



**Evaluación de la relación entre los niveles de *Enterococcus* y la presencia de patógenos
microbianos en ambientes costeros**

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RESUMEN

La contaminación microbiana en ambientes costeros como playas, estuarios, manglares, marismas, entre otros, ha ocasionado una problemática ambiental y de salud pública que afecta tanto a los ecosistemas como a las personas que dependen de estos para su subsistencia. Estos ecosistemas son esenciales para el equilibrio ecológico, siendo ricos en biodiversidad; sin embargo, están siendo amenazados por la presencia de patógenos microbianos. La especie *Enterococcus* spp. es ampliamente utilizada como indicador de contaminación fecal por su capacidad para sobrevivir y persistir en ambientes acuáticos; a pesar de ello, su relación con otros patógenos bacterianos se está cuestionando recientemente lo que ha generado un debate sobre su confiabilidad como indicador de la calidad del agua en este tipo de ecosistemas. Es así como el objetivo de este trabajo fue determinar la relación entre los niveles de *Enterococcus* y la presencia de patógenos microbianos en ambientes costeros.

Para realizar este estudio, se llevó a cabo una revisión sistemática de artículos científicos publicados entre los años 2014 y 2024. La búsqueda se realizó en la base de datos Web of Science, utilizando términos *Enterococcus* spp; patógenos como *Salmonella* spp, *Vibrio cholerae*, *Shigella* spp, *Legionella* spp, *E. coli* y zonas costeras como manglares, playas, marismas, estuarios, entre otros. La búsqueda arrojó un total de 1.352 artículos de los cuales se eligieron 16 estudios, siendo estos los únicos que analizaban *Enterococcus* spp, y los patógenos en los diferentes ambientes costeros al mismo tiempo, además se analizó que estos contaran con los datos exactos que pudieran servir para determinar la relación. Posteriormente se realizó la recopilación de la información de los artículos seleccionados a partir de un análisis crítico y estos fueron registrados en una base de datos, que incluía detalles sobre técnicas de cuantificación y detección de microorganismos, los recuentos obtenidos, factores ambientales, año y ubicación geográfica. Se utilizaron gráficos y descripciones cualitativas para analizar los datos y encontrar así patrones en la relación entre *Enterococcus* spp y los patógenos evaluados.

Los principales resultados obtenidos muestran que, entre los 16 estudios evaluados, se observó una variedad geográfica, destacando las investigaciones realizadas en Estados Unidos e India. Las técnicas más habituales para la identificación de *Enterococcus* spp fueron la filtración por

membrana (46%) y como técnica confirmatoria en algunos trabajos se usó la PCR (33%), lo que evidencia una inclinación hacia el uso reciente de métodos moleculares en las investigaciones. Respecto a las condiciones del entorno, se notó que factores como el pH y la temperatura fueron poco medidos a pesar de que juegan un rol para la proliferación de agentes patógenos. La mayoría de las investigaciones indicaron temperaturas que oscilaban entre los 25°C y 32°C, así como valores de pH que oscilaban entre 7.48 y 8.01. Los patógenos que se identifican con mayor frecuencia fueron *Salmonella* spp (6 investigaciones), *Shigella* spp y *Vibrio cholerae* (5 investigaciones cada uno). Al determinar la relación de estos patógenos con los recuentos de *Enterococcus* spp fue muy difícil establecer una relación clara ya que en algunos trabajos los niveles de *Enterococcus* spp no siempre reflejan la presencia proporcional de patógenos como *Escherichia coli* entero patógenas, *Vibrio cholerae*, *Shigella* spp o *Salmonella* spp, de hecho, en algunos casos fueron significativamente más altos en condiciones ambientales de *Enterococcus* spp.

Acorde a los anteriores resultados se puede concluir que la utilización de *Enterococcus* spp, como indicadores de contaminación fecal, representan un reto en la evaluación microbiológica de ambientes costeros debido a su limitada relación con la presencia de patógenos específicos. Factores ambientales como la temperatura y el pH influyen significativamente en la aparición de microorganismos, pero no se están teniendo en cuenta en los estudios, lo que plantea la necesidad de adaptar los criterios de monitoreo a cada entorno. Es así como integrar múltiples indicadores en la evaluación de la calidad del agua es fundamental para una gestión más efectiva de estos ecosistemas y para proteger la salud pública en zonas costeras.

PALABRAS CLAVES

Contaminación microbiana, indicadores microbiológicos, patógenos bacterianos, ambientes costeros y estuarios.

ABSTRACT

Microbial contamination in coastal environments such as beaches, estuaries, mangroves, marshes, among others, has caused an environmental and public health problem that affects both ecosystems

and the people who depend on them for their subsistence. These ecosystems are essential for ecological balance, being rich in biodiversity; however, they are being threatened by the presence of microbial pathogens. The *Enterococcus* spp. species is widely used as an indicator of faecal contamination due to its ability to survive and persist in aquatic environments; despite this, its relationship with other bacterial pathogens is recently being questioned, which has generated a debate about its reliability as an indicator of water quality in this type of ecosystem. Thus, the objective of this work was to determine the relationship between *Enterococcus* levels and the presence of microbial pathogens in coastal environments.

To carry out this study, a systematic review of scientific articles published between 2014 and 2024 was carried out. The search was carried out in the Web of Science database, using the terms *Enterococcus* spp; pathogens such as *Salmonella* spp, *Vibrio cholerae*, *Shigella* spp, *Legionella* spp, *E. coli* and coastal areas such as mangroves, beaches, marshes, estuaries, among others. The search yielded a total of 1,352 articles from which 16 studies were chosen, these being the only ones that analyzed *Enterococcus* spp, and the pathogens in the different coastal environments at the same time, and it was also analyzed that they had the exact data that could be used to determine the relationship. Subsequently, the information from the selected articles was collected from a critical analysis and these were recorded in a database, which included details on microorganism quantification and detection techniques, the counts obtained, environmental factors, year and geographic location. Graphs and qualitative descriptions were used to analyze the data and find patterns in the relationship between *Enterococcus* spp and the pathogens evaluated.

The main results obtained show that, among the 16 studies evaluated, a geographical variety was observed, with research carried out in the United States and India standing out. The most common techniques for the identification of *Enterococcus* spp were membrane filtration (46%) and PCR was used as a confirmatory technique in some studies (33%), which shows a tendency towards the recent use of molecular methods in research. Regarding environmental conditions, it was noted that factors such as pH and temperature were rarely measured despite the fact that they play a role in the proliferation of pathogens. Most of the research indicated temperatures ranging between 25°C and 32°C, as well as pH values ranging between 7.48 and 8.01. The most frequently

identified pathogens were *Salmonella* spp (6 investigations), *Shigella* spp and *Vibrio cholerae* (5 investigations each). When determining the relationship of these pathogens with the *Enterococcus* spp counts, it was very difficult to establish a clear relationship since in some studies the levels of *Enterococcus* spp do not always reflect the proportional presence of pathogens such as enter pathogenic *Escherichia coli*, *Vibrio cholerae*, *Shigella* spp or *Salmonella* spp. In fact, in some cases they were significantly higher under environmental conditions than *Enterococcus* spp.

According to the above results, it can be concluded that the use of *Enterococcus* spp as indicators of faecal contamination represents a challenge in the microbiological evaluation of coastal environments due to their limited relationship with the presence of specific pathogens. Environmental factors such as temperature and pH significantly influence the appearance of microorganisms, but they are not being taken into account in studies, which raises the need to adapt monitoring criteria to each environment. Thus, integrating multiple indicators in the evaluation of water quality is essential for more effective management of these ecosystems and for protecting public health in coastal areas.

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