

Review

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Integrating Traditional Medicine in the Management of Viral Hepatitis in Nigeria: Epidemiological Insights and Regulatory Perspectives

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Review

Integrating Traditional Medicine in the Management of Viral Hepatitis in Nigeria: Epidemiological Insights and Regulatory Perspectives

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Abstract: Viral hepatitis continues to pose a significant public health issue in Nigeria, where the various types of viral hepatitis (hepatitis A, B, C, D, and E) are endemic. Even with vaccines and antiviral treatments available, the burden of disease remains due to limited healthcare access, socio-economic inequalities, and insufficient public health infrastructure. The high rates of hepatitis B and C, along with the common occurrence of hepatitis A and E, highlight the urgent need for comprehensive and culturally appropriate intervention strategies. Traditional medicine (TM), particularly the utilization of indigenous medicinal plants, plays an essential role in managing hepatitis in marginalized communities. Ethnobotanical studies have discovered numerous plant species with potential antiviral properties. However, incorporating these remedies into mainstream healthcare is challenged by concerns regarding safety, standardization, and regulatory control. This review examines the epidemiology of viral hepatitis in Nigeria, the role of TM in its treatment, and the developing regulatory framework overseeing herbal remedies. It stresses the necessity of clinical validation, standardized protocols, and better training for practitioners to ensure the safe and effective incorporation of TM into national hepatitis control efforts.

Keywords: viral hepatitis; epidemiology; endemic diseases; medicinal plants; herbal remedies; regulatory oversight

1. Introduction

Viral hepatitis (Figure 1) includes a set of infectious diseases caused by five (5) main virus types: hepatitis A virus (HAV), hepatitis B virus (HBV), hepatitis C virus (HCV), hepatitis D virus (HDV), and hepatitis E virus (HEV) [1,2]. These viruses target the liver, resulting in conditions that range from acute self-limiting infections to chronic liver damage, cirrhosis, and hepatocellular carcinoma (HCC) [3-6]. Viral hepatitis poses a significant global health challenge, resulting in approximately 1.1 million deaths in 2019 and rising to 1.3 million in 2022. Among the five hepatitis types, B and C account for most of the morbidity and mortality due to their chronic nature and the potential for severe complications. Hepatitis B alone was responsible for 83% of these fatalities, while hepatitis C contributed 17%. In the WHO-focused countries, 80% of hepatitis-related deaths occur, with Africa alone bearing 55% of the worldwide viral hepatitis burden [7]. Africa, which hosts a large share of the world's population, bears a disproportionately high burden of viral hepatitis [8]. The continent experiences high rates of hepatitis B and C [9], with transmission influenced by socio-economic factors, cultural customs, and deficiencies in healthcare systems [10-13]. In areas with poor sanitation, hepatitis A and E, mainly spread through contaminated food and water [14-16], remain prevalent, while hepatitis D, linked to hepatitis B as a co-infection or superinfection [17,18], presents another challenge in regions where hepatitis B is often endemic.

Despite the existence of efficacious preventive measures, including vaccines for hepatitis A and B and curative modalities for hepatitis C, the endeavor to control viral hepatitis in Africa is impeded by a multitude of factors. Limited access to healthcare services, inadequate surveillance systems, social stigma, and deficient public health resources [19-21] collectively compound the persistent challenges. Additionally, socio-economic inequalities and political instability in certain areas worsen the disease burden, hindering advancement towards global health goals, particularly the WHO's aims to eliminate viral hepatitis as a public health threat by 2030. Additionally, socio-economic inequalities and political instability in certain areas worsen the disease burden [22-25], hindering advancement towards global health goals, particularly the WHO's aim to eliminate viral hepatitis as a public health threat by 2030 [7].

Viral hepatitis presents a major public health challenge in Nigeria. The country is divided into six geopolitical zones: North-Central, North-East, North-West, South-East, South-South, and South-West (Figure 2). Hepatitis A and E are endemic in Nigeria, primarily spread through the fecal-oral route, with hepatitis E specifically endangering pregnant women [26,27]. Hepatitis B is widespread and a primary contributor to liver disease, although vaccination initiatives are currently underway through the national immunization program [28,29]. Nigerians with limited access to direct-acting antivirals are affected by hepatitis C [30]. Hepatitis D, which co-infects individuals with hepatitis B, is less frequently reported but causes more severe liver complications [31,32]. To tackle these infections effectively, enhancements in vaccination, sanitation, surveillance, and accessibility of antiviral treatments are necessary. This review aims to provide a thorough overview of viral hepatitis in Nigeria, highlighting its epidemiology and transmission dynamics. It also explores the role of traditional medicine, particularly indigenous ethnomedicinal practices, in managing hepatitis while assessing the regulatory frameworks and challenges involved in integrating these practices into the national healthcare system.

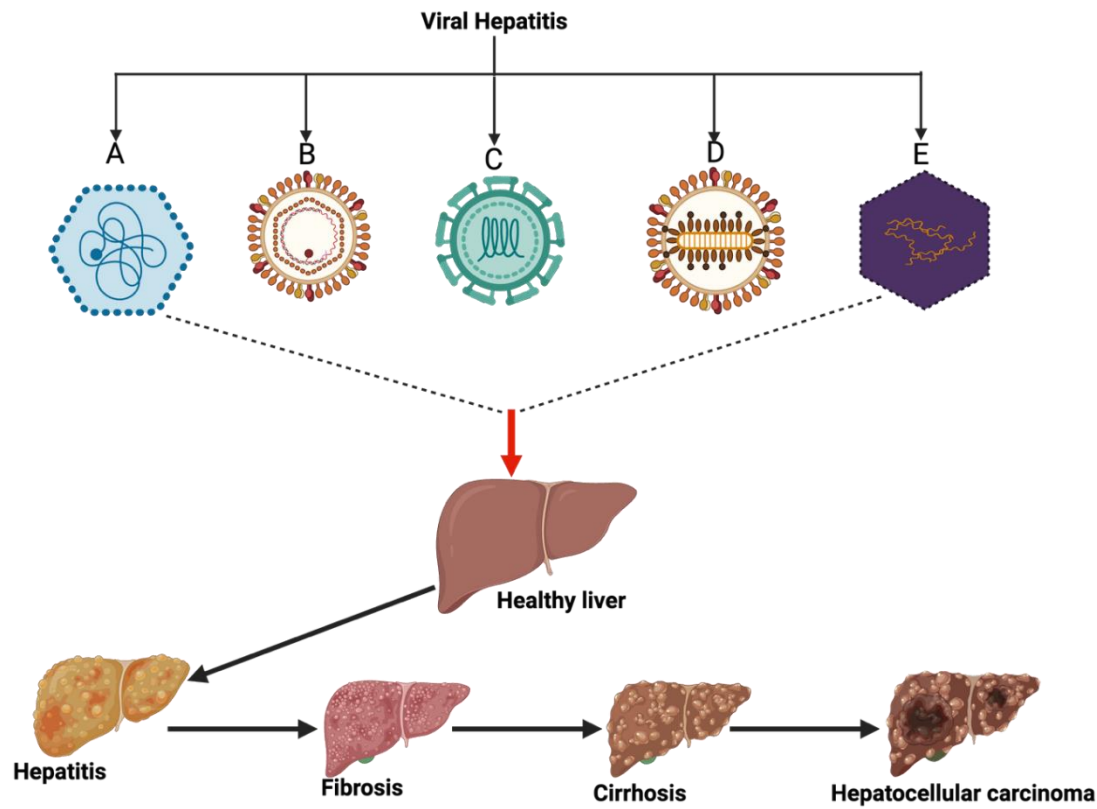


Figure 1. Classification and disease burden of viral hepatitis.

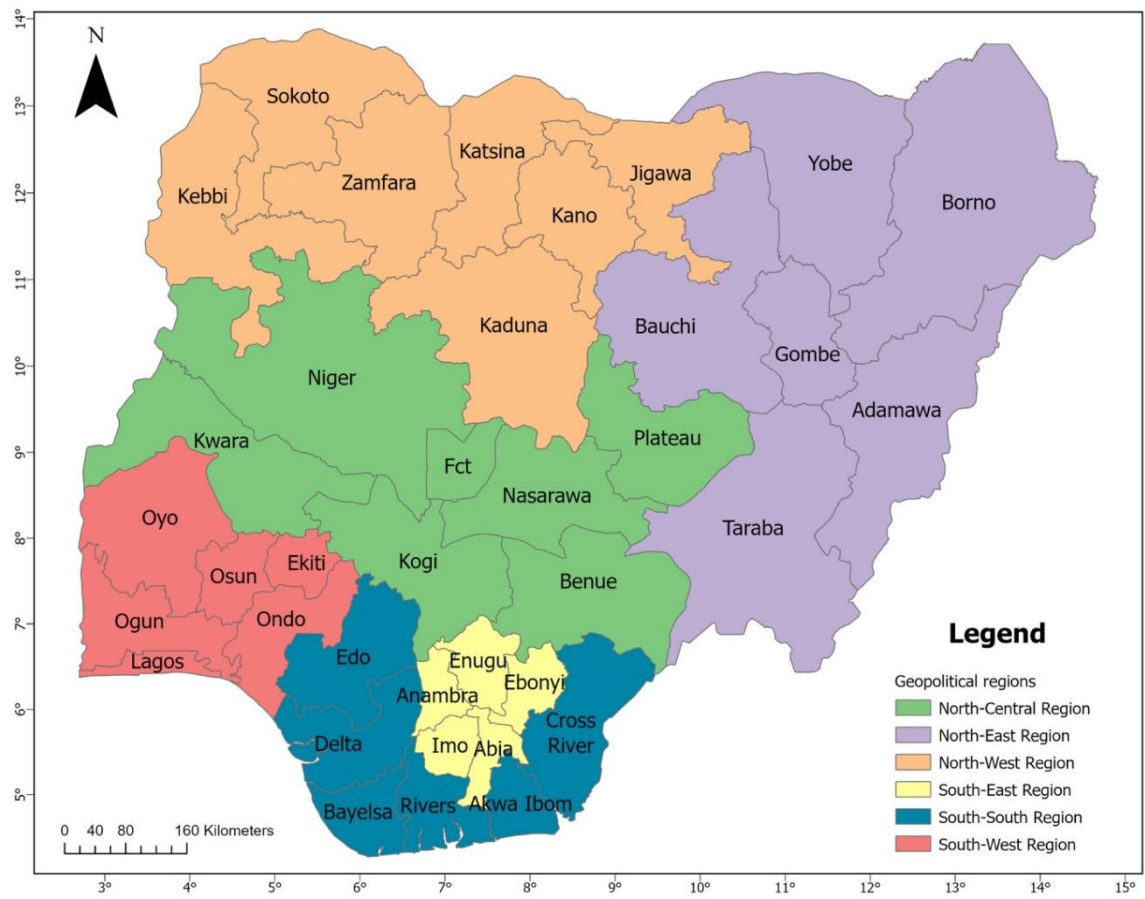


Figure 2. Map of Nigeria showing the six geopolitical zones.

2. Epidemiology of Viral Hepatitis in Nigeria

Viral hepatitis remains a significant public health issue globally. Its prevalence and incidence vary significantly across regions and populations. Differences in healthcare access, socio-economic status, cultural practices, and public health infrastructure influence these variations [8,12,15,18,22,23]. There are five (5) hepatitis viruses known to healthcare. They include hepatitis HAV, HBV, HCV, HDV, and HEV [33,34]. They tend to have a considerable impact on human health, with the ability to cause acute and chronic infections [1]. HAV and HEV are transmitted by contaminated water and food [35], while HBV and HCV are mainly transmitted through bloodborne [36,37]. Despite them having different routes of transmission, they all share common transmission routes, such as having close contact within a household, transfusion of blood, transplantation of an infected allograft, transmission from a pregnant mother to her child, and unprotected sex with an infected person [1,34-36,38].

HAV

HAV is classified within the hepatoviral genus of the Picornaviridae family [39]. HAV (Figure 3) exists in two infectious forms: quasi-enveloped and non-enveloped (naked) virions. The quasi-spheroids, which are surrounded by lipid membranes, primarily reside in the circulatory system and cell culture medium. As they move through the biliary canaliculus, bile acids act as detergents, effectively removing the lipid envelope and producing naked virions, which are then excreted in faeces[40]. HAV has a single-stranded positive-sense RNA genome that is roughly 7.5 kilobases long [41]. Additionally, HAV is notably resistant to extreme physical and environmental conditions, including high temperatures, acidic environments, and freezing, allowing it to survive for hours or even months [42,43]. This increased resistance results from the virus's structurally strong, folding-dependent, and cohesive capsid [44]. The interaction between its environmental stability and the high viral load found in the faeces of infected individuals highlights the critical link between Hepatitis A Virus (HAV) transmission and poor hygiene or insufficient sanitation systems, especially through wastewater contamination [45].

HAV transmission usually occurs through a faecal-oral route, either directly via person-to-person contact or indirectly through consuming contaminated food or water. In developed countries, most outbreaks stem from direct contact, while sporadic cases tend to be linked to foodborne transmission. Nonetheless, recent outbreaks in industrialized nations have increasingly involved contaminated food items[46]; many have been associated with imported frozen foods, including berries, vegetables, and various ready-to-eat products [47]. Although infrequent, HAV transmission through bloodborne routes is still a possibility due to the temporary viremic phase in infected individuals. Historically, those receiving regular blood transfusions, particularly patients with hemophilia, were considered at greater risk and prioritized for vaccination[48,49].

Worldwide, approximately 100 million HAV infections are reported annually, resulting in nearly 1.5 million symptomatic cases and between 15,000 - 30,000 deaths each year [50]. A recent analysis of the Global Burden of Disease (GBD) 2019 database indicates that hepatitis A exhibits the highest incidence among the four primary types of acute viral hepatitis: A, B, C, and E [51]. Nonetheless, the global age-standardized incidence rate of HAV has remained consistent from 1990 - 2019, while there has been a significant decrease in age-standardized disability-adjusted life years (DALYs) over that time, which suggests improved disease outcomes [52]. The incidence rates of hepatitis A differ significantly across countries and are closely tied to their socio-demographic index (SDI). Low and middle-income nations, especially in Africa and South Asia [53], bear the heaviest burden of HAV infection. The effects of HAV are frequently evaluated through seroprevalence surveys that detect anti-HAV immunoglobulin G (IgG), indicating past exposure to the virus [54].

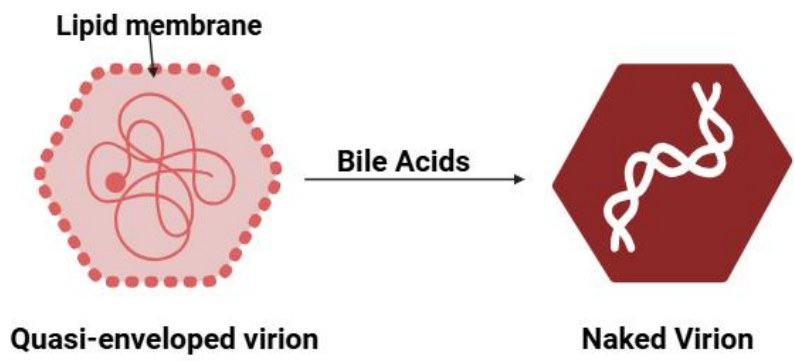


Figure 3. Structure of HAV. Generated with Biorender.com.

In Nigeria, extensive research has been conducted on the seroprevalence of HAV across various regions (Figure 4). For instance, Sule et al. . [55] examined HAV prevalence in Osogbo, Osun State, where they found that 98.9% of participants displayed positive results for anti-HAV-IgG antibodies. In another investigation, Afegbua et al. [56] examined the seroprevalence of HAV infections among schoolchildren and adolescents in Kaduna, Nigeria. They noted that seropositivity differed by age, with rates of 4.6% in children aged 11-15 years and 40% in those under five. This variation was linked to poor sewage disposal and parental education levels.

Similarly, Ikobah et al. [26] analysed the seroprevalence and risk factors of HAV infection among children in Cross River State, Nigeria, finding that 224 subjects were positive for total anti-HAV antibodies, leading to a prevalence rate of 55.2%: 101 males (45.1%) and 123 females (54.9%). Additionally, Ogefere and Egbe [57] looked into HAV seroprevalence in Benin City, Nigeria, identifying three samples testing positive for anti-HAV IgM, attributing the high prevalence in Benin City to substandard hygiene practices. Collectively, these studies highlight the prevalence of HAV in Nigeria.

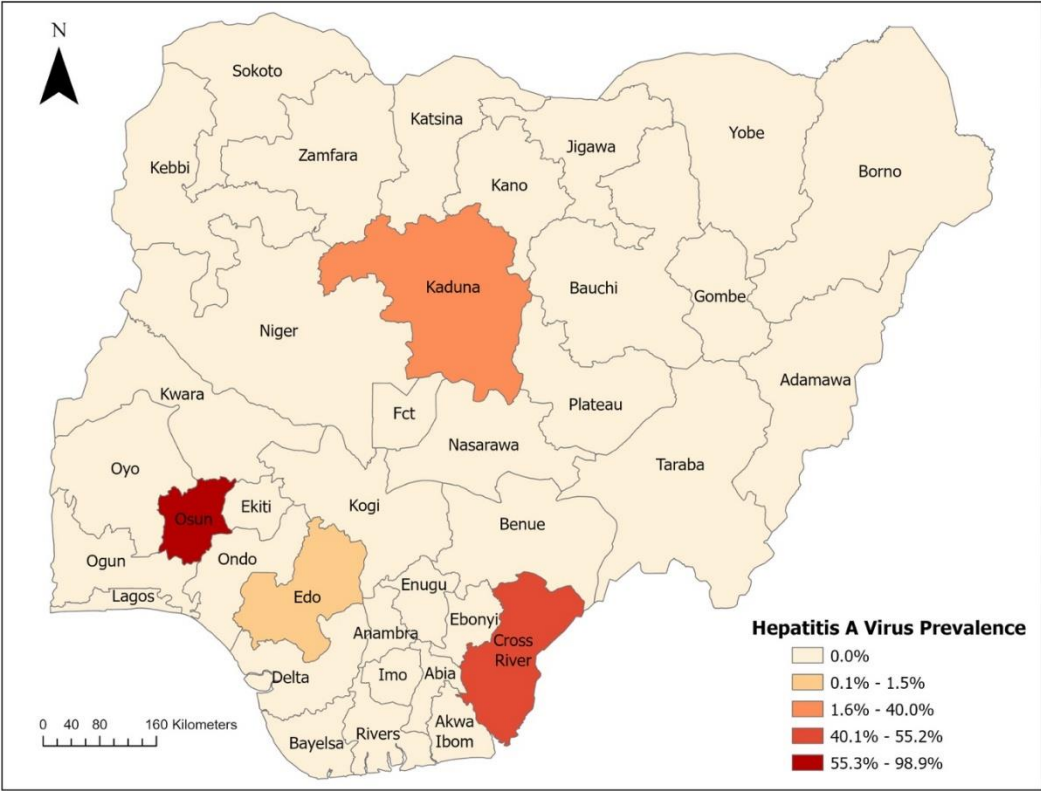
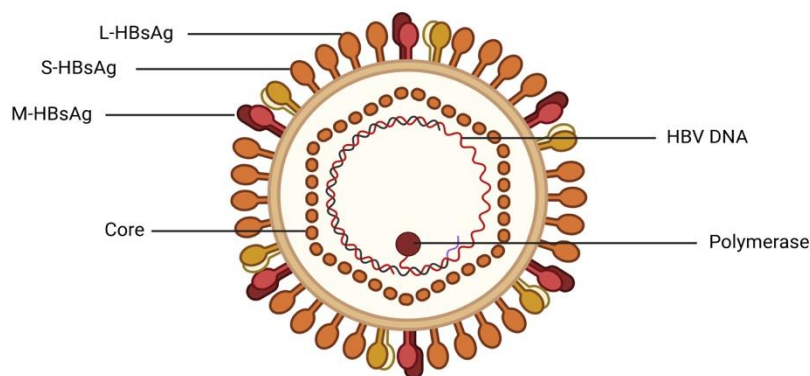


Figure 4. Map of Nigeria showing the distribution of HAV.**HBV**

HBV (Figure 5) continues to pose a major global health threat, especially in developing countries where prevalence rates are considerably higher [58]. Over 2 billion people around the world are estimated to have been infected with HBV at some stage, with 350-400 million living with chronic infections [59]. The risk of developing a chronic HBV infection decreases with the age at which the infection occurs [60]. Neonates infected at birth, particularly those born to HBsAg and HBeAg positive mothers, face a 90% chance of becoming chronic carriers. Chronic HBV infection is responsible for about 80% of global HCC cases, making it a leading cause of liver-related deaths, particularly in Africa and Asia [61].

While 90-95% of adults typically clear acute HBV infections without long-term complications, an estimated 5-10% become chronic carriers. Among chronic carriers, roughly 25% will die from liver-related complications such as cirrhosis, while others may remain long-life carriers or eventually clear the virus [62]. HBV mainly spreads via unprotected sex, contact with infected blood or blood products, and using contaminated medical instruments or personal items. [63]. Importantly, perinatal transmission poses a major risk for severe liver diseases in early adulthood [60].

**Figure 5.** A Structure of HBV. Generated with Biorender.com.

In Nigeria, the HBV infection rate, illustrated in Figure 6, remains significantly high, positioning the country among areas with considerable endemic transmission[64]. Iloh and Ikwudinma [65] estimate that around eighteen (18) million Nigerians are presently infected with HBV. A meta-analysis by Fakunle et al. [28] covering the years from 2000 to 2013 uncovered pooled prevalence rates of 13.6% in adults and 11.5% in children. Furthermore, other studies have shown particularly elevated prevalence rates in specific subpopulations: blood donors (25.7%)[66], surgeons (23.4%) [29], and infants (16.3%) [29]. Although pregnant women are often perceived as lower risk, a study by Mbaawuaga et al. [67] revealed HBV prevalence rates reaching 11% in this demographic. Various studies conducted across different regions of Nigeria have emphasized the prevalence of HBV infection, particularly among pregnant women. In Southwestern Nigeria, different seroprevalence rates of HBV were identified among pregnant women attending antenatal care in Ekiti State (4.0%) by Lesi et al. [68], Lagos State (6.08%) by Rabiun et al. [69], and Osun State (7.1%) by Opaleye et al., [70]. reported prevalence rates of 4.0%, 6.08% and 7.1%, respectively, among pregnant women attending antenatal care in Ekiti, Lagos, and Osun States. In addition, seroprevalence rates of 7.4% were observed by Shittu et al. [71] in Ondo State, 8.0% by Okonko et al. [72] in Ogun State, and 8.3% Anaedobe et al. [73] in Oyo State. In Southeastern Nigeria, prevalence rates among pregnant women have been reported. Studies by Ikeako et al. [74] reported a seroprevalence rate of 3.4% in Enugu State, Chima et al. [75] and Onwuakor et al. [76] reported similar seroprevalence rates of 7.1%. In South-South Nigeria, a seroprevalence rate of 2% among pregnant women was reported by Awanye et al. [77] [77] in Port Harcourt. Seroprevalence rates of 6.6% and 7.9% were observed by Utoo et al.

[78] in Cross River and Bayelsa States, respectively. In comparison, Oazuwa and Erhunwunselmade [79] documented a significantly higher prevalence of 21.1% among blood donors in Delta State. These findings point to an upward trend in HBV prevalence in South-South Nigeria.

In North-Central Nigeria, the prevalence of HBV also varies by state. A seroprevalence of 7.3% was documented by Terwase and Emeka [80] among staff quarter residents in the Federal Capital Territory (Abuja). Pregnant women in Kwara and Niger states had rates of 12.7% and 12.8%, respectively [81]. Higher prevalence rates were found in Kogi State (14.0% among farmers) [82], Plateau State (14.5% among individuals living with HIV) [83], and Nasarawa State (17.1% among female sex workers) [84]. The highest prevalence in the region was reported in Benue State at 20.0% among blood donors [85]. In North-West Nigeria, although HBV prevalence is lower, it is still a concern. Kaduna State had a rate of 3.9% among pregnant women[86], while Kano State reported 6% among HIV-positive individuals [64]. Sokoto State showed a slightly increased prevalence of 6.5% among pregnant women, according to Saidu et al. [87]. In the Northeast, Ndako et al. [88] and Imaranezor et al. [89] reported HBV prevalence rates of 5.3% and 6.0% among students in Gombe and Taraba states, respectively. Aliyu et al. [90] documented an 8.0% prevalence among children in Maiduguri, Borno State, while Okoye and Samba [91] noted a 9.0% rate in Mubi, Adamawa State. Alarmingly, the adjacent states of Bauchi and Yobe recorded seroprevalence rates of 18.0% and 49.0%, respectively, among blood donors and students [92].

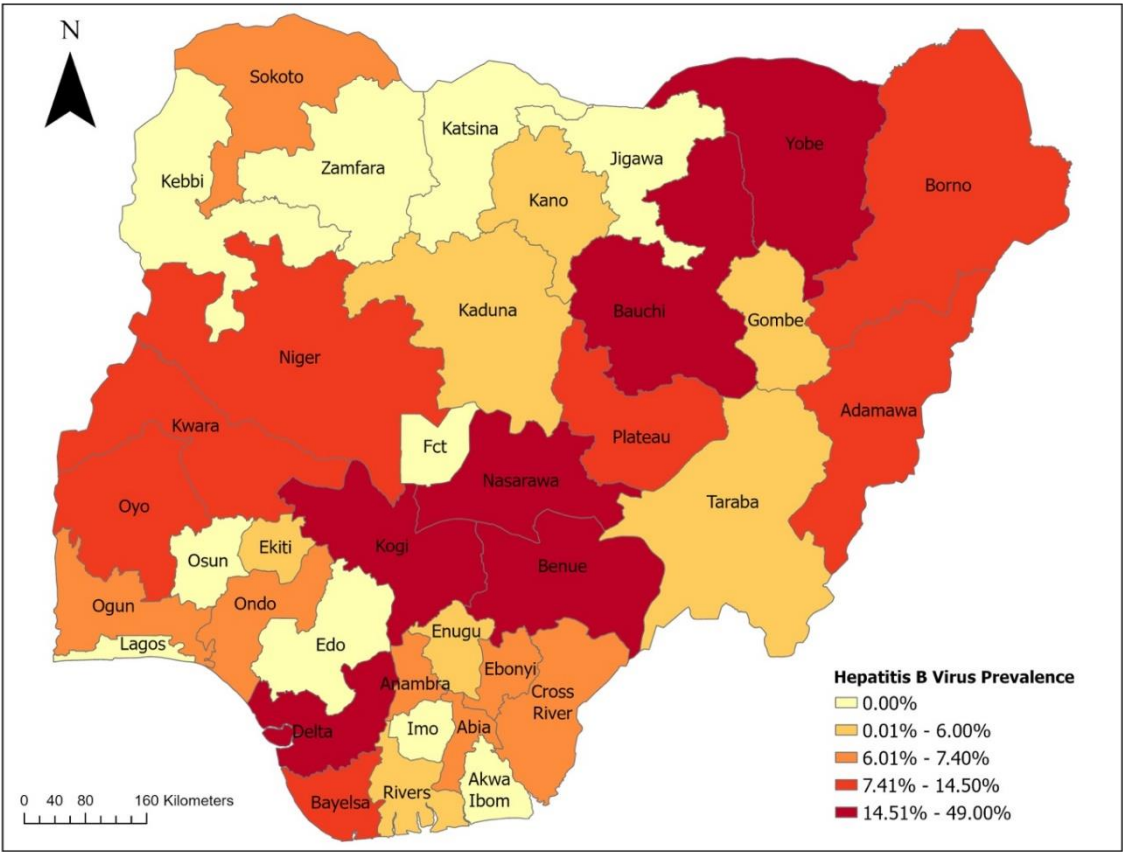


Figure 6. Map of Nigeria showing the distribution of HBV.

HCV

HCV (Figure 7), a single-stranded RNA virus, infects both humans and chimpanzees, inducing comparable hepatic disease in the hosts. The predominant route of HCV transmission is parenteral, although sexual transmission also occurs [93]. HCV is notably more infectious than Human Immunodeficiency Virus (HIV), with estimates suggesting it is up to four times more transmissible

and capable of causing infection with a lower inoculum [94]. Globally, HCV is recognized as a major contributor to chronic liver disease, including cirrhosis and HCC [95].

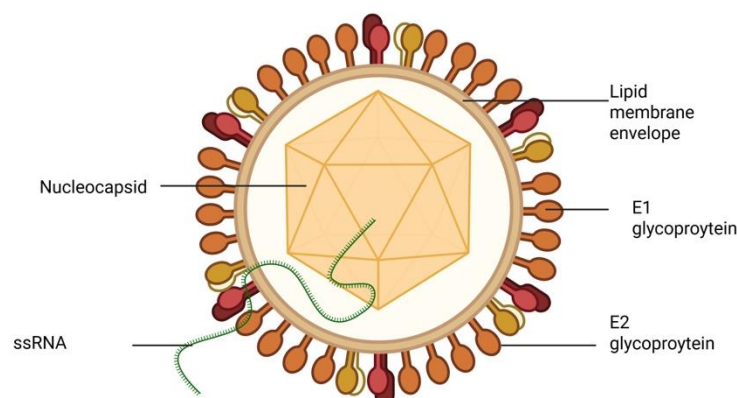


Figure 7. A Structure of HCV. Generated with Biorender.com.

The WHO estimates that around 170 million people globally are chronically infected with HCV, with approximately 3 to 4 million new infections occurring each year [96]. Although comprehensive data on HCV-associated morbidity and mortality in Africa are scarce, existing patterns suggest these metrics may exceed global estimates. The WHO reports approximately 75% of individuals infected with HCV develop chronic liver disease. Among this population, an estimated 1.6% progress to HCC, a malignancy characterized by a dismal prognosis and a mortality rate exceeding 80% [97]. HCV is transmitted through several well-documented routes, including exposure to infected blood, blood products, tissues, and organs; unsafe medical practices; healthcare-related exposures such as needle stick injuries [98]; intravenous drug use [99]; sexual contact [100]; transmission between mother and child during pregnancy [101]; and body piercing procedures [102]. In Africa, blood transfusion remains a significant transmission route, as only about 19% of donated blood is routinely screened for anti-HCV antibodies [103]. The primary barrier to comprehensive screening is the high cost of laboratory diagnostics. Additionally, inconsistent and inadequate screening protocols for blood donors further compound the risk of HCV. The prevalence of HCV has been widely documented in Nigeria (Figure 8). Adedeji et al.[30] investigated the seroprevalence patterns of HCV among internally displaced persons in Borno State, Nigeria. They found a seroprevalence rate of 1.3% for anti-HCV in pregnant and breast-feeding mothers. In Niger Delta, Nigeria, Ejele et al. [104] detected Anti-HCV in 11 subjects. The highest prevalence was found in individuals aged 30 to 39, while the lowest was observed in those aged 40 to 49. Furthermore, it was reported that HCV infection was more common among less educated subjects compared to highly educated participants. These studies confirm a high prevalence of anti-HCV and call for urgent health education and awareness in Nigeria to prevent the further spread of HCV.

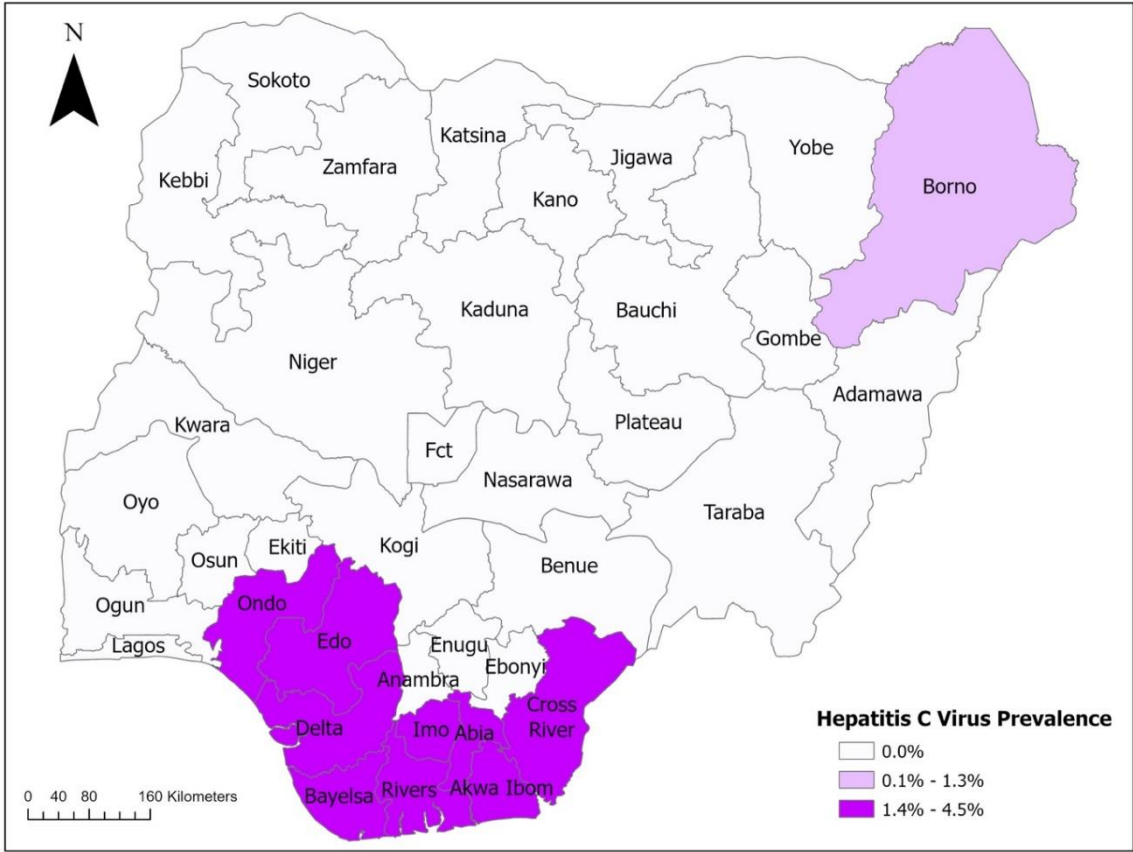


Figure 8. Map of Nigeria showing the distribution of HCV.

HDV

HDV illustrated in Figure 9, is a single-stranded RNA virus featuring a compact genome of approximately 1700 ribonucleotides[105]. This genome is only slightly larger than that of certain plant viroids, placing HDV among the smallest viruses known to infect humans [106]. HDV operates as a defective satellite virus, dependent on HBsAg for its infection and replication. Its envelope is exclusively made up of surface proteins derived from HBV[105]. The HDV genome contains a single open reading frame that transcribes two variants of the hepatitis delta antigen (HDAG): S-HDAG (small HDAG) and L-HDAG (large HDAG). S-HDAG is crucial for both the initiation and continuation of viral replication. In contrast, L-HDAG plays a role in suppressing replication and assisting in HDV enveloping with HBV surface proteins [105]. Moreover, the HDV genome also includes several open reading frames (ORFs) whose functions remain largely unexplored, despite the active transcription of HDAG [107]. The two isoforms of HDAG are: small HDAG (S-HDAG), which consists of 195 amino acids, and large HDAG (L-HDAG), comprising 214 amino acids [107].

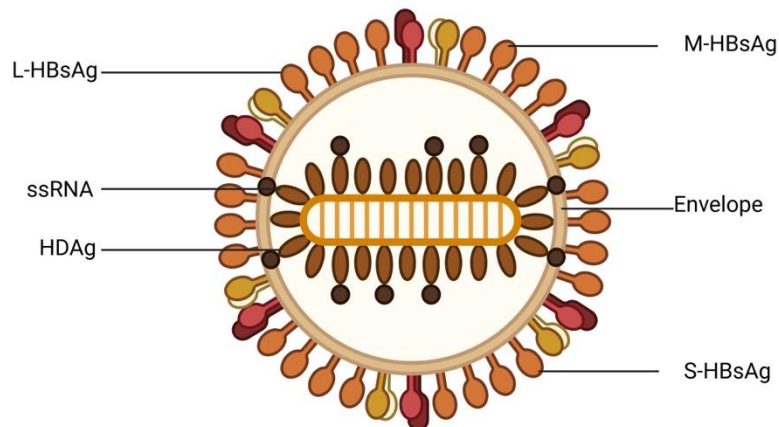


Figure 9. A Structure of HDV. Generated with Biorender.com.

The prevalence of HDV in Nigeria shows significant variation across different regions (Figure 10), with rates documented between 4.3% - 31.6% in the Southwest [108,109], 18.9% and 10.8% in Abuja and Sokoto State[110]. In contrast, Benue State exhibits a lower antigen prevalence of 2.7% among HBsAg-positive individuals in the North-Central region, while Kano State reports a rate of 5.43% in the Northwest [111,112]. Such variations may indicate differences in healthcare accessibility, economic status, and cultural practices that affect disease spread. Research carried out in Cross River and Ekiti States found no HDV cases among patients undergoing antiretroviral therapy (ART) and pregnant women, respectively [113,114]. Another study reported regional variation in HBV prevalence across Nigeria, supporting the association between HDV distribution and HBV-endemic regions. Since HDV infection is contingent upon co-infection with HBV, areas with high HBV prevalence are likely to serve as HDV hotspots. This correlation highlights the necessity of region-specific public health interventions for HDV prevention and control. Such targeted strategies are especially critical in high-risk zones like the Northeastern part of the country, where proximity to Cameroon may enhance cross-border viral transmission, potentially contributing to increased HDV incidence in the region [115].

The investigation conducted by Ifeora et al.[115] found that 64.7% of participants who were positive for HDV RNA were male. This trend aligns with the results of Nwokediuko and Ijeoma[116], who noted that the prevalence of HDV was 13% in males and 10.5% in females. Furthermore, research by Nwika et al. and Okonkwo et al. [117,118] showed that male patients had elevated liver enzyme levels and were at a higher risk for complications linked to HBV/HDV co-infection. Similarly, the findings of Ifeora et al. and Okpokam et al. confirmed that the rates of HDV co-infection were higher in males than females[27,119]. However, a study from Plateau State, Nigeria, reported a greater HDV prevalence in females (14.8%) compared to males (5.5%), especially among those co-infected with HIV[120]. This discrepancy suggests that gender-related risk behaviors and vulnerabilities may vary between regions and demographics. In Southwest Nigeria, studies indicate that the peak incidence of hepatitis D virus (HDV) infection occurs in younger to middle-aged adults, particularly within the age groups of 21 – 30 and 31 – 40 [108,121]. Ifeora et al. [27] also identified a significant prevalence among individuals under 20 years of age. Another study by Ifeora et al. revealed that adults aged 41–50 years, especially those engaging in high-risk sexual behaviors, showed the highest prevalence of HDV [122]. In contrast, Lukman et al.'s research found no notable statistical connection between age and HDV infection[123]. These divergent patterns likely mirror age-related differences in exposure to risk factors, influenced by disparities in healthcare access, vaccination rates, and shifting behaviors over time.

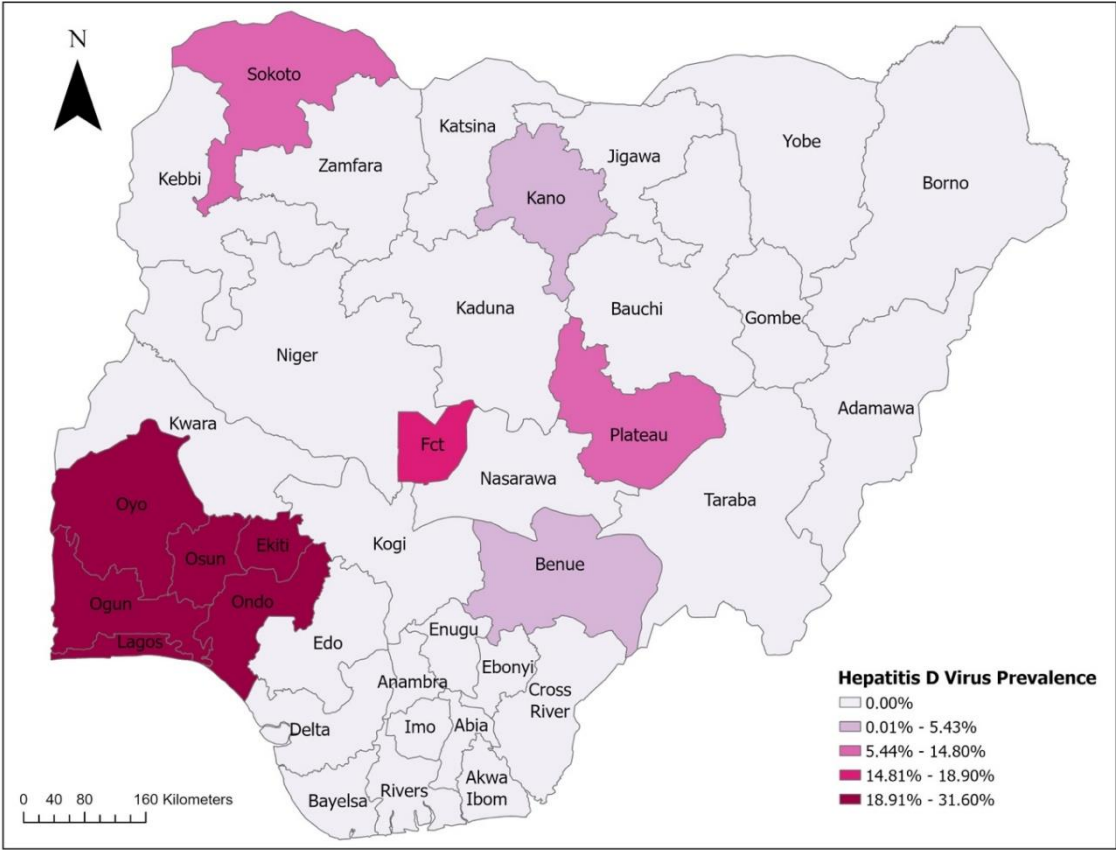


Figure 10. Map of Nigeria showing the distribution of HDV.

HEV

HEV (Figure 11) is categorized as a single-stranded RNA virus within the Hepevirus genus of the Hepeviridae family. It is a significant agent of acute viral hepatitis globally [124]. Structurally, HEV exists in three forms: naked virion, quasi-enveloped virion and enveloped virus[125-127]. Human-infecting HEV strains are classified under the species Orthhepevirus A, which encompasses (HEV-1 to HEV-8) based on whole genome phylogenetic analysis [128]. Notably, genotypes HEV-1 through HEV-4 are established as human pathogens, with emerging evidence suggesting HEV-7 can also infect humans [129]. Genotypes HEV-1 and HEV-2 are exclusively associated with humans and are typically linked to outbreaks in resource-limited settings resulting from water contamination[124]. In contrast, HEV-3 and HEV-4 exhibit zoonotic potential, capable of transmitting to humans from various animals, primarily through the consumption of inadequately cooked animal products or direct contact with infected animals. The prevalence of genotypes 1 and 2 is particularly noted in numerous low-income regions, especially in specific areas of sub-Saharan Africa [130].

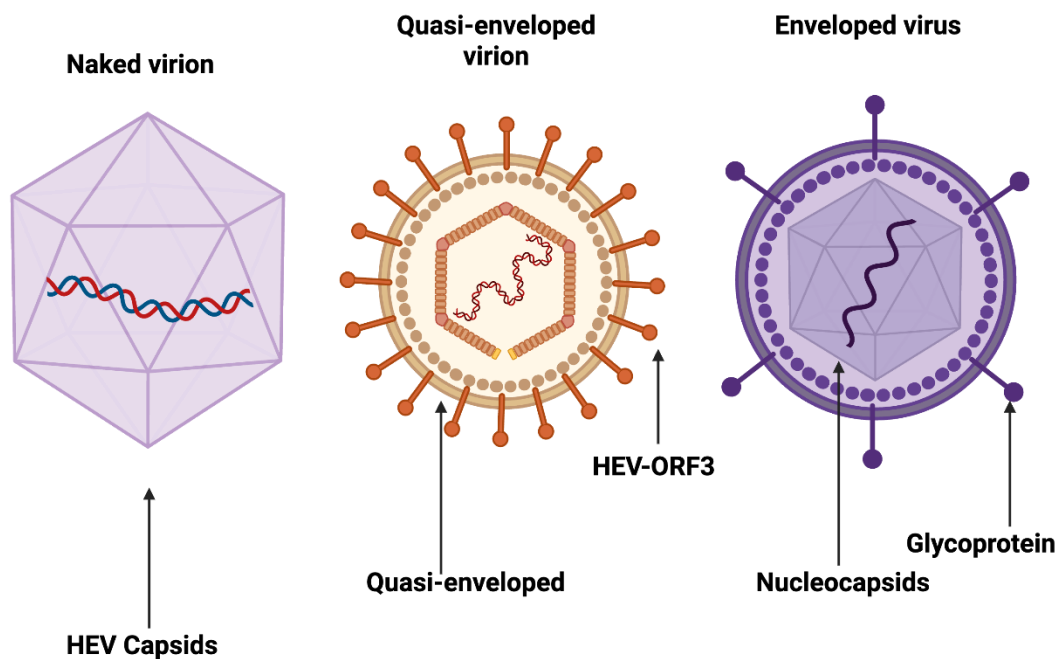


Figure 11. A Structure of HEV. Generated with Biorender.com.

HEV has been reported in different areas of Nigeria (Figure 12). In the North-East region, an outbreak led to 1,815 suspected cases and eight reported deaths, underscoring the virus’s significant public health impact [131]. Despite the public health relevance of HEV, data on its seroprevalence, geographic distribution, and risk factors in Nigeria remain limited. Existing studies have reported highly variable anti-HEV seroprevalence rates across different regions of the country, ranging from 7% to as high as 93% [31]. Molecular evidence has also confirmed the circulation of HEV genotypes 1 and 2 in human populations within Nigeria [132]. Socioeconomic inequalities and limited access to vital services—especially clean drinking water and reliable healthcare—between urban and rural regions may play a role in the spread and persistence of HEV infections. In rural areas, these structural deficiencies are usually more significant, heightening the risk of encountering contaminated water sources. For example, Osun state, which encompasses both urban and rural environments, serves as a relevant area to explore these dynamics.

In a study conducted by Osundare et al. [133], the distribution of HEV infection in Osun State, Nigeria, was investigated, revealing a seroprevalence of 15.0% for total anti-HEV antibodies in the sampled communities. This estimate is comparable to the 13.4% seroprevalence found in Ekiti State, Nigeria[134]. The similarity in these findings may be influenced by shared cultural practices, similar socioeconomic conditions, and geographical proximity, as both states are situated in the South-West region of Nigeria. In contrast, higher anti-HEV seroprevalence rates have been reported in other studies across Nigeria. For instance, Ola et al. [31] found a prevalence of 44% among health workers and 93% among non-health workers in Ibadan, Oyo State, also in South-West Nigeria. Furthermore, Junaid et al. [32] reported a seroprevalence of 47.9% among apparently healthy individuals in Plateau State. The elevated rates observed in these studies may be partly due to the smaller sample sizes used, which can affect the variability and generalizability of their results. In the same study, individuals in rural communities exhibited a higher anti-HEV total antibody seroprevalence (20.1%) than those from urban communities (9.2%). Notably, the lowest seroprevalence rates were observed in Ede (8.0%) and Osogbo (11.4%), both urban settlements[133]. This disparity may be attributed to the relatively greater availability of social amenities in urban areas, including access to potable water supply, improved housing, better sanitation, reliable road infrastructure, and enhanced healthcare services, all of which may contribute to reduced HEV transmission.

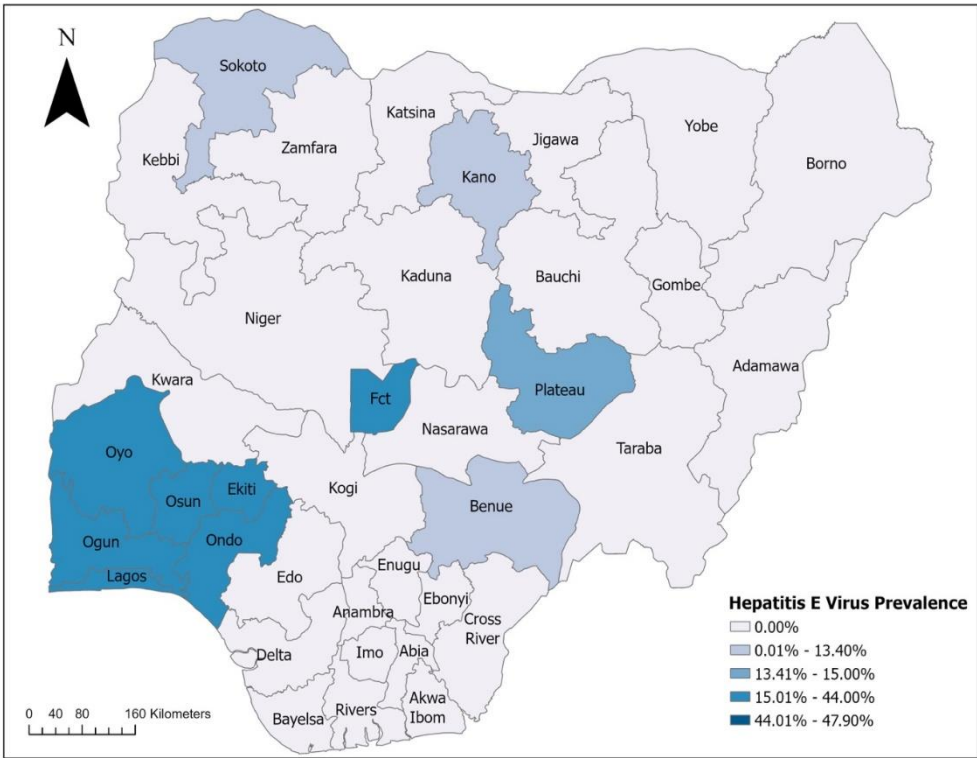


Figure 12. Map of Nigeria showing the distribution of HEV.

In comparison, the seroprevalence of total anti-HEV antibodies was significantly high in the communities of Esa-Odo (22.0%), Ore (21.0%), and Oke-Osun (19.4%) [133]. These areas are largely rural and agricultural, indicating that farming practices may play a role in the increased seroprevalence. Contributing factors could include the use of animal dung as fertilizer, inadequate farm hygiene, and the consumption of stream water that may be contaminated with human or animal feces, all of which could enhance HEV transmission risk. The observations made by Osundare et al. support the findings of Junaid et al. [32], who noted a correlation between rural living and elevated anti-HEV seroprevalence. While the overall seroprevalence of antibodies was comparably high across Esa-Ode, Ore, and Oke-Osun, notable differences were observed in the rates of anti-HEV IgM seroprevalence: Esa-Ode and Ore recorded higher rates of 10.0% and 6.8%, respectively[133].

3. Role of Traditional medicine in treatment practices

TM along with its active components are vital in treating hepatitis in Africa, providing distinctive antiviral and liver-protective benefits. They deliver positive therapeutic outcomes through antiviral effects and immunomodulation in patients with chronic hepatitis B. [135,136]. Demie et al. [137] and Aschale et al. [138] opined that medicinal plants gained widespread use in Ethiopian culture to treat certain diseases, including hepatitis, due to a lack of modern medicine. Social acceptability, affordability, accessibility, and effectiveness are other drivers of its use. Traditional treatment practices often emphasize symptom management and elicit elevated interest in natural bioactive compounds [139,140]. Natural products, usually extracted from plants or herbs and their derivatives have demonstrated significant potency against viral agents like viral hepatitis. They are considered to be the most economically beneficial treatment option with minimal side effects [141]. They impact different phases of the viral life cycle, including replication, release, and specific host interactions [142].

Numerous medicinal plants have undergone various in vitro and in vivo tests to investigate their bioactive properties and hepatoprotective mechanisms. Results have identified a diverse range

of compounds, including terpenoids, alkaloids, flavonoids, furyl compounds, polyphenols, isoquinolines, lignans, coumarins, proteins, and other substances that inhibit viral DNA or RNA synthesis while promoting DNA repair and enhancing immune function[143,144]. Research indicates that *R. nepalensis* [145], *S. incanum* [146], and *A. abyssinicus* [147] exhibit anti-hepatitis properties. Additionally, combinations of *R. nepalensis* with *S. incanum*, as well as with *C. macrostachyus* and *V. apiculata*, have been shown to reduce serum HBV-DNA levels in treated patients¹⁴⁵. Other herbs that have been studied for their hepatoprotective effects include *Silybum marianum* (L.) Gaertn., *Glycyrrhiza glabra*, *Phyllanthus amarus* Schumach. & Thonn., *Schisandra chinensis* (Turcz.), *Capparis spinosa* L., *Solanum nigrum* L., *Ginkgo biloba* L., *Salvia miltiorrhiza* Bunge., *Astragalus membranaceus* (Fisch.) Bunge, *Cichorium intybus* (L.), *Sapindus mukorossi* Gaertn., *Woodfordia fruticosa* (L.) Kurz, *Vitex trifolia* (L.), *Cuscuta chinensis* (Lam.), *Lycium barbarum*, *Angelica sinensis* (Oliv.) Diels, and *Litsea coreana* (H. Lev.), all of which have been explored for their hepatoprotective potentials and underlying mechanisms of action [148].

3.1. Selected medicinal plants effective for hepatitis treatment and their possible mechanism of action

***Silybum marianum* (L.) Gaertn**

Silybum marianum (L.) Gaertn, commonly known as Milk Thistle (Figure 13), is widely recognized as a natural herbal remedy for various chronic inflammatory liver conditions, including hepatitis, cirrhosis, fatty liver disease, and other liver-related injuries [149]. The bioactive compound extracted from *S. marianum*, silymarin (Figure 13), has been extensively studied in preclinical research and is known for its antioxidant and hepatoprotective properties[150-152]. Silymarin is a complex mixture of active compounds primarily consisting of flavonolignans (such as silibinin, isosilibinin, silichristin, and silidianin), flavonoids (like taxifolin and quercetin), and other polyphenolic substances[153]. According to Lu et al. [154], silymarin has shown effectiveness in treating both chronic and acute viral hepatitis, alcoholic liver disease, and liver cirrhosis. It is registered as a treatment for liver ailments in numerous countries across Europe, Asia, America, Africa, and Australia and has received approval for clinical trials targeting Hepatitis C virus infection[155]. Numerous studies have explored silymarin's mechanisms of liver protection. Tunca et al.[156] concluded that silymarin reduces metabolic pyrimidine activation by lowering the concentration of cytochrome P450 1A1 proteins and modulating the expression of inducible nitric oxide synthase, which together provide a protective effect against pyridine-induced liver damage in Syrian hamsters. Additionally, silymarin helps sustain the liver's glutathione levels by stabilizing membrane permeability and inhibiting lipid peroxidation [152].

Furthermore, silymarin protects the liver from toxic substances, such as carbon tetrachloride, by suppressing the production of tumor necrosis factor-alpha (TNF- α), interferon-gamma, and interleukin-2 (IL-2) and IL-4 [157,158]. This action effectively inhibits the activation of hepatic nuclear factor kappa B (NF- κ B) (Figure 14), a crucial step in mitigating inflammation and safeguarding the liver from viral infections [157,159]. Silymarin achieves this by preventing the translocation of NF- κ B to the nucleus, where it binds to various cytokine genes and suppresses their expression[160]. Moreover, silymarin can lower cellular uptake of xenobiotics by blocking organic ion transporters on hepatocyte surfaces[161] and inhibiting TNF- α expression induced by the toxin α -amanitin from poisonous mushrooms[162]. The hepatoprotective effect of silymarin is largely ascribed to its antioxidant activity, which counteracts the free radicals responsible for lipid peroxidation and contributes to cellular enzyme dysfunction, ultimately leading to fibrosis and cirrhosis.



Figure 13. A Structure of *Silybum marianum* (L.) Gaertn. Generated with Biorender.com.

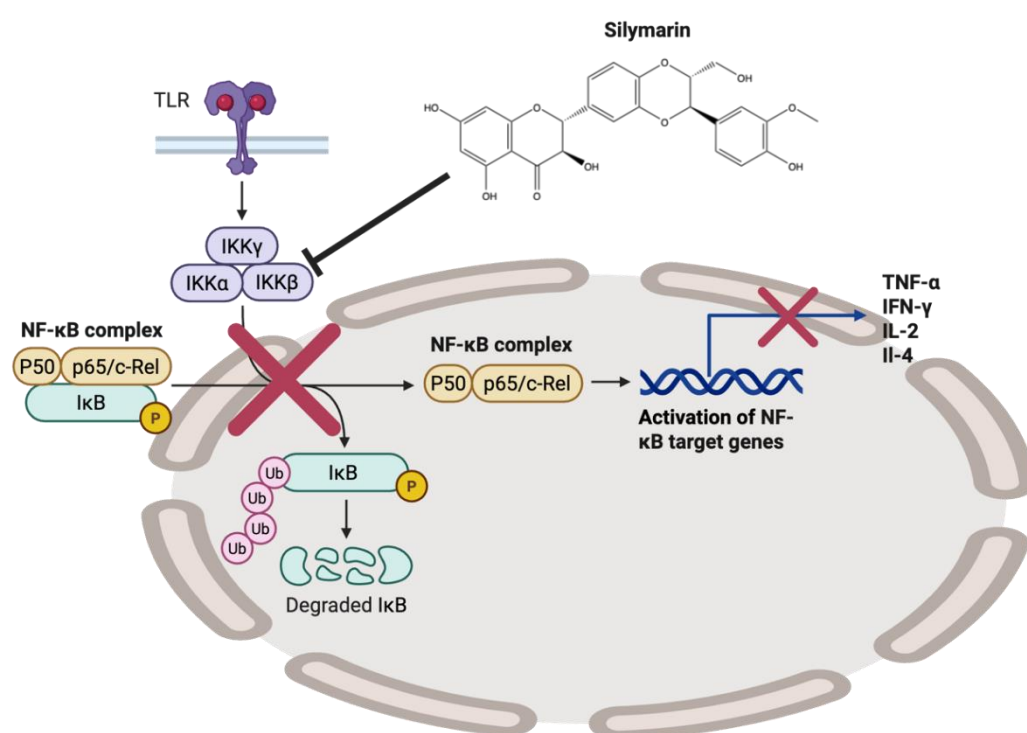


Figure 14. Pharmacological effect of silymarin on the regulation of **NF-κB**. Generated with Biorender.com.

Glycyrrhiza glabra (Licorice)

Glycyrrhizin (Figure 15), a natural compound derived from the roots of liquorice (*Glycyrrhiza glabra*), is widely recognized in folk medicine for treating various ailments, particularly liver diseases and drug-induced liver injuries [163]. Liquorice possesses anti-inflammatory and antioxidant properties, having been utilized to treat chronic hepatitis with notable improvements in liver histology and reductions in serum aminotransferases compared to placebo treatments [164,165]. It contains numerous phytochemicals, such as coumarins (including glycyrin, heniarin, liqcoumarin, and umbelliferone), flavonoids (flavonols and isoflavones), chalcones, and terpenoids (such as glycyrrhizic or glycyrrhizinic acid), with glycyrrhizic acid identified as the main active biological component [166]. Research by Kimura et al. [167] indicates that intraperitoneal administration of glycyrrhizin and epidermal growth factor (EGF) can significantly promote liver regeneration and restore liver function, likely through the stimulation of EGF receptors. Studies have demonstrated that glycyrrhizin can substantially reduce steatosis and necrosis in liver cells, inhibit interstitial

inflammation and liver fibrosis, and support the regeneration of healthy cells[168,169]. Additionally, it acts to inhibit CD4⁺ T-cells and TNF-mediated cytotoxicity [170]. The extract of liquorice root stabilizes cellular membranes and enhances the endogenous production of interferons [171]. Notably, 18- β glycyrrhetic acid has exhibited antiviral properties against multiple DNA and RNA viruses, potentially due to the activation of NF-kB and the induction of IL-8 [172]. Research by Ashfaq et al. has shown that liquorice generates a dose-dependent antiviral effect against HCV, comparable to interferon alpha, which may result from its capacity to decrease membrane fluidity and upregulate Cox-2 or related pathways[173].

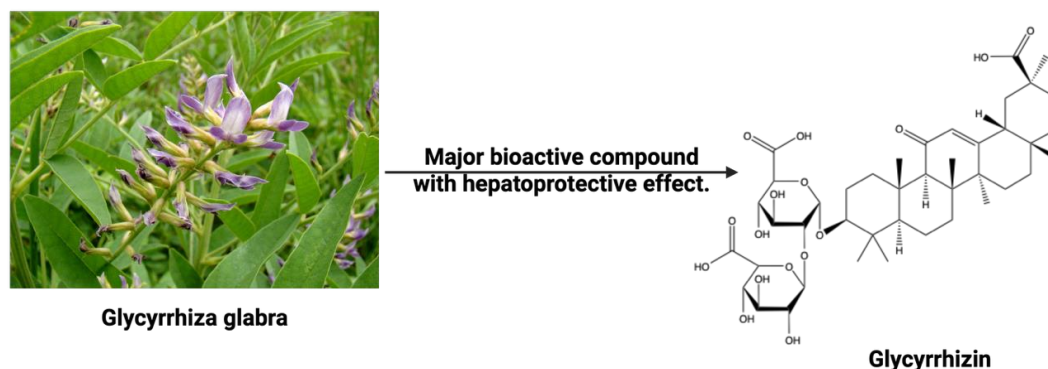


Figure 15. A Structure of Glycyrrhizin extracted from Glycyrrhiza glabra. Generated with Biorender.com.

***Phyllanthus amarus* Schumach & Thonn**

P. amarus (Figure 16) is a small plant that typically grows in tropical areas and has been traditionally employed by practitioners to address various health issues, such as hepatitis B, jaundice, hypotension, inflammation, and oxidative stress [174,175]. Over 500 phytochemicals derived from different *Phyllanthus* species have been linked to notable bioactivities in cases like jaundice and digestive issues [176]. Phyllanthin (Figure 16), a bioactive compound derived from *P. amarus* leaves, has traditionally been employed in the treatment of various liver diseases Hanh, *et al.* [177]. Research by Xin-Hua et al. [178] revealed that the extract did not show a significant difference in the rates of negative conversion for HBeAg and HBV-DNA compared to interferon, indicating its potential therapeutic effect on chronic HBV. Studies suggest that its antioxidant properties may provide hepatoprotective effects against ethanol-induced oxidative damage in primary cultures of rat hepatocytes[179]. In cell culture experiments, *P. amarus* disrupts HBV enhancer I (EN I), which is essential for viral gene expression, leading to the downregulation of HBV mRNA transcription and replication[180].

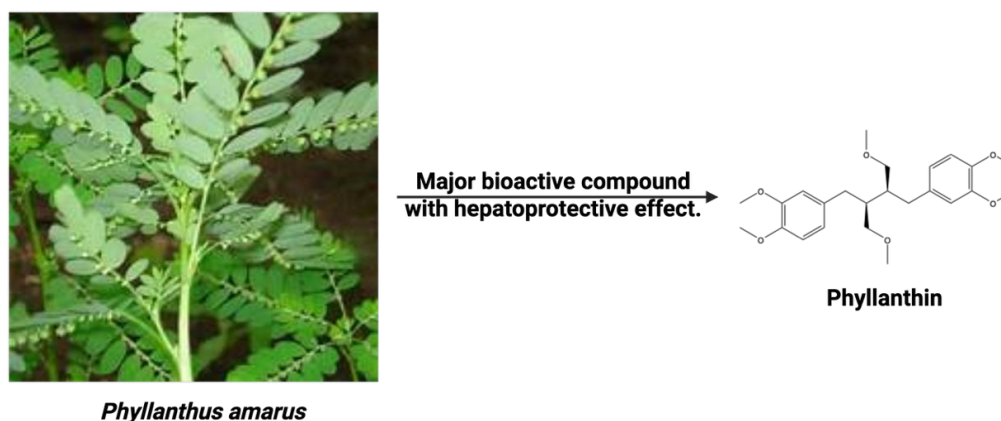


Figure 16. A Structure of phyllanthin extracted from *Phyllanthus amarus*.

Schisandra chinensis (Turcz.)

Schisandra chinensis (Figure 17), commonly referred to as the flavored fruit, is a deciduous woody vine renowned for its various traditional medicinal applications. The fruit is rich in dibenzocyclooctene lignans, primarily including schisandrin, schisandrin A, schisandrin B, and schisandrin C (Figure 16). Notably, research by Wu et al.[181] demonstrated that the combination of Schisandrin C and Luteolin effectively reduces hepatitis B virus (HBV) infection by inhibiting HBV replication and enhancing cGAS-STING pathway activation in macrophages. Furthermore, Zhao et al. [182] found that Schisandrin C triggered the cGAS-STING pathway, resulting in increased production of interferon β (IFN β) and enhanced expression of downstream genes. In their study, they noted that Schisandrin C exhibited anti-HBV effects, significantly decreasing the levels of HBeAg, HBcAg, HBsAg, and HBV DNA in a mouse model of HBV replication induced by hydrodynamic injection, while simultaneously elevating the production of IFN β and the expression of interferon-stimulated genes such as IFIT1, ISG15, and CXCL10. Mechanistically, Schisandrin C facilitated the interaction between TANK-binding kinase 1 (TBK1) and STING, essential for the phosphorylation of IRF3 and subsequent production of IFN β . Various bioactive compounds, such as triterpenoids, phenolic acids, flavonoids, polysaccharides, essential oils, vitamins, and phytosterols, play a significant role in the pharmacological activities and clinical potential of *S. chinensis* [183]. Research has highlighted the hepatoprotective properties of *S. chinensis*[184], establishing its fruit and extracts as effective agents in managing both chemical and viral liver injuries [185]. The hepatoprotective effects stem from multiple mechanisms, notably improved liver detoxification and tissue regeneration. A key mechanism includes the modulation of cytochrome P450 enzymes (like CYP3A and CYP2E1), which are essential for the metabolism of xenobiotics, thereby enhancing the hepatic clearance of toxins and drugs[186]. Following treatment with *S. chinensis* ethanol extract, significant reductions in glutamate oxaloacetate transaminase, glutamate pyruvate transaminase, and alkaline phosphatase levels were observed in rats' livers after acetaminophen-induced injury. Additionally, the extract was found to prevent centrilobular hepatic necrosis and elevate antioxidant levels, including glutathione peroxidase, superoxide dismutase, and catalase [187]. Furthermore, after treatment with *S. chinensis*, there was an increase in the synthesis and levels of intracellular glutathione (GSH) in hepatocytes, offering protection against oxidative damage[183].

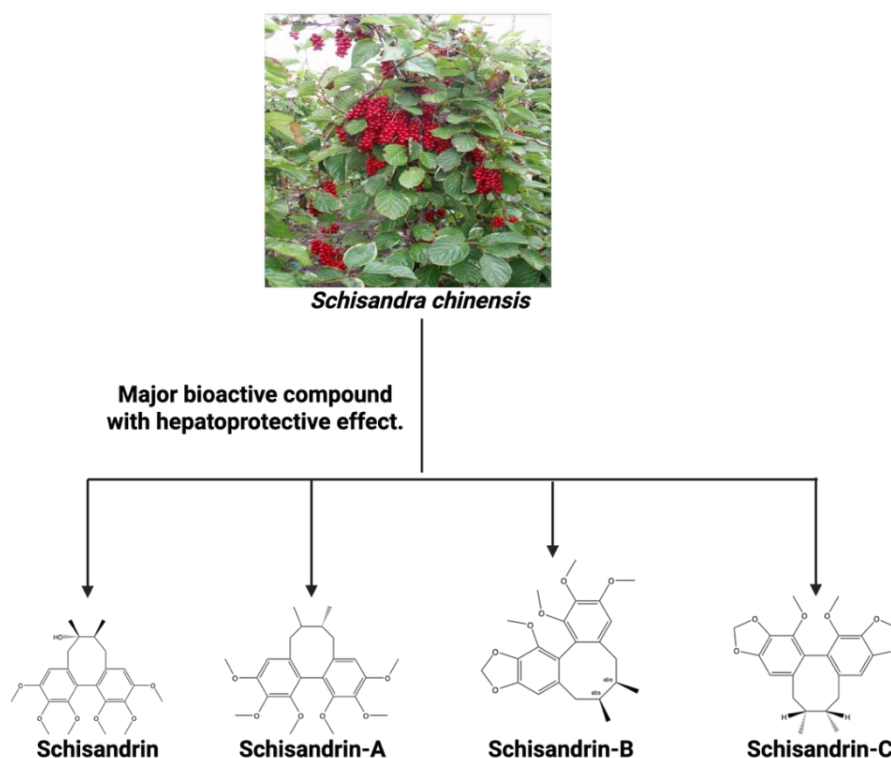


Figure 17. Structures of the major bioactive compounds in *Schisandra chinensis*. Generated with Biorender.com.

Capparis spinosa L.

C. spinosa L. (commonly known as caper, Figure 18) is a plant native to the arid regions of Western and Central Asia. This plant has been utilized in traditional medicine for centuries to address various ailments, including rheumatism, gout, gastrointestinal issues, diabetes, as well as kidney and liver diseases[188-190]. Phytochemical analyses have identified several beneficial compounds within *C. spinosa* (Figure 18), such as flavonoids (including rutin, quercetin, and catechin), alkaloids (like spermidines and indoles), and glucosinolates (notably glucocapparin) [189,191]. Additionally, it contains minor quantities of other valuable compounds like kaempferol, stigmaterol, campesterol, tocopherols, and carotenoids[192]. At moderate levels, *C. spinosa* is also rich in vitamin C, carbohydrates, proteins, dietary fiber, and lipids [191]. Biological studies have demonstrated its antimicrobial, anti-inflammatory, immunomodulatory, antioxidant, and antiviral properties [189]. The extract of *C. spinosa* may positively influence liver health, as it has been linked to reduced gluconeogenesis and decreased fat accumulation in diabetic rats induced by streptozotocin. Furthermore, it is a key ingredient in Liv-52, a herbal remedy extensively used in Indian traditional medicine for treating various liver conditions[193]. A study involving 36 cirrhotic patients indicated that treatment with Liv-52 significantly lowered serum levels of ALT and AST, likely due to the protective effects endowed by its constituent herbs.

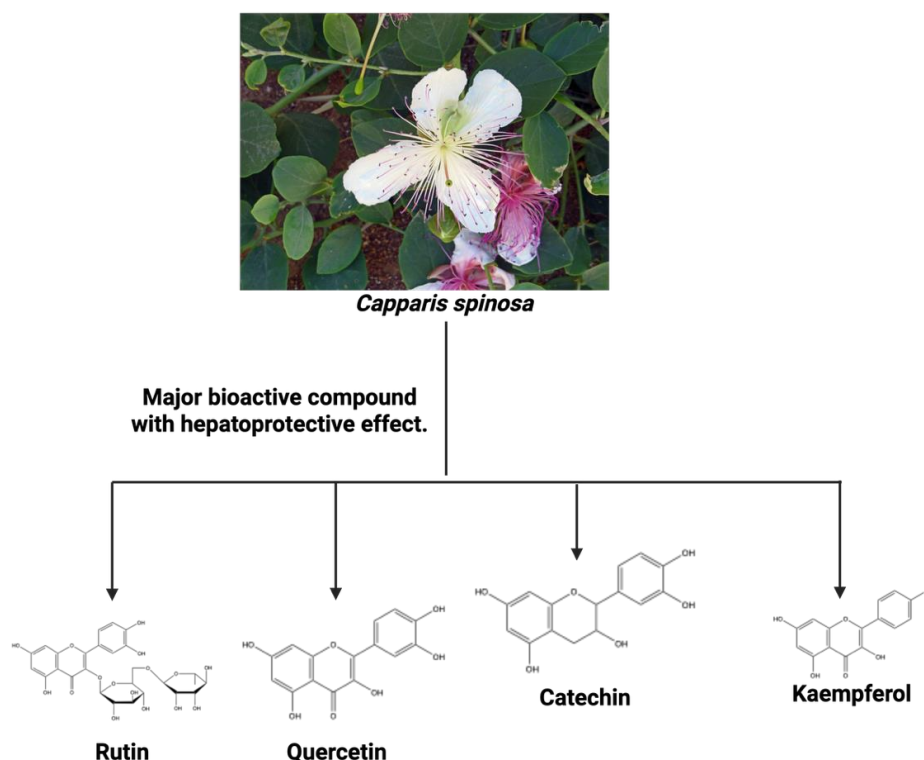


Figure 18. Structures of the major bioactive compounds in *C. spinosa*. Generated with Biorender.com.

***Solanum nigrum* L.**

S. nigrum (Black Nightshade) is a widely recognized herb that flourishes in temperate climate zones[194]. This plant has been utilized in TM as a powerful hepatoprotective agent[195]. The fruit of *S. nigrum* is thought to possess antitumor properties [196] and is traditionally used as a nerve tonic in Mexican folk medicine[197]. Research indicates that its hepatoprotective effects and other therapeutic benefits may be attributed to enhanced free radical scavenging and the inhibition of lipid peroxidation[198,199]. One study demonstrated that treatment with an aqueous extract of *S. nigrum* significantly reduced levels of serum alkaline phosphatase (ALP), serum glutamic-pyruvic transaminase (SGPT), serum glutamic oxaloacetic transaminase (SGOT), total bilirubin, and hydroxyl and superoxide radicals induced by CCl_4 in rats [200]. Additionally, research reported that at non-toxic concentrations, the methanolic extract of *S. nigrum* resulted in a 37% inhibition of HCV RNA expression, while a chloroform extract of *S. nigrum* seeds led to a more than 50% decrease in viral titer concentration [201].

***Ginkgo biloba* L.**

G. biloba L. is a significant herb in Traditional Chinese Medicine, renowned for its therapeutic benefits against a range of diseases, supported by both human and animal studies. Its potential applications include treatment for Alzheimer's disease, multi-infarct dementia, coronary heart disease, cerebral insufficiency, and renal ischemia-reperfusion injury [202-204]. This herb has demonstrated cardioprotective, anti-asthmatic, anti-diabetic, hepatoprotective, and photoprotective effects, along with mechanisms for DNA repair, as well as antioxidant and anti-inflammatory properties [205]. The therapeutic efficacy of *G. biloba* can largely be attributed to its diverse active components, which include two terpene lactones, flavonoids, and organic acids [206]. Many studies have linked *G. biloba* to hepatoprotective effects. Following treatment with *G. biloba*, levels of cellular antioxidant enzymes like glutathione peroxidase (GPX), glutathione S-transferase (GSTs), glutathione reductase, superoxide dismutase (SOD), catalase (CAT), and non-protein thiols have been shown to increase, further indicating its hepatoprotective characteristics [207].

Table 1.0. Some medicinal plants, their bioactive agents and hepatoprotective potentials.

Medicinal Plants	Major Bioactive Agents	Hepatoprotective Effects	References
Picrorhiza kurroa	Picroside I, picroside II, apocyanin, and cucurbitacins	It enhances antioxidant activities and scavenges the superoxide anion (O ₂ ^{•-}).	[208,209]
Adrographis paniculata	Andrographolide	It inhibits viral replication and reduces liver inflammation and injury. It also modulates the NF- κ B pathway, thereby decreasing the production of pro-inflammatory cytokines (IL-6, IL-1 β , TNF- α), scavenges free radicals and enhances antioxidant activities.	[210-212]
Eclipta alba	Wedelolactone, demethylwedelolactone	It stimulates regeneration of hepatocytes, regulates the levels of hepatic microsomal drug-metabolizing enzymes, and inhibits HCV replication	[213,214]
Carica papaya	Papain, phenolic compounds, flavonoids, alkaloids (carpaine), cyanogenic chemicals (benzyl glucosinolates)	It decreases lipid peroxidation, pro-inflammatory cytokines such as tumour NF- α and IL-6, AST and ALT activities, and improves enzymatic antioxidants CAT and SOD.	[215]
Phyllanthus niruri L.	Quercetin rhamnoside, quercetin glucoside, gallic acid, geranin	It inhibits cellular DNA polymerase activity during HBV replication, HBV DNA synthesis and secretion of HBsAg and HBcAg	[216-218]
Musa sapientum L.	Alkaloids, phenols, terpenoids, flavonoids, phytosterols	It mediates antioxidant activities, improves hepatocyte regeneration, and inhibits the expression of inflammatory cytokines. Promotes the production of anti-inflammatory cytokines	[219]
Syzygium aromaticum L.	Eugenol, β -caryophyllene	It inhibits hepatic cell proliferation into fibroblasts, mediates antioxidant and anti-inflammatory activities, and enhances liver defence mechanism	[220,221]

Psidium guajava L.	Flavonoids, gallic acids, catechins, epicatechins	It lowers elevated levels of serum AST, ALT, ALP, and bilirubin, and neutralizes free radicals.	[222,223]
Ziziphus mauritiana L.	Phenolic compounds, flavonoids, tannins, alkaloids, saponins	It lowers AST, ALT, ALP, total bilirubin and lipid peroxide levels, prevents lipid peroxidation, and increases levels of glutathione and vitamin E	[224,225]
Entada africana Guill. & Perr.	Flavonoids, triterpenes, saponins, sugar	It enhances the expression of heme oxygenase-1 and 2'-5' oligoadenylate synthetase-3, inhibits cytochrome P450 2E1 (CYP2E1), activates Nuclear factor-erythroid 2-related factors-2 (Nrf2) signaling pathway, and Inhibits HCV replication	[226,227]
Allium sativum L.	Allicin, alliin, diallyl sulfide, ajoene	Inhibit viral cell cycle. Reduction of cellular oxidative stress. Reduces viral load and improves liver function. Regulates lipid metabolism	[228,229]
Morus alba	Alkaloids (1-deoxynojirimycin), flavonoids, polyphenols	It inhibits the maturation of HBV, suppresses the glycosylation of viral envelop glycoproteins, reduces HBsAg, HBeAg, and HBV DNA, and inhibits the activity of HCV NS3 protease	[230,231]
Phyllanthus amarus Schum. & Thonn.	Lignans (phyllanthin and hypophyllanthin), flavonoids (quercetin)	It inhibits viral DNA polymerase and replication, mediates antioxidant and immunomodulatory activities, scavenges free radicals, and reduces lipid peroxidation of hepatic and intracellular membranes.	[232,233]
Momordica charantia L.	MAP30, α -momorcharin, triterpenes, saponins, flavonoids	It reduces liver inflammation, scavenges free radicals, reduces oxidative stress, inhibits viral DNA replication, HBV proteins (HBsAg and HBeAg) secretion	[234-236]

		in HepG2 cells, and stimulates hepatocyte regeneration	
Adansonia digitata L.	Triterpenoids, flavonoids, tannin, carotenoids	It neutralizes free radicals, increases GSH, CAT, and SOD levels, reduces serum levels of AST, ALT, ALP, total bilirubin, and total proteins as well as lowers serum TNF- α level.	[237,238]
Schisandra chinensis	Schisandrin, Schisandrin A, Schisandrin B, and Schisandrin C	It enhances the activation of the cGAS-STING pathway. When combined with luteolin, it HBV replication and further stimulating the activation of the cGAS-STING pathway in macrophages.	[181,182]

4. Safety Concerns and Regulation of Traditional Medicine in Nigeria

TM remains a crucial part of Nigeria's healthcare system, with a considerable portion of the population depending on herbal remedies and traditional practices for their primary healthcare needs. Nonetheless, concerns over these practices' safety, standardization, and regulation have led to efforts to establish more robust regulatory frameworks. The National Agency for Food and Drug Administration and Control (NAFDAC) is Nigeria's primary authority regulating traditional herbal medicines. NAFDAC's mandate encompasses registering, listing, and monitoring herbal products to ensure their safety and efficacy[239]. Herbal products undergo thorough evaluation for quality and safety[240]. Products that assert therapeutic claims supported by clinical trials receive complete registration and are renewable every five years [239]. Conversely, those lacking such evidence are listed with a disclaimer indicating that NAFDAC has not evaluated their claims, and this listing is subject to renewal every two years[239]. NAFDAC emphasizes the necessity of adherence to Good Manufacturing Practices (GMP) to minimize contamination and ensure product consistency [240].

Nevertheless, challenges persist due to insufficient standardization and documentation among practitioners. Despite regulatory efforts, several safety issues associated with TM practices in Nigeria have been identified. Research indicates that numerous herbal products may have dangerous components, including heavy metals like lead and mercury, as well as aflatoxins, which present serious health hazards [241]. Elevated levels of microbial contamination in herbal preparations have been reported, surpassing acceptable limits set by the World Health Organisation (WHO) [240]. A study among residents in Ikorodu, Lagos, revealed that while most believed herbal medicines were safe, a notable percentage experienced adverse effects, underscoring the need for public education on potential risks [242].

Numerous factors impede the effective regulation of TM in Nigeria. The variability in preparation methods and dosages complicates the establishment of consistent safety and efficacy standards [241]. A significant number of traditional practitioners depend on oral transmission of knowledge, resulting in a lack of formal records essential for evaluation and regulation. Furthermore, there exists a dearth of scientific studies validating the safety and efficacy of numerous traditional remedies, which hinders their integration into mainstream healthcare [242]. Practitioners frequently exhibit reluctance to disclose formulations due to concerns regarding exploitation, thereby obstructing collaborative research efforts[239,240]. To enhance the safety and regulation of TM in Nigeria, it is recommended that the government of Nigeria should strengthen the capacity of

regulatory bodies, NAFDAC and the Lagos State Traditional Medicine Board (LSTMB), to enforce compliance with safety standards.

Scientific studies on traditional remedies should also be encouraged to establish evidence-based practices and implement training programs for traditional practitioners on Good Manufacturing Practices (GMP). Furthermore, efforts must be made to raise public awareness about herbal medicines' potential risks and benefits. NAFDAC should strive to build trust between traditional practitioners and researchers to facilitate knowledge sharing and integration into the national health system. By addressing these challenges through concerted efforts, Nigeria can effectively harness the benefits of TM while ensuring public safety and aligning with global best practices.

5.0. Future Perspectives

TM continues to be a crucial component of healthcare in Nigeria, particularly in managing chronic conditions like viral hepatitis. As the nation faces the dual challenges of a high prevalence of hepatitis and limited access to conventional treatments, the integration of TM presents both opportunities and obstacles. Recent studies emphasize the widespread use of medicinal plants for managing viral diseases, including hepatitis, in various regions of Nigeria. For example, an ethnobotanical survey conducted in northern Nigeria identified 131 plant species used by traditional healers to treat viral infections, with notable references to *Phyllanthus amarus*, *Senna occidentalis*, and *Garcinia kola* for hepatitis management. These findings highlight the rich biodiversity and traditional knowledge that can be leveraged for therapeutic purposes[243].

Nevertheless, the safety and efficacy of these remedies remain areas of concern. A study comparing the effectiveness of herbal and conventional interventions for Hepatitis B Virus (HBV) management indicated that although 73% of patients adopted herbal remedies, there was a significant variance in health outcomes, underscoring the need for standardized treatment protocols[244]. The lack of regulation surrounding many traditional remedies presents significant health risks. Studies show that patients seeking alternative treatments for hepatitis have encountered dangerous substances because of poorly regulated herbal products. These situations highlight the pressing need for strict regulatory frameworks to protect patient safety. Additionally, the lack of thorough clinical trials and standardized dosing protocols makes it difficult to integrate TM into mainstream healthcare. Although agencies like NAFDAC have started initiatives to register and oversee herbal products, a substantial portion of the informal sector continues to be largely unregulated.

To effectively utilize TM in the management of hepatitis, several strategic actions are essential. First, conducting clinical trials to assess the efficacy and safety of commonly used herbal remedies is crucial, as this process will support evidence-based integration into healthcare systems. Additionally, developing standardized methods for extraction and preparation will ensure consistent dosing and reduce variability in therapeutic outcomes. Training programs focusing on hygiene, accurate diagnosis, and referral systems should be established to bridge the gap between traditional and modern medicine. Educating the public about the benefits and potential risks of TM will empower patients to make informed healthcare choices. Furthermore, enhancing the capacity of regulatory bodies to monitor and evaluate herbal products will help mitigate risks associated with adulteration and contamination. Therefore, the integration of TM in managing viral hepatitis in Nigeria can significantly enhance healthcare delivery, especially in underserved areas. However, this process must be approached cautiously to maintain safety, efficacy, and quality. Through collaborative efforts among traditional practitioners, researchers, and regulatory bodies, Nigeria can establish a holistic and inclusive healthcare system that honors cultural heritage while prioritizing patient safety.

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Abbreviation

ALP	- Alkaline Phosphatase
ALT	- Alanine Aminotransferase
ART	- Antiretroviral Therapy
AST	- Aspartate Aminotransferase
CAT	- Catalase
CCl ₄	- Carbon Tetrachloride
cGAS-STING	- Cyclic GMP-AMP synthase – Stimulator of interferon genes
COX-2	- Cyclooxygenase 2
DALYs	- Decline in Age-Standardised Disability adjusted life years
DNA	- Deoxyribonucleic Acid
EGF	- Epidermal growth factor
EN I	- Enhancer I
GBD	- Global Burden of Disease
GBD	- Global Burden of Disease
GMP	- Good Manufacturing Practices
GPX	- Glutathione peroxidase
GSH	- Glutathione
GST	- Glutathione S-transferase
HAV	- Hepatitis A Virus
HBcAg	- Hepatitis B Core Antigen
HBsAg	- Hepatitis B e-antigen
HBsAG	- Hepatitis B surface antigen
HBsAg	- Hepatitis B Surface Antigen
HBV	- Hepatitis B Virus
HCC	- Hepatocellular carcinoma
HCV	- Hepatitis C Virus
HDAg	- Hepatitis delta antigen
HDV	- Hepatitis D Virus
HEV	- Hepatitis E Virus
HIV	- Human Immunodeficiency Virus
IFIT1	- Interferon Alpha/Beta Receptor 1
IFN-γ	- Interferon-gamma
IgG	- Immunoglobulin G
IgM	- Immunoglobulin M

IL	-Interleukin
ISG15	- Interferon Stimulated Gene 15
L-HDAg	- Large Hepatitis Delta Antigen
LSTMB	- Lagos State Traditional Medicine Board
MDA	- Malondialdehyde
NAFDAC	- National Agency for Food Drug Administration and Control
NF- κ b	- Nuclear factor kappa B
ORFs	- Open Reading Frame
RNA	- Ribonucleic Acid
S-HDAg	- Small Hepatitis Delta Antigen
SDI	- Social Demographic Index
SGOT	- Serum glutamic oxaloacetic transaminase
SGPT	- Serum glutamic-pyruvic transaminase (SGPT)
SOD	- Superoxide dismutase
TBK1	- TANK-binding kinase 1
TM	- Traditional medicine
TNF- α	- Tumour necrosis factor - alpha
WHO	- World Health Organization

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