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"A critical review of herbal-infused chocolate: health benefits and nutritional value"

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ABSTRACT
This study focuses on the formulation and evaluation of a paediatric-friendly herbal chocolate designed to improve the palatability and acceptability of traditional herbal medicine among children. The primary objective was to incorporate selected medicinal herbs known for their immune-boosting and digestive properties into a chocolate base that appeals to younger age groups. Herbs such as Tulsi (Ocimum sanctum), Ginger (Zingiber officinale), and Amla (Emblica officinalis) were chosen for their well-established therapeutic benefits. The formulation process involved standardizing the herbal extract concentrations to ensure safety, efficacy, and taste balance. Various parameters such as organoleptic properties, physicochemical stability, texture, and acceptability were evaluated. The final product demonstrated good stability, uniformity, and high sensory appeal, making it suitable for paediatric administration. This herbal chocolate offers a novel, effective, and child-friendly approach to delivering herbal remedies, bridging the gap between traditional medicine and modern dosage forms.

KEYWORDS: Herbal chocolate, paediatric formulation, traditional medicine, Tulsi, Amla, Ginger, childfriendly dosage, herbal drug delivery, sensory evaluation.

I. BACKGROUND

The traditional Indian medical systems of Ayurveda, Siddha, and Unani are well-known. The Ayurvedic philosophy originated in India sometime between 2500 and 500 BC. Since Ayurveda is an old Indian system of medicine, its literal meaning is "science of life." It views man and his sickness as the main focus of treatment. It has been noted that people in good health have well-balanced metabolisms. The main source of sustaining nutritional needs is food. However, certain traditional techniques are discontinued as modernization increases. Because of this, balanced nutrition is being impacted by modern eating patterns. There is an ever-present, increasing nutritional intake inequality, which makes normal living abnormal. [1] A popular kid-friendly delicacy, chocolate offers a promising vehicle for the delivery of herbal treatments. Chocolate is a versatile food that may be mixed to produce a wide range of flavor and textural experiences. Additionally, chocolate is an anhydrous medium that inhibits the growth of microorganisms and the hydrolysis of active ingredients that are susceptible to water. Saturated fat, polyphenols, sterols, triterpenes, aliphatic alcohols, and methylxanthines are among the many substances found in chocolate. Chocolate is a well-liked and tasty vehicle for supplying drugs and supplements. [2]

The Mayans, who most likely cultivated the cocoa plant first in South America, are credited with starting the history of chocolate. Among the Maya, chocolate was traditionally consumed as a hot drink made with water and cocoa, often flavored with spices like pepper and cinnamon. The Aztecs, who referred to it as the 'Food of the Gods,' served it to Emperor Moctezuma II. Christopher Columbus was the first European to come into contact with cocoa in 1502. A canoe carrying cocoa beans, which were regarded as "mysterious-looking almonds" and recognized as a type of money in Mesoamerica, was discovered by him. [3] In 1573, the Swedish botanist Carl von Linné (known as Linnaeus) gave a scientific name to the cocoa plant in his famous book Species Plantarum. The term Theobroma, meaning 'food of the gods' in Latin, was the name he assigned to it (Katz, 2003). While cocoa production and the consumption of derived products had existed for millennia, their existence was largely unknown outside Central America until the Spanish arrived in the early sixteenth century. [4] Due to challenges with a climate that was not conducive to its growth, chocolate's qualities were long disregarded throughout Europe. Cocoa trees naturally thrive in the understory of evergreen rainforests. They grow best in warm climates, where daytime temperatures average between 30–

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32°C and nighttime lows range from 18–21°C. High humidity levels are also essential, often reaching 100% during the day and dropping to around 70–80% at night. The International Cocoa Organization (ICCO) recently released data showing that 4,739,000 tons of cocoa beans were produced worldwide in 2016–17, with Africa accounting for the majority of this number (3,622,000 tons). As customers' concerns about environmental issues and food security grow, so does the demand for organic cocoa products. However, at less than 0.5% of overall production, the organic cocoa industry still only accounts for a very small portion of the cocoa market. [3]

II. INTRODUCTION

Traditionally, chocolate has been regarded as a key ingredient and a sophisticated flavor. The drug and the chocolate base are combined to create medicated chocolate. The method through which a drug is taken up by chocolate and later released is referred to as the chocolate-based drug delivery system.[5] Raw or processed chocolate is made from the seeds of the tropical tree Theobroma cacao. Chocolate may become the perfect medicine delivery technology since they are perfectly suited to be added to the food matrix of a chocolate bar, enhancing the endogenous flavors while improving health in the form of a delicious reward (Vishal et al., 2012). It can also be described as the process of producing ground and roasted cocoa beans, which may be used as a flavoring agent in cooking or transformed into a paste or solid form (Verma et al., 2020).[6]

The seeds of tropical Theobroma cacao trees are used to make chocolate. More than 300 health-promoting substances, including flavonoids, flavanols, polyphenols, and catechins, are present in these beans. Strong antioxidants include epicatechin and anthocyanidin. According to published research, free radicals can harm DNA and other cell constituents. These substances are crucial in hastening aging and causing cancer, heart disease, and other illnesses. Due to their strong antioxidant qualities, chocolates are said to have health benefits; dark chocolate, which has a high cocoa content, is especially potent. Numerous health advantages of chocolate include lowering LDL levels and reducing the risk of cardiovascular illnesses. Organoleptic properties in chocolate help to cover up the taste of some active medications. Chocolate is a semisolid suspension. Small solid particles of sugar and cocoa produced in the fat phase make up chocolate. The primary ingredient in chocolate is cocoa butter, a combination of several triglycerides that are liquid at body temperature but solid below 250. Children's malnutrition, cough, and immune system booster are all treated with this herbal chocolate mixture. Medicated chocolate is made by incorporating an appropriate therapeutic substance into a chocolate base. The chocolate base releases the medication component. Children find medicated chocolate more enticing, and patients are more compliant with it. Vitamin A, phenolics, and all other nutrients are present in cocoa powder. [7]

Fig. No. 1. Herbal chocolate

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HERBAL PLANTS USED IN CHOCOLATE

Table No. 1. Herbal plants used in the preparation of chocolate

PLANT NAME	**Tulsi**	**Turmeric**	**Cardamom**	**Cinnamon**	**Hibiscus**
BOTANICAL NAME	Ocimum sanctum L	Curcuma longa L	Elettaria cardamomum (L.)	Cinnamomic zeylanicum	Hibiscus rosa-sinensis
SYNONYMS	Ocimum sanctum, Holy Basil	Saffron Indian; haldi (Hindi); Curcuma; Rhizoma curcumae.	small cardamom, green cardamom, true cardamom, and Indian cardamom	Cinnamomum zeylanicum, Laurus cinnamomum	Hibiscus Arnottii, Hibiscus piliferous
COMMON NAME	Tulsi	Haldi, Halad, Manjal, Haridra	Elaichi, Velachi, Elakkai	Dalchini, Lawan, canelle	Jasvand, Gurhal
FAMILY	Lamiaceae	Zingiberaceae-Ginger	Zingiberaceae	Lauraceae	Malvaceae
ORDER	Lamiales	Zingiber officinale	Zingiberales	Laurales	Malvales
KINGDOM	Plantae	Plantae	Plantae	Plantae	Plantae
GENUS	Ocimum	rhizomes	Elettaria	shrubs	Hibiscus
DIVISION	Magnoliophyta	Magnoliophyta	Angiosperms	Mangoliphyta	Magnoliophyta
ACTIVE PHYTOCHEMICALS	Oleanolic acid, Ursolic acid, Rosmarinic acid, Eugenol, Carvacrol, Linalool	Curcuminoids (5%) and essential oil (6%), zingiberene (25%), αphellandrene, sabinene, turmerone, arturmerone, borneol, and cineole.	terpinen-4-ol (0.4- 3.4%), αthujene (0.1–1.0%), α-pinene (0.6-1.5%), βpinene (0.2-0.8%), αterpinolene (0.1%-1.9%), αterpinene (0.2-1.4%), β-citral (0.1-0.5%)	Cinnamaldehyde, Eugenol, Caryophyllene oxide, γmuurolene, α-cadinol,	Hibiscus rosa-sinensis contained tannins, anthraquinones, quinines, phenols, flavonoids, alkaloids, terpenoids, saponins, cardiac glycosides, protein,
PART USED FOR RESEARCH	Leaves	Root	Seeds	Leaves, Bark, Fruit, flower	Roots and leaves

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GENERAL USES	Used for heart disease and fever, to relieve insect bites, the common cold, sore throat, headaches, and kidney stones	aromatic, antiinflammatory, stomachic, uretic, anodyne for biliary calculus, stimulant, tonic, carminative, blood purifier, antiperiodic, alternative, spice	antibacterial, antifungal, antioxidant, anticancer, antiulcer, antidiabetic, and gastroprotective activities	Digestive, antiinflammatory, flavored, antioxidants	arthritis, boils and coughs, sprains, wounds, and ulcers
PLANT NAME	**Ashwagandha**		**Liquorice**		
BOTANICAL NAME	Withania somnifera L.		Glycyrrhiza glabra		
SYNONYMS	Withania somnifera Dunal, Physalis somnifera L.		Licoricey, Sweet Root		
COMMON NAME	Ashwagandha, Indian ginseng, and Winter cherry		Mulethi, Atimadhuram, Jethimadh		
FAMILY	Solanaceae		Leguminosae		
ORDER	Solanales		Fabales		
KINGDOM	Plantae		plantae		
GENUS	Withania		legumes		
DIVISION	Mangoliphyta		Magnoliophyta		
ACTIVE PHYTOCHEMICALS	alkaloids, amino acids, steroids, volatile oil, starch, reducing sugars, glycosides		triterpene, saponins, flavonoids, Glycyrrhizin, Glabridin, Glycyrrhizic acid, Isoliquiritigenin		
PART USED FOR RESEARCH	roots		root		
GENERAL USES	Immune support, Anti-inflammatory, Anxiety, Depression		Soothing Throat Irritations, Digestive Aid, Anti-inflammatory, Respiratory Health, Hormonal Balance		

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HERBAL MATERIALS AND THEIR USES IN CHOCOLATE

1.Tulsi

Fig. No. 2. Tulsi

Throughout Indian medicine's history, holy basil (Ocimum sanctum) has been used to cure a wide range of ailments. Holy basil is believed to support overall well-being, offering benefits for conditions ranging from skin infections like ringworm to various eye-related ailments."Various sections of the Plants are suggested to treat various ailments, and bronchitis is treated with their fresh blooms. It also lessens renal stress, strengthening the kidneys. Holy basil's acetic acid aids in the disintegration of kidney stones (Pandey and Madhuri 2010). To treat malaria, tulsi leaves and seeds are mixed with black pepper. Tulsi is used as a whole plant to cure nausea, vomiting, and diarrhea. The herb cures eye conditions and stomach ulcers (Verma et al., 2020). An essential oil extracted from the plant's leaves is applied topically to prevent bug bites. Additionally, the plant leaves are rich in antioxidants, which shield the skin from practically all damage brought on by free radicals. Tulsi functions as a gentle diuretic and natural detoxifier, helping to reduce uric acid levels in the body. [14]

Traditional uses of tulsi:

Tulsi is often called 'the elixir of life' because of its life-extending properties. Many common illnesses and everyday ailments, such as the common cold, headache, cough, flu, earache, fever, colic pain, sore throat, bronchitis, asthma, hepatic diseases, malaria fever, as an antidote for snake bite and scorpion sting, flatulence, migraine headaches, fatigue, skin diseases, wounds, insomnia, arthritis, digestive disorders, night blindness, diarrhea, and influenza, are prevented and cured by using various plant parts in Ayurvedic and Siddha systems of medicine. The leaves help calm tensions and improve memory. Chewing Tulsi leaves also helps to heal oral infections and ulcers.[15]

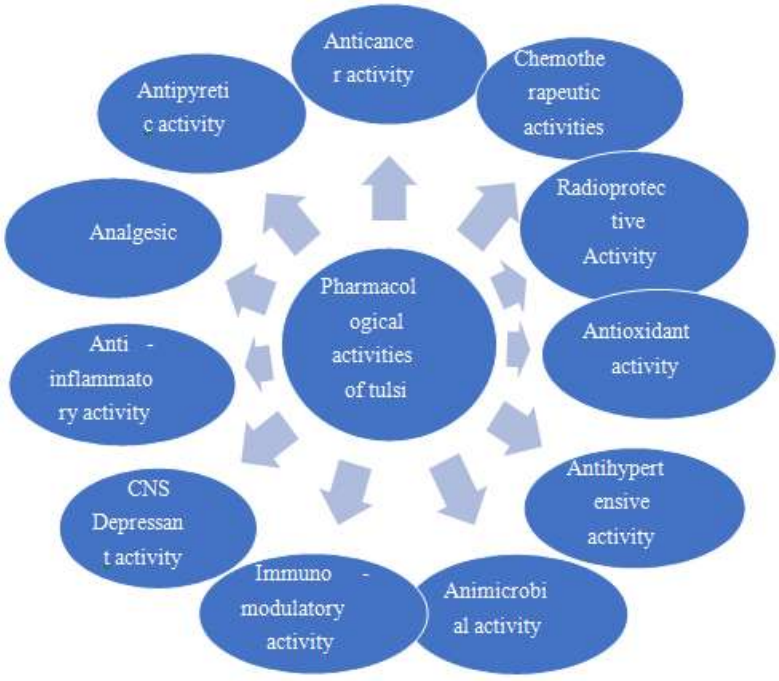

Fig. No. 3. Pharmacological activities of Tulsi

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2.Ashwagandha

Ashwagandha, or Withania somnifera, is a highly esteemed spice in the Indian Ayurvedic therapeutic system (tonic). It is used to treat several ailments, but its most notable use is as a Nervine tonic. Ashwagandha is made up of the dried, mature undersides of Withania somnifera Donal (Fam. Solanaceae), a perennial bush that is found throughout India in open spaces, developed fields, and wasteland.[16]

The pharmacological effect of Ashwagandha:

- Antistress Effect
- Antitumor Properties
- Immunomodulatory
- Antioxidant Effect
- Nervous System Effects
- Effects on the Cardiopulmonary System [16]

3.Hibiscus Rosa-Sinensis

Hibiscus isn't just a beautiful garden flower—its petals, leaves, and seeds are edible and offer several health benefits. Scientific findings suggest that hibiscus may possess both antibacterial and anticancer properties. The health-enhancing effects are largely attributed to anthocyanins, potent antioxidants present in the plant. Various studies have indicated that hibiscus can help in managing cholesterol, blood sugar, and blood pressure levels (Puro et al., 2014; Solangi et al., 2017; Singh et al., 2017). One particular study noted that individuals with hypertension who consumed hibiscus tea three times daily experienced significant reductions in both systolic and diastolic blood pressure.

4.Cinnamon

Cinnamon, frequently used as a spice in various foods and beverages, comes from the bark, leaves, flowers, fruits, and roots of the cinnamon tree. It has been a staple in traditional medicine for centuries across the globe (Ranasinghe et al., 2013). The compound cinnamaldehyde, found in cinnamon, has shown potential health benefits, particularly for individuals with diabetes. Research indicates cinnamon may assist in weight management and is also used in the treatment of digestive issues such as irritable bowel syndrome. Additionally, it may help manage conditions like heart disease, Alzheimer's, cancer, HIV, infections, dental issues, and allergies.

5.Coconut Milk

Coconut milk, extracted from the mature flesh of the coconut palm (Cocos nucifera), is rich in nutrients that support stamina and immunity. It contains medium-chain triglycerides (MCTs), which are known for promoting weight loss and withstanding high temperatures. Some evidence also links coconut milk to improved heart health due to its antioxidant properties and its ability to lower bad cholesterol levels (Hauly et al., 2021; Karunasiri et al., 2020).

6.Linum Usitatissimum (Flax Seeds/Alsai)

Flax seeds are nutrient-dense, packed with omega-3 fatty acids, fiber, and beneficial plant compounds. These seeds support digestive health and may reduce the risk of chronic conditions such as heart disease, type 2 diabetes, and certain cancers (Blondeau et al., 2015). Their high omega-3 content helps fight inflammation and may reduce the risk of breast cancer (Calado, 2018). Furthermore, flax seeds provide both soluble and insoluble fiber, which aid in lowering cholesterol and maintaining stable blood sugar levels (Navnamm et al., 2020; Sartang et al.).

7.Nuts

Cashews (Anacardium occidentale), raisins (Vitis vinifera), and walnuts (Juglans regia) are examples of foods rich in polyphenols, which help fight oxidative stress by neutralizing free radicals and protecting cells from damage (Rahman, 2017). Consuming nuts regularly may aid in weight management, lower cholesterol and triglyceride levels, and reduce inflammation. Moreover, nuts provide a significant amount of dietary fiber (Abazaford et al., 2014; Grosso & Estruch, 2015).

8.Curcuma Longa (Turmeric)

Curcumin, the active compound in turmeric, has been widely studied for its anti-inflammatory effects. Clinical trials show it can alleviate symptoms of rheumatoid arthritis, such as joint pain and stiffness, sometimes even outperforming conventional medications like phenylbutazone. In individuals with anterior uveitis, curcumin led to complete remission within two weeks. It has also shown promising results in treating digestive issues like dyspepsia and gastric ulcers, providing relief within 12 weeks. Additionally, curcumin benefits individuals with IBS, IBD, and those recovering from organ transplants, helping reduce inflammation and maintain remission in conditions like ulcerative colitis and psoriasis.

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9.Zingiber Officinale (Ginger)

Ginger extract has varied effects depending on the dosage and duration of use. While short-term intake can elevate inflammatory markers like TNF-α, long-term consumption tends to reduce these markers and increase beneficial hormones like corticosterone. In type 2 diabetic patients, ginger supplementation over two months significantly decreased inflammatory indicators like TNF-α and hs-CRP. For osteoarthritis, ginger showed pain-relieving effects comparable to medications like Diclofenac and Ibuprofen, but with fewer side effects. It works by inhibiting enzymes involved in inflammation, offering relief for joint and muscular pain.

Pharmacological and Health Benefits of Herbal Chocolate - 1. Tulsi(Ocimum sanctum):

Botanical name: Ocimum sanctum L
Synonyms: Ocimum sanctum, Holy Basil
Common name: Tulsi
Family: Lamiaceae
Order: lamiales
Kingdom: Plantae
Genus: Ocimum
Division: Magnoliophyta
Active Phyto-chemicals: Oleanolic acid, Ursolic acid, Rosmarinic acid, Eugenol, Carvacrol, Linalool
Part used for research: Leaves

General Uses: Used for heart disease and fever, to relieve insect bites, common cold, sore throat, headaches, and kidney stones
Tulsi, commonly known as Holy Basil, is packed with therapeutic compounds.

- **Antioxidants**like rosmarinic acid help neutralize harmful free radicals, reducing oxidative damage to cells.
- **Antibacterial agents** such as carvacrol and terpene, along with β-caryophyllene—a natural, FDA-approved food additive—help guard against disease-causing bacteria.
- **Anti-inflammatory** due to compounds like rosmarinic acid, pegenin, and especially eugenol, which supports insulin production by enhancing pancreatic beta cell function.
- **Adaptogenic properties**—thanks to compounds like eugenol, caryophyllene, ursolic acid, and oleanolic acid—that help regulate stress by lowering corticosterone levels, improving memory, and promoting mental clarity.
- **An immuno-modulator** enhances the immune system's ability to defend against pathogens and maintains a healthy immune response.

2. Arjuna bark

Cardioprotective Activity: Arjuna bark strengthens heart muscles, improves coronary circulation, and reduces blood pressure and cholesterol.

Botanical name: Cinnamomum zeylanicum
Synonyms: Cinnamomum zeylanicum, Laurus cinnamomum
Common name: Dalchini,
Family: Lauraceae
Order: Laurales
Kingdom: Plantae
Genus: shrubs
Division: Mangoliphyta
Active phyto-chemicals: Cinnamaldehyde, Eugenol, Caryophyllene oxide, γ-muurolene, α-cadinol,
Part used for research: Bark, leaves, fruit, flower
General uses: digestive, Anti-inflammatory, flavored, antioxidant

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3. Wound Healing Activity: Its antioxidant and astringent properties promote faster wound closure and tissue regeneration.
4. Anti-inflammatory Activity: Inhibits inflammatory mediators and reduces tissue swelling and pain.
5. Antiasthmatic Activity: Acts as a bronchodilator and reduces airway inflammation, easing breathing in asthma.
6. Antitumor Activity: Induces apoptosis and inhibits tumor cell growth through flavonoids and arjunolic acid.
7. Antimicrobial Activity: Exhibits strong antibacterial and antifungal action against pathogens like E. coli and S. aureus.

Pharmacological activity

- Cardioprotective Activities
- Wound healing activity I
- Anti-inflammatory Activity
- Anti-asthmatic Activity
- Antitumor activity
- Antimicrobial activity

8.Moringa

Botanical name: Moringa oleifera
Synonyms: Saguna, sainjana
Common Name: Drumstick tree
Family: Moringaceae
Order: Brassicales
Kingdom: Plantae
Genus: Moringa
Division: Magnoliophyta
Active Phyto-chemicals: Quercetin, Kaempferol, Isorhamnetin, Chlorogenic acid, Caffeic acid, Gallic acid, Ferulic acid
Parts used for research: Leaves
General uses: Anti-inflammatory, cancer, diabetes, Blood sugar regulation, antioxidant, digestive health, heart health, hypertension, and boost immunity.

- **Cardiovascular activity**: Ethanolic extract of Moringa oleifera leaves showed prominent anti-hypertensive or hypotensive activity. The in vivo activity was done in an animal's heart, and it was found that thiocarbamate and iso thiocyanate glycosides were responsible for this powerful hypotensive activity.
- **Anti-fertility activity**: Aqueous extract of Moringa oleifera roots was found to be effective as an anti-fertility in the presence or absence of estradiol dipropionate and progesterone. The in-vivo antifertility activity and histopathology study was done using aqueous extract to investigate the effect on the histoarchitecture of the uterus during pre- and post–post-implantation stages.
- **Antiurolithiatic activity**: The in vitro anti-urolithiatic activity was performed in aqueous and alcoholic extracts of the bark of Moringa oleifera. It showed a reduction in the weight of stone produced using ethylene glycol induced urothiasis. It also possesses both preventive and curative properties.
- **Anti-asthmatic activity:** A study was carried out to investigate the usefulness of Moringa oleifera seed kernel in patients of bronchial asthma. The patients of either sex with mild-to-moderate asthma were treated with finely powdered dried seed kernels in a dose of 3 g for 3 weeks. The clinical efficacy was assessed using a spirometer before and at the end of the treatment. The majority of patients showed an increase in hemoglobin (Hb) values and a reduction in Erythrocyte sedimentation rate (ESR). Improvement was also observed in symptom score and severity of asthmatic attacks.

4. Cinnamon

Botanical name: Cinnamomum zeylanicum
Synonyms: Cinnamomum zeylanicum, Laurus cinnamomum

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Common name: Dalchini,
Family: Lauraceae
Order: Laurales
Kingdom: Plantae
Genus: shrubs
Division: Mangoliphyta
Active phyto-chemicals: Cinnamaldehyde, Eugenol, Caryophyllene oxide, γ-muurolene, α-cadinol,
Part used for research: Bark, leaves, fruit, flower
General uses: digestive, Anti-inflammatory, flavored, antioxidants.

- **Anti-inflammatory properties:** Research indicates that cinnamon bark may help decrease inflammation in the body, which could be useful for managing conditions like arthritis and inflammatory bowel disease.
- **Antimicrobial effects:** Cinnamon bark has demonstrated the ability to combat various bacteria, fungi, and viruses, potentially preventing the growth of harmful microorganisms and serving as a natural preservative.
- **Antioxidant benefits:** Rich in antioxidants, cinnamon bark helps safeguard cells from damage caused by free radicals. These antioxidants may contribute to lowering the risk of chronic illnesses.
- **Blood sugar control:**Some studies suggest cinnamon might assist in reducing blood glucose levels and enhancing insulin response, which could support people with diabetes or those at risk. However, more definitive research is required to confirm these effects.
- **Support for digestive health:** Traditionally, cinnamon has been used to promote digestion and ease stomach discomfort, helping to alleviate symptoms like bloating, gas, and indigestion.

5.Cardamon

Botanical name: Elettaria cardamomum (L)
Synonyms: small cardamom, green cardamom, true cardamom, and Indian cardamom
Common name: Elaichi, Velachi, Elakkai
Family: Zingiberaceae
Order: Zingiberales
Kingdom: Plantae
Genus: Elettaria
Division: Angiosperms
Active Phyto-chemicals: terpinen-4-ol (0.4-3.4%), α-thujene (0.1–1.0%), α-pinene (0.6-1.5%), β-pinene
(0.2-0.8%), αterpinolene (0.1%-1.9%), α-terpinene (0.2-1.4%), β-citral (0.1-0.5%)
Part used for research: Seeds
General uses: antibacterial, antifungal, antioxidant, anticancer, antiulcer, antidiabetic, and gastroprotective activities.

- **Digestive health:** Traditionally, cardamom has been used to support digestion and ease digestive discomfort, potentially helping to reduce symptoms like bloating, gas, indigestion, and stomach cramps.
- **Antimicrobial properties:** The seeds of cardamom exhibit antimicrobial effects and have been found to inhibit the growth of certain bacteria and fungi, which may aid in preventing oral infections and maintaining oral hygiene.
- **Anti-inflammatory effects:** Research indicates that cardamom might possess anti-inflammatory qualities, which could help lower inflammation linked to various chronic diseases.
- **Antioxidant benefits:** Cardamom contains antioxidant compounds that help protect cells from oxidative stress caused by free radicals, contributing to overall health and disease prevention.

6. Cocoa butter:
Botanical name: Theobroma cacao
Synonyms: Theobroma oil
Common name: Cocoa butter
Family: Malvaceae
Genus: Theobroma
Species: Cacao
Kingdom: Plantae
Division: Magnoliophyta
Active Phyto-constituents: Epicatechin, Catechin, Procyanidins, Anthocyanins
General uses: Carrier, base.

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Pharmacological Actions of Cocoa Butter:

- **Antioxidant Properties:** Cocoa butter is rich in flavonoids and other antioxidant compounds that help protect cells from damage caused by free radicals, according to Drug Bank.
- **Anti-inflammatory Effects:** The bioactive substances found in cocoa butter may help decrease inflammation by reducing the activity of pro-inflammatory cytokines.
- **Possible Heart Health Benefits:** Research indicates that cocoa butter might raise HDL (good) cholesterol levels, lower blood pressure, and enhance the function of blood vessels.

MECHANISM:

Cocoa is a natural source of antioxidant substances that combat free radicals, thereby protecting cell membranes, preserving DNA integrity, and preventing the oxidation of low-density lipoprotein (LDL) cholesterol. The oxidation of LDL plays a significant role in the development of atherosclerosis and the formation of plaque in arterial walls. The antioxidants in cocoa, especially procyanidins along with their precursors epicatechin and catechin, are responsible for this protective effect by inhibiting LDL oxidation. Research indicates that both dark chocolate and cocoa products can lower LDL oxidation and increase high-density lipoprotein (HDL) cholesterol levels. Catechins, a type of phytochemical found in various plant-based foods and beverages, are particularly plentiful in dark chocolate, providing around 12 mg of catechin and 41.5 mg of epicatechin per 100 grams. These compounds have been associated with numerous health advantages, such as heightened antioxidant activity in the blood, better dilation of bronchial arteries, improved fat metabolism, and enhanced resistance to LDL oxidation.

Epicatechin, in particular, is viewed as a vital bioactive component in cocoa and other flavanol-rich consumables.

PREPARATION METHOD OF HERBAL CHOCOLATE:

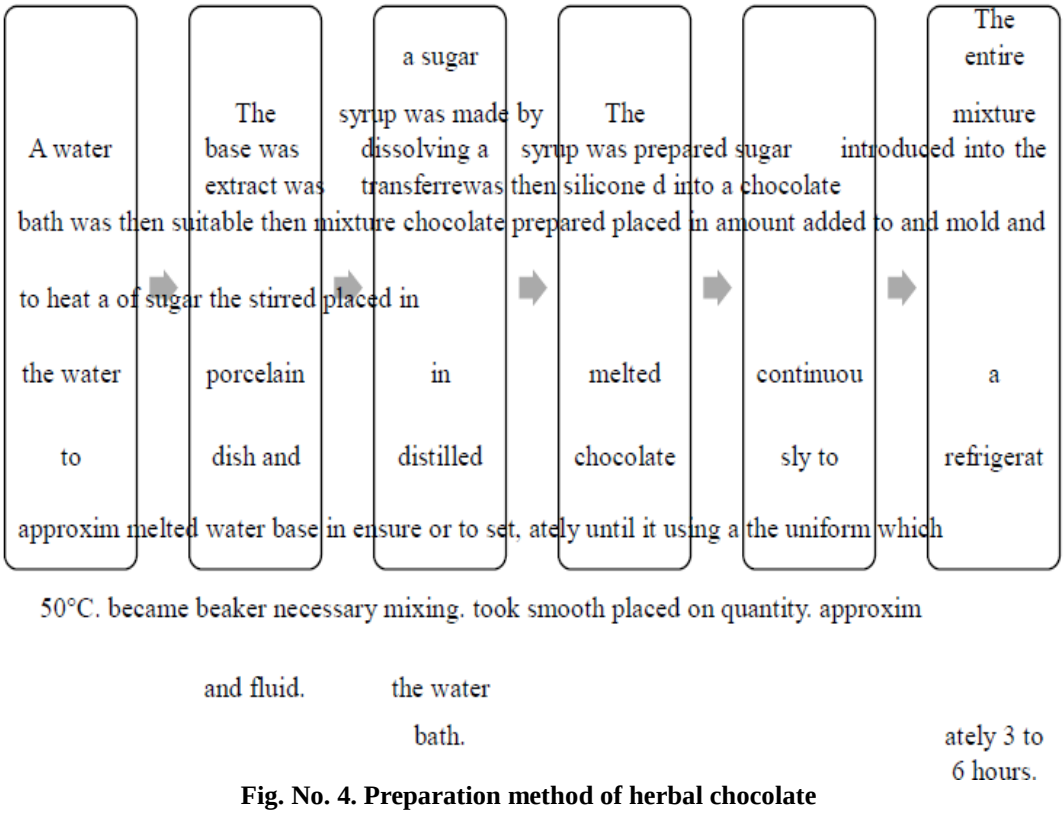

Fig. No. 4. Preparation method of herbal chocolate

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Fig. No. 5. Herbal chocolate

EVALUATION PARAMETERS

1. PRE-FORMULATION STUDY:

Organoleptic properties:

1. Color
2. Odor
3. Taste
4. Appearance
5. Mouth feel

2. Chemical tests:

Table No.2. Chemical tests for herbal chocolate

Sr.No	Chemical tests	Inference
1.	**TEST FOR ALKALOIDS:** **Mayer's test:** Add a few drops of Mayer's reagent (a solution of potassium mercuric iodide) along the inner wall of the test tube. **Wagner's test:** Add a few drops of Wagner's reagent (iodine, Potassium iodide solution)	Formed a white or creamy ppt formed a reddish brown ppt
2.	**TEST FOR CARBOHYDRATES:** **1.Molisch test:** 2 drops (alcoholic solution of alpha-napthol) + 1 mL (concentrated sulphuric acid) are slowly added along the sides of the test tube. **2.Fehling's test:** 1 mL of sample was boiled on a water bath + 1 mL each of feelings solutions A and B.	formed a purple to violet color ring Brick red precipitate
3.	**TEST FOR GLYCOSIDES:** **1.Bontrager's test:** To 2 mL of sample solution, 3 mL of chloroform was added and shaken chloroform layer was separated, and 10% ammonia hydroxide solution was added to it.	Anthraquinone glycosides are present because of the presence of pink color
4.	**TEST FOR PHYTOSTEROLS AND TRITERPENOIDS:** Libermann Burchard test : The extract was dissolved in acetic anhydride, boiled, cooled, and 1ml of concentrated. Sulphuric acid is added along the side of the test tube.	Red, pink, or violet color at the junction of liquid indicates glycosides presence.

3. Determination of pH: The pH of the herbal chocolate was determined using a digital pH meter. 2 g of herbal chocolate was dissolved in 100 mL of phosphate buffer, and then the pH of the solution was determined using by digital pH meter.

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4. **Hardness:** Hardness of the herbal chocolate was determined using a hardness tester, for eg, a Monsanto hardness tester.

5. **Blooming Test**

Fat Bloom:

Fat bloom occurs when a thin layer of fat crystals develops on the surface of a chocolate product. This leads to a loss of the chocolate's shine and results in a dull, whitish coating, which negatively affects its visual appeal. The formation of fat bloom is due to either the recrystallization of fats or the movement of fats from the filling to the outer chocolate layer. Storing chocolate at a stable temperature can help postpone the onset of fat bloom.

6. **Physical Stability:**

To evaluate the physical stability, a chocolate sample was stored in a sealed container at 28°C for one month. After this period, the sample was examined for any changes in physical appearance as well as signs of drug degradation.

7. **Moisture Content:**

Moisture content refers to the quantity of water present in a food sample. To determine this, a clean, dry petri dish is first weighed. Then, 2 grams of the sample is added, and the dish is placed in a hot air oven at 110°C for 2 to 3 hours. After heating, the petri dish is cooled in a desiccator before being reweighed using a precise balance. The moisture content is calculated using the following formula:

Moisture Content (%) = $(W_2 - W_3) / W \times 100$

Where:

W = weight of the sample (g)

$\mathbf{W_2}$ = weight of the Petri dish with the sample before drying (g)

$\mathbf{W_3}$ = weight of Petri dish with the sample after drying (g)

Advantages and Limitations of Paediatric Herbal Chocolate

Advantages

- **Improved Palatability**

The sweet and familiar taste of chocolate effectively masks the bitter or unpleasant taste of many herbal extracts, increasing acceptance among children.

- **Enhanced Compliance**

Children are more likely to consume herbal medicines willingly when presented in a chocolate form, improving medication adherence in pediatric care.

- **Nutritional Benefit**

In addition to herbal therapeutic benefits, chocolate (especially dark or milk chocolate) provides antioxidants and trace minerals like magnesium and iron.

- **Versatile Dosage Form**

Chocolates can be molded into various shapes, sizes, and doses, making it easy to tailor them for different age groups and conditions.

- **Non-invasive Administration**

Oral solid forms, such as chocolate, eliminate the need for syrups (with added preservatives) or bitter decoctions, making administration easier for caregivers.

- **Dual Action: Food + Medicine**

Functions as a nutraceutical — combining dietary benefits with therapeutic herbal properties.

- **Ease of Storage and Portability**

Chocolates do not require refrigeration and are easy to pack, store, and carry, increasing convenience for parents.

Limitations

- **Sugar Content**

High sugar levels may be unsuitable for diabetic or overweight children, unless sugar-free alternatives are used.

- **Thermal Instability**

Chocolates are sensitive to heat and may melt or degrade in warm climates, affecting shelf life and dosage uniformity.

- **Limited Dose Flexibility**

Precise dose adjustment can be difficult compared to liquid or powdered herbal formulations, especially for potent herbs.

- **Herb-Chocolate Interaction**

Certain herbal compounds may degrade when heated or may not mix uniformly with fats in the chocolate base.

- **Microbial Contamination Risk**

If not processed and stored properly, chocolate formulations may be prone to microbial growth, especially in humid conditions.

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- **Regulatory Challenges**

Herbal chocolates straddle the line between food and medicine, making regulatory classification and approval complex.

- **Lack of Clinical Data**

Limited clinical trials specifically on pediatric herbal chocolates make it difficult to assess long-term efficacy and safety.[25]

Future Scope of Paediatric Herbal Chocolate

1. Clinical Research and Trials

- **Need for Pediatric Clinical Trials**: There is a significant need for clinical studies to assess the efficacy, safety, and long-term effects of herbal chocolates in pediatric populations. Such trials could provide the necessary data for regulatory approval and greater adoption in mainstream healthcare.
- **Standardization of Dosages**: Future research could focus on developing standardized dosage forms tailored to age, weight, and health conditions to ensure precise and accurate dosing.

2. Sugar-Free and Health-Conscious Options

- **Diabetic-Friendly Formulations**: There is growing demand for sugar-free or low-sugar herbal chocolates, catering to children with diabetes or those needing to manage their calorie intake. Research could focus on natural sugar substitutes like stevia or monk fruit to maintain taste without compromising health.[21]
- **Vegan and Allergen-Free Options**: Developing vegan versions of herbal chocolates free from dairy or gluten to cater to children with allergies or dietary restrictions could be a promising direction for the future.

3. Advanced Delivery Systems

- **Nano-formulations**: Utilizing nanotechnology to improve the bioavailability and effectiveness of herbal ingredients could help increase the therapeutic efficacy of the chocolates. This technology could enable better absorption of active compounds in the body.
- **Controlled Release Systems**: Developing chocolates with controlled-release mechanisms for sustained delivery of herbal ingredients could extend their therapeutic benefits over time, particularly for chronic conditions.

4. Expanding the Range of Herbal Ingredients

- **New Herb Combinations**: Future formulations could incorporate a wider variety of herbal ingredients based on emerging research into their benefits for children. This includes herbs with immune-boosting, anti-inflammatory, or digestive properties.
- **Personalized Herbal Blends**: Tailoring herbal chocolate formulations to meet the specific health needs of individual children, such as those suffering from anemia, cough, or sleep disorders, could offer a more customized approach to treatment.

5. Improved Manufacturing and Shelf Life

- **Advanced Preservation Methods**: Research into better preservation techniques, such as freeze-drying or the use of natural preservatives, could help increase the shelf life of herbal chocolates without compromising their therapeutic properties.[24]
- **Temperature-Resistant Formulations**: Developing chocolate formulations that are less sensitive to temperature changes could make them more viable in different climates and storage conditions, especially in tropical or warm regions.

6. Regulatory Framework and Acceptance

- **Regulatory Standardization**: As herbal chocolates combine food and medicine, establishing a clear regulatory framework is crucial. Further research could involve collaborating with health authorities like the FDA or the WHO to define the standards for quality, safety, and efficacy.
- **Global Market Expansion**: With the rise in demand for natural and herbal products, there is significant potential for global market expansion, particularly in regions where traditional medicine is still widely used.[27]

7. Public Awareness and Education

- **Parental Acceptance**: Increasing awareness about the benefits of herbal chocolates in managing children's health could enhance market adoption. More educational campaigns or community outreach programs could promote these products as safe, effective, and fun alternatives for children.
- **Integration with Conventional Medicine**: There's potential for herbal chocolates to be integrated into conventional pediatric care as a complementary nutraceutical therapy,

especially for conditions like coughs, colds, and digestion issues.

8. Sustainable Sourcing of Ingredients

•Eco-friendly Manufacturing: There is an increasing interest in the sustainable and ethical sourcing of raw materials. Future formulations may focus on organic and ethically sourced herbal ingredients, chocolate, and packaging, aligning with environmental concerns.

III. CONCLUSION

Paediatric herbal chocolate offers an innovative and effective way to deliver herbal medicines to children in a palatable form, improving compliance and therapeutic outcomes. By combining the health benefits of herbs with the enjoyable taste of chocolate, this formulation can help overcome the challenges of administering conventional medicines to children. While there are some challenges, such as sugar content and stability, the future of paediatric herbal chocolate looks promising. With further research, innovations in formulation, and improved regulatory standards, herbal chocolates have the potential to become a widely accepted and effective solution in pediatric care.

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