

Therapeutic Activity of *Hydnora africana* used in the Treatment of Rheumatoid Arthritis

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ABSTRACT

The parasitic plant, *Hydnora africana*, termed "jackal food," has been included in various African ethnomedicines for the treatment of several diseases, amongst them rheumatoid arthritis (RA). This study, therefore, tries to assess the bioactive constituents and mechanisms of action in a bid to rationalize this perceived therapeutic potential of the subject in the treatment of RA. The preliminary investigation indicated that the plant might be very effective in the management of RA due to its analgesic, immunomodulatory, and anti-inflammatory potential. Flavonoids, phenolic compounds, and tannins were detected by phytochemical screening; all act to suppress pro-inflammatory cytokines TNF- α and IL-6. Secondly, its antioxidative property could reduce oxidative stress that increases the risk of pathophysiology in RA. Therefore, more studies should be conducted on the therapeutic and clinical effects in order to obtain the safe and efficacious status of this plant, though positive traditional use and early scientific data are available. *Hydnora africana's* potential for treating RA highlights the need for further study on natural anti-arthritis treatments.

Keywords: Rheumatoid Arthritis, *Hydnora africana*, Anti-inflammatory, Immunomodulatory, Phytochemicals

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Introduction

Southern Africa is inherent to the parasitic flowering plant *Hydnora africana*, also referred to as jackal food. This specific type of root-holoparasitic plant develops all of its nourishment from its host plants, which are mostly Euphorbiaceae species, and lacks chlorophyll. The flowers emit a strong scent to attract pollinators, especially insects. *Hydnora africana* has been used for oral health and wound care due to its high tannin content in traditional African medicine. It has also been used for wound healing for skin disorders, anti-inflammatory handlings to ease pain and swelling, antimicrobial properties to cure infections, and diverse effects to treat gastrointestinal disorders like diarrhea. A chronic autoimmune disease, rheumatoid arthritis (RA) is defined by enduring inflammation of the synovial joints, which causes pain, swelling, and steady joint destruction. In the disorder, healthy joint tissues are mistakenly attacked by an overenthusiastic immune response, which leads to oxidative stress, increased production of pro-inflammatory cytokines (TNF- α , IL-6, and IL-1 β), and joint stiffness, which over time can cause abnormalities and loss of function. Disease-modifying antirheumatic medications (DMARDs), biologic medicines, and nonsteroidal anti-inflammatory drugs (NSAIDs) are examples of ongoing therapy approaches that help to reduce inflammation and minimize the progression of disease. However, there is increasing interest in natural anti-inflammatory medicines like *Hydnora africana* as alternative or complementary therapy substitutes for managing RA because conservative therapies often have serious adverse effects. *Hydnora africana's* extensive phytochemical profile is thought to be responsible for its therapeutic potentials. Numerous bioactive compounds support the plant's anti-inflammatory, antioxidant, and immunomodulatory qualities, making it a potentially effective treatment for rheumatoid arthritis. Botanical compounds have a great potential as an alternative therapeutic for multiple other diseases [1].

Bioactive Compounds of *Hydnora africana*

Alkaloids

Alkaloids are nitrogenous compounds, most of which exhibit analgesic anti-inflammatory properties. They may be beneficial in some way, either synthesizing immunological reactions or repressing the production of the inflammatory effectors TNF- α and IL-6. Besides, many alkaloids have pain-relieving properties that may relieve the joint pain suffered by rheumatoid arthritis patients [2].

Flavonoids

Flavonoids are strong antioxidants known to reduce oxidative stress and scavenge free radicals. These processes become critical with the onset of rheumatoid arthritis. They also reduce swelling by inhibiting pro-inflammatory enzymes like cyclooxygenase and lipoxygenase. Flavonoids enhance cartilage protection, thus retarding joint degradation [3].

Tannins

Its astringent and anti-inflammatory uses may come to the aid of patients with RA by reducing joint stiffness and edema. They may lower the risk of damage to the joints by stabilizing the connective tissues and protecting them against oxidative stress. Besides, the tannins in *Hydnora africana* elevate its antiseptic properties, which are essential to patients suffering from rheumatoid arthritis, with weakened immune systems, and protecting against infections [4].

Saponins

Saponins are known to modulate many immune responses that characterize rheumatoid arthritis. They also seem to have potential anti-inflammatory effects by inhibiting mediators of inflammation. The saponins aid in lubrication of joints through flexibility enhancement, reduction of stiffness, and enhanced generation of synovial fluid [5].

Phenolic Compounds

They are powerful antioxidants with activities for scavenging free radicals. Such radicals are ordinarily to blame for the oxidative stress-induced damage to the joints in patients with RA. By another activity, these materials show an anti-inflammatory effect by intervening in the inflammatory pathways. Some phenolic compounds will probably impede cartilage breakdown and hence protect the joints [6].

Mechanism of Action in Rheumatoid Arthritis

The principal causes of *Hydnora africana's* pharmacological potential in rheumatoid arthritis are its anti-inflammatory, antioxidant, and immunomodulatory qualities. When combined, these systems reduce joint swelling, relieve pain, and postpone the progression of the disease. Chronic inflammation is the main factor contributing to joint deterioration in RA [8].

Hydnora africana reduces inflammation by several pathways

Pro-inflammatory cytokine inhibition (TNF- α , IL-6, IL-1 β): The hallmark of RA is the overproduction of pro-inflammatory cytokines, including TNF- α , interleukin-6, and interleukin-1 beta. The bioactive components of *Hydnora africana*, including flavonoids, alkaloids, and phenolic compounds, help limit the generation and activation of these cytokines, lowering inflammation and joint damage [9].

Modulation of COX-2 and Prostaglandin Pathways: Prostaglandins, which exacerbate RA pain and inflammation, are produced by the enzyme cyclooxygenase-2. *Hydnora africana's* phytochemicals aid in the inhibition of COX-2 activity, which lowers the synthesis of inflammatory prostaglandins and relieves pain and swelling. Although there may be fewer negative effects, this mechanism functions similarly to that of nonsteroidal anti-inflammatory medications. Joint inflammation and damage in rheumatoid arthritis are caused by oxidative stress, which promotes the production of reactive oxygen species, which break down cartilage and hasten the progression of the illness [10].

Scavenging Free Radicals to Reduce Oxidative Stress: Prominent in *Hydnora africana*, flavonoids, tannins, and phenolic compounds serve as antioxidants by scavenging free radicals and protecting joint tissues from

oxidative damage. The plant assists RA sufferers to maintain cartilage reliability and slow the progression of their condition by lowering oxidative stress. In RA, an autoimmune disease, the body's immune system unintentionally targets joint tissues. *Hydnora africana* contains bioactive compounds that help regulate immune activity and prevent overreactions [11].

Controlling Immune Cell Reactions to Avoid Autoimmune Attacks:

The alkaloids and saponins found in *Hydnora africana* have immunomodulatory properties that help in controlling immune system activity and preventing excessive inflammation. According to these chemicals, T-helper 1 and T-helper 17 cells—two crucial initiators of the autoimmune attack on joint tissues in RA—may be less active. By controlling immune responses, *Hydnora africana* may help prevent further joint degradation while maintaining optimal immunological function. Due to its anti-inflammatory, antioxidant, and immunomodulatory qualities, *Hydnora africana* is a beneficial natural treatment for rheumatoid arthritis that can reduce joint pain, prevent the disease from progressing, and increase joint health [7].

Pharmacological Studies and Evidence

Scientific studies exploring the pharmacological effects of *Hydnora africana* on rheumatoid arthritis generally emphasize on the plant's antioxidant, anti-inflammatory and immunomodulatory properties. Comparative, in vitro and in vivo studies have been conducted to observe its efficacy in treating RA symptoms.

In Vitro Studies on Anti-Inflammatory Activity

The bioactive compounds like flavonoids, tannins, and alkaloids present in *Hydnora africana* extracts have been exposed in studies using laboratory-based cell cultures to significantly decrease the levels of pro-inflammatory cytokines such as TNF- α , IL-1 β and IL-6. Furthermore, some studies suggest that by inhibiting COX-2 expression, these extracts lower the synthesis of inflammatory prostaglandins, which result in discomfort and swelling. Free radical scavenging experiments, such as DPPH and ABTS assays, have demonstrated the strong antioxidant capacity of *Hydnora africana* extracts, which may shield joint tissues from oxidative stress-induced damage. Flavonoids and phenolic compounds have been linked to decreased oxidative stress, which is a major factor in the development of rheumatoid arthritis.

In Vivo Studies in Animal Models of RA

Hydnora africana extracts have been found in animal tests to reduce paw swelling, joint stiffness, and inflammatory markers in rats or mice with collagen-induced arthritis (CIA) models. In contrast to untreated controls, histological examination of treated joints shows compact synovial inflammation and cartilage deterioration. Animals treated with *Hydnora africana* extracts reveal better mobility and less pain sensitivity, according to behavioral studies accompanied in animal models of RA. These results are similar to those seen with traditional anti-inflammatory medications. The effects of *Hydnora africana* extracts in contrast to popular NSAIDs like ibuprofen and diclofenac have been studied. The potential of *Hydnora africana* as a natural remedy for rheumatoid arthritis is definitely supported by the pharmacological research and supporting data. Its medicinal potential is demonstrated by its capacity to lower oxidative stress, inflammation, and immunological responses. *Hydnora africana* is a favorable natural treatment for RA that may have numerous therapeutic uses due to its anti-inflammatory, antioxidant, and immunomodulatory properties [7].

Potential Formulation as Herbal Supplements or Extracts

Teas, tinctures, or liquid extracts could be prepared from *Hydnora africana* to offer its therapeutic components in a concentrated form. Ethanol or water-based extractions could be modified to ensure the maximum preservation of alkaloids, flavonoids, and phenolic compounds. Standardized powdered extracts can be designed into tablets or capsules for ease and accurate dosage. Maintaining consistency and efficacy in the treatment of RA requires that active substances be standardized. *Hydnora africana* may be included to topical treatments for direct application to inflammatory joints due to its analgesic and anti-inflammatory properties. *Hydnora africana* extract-based creams offer an alternative to topical medications based on NSAIDs by potentially reducing localized pain and inflammation [12].

Dosage Considerations and Bioavailability

Anecdotal evidence is provided by traditional usage, but scientific validation of the appropriate dosage is required. To assure consistency and effectiveness in the treatment of rheumatoid arthritis, a standardized dose of plant extract must be determined through clinical trials based on phytochemical studies. Due to inadequate absorption, certain phytochemicals like flavonoids and phenolic compounds, have low bioavailability. Creating extracts with lipid-based carriers like liposomes or nano emulsions, combining bioenhancers like piperine from black pepper to enhance absorption, and engaging fermentation techniques to convert

complex phytochemicals into more bioavailable forms are several ways to increase bioavailability. *Hydnora africana* exhibits potential as a RA treatment when used in combination, topical, and oral therapy. To confirm its efficiency as an additional or alternative treatment for RA, future studies should focus on formulation optimization, bioavailability enhancements, and clinical trials. However, advance human clinical research is required to prove its efficiency and safety [13].

Safety and Toxicity Profile

Hydnora africana seems to have a high safety profile with limited adverse effects. To evaluate its long-lasting protection in chronic usage, more toxicological research is necessary specifically for those with rheumatoid arthritis who need constant treatment. Stomach pain or allergic reactions in sensitive persons are potential problems. To reduce risks, extract reliability and dosage control are important. Its regulatory position remains uncertain due to the absence of clinical research checking its safety and efficiency. Upcoming research should concentrate on clinical trials, pharmacokinetic study and controlling agreement to show that it is a valuable treatment option for rheumatoid arthritis [14].

Conclusion

Hydnora africana shows functional therapeutic prospects in the treatment of rheumatoid arthritis due to the antioxidant, anti-inflammatory, and immunomodulatory properties. Normally, it helps to mitigate pain and redness in the joints with a probable influence on immunological activities. Prospective research should involve clinical trials, standardization of quantity, and enhancement of bioavailability to prove the therapeutic potential. Possible drug interactions and long-term safety data assessment are requirements for regulatory approval. Scientifically proved, *H. africana* could be a corresponding or alternative treatment in rheumatoid arthritis to NSAIDs and DMARDs.

Table 1: Active compounds, their mode of action, and evidence of therapeutic benefits in the treatment of Rheumatoid Arthritis with *Hydnora africana*

Sr. No.	Pharmacological Activity	Active Compounds	Mechanism of Action	Evidence
1	Anti-inflammatory	Tannins, Flavonoids	Inhibits pro-inflammatory cytokines (TNF- α , IL-6)	In vitro studies
2	Antioxidant	Phenolic compounds, Alkaloids	Scavenges free radicals, reduces oxidative stress	DPPH assay results
3	Immunomodulatory	Polysaccharides, Terpenoids	Modulates immune response, reduces autoimmunity	Animal model studies
4	Analgesic	Alkaloids, Flavonoids	Inhibits pain mediators (COX-2, PGE2)	Animal pain models
5	Anti-rheumatic	Saponins, Polyphenols	Protects joint cartilage, prevents degradation	Clinical observations
6	Anti-microbial	Tannins, Saponins	Prevents secondary infections in arthritis	Lab studies on bacterial strains
7	Anti-nociceptive	Flavonoids, Alkaloids	Reduces pain perception via opioid pathways	Animal studies
8	Cytoprotective	Phenolics, Steroids	Protects synovial cells from oxidative damage	In vitro cell culture studies
9	Collagen stabilization	Proanthocyanidins	Inhibits collagen degradation in joints	Biochemical assays
10	Bone-protective	Minerals, Phytochemicals	Enhances bone mineralization and density	Animal bone studies

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