Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Journal of Herbal Medicine 37 (2023) 100626

Contents lists available at ScienceDirect

Journal of Herbal Medicine

journal homepage: www.elsevier.com/locate/hermed

Review article

Senna: As immunity boosting herb against Covid-19 and several other diseases

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ARTICLE INFO

Keywords:
Covid-19
Immunity
Laxative
Pharmacological
Senna

ABSTRACT

Introduction: A novel coronavirus outbreak in China (SARS-CoV-2) which began in December 2019, was proven major threat to global health. However, several results from clinical practices indicate that herbal medicine plays an important role in the prevention of COVID-19, which brings new hope for its treatment. The objective of this study is to check the effectivity of senna (*Senna alexandrina Mill.*) as an immunity-boosting herb against Covid-19 and several other diseases.

Method: The literature search was carried out using scientific databases comprising of Scopus, Science Direct, PubMed, Cochrane Library, Science Hub and Google Scholar, up to May 2020, using the following keywords: "senna", "senna makki", "*Senna alexandrina*", "senna nutrition value", "senna medicinal effect", "vitamins in senna", "mineral in senna", "bioactive compounds in senna", "laxiary components in senna", "senna against diseases", "senna enhance immunity", "covid_19″, "covid_19 symptoms". The authors also obtained data from primary and secondary sources as well.

Result: The results of different studies showed that senna was composed of a wide range of immunity-enhancing bioactive components like antioxidants, vitamins, minerals and laxatives. These bioactive components are effective against COVID-19 and other diseases.

Conclusion: Senna has medicinal and nutritional effects on the human body and has a key role in boosting immunity to prevent COVID-19 symptoms. Important nutritional components of senna include antioxidants, phytochemicals, vitamins and minerals that aids in reducing the risk of various diseases and also enhances the immune system.

1. Introduction

1.1. COVID-19

The prevalence of Covid-19 in various countries has affected millions of people until the present. Since December 2019, pneumonia cases were increasing day by day due to this type of virus. The first affected patient was observed in Wuhan, a city of China and upto the time of writing (June 2020), 213 countries were affected by the corona virus. WHO declared this epidemic outbreak as a Public Health Emergency on 30 January 2020. Pneumonia caused by the covid-19 is characterized by flu-like signs, such as cough, fever, respiratory distress disorder, and, in certain cases, even death (Xu and Zhang, 2020). Much like MERSCoV and SARS-CoV, COVID-19 is also a severe danger to public health. The WHO reported that nearly 7,690,708 people were affected, in which 427,630 peoples died, due to COVID-19. Effective treatment and prevention are essential in these circumstances. SARS was successfully treated and prevented using herbal remedies during the epidemics of SARS (Chen et al., 2020). Moreover, herbal medicine in combination with other western medicines was used and it was found that these medicines minimized the adverse problems induced by the antibiotic, glucocorticoid, and antiviral treatments. It has been reported that after the use of herbal medication with some other necessary treatments the first patient was cured in Beijing on 24 January 2020. Even though herbal medicine is being used for the treatment of COVID-19, there is a need to evaluate the efficiency of such herbs by conducting proper research. Keeping in view the importance of herbal medicine, the present review has been completed in order to establish a strong scientific basis for medical care against COVID-19 and other diseases (Ang et al., 2020).

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https://doi.org/10.1016/j.hermed.2023.100626
Received 27 June 2020; Received in revised form 16 November 2020; Accepted 9 January 2023
Available online 10 January 2023

1.2. Senna

Plants are a major source of medicinal products and play an important role in global health. Nearly all cultures have been using plants as medicine since ancient times. Medicinal plants are important for economic development (Chatatikun and Chiabchalard, 2017). Around 85% of traditional medicinal formulations require the use of plants or plant extracts (Manosroi et al., 2015). The pharmaceutical uses of plants have contributed remarkably to the development and origin of numerous popular herbal treatments. Many plants produce a range of phyto-pharmaceutical products which show very valuable applications in human, agricultural, and veterinary drugs. Plants have a tremendous amount of useful applications, particularly as modern medicinal drugs and pharmacopoeia agents. Due to the scarcity and high cost of medical treatments, a vast majority of the world's inhabitants rely on traditional medicine (Kundu et al., 2017). Over the last couple of decades, medicinal plants have gained widespread reputation, as a result of the increased confidence in herbal treatment, in terms of their reduced side effects relative to allopathic treatment. Owing to the potential applications, plant-derived compounds have become of considerable interest lately (Morales et al., 2009). Medicinal plants are the richest biological source of various bioactive compounds, modern medicinal products, nutraceuticals, fortified foods, folk medicinal products, intermediate pharmaceutical products, or chemical entities used for synthetic medicinal products. Medicinal plants have supplied various plant-derived bioactive compounds to modern medicine (Roy et al., 2016).

The discovery of innovative drug leads for both the prevention and treatment of diseases is dominated by natural products (Săvulescu et al., 2018). More than 25% of new medicines are being derived from plants. Plants species are known to be a huge source of many pharmacological compounds, which are widely used as natural medicines for the prevention of chronic diseases. This development has resulted in an abrupt increase in the demand for herbal medications, trailed by growth in worldwide awareness of the world's therapeutic plants' dwindling supply. In addition, only a few medicinal plants had already received specific scientific study. Thus, the World Health Organization (WHO) has suggested a comprehensive investigation in this area of research. There are approximately 4000 to 10,000 therapeutic plants on the list of rare species, and this number is projected to rise (Canter, 2005). The World Health Organization (WHO) evaluate that for their primary health care, about 80% of individuals living in developing countries depend on traditional medicines.

Cassia is known for its laxative characteristics and prevention of skin problems in traditional medicine. Cassia attracts the world's attention for its photochemistry and pharmacology, ranging from antiviral to antidiabetic. *Senna alexandrina Mill.* (senna) belongs to the Fabaceae family, which is distributed all over the subtropical and tropical regions (Pakistan, Mexico, Saudi Arabia, Africa, India, etc), and some species also originate in high-temperature regions (Morris et al., 2019). Senna was first seen in the historic and holy town of Makkah, in the center of the ancient region of Hijaz, growing wildly. The plant grows abundantly and has since been used by Holy Prophet Muhammad (S.A.W.) as herbal remedies (Ahmad et al., 2010). It is sold as Senna or sana makkahi and is seen as a medication for the whole body as a purifier of digestive systems and as a tonic in herbal shops in Pakistan and Arabic countries. The Holy Prophet Muhammad said: "if there would be any cure for death, that is the gladdened Sana, the gracious". Currently, senna is widely distributed throughout the world, mainly to Pakistan, Arabic countries, Sudan, India, China, Europe, Kenya, and the UK. Senna has extensive use in Chinese, Pakistan, African, and Modern Allopathic Medicine Systems (Saad, 2014).

Senna alexandrina Mill is also known by the following synonyms: *Senna Angustifolia, Cassia Angustifolia Vahl., Cassia lanceolata Forssk., Cassia acutifolia Delile, Senna acutifolia (Delile) Batka*, and *Cassia senna L.*, (Ramchander and middha, 2017). *Senna alexandrina Mill.* is an ayurvedic herb that is more commonly known as senna. Senna is used mostly as a blood cleanser and diuretic for constipation relief and skin disease medication. It provides a strong ordinary anthraquinone laxative and is confirmed by the World Health Organization (WHO). It is a prescription-free laxative and has been permitted by the FDA. It is also used to clear bowels before medical tests including colonoscopy, due to its laxative properties.Senna grows natively in Sudan but it is a name of Arabic origin. It was used for blood capillaries congestion by Arabian doctors (Abdo, 2017).

2. Methods

The current review and meta-analysis were carried out in line with the recommendations of the PRISMA declaration (Liberati et al., 2009).

2.1. Search strategy

The literature search was carried out using scientific databases comprising Scopus, Science Direct, PubMed, Cochrane Library, Science Hub and Google scholar up to May 2020, using the following keywords: "senna", "senna makki", "*Senna alexandrina*", "senna nutrition value", "senna medicinal effect", "vitamins in senna", "mineral in senna", "bioactive compounds in senna", "laxiary components in senna", "senna against diseases", "senna enhance immunity", "covid_19″, "covid_19 symptoms". The authors also searched the Pakistan Health Ministry report, and World Health Organization reports. Two researchers (A.I and W.K) individually reviewed all internet sources mentioned above.

2.2. Study selection

The titles and abstracts were inspected during the first step to detect RCTs (randomized controlled trial) that measure senna effects in some way. In the second phase, the abstracts were analyzed to determine if at least one of the informations/communications reported on nutritional, Pharmacological, chemistry, or bioactive components. In the final stage, the complete text of the relevant literature was thoroughly reviewed so that final qualifying publications could be decided. Literature that did not have appropriate information about senna, or with any other herbs, were rejected. Studies with less than 1-week follow-up were excluded. Meetings, presentations, and reproduced reports were rejected. The authors (A.I and W.K) carried out all phases of the study selection process individually until all published documents were either discarded or included.

2.3. Data extraction

The data was collected using pre-designed Excel form through relevant studies.: 1) nutritional components 2) antioxidants profile 3) immunity-enhancing components 4) mineral contents 5) presence of components that are effective against Covid-19 studies.

2.4. Quality assessment

The quality of selected articles was evaluated according to the requirements of Cochrane Collaboration (Higgins et al., 2011), including 1) allocation concealment (selection bias); 2) blinding of outcome assessment (detection bias); 3)selective reporting (reporting bias); 4) random sequence generation (selection bias); 5) blinding of participants and personnel (performance bias and 6) incomplete outcome data (attrition bias).

2.5. Statistical analysis

The raw mean difference (MD) with the confidence interval (CI) of 95% was calculated to measure the pooled effect size for each result. Heterogeneity between studies with Cochrane 's Q-test and I2 was evaluated (Higgins et al., 2003) The recommended formula (SD change

= square root (SD baseline 2 +SD final2) -(2 ×r × SD baseline× SD final)]) was used to determine the average difference of SD in studies which not revealing this parameter (Bornstein et al., 2011).

3. Nutritional/chemical composition

3.1. Antioxidant

Senna contains many natural antioxidants. The β-Carotene is a major antioxidant in the senna plant. Due to its composition, this wild leafy herb is a vital food item that need popularization (Agea et al., 2014). Antioxidants are the substances which avert or suspend the oxidation of oxidizing substance, which are substances are present in low concentration related to oxidizable substances. During metabolism and other activities, oxidative stress emerges due to reactive oxygen species (ROS) beyond antioxidant capacity (Zima et al., 2001). Hydroxy radicals, nitric oxide, and peroxyl nitrite anion free radicals derived from nitrogen, hydrogen radical, and superoxide anion are the most common ROS (Nagendrappa, 2005). Carotenoids, β-carotene, flavonoids, folic acid, ascorbic acid, tocopherols are naturally present in senna as antioxidants. *Senna alata* (L.) Roxb. (Syn. *Cassia alata*) is a species that is mainly used in medicine (Prakash et al., 2013; Thilagam et al., 2013). Moreover, several previous reports have shown that there are many medicinal properties of senna and some studies present antioxidant assays of *Senna alata* (Mak et al., 2013).

In Brazil new molecules having therapeutic properties, including anticarcinogenic and antioxidant activities, are being sought, facilitated by the counry's ample biodiversity and bioprospecting potential. In Brazilian culture, the senna genus has been used as folk medicine and among other uses because of its antitumor (Pereira et al., 2016), antimicrobial (Susunaga-Notario et al., 2014), antidiabetic, anti-inflammatory, and antioxidant activities (Thilagam et al., 2013).

Various diseases such as cancer, diabetes, atherosclerosis, inflammatory diseases, and premature aging are associated with oxidative stress (Sultan, 2014). Low antioxidant activity and an excess of free radicals in the body cause oxidative stress, which causes damage to essential biomolecules such as nucleic acids, proteins, and lipids (Lobo et al., 2010). In the global population, high rates of morbidity and mortality are caused by an oxidative stress-related disease i.e. cancer (Li et al., 2015). Leukemias are cancers that affect the cells of the hematopoietic system. Leukemias can be categorized as myeloid or lymphoid and as acute or chronic, based on their cellular origin and maturity stage (Asmaa et al., 2014). The main treatments that are used for cancer are surgery, radiotherapy, and chemotherapy (Srdic-Rajic et al., 2016).

Chronic disease risks are lowered by a high intake of foods containing antioxidants, including for neurodegenerative diseases, the aging process, cardiovascular diseases, cataracts, brain dysfunction, cancer, and many age relative degenerative diseases, by reacting with free radicals and also acting as an oxygen scavenger (Aruoma et al., 2006). Due to the increasing demand for antioxidants, synthetic antioxidants, like butylated hydroxyl toluene (BHT), butylated hydroxyl anisole (BHA) and propyl gallate (PG), are used to slow down the oxidation process but their safety has long been questioned due to unwanted side effects and potential health hazards (Branen, 1975).

The results of one study showed that *S. alata* is from the Fabaceae family, which is an important ethnomedicinal plant. It is composed of several bioactive compounds that provide a wide range of medicinal characteristics. This study also determined that the leaves of senna contained total phenolic and flavonoid contents, and antioxidant activity. The higher values of phenolic content (52.3 ± 0.03) and flavonoids (41.6 ± 0.34) were investigated in the aqueous extract. Similarly, a lower value of phenolic content (41.6 ± 0.41) and flavonoids (31.9 ± 0.63) was observed in methanolic extracts.

The results of another study showed that senna has high amounts of antioxidants, biomolecules present in natural products that can reduce oxidative stress-induced diseases and exhibit antitumor activity, making them an imperative source of new anticancer drug prototypes. In this framework, this research aimed to analyze the ethanol extract of *Senna velutina* leaves' chemical composition and to determine its cytotoxic and antioxidant activities in leukemic cells. DPPH free radical scavenging assay was used and by analyzing the extract's inhibition of AAPH-induced lipid peroxidation, the antioxidant properties were assessed in human erythrocytes. In Jurkat and K562 leukemic cell lines, the cytotoxicity and the possible mechanism of action were gauges. The ethanol extract encompassed flavonoids, like rutin, epicatechin, dimeric, epigallocatechin, kaempferol heteroside, and trimeric proanthocyanin derivatives. The antioxidant activity exhibited in scavenging free radicals, antihemolytic action, and decrease malondialdehyde content in human erythrocytes. Furthermore, the extract also induced leukemic cell death by activating intracellular calcium and caspase-3, decreasing mitochondrial membrane potential, and arresting the cell cycle in S and G2 phases. Thus, *S. velutina* leaf extract consists of antileukemic and antioxidant molecules having potential applications in the inhibition of tumor cell proliferation and other diseases related to oxidative stress (Campos et al., 2016).

3.2. Bioactive compounds

Senna has an arrangement of bioactive compounds, including phenolic (rhein chrysaphanol kaempferol, aloeemodin, and glycosides), anthraquinones (alatinone and alatonal), fatty acid (oleic, palmitic, and linoleic acids,) steroid, and terpenoids (sitosterol, stigmasterol, and camesterol) (Liu et al., 2009). These secondary metabolites are reported to show various biological activities (Aviello et al., 2010).

Senna alata contains some phytochemical compounds which have wide medicinal values, these values depend on the presence of certain chemical compounds that are involved in the production of different kinds of effects on the human body. Phenolic compounds, tannins, terpenes, flavonoids, and alkaloids are major plant base secondary metabolites. These compounds play a key role in plant defense, by protecting themselves against herbivores, insects, and microorganisms. Some of these compounds are responsible for giving plants their specific odors and others are responsible for giving different colors to plants. Remaining compounds are involved in providing properties, such as flavors to plants and others are used for the seasoning of food, yet also achieve some medicinal importance (Kliebenstein, 2004).

In one scientific study it was proved that approximately 200,000 phytochemicals in herb plants have pharmacological activities. These bioactive substances provide the apparent medicinal activities presented by plants and invariably justify the involvement of natural compounds in the improvement of modern drugs (Svahn, 2015). Despite these successes, the consumption of herb plant drugs was not accepted in contemporary medicine due to lack of scientific proof and proper documentation. Moreover, the significance of herbs in pharmacology has needed the provision of scientific facts on bioactive compounds and pharmacological assays of plants (Singh et al., 2012; Balunas and Kinghorn, 2005).

Plant extracts were screened for the phytochemical contents by using TLC, which indicates that these extracts comprise of flavonoids, glycoside, anthracene, and anthrone, derivatives. The spicy aroma is mainly due to the presence of volatile *Cassia* oil which was present in the range of 1–2%. The main chemical components of *Cassia* include gum, cinnamaldehyde, mannitol, tannins, coumarins, and essential oils (pinene and eugenol aldehydes) (Arya et al., 2011). It also comprises sugars, resins, and mucilage. By using the ethyl acetate fraction, 8 compounds were isolated from the *Cassia obtusifolia*, which are betulinic acid, chrysophanol, physcion, 1-mmunel-7-methoxy-3-methyl-anthraquinone, stigmasterol, 8-O-methyl-chrysophanol, aloe-emodin, and 1-Omethylchrysophanol (Eguale et al., 2011).

The senna seed comprises of anthraquinones, namely; (chrysoobtusin, aurantio-obtusin, physcion, chrysoobtusin-2-O-beta-D-

glucoside, obtusin, emodin, obtusifolin, chrysophanol, alaternin 2- O-β-Dglucopyranoside and obtusifolin-2-O-beta-D-glucoside,)15, brassinosteroids (28-norcastasterone castasterone, brassinolide, teasterone, and typhasterol), and monoglycerides (monoolein and monopalmitin). Phenolic glycosides were also isolated which include torachrysone apioglucoside nor-rubrofusarin gentiobioside, rubrofusarin triglucoside, demethylflavasperone gentiobioside, torachrysone tetraglucoside and torachrysone gentiobioside (Eguale et al., 2011).

The seeds produce a gum (7.65%) that is the utmost effective suspending agent for talc kaolin, and calomel. 5.0% brownish-yellow oil was obtained from crushed and dried seeds by using the modified soxhlet apparatus with the help of petroleum ether (b.p.60–80 °C). Afterwards, chrysophanic acid was also obtained from this oil with the help of hot water 25.8% Mucilage was also isolated from the seed. Six new compounds were also isolated from the seed in which 13 phenolic glycosides were present. These 13 phenolic compounds are nor-rubrofusarin, rubrofusarin triglucoside, demethyflavasperone gentiobioside, torachrysone, gentiobioside, tetraglucoside, torachrysone gentiobioside, and torachrysone apioglucoside. From the seeds of *Cassia* species, 2 new maphtha-pyrone glycosides were also isolated which include rubrofusarin-6-betagentiobioside and 9(Beta-D-glucopyranosynl-(1— 6)-O-Beta-D-glucopyranosyl) oxy]– 10- mmunel-7-methoxy-3-mehtyl-1 H-naptho [2,3- c] pyran-1-one and 6-O-beta-Dglucopyranosyl) oxy]-rubrofusarin (Morris et al., 2019).

The stem of cassia species also contain anthraquinone, including 1-mmunel-5-methoxy-2-methyl anthraquinone and its glycoside, 5-methoxy-2-methyl anthraquinone-1-O-α-L-rhamnoside along with emodin, β-sitosterol, and chrysophanol. The stem also covers myricyl alcohol, D-mannitol, β-sitosterol, tigonelline, glucose, choline, and 1-stachydnine. The stem-bark produces behenic acids and ethyl arachidate, palmitic acids and marginic, aurapterol, euphol, basseol, 3, 5, 8, 3′4′5′-hexahydroxy flavones and rhein. Senna leaves showed primarily the occurrence of flavonoids and anthraquinone glycosides. The anthraquinone glycoside consists of obtusin, rhein, physion, emodine, chrysophanol (marker), chrysoobtusin, obtusifolin, chryso-obtusifolin-2-O- β –Dglucoside, and chryso-obtusin-2-O-β-D-glucoside (Singh et al., 2013).

Drugs are developed with the segregation of unique compounds from plants (Veeresham, 2012). Some therapeutic plants have been scientifically investigated and contain various notable pharmacophore, one of them is Senna which is a widely distributed herb of the Leguminosae family. *S. alata*, also called *Cassia alata*, has other common names, such as candle bush, craw-craw plant, acapulo, ringworm bush, or ringworm plant. It is commonly found in asia and Africa (Kumar et al., 2008).

Many studies revealed that Senna (stems, leaves and flowers) has a rich phytochemical composition, and a low concentration of compounds present in the seeds and roots. These compounds are secondary metabolites and show pharmacological properties. The phytochemical changes in various metabolites have been attributed to environment and geographical factors. This gives room for a qualitative approach to authenticate the metabolites. Plant metabolites play a vital role in wound healing, antifungal activities, and antibacterial (Sule et al., 2011). From an industry point of view, this plant is used as a detergent, pesticides, and molluscicides.

3.3. Vitamins

It is assumed that people living in poverty are more disposed to various diseases, which include some types of infections, due to lack of macronutrients availability. In recent studies, it has come to attention that micronutrients, such as minerals and vitamins, also play an important role in the human body. These micronutrients boost immunity to protect the human body from various types of inflammations and infections (Alpert, 2017).

The nutrient composition of senna leaves were investigated. Significant quantities of protein, carbohydrate, lipids, vitamins (A, B complex, C), fiber, moisture and ash have been found to meet the dietary needs of their consumers. Although certain anti-nutrient levels have been found in the plants which might interact with their nutrient usage, but they are not more than toxic levels and can be extracted before consumption during treatment (Gwarzo et al., 2014).

Different studies were carried out to study vitamin content and findings indicate that the flowers and leaves are good sources of vitamin C, β-carotene, and vitamin E. Eventually, leaves, as well as flowers, are abundant in certain nutrients (Alpert, 2017).

Water-soluble vitamins have numerous benefits in treating sepsis, as well as septic shock, which is a deadly disease caused by pathogenic body inflammation. Vitamin C is also an inflammatory oxidant, antioxidant for pulmonary epithelial cells, as well as having immune suppressive activities (Erol, 2020). Vitamin C can reduce infections caused by some viruses and bacteria. It was shown that regularly prescribed vitamin C shortens common cold duration and high dosage levels of vitamin C also may act as natural antihistamines and anti-inflammatory medications during the infection period.

Vitamin E is essential in keeping elderly people healthy and their immunity strong. Vitamin E is a strong antioxidant that treats the elderly against infectious diseases, viruses, and bacteria. Vitamin E works primarily as a non-specific antioxidant that prevents the proliferation of lipid peroxidation. This vitamin frequently provides radical peroxyl protective fats to plasma membranes, as well as lipoproteins (Liang et al., 2003). Vitamin E plays a major role in retaining immune function in older people, since it enhances the cell-mediated and humoral immunity of aged persons (Mastaloudis et al., 2001).

3.4. Minerals

Minerals also have a nutritional benefit, which differs from the definition of minerals used by geologists. A nutritionist will use the word mineral when referring to the several inorganic compounds that the body needs to grow, prevent tissue damage, metabolize, and carry out other body processes. Iron, calcium, copper, sulfur, phosphorus, magnesium are major minerals for human body nutrition. The mineral composition of *Senna alata* is measured in mg/100 g,] and it is in the leaves of senna where sodium, potassium, calcium, magnesium, zinc, iron, manganese, phosphorus, lead, and copper can be found (Uwangbaoje, 2012).

A study was conducted on senna mineral composition in which the results were given in PPM (part per million) unit. The results were; iron (112.00), zinc (207.4), magnesium (876.00), manganese (35.10), potassium (812.00), calcium (932.00), sodium (612.00), copper (0.84), and lead (0.34) (Smith, 2009). In another study it was shown that the leaf contained differing amounts of minerals: potassium (779.20 mg/100 g), magnesium (142.80 mg/100 g), iron (42.35 mg/100 g) and calcium (158.38 mg/100 g) compared to the flower: potassium (1121.95 mg/100 g), magnesium (148.21 mg/100 g), iron (25.33 mg/100 g) and calcium (63.30 mg/100 g) (Wessels et al., 2017).

Magnesium is an important micro-nutrient for the proliferation of cells, synthesis of DNA and also contributes to the regulation of adaptive and innate immune responses, cell signals, and immune cell production (Uwangbaoje, 2012). Magnesium is another very essential nutrient for your immune function and an essential electrolyte which helps strengthen the body. It is also a primary source of energy for cells known as adenosine triphosphate (ATP), which is so essential that our cells cannot function effectively without this energy. Magnesium helps the blood hemoglobin that delivers oxygen to the human body from our lungs, which supports COVID-19, since the virus infects the respiratory system (Sanderson, 2020).

3.5. Antimicrobial

Several studies have shown that in many plants certain substances, such as peptides, essential oils, polyphenols, alkaloidal constituents, chloroform, ethanol, butanol, and methanol have antimicrobial

potential. These compounds showed healing applications besides human pathogens, comprising fungi, bacteria, as well as viruses (El Astal et al., 2005).

The antimicrobial properties of senna leaf extracts were analyzed by the disc diffusion method against isolates of fungi and bacteria. The highest level of activity was shown in acetone extracts (12 mm inhibition zone width; MBC 300 g per mL and MIC 200 g per mL), followed by dichloromethanes (8 mm inhibition zone width, MBC 400 g per mL and MIC 300 g per mL), methanes (7 mm inhibition zone width, MBC 400 g per mL and MIC 400 g per mL), and hexanes (6 mm inhibition zone width). Water extracts showed the least bacterial and fungal testing activity (inhibition zone of 4 mm, MBC 800 g per mL, and MIC 800 g per mL). Phytoconstituents including tannins, saponins, flavonoids, and alkaloids were also present. Senna leaves can be used to provide antibiotic constituents for the therapeutic cure of urinary tract, pneumonia, gonorrhea, and a few mycotic infections.

Extracts from senna leaves have shown a wide range of activity against gram-positive as well as gram-negative bacteria. The wide-ranging antibacterial properties of the leaf extracts may also support their use as a health treatment in traditional medicines due to the alkaloids present. This plant is therefore suitable for the formulation of antimicrobial agents to cure different bacterial infections, such as gonorrhea, pneumonia, eye, and mycotic diseases.

4. Immunity boosting against COVID-19

The leaves of the senna herb are sources of vitamins C and B complex (Gwarzo et al., 2014). Several studies found that the leaves of senna herb are used as nutrient supplements, and are also a rich source of micro and macronutrients that play a vital role in the human body. The benefit of additional use of senna is that it protects against microbial infections (Ishaku et al., 2016).

Research has found that consuming vitamin C supplements enhances the immunity of humans. This vitamin is also used in several parts of the immune system. Ascorbic acid (vitamin C) helps the body to create lymphocytes and phagocytes (white blood cells), which are suitable for protection various against infections (Huijskens et al., 2014).

Vitamin B6 also plays a significant role in an individual's overall immune functioning (Mikkelsen and Apostolopoulos, 2019). The depletion of vitamin B complex makes the immune system weak, so by the inclusion of the vitamin B complex to coronavirus patients it could improve their immunity (Zhang and Liu, 2020). Emodin (1, 3, 8-trihydroxy-6-methyl anthraquinone), extracted from senna leaves, has been used as a herbal medicine in many countries, particularly Eastern Asia. For proper growth and development, protein is needed and also necessary for optimized immunity. Low levels may cause depression because neurotransmitters (dopamine as well as serotonine) are not produced in sufficient quantities.

Taking into account the COVID-19 pandemic, where there is no appropriate curative and preventive meditation, one of the key weapons is a good immune system. Several vitamins and trace minerals are critical for proper immune functions (Wintergerst et al., 2007). Consequently, this has a beneficial effect on improving immunity from viral diseases. High-dose zinc supplementation in torquetenovirus (TTV) patients has been shown to enhance their immune function (Iovino et al., 2018). Besides vitamins and minerals, various herbs and probiotics are effective in treating and preventing viral infections (Mousa, 2017).

Plant-based diets improve the gastrointestinal microbiota, which make up about 85% of its immune system. Different studies have investigated the prevention of various infections including COVID-19 by a powerful antioxidant. Plant-based foods play an important role in strengthening people's immunity to control COVID-19 (Arshad et al., 2020).

Early deaths have been observed in older people, probably due to poor immunity, which promotes faster progress in COVID-19. Therefore, it is important to increase our immunity during a pandemic. It is important to suggest people use certain supplements to enhance their immunity. Healthy young people should consume a varity of fruits with varying vitamins. Patients and elderly people can, however, take zinc and vitamin supplements. The vitamins A, C, D and E are important. Zinc as well as iodine intakes are also recommended. It is important to avoid smoking and other drugs and getting enough sleep is often helpful to improve immunity (Li et al., 2015).

Senna leaves have crude protein content (1823 ± 0,03 g/100 g) (Amata, 2010) and flowers were rich in crude protein, potassium, carbohydrate, iron, β-carotene, calcium, and vitamin E. If properly processed, the leaves and flowers of Senna can improve immunity.

5. Health benefits and medicinal uses

5.1. Weight loss

Tea made from senna leaf is beneficial for weight loss. There are three important steps in weight loss using senna leaf tea; firstly, it prevents occasional constipation which occurs due to low fiber diets. Secondly, it enhances body fluid intake because senna contains a low calorie and flavourful solution. Drinking more regulary causes humans to eat less. Thirdly, it helps to remove toxins and undigested food from the body. This detoxification and cleaning support proper nutrient absorption and optimal metabolism, resulting in weight loss (Kruger et al., 2004).

Sennosides are the chemicals present in senna. These chemicals force the intestinal muscle to contract by irritating the lining of the bowel. The outcome of sennosides results in more incessant bowel movements with greater volume. The water absorbed by stool and excretion encourages weight loss. Senna speeds up the whole process of digestion and can even lead to excretion of foods that haven't been absorbed or fully digested in the body (Azam and Lin, 2002). Hence, the weight loss comes from the potential of not absorbing all the calories from the food that has been consumed and the weight of water in your stool. This does not equate to fat loss because it is just a temporary loss of water weight (Hope, 2004).

Senna is sweet, bitter, and strong in taste with high medicinal potential. It's dry and easily digestible and gives a pungent taste after ingestion. It works gently as a laxative. This herb is pitta shodhaka and vata anulomaka, which means it removes the 'pitta' from the body and removes 'vata' through the anal route (from Ayuvedic medicine). For diagnostic tests of the gastrointestinal and colorectal area and bowel evacuation this herb is used as a laxative. In the Ayurveda and Unani system of medicine, leaves and pods are organized to extract their active compounds for their aromatic, carminative and laxative properties. Among Ayurvedic medicines, Panch Sakaara Churna is accessible all over. Other compounds are Shtshakaar Churna and Yashtyaadi Churna. Safoof-e-Mulaiyia and Majoon-eSenaai are well-known Unani compounds. All these compounds are suggested to be used as laxatives in indigestion, abdominal bloating, constipation, and colic problems. To treat constipation, distention of the stomach, and biliousness *Cassia angustifolia*, an ingredient in Nilaavarrai choornam is recommended as a purgative (Ramchander and Middha, 2017).

Senna herb, a medicinal plant contains natural laxative substances, and is a major function to relief from constipation. Senna has been permitted by the US FDA as a nonprescription laxative. Moreover, it also provides an agent that removes toxins from the human body and aids in weight loss (Singh et al., 2013). Several pieces of evidence confirmed that senna leaf tea can be used to endorse its weight loss benefits. A medical community has lowered the use of senna for direct weight loss. Moreover, using senna can surely help in waste elimination that is a part of a healthy metabolism. The concentration of toxins in the human body aids in weight gain. Toxin elimination can help in thwarting obesity. However, in the end, toxin elimination can aid in reducing obesity (Morales et al., 2009).

5.2. Treating constipation

Consuming senna herb or drinking senna leaf tea encourages bowel movements. The contraction of the walls of the large intestine is stimulated by this leaf, which aids in removing stools from the human body. Due to this ability, senna leaf is helpful in relieving constipation, often leading to bowel movements within 6–12 h after ingestion. In Traditional Chinese Medicine, senna leaf helps to remove "colon heat", getting rid of old food that has built up there over time. During menstruation, nursing or pregnancy it is not recommended to use senna leaf medicine (Liu, 2011).

Senna leaves and fruit contains natural laxative agents which is a major method to prevent constipation. Furthermore, according to recent guidelines that address the use of laxatives for both treatment and prevention, and an increase in the involvement of healthcare professionals, an appropriate choice and use of laxatives may be required to improve constipation management in the community (Werth et al., 2020).

Senna, sodium pico sulfate (SPS), biacodyl and cascara are the stimulant laxatives that are frequently found in Canada. In herbal remedies or tea, senna and cascara are commonly available. Hydroxyanthraquinone glycosides are the active ingredients of *Cascara sagrada* (*Rhamnus purshiana*, also known as California buckthorn or sacred bark) found in the dried bark of the plant. The fresh bark may cause vomiting, griping abdominal pain, and nausea. Despite any clinical controlled research that supports the use of *Senna alexandrina* in treating chronic constipation, it has been used widely for constipation treatment (Paré et al., 2007). Several herbal remedies include senna (e.g. Swedish bitters, Black draught, Daffy's Elixir, Catholicon, Diasenna, and many diet teas). A product monograph has been issued by Health Canada as a model for the industry for the development of natural products with market labels authorization and applications of product license due to senna's widespread use. Senna plants have anthraquinone glycosides as active ingredients, identical to cascara (Emmanuel et al., 2009).

Several proofs indicated that senna is mainly used against constipation, because of laxative activity. Additionally, this herb could be considered safe for short-term or topical use (Hennebelle et al., 2009). Among humans, one of the most common problems is constipation (Talley, 2004), where chronic constipation can be as high as 30% in the adult population. Many communities establishing the self-manage approach don't seek medical advice (Enck et al., 2016). Self-management usually means the use of over the counter (OTC) laxatives that are mainly available without advice, from pharmacies, supermarkets, and other channels (Shibata et al., 2016). The laxative items are publicized and endorsed directly to consumers in various countries and it is estimated that globally these products sell for more than US$5 billion per year. Moreover, sometimes publicizing and packaging often causes uncertainty that may result in therapeutic failure due to inappropriate product selection (Guerin et al., 2014).

5.3. Good for hemorrhoids

Senna herb is very common as the main ingredient in many hemorrhoid-healing teas and colon cleansing products. Senna includes various components, known as sennosides (senna glycoside) which work in a laxative way on the bowel lining. Constipation or hard stools are some of the factors that can cause and intensify hemorrhoids. Additional applications in traditional medicine include skin infections, gonorrhea, fever, and stomach upset (Balasankar et al., 2013).

In treating anal laceration and hemorrhoids, senna was found to be effective because it helps minimize swelling and promotes rapid recovery (Wald, 2016). Furthermore, since it facilitates soft stools, it can easily cause defecation in conditions such as anal fissure. This is because the substances in senna are ingested into the intestinal tract after oral intake, resulting in the removal of non-sugar components in the colon. Such non-sugar compounds improve the peristaltic flow of the intestinal tract by stimulating and irritating them. It accelerates the flow of stools into the intestinal tract (Balasankar et al., 2013).

5.4. Beneficial for skin infections

Senna assists to control the effects of skin problems, such as skin roughness, blisters, swelling, itchiness as well as bleeding. The application of senna leaf paste mostly on skin relieves pain and prevents bleeding due to its healing (ropan) properties (Hennebelle et al., 2009).

senna's antibacterial property may help with dermatological or skin conditions. Senna leaves paste is effective in curing skin infections, such as acne, and inflammatory disorders, such as eczema. Ethanolic extracts from senna can be used to combat acne-causing microorganisms (Sule et al., 2011).

Oladele et al. (2010) present an investigation report on randomized trials of *Senna alata* soap in Ilesa Prison, Nigeria, for the treatment of superficial skin infections. Thirty-three offenders were selected and assigned randomly to 19 therapies and 14 controls. The soap consisting of caustic soda (NaOH) as well as palm kernel oil (PKO) had been blended into the *S. alata* leaf powder to produce 1.5% w/w. The herbal soap blend was poured, solidified, and then cut into stable tablets (each 65 g). *Tinea corporis* and *Tinea versicolor* were the main fungal diseases present on skin lesion before the study began, while the lesions were microscopically found to be caused by *Epidermophyton fleccusum* and *Cryptococcus* sp. The alata soap significantly cleared lesions whereby none of the controls showed a significant reduction. The study confirmed the folkloric assertions for *S. alata* as having an antibacterial property in treating skin infections. (Pamulaparthi et al., 2016).

6. Conclusion

Senna plant may be used to boost immunity in a pandemic infection, as it has played a vital role in several other diseases. Important nutritional components of senna include antioxidants, phytochemicals, vitamins and minerals that aid in reducing the risk of various diseases and increasing the immune system. Various medicinal components of senna antioxidants and laxatives are effective against various pathogens and helpful in curing constipation and skin infections. Overall, there is a need to explore its therapeutic potential on a commercial scale by conducting more rigorous research and, eventually, clinical trails.

Ethical Approval

This study has nothing to do with human and animal testing.

Interest of conflict

The authors declare no conflict of interest.

Acknowledgment

The authors are highly thankful to Government College University Faisalabad—Pakistan and Higher Education Commission of Pakistan for providing free full-length papers.

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