent in seafood products. Despite of the new techniques and safety assessments, there are wide range of preservation techniques are available but the number of foodborne illnesses are on the rise and the safety of food is still an increasingly crucial public health concern. It is declared by Centers for Disease Control and Prevention (CDC) that each year about 48 million people get ill, 128,000 of them are hospitalized, and approximately 3,000 of them lose their lives as result of the foodborne diseases in the United States (Anonymous 2016, Karthik et al. 2013). On the other hand, due to the various nutrient composition of seafood and their products, they are particularly suitable for both microbiological spoilage and biochemical deterioration so it is essential to develop proper strategies to protect these products' safety, maintain the higher quality and also extend their shelf life (Cakli and Kislak 2003, Jamuna et al. 2005, Ghanbari and Jami 2013). The processes, using for the control of foodborne bacteria, are generally not adequate for eliminating these bacteria that can survive during traditionally processing such as salting, canning or smoking of the seafoods and products (Ghanbari and Jami 2013). Since seafood products are consumed without heat treatment or they are minimally heat-treated, it is very significant to improve suitable preservation techniques to provide their safety, quality and also improve their shelf life (Soomro et al. 2002, Cortesi et al. 2009). Biological preservation means a food safety development by means of using a natural microflora or antimicrobial metabolites. With the increasing antibiotic resistance problem and awareness of the risks of chemical preservatives for public health, bacteriocins have attracted a considerable attention. Due to their naturally produced structure, bacteriocins are much more admissible by consumers (Galvez et al. 2010, Ghanbari and Jami 2013). Polypeptide structured bacteriocins are synthesized ribosomally by bacteria and they are assimilated by the digestion system to human body and they have bacteriocidal activity. Since food-related diseases are on the rise and the safety of food is still an increasingly important public health concern, using of bacteriocins, inhibit foodborne pathogens without any adverse effects, has aroused great interest. Only nisin is approved for using as a food preservation agent by Food and Agriculture Organization (FAO), but also there are plenty of bacteriocins generated by lactic acid bacteria have possible applications in foods (Cleveland et al. 2001, Chen and Hoover 2003, Delves-Broughton 2005,

Kislak and Unluturk 2003). Especially Gram-negative microorganisms cause the spoilage in fresh fish and there are not a plenty number of studies related to using bacteriocins as a biological preservation agent in these products. Spoilage and foodborne pathogens like *Clostridium botulinum* and *Listeria monocytogenes* may create a public health danger in these products. Several researchers have studied for decreasing the risks related with these pathogens. Eventually nisin and sakacin P are the most studied bacteriocins, but the other bacteriocins like curvaticin, carnocin, bavaricin, and divergicin also studied for potential applications in seafood products (Degnan et al. 1994, Einarsson and Lauzon 1995, Nilsson et al. 1997, O'Sullivan et al. 2002). Limitation of *L. monocytogenes* in smoked and vacuum packaged salmon with using bacteriocins has been observed via different researchers. Sakacin P has been demonstrated for its potential effects to eliminating *L. monocytogenes* and use of this bacteriocin is familiar with seafood products (Katla et al. 2002, Blom et al. 1997, Brurberg et al. 1997, Eijsink et al. 1998, Ganzle et al. 1999, Aasen et al. 2000). For the elimination of *L. monocytogenes* in smoked rainbow trout, nisin and sodium lactate concentrations were analyzed in another study. Nisin and sodium lactate concentrations were inoculated into the trout before and after the smoking. Effects of the treatments for organoleptic properties and shelf life were also tested. The study showed that nisin and sodium lactate are both effective for inhibition of the *L. monocytogenes* when they were used separately in smoked trout, however the treatment was much more efficient when nisin and sodium lactate using together. Whenever they were used together, *L. monocytogenes* counts diminished from 3.3 to 1.8 log cfu/g in 16 days. Besides, the study showed that the organoleptic properties of the trout was not effected after the treatments and also the treatments extended the shelf life for additionally 7 days of storage (Nykanen et al. 2000). Aasen et al. (2000) analyzed the efficiency of nisin and sakacin P treatments in smoked salmon and chicken meat. They pointed out that due to their amphiphilic structure, bacteriocins may be adsorbed by food structure and exposed to proteolytic deterioration, so this can restrict their use in preservation. They observed that muscle proteins adsorbed less nisin than sakacin P, however there was not a statistically significant difference between nisin and sakacin P according to their bacteriocin activity. Both in chicken meat and smoked salmon, inhibition of *L. monocytogenes* continued for 3 weeks, but salmon exposed to proteolytic deterioration. They also stated that nisin and sakacin P activities didn't show a difference in heat processed foods at least 4 weeks. In another study, sakacin P, nisin, and two strains of *L. sakei* (one of them sakacin P producing and the other is not) were analyzed for *L. monocytogenes* limitation in

vacuum-packaged smoked salmon samples. Salmon were observed during 4 weeks. In salmon samples added only sakacin P, limitation of *L. monocytogenes* was determined for one week. However, in salmon samples added *L. sakei* strain that can produce sakacin P, limitation of *L. monocytogenes* was determined. Also, both of the *L. sakei* strains showed bacteriostatic effect on *L. monocytogenes* throughout the whole storage time. Whilst, in samples which were added with the combination of sakacin P and *L. sakei* strain That can produce sakacin P, bacteriocidal effect was observed (Katla et al. 2002). *L. curvatus* SB13 produce a bacteriocin called curvaticin 13. Curvaticin 13 and nisin activities for repressing the redevelopment of *L. monocytogenes* are analyzed by Bouttefroy and Milliere (2000) in their study. They observed that the combination of curvaticin 13 and nisin caused higher inhibition effect than their use in separately. In another study, treatments of sprayed nisin to cod fillets, herrings and smoked mackerels were studied for the inhibition of *C. botulinum*. In the study, spores of *C. botulinum* Type E injected into packaged fishes and observed statistically important delay for toxin production at the temperatures of 10 and 26°C (Delves-Broughton 2005). Nisin was also effective for *L. monocytogenes* in a carbon dioxide atmosphere packaged smoked salmon. Besides, heat treatment with the combination of nisin was not harm to lobster meat's organoleptic properties and achieved better inhibition of *L. monocytogenes* than when nisin and heat treatment were used separately (Delves-Broughton 2005). As a means of extending shelf life, benzoic and sorbic acids are usually added for the production of brined shrimps. Concerns about using organic acids have given rise researchers to study about the potential effect of bacteriocins for brined shrimp preservation. Einarsson and Lauzon (1995) analyzed the efficiency of carnocin UI49, bavaricin A, and nisin Z for shelf life improvement. According to the study, carnocin UI49 was not effective for the improvement of shelf life, whilst bavaricin A, produced by *Lactobacillus bavaricus* MI 401, and nisin Z prolonged the shelf life up to 16 and 31 days, respectively. When brined shrimps were treated with carnocin UI49, bavaricin A and a control group with no preservatives, Gram-positive bacteria dominated in the microflora. However in nisin Z treated group Gram-negative bacteria dominated during the whole storage time (Einarsson and Lauzon 1995). Divergicin M35, bacteriocin generated by *Carnobacterium divergens* M35, was isolated by Tahiri et al. (2004) from a commercially available frozen smoked mussels. According to their study, divergicin M35 was effective for inhibiting both *L. monocytogenes* and carnobacteria. Consequently, divergicin M35 can be used as

preservation agent in seafood products for *L. monocytogenes*.

CONCLUSIONS

As a result, since food related diseases are on the rise and the safety of food is still an increasingly important public health concern in worldwide, using of bacteriocins, inhibit foodborne pathogens without any adverse effects, has aroused great interest. The effectiveness of bacteriocins for preservation of foods is proved. Only nisin is approved for using as a food preservation agent by FAO, but also other bacteriocins like sakacin P, curvaticin, carnocin, bavaricin, and divergicin have applications in seafood systems. With the increasing antibiotic resistance problem and awareness of the risks of chemical preservatives for public health, bacteriocins have attracted a considerable attention about their use in seafood products. Addition of the bacteriocin producing culture or just the bacteriocin presents an attractive alternative for food preservation. A probable drawback associated with using bacteriocins as biopreservatives in foods is the improvement of bacteriocin resistance in spoilage or pathogenic bacteria. Consequently, the opportunity of using multiple bacteriocin producing bacteria or only the bacteriocins for the inhibition of foodborne pathogens in seafoods can be studied in further studies and it will be a important improvement for food safety in worldwide.

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