Title: Molecular Mechanisms of Anti-Infammatory andImmunomodulatory Activities of Key Phytochemicals: AComprehensive Review

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Abstract: Phytochemicals derived from medicinal plants represent a rich and largely underexploited source of anti-infammatory andimmunomodulatory agents. Chronic infammation and dysregulated immune responses underpin many tropical and globaldiseases, including infectious, autoimmune, and metabolic disorders. This review examines the spectrum of plant-derivedcompounds with defned bioactivity in infammation and immune regulation. To ensure comprehensive coverage of currentresearch, an extensive literature search was conducted across multiple scientifc databases, including Web of Science, ScienceDirect, SpringerLink, Wiley Online Library, PubMed/MEDLINE, Scopus, and Google Scholar. The search encompassedpublications available up to May 2025. Combinations of relevant Medical Subject Headings (MeSH) terms and free-text keywordswere used, such as “phytochemicals,” “medicinal plants,” “anti-infammatory activity,” “immunomodulatory efect,” “plant-derivedcompounds,” “favonoids,” “alkaloids,” “terpenoids,” and “polyphenols” (including modulation of cytokines, NF-κB, MAPK, NLRP3infammasome, T-cell, and macrophage functions), and relevance to tropical-disease contexts. Boolean operators (AND, OR, andNOT) were applied to refne and broaden the search. Reference lists of retrieved articles and related reviews were also manuallyscreened to identify additional relevant studies. Numerous phytochemicals such as quercetin, curcumin, baicalin, resveratrol, andothers demonstrate multitarget anti-infammatory efects including the suppression of proinfammatory cytokines (IL-1β, IL-6,TNF-α), inhibition of NF-κB/MAPK pathways, modulation of T-helper and regulatory T-cell profles, and attenuation ofinfammasome activation. Emerging studies highlight immunomodulatory roles in enhancing host resistance or dampeningoveractivation in infection, allergy, and autoimmunity. However, human data remain limited, and the pharmacokinetic, toxicity,and compositional profles of standardized plant extracts are still poorly defned. Medicinal plant phytochemicals ofer promisingleads for anti-infammatory and immunomodulatory therapy, especially in tropical regions where safe, afordable agents are

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