ESTRATEGIAS PARA LA ELIMINACIÓN DE BIOPELÍCULAS DE *SALMONELLA* spp. EN SUPERFICIES PLÁSTICAS

Nombres y apellidos

Erika Patricia Caraballo Ortega
Código estudiantil: 201922218834

Laura Daniela Díaz López
Código estudiantil: 201922219165

Sebastián Andrés Ojeda Navarro
Código estudiantil: 20191113004

Shely Dareicy Ramírez Polo
Código estudiantil: 201922216735

Trabajo de Investigación del Programa de Microbiología

Tutor(es):
Liliana Pérez Lavalle
Zamira Soto Valera

RESUMEN

Antecedentes: *Salmonella* spp., es una de las principales bacterias involucradas en enfermedades transmitidas por alimentos (ETA) a nivel mundial. En la Unión Europea (UE) se notificaron 33 brotes de origen alimentario siendo 14 producidos por *Salmonela* spp.; en el 2018, se reportaron 8 casos causados por S. Enteritidis; en el 2019, el número de casos confirmados fue de 45 y en el 2020 fue de 131 casos en 8 países (EFSA, 2021). Según el último reporte de National Outbreak Reporting System (NORS), en Estados Unidos entre los años 2017-2020 el número de enfermedades causadas por *Salmonella* spp. fue de 20.384, el número de hospitalizaciones fue de 3802 y las muertes causadas fueron 31. En Colombia en el 2022, se reportaron 126 brotes de enfermedades transmitidas por alimentos (ETA) al sistema de vigilancia en salud pública (SIVIGILA), con 1253 casos involucrados, de los cuales las personas de 5 a 19 años representaron el 59,1%, mayores de 20 años un 30,6%, menores de 5 años 10,3%. Se reconoció que los agentes etiológicos fueron más frecuentes fueron *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* spp., coliformes totales y otros.

Salmonella spp. tiene la capacidad de formar biopelículas, estas son agrupaciones de células que se mantienen unidas por una matriz polimérica autoproducida, la cual se adhiere a superficies tanto inertes o vivas (Donlan & Costerton, 2002). Varios estudios han demostrado que *Salmonella* spp. puede adherirse a las superficies y formar biopelículas en la industria alimentaria, incluidos los plásticos (Joseph et al., 2001). Las biopelículas brindan protección frente a agentes desinfectantes y diferentes tipos de estrés encontrados en ambientes de procesamiento de alimentos (Soni et al., 2013).

Objetivo: analizar las estrategias que se han investigado en los últimos años para el control de biopelículas de *Salmonella* spp. preestablecidas en superficies plásticas.

Materiales y métodos: se realizó una búsqueda bibliográfica que incluyó estudios publicados entre 2013 y 2023 en la base de datos científica Web of Science. Las palabras de búsqueda utilizadas fueron: (*Salmonella* biofilm) AND (plastic surface OR Acrylic OR Polymethyl Methacrylate OR Polyethylene Terephthalate OR Polyvinyl Chloride OR Acrylonitrile Butadiene Styrene OR Polystyrene OR polyethylene OR polypropylene) AND (Control OR disinfection OR eradication OR elimination). Durante la búsqueda se encontraron 88 artículos y se seleccionaron un total de 22 artículos de los cuales se descartaron los que eran reviews y los que durante la investigación no analizaran superficies de plástico o abarcaron biopelículas preformadas. Para la extracción de la información se seleccionó los datos más importantes de los artículos seleccionados como: la estrategia aplicada, el serotipo, el tipo de plástico, las condiciones de formación de la biopelícula, las condiciones de tratamiento y la eficacia del tratamiento. Esta información fue organizada en un cuadro para su análisis. Adicional a esto, se tuvo en cuenta información relevante relacionada con las estrategias en cada uno de los artículos seleccionados, la cual fue complementada con otros artículos para la descripción de cada estrategia.

Resultados: Diferentes estrategias mostraron ser efectivas contra las biopelículas. Dentro de los métodos químicos resaltan los aceites esenciales, ácidos orgánicos y el ácido peracético. En este último, se reportó una reducción de 7,61 log$_{10}$ UFC/cm^2 a 3500 ppm, a

25°C en 10 min (Iñiguez-Moreno et al., 2018). En el caso de los aceites esenciales, el carvacrol y el timol demostraron una alta eficacia.

En cuanto a combinación de estrategias físicas y químicas, la luz UV junto con ácido peroxiacético tuvo una reducción de 4,69 log CFU/cm^2 en 5 min con ácido láctico tuvo una reducción de 6,00 log CFU /cm^2 en 10 min (Byun et al., 2022).

En el caso de las estrategias biológicas el fago PVP-SE2 tuvo una reducción de 1,5 log y 3,4 log para biopelículas de 24 h y 2,1 y 5,1 log UFC en biopelículas de 48 h a una multiplicidad de infecciones de 0.1 a 22°C. Se encontró que los bacteriófagos presentan bajos o nulos efectos en las características organolépticas de los productos (Meireles et al., 2016), también se encontraron algunas limitaciones en relación con limpiezas rápidas, ya que necesita un rango de tiempo amplio para poder tener una reducción sustancial de las biopelículas (Sillankorva et al., 2010).

Conclusión: Diferentes estrategias químicas y físicas mostraron gran efectividad en la eliminación de biopelículas. No obstante, algunos de estos métodos tienen repercusiones secundarias en los seres humanos y el medio ambiente; es por esto por lo que más estudios deben enfocarse en la aplicación de estrategias biológicas las cuales resultan ser una alternativa prometedora a futuro, al ser inocuas y amables con el medio ambiente.

Palabras clave: superficies plásticas, *Salmonella* spp., biopelícula, erradicación.

ABSTRACT

Background: *Salmonella* spp. is one of the main bacteria involved in foodborne diseases (ETA) worldwide. In the European Union (EU) 33 foodborne outbreaks were reported, 14 of which were caused by Salmonella spp.; in 2018, 8 cases caused by S. Enteritidis were reported; in 2019, the number of confirmed cases was 45 and in 2020 it was 131 cases in 8 countries (EFSA, 2021). According to the latest report from the National Outbreak Reporting System (NORS), in the United States between the years 2017-2020 the number of diseases caused by *Salmonella* spp. was 20,384, the number of hospitalizations was 3,802 and the deaths caused were 31. In Colombia in 2022, 126 outbreaks of foodborne diseases (ETA) were reported to the public health surveillance system (SIVIGILA), with 1,253 cases involved, of which people between the ages of 5 and 19 represented 59,1%, over 20 years of age 30,6%, and children under 5 years of age 10,3%. It was recognized that the most frequent etiological agents were *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* spp., total coliforms and others.

Salmonella spp. it has the ability to form biofilms, these are groups of cells that are held together by a self-produced polymeric matrix, which adheres to both inert and living surfaces (Donlan & Costerton, 2002). Several studies have shown that *Salmonella* spp. it can adhere to surfaces and form biofilms in the food industry, including plastics (Joseph et al., 2001). Biofilms provide protection against sanitizing agents and different types of stress found in food processing environments (Soni et al., 2013).

Objective: to analyze the strategies that have been investigated in recent years for the control of biofilms of *Salmonella* spp. presets on plastic surfaces.

Materials and methods: a bibliographic search was carried out that included studies published between 2013 and 2023 in the Web of Science scientific database. The search words used were: (*Salmonella* biofilm) AND (plastic surface OR Acrylic OR Polymethyl Methacrylate OR Polyethylene Terephthalate OR Polyvinyl Chloride OR Acrylonitrile Butadiene Styrene OR Polystyrene OR polyethylene OR polypropylene) AND (Control OR disinfection OR eradication OR elimination). During the search, 88 articles were found and a total of 22 articles were selected, of which those that were reviews and those that during the investigation did not analyze plastic surfaces or covered preformed biofilms were discarded. For the extraction of the information, the most important data of the selected articles was selected, such as: the applied strategy, the serotype, the type of plastic, the biofilm formation conditions, the treatment conditions and the efficacy of the treatment. This information was organized in a table for analysis. In addition to this, relevant information related to the strategies in each of the selected articles was taken into account, which was complemented with other articles for the description of each strategy.

Results: Different strategies were shown to be effective against biofilms. Among the chemical methods, essential oils, organic acids and peracetic acid stand out. In the latter, a reduction of 7,61 $\log_{10}$ CFU/cm^2 was reported at 3500 ppm, at 25°C in 10 min (Iñiguez-Moreno et al., 2018). In the case of essential oils, carvacrol and thymol demonstrated high efficacy.

Regarding the combination of physical and chemical strategies, UV light together with peroxyacetic acid had a reduction of 4,69 log CFU/cm^2 in 5 min with lactic acid had a reduction of 6,00 log CFU/cm^2 in 10 min (Byun et al., 2022).

In the case of the biological strategies, the PVP-SE2 phage had a reduction of 1,5 log and 3,4 log for 24-h biofilms and 2,1 and 5,1 log CFU in 48-h biofilms at a multiplicity of infections of 0.1 at 22°C. It was found that bacteriophages have low or no effects on the organoleptic characteristics of the products (Meireles et al., 2016), some limitations were also found in relation to quick cleaning, since it requires a wide range of time to be able to have a reduction of biofilms (Sillankorva et al., 2010).

Conclusion: Different chemical and physical strategies showed great effectiveness in the removal of biofilms. However, some of these methods have secondary impacts on humans and the environment; This is why more studies should focus on the application of biological strategies, which turn out to be a promising alternative for the future, since they are harmless and kind to the environment.

Keyword's: plastic surfaces, *Salmonella* spp., biofilm, eradication.

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