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RESEARCH INVENTION JOURNAL OF RESEARCH IN MEDICAL SCIENCES 3(2):38-49, 2024

©RIJRMS Publications ISSN: 1597-3107

Dual Burden of Diabetes Mellitus and Malaria: Exploring the Role of Phytochemicals and Vitamins in Disease Management

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ABSTRACT

The global rise in diabetes mellitus (DM) coincides with persistent malaria in certain regions, creating a dual burden of disease. This paper explores the historical context of diabetes, from early descriptions to modern management practices, and examines the intricate relationship between diabetes and malaria. It highlights the chronic low-grade inflammation common to both conditions and explores the potential role of anti-inflammatory treatments, particularly phytochemicals and vitamins, in managing these diseases. Focusing on the interaction of anti-diabetic and anti-malarial drugs, the study emphasizes the need for integrated management strategies, especially in malaria-endemic regions. This paper aims to provide a comprehensive understanding of the co-morbidity of diabetes and malaria and to advocate for the development of therapies that address both conditions simultaneously.

Keywords: Diabetes Mellitus, Malaria, Phytochemicals, Vitamins and Disease Management

INTRODUCTION

Globally, the number of people with diabetes continues to rise. Areas where malaria persists suffer from this double burden [1-3]. The history of diabetes mellitus dates back to as early as 250 AD in the reign of Apollo and Galen, with the first attempt at quantifying the sweetness of urine made in the 19th century. Diagnosis and management have seen steady development since then [2]. Despite the clearly defined management protocol for diabetes, complications still occur due to various reasons. Blood sugar levels are the central focus of diabetes management, as complications arise from their effects on capillaries, nephrons of the kidney, blood vessels, autonerves, and non-vascular cells - all areas of the body that are also affected by malaria. Diabetics manage their hyperglycemia without the hope of becoming normoglycemic, as scientific advancements and treatments progress, making Diabetes Mellitus management symptomatic in areas where malaria is prevalent [4]. It is essential for us to understand the entire disease and which parts are affected in order to normalize the chronicity [5]. These disease areas are characterized by chronic low-grade inflammation and its consequences, making an anti-inflammatory treatment approach necessary. Conventional extracts from a combination of compounds that have been tested and demonstrated in models may provide insights that can guide other families containing a mimetic, as it is clear that it would be difficult to identify a prescriptive replacement from the mixture of compounds from which the leads were singled out [3]. Malaria and diabetes are two devastating diseases that have claimed and continue to claim lives, even with technological advancements. Diabetes is an old-age disease that is gaining ground in developing countries, despite symptomatic management [6-9]. Good diabetes management requires a thorough understanding of the complications it entails. There are many theories as to how these complications occur, but the consensus lies in the connection between diabetes and chronic inflammation [10]. Diabetes can occur with or without malaria comorbidity. However, in areas where malaria is prevalent and people survive childhood, chronic low-grade inflammation, which malaria can contribute to, becomes a possibility. It is also important to note the widespread use of phytochemicals in traditional malaria and diabetes management, making this subject particularly relevant. The anti-inflammatory and antioxidative

capabilities of some of these phytochemicals are no longer disputed, and they may play a central role in the interactions within the body in areas where malaria is a problem and diabetes occurs with malaria comorbidity [11-13].

Background and Rationale

These calls to study the potential of antidiabetic and antimalarial herbal, allopathic remedies, and other management approaches such as physical exercises, breathing exercises, and stress-reducing therapies to prevent and manage these diseases together [14-18]. An escalating number of documented cases demotivate people in malaria-endemic regions from getting diagnosed or even treated in the face of infections with both diseases. Moreover, hyperglycemia, a characteristic of diabetes, and anorexia are symptoms of malaria with no specificity in differential diagnosis, leading to misdiagnoses and improper management of the diseases [15]. Malaria and diabetes are two diseases that are among others effectively managed with natural remedies. In malaria-endemic zones, hypersensitivity to anti-diabetic synthetic drugs can provoke hypoglycemia during malaria therapy, leading to death of diabetic patients [16]. The use of oral antidiabetic drugs or insulin may also lead to an increased number of bites of infected female anopheles on diabetic patients due to attractive scent projections. Even quinine, an early anti-malarial medication, was discovered as a muscle relaxant after using it in the treatment and analysis of diabetic patients [17].

Scope of the Study

Previous studies mainly focused on identifying medicinal plants in malaria-endemic areas and failed to identify food sources of diabetic-care phytochemicals [15]. It is, however, known that healthy foods minimize hospital visits and mortality rates of people with chronic diseases in malaria-endemic regions. In our efforts to strengthen the immune system of people with chronic diseases, it is good to supply them with vitamins and prevent deposition of harmful iron through the use of ceruloplasmin, a natural oxidase produced through sufficient copper absorption [16-18]. Glucose control in diabetes therapy and the prevention of vascular occlusion during malaria attacks follow [19]. Medicinal plants screened and identified earlier for medicinal properties were found to contain the diabetic-care phytochemicals and vitamins needed to implement combinatory therapies of both chronic diseases in one dish. Noteworthy chemicals found in some of the medicinal plants include iron/ferritin inhibitor, phosphotyrosine phosphatase inhibitor, glucose inhibitor, and latent transforming growth factor β-binding protein II inhibitor [20-23]. Some of the functions of vitamin E (ceruloplasmin) in the prevention of complications among people with chronic diseases in malaria-endemic regions are to protect them against secondary infections probably caused by Plasmodium ovale. Two medicinal plants identified as potentially rich in diabetic-care phytochemicals and vitamins include Amaranthus caudatus L. and Senna uniflora [24].

Diabetes and Malaria: An Overview

The Tromsø study in Northern Norway reported that DM2 patients carry an increased susceptibility to malaria [25]. In addition, several anti-diabetic drugs have been identified to possess anti-malarial activity, advocating the need for alternative management of diseases as well as advocating for the discovery and development of drugs that can manage and prevent both diseases. Chronic malaria can increase diabetes risk as a result of pancreatic β-cells affected by Plasmodium infections, so people living in regions with malaria should be aware of the potential malaria-related risk of diabetes [26-28]. Diabetes mellitus (DM) is a non-communicable and lifestyle-related disease characterized by complications derived from chronic hyperglycemia [27]. Malaria, on the other hand, is an infectious disease caused by parasites of the genus Plasmodium that continue to emerge in tropical and subtropical countries [29]. The coexistence of these two pathologies is of particular concern, as a significant number of individuals in malaria-endemic regions live with diabetes. The results of the study showed that most of the shared antimalarial drugs inhibit cytochrome P450 enzymes that metabolize prediabetes, diabetes, and comorbidity drugs [25]. Among the top 50 common drugs bound, the antimalarials inhibited the action of the drugs related to hyperlipidemia, dyslipidemia, prediabetes, diabetes, and comorbidities [30]. These findings might have implications in the management of comorbid prediabetes and diabetes in malaria-endemic regions. Diabetes mellitus and malaria are both major public health problems that have lasting negative repercussions on the lives of individuals. Recent statistics show that both diseases can coexist within the same human host [28-31]. This study aims to analyze the effects of drug-gene interactions on two shared classes of antimalarial drugs: the antifolates and the artemisinins, and drugs used for prediabetes, diabetes, and diabetes-related comorbidities, in combination with three phytochemicals that are also antimalarial agents [32].

Epidemiology of Diabetes and Malaria

The prevalence of diabetes mellitus has increased significantly worldwide. This is attributed largely to increasing longevity, changing lifestyles, obesity, physical inactivity, urbanization, and unhealthy diets [33]. The International Diabetes Federation described Africa as the "Region with the highest proportion

of undiagnosed diabetes." The Federation in 2019 reported that almost half a billion people are expected to develop type 2 diabetes by 2030 [34]. Malaria tends to afflict the vulnerable and poor people living in tropical and subtropical regions of the world, who are often unexposed or have access to inadequate healthcare systems. Sustained economic development has led to the growth and expansion of sanitation systems, reduction in incidence, and the associated levels of natural immunity against malaria in populations not previously exposed [35-39]. This has resulted in increased susceptibility of migrants to malaria-endemic regions as well as other travelers, who can get both mild and severe life-threatening illnesses. These situations present a confounding situation where hyperglycemic migrants must remember to also protect themselves against hypoglycemia when receiving malaria prophylactic drugs before returning to their homelands [28]. Malaria and diabetes mellitus constitute global health problems. Malaria, more common in developing countries such as sub-Saharan Africa, is responsible for millions of mortalities and morbidities annually. Often, people living in malaria-endemic regions are also at greater risk of exposure to poor environmental and socio-economic conditions [27]. This makes them less capable of dealing with the additional burden of chronic diseases such as diabetes, which itself is a global public health emergency. When there is a coexistence of these diseases, there is an increase in healthcare challenges due to overlapping points of care and overzealous dosing of antimalarials, which can result in dangerous hypoglycemic reactions. Therefore, there is an urgent need to adopt strategies to not only manage one disease but both diseases concomitantly [34].

Shared Risk Factors and Complications

Individuals with malaria have increased rates of complications, such as coma, severe anemia, and death, when they also have hyperglycemia and diabetes. Chloroquine, commonly used in malaria treatment, exacerbates hepatic insulin resistance, and Zn(II) enhances glucose homeostasis and insulin sensitivity in chloroquine-exposed mice, providing plausible mechanisms for the hypoglycemic effects of malaria treatment. Animal studies have reported the diabetogenic effects of malaria treatment with other drugs. Type 2 diabetes mellitus (T2D) can predispose to severe malaria via impairment in T-cell signaling by the ZAP70 gene and nonglycemic metabolic pathways. Hyperglycemia and malaria are independently associated with severe malaria anemia in children living in high malaria transmission areas, and this risk increases further in diabetics [40-45]. The increasing prevalence of diabetes in malaria-endemic regions necessitates differential diagnosis of fevers in patients who present with hyperglycemia [42]. Treated diabetes has been associated with high tolerance to artemether-lumefantrine, involving different pharmacokinetics and tissue-dependent disposition between diabetic and non-diabetic subjects. Plasma and tissue concentrations of the bioprotective and therapeutic angiogenic isoform of vascular endothelial growth factor-A negatively correlate with body mass index in diabetic patients, with clinical implications. It is suggested that the contribution of extracellular vesicles to the intercellular cross-talk in diabetes and malaria is affected by host-vector relationships [46]. Optimal management of diabetes and malaria requires care synchronization between hospitals and public health. Diabetics are shown to be at increased risk of failure of antimalarial drug treatment, as well as relapsing caused by microgametocyte dose [47]. Dominant arm grip strength is reduced in patients with malaria, and among patients who are known to have diabetes, diabetes-related complications have increased healthcare costs [48]. Severe, as well as typical focal neurological deficits, can be observed in the non-elderly, non-HIV-infected, diabetic African patient for diverse etiologic reasons among the TIA simulator-diagnosis-related group. Taken together, these data suggest that glioma outcomes should not be affected in diabetics receiving metformin and other inhibitors of growth or intensive blood glucose control [43-46]. Finally, growing evidence has shown that diabetes mellitus can lead to severe alterations of the macrophages with antimalarial effects, with potentially important implications on malaria vaccine strategies among the escalating number of patients with cancer. 4-1BB co-stimulation of activated T cells inhibits malaria in diabetic NOD mice through CD8(+) T cell Th1 and TRP effector functions [45]. Diversion of important innate regulatory cells from RCC cells with modeled products psychological mechanism of action to recommend for diabetes treatment in malaria-endemic and other tours. These propose a cooperative effect on the pathogenesis of malaria and diabetes through signal transduction pathways, such as protein tyrosine kinase, serine/threonine phosphorylation, and oxidative disorders [47].

Diabetes and malaria are two of the most peculiar diseases in the world, especially in sub-Saharan African countries, and they present risk factors predisposing individuals to each other. Both have some common complications, such as foam cell generation which can develop into atherosclerosis; retinopathy and nephropathy caused by hyperglycemia and plasmodium; inflammation; oxidative stress leading to insulin resistance and thickening of the alveolar wall [48]. This necessitate s the usage of the same strategy, including vitamins and phytochemicals, in combating these diseases, especially among individuals susceptible to either of them [49].

Vitamins and Phytochemicals in Diabetes Management

Bioactive parts exist in phytochemicals, which are beneficial for health. They are essential to human health. Many phytochemicals are useful for obesity, cancer, dyslipidemia, and diabetes [47]. Antioxidative, peroxide scavenging, antidisease, and disease-preventing phytochemical components exist [. Prevention of damage to activation mechanisms might cause cell rundown, antioxidant phytochemicals guarantee safety. Indeed, diseases such as cancer and diabetes may be caused by the production of reactive molecules that come from the metabolism process [48]. Vitamins and phytochemicals are essential food supplements that account for beneficial health effects. Metabolism and energy, responsible for development and maintenance, originate largely from vitamins. The metabolism of macronutrients (carbohydrates, amino acids, and fatty acids) is done by vitamins, which combine to support energy production [49-51]. Vitamins are helpful for the prevention of diseases like pellagra and beriberi when included in required quantities. Vitamins are also helpful for growth and bone maintenance. Other minerals and water also help combat fatigue from physical stress [50]. Antioxidant activity for neutralizing free radicals is another essential role of vitamins. Water and liposoluble chains are vitamins. For balanced human health, all vitamins are required in appropriate proportions [52]. High doses of vitamins can have many consequences, like birth defects and kidney stones, etc.

Role of Vitamins in Diabetes Management

Vitamin B1 (thiamine), B3 (niacin or nicotinic acid), and B6 (pyridoxine) are a group of water-soluble vitamins. Deficiency of them in the diet causes many types of health issues. Diabetes also has a kind of linked depletion of these vitamins. They are responsible for initiating coenzymes in the metabolism of carbohydrates to produce energy [23-30]. Ample evidence has been written on the benefits derived from the supplementation of vitamins and minerals in the maintenance of normal blood glucose metabolism, the risk of developing diabetes, and to reduce the risk of diabetic complications. Supplementation of these vitamins with other recommended medications for diabetics decreased the risk of retinopathy and neuropathy [53]. Vitamin B1 and B6 are responsible for enhancing the effects of insulin, a hormone that helps glucose undergo cellular metabolism, preventing blood sugar imbalances. Their deficiency is linked to diabetes. Noninsulin-dependent diabetes patients have low blood levels of biotin. Diabetics are encouraged to avoid alcohol consumption [54]. Alcohol consumption decreases vitamin B1 (thiamine) levels. The pancreas, the organ that releases insulin, is severely affected by alcohol consumption. Insufficient secretion can result in hyperglycemia. The lie of vitamins, minerals, and herbs to cure diabetes is not founded. Five scientists in 2011 published peer-reviewed articles that physiologically link these vitamins with diabetes. That is why correction and supplementation with drugs are needed in many diabetic patients. Diabetes mellitus (DM) can be controlled with the proper use of oral hypoglycemic, recombinant insulin, nutritional supplements, and exercise [55-59]. Management of diabetic patients by nutritional supplementation is relatively low. However, dose-dependent vitamin intake could be effectively used to manage diabetes. Vitamins K1, K2, K4, and K5 have potent antidiabetic activity determined from a study conducted on Northern Nigerian Diabetes. 5-methoxy-N,N-dimethyl tryptamine (5-MDMT) was isolated from the fractions of unripe Carica papaya with potent glucose utilization in a rat model study. Biotin and Mg2+ also have antidiabetic activity. There is a possibility that 5-MDMT, which possessed antidiabetic activity, could have been a vitamin like riboflavin; studies need to be conducted on this phenomenon [48-52].

Phytochemicals and Their Potential Benefits

Research has shown that phytochemicals such as polyphenolic compounds, terpenoids, and flavonoids reduce the harmful effects of hyperglycemia [53-57]. Therefore, in addition to vitamin supplementation, both adequate intake of phytochemical-rich plants in the diet and consumption of herbal preparations with antidiabetic effects are strongly recommended. This chapter discusses the health benefits of eight select phytochemical-rich plants that are frequently consumed in malaria-endemic regions to improve general health and to reduce the risk of developing diabetes [56]. These eight plants include bamboo, coconut, curry, herbs from the family Asclepiadaceae, longan, sweet grass, turmeric, and vetiver. Their potential contribution to managing diabetes and its complications is also reviewed. Finally, development of functional drinks using these phytochemical-dense phytochemical-rich plants is explored as a potential addition to the market for convenient functional and healthy drinks [58].

Interactions Between Diabetes, Malaria, and Nutritional Deficiencies

Diabetics and, to a larger extent, hypoglycemics, increased malarial parasite asexual development and hampered sexual development, resulting in compromised populations of sporozoites [60]. However, rather than focusing on complex and not clearly defined major histocompatibility complex effects, which may exert undesirable influencing effects on beta-cell reactions, the mere presence of attached of which alters the diabetic symptoms in less well-cared-for patients should instigate the consideration of a possible role of

vitamins in the prevention and management of diabetic complications in malarial endemic regions [60-64]. Whether these vitamins would act prophylactically, or whether better diabetes management in malarial endemic areas would be to ensure an adequate vitamin intake in food and diet, is subject for further research, but supplementation with vitamins is likely to cause less public concern [59]. Diabetes has significant worldwide complications. Underlying malnutrition, resulting from a variety of factors and combined with the added insults of malarial infections, exacerbates these diabetic complications. The interactions between malarial and diabetic anemia, hemolysis, glucose control and hypoglycemic episodes, and nutritional deficiencies are complex and potentiate adverse outcomes in low-income settings. Nutritional support, including vitamins such as vitamin C, is likely to be important in reducing the likelihood of malaria in diabetics. Vitamin E may be important in reducing the risk of cerebral malaria [61].

Impact of Malaria on Diabetes Progression

On the other hand, the potential effects of T2DM on malaria infection could be the glucose content of the RBC, which could alter the systemic antioxidant levels, leading to increased sensitivity of the RBC to oxidative damage and malarial infection with non-healing or long-term chronic symptoms [60]. Furthermore, the hyperglycemia in T2DM cases would lead to a higher progression of the malarial complications or an increased frequency of progression compared to the uninfected patients. Indeed, there are a myriad of overlap factors, including an immunosuppressed state; poor RBC cell membrane integrity; and immune evasion induced by malarial products, such as PfEMP1, RIFIN, or STEVOR, under certain cellular conditions [61-65]. Additionally, behavioral patterns and population-wide effects of the mindful use of antidiabetic supplements in malaria-endemic regions on T2DM progression may have indirect positive effects in reducing the frequency and the burden of malaria infection through economic contributions [63]. Malaria has co-endemicity with T2DM in several developing countries, such as sub-Saharan Africa. However, very little is known about the effects of one disease on the other or the impact of the co-endemicity [66]. Malaria infection tends to have harmful or beneficial effects on T2DM progression and vice versa. In terms of T2DM, the potential effects of malaria infection are through the production of inflammatory cytokines, which is vital in the T2DM progression and its associated maternal and pregnancy-related complications [56]. Also, from the hypoglycemic association with malaria, it is tempting to speculate that either in the convalescent phase of malaria or during the administration of antimalarial drugs to the patient, optimal glucose level is achieved, leading to T2DM-unrelated complications and death [67].

Nutritional Deficiencies in Malaria-Endemic Regions

Nutritional deficiencies in malaria-endemic regions negatively impact diabetic patients, predisposing them to infections, anemia, and possible hidden hunger [68]. Hyperglycemia and chronic hyperglycemia from dietary consumption, mostly and not diabetes per se, are metabolically energetic and play a large role in the body's host defenses against the different stages of a malarial infection. Redirecting an adaptive immune response from effector to regulatory in weighing in on a two-practices debate, we position our assumptions on toll-like receptor signaling to advantage our anti-diabetic hyperglycemic treatment plan. We present a therapeutic anti-malarial diarrhea and diabetes plan integrating vitamin D, medicinal compounds from Osteocochsa mossambicensis, dietary manipulation, and probiotic usage [69]. Interaction between infectious diseases and micronutrient deficiencies is complex, especially in the backdrop of prominent diseases of the tropics. In regions where malaria is endemic, both diabetic deficiency diseases, including micronutrient deficiencies, are common [69-73]. These relationships between diabetes mellitus, prediabetes mellitus (sub-optimally controlled hyperglycemia), and prediabetes dysglycemia (impaired fasting glucose, impaired glucose tolerance) occur in a latitude-dependent association with malaria. For instance, where there is a significant difference between vitamin D3 levels of diabetic hypertensive and hypertensive-only patients, vitamin D3 levels and hypertension control are predictors of diabetic complications. Such a region's food supply does not meet basic dietary nutritional needs with the required incident micronutrient intake. Included in this, but not limited to, are vitamins A (and probably E), C; selenium and zinc, iron, magnesium, vitamins D, and B12. Since diabetic patients are already nutritionally challenged, how do we then advocate a calorie-restricted protocol followed with phytochemical-rich supplementation? Vitamin Supplementation and Phytochemicals in the Prevention and Management of Diabetic Complications in Malaria-Endemic Regions [61].

Research Evidence on Vitamin Supplementation and Phytochemicals in Diabetic Complications and Malaria

Traditional plant-based medicine for the management of chronic complications of diabetes is becoming patients' preference since it is natural, affordable, accessible, and less responsible for side effects. The major groups of natural compounds that are commonly used for the prevention and management of diabetic complications are vitamin supplements and phytochemicals, since many of them are nearly devoid of

adverse effects on different body systems, including the genotoxic effect [62]. The purpose of this paper is to review the research evidence on the role of phytochemicals and vitamins associated with complications of diabetes in the region where diabetes and malarial infection have been reported at a higher rate and further discuss their possible mechanistic actions and the suitable combination based on the factual evidence [74-76]. Diabetes mellitus is considered among the chronic metabolic disorders affecting many people in the world, especially in the malaria-endemic region. Untreated and uncontrolled diabetes increases the severity of different complications, including retinopathy, kidney disorders, damage to the blood vessels of the lower extremities, weakness, and susceptibility to different infections [75]. Diabetic patients need long-term medical care in order to decrease the progression and severity of such complications. However, the availability and affordability of recommended antidiabetic medications are a major problem in most developing countries, causing many people to turn their attention to phytochemicals and dietary supplementation as traditional medicine for the prevention and management of different complications of diabetes [73].

Clinical Studies on Vitamin Supplementation

Clinical studies have demonstrated an association between the consumption of certain vitamins and the prevention of T2 diabetic complications in malaria-endemic areas infected by Plasmodium falciparum [74]. People living in malaria-endemic regions should ensure they have an appropriate intake of vitamins C and E to protect themselves against oxidative damage since their diet is not sufficient to maintain their body's stores at recommended levels [75-77]. In the past, vitamins were used therapeutically in times of infection, and also particularly in the treatment and prevention of epithelial abnormalities. Antioxidants, such as carotenoids, seemed to protect individuals against the risk of ontogenesis, while other nutrients were apparently protective against diseases. In this sense, patients with chronic diseases or those under stress and/or extra exertion may require an extra intake of vitamins, as outlined in several scientific society guidelines. Several reports have documented low levels of vitamins in patients with type 2 DM and have demonstrated that higher intakes of vitamins, in addition to promoting better glycemic control, also decrease the incidence of chronic complications [70]. Previous studies have shown that an improvement in vitamin nutriture, particularly vitamins C and D, increased the total antioxidant status (TAS) in T2DM patients. Several clinical trials have evaluated the effects of vitamin supplementation on the prevention of T2DM complications [71]. Overall, clinical and observational studies have suggested that vitamins and trace elements may play a beneficial role in preventing and managing DM and its complications. High clinical doses of retinoic acid have been administered with apparent positive effects, increasing cell differentiation and insulin sensitivity, as well as decreasing the abnormalities of hepatic glycogen metabolism [75]. Other studies have shown that a high intake of vitamin E together with good glycemic control reduced protein glycosylation and also had beneficial effects on motor conduction velocity and the amplitude of the sensory nerve action potential. Fish oil is an excellent source of essential fatty acids, such as omega-3 fatty acids, and is important since individuals with diabetes often exhibit lipid abnormalities [76-79].

In Vitro and In Vivo Studies on Phytochemicals

Several chronic diseases present with complications that show a certain degree of correlation [80-85]. It could be considered a great breakthrough in the field if a common pathway associated with the occurrence and prevention of complications of both diabetes and its associated complications, and the complications associated with other diseases will be well defined [82]. This information will be valuable in developing alternative therapies for some of the world's important medical problems. Likewise, the elaborate compilation of this information would have to help malaria sufferers in the malaria-endemic tropical countries where medicinal plants are extensively utilized as an alternative therapy [86]. These medicinal plants are frequently used to cure diabetes and concomitantly utilized to treat the disease, with some of the common plants associated with other medical problems. In vitro studies have shown the application of phytochemicals in numerous studies to prevent diabetic complications. Similarly, specific compounds have been implicated in the amelioration of diabetes-associated malaria [81-83]. The in vitro and in vivo administration of specific compounds shows their ability to prevent and/or ameliorate diabetic complications [87]. Moreover, the oral administration of specific phytochemicals may appear to increase the lifespan of patients to a certain plausible rate [82]. However, precise information on the molecules involved, their structural analog, bonding, and synergistic or associated actions with specific molecules when administered in combination has not been well established [79-84].

CONCLUSION

Diabetes mellitus and malaria represent a significant double burden, particularly in regions where both diseases are prevalent. The historical evolution of diabetes management has provided insights into the complexities of chronic disease management, yet the co-morbidity with malaria presents unique challenges.

Chronic low-grade inflammation is a common feature of both diseases, suggesting that anti-inflammatory and antioxidative treatments, including phytochemicals and vitamins, could play a pivotal role in managing these conditions. Integrating traditional and modern medicinal approaches, especially in malaria-endemic regions, could enhance disease management and improve patient outcomes. Further research is needed to develop effective combinatory therapies that address the intricate interplay between diabetes and malaria.

REFERENCES

1. Okechukwu, P. U., Okwesili, F. N., Parker, E. J., Abubakar, B., Emmanuel, C. O., & Christian, E. O. (2013). Phytochemical and acute toxicity studies of Moringa oleifera ethanol leaf extract. *International Journal of Life Science BiotechNology and Pharma Research*, *2*(2), 66-71.
2. Odo, C. E., Nwodo, O. F., Joshua, P. E., Ugwu, O. P., & Okonkwo, C. C. (2013). Acute toxicity investigation and anti-diarrhoeal effect of the chloroform–methanol extract of the seeds of Persea americana in albino rats. *journal of pharmacy research*, *6*(3), 331-335.
3. Adonu Cyril, C., Ugwu, O. P. C., Esimone Co, O., Bawa, A., Nwaka, A. C., & Okorie, C. U. (2013). Phytochemical analyses of the menthanol, hot water and n-hexane extracts of the aerial parts of cassytha filiformis (Linn) and leaves of cleistopholis patens. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, *4*, 1143-1149.
4. Orji, O. U., Ibiam, U. A., Aja, P. M., Ugwu, P., Uraku, A. J., Aloke, C., ... & Nwali, B. U. (2016). Evaluation of the phytochemical and nutritional profiles of Cnidoscolus aconitifolius leaf collected in Abakaliki South East Nigeria. *World Journal of Medical Sciences*, *13*(3), 213-217.
5. Offor, C. E., Ugwu, P. C., Okechukwu, P. M., & Igwenyi, I. O. (2015). Proximate and phytochemical analyses of Terminalia catappa leaves. *European Journal of Applied Sciences*, *7*(1), 09-11.
6. Nwali, B. U., Egesimba, G. I., Ugwu, P. C. O., & Ogbanshi, M. E. (2015). Assessment of the nutritional value of wild and farmed Clarias gariepinus. *International Journal of Current Microbiology and Applied Sciences*, *4*(1), 179-182.
7. Afiukwa, C. A., Igwenyi, I. O., Ogah, O., Offor, C. E., & Ugwu, O. O. (2011). Variations in seed phytic and oxalic acid contents among Nigerian cowpea accessions and their relationship with grain yield. *Continental Journal of Food Science and Technology*, *5*(2), 40-48.
8. Aja, P. M., Okechukwu, P. C. U., Kennedy, K., Ibere, J. B., & Ekpono, E. U. (2017). Phytochemical analysis of Senna occidentalis leaves. *IDOSR J Appl Sci*, *2*(1), 75-91.
9. Igwenyi, I. O., Isiguzo, O. E., Aja, P. M., Ugwu Okechukwu, P. C., Ezeani, N. N., & Uraku, A. J. (2015). Proximate composition, mineral content and phytochemical analysis of the African oil bean (Pentaclethra macrophylla) seed. *American-Eurasian J Agric Environ Sci*, *15*, 1873-1875.
10. Orji, O. U., Ibiam, U. A., Aja, P. M., Ugwu, P., Uraku, A. J., Aloke, C., ... & Nwali, B. U. (2016). Evaluation of the phytochemical and nutritional profiles of Cnidoscolus aconitifolius leaf collected in Abakaliki South East Nigeria. *World Journal of Medical Sciences*, *13*(3), 213-217.
11. Offor, C. E., Ugwu, P. C., Okechukwu, P. M., & Igwenyi, I. O. (2015). Proximate and phytochemical analyses of Terminalia catappa leaves. *European Journal of Applied Sciences*, *7*(1), 09-11.
12. Afiukwa, C. A., Ugwu, O. P., Ebenyi, L. N., Oketa, H. A., Idenyi, J. N., & Ossai, E. C. (2013). Phytochemical analysis of two wild edible mushrooms, Auricularia polytricha and Pleurotus ostreatus, common in Ohaukwu area of Ebonyi state, Nigeria. *Res J Pharm Biol Chem Sci*, *4*(2), 1065-70.
13. Chukwuemeka, I. M., Udeozo, I. P., Mathew, C., Oraekwute, E. E., Onyeze, R. C., & Ugwu, O. P. C. (2013). Phytochemical analysis of crude ethanolic leaf extract of Morinda lucida. *Int. J. Res. Rev. Pharm. Appl. Sci*, *3*(4), 470-475.
14. Udeozo, I. P., Nwaka, A. C., Ugwu, O. P., & Akogwu, M. (2014). Anti-inflammatory, phytochemical and acute toxicity study of the flower extract of Newbouldia laevis. *Int J Curr Microbiol App Sci*, *3*(3), 1029-35.
15. Afiukwa, C. A., Ugwu Okechukwu, P. C., Ebenyi, L. N., Ossai, E. C., & Nwaka, A. C. (2013). Phytochemical analysis of three wild edible mushrooms, coral mushroom, Agaricus bisporus and Lentinus sajor-caju, common in Ohaukwu Area of Ebonyi State, Nigeria. *International Journal of Pharmaceutics*, *3*(2), 410-414.
16. PC, U. O., & Amasiorah, V. I. (2020). The effects of the crude ethanol root extract and fractions of Sphenocentrum jollyanum on hematological indices and glycosylated haemoglobin of streptozotocin-induced diabetic albino rats. *INOSR Scientific Research*, *6*(1), 61-74.
17. Ikechukwu, A. A., Ibiam, U. A., Okechukwu, P. U., Inya-Agha, O. R., Obasi, U. O., & Chukwu, D. O. (2015). Phytochemistry and acute toxicity study of Bridelia ferruginea extracts. *World J. Med. Sci*, *12*(4), 397-402.

18. Igwenyi, I. O., Dickson, O., Igwenyi, I. P., Okechukwu, P. C., Edwin, N., & Alum, E. U. (2015). Properties of Vegetable Oils from Three Underutilized Indigenous Seeds. *Global Journal of Pharmacology*, *9*(4), 362-365.
19. Ibiam, U. A., Alum, E. U., Aja, P. M., Orji, O. U., Nwamaka, E. N., & Ugwu, O. P. C. (2018). COMPARATIVE ANALYSIS OF CHEMICAL COMPOSITION OF BUCHHOLZIA CORIACEA ETHANOL LEAF-EXTRACT, AQUEOUS AND ETHYLACETATE FRACTIONS. *INDO AMERICAN JOURNAL OF PHARMACEUTICAL SCIENCES*, *5*(7), 6358-6369.
20. Chimezie O. Onukwuli, Chisom E. Izuchukwu and Ugwu Okechukwu Paul-Chima (2024). Harnessing the Potential of Indigenous African Plants in HIV Management: A Comprehensive Review Integrating Traditional Knowledge with Evidence-Based Medicine. IDOSR JOURNAL OF BIOCHEMISTRY, BIOTECHNOLOGY AND ALLIED FIELDS 9(1): 1-11. https://doi.org/10.59298/IDOSR/JBBAF/24/91.111
21. Chimezie O. Onukwuli, Chisom E. Izuchukwu and Ugwu Okechukwu Paul-Chima (2024). Exploring Phytochemicals for Diabetes Management: Mechanisms, Efficacy, and Future Directions. NEWPORT INTERNATIONAL JOURNAL OF RESEARCH IN MEDICAL SCIENCES 5(2):7-17. https://doi.org/10.59298/NIJRMS/2024/5.2.0717
22. Chimezie O. Onukwuli, Chisom E. Izuchukwu and Ugwu Okechukwu Paul-Chima (2024). Harnessing the Potential of Indigenous African Plants in HIV Management: A Comprehensive Review Integrating Traditional Knowledge with Evidence-Based Medicine. IDOSR JOURNAL OF BIOCHEMISTRY, BIOTECHNOLOGY AND ALLIED FIELDS 9(1): 1-11. https://doi.org/10.59298/IDOSR/JBBAF/24/91.111
23. Odo, C. E., Nwodo, O. F., Joshua, P. E., Ugwu, O. P., & Okonkwo, C. C. (2013). Acute toxicity investigation and anti-diarrhoeal effect of the chloroform–methanol extract of the seeds of Persea americana in albino rats. *journal of pharmacy research*, *6*(3), 331-335.
24. Aja, P. M., Igwenyi, I. O., Okechukwu, P. U., Orji, O. U., & Alum, E. U. (2015). Evaluation of anti-diabetic effect and liver function indices of ethanol extracts of Moringa oleifera and Cajanus cajan leaves in alloxan induced diabetic albino rats. *Global Veterinaria*, *14*(3), 439-447.
25. Ugwu Okechukwu Paul-Chima and Amasiorah, V. I. (2020). The In Vivo Antioxidant Potentials of the Crude Ethanol Root Extract and Fractions of Sphenocentrum jollyanum on Oxidative Stress Indices in Streptozotocin-Induced Diabetic albino rats. *IDOSR Journal Of Biology, Chemistry and Pharmacy*, *5*(1), 26-35.
26. Enechi, O. C., Oluka, I. H., Ugwu, O. P., & Omeh, Y. S. (2013). Effect of ethanol leaf extract of Alstonia boonei on the lipid profile of alloxan induced diabetic rats. *World Journal Of Pharmacy and Pharmaceutical Sciences*, *2*(3), 782-795.
27. C.M. Ude and T.J. Iornenge M.C. Udeh Sylvester, O.F.C. Nwodo, O.E. Yakubu, E.J. Parker, S. Egba, E. Anaduaka, V.S. Tatah, O.P. Ugwu, E.M. Ale (2022). Effects of Methanol Extract of Gongronema latifolium Leaves on Glycaemic Responses to Carbohydrate Diets in Streptozotocin-induced Diabetic Rats. *Journal of Biological Sciences*, 22. 70-79. https://ascidatabase.com/.
28. Ugwu, O. P., Nwodo, O. F., Joshua, P. E., Odo, C. E., Bawa, A., Ossai, E. C., & Adonu, C. C. (2013). Anti-malaria and hematological analyses of ethanol leaf extract of Moringa oleifera on malaria infected mice. *International Journal of Pharmacy and Biological Science*, *3*(1), 360-371.
29. Ugwu, O. P. C., Nwodo, O. F. C., Joshua, P. E., Odo, C. E., Ossai, E. C., & Aburbakar, B. (2013). Ameliorative effects of ethanol leaf extract of Moringa oleifera on the liver and kidney markers of malaria infected mice. *International Journal of Life Sciences Biotechnology and Pharma Research*, *2*(2), 43-52.
30. Ekpono, E. U., Aja, P. M., Ibiam, U. A., Alum, E. U., & Ekpono, U. E. Ethanol Root-extract of Sphenocentrum jollyanum Restored Altered Haematological Markers in Plasmodium berghei-infected Mice. *Earthline Journal of Chemical Sciences*. 2019; *2*(2): 189-203. https://doi.org/10.34198/ejcs.2219.189203.
31. Egwu, C. O., Aloke, C., Chukwu, J., Agwu, A., Alum, E., Tsamesidis, I, et al. A world free of malaria: It is time for Africa to actively champion and take leadership of elimination and eradication strategies. Afr Health Sci. 2022 Dec;22(4):627-640. doi: 10.4314/ahs.v22i4.68.
32. Egwu, C.O., Aloke, C., Chukwu, J., Nwankwo, J.C., Irem, C., Nwagu, K.E., Nwite, F., Agwu, A.O., Alum, E., Offor, C.E. and Obasi, N. A. Assessment of the Antimalarial Treatment Failure in Ebonyi State, Southeast Nigeria. J Xenobiot. 2023 Jan 3;13(1):16-26. doi: 10.3390/jox13010003.
33. Kungu, E., Inyangat, R., Ugwu, O.P.C. and Alum, E. U. (2023). Exploration of Medicinal Plants Used in the Management of Malaria in Uganda. NEWPORT INTERNATIONAL JOURNAL OF

RESEARCH IN MEDICAL SCIENCES 4(1):101-108. https://nijournals.org/wp-content/uploads/2023/10/NIJRMS-41101-108-2023.docx.pdf

34. Obeagu, E. I., Alum, E. U. and Ugwu, O. P. C. Hepcidin's Antimalarial Arsenal: Safeguarding the Host. NEWPORT INTERNATIONAL JOURNAL OF PUBLIC HEALTH AND PHARMACY. 2023; 4(2):1-8. https://doi.org/10.59298/NIJPP/2023/10.1.1100
35. Obeagu, E. I., Alum, E. U. and Ugwu, O. P. C. Hepcidin: The Gatekeeper of Iron in Malaria Resistance NEWPORT INTERNATIONAL JOURNAL OF RESEARCH IN MEDICAL SCIENCES. 2023; 4(2):1-8. https://doi.org/10.59298/NIJRMS/2023/10.1.1400
36. Alum, E. U., Obeagu, E. I., Ugwu, O. P. C., Samson, A. O., Adepoju, A. O., Amusa, M. O. Inclusion of nutritional counseling and mental health services in HIV/AIDS management: A paradigm shift. Medicine (Baltimore). 2023;102(41):e35673. http://dx.doi.org/10.1097/MD.0000000000035673. PMID: 37832059; PMCID: PMC10578718.
37. Alum EU, Obeagu EI, Ugwu OPC, Egba SI, Ejim Uti DE, Ukaidi CUA, Echegu DA. Confronting Dual Challenges: Substance Abuse and HIV/AIDS. Elite Journal of HIV, 2024; 2(5): 1-8. https://epjournals.com/journals/EJHIV
38. Alum, E. U., Obeagu, E. I., Ugwu, O. P.C., Aja, P. M. and Okon, M. B. HIV Infection and Cardiovascular diseases: The obnoxious Duos. *Newport International Journal of Research in Medical Sciences (NIJRMS)*, 2023; 3(2): 95-99. https://nijournals.org/wp-content/uploads/2023/07/NIJRMS-3-295-99-2023.pdf.
39. Alum, E. U., Ugwu, O. P.C., Obeagu, E. I. and Okon, M. B. Curtailing HIV/AIDS Spread: Impact of Religious Leaders. *Newport International Journal of Research in Medical Sciences (NIJRMS)*, 2023; 3(2): 28-31. https://nijournals.org/wp-content/uploads/2023/06/NIJRMS-32-28-31-2023-rm.pdf
40. Obeagu, E.I., Alum, E.U. and Obeagu, G.U. Factors Associated with Prevalence of HIV Among Youths: A Review of Africa Perspective. *Madonna University Journal of Medicine and Health Sciences*, 2023; 3(1): 13-18. https://madonnauniversity.edu.ng/journals/index.php/medicine
41. Alum, E. U., Ugwu, O. P. C., Obeagu, E. I., Aja, P. M., Okon, M. B., Uti, D. E. Reducing HIV Infection Rate in Women: A Catalyst to reducing HIV Infection pervasiveness in Africa. International Journal of Innovative and Applied Research. 2023; 11(10):01-06. DOI: 10.58538/IJIAR/2048. http://dx.doi.org/10.58538/IJIAR/2048
42. Obeagu, E. I., Nwosu, D. C., Ugwu, O. P. C. and Alum, E. U. Adverse Drug Reactions in HIV/AIDS Patients on Highly Active Antiretro Viral Therapy: A Review of Prevalence. NEWPORT INTERNATIONAL JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES (NIJSES). 2023; 4(1):43-47. https://doi.org/10.59298/NIJSES/2023/10.6.1000
43. Obeagu, E. I., Obeagu, G. U., Alum, E. U. and Ugwu, O. P. C. Anemia as a Prognostic Marker for Disease Progression in HIV Infection. *IAA Journal of Biological Sciences*. 2023; 11(1):33-44. https://doi.org/10.59298/IAAJB/2023/3.2.23310
44. Obeagu, E. I., Obeagu, G. U., Alum, E. U. and Ugwu, O. P. C. Comprehensive Review of Antiretroviral Therapy Effects on Red Blood Cells in HIV Patients. *INOSR Experimental Sciences*. 2023; 12(3):63-72. https://doi.org/10.59298/INOSRES/2023/6.3.21322
45. Obeagu, E. I., Obeagu, G. U., Alum, E. U. and Ugwu, O. P. C. Persistent Immune Activation and Chronic Inflammation: Unraveling Their Impact on Anemia in HIV Infection. *INOSR Experimental Sciences*. 2023; 12(3):73-84. https://doi.org/10.59298/INOSRES/2023/7.3.21322
46. Obeagu, E. I., Obeagu, G. U., Alum, E. U. and Ugwu, O. P. C. Understanding the Impact of HIV-Associated Bone Marrow Alterations on Erythropoiesis. *INOSR Scientific Research*. 2023; 10(1):1-11. https://doi.org/10.59298/INOSRSR/2023/1.2.12222
47. Obeagu, E. I., Obeagu, G. U., Alum, E. U. and Ugwu, O. P. C. Advancements in Immune Augmentation Strategies for HIV Patients. *IAA Journal of Biological Sciences*. 2023; 11(1):1-11. https://doi.org/10.59298/IAAJB/2023/1.2.23310
48. Obeagu, E. I., Obeagu, G. U., Odo, E. O., Igwe, M. C., Ugwu, O. P. C., Alum, E. U. and Okwaja, P. R. Combatting Stigma: Essential Steps in Halting HIV Spread. *IAA Journal of Applied Sciences*. 2023; 11(1):22-29. https://doi.org/10.59298/IAAJAS/2024/3.5.78156
49. Obeagu, E. I., Obeagu, G. U., Odo, E. O., Igwe, M. C., Ugwu, O. P. C., Alum, E. U. and Okwaja, P. R. Revolutionizing HIV Prevention in Africa: Landmark Innovations that Transformed the Fight. *IAA Journal of Applied Sciences*. 2024; 11(1):1-12. https://doi.org/10.59298/IAAJAS/2024/1.3.5288

50. Obeagu, E. I., Obeagu, G. U., Odo, E. O., Igwe, M. C., Ugwu, O. P. C., Alum, E. U. and Okwaja, P. R. Disaster Fallout: Impact of Natural Calamities on HIV Control. *IAA Journal of Applied Sciences.* 2024; 11(1):13-21. https://doi.org/10.59298/IAAJAS/2024/2.5.9243.
51. Obeagu, E. I., Obeagu, G. U., Ugwu, O. P. C. and Alum, E. U. Navigating Hemolysis in Expectant Mothers with Sickle Cell Anemia: Best Practices and Challenges. *IAA Journal of Applied Sciences.* 2024; 11(1):30-39. https://doi.org/10.59298/IAAJAS/2024/4.78.99.11
52. Obeagu, E. I., Obeagu, G. U., Odo, E. O., Igwe, M. C., Ugwu, O. P. C., Alum, E. U. and Okwaja, P. R. Nutritional Approaches for Enhancing Immune Competence in HIV-Positive Individuals: A Comprehensive Review. *IDOSR JOURNAL OF APPLIED SCIENCES.* 2024; 9(1)40-50. https://doi.org/10.59298/IDOSRJAS/2024/1.7.8.295
53. Obeagu, E. I., Nimo, O. M., Bunu, U. M., Ugwu, O. P.C. and Alum, E.U. Anaemia in children under five years: African perspectives. *Int. J. Curr. Res. Biol. Med.*, 2023; (1): 1-7. DOI: http://dx.doi.org/10.22192/ijcrbm.2023.08.01.001.
54. Obeagu, E. I., Ali, M. M., Alum, E. U., Obeagu, G. U., Ugwu, O. P. C. and Bunu, U. M. An Update of Aneamia in Adults with Heart Failure. *INOSR Experimental Sciences*, 2023; 11(2):1-16. https://doi.org/10.5281/zenodo.7791916
55. Alum, E. U., Ugwu, O. P. C., Aja, P. M., Obeagu, E. I., Inya, J. E., Onyeije, P. E., Agu, E. and Awuchi, C. G. Restorative effects of ethanolic leaf extract of *Datura stramonium* against methotrexate-induced hematological impairments, Cogent Food & Agriculture, 2023; 9:1, DOI: 10.1080/23311932.2023.2258774. https://doi.org/10.1080/23311932.2023.2258774
56. Aja, P. M., Uzuegbu, U. E., Opajobi, A. O., Udeh, S. M.C., Alum, E. U., Abara, P. N., Nwite, F. and Ibere, J. B. Comparative Effect of Ethanol Leaf-Extracts of *Ficus capensis* And *Moringa oleifera* on some haematological indices in normal Albino Rats. *Indo American Journal of Pharmaceutical Sciences*, 2017;4 (2): 471-476. https://www.iajps.com/pdf/february2017/38.%20(1).pdf
57. Obeagu, E. I., Bot, Y. S., Obeagu, G. U., Alum, E. U. and Ugwu, O. P. C. Anaemia and risk factors in lactating mothers: a concern in Africa. *International Journal of Innovative and Applied Research*, 2023;11(2): 15-17. Article DOI: 10.58538/IJIAR/2012 DOI URL: http://dx.doi.org/10.58538/IJIAR/2012.
58. Orji, O. U., Ibiam, U. A., Aja, P. M., Ezeani, N., Alum, E. U. and Edwin, N. Haematological Profile of *Clarias gariepinus* (Burchell 1822) Juveniles Exposed to Aqueous Extract of *Psychotria microphylla* Leaves. IOSR-JESTFT, 2015; 9 (9): 79-85. https://www.iosrjournals.org/iosr-jestft/papers/vol9-issue9/Version-1/M09917985.JESTFT%20[ZSEP08].pdf
59. Agbafor, K. N., Onuoha, S. C., Ominyi, M. C., Orinya, O. F., Ezeani, N. and Alum, E. U. Antidiabetic, Hypolipidemic and Antiathrogenic Properties of Leaf Extracts of Ageratum conyzoides in Streptozotocin-Induced diabetic rats. *International Journal of Current Microbiology and Applied Sciences.* 2015; 4 (11): 816-824. http://www.ijcmas.com. https://www.ijcmas.com/vol-4-11/Agbafor,%20K.%20N,%20et%20al.pdf
60. Uti, D. E., Igile, G. O., Omang, W. A., Umoru, G. U., Udeozor, P. A., Obeten, U. N., Ogbonna, O. N., Ibiam U. A., Alum, E. U., Ohunene, O. R., Chukwufumnanya, M. J., Oplekwu, R. I. and Obio, W. A. Anti-Diabetic Potentials of Vernonioside E Saponin; A Biochemical Study. *Natural Volatiles and Essential Oils.* 2021; 8(4): 14234-14254.
61. Alum, E. U., Umoru, G. U., Uti, D. E., Aja, P. M., Ugwu, O. P., Orji, O. U., Nwali, B. U., Ezeani, N., Edwin, N., Orinya, F. O. Hepato-protective effect of Ethanol Leaf Extract of *Datura stramonium* in Alloxan-induced Diabetic Albino Rats. *Journal of Chemical Society of Nigeria.* 2022; 47 (3): 1165 – 1176. https://doi.org/10.46602/jcsn.v47i5.819.
62. Ugwu, O. P.C., Alum, E. U., Okon, M. B., Aja, P. M., Obeagu, E. I. and Onyeneke, E. C. Ethanol root extract and fractions of *Sphenocentrum jollyanum* abrogate hyperglycemia and low body weight in Streptozotocin-induced diabetic Wistar albino Rats, *RPS Pharmacy and Pharmacology Reports.* 2023; 2,1-6. https://doi.org/10.1093/rpsppr/rqad010.
63. Offor, C. E., Ugwu, O. P. C., Alum, E. U. The Anti-Diabetic Effect of Ethanol Leaf-Extract of *Allium sativum* on Albino Rats. *International Journal of Pharmacy and Medical Sciences.* 2014; 4 (1): 01-03. DOI: 10.5829/idosi.ijpms.2014.4.1.1103.
64. Obeagu, E. I., Scott, G. Y., Amekpor, F., Ugwu, O. P. C., Alum, E. U. COVID-19 infection and Diabetes: A Current Issue. *International Journal of Innovative and Applied Research.* 2023; 11(01): 25-30. DOI: 10.58538/IJIAR/2007. DOI URL: http://dx.doi.org/10.58538/IJIAR/2007.

65. Obeagu, E. I., Ugwu, O. P. C., Alum, E. U. Poor glycaemic control among diabetic patients; A review on associated factors. *Newport International Journal of Research in Medical Sciences (NIJRMS)*. 2023; 3(1):30-33. https://nijournals.org/newport-international-journal-of-research-in-medical-sciences-nijrms-volume-3-issue-1-2023/.
66. Aja, P. M., Ani, O. G., Offor, C. E., Orji, U. O., Alum, E. U. Evaluation of Anti-Diabetic Effect and Liver Enzymes Activity of Ethanol Extract of *Pterocarpus santalinoides* in Alloxan Induced Diabetic Albino Rats. *Global Journal of Biotechnology & Biochemistry*. 2015; 10 (2): 77-83. DOI: 10.5829/idosi.gjbb.2015.10.02.93128.
67. Aja, P. M., Igwenyi, I. O., Ugwu, O. P. C., Orji, O. U., Alum, E. U. Evaluation of Anti-diabetic Effect and Liver Function Indices of Ethanol Extracts of *Moringa oleifera* and *Cajanus cajan* Leaves in Alloxan Induced Diabetic Albino Rats. *Global Veterinaria*. 2015; 14(3): 439-447. DOI: 10.5829/idosi.gv.2015.14.03.93129.
68. Ugwu, O. P.C., Alum, E. U., Obeagu, E. I, Okon, M. B., Aja, P. M., Samson, A. O., Amusa, M. O. and Adepoju, A. O. Effect of Ethanol Leaf extract of *Chromolaena odorata* on hepatic markers in streptozotocin-induced diabetic wistar albino rats. *IAA Journal of Applied Sciences*, 2023; 9(1):46-56. https://doi.org/10.5281/zenodo.7811625
69. Egwu, C. O., Offor, C. E. and Alum, E. U. Anti-diabetic effects of *Buchholzia coriacea* ethanol seed Extract and Vildagliptin on Alloxan-induced diabetic albino Rats. *International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)*. 2017; 6 (6):1304-1314.www.ijbpas.com. https://ijbpas.com/pdf/2017/June/1497506120MS%20IJBPAS%202017%204202.pdf
70. Ugwu OPC, Alum EU, Obeagu EI, Okon MB, Aja PM, Samson AO, Amusa MO, Adepoju AO. Effect of Ethanol leaf extract of Chromolaena odorata on lipid profile of streptozotocin induced diabetic wistar albino rats. *IAA Journal of Biological Sciences*. 2023; 10(1):109-117. https://www.iaajournals.org/wp-content/uploads/2023/03/IAAJB-101109-117-2023-Effect-of-Ethanol-leaf-extract-of-Chromolaena-odorata-on-lipid-profile-of-streptozotocin-induced-diabetic-wistar-albino-rats..docx.pdf.
71. Ezeani NN, Edwin N, Alum EU, Orji OU, Ugwu OPC. Effect of Ethanol Leaf Extract of *Ocimum gratissmum* (Scent Leaf) on Lipid Profile of Alloxan-Induced Diabetic Rats. *International Digital Organization for Scientific Research Journal of Experimental Sciences*, 2017; 2 (1): 164-179. www.idosr.org. https://www.idosr.org/wp-content/uploads/2017/07/IDOSR-JES-21-164-179-2017.-ezeani-2-updated.pdf
72. Ezeani NN, Alum EU, Orji OU, Edwin N. The Effect of Ethanol Leaf Extract of *Pterocarpus santalinoids* (Ntrukpa) on the Lipid Profile of Alloxan-Induced Diabetic Albino Rats. *International Digital Organization for Scientific Research Journal of Scientific Research*. 2017; 2 (2): 175-189. www.idosr.org. https://www.idosr.org/wp-content/uploads/2017/07/IDOSR-JSR-22-175-189-2017-EZEANI-updated.pdf
73. Alum, E. U., Ugwu, O. P. C., Obeagu, E. I., Aja, P. M., Ugwu, C. N., Okon, M.B. Nutritional Care in Diabetes Mellitus: A Comprehensive Guide. *International Journal of Innovative and Applied Research*. 2023; 11(12):16-25. Article DOI: 10.58538/IJIAR/2057 DOI URL: http://dx.doi.org/10.58538/IJIAR/2057.
74. Ugwu, O.P.C., Kungu, E., Inyangat, R., Obeagu, E. I., Alum, E. U., Okon, M. B., Subbarayan, S. and Sankarapandiyan, V. Exploring Indigenous Medicinal Plants for Managing Diabetes Mellitus in Uganda: Ethnobotanical Insights, Pharmacotherapeutic Strategies, and National Development Alignment. INOSR Experimental Sciences.2023; 12(2):214-224. https://doi.org/10.59298/INOSRES/2023/2.17.1000.
75. Alum, E. U., Ugwu, O. P. C., Obeagu, E. I. Beyond Pregnancy: Understanding the Long Term Implications of Gestational Diabetes Mellitus. *INOSR Scientific Research*. 2024; 11(1):63-71. https://doi.org/10.59298/INOSRSR/2024/1.1.16371
76. Obeagu, E. I., Omar, D. E., Bunu, U. O., Obeagu, G. U., Alum, E. U. and Ugwu, O. P. C. Leukaemia burden in Africa. *Int. J. Curr. Res. Biol. Med.*, 2023; (1): 17-22. DOI:10.22192/ijcrbm.2023.08.01.003
77. Obeagu, E.I., Alum, E.U., Obeagu, G.U. and Ugwu, O. P. C. Prostate Cancer: Review on Risk Factors. *Eurasian Experiment Journal of Public Health (EEJPH)*. 2023; 4(1): 4-7. https://www.eejournals.org/public/uploads/1688032824_872978821ba373725554.pdf
78. Obeagu, E.I., Alum, E.U., Obeagu, G.U. and Ugwu, O. P. C. Benign Prostatic Hyperplasia: A Review. *Eurasian Experiment Journal of Public Health (EEJPH)*. 2023; 4(1): 1-3. https://www.eejournals.org/public/uploads/1687980288_52785ca83cc0c789d8ae.pdf

79. Ibiam, U. A., Uti, D. E., Ejeogo, C. C., Orji, O. U., Aja, P. M., Ezeaani, N. N., Alum, E. U., Chukwu, C., AlokeC., Chinedum, K. E., Agu, P. and Nwobodo, V. In Vivo and in Silico Assessment of Ameliorative Effects of Xylopia aethiopica on Testosterone Propionate-Induced Benign Prostatic Hyperplasia. *Pharmaceut Fronts.* 2023;5: e64–e76. DOI:10.1055/s-0043-1768477
80. Alum, E. U., Inya, J. E., Ugwu, O. P. C., Obeagu, I.E., Aloke, C., Aja, P. M., Okpata, M. G., John, E. C., Orji, M. O. and Onyema, O. Ethanolic leaf extract of *Datura stramonium* attenuates Methotrexate-induced Biochemical Alterations in Wistar Albino rats. *RPS Pharmacy and Pharmacology Reports*, 2023; 2(1):1–6. doi: 10.1093/rpsppr/rqac011.
81. Aja, P. M., Agu, P. C., Ezeh, E. M., Awoke, J. N., Ogwoni, H. A., Deusdedit, T., Ekpono, E. U., Igwenyi, I. O., Alum, E. U., Ugwuja, E. I., Ibiam, U. A., Afiukwa, C. A. and Adegboyega, A. E. Prospect into therapeutic potentials of Moringa oleifera phytocompounds against cancer upsurge: de novo synthesis of test compounds, molecular docking, and ADMET studies. *Bulletin of the National Research Centre.* 2021; 45(1): 1-18. https://doi.org/10.1186/s42269-021-00554-6.
82. Obeagu, E. I., Ahmed, Y. A., Obeagu, G. U., Bunu, U. O., Ugwu, O. P. C. and Alum, E. U. Biomarkers of breast cancer: Overview. *Int. J. Curr. Res. Biol. Med.*, 2023; (1): 8-16. DOI:10.22192/ijcrbm.2023.08.01.002.
83. Alum, E. U., Famurewa, A. C., Orji, O. U., Aja, P. M., Nwite, F., Ohuche, S. E., Ukasoanya, S. C., Nnaji, L. O., Joshua, D., Igwe, K. U. and Chima, S. F. Nephroprotective effects of *Datura stramonium* leaves against methotrexate nephrotoxicity via attenuation of oxidative stress-mediated inflammation and apoptosis in rats. *Avicenna Journal of Phytomedicine.* 2023; 13(4): 377-387. doi: 10.22038/ ajp.2023.21903.
84. Alum, E. U., Obeagu, E. I., Ugwu, O. P. C., Orji, O. U., Adepoju, A. O., Amusa, M. O. Edwin, N. Exploring natural plant products in breast cancer management: A comprehensive review and future prospects. *International Journal of Innovative and Applied Research.* 2023; 11(12):1-9. Article DOI: 10.58538/IJIAR/2055. DOI URL: *http://dx.doi.org/10.58538/IJIAR/2055*
85. Alum, E. U., Ugwu, O. P. C., Obeagu, E. I. Cervical Cancer Prevention Paradox: Unveiling Screening Barriers and Solutions, *J, Cancer Research and Cellular Therapeutics. 2024*, 8(2):1-5. DOI:10.31579/2640-1053/182
86. Alum, E. U., Ugwu, O. P. C., Obeagu, E. I., Ugwu, C. N. Beyond Conventional Therapies: Exploring Nutritional Interventions for Cervical Cancer Patients, *J, Cancer Research and Cellular Therapeutics*, 8(1);1-6. DOI:10.31579/2640-1053/180
87. Ibiam U. A., Uti, D. E., Ejeogo, C.C., Orji, O. U. Aja, P. M., Ezeani, N. N., Alum, E. U., Chukwu, C., Aloke, C., Itodo, M. O., Agada, S. A., Umoru, G. U., Obeten, U. N., Nwobodo, V. O. G., Nwadum, S. K., Udoudoh, M. P. Xylopia aethiopica Attenuates Oxidative Stress and Hepatorenal Damage in Testosterone Propionate-Induced Benign Prostatic Hyperplasia in Rats. Journal of Health and Allied Sciences. 2024, 01: 1-148. https://doi.org/10.1055/s-0043-1777836.

CITE AS: Ugwu Okechukwu Paul-Chima, Alum Esther Ugo and Uhama Kingsley Chukwuka (2024). Dual Burden of Diabetes Mellitus and Malaria: Exploring the Role of Phytochemicals and Vitamins in Disease Management. RESEARCH INVENTION JOURNAL OF RESEARCH IN MEDICAL SCIENCES *3(2)*:38-49.