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Exploring Antidiabetic Properties of Medicinal Plants in Malaria-Affected Regions

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ABSTRACT

This study investigates the potential antidiabetic properties of medicinal plants commonly used in malaria-affected regions. Diabetes and malaria, both prevalent in tropical and subtropical regions, often co-occur, posing unique challenges for healthcare management. Traditional remedies, including medicinal plants, have been widely employed to treat both diseases. This paper reviews the ethnobotanical use of plants with antidiabetic properties in areas where malaria is endemic, analyzing their pharmacological mechanisms, such as glucose transport inhibition and insulin sensitization. The synergistic relationship between malaria and diabetes is also examined, with an emphasis on shared pathophysiological mechanisms, such as oxidative stress and altered blood flow. The paper highlights the need for further clinical research to standardize the use of these plants and enhance their therapeutic potential.

Keywords: Antidiabetic properties, medicinal plants, malaria, diabetes, ethnobotany.

INTRODUCTION

Diabetes is no longer a disease confined only to affluent societies, with 80% of adult-onset diabetes mellitus occurring now in developing countries. Just like diabetes, malaria is also predominantly a disease of poverty and results in approximately 2.5 million deaths annually. Many epidemiological studies have highlighted the co-occurrence of both these maladies in the tropics and subtropics. Scientific evidence linking these two diseases is still at a nascent stage, but because of their co-distribution, healthcare providers need to be aware of their combined manifestation. As these diseases collide, regions of high diabetes prevalence may face new and challenging problems of managing hyperglycemia in the face of acute malaria, while sudden initiation of insulin therapy during malarial recovery can lead to life-threatening hypoglycemia or fast recovery from diabetes complications in previously hyperinsulinemic uncomplicated diabetes patients [1, 2]. A bewildering number of medicinal plants are used by traditional healers and paraprofessionals for treating various symptoms associated with diabetes and parasitic diseases like diabetes and malaria. Some of these plant decoctions have been found to possess both antidiabetic and antimalarial properties, which hold promise as possible therapeutic agents. Yet, as these plants are used in traditional medicine, they are also poorly understood anatomically, biologically, chemically, and pharmacologically. A brief rationale of a few such plants that have been studied in our laboratory is presented here along with some of their antidiabetic and antimalarial active principal compounds isolated. Genomic analyses on identified molecular targets such as glucose transport inhibitors, insulin mimetics, insulin secretagogues, glucose-6-phosphate dehydrogenase inhibitors, protein farnesyltransferase inhibitors, and plasmepsins are suggested [3, 4].

Medicinal Plants as Traditional Remedies in Malaria-Affected Regions

Medicinal plants are part of the traditional configuration of healing and curing. They are locally known as strong remedies against different kinds of diseases and are especially recognized in areas that are severely affected by malaria, as quinine or artemisinin are extracted from some of these plants. Plants and their

residues have been used to treat many diseases since ancient times. All cultures, during the resolution of health problems, rely on traditional remedies including healing techniques irrespective of their historical beliefs, linguistic dimensions, inhabited localities, or social-political traditions. Some communities attach extraordinary significance to useful plants in their habitats, primarily because they have been living very close to the activity of such plants. The usage, collection, preparation, and application of the herb-mixed cognitive dimensions and therapy and herbal training are passed down to them from their predecessors [5, 6]. An African person relies on herbal medicine either because they were not educated or because of its effectiveness. It is most likely due to the traditional use of medicinal plants that local people adapted to the signs and symptoms of highly endemic diseases, including malaria and lymphatic filariasis. Several traditional knowledge holders are very aware of identifying medicinal plants and the diseases that can be treated by a particular household-level herbalist who treats malaria and its associated consequences. The meditation of certain typical signs and symptoms of malaria focuses on these signs and symbols related to medicinal plants and treatment for malaria by healers. Many of the ethnobotanical research reports suggest that some herbal practitioners are recognized to be effective in treating local malaria. In modern healthcare, these traditional antimalarial remedies are potentially integrated with conventional antimalarial treatment. However, for many years, various studies have demonstrated these effects in numerous antimalarial medicinal plants in particular [7, 8].

Commonly Used Medicinal Plants in Traditional Medicine

Many medicinal plants are utilized for antidiabetic or antimalarial treatment within traditional medicine in endemic regions for communicable diseases. A review was conducted in light of the possibility of overlooking some of these antidiabetic plants in malaria-affected regions while searching for natural antidiabetic agents based on the review of these regions on potential plants used for antimalarial and malaria treatment, which uncovered some plant species used for the treatment of diabetes in these areas. As a further yearly initiative, medicinal plants used as food and medicine have yet to be looked into. This theoretical study aims to provide a comprehensive narrative of the most often utilized medicinal plants in the traditional healing process for the treatment of diabetes and malaria within malaria-affected regions based on the review presented in this paper. Medicinal plants play an important role in curing diseases as an important component of traditional health care in malaria-affected regions. These therapeutic herbs have already been employed for a long time and are considered to be recommended for long-term use by cultural traditions. Leaves, roots, and the whole plant are the most frequent parts of the plant used in the therapy of malaria and malaria-related conditions in the majority of cases. Frequent techniques of preparation of unimproved extracts from these plants involve the pounding and/or crushing of leaves into a fine powder or paste. This paste may then be utilized to prepare a tonic or syrup to be consumed as morsel or as a decoction in boiling water. This is also classified as a macerate, with crude leaf and root chemicals being mashed with hot water to form a soothing medicinal herbal drink. Accounts of ethnobotanical flora used in the control or treatment of malaria and antidiabetic procedures in malaria-affected areas, collated from documented interviews of individuals who use these health facilities, were also used. The number of applicable diagnostic plants and traditional or local medicine employed to cure and control malaria and other allopathic healthcare necessities from many regions of malaria-endemic areas is documented. Data demonstrate that plants have some beneficial antidiabetic properties correlated with the findings of other researchers. This could be a reasonable premise for further phytochemical evidence and pharmacological assessment in clinical trial formulation to condone validation. Research in this area could lead to the establishment of a variety of very powerful pure pharmacopeias that reduce the number of new plant-based medications. More discussion is provided on the need to document more of Angola's ethnobotany because of the sheer number of species out there. Given diabetes' long-standing relationship with malaria, fewer ethnobotanical research articles have investigated the relationship between plants that can treat the two diseases [9, 10].

Link Between Diabetes and Malaria: Shared Pathophysiological Mechanisms

There are increasing concerns regarding comorbidity and the associated risk factors of non-communicable diseases in malaria-affected areas as the prevalence of diabetes and other metabolic syndromes continues to rise in these regions. Interestingly, both diabetes and malaria share pathophysiological mechanisms. For instance, a person suffering from uncomplicated malaria could present with malaria-induced hypoglycemia that could lead to coma. On the other hand, Plasmodium parasites inside chronic hyperglycemic diabetic patients may increase the severity of malarial complications. Elevated blood glucose can be detected in some Plasmodium-infected patients irrespective

of whether they are diabetic or not [11, 12]. Pathophysiological mechanisms indicate that underlying diabetes in hyperglycemic patients may affect the microcirculation, endothelial lining, and blood flow, much like the mechanisms underlying malarial pathogenesis. There is also conclusive evidence that diabetes and malaria have varied biological interactions that may impact disease outcomes. For example, certain infection-related factors may alter a diabetes patient's susceptibility to malarial infection, as well as intermediate and long-term complications. Although the exact molecular mechanisms are not fully understood, diabetes or malarial parasites can profoundly induce changes, including oxidative stress, blood flow disturbances, and metabolic alterations, in the opposite disease physiology. Plasmodial infection is also characterized by inflammation, complement activation, and coagulation. These changes can exacerbate existing risk factors and may worsen disease outcomes unless proper intervention is delivered. Biochemically, a reciprocal relationship is observed in both conditions. Extreme hyperglycemia in diabetes could interfere with iron transport and enhance the risk of developing malaria. Infected red blood cells exhibited iron deprivation, as well as concentrations of selected iron regulators, such as iron storage protein. Therapeutically, managing the two disorders concurrently holds the key to preventing any potential disease deterioration [13, 14].

Antidiabetic Properties of Medicinal Plants

Medicinal plants have long been recognized for their antidiabetic potential and could be one of the possible answers for curing diabetes mellitus, a multifactorial disease affected by genetic and environmental factors. Traditional use of herbal medicines across the globe has shown that several plant species play a significant role in the management of diabetes. In recent times, several preclinical and clinical studies have been conducted on medicinal plants and their potential effects on blood sugar and hemoglobin levels. Regional traditional knowledge about medicinal plants and their uses for the treatment of diabetes is also reported by scientists, health professionals, and sociologists. Epidemiological surveys have revealed that the incidence of malaria is associated with decreased secretion of insulin or insulin resistance. There is a high prevalence of malaria in the study area; hence, to reduce such malarial load, hypoglycemic plants may be necessary to increase [15, 16]. Several plant species have shown signs of hypoglycemic activity and they are known as antidiabetic medicinal plants. The active constituents of plants that are responsible for such hypoglycemic effects are flavonoids, saponins, tannins, alkaloids, coumarin, sterols, terpenes, and lignans. The antidiabetic effect of these phytochemicals is mediated through different mechanisms such as inhibition of hepatic glucose output, stimulation of insulin release, inhibition of certain disaccharidase activity, hyperphosphorylation activity, delay of carbohydrate digestion and absorption, antioxidant activity, increased glucose uptake through IRS-1-mediated signaling pathway, insulin mimetic and sensitization of insulin receptors, and gluconeogenesis regulation. Alternative approaches to managing diabetes through hypoglycemic plants are gaining interest. Not only can these plants be used in diabetes treatment, but they could also reduce the incidence and severity of some of the morbid complications through complementary and primary preventive approaches. However, the long-term use of these plants does not cause drastic reductions in blood glucose levels and is also free from any deleterious effects. Further long-term, systematic studies on humans are necessary to standardize the use of such medicinal plants in clinical treatment [17, 18].

Phytochemicals with Antidiabetic Activity

Various phytochemical constituents in medicinal plants have anti-diabetic properties. These include flavonoids, alkaloids, carbohydrates, proteins, amino acids, terpenes, terpenoids, polysaccharides, saponins, fiber, phytosterols, phenolics, and tannins. These compounds can lower blood sugar levels and body weight through different mechanisms, such as enhancing insulin secretion or receptor activity, inhibiting hepatic glucose release, stimulating or inhibiting glucose uptake, and delaying glucose polymers' hydrolytic process. They also relieve symptoms, and complications, and prevent the development of diabetes. However, their bioavailability and efficacy as antidiabetic agents are often low. Challenges in harvesting, drying, and standardizing plant tissues affect the development and processing of these compounds. Clinical use of many isolated and synthesized phytochemicals is limited due to methodological development issues. More research is needed to isolate and identify antidiabetic compounds in different medicinal plant classes [18, 19].

Challenges and Opportunities in Research and Development

Efforts in research and development in the whole process – from major cultivation to extraction and formulation – are the most expensive parts of developing new drugs [20, 21, 22]. There is little flow of funds for drug development for diseases that predominantly affect low-income countries. Regulatory

authorities for health classification of traditional medicines need addressing, and in malaria-affected countries, there are often differences in procedures and priorities between malaria control programs. Ancient indigenous medical practices associated with medicinal plants exhibit a great range in their diversity and complexity [23, 24]. Due to various harvesting times, a single medicinal plant can be useful in communicating an understanding of the targeted plants with the different indigenous communities that use it. The lack of best practices for distance foodstuffs and dosages for the use of medicinal plants all across the world is some of the scarce information available [25, 26]. Pharmacists and indigenous healers are dependent on herbal remedies popular from the past. Most of the clinical trials, because of variations in sources of the plants and how the preparations were made, are difficult to conduct and are consistently pitched as complex and mostly official in a difficult regulatory environment [27, 28]. The significance of this results in the primary focus of most medical research being treatments developed from any chemical entity from synthetic sources [29, 30, 31]. A broad rumination of herbal medicine worldwide over the last few decades suggests that a multifaceted program thoroughly planned for interaction between traditional healers and classical physicians can be advantageous for the aid of patients. Herbal medicines have an increased scientific base for efficacy and safety [32]. Dependency on natural ecosystem products, i.e., raw materials, extraction, formulation, and administration systems, and classical medicines have been proposed for the commonplace use of both traditional drugs [30, 31]. Rediscovery is based on the society at large given the relentless malaria transmission mechanism and frequent failures in substantially arresting the disorders. Knowledge of the existing sociocultural and economic events in tropical situations in every society, along with ensuring adaptable and socially acceptable antidiabetic drugs, leads from an integrative approach accordingly on medically tested new drugs. A greater stake of protection for rural and indigenous communities, along with the socio-economic projection of their traditional cultures, may help the overall development of rural communities and eliminate poverty by enhancing raw materials, herbals, tonics, and drugs all over the world, creating knowledge-based societies [22, 23].

CONCLUSION

The antidiabetic potential of medicinal plants in malaria-affected regions offers a promising avenue for therapeutic interventions in managing both diseases simultaneously. These plants, rich in phytochemicals, provide a natural alternative to conventional treatments, with several mechanisms supporting their hypoglycemic effects. However, clinical validation and standardized formulations are essential to ensure their safety and efficacy. A deeper understanding of the shared pathophysiology between malaria and diabetes could pave the way for integrative treatment strategies. Increased investment in ethnopharmacological research could not only improve healthcare outcomes in endemic regions but also contribute to global efforts in combating both diabetes and malaria through natural resources.

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