

ESTRATEGIAS PARA EL CONTROL DE BIOPELÍCULAS DE *Salmonella* spp FORMADAS EN ACERO INOXIDABLE

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RESUMEN

Antecedentes: *Salmonella* spp. es una de las principales bacterias involucradas en enfermedades transmitidas por alimentos. De acuerdo con el National Outbreak Reporting System (NORS) en Estados Unidos fueron reportados entre 2018-2020, 57,649 brotes de los cuales 244 brotes eran causados por *Salmonella* spp., ocasionando 5.532 enfermedades, 1.037 hospitalizaciones y 6 fallecidos (CDC, 2022). Esta bacteria es capaz de formar biopelículas; la cual es una comunidad de microorganismos con células unidas irreversiblemente a un sustrato, e incrustadas en una matriz de sustancias poliméricas extracelulares (EPS) (Donlan & Costerton, 2002). Las biopelículas brindan protección frente a agentes desinfectantes y diferentes tipos de estrés encontrados en ambientes de procesamiento de alimentos (H. Steenackers et al., 2011). Diferentes estudios han demostrado la capacidad de *Salmonella* spp. de formar biopelículas en acero inoxidable, el cual es una de las superficies abióticas más utilizadas en la industria alimentaria por su gran resistencia (Lee et al. 2020). En esta línea, se ha evidenciado que biopelículas de *Salmonella* spp. formadas en acero inoxidable son difíciles de eliminar con desinfectantes comúnmente utilizados en la industria alimentaria (H. Steenackers et al., 2011).

Objetivo: Analizar estudios sobre estrategias para el control de biopelículas de *Salmonella* spp. formadas en acero inoxidable.

Materiales y Métodos: Se realizó una búsqueda bibliográfica que incluyó estudios publicados entre 2018 y 2022 en la base de datos científica Web of Science. Las palabras de búsqueda utilizadas fueron: (*Salmonella* biofilm) AND (Stainless steel) AND (Control OR disinfection OR eradication OR elimination). Posteriormente, se revisaron los resultados de la búsqueda para seleccionar los correspondientes a la aplicación de estrategias de erradicación de biopelícula de *Salmonella* spp. en acero inoxidable. Es así como de un total de 98 artículos, se seleccionaron 34 artículos.

Cada artículo fue revisado y se extrajo la información más relevante tal como serotipo, estrategia aplicada, condiciones de tratamiento, reducciones logarítmicas, la cual se organizó en un archivo de Excel. Además de lo mencionado anteriormente, se tuvieron en cuenta otros hallazgos en relación con la evaluación del control de las biopelículas por otros métodos de estudio.

Resultados: La mayoría de las estrategias muestran reducciones significativas de las biopelículas. Dentro de los métodos químicos, el ácido peracético muestra reducciones de hasta 1.16 Log UFC/ml desde los 3 minutos de tratamiento. Asimismo, la combinación de aceites esenciales con algunas sustancias orgánicas evidencia reducciones mayores a 4 Log UFC/cupón en cinco minutos, siendo esta última una alternativa poco agresiva con el medio ambiente. Por otro lado, en el caso de las estrategias físicas la más eficiente en cuanto a la eliminación de biopelículas es la ionización catalítica radiante y la combinación de luz UV con agua electrolizada ligeramente ácida la cual muestra inactivación de la biopelícula a los

80 segundos de tratamiento. La implementación de estrategias biológicas como los péptidos antimicrobianos y bacteriófagos podrían ser una alternativa prometedora en un futuro ya que el péptido antimicrobiano WK2 muestra reducciones de 3.4 Log UFC/mL desde los cinco minutos de tratamiento y los cocteles de fagos reducen eficazmente el biofilm hasta un 6.42 Log UFC/cm²

Conclusiones: En los últimos años, se han evaluado e implementado diferentes estrategias químicas, físicas y biológicas para controlar y eliminar la formación de biopelículas de *Salmonella* spp. en superficies de acero inoxidable en la industria alimentaria. Dentro de las estrategias químicas, el ácido peracético representa una buena alternativa; así mismo, la combinación de sustancias químicas como el uso de ácidos orgánicos junto con aceites esenciales son prometedores. Entre los métodos físicos se destacan la ionización catalítica radiante y la combinación de luz UV con agua electrolizada ligeramente ácida. Sin embargo, a pesar de que los métodos tradicionales fisicoquímicos muestran un gran porcentaje de efectividad en la eliminación parcial o total de la biopelícula de este microorganismo, la gran mayoría tiene repercusiones secundarias en los seres humanos y el medio ambiente. Es por esto, que la implementación de las estrategias biológicas resulta ser más sustentable para controlar y eliminar este patógeno en cortos periodos de tiempo siendo además amigable con el planeta. La implementación de estrategias biológicas como los péptidos antimicrobianos y los bacteriófagos podrían ser una alternativa prometedora en un futuro.

Palabras clave: Acero inoxidable, *Salmonella* spp, biopelícula, control, desinfección, erradicación, eliminación.

ABSTRACT

Background: *Salmonella* spp. it is one of the main bacteria involved in foodborne illnesses. According to the National Outbreak Reporting System (NORS) in the United States, between 2018-2020, 57,649 outbreaks were reported, of which 244 outbreaks were caused by *Salmonella* spp., causing 5,532 illnesses, 1,037 hospitalizations, and 6 deaths (CDC, 2022). This bacterium is capable of forming biofilms; which is a community of microorganisms with cells irreversibly attached to a substrate, and embedded in a matrix of extracellular polymeric substances (EPS) (Donlan & Costerton, 2002). Biofilms provide protection against sanitizing agents and different types of stress found in food processing environments (H. Steenackers et al., 2011). Different studies have shown the ability of *Salmonella* spp. to form biofilms on stainless steel, which is one of the most used abiotic surfaces in the food industry due to its great resistance (Lee et al. 2020). Along these lines, it has been shown that *Salmonella* spp. formed in stainless steel are difficult to remove with disinfectants commonly used in the food industry (H. Steenackers et al., 2011).

Objective: Analyze studies on strategies for the control of biofilms of *Salmonella* spp. made of stainless steel.

Materials and Methods: A bibliographic search was carried out that included studies published between 2018 and 2022 in the Web of Science scientific database. The search words used were: (*Salmonella* biofilm) AND (Stainless steel) AND (Control OR disinfection OR eradication OR elimination). Subsequently, the search results were reviewed to select those corresponding to the application of *Salmonella* spp. biofilm eradication strategies. in stainless steel. Thus, from a total of 98 articles, 34 articles were selected.

Each article was reviewed and the most relevant information such as serotype, applied strategy, treatment conditions, logarithmic reductions was extracted, which was organized in an Excel file. In addition to what was mentioned above, other findings were taken into account in relation to the evaluation of biofilm control by other study methods.

Results: Most of the strategies show significant reductions in biofilms. Within the chemical methods, peracetic acid shows reductions of up to 1.16 log CFU/ml from 3 minutes of treatment. Likewise, the combination of essential oils with some organic substances shows reductions greater than 4 log CFU/coupon in five minutes, the latter being a less aggressive alternative to the environment. On the other hand, in the case of physical strategies, the most efficient in terms of biofilm removal is catalytic radiant ionization and the combination of UV light with slightly acidic electrolyzed water, which shows biofilm inactivation after 80 seconds of treatment. . The implementation of biological strategies such as antimicrobial peptides and bacteriophages could be a promising alternative in the future, since the WK2 antimicrobial peptide shows reductions of 3.4 log CFU/mL after five minutes of treatment and phage cocktails effectively reduce biofilm up to a 6.42 log CFU/cm²

Conclusions: In recent years, different chemical, physical, and biological strategies have been evaluated and implemented to control and eliminate the formation of *Salmonella* spp. biofilms. on stainless steel surfaces in the food industry. Within the chemical strategies, peracetic acid represents a good alternative; Likewise, the combination of chemical substances such as the use of organic acids together with essential oils are promising. Among the physical methods, catalytic radiant ionization and the combination of UV light with slightly acidic electrolyzed water stand out. However, despite the fact that traditional physicochemical methods show a large percentage of effectiveness in the partial or total elimination of the biofilm of this microorganism, the vast majority have secondary repercussions on humans and the environment. This is why the implementation of biological strategies turns out to be more sustainable to control and eliminate this pathogen in short periods of time, while also being friendly to the planet. The implementation of biological strategies such as antimicrobial peptides and bacteriophages could be a promising alternative in the future.

Key words:

Stainless steel, *Salmonella* spp, biofilm, control, disinfection, eradication, elimination.

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