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OPINION ARTICLE

Integration of medicinal plants in post-COVID-19 family and community integrative rehabilitation

Integración de plantas medicinales en la rehabilitación integrativa familiar y comunitaria post-COVID-19

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RESUMEN

El síndrome post-COVID-19 constituye un desafío sanitario crónico que cursa con desincronización de los ritmos biológicos, perpetuando la inflamación y la disfunción sistémica. Ante esta problemática, el presente artículo de opinión propone un enfoque de rehabilitación integrativa familiar y comunitaria, fundamentado en el proyecto SEN, el cual trasciende el modelo biomédico tradicional para centrarse en la restauración de la homeostasis. El paradigma expuesto concibe las plantas medicinales como señalizadores metabólicos y moduladores epigenéticos naturales, capaces de resincronizar el organismo en sus distintos estados cronobiológicos: vigilia-despertar, sueño, atardecer, alimento y ayuno. La evidencia científica respalda el uso de compuestos bioactivos como polifenoles, flavonoides y terpenos —presentes en plantas como la cúrcuma, la centella asiática y la morera— por su capacidad para regular la expresión génica, inhibir vías proinflamatorias y reducir el daño oxidativo, efectos fundamentales para el manejo de las secuelas posinfecciosas. Un aspecto medular del trabajo es su carácter traslacional, al delinear una ruta concreta que vincula el conocimiento científico, la producción local de fitofármacos y un plan de cuidado personalizado, articulado mediante una red intersectorial que integra instituciones académicas, sanitarias y comunitarias. En síntesis, el artículo ofrece una visión transdisciplinaria que convierte conceptos complejos de la cronobiología y la epigenética en herramientas prácticas para el autocuidado, proporcionando una vía viable para restaurar el equilibrio perdido en la era pospandémica.

ABSTRACT

Post-COVID-19 syndrome presents a chronic health challenge characterized by a desynchronization of biological rhythms, perpetuating inflammation and systemic dysfunction. In response to this problem, this opinion piece proposes an integrative family and community rehabilitation approach, based on the SEN project, which transcends the traditional biomedical model to focus on restoring homeostasis. The presented paradigm views medicinal plants as natural metabolic signalers and epigenetic modulators, capable of resynchronizing the body in its various chronobiological states: wakefulness, sleep, sunset, feeding, and fasting. Scientific evidence supports the use of bioactive compounds such as polyphenols, flavonoids, and terpenes—present in plants like turmeric, gotu kola, and mulberry—due to their ability to regulate gene expression, inhibit pro-inflammatory pathways, and reduce oxidative damage, effects that are fundamental for managing post-infectious sequelae. A key aspect of this work is its translational nature, outlining a concrete path that links scientific knowledge, local production of phytopharmaceuticals, and a personalized care plan, articulated through an intersectoral network integrating academic, healthcare, and community institutions. In short, the article offers a transdisciplinary vision that transforms complex concepts from chronobiology and epigenetics into practical tools for self-care, providing a viable way to restore the balance lost in the post-pandemic era

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The COVID-19 pandemic not only left an acute mark on global health, but also gave rise to a chronic challenge: post-COVID syndrome. This is characterized by a constellation of symptoms—persistent fatigue, cognitive dysfunction, low-grade inflammation, and autonomic dysregulation—that point to a common denominator: desynchronization of fundamental biological rhythms [1,2].

The human being, deeply influenced by the cycles of sunlight, food and activity, maintains its homeostasis thanks to a circadian timing system that coordinates the expression of clock genes in each cell and tissue [3,4]. However, modern life, with artificial exposure to light, irregular meal times and chronic stress, has generated a true epidemic of desynchronization that perpetuates inflammatory states by altering the rhythmicity of macrophages and the production of cytokines [5,6]. The post-COVID syndrome is nothing more than the exacerbation of this imbalance in an already vulnerable organism. Consequently, restoring biological synchronization stands as a priority therapeutic axis to address the sequelae of infection.

To realize this approach, the SEN (Natural Epigenetic Synchronization) project operates under a holistic "life course causality" paradigm, where synchronization is used as a systemic, not merely biochemical, concept. This change of outlook—from a model focused on the disease to one focused on the restoration of homeostasis—coincides with the proposals of Uecker et al. [1] and Chuang et al. [7], who advocate multimodal approaches that integrate gradual exercise, nutritional support, stress management and phytotherapy.

From the perspective of the SEN, medicinal plants are not conceived as simple supplements, but as natural signalers that, due to their similarity to the human organism and their interaction with circadian rhythms, allow the epigenetic terrain to be resynchronized in the different metabolic states that make up chronostasis (wake-wake, sleep, sunset, food and fasting).

This view is supported by a growing body of evidence. Authors such as Cord et al. [8] have shown that bioactive compounds such as polyphenols, flavonoids, and terpenes act as natural epigenetic modulators, inhibiting histone deacetylases and affecting DNA methylation. Shekhar Patil et al. [9] point out that curcumin and mulberry polyphenols can reverse aberrant methylation of pro-inflammatory genes, while Yang et al. [10] verified that centella asiatica inhibits the TGF-β/Smad pathway, reducing lung and liver fibrosis. Turmeric, for its part, through the inhibition of the NF-κB factor and the activation of SIRT1, reduces the residual cytokine cascade (11).

However, although the broad potential of medicinal plants as epigenetic modulators is recognized, a translational gap persists that prevents connecting the solid scientific evidence with its practical application in community contexts of integrative rehabilitation. The objective of this article is precisely to narrow this gap, proposing a transdisciplinary synthesis that translates complex concepts—chronobiology, epigenetics and phytotherapy—into a language and community practice applicable in post-COVID family rehabilitation.

To materialize the proposed rehabilitative approach, the SEN (Natural Epigenetic Synchronization) project articulates an intervention model that is based on a central premise: health emerges from the correct synchronization between the internal rhythms of the organism and the external cycles of the environment. This synchronization operates in five fundamental chronobiological states—wake-wake, sleep, dusk, feeding, and fasting—each characterized by specific hormonal, metabolic, and epigenetic profiles. The desynchronization of these states, exacerbated by stress, poor diet and modern lifestyle habits, constitutes the pathophysiological substrate on which the persistent sequelae of COVID-19 are installed (1,2,6). Therefore, integrative rehabilitation must be aimed at resynchronizing these metabolic terrains, and medicinal plants, due to their signaling affinity with each state, emerge as first-order modulating tools.

The SEN project has operationalized this vision by establishing a translational circuit that involves multiple actors—University of Medical Sciences of Matanzas, CAM Jovellanos, National Council of Churches, INDER and MINSAP, among others. This circuit covers everything from sowing and cultivation on local farms to processing and packaging in the Integrative Natural Processing Area, guaranteeing the traceability and quality of phytopharmaceuticals. This network allows medicinal plants, selected for their affinity with each metabolic state, to be integrated into a personalized care plan that addresses biological cycles and restores lost synchronization, acting as chemical signalers that reinforce tissue rhythmicity when ingested at the appropriate time of day.

Table 1 summarizes the physiological bases of each chronobiological state, including their external synchronizers, the main metabolites and the biological functions they govern.

Table 1. Fundamental chronobiological states: synchronizers and metabolic functions

Chronobiological state	Physical synchronizer	Main chronometabolite	Dominant physiological function
Wakefulness-awakening	Sunlight (dawn)	Cortisol, steroids	Transition from rest to antigravitational activity; activation of clock genes and early inflammatory response [2,3].
Sleep	Darkness (night)	Pineal and extrapineal melatonin	DNA repair, protein synthesis, immune modulation, and elimination of neurotoxic metabolites [4,5].
Dusk	Light-darkness transition	Steroids, SIRT1, irisin	Adaptation from activity to replenishment; activation of sirtuins and mitochondrial melatonin [6,11].
Feeding	Nutrient intake	Bile acids, digestive enzymes, incretins	Digestion, absorption, and gut–microbiota–brain axis signaling; modulation of nutrition-associated immune response [13,16].
Fasting	Absence of intake	SIRT1, AMPK, ketones	Metabolic remodeling, autophagy, reduction of oxidative stress, and activation of longevity pathways [11,18].

Source: Own elaboration.

The selection of medicinal plants within the SEN project is based on their ability to mimic or enhance the metabolic signals of each state, modulating gene expression and inflammatory pathways. Tables 2

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and 3 present, respectively, the plants recommended for diurnal activity states (wakefulness-awakening, dusk, and feeding) and for rest and fasting states (sleep and fasting), along with the epigenetic mechanisms identified in the literature.

Table 2. Medicinal signaling plants for activity states (wakefulness-awakening, dusk, feeding)

State	Plants (common and Latin name)	Epigenetic/modulatory mechanism
Wakefulness-awakening	Garañón (*Morinda royoc*), Chicory (*Cichorium intybus*), Aralia (*Polyscias fruticosa*), Moringa (*Moringa oleifera*), Gotu kola (*Centella asiatica*), Mulberry (*Morus alba*), Turmeric (*Curcuma longa*), Garlic (*Allium sativum*), Ginger (*Zingiber officinale*)	Inhibition of NF-κB and reduction of proinflammatory cytokines (IL-6, TNF-α); activation of Nrf2 and antioxidant enzymes; modulation of circadian clock genes [8,9,12,17].
Dusk	China root (*Smilax* sp.), Nutgrass (*Cyperus rotundus*), Gotu kola (*C. asiatica*), Mulberry (*M. alba*), Turmeric (*C. longa*)	Activation of SIRT1 and irisin; induction of mitochondrial melatonin; transition from antigravitational to gravitational metabolism [11,15].
Feeding	Sago (*Maranta arundinacea*), Chicory (*C. intybus*), Sesame (*Sesamum indicum*), Gotu kola (*C. asiatica*), Mulberry (*M. alba*), Turmeric (*C. longa*), Aloe vera (*Aloe vera*), Chamomile (*Matricaria recutita*), Peppermint (*Mentha piperita*)	Regulation of the gut–microbiota–brain axis; modulation of digestion-associated immune response; inhibition of intestinal and hepatic fibrosis [10,13,16].

Source: Own elaboration.

Table 3. Medicinal signaling plants for rest and fasting states (sleep, fasting)

State	Plants (common and Latin name)	Epigenetic/modulatory mechanism
Sleep	Moringa (*M. oleifera*), Gotu kola (*C. asiatica*), Mulberry (*M. alba*),	Induction of DNA repair and protein synthesis; potentiation of melatoninergic activity; reduction of

	Turmeric (*C. longa*), Citrus peel (*Citrus cortex*), Ginger (*Z. officinale*)	nocturnal inflammation [10,13,16].
Fasting	Mulberry (*M. alba*), Citrus peel (*Citrus cortex*), Turmeric (*C. longa*), Chicory (*C. intybus*)	Activation of SIRT1 and AMPK; induction of autophagy and elimination of oxidative damage; epigenetic regulation of metabolic genes [11,14,18].

Source: Own elaboration.

The versatility of species such as gotu kola, mulberry, and turmeric, which appear across multiple states, reflects their broad spectrum of action. Yang et al. [10] demonstrated that the triterpenes of *Centella asiatica* (asiaticoside and madecassoside) modulate innate immune response and reduce IL-6 and TNF-α expression, while also inhibiting pulmonary and hepatic fibrosis. Mulberry polyphenols (morin and rutin) activate the Nrf2 factor, inducing endogenous antioxidant enzymes that protect mitochondrial function and reduce oxidative damage in post-infectious tissues [18]. Turmeric, through inhibition of NF-κB and activation of SIRT1, reduces residual cytokine storm and tissue fibrosis, with a consistent systemic effect across multiple clinical trials [11].

Critical analysis and translational challenges

Despite the solid mechanistic foundations, the community implementation of this approach faces limitations that must be rigorously addressed. Table 4 summarizes the main challenges and the proposed strategies to overcome them, derived both from available evidence and from the experience of the SEN project.

Table 4. Translational challenges and strategies for community implementation of the SEN approach

Identified challenge	Empirical basis	Proposed strategy
Low bioavailability of key compounds (curcumin, polyphenols).	Rapid hepatic metabolism and poor intestinal absorption; co-administration with piperine improves absorption [11].	Standardize the combination with natural enhancers (e.g., piperine) in locally processed phytopharmaceuticals.
Variability in active principle concentration depending on origin and cultivation method.	Differences in soil, climate, and harvesting techniques affect phytochemical	Implement quality controls in the Integrative Natural Processing Area, using chromatography to standardize batches.

	composition [8,13].	
Scarcity of specific clinical trials in patients with post-COVID syndrome.	Most studies come from animal models or other chronic inflammatory diseases [1,7].	Design pragmatic, randomized, controlled trials with representative samples of the Cuban post-COVID population.
Potential drug interactions (anticoagulants, antihypertensives, antidepressants).	Inhibition of cytochrome P450 (CYP3A4) by flavonoids and terpenes [16].	Develop safety guidelines and interaction fact sheets; establish pharmacovigilance systems at the primary care level.
Acceptability and adherence in the community context.	Integrating phytotherapy into a care plan requires ongoing education and support.	Develop culturally adapted educational materials and train community health agents.

Source: Own elaboration.

These limitations do not invalidate the SEN proposal but rather outline a roadmap for future research and prudent implementation. The intersectoral articulation proposed by the project—involving academic, healthcare, and community institutions—constitutes the necessary scaffolding to address these complexities and translate evidence into safe and effective practice, thereby consolidating the paradigm of "cultivating health from within" in the context of post-pandemic rehabilitation.

Post-COVID-19 syndrome, with chronic desynchronization of biological rhythms, demands a rehabilitation paradigm that transcends the symptomatic approach. The SEN project proposes restoring homeostasis through epigenetic synchronization, using medicinal plants as metabolic signaling agents that modulate gene expression and reduce residual inflammation. The evidence supports bioactive compounds (mulberry polyphenols, gotu kola triterpenes, curcumin) according to their affinity with chronobiological states (wakefulness, sleep, dusk, feeding, fasting). However, translation faces limitations: low bioavailability, standardization variability, and a scarcity of clinical trials in post-COVID populations, necessitating pragmatic studies and pharmacovigilance in primary care.

The intersectoral circuit of the SEN, which integrates academic, healthcare, and community institutions, provides the scaffolding to transform complex concepts into safe, culturally adapted self-care tools. Thus, integrative rehabilitation based on chronobiology and phytotherapy, with a rigorous approach to translational challenges, emerges as a viable and sustainable strategy to restore post-pandemic equilibrium.

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CONFLICT OF INTEREST

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