After HCV Eradication with Sovaldi®, Can Herbs Regenerate Damaged Liver, Minimize Side Effects and Reduce the Bill?

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**Abstract**

**Objective:** Hepatitis C virus is a major health burden. It has infected millions of people worldwide with the highest prevalence in Egypt. Sofosbuvir (Sovaldi®) has been recently approved for treating chronic hepatitis C virus infections. Herbal medicine has been searched for centuries for the remedy of liver diseases.

**Keywords:** Hepatitis C virus; Herbal medicine; Sovaldi®; Hepatoprotective; Liver regeneration

**Introduction**

Hepatitis C virus (HCV) is considered a significant public health problem [1]. It currently infects more than 170 million people worldwide. The great majority of patients develop chronic HCV infection, which can ultimately result in hepatic cirrhosis, failure or hepatocellular carcinoma, leading to about 350,000 deaths each year [2,3]. Egypt shows the highest prevalence (15%) of hepatitis C virus worldwide. It also has the highest predominance of HCV- 4 (67%), especially subtype 4a (55%). The history of infection and the disease progression are influenced by various factors such as level of HCV viremia, age at the onset of infection, sex, co-infection with hepatitis B virus and duration of infection [4].

Sofosbuvir (Sovaldi®) Sofosbuvir is a new antiviral candidate against multiple Hepatitis C virus genotypes [1]. It is a nucleotide analogue that is a potent inhibitor of NS5B polymerase in HCV. NS5B is a non-structural protein which is essential for viral RNA replication and has been a valuable target for many directly acting antiviral agents [3]. Numerous in vitro studies show promising results against all genotypes of HCV. Sovaldi® is approved by the Food and Drug Administration for the treatment of chronic HCV infection [1]. It has shown high efficacy in combination with other drugs in antiviral treatment regimen. This drug is of special interest among directly acting antiviral drugs due to its high potency, oral administration, low side effects and high barrier to resistance [3].

Liver is the main organ responsible for the detoxification processes in our bodies and it is likely to be injured regularly by ingested toxins. The regenerative properties of the liver are in fact logical adaptation in our bodies and it is likely to be injured regularly by ingested toxins. The regenerative properties of the liver are in fact logical adaptation

In the absence of reliable liver-protective drugs in the modern medicine, a variety of medicinal preparations are recommended for the treatment of liver disorders [7]. Herbal drugs contain a wide number of phytochemicals that occur naturally in the plants, and may have potential protective or disease preventive properties [8-12]. Thus, studying the potential biological activity of crude drugs can result in the discovery of novel lead drugs for certain diseases and can lead to combining the strength of traditional application of herbal therapy with the modern concept of standardization, evidence-based pharmacological evaluation and controlled clinical trials in order to support clinical efficacy [13,14].

**Hepatoprotective Plants**

Some fruits (grapefruit, grapes, cranberries and cactus pear fruit); plants such as chamomile and resin (propolis), which are consumed frequently by humans, in addition to some phytochemicals extracted from fruits, plants, algae, and yeasts have been evaluated in different models of hepatotoxicity and demonstrated hepatoprotective capacity [15]. A number of hepatoprotective plants have been tested in hepatotoxicity experimental models, which are often supported by histopathological examination of liver, thus provide an insight to the use of these plants against liver disorders in addition to regeneration of damaged hepatic tissues [16]. Some examples of these plants are listed below.

**Glycyrrhiza glabra** (Leguminosae)

Glycyrrhizic acid is a triterpene glycoside found in the roots of liquorice (Glycyrrhiza glabra). It possesses a variety of pharmacological

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activities such as anti-inflammatory, antiviral effects, immune regulatory actions, and inhibition of hepatic apoptosis, necrosis and antitumor effects [17]. In addition, glycyrrhizin and 18β-glycyrrhetinic acid (active components in liquore) have been shown to protect against a number of hepatotoxins such as CCl₄ and D-galactosamine [18].

**Silybum marianum (Asteraceae)**

Silymarin is a mixture of flavonolignans isolated from the seeds of milk thistle. It is known for its hepatoprotective action. It has been used to treat many liver disorders, including acute or chronic viral hepatitis, toxin drug-induced hepatitis, cirrhosis and alcoholic liver diseases [16]. The mechanism of its action includes inhibition of hepatotoxin binding to the receptor sites on hepatocyte membranes, reduction of glutathione oxidation in order to enhance the level of hepatocytes in liver. It lowered the elevated serum level of bilirubin, AST, and ALT in various experimental models [19]. Silymarin acts as an antioxidant, regulator of the intracellular glutathione, stabilizer and regulator of cell membrane permeability to prevent entering of hepatotoxic substances into hepatocytes; it also promotes ribosomal RNA synthesis simulating regeneration of the liver, in addition, it inhibits the transformation of liver stellate cells into myofibroblasts thus prevents deposition of collagen fibres in liver [16,20].

**Cynara scolymus (Asteraceae)**

Artichoke has been traditionally used in treating liver diseases. It contains caffeoylquinic acids that have powerful hepatic regenerating effects similar to silymarin Caffeoylquinic acids can protect, regenerate liver cells, eliminate toxins from the blood, help in treating liver damage and insufficiency [21,22].

**Taraxacum officinale (Asteraceae)**

The hepatoprotective activity of aqueous extract of dandelion was evaluated against D-galactosamine induced hepatitis in rats and supported by histological examination of liver sections. Results suggest that dandelion could be used as a potential therapeutic agent for treating chemically induced or viral hepatitis. Dandelion also possesses liver-healing properties. It enhances bile flow and improves both hepatocytes and jaundice [23].

**Cichorium intybus (Asteraceae)**

*Cichorium intybus* is commonly known as Chicory, traditionally reputed as a liver tonic. It has been used as for gall and liver disturbances and it forms an important component of several liver preparations [24]. In preclinical studies its alcohol extract was found to be effective against chlorpromazine induced hepatic damage in albino rats. Using ethanolic extract of *Cichorium intybus* in dose of 300 mg/kg, showed significant increase in circulating leukocytes and relative weights of liver, as compared with alcohol alone which proves the liver protective effects of the herb [24].

**Phyllanthus niruri (Euphorbiaceae)**

Traditionally, the decoction of this plant has historically been used in jaundice. Extracts of *Phyllanthus niruri* have exerted hepatoprotective effect against both CCl₄ induced HepG2 cell damage in rabbits and paracetamol induced acute liver damage in rats [25]. In a preliminary study, treating carriers of hepatitis B virus with a preparation of *Phyllanthus niruri* for 30 days; 59% of the treated patients had lost hepatitis B surface antigen when they were tested 15-20 days after the end of the treatment. No case has the surface antigen returned. Preclinical studies demonstrate that *Phyllanthus niruri* extract inhibits endogenous DNA polymerase of hepatitis B virus and binds to the surface antigen of hepatitis B virus [16].

**Curcuma longa (Zingiberaceae)**

The ethanol extract of *Curcuma longa* showed hepatoprotective activity against paracetamol-induced liver damage in rats. Pretreatment of rats with the ethanol extract of *Curcuma longa* prior to paracetamol dosing, statistically lowered the serum liver enzyme (AST, ALT and ALP) activities [26].

**Ginkgo biloba (Ginkgoaceae)**

The *Ginkgo biloba* exhibits many pharmacological properties such as antioxidant, membrane stabilizing effect, increase in blood fluidity, hepatoprotective effect and improvement in cognitive function. Its extract (0.24 mg of ginkgoflavon -glycosides/g of dry extract) reduces the AST, ALT and ALP levels in hepatotoxicity induced by CCl₄ in rats [16,27].

**Zingiber officinale (Zingiberaceae)**

Hepatoprotective effects, as documented by a decrease in liver enzymes, were observed by aqueous ethanol extract of *Zingiber officinale* against single dose of acetaminophen induced (3 g/kg, orally) acute hepatotoxicity in rat [28].

**Camellia sinensis (Theaceae)**

The leaves of *Camellia sinensis* contain a number of catechins (flavanols) especially epigallocatechin gallate that possess antioxidant property, and have the ability to stabilize cell membranes [29]. Its aqueous extract given orally to rats with CCl₄ induced hepatotoxicity, reduced serum liver enzymes and lipid peroxide and significantly increase serum total protein, albumin and liver glutathione (GSH), superoxide dismutase (SOD) and catalase enzyme (CAT) as compared to rats treated by carbon tetrachloride alone [30].

**Herbs for Relief of Drugs Adverse Effect**

Sofosbuvir (Sovaldi®) has shown a good safety profile in clinical trials. The adverse effects reported in patients being treated with it are headache, insomnia, fatigue, nausea, dizziness, pruritis, upper respiratory tract infections, rash, back pain, grade 1 anemia, and grade 4 lymphopenia [3]. Headache, being the most common side effect observed, can be overcome by a variety of herbs well known for their effectiveness against migraine and headache. Most of herbs are available and not expensive thus herbal drugs can be an ally to HCV patients suffering from the acquisition high cost of treatment ($1,000 per pill of Sovaldi®) [1].

Below are presented some plants that can be used in medicinal preparations to relief headache:

**Tanacetum parthenium (feverfew)** has been used traditionally to treat migraine. It is suggested to have serotonin 5-HT receptor blocking effects [31]. Feverfew inhibits the release of serotonin and histamine from platelets, and decreases the smooth muscle response to endogenous vasoactive substances, such as norepinephrine, prostaglandins, acetycholine, histamine, bradykinin and serotonin. It has also been shown to produce a dose-dependent inhibition of the inflammatory leukotrienes and thromboxane B2 [32,33].

**Salix alba** (white willow) has been traditionally used to relieve various pains including headache. It was shown to strongly inhibit binding to serotonin 5-HT₁A, and 5-HT₄ receptors in a similar mode to *T. parthenium*. However, in contrast to *T. parthenium, Salix alba*
interact strongly with 5-HT$_1$ receptors. Thus raising the possibility that combining *T. parthenium* with *S. alba* might provide more effective prophylaxis than *T. parthenium* alone [31].

**Zingiber officinale** (ginger) contains active ingredients (gingerols and shogaols), which are capable of inhibiting platelet aggregation [34]. Ginger ethanol extract completely inhibited *in vitro* arachidonate-induced platelet aggregation [35]. It was reported that gingerols are potent inhibitors of prostaglandin synthetase and inhibitors of leukotriene biosynthesis. Through inhibition of these inflammatory neurotransmitters, ginger may play an important role in migraine prevention [36].

**Ginkgo biloba** (ginkgo) extract has been shown to contain three specific platelet-activating factor (PAF) antagonists [37]. In clinical trials conducted on Ginkgo extract in France, they suggested that Ginkgo may be beneficial in migraine patients [38].

**Herbs in Clinical Trials**

A number of clinical trials were conducted to prove the effectiveness of herbal medicine in combination with antiviral therapy in hepatitis patients. Here presented below are some of those trials reported.

Liu et al. conducted ten randomized trials, which included 517 patients with chronic hepatitis C. They evaluated ten different medicinal herbs, versus a number of control interventions (two other herbs, four placebo and four interferon). The herbal compound Bùng Gàn Tăng when combined with interferon (INF)-alpha showed significantly better clearance of serum HCV RNA and better effect on normalization of serum ALT activity than INF-alpha alone. While, the herbal compound Yi Zhu decocction demonstrated a significant effect on the clearance of serum HCV RNA and the normalization of ALT levels as compared to glycyrrhizin in addition to ribavirin. Tang also showed similar significant effect on normalizing serum ALT, as compared to silymarin plus glucuro lactone. No significant efficacy of the other examined herbs was observed [39].

Kainuma et al. evaluated the effectiveness of combining a herbal medicine (Mao-to) with natural interferon–beta in patients with chronic hepatitis C having a high serum viral load and genotype 1b, who seem to be resistant to interferon therapy. Their study was conducted on eighteen patients and they concluded that Mao-to administration with IFN-beta treatment could increase the patient’s biochemical response rate and reduce liver fibrosis [40].

McCutloch et al. examined the efficiency of Chinese herbal medicine (alone or with interferon alfa) in the treatment of chronic hepatitis B. They found that Chinese herbal medicine was equivalent to interferon alfa in the seroreversion of both HBeAg and hepatitis B virus DNA. The herbal medicine when combined with interferon alfa significantly raised the seroreversion of HBeAg, HBsAg and HBV DNA. The active component, bufotoxin, when combined with interferon alfa increased significantly HBeAg and HBV DNA seroreversion. While the active component, kurorinone, was equivalent to interferon alfa in the seroreversion of both HBeAg and hepatitis B virus DNA. The herbal medicine when combined with interferon alfa in the treatment of chronic hepatitis C patients, they concluded that Mao-to administration to those patients might provide more effective prophylaxis than natural interferon–beta alone [41].

Motoo et al. suggested that the herbal medicine Ninjinyoito (NYT) can reduce the ribavirin-induced anemia in a clinical trial conducted on twenty-three patients with chronic HCV [42].

Barakat et al. examined the efficacy of *Nigella sativa* in thirty patients with HCV infection, who were not eligible IFN/ribavirin therapy. They concluded that *N. sativa* administration to those patients was safe, tolerable; it decreased the viral load and improved the clinical condition, oxidative stress and glycemic control in diabetic patients [4].

Shawkat et al. conducted a clinical trial on eighty-two patients with chronic HCV. They concluded that adding-on a herbal medicine Viron* to the oral directly acting antiviral therapy of those patients can benefit in decreasing the viral load and offer better clinical manifestations and quality of life [43].

**Conclusion**

The ultimate goal of this article is to highlight the role of crude herbal drugs in helping HCV patients, which extends from aiding in liver regeneration after elimination of the virus, to reducing some of the cost burden on those patients and offering a concomitant relief of their main medication side effect, which is headache. This can draw our attention to the possibility of formulating a herbal medication with a mixture of those magnificent crude drugs to help HCV patients satisfaction and relief. Yet, further clinical studies should be performed for the efficacy of such formulations.

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