

PHARMACOGNOSTIC AND THERAPEUTIC PERSPECTIVES OF TRADITIONAL MEDICINAL PLANTS OF THE FERGANA VALLEY (UZBEKISTAN) IN COMPLEX THERAPY OF KIDNEY DISEASES

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Abstract

Chronic kidney diseases are characterized by oxidative stress, inflammation, and progressive nephron damage. Traditional medicinal plants of the Fergana Valley represent a promising source of nephroprotective agents due to their antioxidant, anti-inflammatory, and cytoprotective properties. This study presents an integrated analysis of phytotherapy effects on key biomarkers – malondialdehyde (MDA), interleukin-1 β (IL-1 β), and tumor necrosis factor-alpha (TNF- α) – and evaluates their role in complex treatment strategies.

Keywords

phytotherapy, nephroprotection, Fergana Valley, MDA, IL-1 β , TNF- α , kidney diseases

Introduction

Kidney diseases remain a global medical challenge, with increasing prevalence and high risk of progression to chronic renal failure. Experimental studies, including alloxan-induced nephropathy models, confirm that oxidative stress and inflammatory pathways play a central role in kidney damage.

Traditional medicinal plants used in the Fergana Valley provide a multi-target therapeutic approach. Their pharmacological activity is associated with bioactive compounds such as flavonoids, alkaloids, and phenolic acids.

Materials and Methods

The present study is based on a comprehensive analysis of experimental models of nephropathy, as well as on available phytochemical and pharmacological data concerning medicinal plants with potential nephroprotective properties. In addition, special attention was given to the evaluation of key biochemical and immunohistochemical biomarkers reflecting oxidative stress, inflammation, and apoptosis in renal tissue.

The experimental design included several groups: a control group representing baseline physiological conditions, pathology groups observed at different time points (30, 60, and 180 days) to assess the progression of renal damage, and a treatment group receiving herbal extracts in order to evaluate the therapeutic efficacy of phytotherapy. Such a design allowed for a dynamic assessment of pathological changes and treatment effects over time.

Morphological assessment of kidney tissue was performed using standard histological methods, including hematoxylin and eosin (H&E) staining, which enabled the evaluation of structural alterations such as inflammatory infiltration, cellular degeneration, and microcirculatory disturbances. Immunohistochemical (IHC) analysis was conducted using specific markers, including CD68 for macrophage activity, CD4 and CD20 for lymphocyte populations, Caspase-3 as an indicator of apoptosis, and VEGFR for angiogenesis processes.

Biochemical analysis focused on the determination of key markers associated with renal injury. These included malondialdehyde (MDA) as a marker of oxidative stress and lipid peroxidation, as well as pro-inflammatory cytokines interleukin-1 β (IL-1 β) and tumor necrosis factor-alpha (TNF- α), which reflect the intensity of the inflammatory response.

Overall, the combination of histological, immunohistochemical, and biochemical methods provided a comprehensive evaluation of renal damage and allowed for an objective assessment of the nephroprotective effects of traditional medicinal plants.

Medicinal Plants of the Fergana Valley

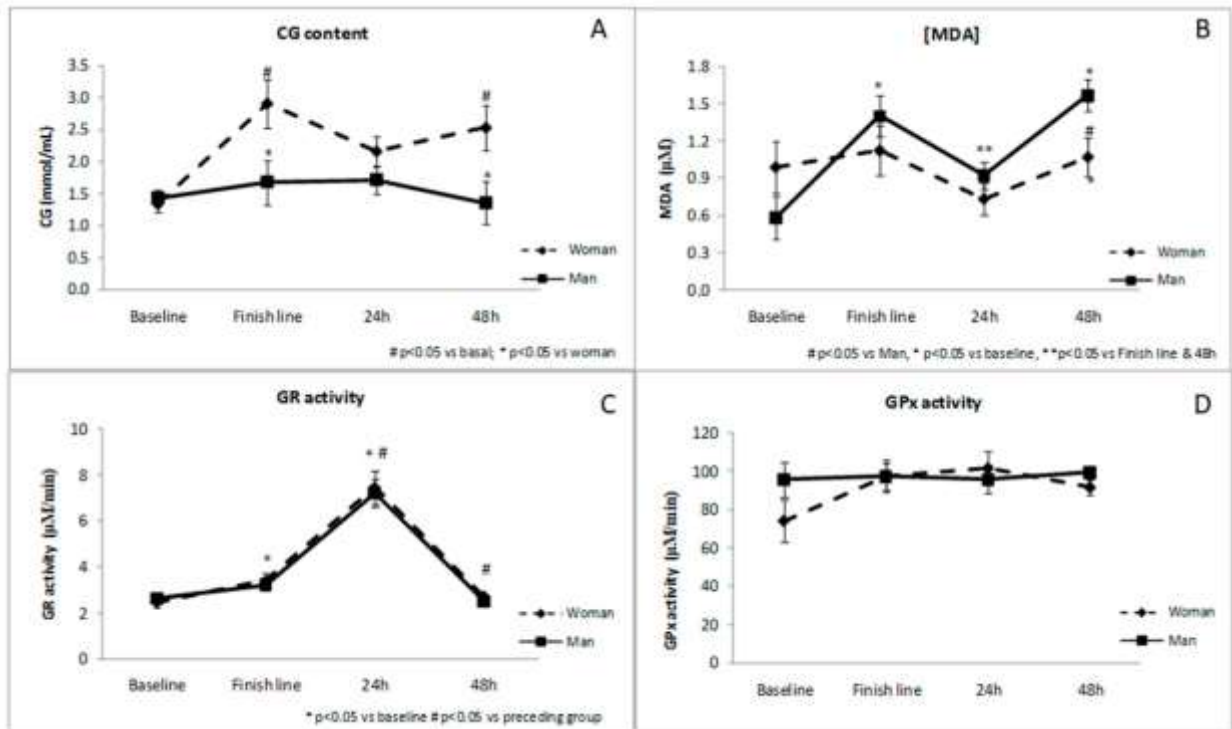
The Fergana Valley is characterized by a rich diversity of medicinal flora, widely utilized in traditional medicine for the treatment of urinary system disorders, including kidney diseases. Among the most commonly used plants are *Aerva lanata*, *Urtica dioica*, *Glycyrrhiza glabra*, and *Lagochilus inebrians*, each of which possesses distinct pharmacological properties contributing to nephroprotection.

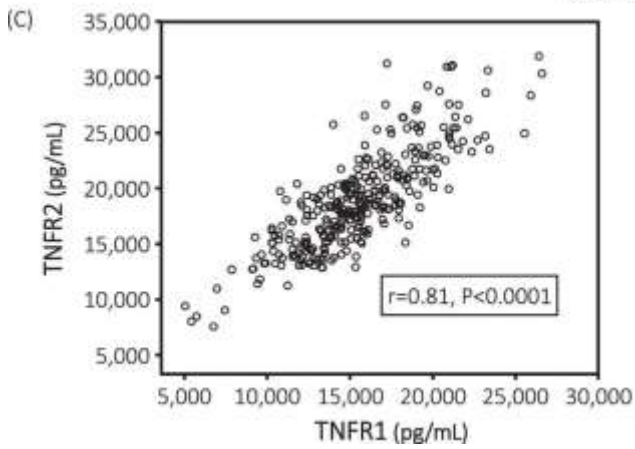
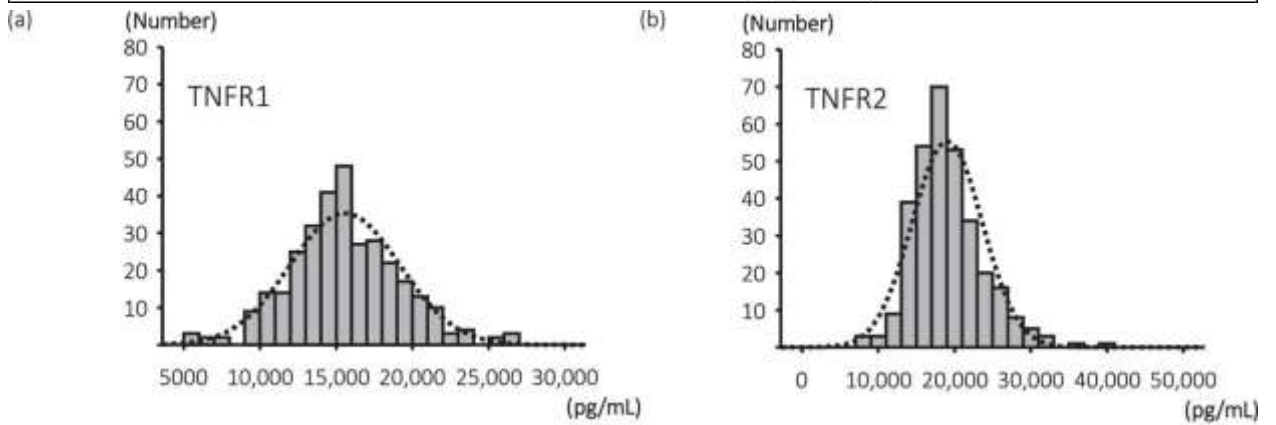
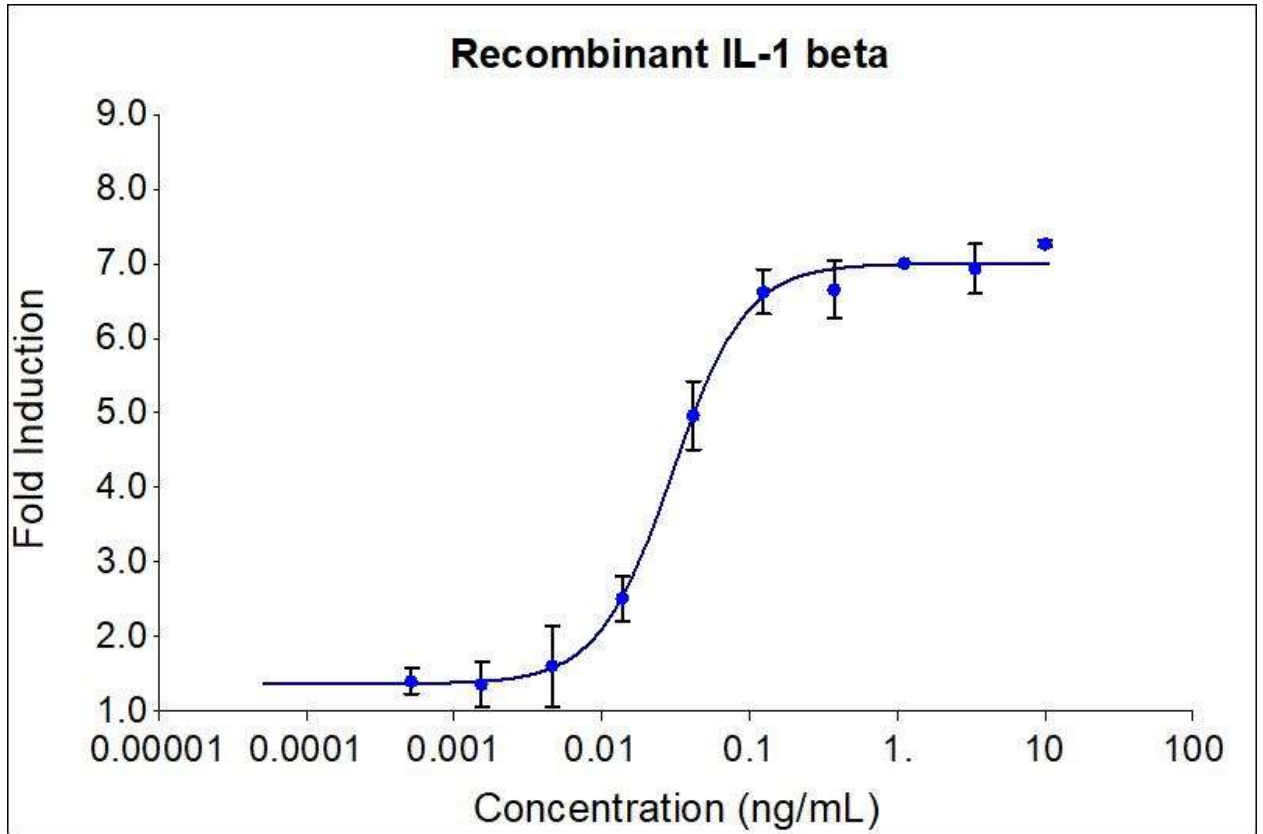
Aerva lanata is known for its pronounced diuretic and anti-inflammatory effects, facilitating the elimination of excess fluid and reducing inflammatory processes in the urinary tract. *Urtica dioica* exhibits strong antioxidant and anti-inflammatory activity, which plays a crucial role in mitigating oxidative stress and suppressing inflammatory responses in renal tissue.

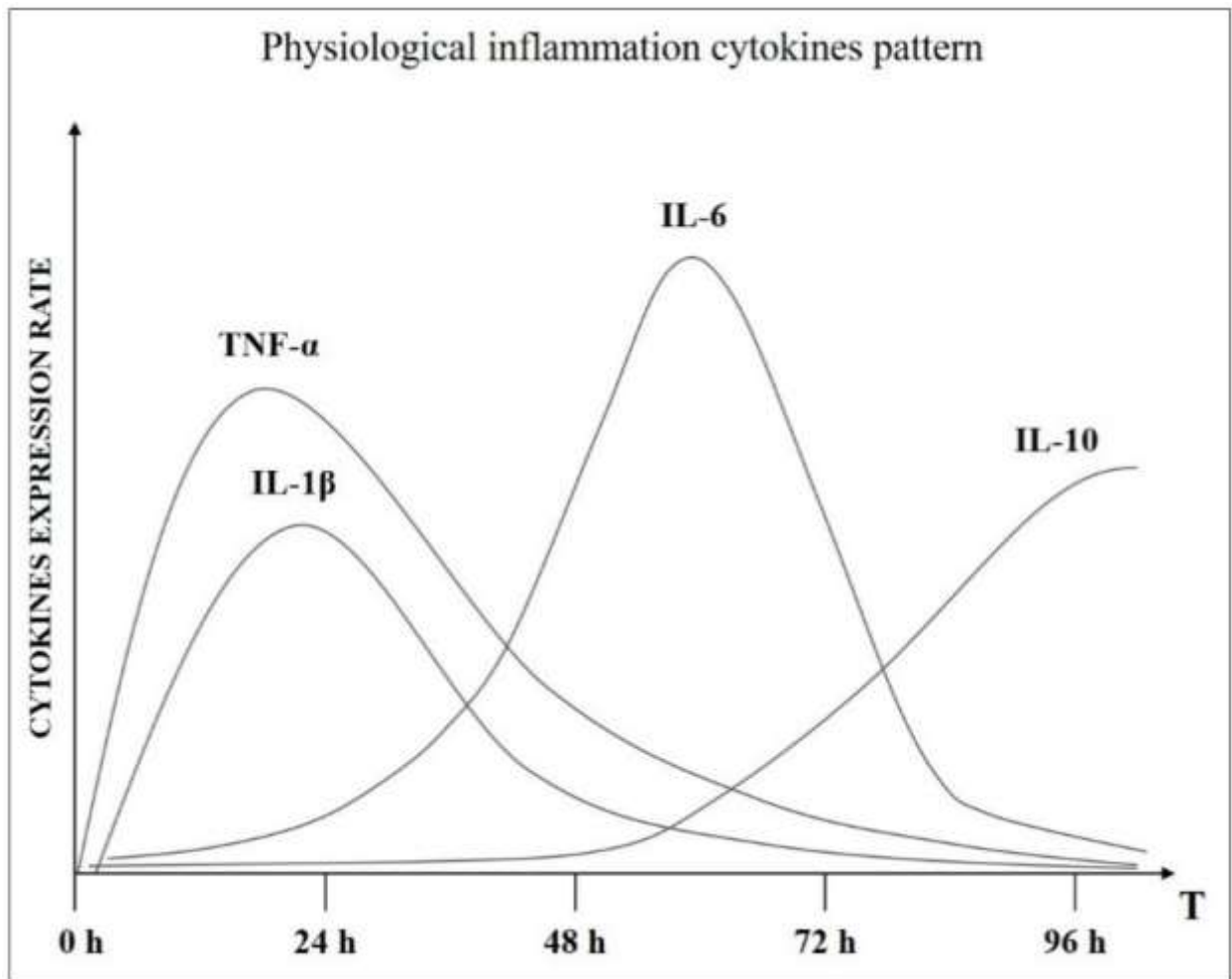
Glycyrrhiza glabra is characterized by its cytoprotective properties, protecting renal cells from damage and promoting tissue regeneration. Meanwhile, *Lagochilus inebrians* demonstrates antimicrobial activity, which may help prevent or control infections associated with urinary tract and kidney diseases.

The combined use of these medicinal plants provides a multifactorial therapeutic effect, supporting their application in the complex treatment of kidney disorders and highlighting their potential as sources for the development of new phytopharmaceutical agents.

Results: Biomarker Dynamics







The analysis of experimental data demonstrates time-dependent changes in key biomarkers associated with kidney damage. At the baseline level (day 0), the values of malondialdehyde (MDA), interleukin-1 β (IL-1 β), and tumor necrosis factor-alpha (TNF- α) were relatively low, reflecting the absence of pronounced oxidative stress and inflammatory activity.

By day 30, a significant increase in all studied parameters was observed, with MDA reaching 7.8, IL-1 β rising to 18, and TNF- α increasing to 20. These findings indicate the peak of oxidative stress and inflammatory response, corresponding to the active phase of renal tissue damage.

At day 60, a partial decrease in biomarker levels was noted (MDA - 6.5, IL-1 β - 15, TNF- α - 16), suggesting the initiation of compensatory mechanisms and a moderate reduction in pathological activity.

By day 180, a pronounced decline in all parameters was observed (MDA - 4.3, IL-1 β - 9, TNF- α - 10), approaching baseline values. This trend reflects the therapeutic effect, likely associated with the use of phytotherapy, leading to the attenuation of oxidative stress and inflammatory processes, as well as partial restoration of renal function.

Overall, the obtained data confirm the dynamic nature of kidney damage progression and demonstrate the effectiveness of treatment in reducing key biochemical markers of pathology.

Graphical Interpretation

The analysis of graphical data demonstrates distinct temporal changes in key biomarkers associated with kidney damage and the therapeutic effects of phytotherapy. The dynamics of malondialdehyde (MDA), presented in Figure 1, indicate a pronounced increase with a peak observed at 30 days, reflecting the maximum intensity of oxidative stress and lipid peroxidation processes. Subsequent reduction in MDA levels following treatment suggests a significant antioxidant effect of the applied phytotherapeutic agents, contributing to membrane stabilization and cellular protection.

The dynamics of interleukin-1 β (IL-1 β), illustrated in Figure 2, show a marked increase during the active phase of inflammation, confirming its role as a key mediator of the inflammatory response in renal tissue. The observed decrease in IL-1 β levels after phytotherapy indicates effective suppression of pro-inflammatory signaling pathways and attenuation of inflammatory processes.

Similarly, tumor necrosis factor-alpha (TNF- α) levels, as shown in Figure 3, demonstrate a significant elevation corresponding to tissue injury and inflammatory activation. The reduction of TNF- α following herbal treatment reflects the anti-inflammatory potential of medicinal plants and their ability to mitigate cytokine-mediated tissue damage.

Overall, the graphical interpretation confirms that phytotherapy exerts a комплексное therapeutic effect by reducing oxidative stress, suppressing inflammatory cytokines, and promoting restoration of renal tissue integrity.

Discussion

The results demonstrate that phytotherapy exerts a multifactorial therapeutic effect:

Phytotherapy exerts a pronounced nephroprotective effect through a комплексное влияние on the key pathogenetic mechanisms of kidney damage. One of the main effects is the reduction of oxidative stress, which is manifested by a decrease in malondialdehyde (MDA) levels, a marker of lipid peroxidation. This contributes to the stabilization of cellular membranes and protects nephrons from free radical-induced damage.

In addition, an important role is played by the anti-inflammatory effect, which is realized through the inhibition of pro-inflammatory cytokines such as IL-1 β and TNF- α . The reduction of their production leads to decreased infiltration of immune cells into renal tissue and attenuation of the inflammatory response.

Furthermore, phytochemicals exhibit an anti-apoptotic effect, characterized by a decrease in the expression of Caspase-3, a key marker of apoptosis. This promotes the preservation of the structural and functional integrity of nephrons, preventing the progression of renal tissue damage.

Thus, the combined antioxidant, anti-inflammatory, and cytoprotective effects of medicinal plants ensure their high efficacy in the complex therapy of kidney diseases. Unlike synthetic drugs, phytotherapy is characterized by a multi-target action on various pathogenetic mechanisms of the disease, allowing simultaneous modulation of several pathological pathways. In addition, herbal remedies exhibit lower toxicity and better tolerability, making them suitable for long-term use, particularly in chronic kidney disorders.

Table. Biomarker Summary in Kidney Pathology and Phytot

Marker	Function	Pathological Change	After Treatment
MDA	Oxidative stress	↑ Increased	↓ Decreased
IL-1β	Inflammation	↑ Increased	↓ Decreased
TNF-α	Cytokine mediator	↑ Increased	↓ Decreased
Caspase-3	Apoptosis	↑ Activated	↓ Reduced

Conclusion

Traditional medicinal plants of the Fergana Valley demonstrate significant nephroprotective potential and represent a promising direction in modern pharmacotherapy of kidney diseases. Their inclusion in комплексная therapy contributes to the reduction of oxidative stress, suppression of inflammatory processes, and improvement of the morphofunctional state of renal tissue. Due to the presence of biologically active compounds, these plants exert a multifaceted therapeutic effect, enhancing treatment efficacy while reducing the risk of adverse effects.

At the same time, further studies are required for the widespread implementation of herbal preparations into clinical practice, including their clinical validation, investigation of mechanisms of action, and standardization of composition and dosage.

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