Colágeno marino como biomaterial en medicina regenerativa: Revisión sistemática de su biocompatibilidad, regeneración celular y potencial antimicrobiano

Nombres y apellidos

María Ema Bejarano De la Ossa
Código estudiantil: 202223347289

Valentina Corcione Echeverria
Código estudiantil: 202211643482

Yeilis Daniela Helbrum Rojas
Código estudiantil: 202213339556

Trabajo de Investigación del Programa de Química y Farmacia

Tutor:
Aranys de Carmen Borja Úrsula

RESUMEN

El colágeno marino se puede consolidar como un biomaterial de alto impacto en la medicina regenerativa, presentándose como alternativa segura y sostenible frente a otras fuentes de origen bovino y porcino. Esta reorientación hacia fuentes marinas aborda limitaciones claves de sus predecesores, atenuando los riesgos en las transmisiones de enfermedades zoonóticas, descartando controversias éticas y culturales, reduciendo el choque ambiental presentado en la ganadería. Así mismo, la extracción del colágeno marino se ajusta aquellos fundamentos que pertenecen a la economía circular, ya que este se obtiene principalmente de escamas, piel y huesos. Esta valoración de subproductos pertenecientes a la industria pesquera lo posiciona como material de gran valor. Por consiguiente, este por su parte asegura que los tejidos sean

más resistentes, elásticos y cohesivos al conectarse unos con otros. Además, por su versatilidad en sus funciones se ha convertido muy importante en las aplicaciones biomédicas en cuenta a la producción de dispositivos médicos como los andamios tisulares, hidrogeles, apósitos y películas. La prueba científica documentada resalta sus características bioactivas, siendo la biocompatibilidad su propiedad mas crucial. Este aspecto es esencial para garantizar una relación tisular adecuada sin provocar un rechazo por el sistema inmune. Su estructura contribuye a la adhesión celular y a la proliferación de fibroblastos. En sus usos en medicina regenerativa representa la mayor parte de las investigaciones, también, funciona como un soporte promoviendo la cicatrización de heridas y regeneración celular mediante el control del desarrollo de tejido de granulación y estimulo en la angiogénesis. Pero, su aplicabilidad aborda su capacidad antioxidante y antimicrobiana, por lo cual, se extiende estratégicamente en la formulación de biomateriales con capacidad de protección.El traslado del colágeno marino al uso clínico enfrenta retos significativos en términos metodológicos, pese a la fortaleza en sus propiedades y un aumento notable del interés investigativo. La mayor limitación radica en los estudios clínicos, ya que sobresalen principalmente modelos in vitro y contraponen a la falta de validaciones in vivo solidas. La falta de pruebas clínicas limita la evaluación a largo plazo en aspectos como la seguridad y eficacia en situaciones reales. Otra barrera importante es la diversidad de pureza y de composición del colágeno que depende de la especie marina de la que provenga y los procesos de extracción que no alteren su funcionalidad. Sin embargo, aunque se presenten obstáculos es sus validaciones sigue siendo un foco investigativo de alto potencial terapéutico.

Palabras clave: Colágeno marino, biomaterial, biocompatibilidad, regeneración celular, estudios clínicos.

ABSTRACT

Marine collagen can be consolidated as a high-impact biomaterial in regenerative medicine, presenting itself as a safe and sustainable alternative to other sources of bovine and porcine origin. This reorientation towards marine sources addresses key limitations of its predecessors, mitigating the risks of zoonotic disease transmission, ruling out ethical and cultural controversies, and reducing the environmental impact of livestock farming.Likewise, the extraction of marine collagen is in line with the principles of the circular economy, as it is obtained mainly from scales, skin, and bones. This valuation of by-products from the fishing industry positions it as a highly valuable material. Consequently, it ensures that tissues are more resistant, elastic, and cohesive when connected to each other. In addition, due to its versatility in its functions, it has become very important in biomedical applications in the production of medical devices such as tissue scaffolds, hydrogels, dressings, and films. Documented scientific evidence highlights its bioactive characteristics, with biocompatibility being its most crucial property. This aspect is essential to ensure proper tissue bonding without causing rejection by the immune system. Its structure contributes to cell adhesion and fibroblast proliferation. In its uses in regenerative medicine, it represents the majority of research. It also functions as a support, promoting wound healing and cell regeneration

by controlling the development of granulation tissue and stimulating angiogenesis. However, its applicability addresses its antioxidant and antimicrobial capacity, which is why it is strategically extended in the formulation of biomaterials with protective capacity. The transfer of marine collagen to clinical use faces significant methodological challenges, despite its strong properties and a notable increase in research interest. The greatest limitation lies in clinical studies, as in vitro models predominate and contrast with the lack of solid in vivo validations. The lack of clinical trials limits long-term evaluation in areas such as safety and efficacy in real-world situations. Another important barrier is the diversity of collagen purity and composition, which depends on the marine species from which it is derived and the extraction processes that do not alter its functionality. However, despite these obstacles, its validation remains a research focus with high therapeutic potential.

KeyWords: Marine collagen, biomaterial, biocompatibility, cell regeneration, clinical studies.

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