ScienceDirect

International Journal of Biological Macromolecules
Volume 241, 30 June 2023, 124649

Review

Helminth-derived biomacromolecules as therapeutic agents for treating inflammatory and infectious diseases: What lessons do we get from recent findings?

Pritha Chakraborty [a], Vivekanandhan Aravindhan [b], Suprabhat Mukherjee [a]

Show more

Outline | Share Cite

https://doi.org/10.1016/j.ijbiomac.2023.124649 ↗
Get rights and content ↗

Highlights

- Helminths and helminth-derived macromolecules (HDMs) can alter the pathophysiology of different human diseases.
- Mechanistic insights of HDM-mediated protection to inflammatory, autoimmune, and infectious diseases have been elaborated.
- Current trends of implicating HDMs and helminth therapy in the intervention of different human diseases have been reviewed
- Promises and possible limitations in adopting bioactive HDMs as therapeutics have been enumerated.

Abstract

Despite the tremendous progress in healthcare sectors, a number of life-threatening infectious, inflammatory, and autoimmune diseases are continuously challenging mankind throughout the globe. In this context, recent successes in utilizing helminth parasite-derived bioactive macromolecules viz. glycoproteins, enzymes, polysaccharides, lipids/lipoproteins, nucleic acids/nucleotides, and small organic molecules for treating various disorders primarily resulted from inflammation. Among the several parasites that infect humans, helminths (cestodes, nematodes, and trematodes) are known as efficient immune manipulators owing to their explicit ability to modulate and modify the innate and adaptive immune responses of humans. These molecules selectively bind to immune receptors on innate and adaptive immune cells and trigger multiple signaling pathways to elicit anti-inflammatory cytokines, expansion of

alternatively activated macrophages, T-helper 2, and immunoregulatory T regulatory cell types to induce an anti-inflammatory milieu. Reduction of pro-inflammatory responses and repair of tissue damage by these anti-inflammatory mediators have been exploited for treating a number of autoimmune, allergic, and metabolic diseases. Herein, the potential and promises of different helminths/helminth-derived products as therapeutic agents in ameliorating immunopathology of different human diseases and their mechanistic insights of function at cell and molecular level alongside the molecular signaling cross-talks have been reviewed by incorporating up-to-date findings achieved in the field.

Previous Next

Abbreviations

AAI, allergic airway inflammation; Ac-NIF, *Ancylostoma caninum* neutrophil inhibitory factor; ACPA, anti-citrullinated protein antibodies; AD, Alzheimer's disease; ADP, adenosine diphosphate; AE, adverse events; AEP, asparaginyl endopeptidase; AESI, adverse events of special interests; ALS, amyotrophic lateral sclerosis; AMP, adenosine monophosphate; APC, antigen presenting cells; AQLQ, asthma quality of life questionnaire; ASD, Autism Syndrome Disorder; AsnRS, asparaginyl-tRNA synthetase; ATP, adenosine triphosphate; BCR, B-cell antigen receptor; BHR, bronchial hyperresponsiveness; Breg, regulatory B-cells; CAD, coronary artery disease; CAM, classically activated macrophages; CAS-1, caspase-1; CD, Crohn's disease; Cd, Crypt depth; CDAI, Crohn's disease Activity Index; CeD, Celiac disease; CGI, clinical global impression – improvement scale (CGI-I); CLRs, C-type lectin receptors; CNS, Central nervous system; CRP, C-reactive protein; CTLA-4, cytotoxic T-lymphocyte associated antigen-4; CVD, cardiovascular disease; DALYs, disability-adjusted life years; DAMPs, damage-associated molecular patterns; DAS28, disease activity score; DC, dendritic cells; DD, doubling of dose; DEC, diethylcarbamazine; DiES, *Dinofilaria immitis* ES product; DSS, dextran sodium sulphate; ERK, extracellular signal-regulated kinase; EAE, experimental autoimmune encephalomyelitis; Em-TIP, *Echinococcus multilocularis* homolog TIP; EoT, end of treatment; ES, excretory secretory; EV, excretory vesicles; FC, fecal calprotectin; FeNO, fractional exhaled nitric oxide8; hCL1, *Faciola hepatica* cathepsin-1; FhHDM, *Faciola hepatica* helminth defense molecule; FHES, *Faciola hepatica* excretory-secretory molecule; GI, gastrointestinal; GIT, gastrointestinal tract; GM-CSF, granulocyte-macrophage colony stimulating factor; HdAg, *Hymenolepsis dimunita* Antigen; HD-DC, *Hymenolepsis dimunita* dendritic cells; HDM, Helminth-derived macromolecules; HPARI, *Heligmosomoides polygyrus* alarmin release inhibitor; Hp-TGM, *H. polygyrus* TGM (TGF-β mimic); HRV, human rhinovirus; HW, hookworm; IBD, inflammatory bowel diseases; IBDQ, Inflammatory Bowel Disease Quality of Life Index; IEL, intestinal epithelial lymphocyte; Ig, immunoglobulin; IL, interleukin; ILCs, innate lymphoid cells; IPSE, interleukin-4 inducing principle schistosome eggs; IRAK-1, interleukin-1 receptor-associated kinase-1; ITAM, immunoreceptor tyrosine-based activation motif; JNK, c-Jun N-terminal kinase; LNFPIII, lactose-N fucopentose III; LPMC, lamina propria mononuclear cells; LPS, lipopolysaccharide; MΦ, macrophages; MAPK, mitogen-activated protein kinase; mBSA, methylated bovine serum albumin; MCP-1, monocyte chemoattractant protein-1; MDA, mass drug administration; MetS, metabolic syndrome; MHCII, major histocompatibility complex II; MIF, macrophage migration inhibitory factor; MIP-1, macrophage inflammatory protein-1; MLN, mesenteric lymph nodes; MPO, myeloperoxidase; Mregs, regulatory macrophages; MS, multiple sclerosis; mTOR, mammalian target of rapamycin; MyD88, myeloid differentiation factor 88; NIF, neutrophil inhibitory factor; NK cells, natural killer cells; NLRP3, nucleotide-binding oligomerization domain-like receptor and pyrin domain-containing protein 3; NLS, nuclear localization signal; NOD, non-obese diabetic; NPD, neuropsychiatric disorders; NTD, neutral thiol proteases; PAMPs, pathogen associated molecular patterns; PC, phosphocholine; PD_{20}AMP, provocative dose of adenosine monophosphate causing a 20% fall in forced expiratory volume in 1s; PD, Parkinson's disease; PDL1, programmed death ligand-1; PGE2, prostaglandin

E2; PI3K, phosphoinositide 3-kinases; PLCγ, phospholipase Cγ; PLD, phospholipase D; PLNs, pancreatic lymph nodes; PMBC, peripheral blood mononuclear cells; PPD, purified protein derivative; PRRs, pathogen recognized receptors; PTM, post translational modifications; QOL, quality of living; RA, rheumatoid arthritis; RANKL, receptor activator of nuclear factor; RAS, receptor-linked tyrosine kinases; RSV, respiratory syncytical virus; rSjcystatin, recombinant *S. japonicum* cystatin; SC, serum calprotectin; SCFAs, short chain fatty acids; SEA, soluble egg antigen; SmCKBP, *S.mansoni* chemokine binding protein; SmCalP, *S. mansoni* calpain; SmCBI, *S. mansoni* cathepsin B-1; SmATPDase-1, *S.mansoni* ATP diphosphate hydrolase; SmNPP5, *S.mansoni* phosphodiesterase; SPHK1, sphingosine kinase-1; STAT6, Signal transducer and activator of transcription 6; STH, soil-transmitted helminths; SWA, soluble worm antigen; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus; TEAE, treatment-emergent adverse events; TCR, T-cell receptor; TGF, transforming growth factor; Th1, T-helper 1; Th2, T-helper 2; Th17, T-helper 17; TLR, toll-like receptors; TNBS, tri-nitrobenzene sulfonic acid; TNFα, Tumor necrosis factor; Tregs, regulatory T-cells; TSLP, thymic stromal lymphopoietin; TSO, *Trichuris suis* ova; UC, ulcerative colitis; UCAI, Ulcerative colitis Activity Index; URTI, upper respiratory tract infection; Vh, villous height; WHO, world health organisation

Keywords

Helminth therapy; Biomacromolecules; Inflammation; Immunomodulators; Inflammatory diseases; Therapeutic intervention

Recommended articles

Cited by (0)

View full text

© 2023 Elsevier B.V. All rights reserved.

Copyright © 2023 Elsevier B.V. or its licensors or contributors.
ScienceDirect® is a registered trademark of Elsevier B.V.

ELSEVIER

RELX™