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Development and physicochemical evaluation of a sugar-free polyherbal immunity booster powder

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Abstract

Microgreens are emerging as nutrient-dense functional foods that offer health benefits beyond basic nutrition. This review addresses the growing demand for sustainable and health-promoting dietary options by examining the nutritional potential, cultivation practices, and functional applications of microgreens. A comprehensive analysis of existing literature was conducted to evaluate their composition, including vitamins, minerals, and bioactive compounds such as polyphenols and carotenoids. The findings indicate that microgreens possess significantly higher nutrient concentrations than mature plants and exhibit antioxidant, anti-inflammatory, cardioprotective, and anti-diabetic properties. The study also highlights the influence of growing media on yield and quality, as well as the successful incorporation of microgreens into value-added functional food products. In conclusion, microgreens represent a promising component of modern diets and sustainable food systems, with considerable potential to enhance nutritional security and human health.

Keywords: Microgreens, antioxidants, bioactive compounds, health benefits, functional food

1. Introduction

Our immune system defends our body against harmful microbes, diseases, infections, and cancer. To protect the body from foreign substances, the immune system creates an immune response to fight against foreign substances or harmful bacteria and disease. Major immune system components are macrophages and lymphocytes (B cells and T cells) which are responsible for protecting the body against infections ^[1].

Immune system is of two types, Innate and adaptive immunity, which provides different functions, while innate immunity provides a rapid, non-specific defence mechanism, adaptive immunity uses memory cell to provide long term, antigen-specific protection ^[2].

Boosting immunity is crucial for our health since the COVID-19 pandemic has brought difficulty for the entire world. The primary objectives of COVID-19 were elderly and young people with weakened immune systems. Our immune system contains various of useful bacteria in our body that protect our body from several diseases. When the immune system gets weakened, it causes infections like corona virus and diseases such as diabetes, heart disease, or blood cancer ^[3].

The most important way for improving the immune system is to adopt a healthy lifestyle which includes consuming nutritious food, getting enough rest. and regular physical workout. Further, research have shown that taking supplements containing specific vitamins, minerals, herbs, and other substances boost immunity and prevent disease ^[4].

Human beings have suffered severely in recent decades because of the rapid increase in the frequency of various infectious, inflammatory diseases, allergies, cancer, and autoimmune disorders. Immunity should be balance which is crucial for maintaining human health there are numerous benefits of using natural herbs with immune modulating properties to prevent or enhance the immune system. Plant based natural ingredients have fewer side effects and lower toxicity in the body compared to synthetic (organic) drugs, which makes them beneficial for human health, they have numerous of benefits, one of which is enhancing the immune system of the body. By boosting host immunity, plant based natural ingredients support health and help in the fight against illnesses the Phytoconstituents present in the plants-based ingredients responsible for various therapeutic benefits in body ^[11].

A polyherbal formulation is a preparation that combines two or more herbs. Polyherbalism is the idea of synergism, which balance the combined therapeutic effect of each herb which is greater than the sum of individual effects. In Ayurveda, polyherbal solutions are frequently used to boost immune system and maintain energy balance. The immune system can be significantly strengthened and risk of disease by combining herbs with anti-inflammatory, antioxidant, adaptogenic and immune stimulatory qualities.

Traditional herbal formulations often use sugar or honey as base ingredients to enhance flavour and preserve the composition; however, individuals' obesity, diabetes or metabolic disorders have significant difficulties as a result. Sugar intake can worsen pre-existing metabolic disorders in certain individuals, leading to insulin resistance and hypercalcemia. Due to increased awareness of dietary restrictions and lifestyles disorders, there is an increasing need for sugar-free alternatives that are both pleasant and medicinal. Safe, low-calorie sweeteners like stevia and mannitol which are suitable for all the individuals [51].

The best way to cope with health problems and the best substitute of energy drink is herbal immunity boosters. The name of selected plants for study:

Amla (*Phyllanthus emblica*): family is Phyllanthaceae, Amla is a great source of vitamin C, which improves immunity, speedup metabolism and guards against bacterial and viral infections like cold and cough [25].

Tulsi (*Ocimum sanctum*): family is Liliaceae, Tulsi is commonly used to treat illness, such as the common cold,

irritation, intestinal illness, cardiovascular disease, digestive issues and more [24].

Ginger (*Zingiber officinale*): family is Zingiberaceae, Ginger has a strong anti-bacterial and anti-inflammatory properties, which help to boost the immunity [39].

Turmeric (*Curcuma longa*): family is Zingiberaceae Turmeric is a well-known for its ability to boost immunity, its main constituent, curcumin has strong antioxidant and anti-inflammatory properties which enhances immune cell activity, reduces inflammation strengthen the body's defence against infections [39].

Cinnamon (*Cinnamomum verum*): family is Lauraceae, Cinnamon is used to increase the immunity because of its bioactive ingredients including cinnamaldehyde, cinnamic acid and cinnamyl alcohol. These ingredients, support the body's immune system response because of their antibacterial, anti-inflammatory properties [39].

Stevia (*Stevia rebaudiana*): family is Asteraceae Stevia leaf extract contain different bioactive ingredient like flavonoids, steviol glycosides, diterpenoids which gives S. rebaudiana its sweetness, its bioactive metabolites provide a variety of medicinal benefits including as immunomodulatory, anti-inflammatory, antibiotic and neuro protective properties [52].

Flax Seeds (*Linum usitatissimum*): family is Linaceae flax seed is very rich in omega-3 fatty acids, fiber, protein, and antioxidants.

2. Plant Profile

2.1 Amla (*Phyllanthusemblica*)



Fig 1: Amla

Synonym: Emblica, Indian gooseberry

Biological Source: This involves both fresh and dried fruits from the *Emblica officinalis* plant.

Family: Euphorbiaceae

Geographical source: It is most found in countries in like India, Pakistan, Uzbekistan, Sri Lanka, Southeast Asia, China and Malaysia.

Chemical Constituents: One of the Plants that has been studied the Most is amla. It may contain phenols, alkaloids, and tannins, according to several studies. 28% of the tannins found across the whole plant have been discovered in fruits. it generally consist of carbohydrates, amino acids, and other substances. its fruit juice has the greatest vitamin C concentration (478.56mg/100mL). There is more vitamin C than oranges, tangerines, and lemons. The edible fruit tissue has much greater of most minerals and amino acids and is multiple times richer in proteins and 160 times more ascorbic acid than apple.

Uses: Amla, often known as Indian gooseberry, is a nutritious fruit with numerous health benefits. By boosting the body's immune system with its antibacterial properties and by creating more white blood cells, which help with detoxification, it improves immunity. Amla is also beneficial for hair care because of its high iron and antioxidant content.

2.2 Tulsi (*Ocimum sanctum*)



Fig 2: Tulsi

- **Synonym:** Holy basil, Sacred basil.
- **Biological Source:** Tulsi generally contain fresh and dried leaves *Ocimum sanctum* L. and *Ocimum basilicum*.
- **Family:** Labiatae.
- **Geographical Source:** *Ocimum sanctum* is found in Latin America, the southern hemisphere, and tropical and subtropical parts of Asia.
- **Chemical Constituents:** Several phenolic substances (antioxidants), including cirsilineol, cirimaritin, isothymusin, apigenin, rosameric acid, and eugenol, were extracted from fresh leaves and stem of *Ocimum sanctum*. 0.7% of the volatile oil found in *Ocimum sanctum* leaves is made up of roughly 71% eugenol and 20% methyl eugenol. Additionally, the oil contains the sesquiterpine hydrocarbon caryophyllene and carvacrol. Two flavonoids, orientin and vicanin, have been identified from *Ocimum sanctum*'s aqueous leaf extract.

2.3 Ginger (*Zingiber officinale*)



Fig 3: Ginger

- **Synonym:** Rhizoma zingiberis, Zingibere.
- **Biological Source:** Ginger contains dried rhizomes of the Rosoce *Zingiber officinale*.
- **Family:** Zingiberaceae
- **Geographical Source:** it is mostly grown in Africa, Nigeria, jamaica, India, Japan and the west indies.
- **Chemical constituents:** Ginger mainly contain Sesquiterpenes including β -bisabolene, α -farnesene, zingiberene, and β -sesquiphellandrene, Paradols, zingerone, quercetin, gingerone-A, and 6-dehydrogingerdioneare other phenolic compounds. Ginger also includes raw fibres, lipids, organic acids, and polysaccharides; roughly 50-70% of its composition is madeup of carbohydrates Which shows antioxidant, anti-inflammatory, antimicrobial, and anticancer properties.

2.3 Turmeric (*Curcuma longa*)



Fig 4: Turmeric

- **Synonym:** Indian saffron, Turmeric
- **Biological Source:** it is obtained from a dried rhizome of *Curcuma longa* Linn.
- **Family:** Zingiberaceae
- **Geographical Source:** The plant is widely cultivated in temperate regions and is native to southern Asia. Larger-scale cultivation takes place in Pakistan, Malaysia, China, India, and the East Indies.
- **Chemical constituents:** *Curcuma longa* is the main constituent of turmeric, which contain different chemical constituents that contribute to its culinary and medicinal properties. Curcumin (around 3-6%) make up curcuminoids, the main colouring compound. The essential oils include around 3-Zingiberene (25%), α -phellandrene, sabinene, turmerone, and arturnerone are found in 7% of Turmeric. Cineole and borneol other substances found in turmeric include phenylpropene, diterpenes, sterols and alkaloid. These chemical constituents contain antioxidants, anti-inflammatory properties in it [14].

2.4 Cinnamon (*Cinnamomum zeylanicum*)



Fig 5: Cinnamon

- **Synonym:** Kalmi-Dalchini, Ceylon Cinnamon.
- **Biological source:** it is obtained from a inner bark of the shoots of coppiced trees of *Cinnamomum zeylanicum* Nees.
- **Family:** Lauraceae
- **Geographical source:** *Cinnamomum zeylanicum* is widely cultivated in Ceylon, Java, Sumatra, West Indies, Brazil, Mauritius, Jamaica, and India.
- **Chemical Constituents:** About 0.5 to 1% volatile oil, 1.2% tannins, mucilage, calcium oxalate, starch, a sweet molecule called mannitol are found in cinnamon bark. The active ingredient in the molecule is the volatile oil, 14-16% of the 90% alcohol-soluble extraction is produced by bark. 60-70% of cinnamonaldehyde, 5-10% eugenol, benzaldehyde, cumin aldehyde are found in Cinnamon oil. These ingredients show carminative, stomachic, and mild astringent properties [24].

2.5 Stevia (*Stevia rebaudian*)



Fig 6: Stevia

- **Synonym:** Asteraceae
- **Biological Source:** it is obtained from dried leaves of *Stevia rebaudiana*.
- **Family:** Asteraceae
- **Geographical source:** Native to the semi-humid subtropical regions of Paraguay's Amambay Mountains. It is now widely cultivated in nations including India, China, Japan, and the United States, but it is mostly found in Paraguay and Brazil.
- **Chemical constituents:** *Stevia rebaudiana* contain a rich source of bioactive metabolites glycosides, amino acids, fatty acids, glycerides, and oligosaccharides are among the more than 153 active components that have been extracted and identified from leaf extracts to date. In addition to contributing to *S. rebaudiana*'s sweetness. Its bioactive metabolites consist of a numerous of health benefits including as immunomodulatory, anti-inflammatory, antidiabetic, antioxidant, and neuroprotective properties.

2.6 Flax Seed (*Linum usitatissimum* L.)



Fig 7: Flax seed

- **Synonym:** Linseed
- **Biological Source:** it is obtained from dried ripe seeds of *Linum usitatissimum* L.
- **Family:** Linaceae
- **Chemical Constituents:** Flax seed, or *Linum usitatissimum*, is becoming increasingly well-liked because of its high α -linolenic acid, lignans, Fiber and Omega 3 fatty acids which act as an antioxidant.

2.8 Mannitol

Mannitol commonly known as D- mannitol, is a polyol or low-calorie sugar alcohol. It has a similar chemical structure to mannose and is an isomer of the medicinal excipient sorbitol. It is either a white, odourless, crystalline powder or free-flowing granules. It is similar to glucose and tastes half as sweet as sucrose. It functions as a tonicity agent, tablet, capsule diluent, chewable tablet excipient, sweetener. Five popular herbs-Amla, Tulsi, Ginger, Turmeric, Cinnamon, Stevia and Flax seed were employed in this study to make and evaluate a sugar free polyherbal mixture. These plants are well-known for their immunomodulatory, adaptogenic, and antioxidant properties. The main objective was to formulate a pleasant, sugar free supplement and assess its basic physiochemical characteristics.

Clinical investigation in selected herbs

In the present study, a selection of medicinal plants is clinically investigated in animal's models to assess their immunomodulatory, antioxidant, and health promoting properties. Many of them utilize herbs including *Phyllanthus emblica*, *Ocimum sanctum*, *Zingiber officinale*, *Curcuma longa*, and *Stevia rebaudiana*, *Linum usitatissimum* used to determine the activity on animals.

- Toll-like receptor (TLR2, TLR4, and TLR7) gene expression was assessed in this study after amla fruit powder added to the diets of broiler chicks. The study showed that while TLR4 expression reduced in all treatment groups. Based on these studies, amla may strengthen broiler hens' immunity and serve as a natural antibiotic substitute.
- The analgesic and anti-inflammatory properties of *Ocimum sanctum* leaves were assessed in this study. Using the hot-plate method in mice and carageenan-induced paw edema in rats, the leaves' ethanol extract was tested for its analgesic and anti-inflammatory effects. The analgesic effect was proven by a significant, dose dependent increase in reaction time at doses of 250-500mg/kg. By reducing paw edema (43.33% inhibition at 500 mg/kg), the extract showed its anti-inflammatory. The Findings verify the traditional use of *Ocimum sanctum* refer to its potential as source of herbal medicine [54].
- The continued use of antibiotics in poultry production is no longer desirable because of the negative effects on animal and human health. Lengthened. In this study the production of poultry has led to the discovery and testing of numerous organic products. As well as turmeric. Curcumin, the active ingredient in turmeric, has demonstrated broad-spectrum antibacterial properties in this study it can also boost the chicken's immunity. These are also anti-inflammatory qualities to turmeric. That's studies have shown that turmeric can enhance gut health, boost feed intake, and hasten chicken growth, making it a very excellent organic product that can readily take the place of antibiotics in chicken production.
- The current study claims that an aqueous extract from stevia leaves may lower blood sugar level, glycosylated haemoglobin (HbA1c), and fasting blood sugar haemoglobin, but the diabetic rats' levels of insulin and liver glycogen considerably rose in comparison with the control rats with and without diabetes after eight weeks' time for study. The aqueous extract of stevia was found to have a concentration of 500ppm/kg body weight in rats. Demonstrated the best outcomes of every parameter examined. It is clear from the findings that stevia extracts anti-diabetic effects in albino rats, so it could be used as a naturally occurring antidiabetic medication of diabetes and the problems it causes.
- In this study they evaluated the effects of giving broiler chickens different amounts of ginger (*Zingiber officinale*). A total of 1500 chicks were divided into five groups with varying amounts of ginger. The results showed that supplementing with ginger improved gut morphology (longer and wider villi), reduced the total bacterial count, and increased feed intake. Additionally, by increasing HDL and lowering LDL triglycerides, and cholesterol, it enhanced serum biochemistry. A0.6% ginger inclusion produced the best outcomes.

4. Material and Method

4.1 The following herbs were used

- Amla (Phyllanthusemblica)
- Tulsi (*Ocimum basilicum*)
- Ginger (*Zingiber officinale*)
- Turmeric (*Curcuma longa* Linn)
- Cinnamon (*Cinnamomum zeylanaicum* Nees)
- Stevia (*Stevia rebaudiana*)
- Flaxseed (*Linum usitatissimum* L.)
- Mannitol

4.2 Standardization of herbal plant powder

The following standardization procedures were performed for each powdered plant ingredient to ensure the effectiveness, quality, and purity of the herbal raw materials used in the formulation

(Phyllanthus emblica, *Ocimum basilicum*, *Zingiber officinale*, *Curcuma longa* Linn, *Cinnamomum zeylanaicum* Nees, *Stevia rebaudiana*)

4.3 Glassware's used

1. Beaker
2. Conical flask
3. Measuring cylinder
4. Funnels
5. Glass rods
6. Mortar Pestle

4.4 Equipment's used:

1. Hot air oven (for loss on drying)
2. Muffle furnace (for total ash and acid-insoluble ash determination)
3. Electronic weighing balance
4. Standard sieves.

5. Method of preparation

5.1 Cleaning and Drying

All herbs (Amla, Tulsi, Ginger, Turmeric, Flax seed, Stevia) were cleaned thoroughly removed dust and impurities. The material was shade-dried at room temperature.

5.2 Grinding

Each dried material was coarsely powdered using a mechanical grinder and passed through a 60 no of sieve to obtain uniform particle size. The powders were stored separately in airtight containers.

5.3 Mixing and Blending

All powdered herbal ingredients were accurately weighed according to the formula and mixed thoroughly in a clean, dry mortar and pestle to ensure uniformity.

5.4 Sieving and packaging

The final blend was passed again through a 60 no sieve to achieve a fine, homogenous powder. The polyherbal powder was then packed in airtight container.

6. Evaluation procedure

6.1 Organoleptic evaluation: The product was evaluated based on its colour, taste, odour, appearance.

6.2 Physiochemical evaluation: Numerous of

physiochemical test was performed such as angle of repose, bulk density, tapped density, moisture content, etc.

1. Angle of repose: To evaluate angle of repose a funnel is used and placed in such away so that the powder can flow easily after that a grid of paper was placed in a flat surface the before pouring the powder block the tip of funnel then pour the powder through the funnel on the paper then mark was made on the paper along the circumference of the pile. The radius(r) of the pile and the height(h) was measured. The angle of repose was measured by using:

$$\tan\theta = \text{height/radius}$$

Where,

θ = angle of repose

h = height of pile,

r = radius of pile

Table 1: Angle of repose values

Value of angle of repose	Flow properties
≤ 25	Excellent flow
25-30	Good flow
30-40	Passable
40	Bad flow

2. Bulk density

To measure bulk density a 100ml measuring cylinder was used and the fine powder was poured into a clean and dry measuring cylinder ensuring the powder does not compact or tapped then note the reading volume occupied by the powder. Formula for calculating bulk density is as follows:

$$\rho(b) = M/V_o(\text{gm/ml})$$

Where, $\rho(b)$ = Bulk density, M = sample's weight, V_o = volume of sample.

3. Tapped density: after measuring bulk density, the measuring cylinder containing powder was tapped using glass rod. The powder was tapped 100-200 times after tapping the volume was recorded to the closet graduated unit. To calculate the tapped density, we use the formula:

$$\rho(\text{tap}) = M/V_f(\text{gm/ml})$$

Where, $\rho(\text{tap})$ = tapped density, M = weight of sample, V_f = volume of sample.

4. Carr's Index (The Compressibility Index): The tendency of a powder formulation is measured by an index. To be compressed, which is determined using the bulk and densities were tapped. It is better to have less compatibilities' a property of flow it measures the interparticulate interaction of the material, The disparity between bulk and tapped densities are far more significant. The formula used for calculation of Carr's Index is,

$$\text{Compressibility Index} = \{[\rho(b) - \rho(\text{tap})]/\rho(\text{tap})\} * 100$$

Where, $\rho(b)$ = Bulk density, $\rho(\text{tap})$ = Tapped density.

Table 2: Compressibility Index Values

Carr's Index(%)	Flowproperty
≤10	Excellent
11-15	Good
16-20	Fair
21-25	passable
26-31	Poor
32-37	Very poor
>38	Very Very poor

5. Hausner's Ratio: Hausner's ratio comes in second measurement of a bulk property, the quantity associated with the flowability of a powder formulation. The formula is as follows:

$$Hr = \rho(\text{tap}) / \rho(b)$$

Where, $\rho(\text{tap})$ = Tapped density, $\rho(b)$ = Bulk density

Table 3: Hausner's Ratio Index

Hausner's ratio	Flow properties
1.00-1.11	Excellent
1.12-1.18	Good
1.19-1.25	Fair
1.26-1.34	Passable
1.35-1.45	Poor
1.46-1.59	Very poor
>1.60	Very Very poor

6. Moisture Content: since the moisture content is high, which encourage the hydrolytic process that results in the development of microorganisms. As a result, herbal powder contains more moisture content compared to its peers, which is why it is important to know the moisture content, to select proper packaging for the product. The hot air oven was used to measure the moisture content by placing the measured amount of powder was placed in preheated porcelain dish and weigh the dish (W1) along with the powder and then the porcelain dish was placed in hot air oven for 60 C for 2 hours. After that porcelain dish was removed from the oven and weight again (W2). Then the moisture content was calculated:

$$\text{Moisture Content(\%)} = [(W1 - W2) / W] * 100$$

Where, W = powder weight(gm), W1 = weight of dish before drying(gm), W2 = weight of dish after drying(gm).

7. Ash Content: It symbolizes the inorganic residue, including silicate, carbonate, and phosphate in herbal drugs. It is significant because it demonstrates the quality as well as purity of herbal medicines.

Total ash content - To a weighed crucible (W1) predetermined dry sample is added. The crucible is weighed again with the sample (W2). The crucible is then placed in a furnace until it burned off. Then again weight the crucible along with the residue (W3).

$$\text{Total Ash(\%)} = [(W3 - W1) / (W2 - W1)] * 100$$

6.3 Phytochemical Evaluation:

Phytochemical test was done using standard qualitative

methods to detect the presence of phytoconstituents such as alkaloids, flavonoids, saponins, tannins, glycosides, and steroid/terpenoids.

Preparations of Extract

- Weigh 1-2 gm of the sample powder.
- 10ml of distilled water or ethanol is used depending on solubility.
- The powder is mixed with distilled water, shake well and filtered. The filtrate was used for testing.

1. Test for Alkaloids (Mayer's Test)

- Take 1-2 ml of the extract.
- Add 1ml of Mayer's reagent.
- Creamy coloured precipitate was observed.

2. Test for Tannins (Ferric chloride Test)

- Take 1-2 ml of the extract.
- Add few drops ferric chloride solution.
- Black colour was observed.

3. Test for Glycosides (Keller-Killiani test)

- Take 2 ml of the extract
- Add few drops of glacial acetic acid, one drop of ferric chloride and sulphuric acid carefully down the side.

Reddish brown layer at the interface and bluish-green layer below was Observed.

4. Test for Saponin (Foam Test)

- Take 2 ml of the extract.
- Shake 2ml of extract vigorously with 5ml distilled water in a test tube.
- Allow to stand for few minutes.
- Foam formation was observed.

5. Test for protein (Millon's Test)

- Take 3 ml of the extract.
- Add 5ml of Millon's reagent.
- Heat the solution in a water bath.
- White precipitate turns red on heating was observed

6. Test for Carbohydrates (Molisch Test)

- Take 3ml of extract and add few drops of alcoholic alpha naphthalol
- Shake well and add 2ml of conc. Sulphuric acid from the side wall of the test tube.
- Purple colour was observed.

7. Results

7.1 Organoleptic Evaluation Results

Table 4: Organoleptic Evaluation Results:

Sr. No	parameter	Trial 1	Trial 2	Trial 3	Trial 4
1	Appearance	Powder	Powder	Powder	Powder
2	Texture	Fine	Fine	Fine	Fine
3	Colour	Greenish brown	Greenish brown	Greenish brown	Greenish brown
4	Odour	Sweet	Sweet	Sweet	Sweet

7.2 Physiochemical Evaluation Results

The result of the physiochemical evaluation is as follows:

1. Angle of repose

Height of pile(h) = 2.5cm

Radius of the pile(r) = 4.5 cm

Angle of repose= θ

$$\tan\theta = h/r$$

$$= 2.5 / 4.5$$

$$= 0.55$$

$$\theta = \tan^{-1}(0.55)$$

$$= 28.8^\circ$$

Therefore, angle of repose is 28.8°

Thus, the flow properties of powder is good flow properties.

2. Bulk Density:Sample powder weight (M) = 20 gm Apparent Volume of sample(V_o)=43ml

$$\text{Bulk density} = \rho(b)$$

$$\rho(b) = M/V_o(\text{gm/ml}) = 20/43$$

$$\rho(b) = 0.465 \text{ gm/ml}$$

Thus, the Bulk density of powder was observed to be 0.465gm/ml.

3. Tapped DensityWeight of sample powder (M) = 20 gm Volume of sample after tapping (V_f)=38ml Tapped density= $\rho(\text{tap})$

$$\rho(\text{tap}) = M/V_f(\text{gm/ml})$$

$$\rho(\text{tap}) = 20/38$$

$$\rho(\text{tap}) = 0.526 \text{ gm/ml}$$

The Tapped density of powder is found to be 0.50 gm/ml.

4. Carr's IndexBulk density = $\rho(b)$ = 0.465gm/ml Tapped

$$\text{density} = \rho(\text{tap}) = 0.526 \text{ gm/ml}$$

$$\text{Compressibility Index} = \{[\rho(b) - \rho(\text{tap})] / \rho(\text{tap})\} \times 100$$

$$= \{[0.526 - 0.465] / 0.526\} \times 100$$

$$= \{0.061 / 0.526\} \times 100$$

$$= \{0.116\} \times 100$$

$$= 11.6\%$$

Thus, the flow property of powder is good.

5. Hausner's RatioBulk density = $\rho(b)$ = 0.465 gm/ml Tapped density = $\rho(\text{tap})$

$$= 0.526 \text{ gm/ml Hausner's Ratio} = H_r$$

$$H_r = \rho(\text{tap}) / \rho(b)$$

$$H_r = 0.526 / 0.465 H_r = 1.13$$

Thus, Hausner's Ratio value came out to 1.13 means flow properties of the formulation is good.

6. Moisture Content

Weight of powder(W)=20gm

Weight of dish before drying (W1) = 21.550 Weight of dish after drying (W2) = 20.170

$$\text{Moisture content}(\%) = [(W1 - W2) / W] \times 100$$

$$= [(21.5550 - 20.170) / 20] \times 100$$

$$= [1.380 / 20] \times 100$$

$$= 6.9\%$$

Thus, the moisture content of powder is 6.9%

7. Ash Content

Weight of empty crucible(W1)= 62.930

Weight of Crucible with the sample (W2)= 63.880 Weight of Crucible with the residue (W3)=63.020

$$\text{Total ash}\% = [(W3 - W1) / (W2 - W1)] \times 100$$

$$= [(63.020 - 62.930) / (63.880 - 62.930)] \times 100$$

$$= [0.090 / 0.950] \times 100$$

$$= [0.0947] \times 100$$

$$= 9.47\%$$

Therefore, the total ash value was found to be 14%.

7.3 Phytochemical Evaluation Results**Table 5:** Phytochemical Testing of Trial Formulation (Trial 1 to Trial 4)

Phytoconstituent	Trial 1	Trial 2	Trial 3	Trial 4
Alkaloids	—	—	—	—
Flavonoids	+	+	+	+
Saponin	+	+	+	+
Tannins	+	+	+	+
Glycosides	—	+	+	+
Carbohydrates	+	+	+	+
protein	—	—	—	—

Note:(+) indicates presence;(-) indicates absence.



Fig 8: Phytochemical evaluation of plant extract

7.4 Antioxidant Activity

Antioxidant test was determined by DPPH (2, 2-diphenyl-1-picrylhydrazyl) radical scavenging assay) DPPH assay scavenging assay of test sample, sample batch 1 and batch 2 was performed using the modified method. In brief, 0.135mM DPPH was prepared in methanol. Different concentrations (5, 10, 20, 40, 80, 160 and 320 μ g/ml of sample were mixed with 2.5ml of DPPH solution. The mixtures were stirred thoroughly and kept at room temperature for 30mins. The absorbance was measured at 517nm. Ascorbic acid was used as the reference standard. The ability of extract to scavenge DPPH radical and control

was calculated from the following formula,

$$\% \text{ DPPH inhibition} = \frac{[(\text{OD of control} - \text{OD of test}) / (\text{OD of control})] \times 100}{1}$$

The result showed that among the two batches, sample Batch 1 has a strong antioxidant activity with an IC_{50} value (3.62 μ g/ml) nearly equal to ascorbic acid (3.60 μ g/ml), where as sample batch2 showed slightly lower activity (IC_{50} = 4.02 μ g/ml). Overall, Batch1 demonstrated stronger free radical scavenging potential compared to batch 2.

Table 6: Table for graph batch 1

Conc. (μ g/ml)	Ascorbic acid	Batch 1
0	0.000	0.000
5	32.332	48.522
10	49.571	57.841
20	59.299	60.896
40	76.585	66.243
80	88.698	69.960
160	91.588	75.967
320	94.680	85.133

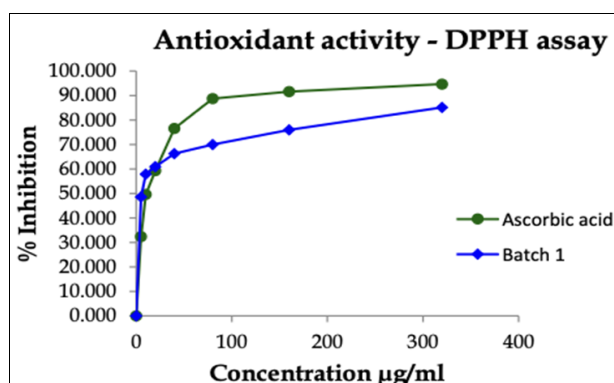


Fig 9: Graph of DPPH assay Batch 1

Table 7: Table for graph batch 2

Conc. (μ g/ml)	Ascorbic acid	Batch 2
0	0.000	0.000
5	32.332	32.281
10	49.571	51.731
20	59.299	56.415
40	76.585	64.359
80	88.698	68.432
160	91.588	77.546
320	94.680	91.243

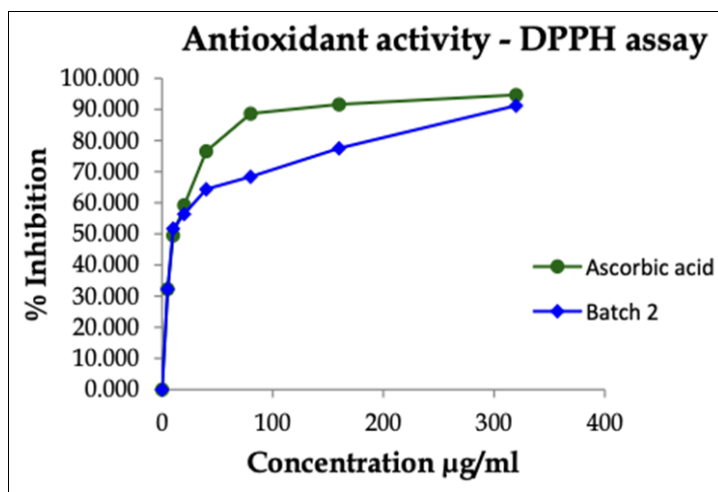


Fig 10: Graph of DPPH assay Batch 2

7.5 FTIR Analysis

FTIR analysis of the two polyherbal formulations revealed three absorption peaks. In Trial 1 (containing mannitol), peaks were observed at $\sim 3428\text{ cm}^{-1}$ (O-H stretching), $\sim 2938\text{ cm}^{-1}$ (C-H stretching), and $\sim 1100\text{ cm}^{-1}$ (C-O stretching), indicating the presence of polyphenols, aliphatic compounds, and carbohydrate-related constituents, with mannitol contributing to hydroxyl and ether groups. In Trial

2 (containing flaxseed), peaks at $\sim 3397\text{ cm}^{-1}$ (O-H stretching), $\sim 2900\text{ cm}^{-1}$ (C-H stretching), and $\sim 1742\text{ cm}^{-1}$ (C=O stretching) were observed, confirming the presence of phenolic compounds along with lipid and ester components attributed to flaxseed. Overall, both formulations exhibited important phytochemical functional groups; however, Trial 2 additionally showed a distinct carbonyl peak, indicating the presence of lipid-rich constituents.

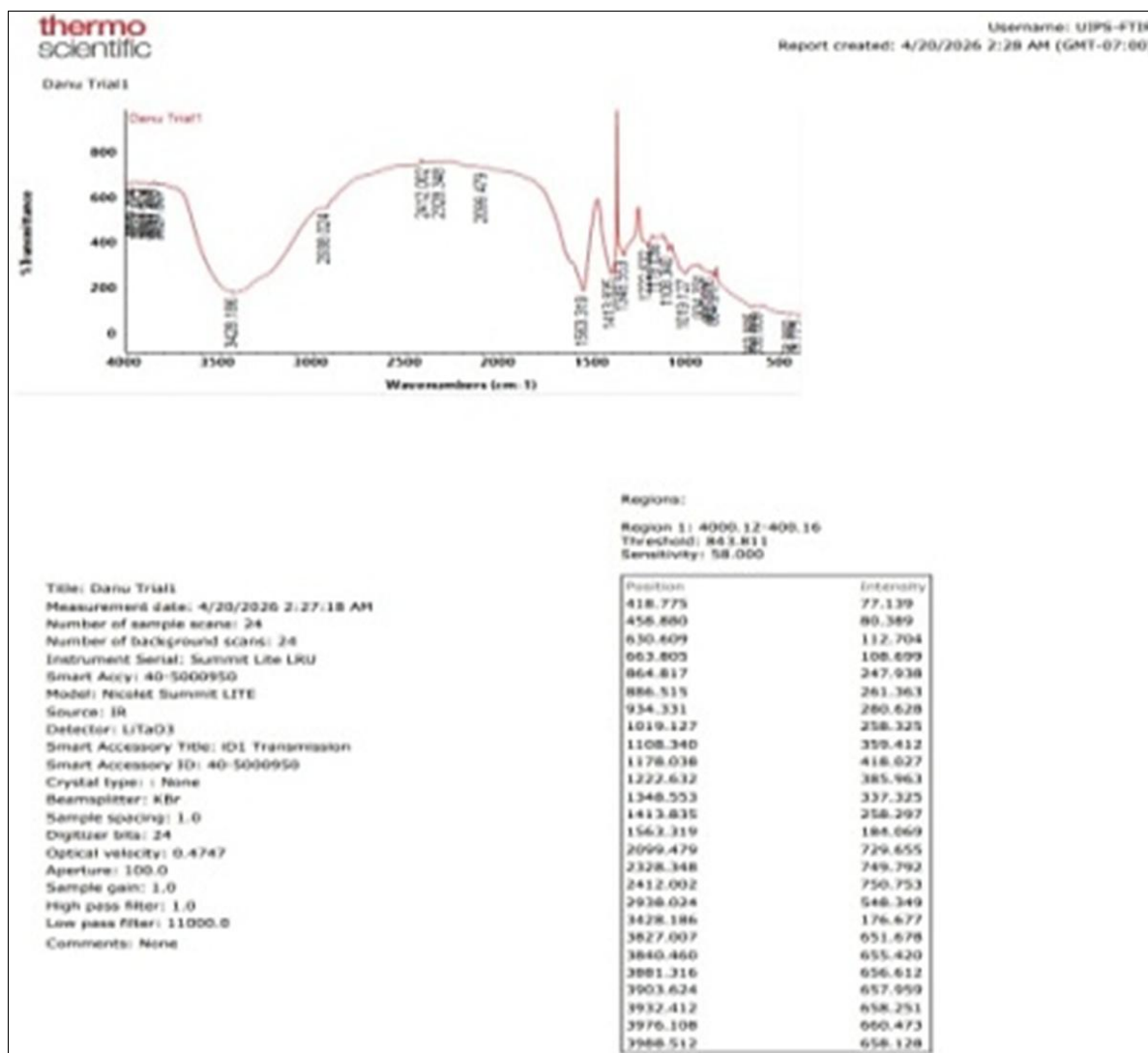


Fig 11: Graph of FTIR Trial 1

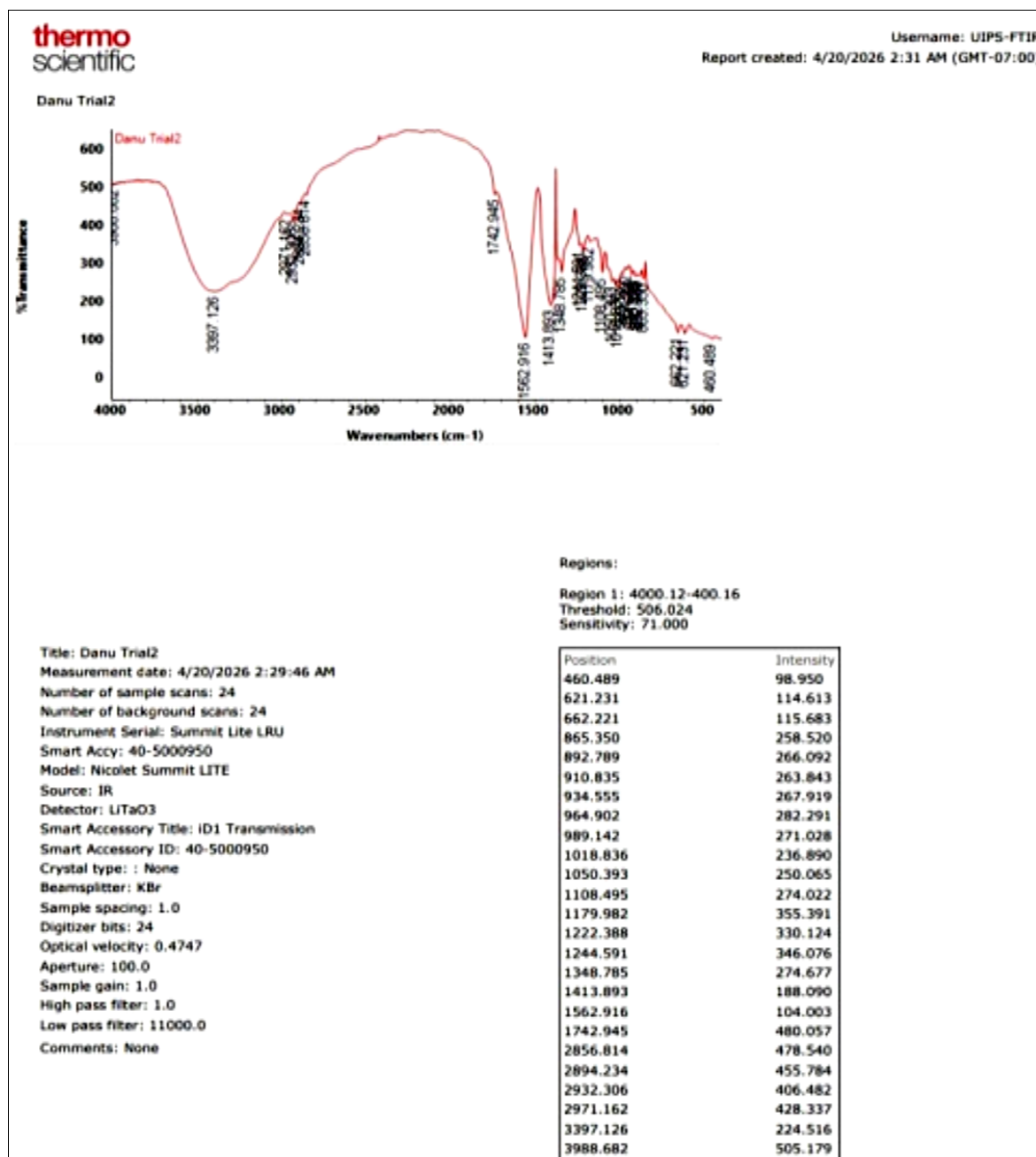


Fig 12: Graph of FTIR Trail 2

8. Discussion

The present study was carried out to evaluate the organoleptic, physicochemical, phytochemical, and antioxidant properties of the developed polyherbal powder formulation. The findings obtained from the evaluation confirmed the acceptable quality, stability, and therapeutic potential of the formulation.

Organoleptic evaluation showed that all the trial formulations possessed a uniform powder appearance with fine texture, greenish-brown colour, and sweet odour. These characteristics indicate good blending of herbal ingredients and acceptable sensory properties, which are important for patient acceptability and product quality.

The physicochemical parameters demonstrated satisfactory flow and handling properties of the powder formulation. The angle of repose value of 28.8° indicated good flowability of the powder blend. Similarly, Carr's index (11.6%) and Hausner's ratio (1.13) also confirmed excellent compressibility and flow characteristics, suggesting that the

formulation can be easily processed during manufacturing. The bulk density and tapped density values indicated proper packing ability of the powder particles. Moisture content was found to be 6.9%, which is within acceptable limits and suggests lower chances of microbial growth and better stability during storage. The ash value reflected the presence of inorganic and mineral constituents in the formulation.

Phytochemical screening revealed the presence of important secondary metabolites such as flavonoids, saponins, tannins, glycosides, and carbohydrates. These phytoconstituents are well known for their medicinal properties including antioxidant, antimicrobial, anti-inflammatory, and therapeutic activities. The absence of alkaloids and proteins in most formulations may be attributed to the nature of selected herbal ingredients and extraction methods used.

The antioxidant activity assessed by DPPH radical scavenging assay showed promising results. Batch 1 exhibited stronger antioxidant activity with an IC_{50} value of $3.62 \mu\text{g/ml}$, which was almost comparable to the standard

antioxidant ascorbic acid (3.60 µg/ml). Batch 2 also showed significant antioxidant activity but comparatively lower than Batch 1. The strong antioxidant potential may be due to the presence of flavonoids and phenolic compounds in the formulation, which are capable of scavenging free radicals and reducing oxidative stress.

FTIR analysis further confirmed the presence of various functional groups such as hydroxyl, carbonyl, ether, and aliphatic compounds in the formulations. Trial 1 showed characteristic peaks corresponding to polyphenols and carbohydrate-related compounds, whereas Trial 2 exhibited an additional carbonyl peak indicating the presence of lipid-rich constituents due to flaxseed incorporation. These findings support the phytochemical screening results and indicate the presence of bioactive compounds responsible for antioxidant activity.

References

- Jayakumari S, Vijayalakshmi A, Velraj M, Shyamsundar D, Sharmila E, Sakthipriya R, Suriyaprakash K, Musharaf SS. Formulation and evaluation of polyherbal cookies for immunity booster. *Annals of Phytomedicine*. 2024;13(1):1252-1258.
- Kumari R, Venaik A, Hasibuzzaman MA, Azure SA, Ojha RP, Sahi AK. Repurposing of the herbals as immune-boosters in the prevention and management of COVID-19: A review. *Journal of Pure and Applied Microbiology*. 2021;15(1):1-19.
- Gadge SA, Pingale RA, Nimse KS, Jadhav SN. Design of polyherbal powder drink formulation as an immunity booster. *Journal of Chemical Health Risks*. 2024;14(5):212-224.
- Godge GR, Bhor KJ, Dalvi SB, *et al.* Research on preparation and evaluation of polyherbal chocolate. *International Journal of Pharmaceutical Research and Applications*. 2023;8(4):883-893.
- Gawade M, Adlinge A, Lipabe V. Formulation and evaluation of polyherbal antidiabetic powder. *Clinical Interventions and Clinical Trials*. 2023;1(1):1-7.
- Sonawane P, Rasikal M, Kandale J, Bhujbal S. Effect of polyherbal formulation for immunomodulation in immunosuppressed mice. *International Journal of Pharmacognosy and Life Science*. 2022;3(1):19-23.
- Patankar SB, Gore A, Joshi K, *et al.* Efficacy and safety of polyherbal formulation as an add-on to standard-of-care in mild-to-moderate COVID-19: A randomized, double-blind, placebo-controlled trial. *Journal of Ayurveda and Integrative Medicine*. 2022;13(4):100653.
- Chandra K, Das AK, Banday S, *et al.* Efficacy of polyherbal formulations for prevention of COVID-19 infection in high-risk subjects: A randomized open-label controlled clinical trial. *Phytotherapy Research*. 2022;36(9):3632-3643.
- Arun A, Subramanian S, Kambhoj D. Efficacy of polyherbal formulation along with standard care of treatment in early recovery of COVID-19 patients: A randomized placebo-controlled trial. *Beni-Suef University Journal of Basic and Applied Sciences*. 2023;12:103.
- Rani S, Sharma U, Deshmukh MP, *et al.* Immunomodulatory and antioxidant potential of polyherbal Dhatriyadi Rasayana in the form of churna and granules. *ACS Omega*. 2024;9(13):14781-14790.
- Gasmi A, Shanaida M, Oleshchuk O, Semenova Y, Mujawdiya PK, Ivankiv Y, Pokryshko O, Noor S, Piscopo S, Adamiv S, Bjørklund G. Natural ingredients to improve immunity. *Pharmaceuticals*. 2023;16(4):528.
- Meera S, Gupta SS, Kumar NS. Immunomodulatory and antioxidant activity of a polyherbal formulation. *International Journal of Pharmacology*. 2008;4(4):287-291.
- Kumar NM, Murugan SK, Bethapudi B, Mundkinajeddu D. Evaluation of immunomodulatory activity of a polyherbal formulation (Phytocee™) using ex vivo and in vitro models. *Pharmacognosy Magazine*. 2025;21(1):67-73.
- Kumar R, Bharti G, Kumar A, Prakash G. Formulation and evaluation of herbal immunity booster tablets. *Journal of Biomedical and Pharmaceutical Research*. 2025;14(5):21-46.
- Srivastava SP, *et al.* Herbal immunomodulators: A powerful preventive weapon for COVID-19. *Letters in Applied NanoBioScience*. 2023;12(4):134-143.
- Paul S, Tamey T, Koirala P, Bhattacharya S, Das R. Formulation and evaluation of polyherbal tablet by using neem, tulsi, turmeric and ginger extract. *Journal of Drug Delivery and Therapeutics*. 2023;13(7):46-51.
- Chalk A, Kunde V. Formulation and evaluation of herbal immunity booster tablets. *International Journal of Research Publication and Reviews*. 2022;3(4):5983-5988.
- Khedekar SL, Biyani KR. Herbal immunomodulators: Formulation and evaluation of a tablet containing Indian herbs. *International Journal of Pharmaceutical Sciences and Research*. 2025;16(6):1651-1655.
- Veer M, Patil M, Shewale M, Nikam R. Formulation and evaluation of dispersible polyherbal immunity booster green tea tablets. *International Journal of Biology, Pharmacy and Allied Sciences*. 2025;14(1):18-26.
- Rathor D, Prakash O, Nainwal P. Standardization of in-house prepared an immunobooster polyherbal formulation. *Ayushdhara*. 2018;5(1):1521-1524.
- Khade S, Gupte P, Mourya A, *et al.* Immunomodulatory effect of a proprietary polyherbal formulation on healthy participants: A single-blind, randomized, placebo-controlled, exploratory clinical study. *Perspectives in Clinical Research*. 2023;14(3):130-138.
- Gawali VB, Bhalsing M, Dalvi NB, Tarksband YS. Development and evaluation of polyherbal powder formulation as energy booster. *Journal of Pharmacognosy and Phytochemistry*. 2018;7(3):1576-1580.
- Raut S, Waghchaure A, *et al.* Formulation and evaluation of herbal immunity booster tablet using *Tinospora cordifolia* satva. *Research Journal of Science and Technology*. 2025;17(1):66-72.
- Mirza P, Rajendrin K. Formulation and development of polyherbal tea formulation intended for immunity boosting for the treatment of COVID-19. *International Journal of Pharmacy and Pharmaceutical Research*. 2022;23(2):1-8.
- Patil CD, Bhandare MB, Bedis SP. Formulation and evaluation of polyherbal energy drink. *International Journal of Trend in Scientific Research and Development*. 2022;6(4):719-722.
- Umesh A, Kumudhavalli MV, Kumar M,

- Venkateswarlu BS. Formulation and evaluation of polyherbal formulation containing indigenous medicinal plants. *European Chemical Bulletin*. 2023;12(4):3719-3726.
27. Aziz N, Wal A, Wal P, Saxena Pal R. Preparation and evaluation of the polyherbal powder: The nature's pharmacy for the treatment of diabetes mellitus and its complications. *Pharmacophore*. 2019;10(1):60-70.
 28. Shinde SS, Nimbalkar AV, Bundela KP. Formulation and evaluation of immune booster powder. *International Journal of Advanced Research in Innovative Engineering*. 2024;10(3):202-209.
 29. Maurya H, Kumar T. Formulation, standardization, and evaluation of polyherbal dispersible tablet. *International Journal of Applied Pharmaceutics*. 2019;11(1):158-167.
 30. Garg NK, Katara A, Mathur M. Formulation development, quality evaluation and *in vitro* antioxidant activity of a polyherboceutical composition. *International Journal of Pharmaceutical Sciences and Drug Research*. 2021;13(2):190-196.
 31. Patel JK, Patel D, Patel R, Akbari JA, *et al.* Development and evaluation of poly herbal powder formulation as an energy booster. *International Journal of AYUSH*. 2023;12(2):19-32.
 32. Modak AW, Kale V, Hake K, *et al.* Formulation and evaluation of herbal immunity booster Powder. *International Journal of Scientific Development and Research*. 2024;9:890-905.
 33. Kumaran R, Sudha S, Athira A, *et al.* Formulation and evaluation of instant polyherbal tea powder: A nutraceutical solution for modern lifestyles. *International Journal of Pharmacy and Industrial Research*. 2025;15(1):87-100.
 34. Gwade M, Adlinge A, Lipane V, *et al.* Formulation and evaluation of polyherbal antidiabetic powder. *Open Access Journal of Disease and Global Health*. 2023;1(1):1-6.
 35. Chandra K, Das AK, Banday S, *et al.* Efficacy of polyherbal formulations for prevention of COVID-19 infection in high-risk subjects: A randomized open-label controlled clinical trial. *Phytotherapy Research*. 2022;36:3632-3643.
 36. Kumar A, Khan MS, Haque ZU, *et al.* Immunomodulatory effect of Unani polyherbal formulation (Tiryaa Wabai) in mild to moderate COVID-19 patients: A randomized placebo-controlled clinical trial. *Journal of Ayurveda and Integrative Medicine*. 2024;15:100903.
 37. Sushmitha K, Sirini S, Tejaswini CH, *et al.* Formulation and evaluation of polyherbal medicated jelly. *Indian Journal of Novel Drug Delivery*. 2025;17(2):84-93.
 38. Godge GR, Jhor KJ, Dalvi SB, *et al.* Research on preparation and evaluation of polyherbal chocolate. *International Journal of Pharmaceutical Research and Applications*. 2023;8(4):883-893.
 39. Pal A, Martolia J. Formulation and evaluation of immunity boosting poly-herbal drink. *International Journal of Creative Research Thoughts*. 2024;12(6):788-801.
 40. Pathak KS, Jain S, Waghmode DM, *et al.* The formulation, development, and evaluation of an immunity booster aimed at boosting immunity during cancer therapy. *International Journal of Pharmaceutical Sciences*. 2024;2(7):1570-1580.
 41. Mishra S, Raj R, Raj V, *et al.* Formulation and characterization of sugar-free polyherbal immunity boosting granules. *YMER*. 2025;24(6):528-542.
 42. Chalakanti S, Reddy AD, Begum SA, *et al.* Development and evaluation of polyherbal powder formulation as immunity power booster. *EPRA International Journal of Research and Development*. 2021;6(1):95-101.
 43. Alanazi HA, Elsabili AM, Alanzi MK, Elazab EF. Medicinal herbs: Promising immunomodulators for the treatment of infectious diseases. *Molecules*. 2023;28:8045.
 44. Geetha V. Natural preservation development in the pharmaceutical industry. *International Journal for Multidisciplinary Research*. 2025;7(1):1-9.
 45. Bag BB, Panigrahi C, Gupta S, Mishra HN. Efficacy of plant-based natural preservatives in extending shelf life of sugarcane juice: Formulation optimization by MOGA and correlation study by principal component analysis. *Applied Food Research*. 2022;2:100164.
 46. Aguiar G, Campolina MG, Cardoso A, Caetano SR, Nelson DL, Ramos EM. Essential oil and plant extracts as preservatives and natural antioxidants applied to meat and meat products: A review. *Food Technology and Biotechnology*. 2023;61(2):212-225.
 47. Chakraborty S, Shalini. Immunomodulatory herbs of Ayurveda and COVID-19: A review article. *Journal of Ayurveda and Integrated Medical Sciences*. 2020;5(2):203-210.
 48. Mazzio E, Barnes A, Badisa R, Councell CFA, Soliman KFA. Plants against cancer: The immune-boosting herbal microbiome: Not of the plant, but in the plant. Basic concepts, introduction, and future resource for vaccine adjuvant discovery. *Frontiers in Oncology*. 2023;13:1180084.
 49. Kadiyska T, Tourtourikov I, Dabchev K, *et al.* Herbs and plants in immunomodulation (Review). *International Journal of Functional Nutrition*. 2023;4(1).
 50. Ibtessam IA, Mohamed BA, Habib EM. Optimization of natural food preservatives extraction from spices and herbs. *Food Technology Research Journal*. 2023;1(Special Issue 1):1-8.
 51. Mishra S, Raj R, Raj V, Martolia J. Formulation and characterization of sugar-free polyherbal immunity boosting granules. *YMER*. 2025;24(6):528-542.
 52. Wang L, Chang T, Zhu T, *et al.* *Stevia rebaudiana* Bertoni as a sweet herbal medicine: Traditional uses, potential applications, and future development. *Frontiers in Pharmacology*. 2025;16:1638147.
 53. Mishra N, Singh R, Sirohi R, *et al.* Effect of a polyherbal immunomodulator on the immunogenicity of booster dose of FMD and FMD-HS-BQ vaccines in dairy cattle. *Indian Journal of Animal Sciences*. 2025;95(2):103-106.
 54. Hannan JMA, Das BK, Uddin A, *et al.* Analgesic and anti-inflammatory effects of *Ocimum sanctum*. *International Journal of Pharmaceutical Sciences and Research*. 2011;2(8):2121-2125.
 55. Mueed A, Shibli S, Korma SA, Madjirebaye P, Esatbeyoglu T, Deng Z. Flaxseed bioactive compounds: Chemical composition, functional properties, food applications and health benefits-related gut microbes. *Foods*. 2022;11(20):3307.