

Herbal Immunomodulators for Immune Support: A Review of *Moringa oleifera*, Sea Buckthorn, and Bael

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ABSTRACT: Herbal remedies are becoming more popular as natural alternatives for boosting immunity and overall health, driven by the growing emphasis on preventive healthcare worldwide. Due to their safety, therapeutic efficacy, affordability, and reduced frequency of side effects when compared to synthetic drugs, herbal formulations are widely accepted. *Moringa oleifera*, *Hippophae rhamnoides* (sea buckthorn), and Bael fruit are a few examples of natural products and medicinal plants that have long been employed for their anti-inflammatory, antimicrobial, antioxidant, and immunomodulatory qualities. Vitamins, minerals, flavonoids, phenolic compounds, and other bioactive components that support the body's defences are abundant in these plants.

The extracts are incorporated into syrup formulations with suitable excipients such as sweetening agents, flavouring agents, preservatives, and stabilizers to improve palatability, stability, and patient compliance. The prepared syrups are generally evaluated for physicochemical parameters including colour, odour, taste, pH, viscosity, specific gravity, microbial load, and stability, and most formulations have demonstrated acceptable characteristics with good stability.

Therefore, although more preclinical and clinical research is required to determine their effectiveness and therapeutic potential, herbal immunity-boosting syrups represent a promising and safe approach for preventive healthcare.

KEYWORDS: IMMUNOMODULATOR, ANTI-OXIDANT, DIGESTIVE WELLNESS, NUTRITIONAL SUPPLEMENTATION

INTRODUCTION:

Herbal syrup is a sweet, liquid dosage form prepared by dissolving herbal extracts or plant-based active ingredients in a sugar or sugar-free syrup base. It delivers the therapeutic benefits of medicinal herbs in an easy-to-consume, palatable form. [1,2].

The growing prevalence of infectious diseases, environmental pollution, unhealthy lifestyles and psychological stress has increased interest in natural approaches to maintaining health and supporting immune function. As a result, herbal products and functional foods have gained significant attention because they contain bioactive compounds that may contribute to overall wellness. Unlike synthetic supplements, medicinal plants are often valued for their diverse phytochemicals, including flavonoids, phenolic acids, vitamins, carotenoids, alkaloids and terpenoids, which exhibit antioxidant, anti-inflammatory, antimicrobial and immunomodulatory properties. [3-5].

The worldwide pandemic was brought on by SARS-CoV-2, also referred to as the corona virus. When it was first identified in Wuhan, China, in December 2019, many people had already been infected. It spreads from person to person and causes fever, sneezing and coughing fits due to respiratory infections, which can lead to worldwide illness and death. People with compromised immune systems are particularly vulnerable to the coronavirus. The ageing process starts in the middle age range, which is between 40 and 60 years old. People become more susceptible to viruses as a result of the immune system's deterioration. A robust immune system was maintained through the use of numerous home remedies to fight the corona virus. [1].

Due to this, herbal treatments are now available in syrup form in preparation for commercialization, in addition to drug storage. Additionally, it has been meticulously and carefully estimated by WHO that up to four billion people, or 80% of the world's population, who live in poorer nations depend on herbal remedies. [1,2].

The purpose of this review is to provide an overview of the phytochemical makeup, pharmacological properties and therapeutic potential of specific medicinal plants that are frequently utilised in herbal immunity-supporting products. In order to give a thorough picture of their function in fostering general health and wellness, it also highlights recent scientific data regarding their antioxidant, immunomodulatory, anti-inflammatory, antimicrobial and nutritional qualities. [3-5].

TYPES OF IMMUNOBOOSTERS

Substances known as immunoboosters are used for improving the immune system, which aids the body's defense against illnesses and infections. There are numerous varieties of immunoboosters on the market.

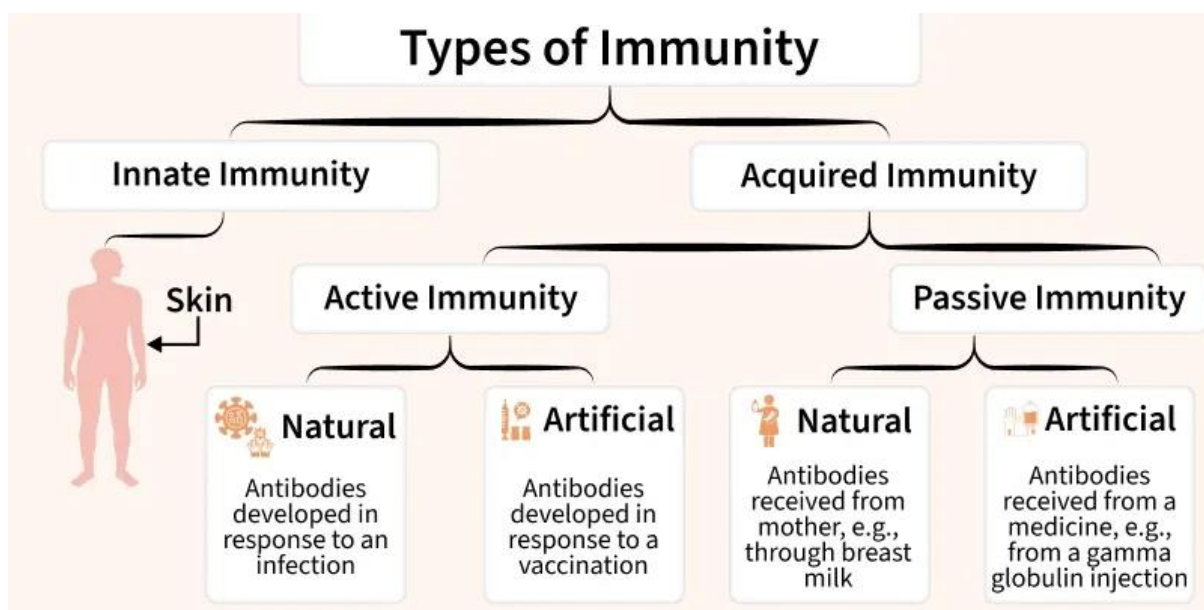


FIG 1: TYPES OF IMMUNITY [21]

Natural Substance: The World Health Organisation defines natural substances as materials of natural origin, such as plant, animal, microbial and mineral products, that, after suitable processing while maintaining their naturally occurring constituents, may be used for health promotion, disease prevention, or treatment. [1].

Vitamins, minerals and herbs are commonly used as organic immunoboosters. They promote the immune system's efficient and healthy functioning. For example, vitamin C helps the body produce white blood cells, which are its first line of defense against infections. Zinc is essential for immune system function because it helps white blood cells fight off dangerous bacteria and viruses.

Vaccines: A vaccine is an active biological preparation that acts as a specific immunomodulator by introducing a small amount of an antigen or pathogen component to stimulate the immune system. This induces active acquired immunity and long-term immunological memory, enabling the body to recognise and fight the disease effectively in the future without causing the disease itself. Vaccination has been highly successful in preventing infectious diseases such as COVID-19, polio and measles. [1].

Medication: Immunomodulators are pharmacological agents that modify the immune system by stimulating (immunostimulants), suppressing (immunosuppressant), or regulating (immunoregulators) immune functions to restore normal immune responses and treat or prevent diseases.

Lifestyle changes: Some aspects of one's lifestyle may improve the immune system. This includes eating a balanced diet, managing stress, exercising frequently, and getting adequate sleep. Sleep is essential for the body's ability to heal and recover cells, especially immune cells. By enhancing blood flow and lowering inflammation, exercise can also aid in enhancing immune function. Stress can impair immunity and increase susceptibility to infections, so it's critical to manage it. Last but not least, maintaining a nutritious diet rich in fruits, vegetables and whole grains can give the body the building blocks it requires to maintain immune function. [1].

NEED OF HERBAL SYRUP

Herbal syrups act as immunomodulator by supplying bioactive plant compounds like polyphenols and polysaccharides that balance immune cell activity, reduce harmful inflammation and support the body's defence against seasonal infections. [3-5].

The increasing global preference for natural and holistic healthcare has brought herbal syrups into focus as an effective alternative to synthetic medicines. Herbal syrups provide a convenient and palatable form of delivering therapeutic plant extracts, making them particularly suitable for children and the elderly. [1,2].

Moringa (*Moringa oleifera*) A nutrient-rich herb that supports healthy immune function through its antioxidant and immunomodulatory properties.

Sea Buckthorn (*Hippophae rhomboids*) A vitamin C-rich super fruit that provides powerful antioxidant protection and supports immune health.

Bael (*Aegle marmelos*) A traditional medicinal fruit that promotes digestive wellness and supports overall immune health.

Immunomodulatory and Therapeutic Properties: Many herbal ingredients such as Moringa oleifera, Sea Buckthorn and Bael fruit are rich in antioxidants and bioactive compounds that enhance immunity, reduce inflammation and support overall health. [6-8,11,15].

Palatable and Easy to Administer: The syrup form is especially suitable for children, elderly patients and individuals who have difficulty swallowing tablets or capsules. The addition of natural sweeteners like Jaggery improves taste and compliance.

Use of herbal syrup

- Immune system support
- Relief from respiratory disorders
- Digestive Aid
- Anti-inflammatory and antioxidant effects
- General health and nutritional support
- Pediatric and geriatric care
- Complimentary use with allopathic medicines



FIG 2: SAMPLE DESIGN OF BOTTLE [22]

A polyherbal syrup made with Bael, sea buckthorn and Moringa that supports healthy digestion, natural antioxidant protection and normal immune function. This formulation is intended as a daily herbal nutritional supplement for general health and well-being and is rich in vitamins, polyphenols, flavonoids and other plant-derived bioactive compounds. [6,11,15].

AIM AND OBJECTIVES

Aim: Immunomodulator Herbal Syrup Formulation and Evaluation

Objectives:

- To create an herbal syrup with immunity-boosting ingredients, such as Moringa oleifera. Sea buckthorn, Bael fruit
- To assess the stability and physicochemical characteristics of the syrup.
- To evaluate the physicochemical safety of the syrup.
- To create an immune-boosting formulation that is safe, effective and natural.

Herbal Products as syrup

A. Moringa Oleifera

- Scientific Name: Moringa oleifera Lam
- Family: Moringaceae.
- Order: Brassicales
- Genus: Moringa
- Species: Oleifera
- Chemical Constituents:

1. Vitamins:

- Vitamin A (Beta-carotene)
- Vitamin C (Ascorbic acid)
- Vitamin E
- Biological Source: Dried leaves, roots, seeds and pods obtained from the Moringa oleifera plant.
- B-complex vitamins (B1, B2, B3, B6)

B. Minerals:

- Calcium, Iron, Potassium, Magnesium, Zinc

C. Phytochemicals

- Flavonoids (Quercetin, Kaempferol)
- Phenolic acids
- Tannins
- Alkaloids
- Glucosinolates and Isothiocyanates

4. Proteins and Amino Acids:

- Contains all 9 essential amino acids
- Rich in plant protein

D. Fatty Acids

- Oleic acid
- Palmitic acid
- Linoleic acid

➤ Pharmacological Actions:

- Immunomodulatory
- Antioxidant
- Anti-inflammatory
- Antidiabetic
- Antimicrobial
- Antihypertensive
- Nutritional supplements

Description:

Moringa oleifera is a medicinal plant that has long been used for a variety of ailments in Ayurvedic and folk medicine. Its fruits and leaves are high in antioxidants and micronutrients that may help maintain a healthy immune system. Numerous pharmacological properties of the plant have been shown, such as anti-inflammatory, antioxidant, antibacterial, antifungal, Hepatoprotective, hypoglycemic and antitumor effects. According to earlier research, supplementing with Moringa may have immunostimulatory effects, especially in people with weakened immune systems. Moringa oleifera* may therefore be used as a natural immunomodulatory agent. [6-10].



Fig.2 Moringa Oleifera [23]

B. Sea Buckthorn

- Scientific Name: *Hippophae rhamnoides* L.
- Family: Elaeagnaceae
- Order: Rosales
- Genus: *Hippophae*
- Species: *Hippophae rhamnoides*
- Chemical constituents:

Vitamins

- Vitamin C
- Vitamin E
- Vitamin A (carotenoids),
- Vitamin K

Carotenoids

- β -carotene
- lycopene
- Lutein
- zeaxanthin

Flavonoids

- Quercetin
- Kaempferol,
- isorhamnetin and their glycosides

Essential fatty acid

- Omega-3
- Omega-6
- Omega-7
- Omega-9

➤ Pharmacological action

- Antioxidant
- Immunomodulatory
- Anti-inflammatory
- Antimicrobial
- Hepatoprotective
- Cardioprotective

Description :

Flavonoids, carotenoids, vitamins, polyunsaturated fatty acids, phytosterols and polysaccharides are abundant in *Hippophae rhamnoides* L. (Sea buckthorn). The pharmacological activities of its berries, seeds, leaves and bark include antioxidant, anti-inflammatory, immunomodulatory, antimicrobial, Cardioprotective, Hepatoprotective, antidiabetic and wound-healing effects. Research also shows a good safety profile. Because of its immunomodulatory and antioxidant qualities, sea buckthorn has great potential as a natural bioactive ingredient for nutraceutical, pharmaceutical and functional food formulations.



Fig 3: *Hippophae rhamnoides* L.[24]

C. Bael Fruit

- Scientific Name: *Aegle marmelos* (L.) Corrêa
- Family: Rutaceae
- Order: Sapindales
- Genus: *Aegle*
- Species: *Aegle marmelos*

Major Chemical Constituents

Bael fruit contains several bioactive compounds, including:

- Marmelosin – a major coumarin constituent
- Marmesin
- Imperatorin
- Scopoletin
- Skimmianine
- Aegeline
- Tannins

➤ Pharmacological action

- Anti-oxidant
- Anti- inflammatory
- Gastro- protective,
- Supports immune function
- Antimicrobial

Description:

Aegle marmelos (Bael) is a traditional Ayurvedic and folk medicine medicinal plant that has shown significant antioxidant and anti-inflammatory potential. Bioactive substances like marmelosin, marmin, flavonoids, alkaloids and triterpenoids are found in its leaves, fruits, bark and roots. Research suggests that extracts from marmelos may decrease inflammatory mediators such as TNF- α , IL-1 β , IL-6, COX, LOX, nitric oxide and NF- κ B and may also prevent tissue inflammation and macrophage activation. Preclinical research indicates that *A. marmelos* may have potential as a natural anti-inflammatory and immunomodulatory agent, despite the paucity of clinical evidence in humans. [15-17].



Fig .4: *Aegle marmelos* (L.) Corrêa[25]

D. HONEY

Scientific Name *Apis mellifera* (common honey bee; honey is produced by bees)

Family Apidae
Order Hymenoptera
Genus *Apis*
Species *Apis mellifera*

➤ **Chemical Constituents**

- Enzymes: Invertase (sucrase), glucose oxidase, diastase (amylase), catalase
- Organic acids: Mainly gluconic acid, with citric, malic, acetic and formic acids
- Phenolic compounds: Phenolic acids and flavonoids such as quercetin, kaempferol, chrysin and pinocembrin
- Vitamins: Small amounts of B-complex vitamins and vitamin C
- Minerals: Potassium, calcium, magnesium, phosphorus, sodium, iron and zinc

➤ **Pharmacological Action:**

- Antioxidant
- Antimicrobial
- Anti-inflammatory
- Immunomodulatory
- Gastroprotective



Fig 4: *Apis mellifera*[26]

Description:

Honey has multifunctional immunomodulatory properties that may support wound healing. It can regulate reactive oxygen species production by immune cells based on the wound environment and control the release of cytokines such as TNF- α , IL-1 β and IL-6. Additionally, honey supports debridement, cell migration, proliferation, collagen formation, re-epithelialization and wound closure by stimulating monocytes, macrophages, neutrophils, keratinocytes, fibroblasts and endothelial cells. The numerous bioactive substances found in honey from diverse sources determine its intricate immunomodulatory effects. [18,19].

Review Summary:

The main point of this review is that *Moringa oleifera* sea buckthorn (*Hippophae rhamnoides*) and Bael (*Aegle marmelos*) are promising plant-based ingredients for creating a syrup aimed at supporting immune health. These plants contain a variety of phytochemicals. Have been reported to have antioxidant, anti-inflammatory and immunomodulatory effects, which provide a scientific basis for studying their combined use in one formulation. Including honey in the syrup may also enhance its taste and overall effectiveness.

The importance of this research is in examining a formulation that brings together the properties of three medicinal plants in an easy-to-use liquid form. However just because each plant has its benefits does not mean that their combination will be equally effective. Therefore, the syrup needs to be tested for its physical and chemical properties, microbial safety, stability and biological activity. Additional studies are also necessary to explore whether the combination of these ingredients offers health benefits than each individual component alone.

In summary this review offers a basis for the future development and assessment of a polyherbal immunomodulatory syrup. Its real impact will depend on evidence showing that the syrup is of high quality, safe and effective rather, than just relying on traditional use or the presence of certain plant compounds.

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24. Figure: Sea buckthorn (*Hippophae rhamnoides* L.) fruit and fruit powder. Source: Adapted from Bal et al. (2023)
25. Figure: Bael (*Aegle marmelos* (L.) Corrêa) fruit and fruit powder. Source: Adapted from the literature on bael pulp powder.
26. Figure: Natural honey and honeycomb. Source: Adapted from Samarghandian et al. (2017).

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