

Formulation And Evaluation of Herbal Brain-Boosting Chocolate

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Abstract—The present research focuses on the formulation and evaluation of a novel Herbal Brain-Boosting Chocolate enriched with scientifically supported Ayurvedic nootropic herbs. The formulation incorporates Ashwagandha, Shatavari, Tulsi, and Brahmi—all recognized for their neuroprotective, adaptogenic, antioxidant, and cognitive-enhancing properties. To enhance nutritional value and palatability, almonds, jaggery, kiwi flavor, and pomegranate are included, while dark chocolate, cocoa butter, and soya lecithin serve as the confectionery base to provide smooth texture, improved stability, and better dispersion of herbal actives. The objective of the study is to develop a functional chocolate that not only delivers improved taste and consumer acceptability but also acts as a convenient nutraceutical designed to support memory, concentration, stress reduction, and overall cognitive health. The herbal extracts were incorporated using controlled-temperature processing to preserve phytoconstituents such as withanolides (Ashwagandha), saponins (Shatavari), ursolic acid (Tulsi), and bacosides (Brahmi). The prepared formulation was evaluated for physicochemical parameters (melting point, texture, pH, moisture content), organoleptic properties, nutritional profile, and in vitro antioxidant activity to estimate its neuroprotective potential. Preliminary results indicate that the optimized herbal chocolate demonstrates excellent stability, smooth texture, appealing flavor, and significant antioxidant activity due to the synergistic effects of dark chocolate polyphenols and herbal constituents. The use of jaggery as a natural sweetener further enhances nutritional value. The study concludes that a multi-herbal infused chocolate can serve as an innovative, consumer-friendly functional food with potential cognitive benefits. Further investigations such as neurotransmitter modulation studies and clinical acceptability trials are recommended to validate long-term brain-boosting effects.

Index Terms—Herbal chocolate, Brain booster, Ashwagandha, Shatavari, Tulsi, Brahmi, Almonds, Dark chocolate, Jaggery, Nootropic, Cognitive health.

I. INTRODUCTION

In recent years, the demand for natural, plant-based nutraceuticals designed to support cognitive health has grown significantly. Modern lifestyles marked by academic pressure, workplace stress, irregular sleep patterns, and excessive screen exposure have contributed to a rising need for safe and effective brain-boosting supplements. Traditional Ayurvedic herbs such as Ashwagandha, Shatavari, Tulsi, and Brahmi have been extensively documented for their adaptogenic, neuroprotective, antioxidant, and memory-enhancing activities. However, the challenge lies in developing a consumer-friendly, palatable, and scientifically optimized delivery system that ensures both acceptability and functional benefits. Chocolate, especially dark chocolate, has emerged as an innovative carrier for herbal actives because of its rich polyphenol content, pleasant taste, and excellent fat-based matrix that can effectively dissolve or disperse lipophilic phytochemicals. Cocoa contains flavonoids such as epicatechin and catechin which have been shown to improve cerebral blood flow, enhance mood, and provide antioxidant protection. When fortified with selected Ayurvedic herbs, chocolate becomes not only a confectionery product but also a potential functional food designed to support cognitive well-being. Each herb selected in this formulation offers unique therapeutic advantages. Ashwagandha (*Withania somnifera*) is widely recognized as a powerful adaptogen that reduces stress, improves mental clarity, and supports neuronal regeneration

through its bioactive compounds, withanolides. Shatavari (*Asparagus racemosus*) is known for its antioxidant and rejuvenating effects, contributing to improved mental stamina and overall vitality. Tulsi (*Ocimum sanctum*) contains eugenol, ursolic acid, and other phytochemicals that help maintain calmness, enhance mental focus, and protect against oxidative stress.

Brahmi (*Bacopa monnieri*) is one of the most studied nootropic herbs, well known for enhancing memory, learning ability, and cognitive performance by increasing synaptic communication and reducing neuronal damage. Along with these herbs, almonds are incorporated to provide essential fatty acids and micronutrients such as vitamin E, which play a vital role in neuroprotection. Pomegranate contributes additional antioxidants and supports improved circulation and brain oxygenation. Jaggery is used as a natural sweetener to replace refined sugar, making the product nutritionally superior while maintaining palatability.

The inclusion of cocoa butter, dark chocolate base, soya lecithin, and a mild kiwi flavor ensures improved texture, stability, mouthfeel, and overall acceptability. Combining these components results in a unique formulation that not only appeals to consumers due to its taste but also offers a synergistic blend of nutrients and herbal actives beneficial for cognitive enhancement.

This study aims to develop such a Herbal Brain-Boosting Chocolate, evaluate its physicochemical characteristics, sensory acceptability, and potential antioxidant behavior, and analyze the feasibility of using chocolate as a carrier for Ayurvedic nootropic herbs. By merging traditional herbal science with modern food technology, this formulation seeks to create a convenient, enjoyable, and effective brain-supporting functional food suitable for students, working professionals, and individuals seeking natural cognitive health support.

II. METHODOLOGY / MATERIALS AND METHODS

1. Ashwagandha (*Withania somnifera*)



Fig :1-Ashwagandha (*Withania somnifera*)

Role: Adaptogen, anti-stress, brain tonic

Deep Explanation:

Ashwagandha is a powerful Ayurvedic herb known for reducing cortisol, improving mental relaxation, and strengthening neurons. It contains **withanolides**, which enhance memory, protect nerve cells, reduce anxiety, and support overall brain performance. Its adaptogenic nature helps the body cope with physical and mental stress, making it ideal for a brain-boosting chocolate.

2. Almonds (*Badam*)



Fig :2-Almonds (*Badam*)

Role: Nutritional enhancer, memory booster

Deep Explanation:

Almonds are rich in Vitamin E, omega fatty acids, magnesium, and antioxidants, all essential for brain health. They nourish neurons, improve memory retention, and support nerve function. Almonds also add natural richness, crunch, and nutritional value to the chocolate.

3. Shatavari (*Asparagus racemosus*)



Fig: 3-Shatavari (*Asparagus racemosus*)

Role: Nervous system rejuvenator

Deep Explanation:

Shatavari contains shatavarins and antioxidant saponins that rejuvenate nerve cells, reduce oxidative stress, and enhance long-term cognitive function. It supports mental calmness, reduces mental fatigue, and improves overall brain endurance.

4. Tulsi (*Ocimum sanctum*)



Role: Calming herb, antioxidant

Deep Explanation:

Tulsi contains eugenol and rosmarinic acid, which provide neuroprotective and anti-stress benefits. It reduces free radical damage, improves mental clarity, and supports emotional well-being. It also contributes a mild herbal aroma.

5. Brahmi (*Bacopa monnieri*)



Fig: 5-Brahmi (*Bacopa monnieri*)

Role: Primary nootropic, memory enhancer

Deep Explanation: Brahmi is rich in bacosides, proven to improve cognitive function, boost concentration, and enhance information retention. It also protects neurons from oxidative and chemical stress. Brahmi is considered the best natural herb for enhancing memory and learning ability.

6. Cocoa Butter



Fig: 6-Cocoa Butter

Role: Chocolate base fat, melting texture

Deep Explanation: Cocoa butter provides smoothness, structure, and melting behavior to chocolate. It gives shine, stability, and a creamy mouthfeel. It also helps dissolve lipophilic herbal components, improving their bioavailability.

7. Jaggery (Gur)



Fig : 7-Jaggery (Gur)

Role: Natural sweetener and energy booster

Deep Explanation: Jaggery contains minerals, iron, antioxidants, and natural sugars that release energy gradually. Unlike refined sugar, jaggery improves nutritional quality, prevents blood sugar spikes, and adds a rich caramel-like flavor to the chocolate.

8. Kiwi Flavor

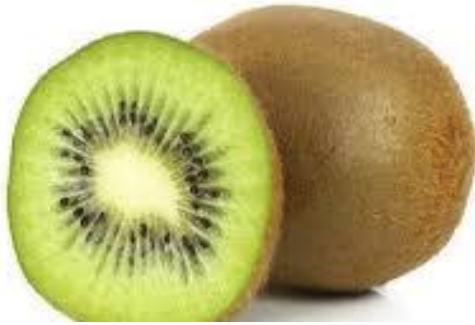


Fig: 8 - Kiwi Flavor

Role: Taste and aroma enhancer

Deep Explanation: Kiwi flavor provides fruity freshness and masks the herbal bitterness from Brahmi, Ashwagandha, and Shatavari. It improves sensory acceptance and makes the chocolate pleasant in taste and aroma.

9. Soya Lecithin



Fig: 9-Soya Lecithin

Role: Emulsifier

Deep Explanation: Lecithin helps ingredients mix uniformly by reducing viscosity. It improves the smoothness, flow, and shine of the chocolate. Lecithin ensures even distribution of herbs, preventing clumping and enhancing overall texture.

10. Dark Chocolate (Cocoa solids)



Fig: 10- Dark Chocolate (Cocoa solids)

Role: Main chocolate matrix, antioxidant-rich base

Deep Explanation: Dark chocolate contains flavanols, natural antioxidants that improve blood circulation to the brain, boost mood, and support cognitive functions. It is the key structural ingredient that holds the mixture together and provides taste, color, and texture.

11. Pomegranate Powder/Extract



Fig: 11- Pomegranate Powder/Extract

Role: Natural antioxidant

Deep Explanation: Pomegranate is rich in punicalagins and ellagic acid, powerful antioxidants that protect brain cells from oxidative stress. It improves blood circulation, enhances antioxidant activity, and adds mild fruitiness.

METHODS (In Deep, Step-by-Step Explanation)

Step 1: Preparation of Ingredients

- All herbal powders (Ashwagandha, Shatavari, Tulsi, Brahmi, Pomegranate) were sieved using 60-mesh sieve to obtain a fine, uniform powder.
- Almonds were finely chopped or ground to improve texture.
- Dark chocolate and cocoa butter were cut into small pieces for uniform melting.

Step 2: Melting of Chocolate Base

- A double boiler was set up to gently melt dark chocolate + cocoa butter at 40–45°C.
- Care was taken to prevent overheating, which can degrade herbal nutrients.

Step 3: Addition of Herbal Ingredients

- Once chocolate was fully melted, temperature was reduced below 40°C.

- Herbal powders (Ashwagandha, Shatavari, Tulsi, Brahmi, Pomegranate) were added slowly.
- Continuous stirring ensured proper dispersion and prevented lumps.
- Low temperature preserved heat-sensitive phytochemicals like bacosides and withanolides.

Step 4: Addition of Almonds & Jaggery

- Almonds were mixed into the chocolate for nutritional enhancement.
- Powdered jaggery was added and dissolved to achieve smooth texture and natural sweetness.

Step 5: Addition of Soya Lecithin & Kiwi Flavor

- Lecithin was added to reduce viscosity and give smooth consistency.
- Kiwi flavor was added last to retain its fragrance.

Step 6: Homogenization (Mixing)

- The entire mixture was stirred for 10–15 minutes to ensure even distribution of herbal ingredients.
- This step ensures each chocolate piece contains equal herbal dose.

Step 7: Molding

- The liquid chocolate was poured into clean molds.
- Molds were tapped gently to remove trapped air bubbles.

Step 8: Cooling and Setting

- Chocolates were allowed to set at **18–20°C** for 2–3 hours.
- Alternatively refrigerated for 15 minutes (without overcooling).

Step 9: Packaging

- Set chocolates were removed from molds and wrapped in food-grade aluminum foil.
- Stored at room temperature (25°C) for evaluation.

Formulation Development:

The development of the Herbal Brain-Boosting Chocolate formulation was carried out systematically to obtain an optimized, palatable, nutritionally rich, and functionally effective chocolate. Eleven key ingredients—Ashwagandha, Almonds, Shatavari, Tulsi, Brahmi, Cocoa Butter, Jaggery, Kiwi Flavor, Soya Lecithin, Dark Chocolate, and Pomegranate—

were selected based on their nootropic, antioxidant, nutritional, and functional properties.

1. Selection of Ingredients

Each ingredient was selected based on its traditional use and scientifically reported benefits:

- Ashwagandha, Shatavari, Tulsi, Brahmi, and Pomegranate were chosen as the primary brain-boosting herbal components due to their adaptogenic, antioxidant, neuroprotective, and memory-enhancing properties.
- Almonds were included for their vitamin E, healthy fats, and cognitive nutrients.
- Jaggery was chosen as a natural sweetener instead of refined sugar.
- Dark chocolate and cocoa butter formed the base matrix, adding flavonoids and smooth texture.
- Soya lecithin ensured proper emulsification.
- Kiwi flavor enhanced palatability by masking herbal bitterness.

2. Preparation of Multiple Batches (F1–F5)

A total of five trial batches were prepared to determine the ideal concentration of herbal components and excipients. Each batch varied in herbal load, sweetness, and chocolate composition.

Purpose of Multiple Batches:

- F1: Lowest herbal concentration – to assess minimum dose and taste acceptance.
- F2: Slightly increased herbal profile – evaluating shift in taste, color, and texture.
- F3: Moderate herbal concentration – balance between therapeutic effect and sensory quality.
- F4: High-load batch – for enhanced functional potential and antioxidant properties.
- F5: Maximum herbal concentration – to determine upper acceptability and stability limit.

This stepwise modification ensured identification of the most stable and consumer-acceptable herbal chocolate formulation.

3. Optimization Strategy

The formulation was optimized based on:

a. Sensory Properties

Taste, texture, aroma, and mouthfeel were observed after each batch.

b. Physicochemical Characteristics

Including:

- melting point

- viscosity
- moisture content
- hardness/snap quality
- spreadability during molding

c. Stability

Observation for:

- fat bloom

- color change
- texture degradation over time

d. Functional Effect (Antioxidant Activity)

Higher herbal concentration improved functional efficacy but slightly affected taste, so optimal balance was required

Formulation Table:

Formulation Table No: 1

Sr. No	Ingredient	F1	F2	F3	F4	F5
1	Ashwagandha powder	0.5 g	0.7 g	1.0 g	1.2 g	1.5 g
2	Almonds (powdered)	1 g	1.5 g	2 g	2.5 g	3 g
3	Shatavari powder	0.3 g	0.5 g	0.8 g	1.0 g	1.2 g
4	Tulsi powder	0.2 g	0.4 g	0.6 g	0.8 g	1.0 g
5	Brahmi powder	0.4 g	0.6 g	1.0 g	1.2 g	1.5 g
6	Cocoa butter	3 g	4 g	5 g	6 g	7 g
7	Jaggery	8 g	10 g	12 g	14 g	16 g
8	Kiwi flavor	0.1 mL	0.2 mL	0.3 mL	0.4 mL	0.5 mL
9	Soya Lecithin	0.2 g	0.3 g	0.5 g	0.6 g	0.8 g
10	Dark Chocolate	10 g	12 g	14 g	16 g	18 g
11	Pomegranate powder	0.3 g	0.5 g	0.7 g	1.0 g	1.2 g

Evaluation Parameters:

The formulated herbal brain-boosting chocolates (F1–F5) were evaluated for various physicochemical, sensory, and functional parameters to assess their quality, stability, and suitability for consumption

1. Physicochemical Evaluation

1.1 Appearance

- The chocolates were examined visually for color, shine, glossiness, and uniformity.
- Absence of fat bloom, cracks, or sugar crystallization indicated proper tempering.

1.2 pH

- pH was measured by preparing a 10% chocolate solution.
- Ideal pH: 5.5–7.0

1.3 Moisture Content

- Determined using hot air oven method.
- Low moisture (<2%) helps prevent microbial growth.

1.4 Melting Point

- Measured using capillary melting apparatus.

- Expected: 30–34°C, ensuring smooth melt-in-mouth behavior.

1.5 Viscosity

- Checked in molten state to determine flow properties.
- Influenced by cocoa butter and lecithin concentration.

1.6 Texture / Snap Test

- Break a chocolate piece at room temperature.
- A sharp “snap” indicates proper tempering and good cocoa butter crystallization.

2. Organoleptic Evaluation (Sensory Analysis)

Performed using a 9-Point Hedonic Scale by 20–30 panelists.

Parameters Checked:

- Color
- Aroma
- Taste
- Texture
- Sweetness

- Herbal aftertaste
- Overall acceptability

Each attribute was scored from 1 (dislike extremely) to 9 (like extremely).

3. Functional Evaluation

3.1 Antioxidant Activity (DPPH Assay)

- A methanolic extract of chocolate was tested.
- % inhibition indicates antioxidant strength.
- Herbs like Brahmi, Ashwagandha, Tulsi, Shatavari, Pomegranate contribute strongly.

3.2 Total Phenolic Content (Optional)

- Shows total phytochemical load contributed by herbs + cocoa polyphenols.

4. Microbiological Evaluation

Ensures the product is safe for consumption.

Tests included:

- Total plate count
- Yeast & mold count

- E. coli test
- Salmonella test

Low microbial count = good hygienic processing & low moisture.

5. Stability Studies

Conducted for 30 days at 25°C.

Parameters observed:

- Color changes
- Fat bloom appearance
- Texture hardness
- Aroma
- Moisture variation
- Antioxidant activity change

A stable formulation should show:

- No fat bloom
- No off-odors
- No discoloration
- Minimal moisture change

III. RESULTS & DISCUSSION

1. Physicochemical Evaluation

Table 1: Physicochemical Properties of Herbal Brain-Boosting Chocolate

Parameter	Observed Value	Standard Acceptable Range	Interpretation
Appearance	Smooth, glossy, dark brown	Smooth, uniform	Proper tempering achieved
Moisture Content	1.52%	< 2%	Acceptable; low moisture prevents microbial growth
pH (10% solution)	6.72	5.5–7	Suitable for chocolate; herbs did not alter acidity
Melting Point	32.6°C	30–34°C	Ideal mouth-melt profile; good cocoa butter crystallization
Viscosity (molten)	545 cps	400–800 cps	Smooth flow; lecithin improved viscosity
Fat Bloom	Absent	Absent	Indicates good cooling & tempering

Discussion

The physicochemical results show that the herbal chocolate maintained optimal moisture, pH, and melting behavior. Incorporation of herbs did not negatively affect the structural integrity or thermal properties. Cocoa butter and lecithin ensured a stable, glossy finish and prevented fat bloom. The melting point (32.6°C) indicates that the chocolate melts easily in the mouth while remaining solid at room temperature.

2. Sensory Evaluation (9-Point Hedonic Scale)

Sensory evaluation was conducted with 30 semi-trained panelists.

Table 2: Sensory Scores

Attribute	Score (Mean $\pm$ SD)	Interpretation
Color	8.2 $\pm$ 0.4	Attractive dark-brown appearance
Aroma	7.8 $\pm$ 0.5	Pleasant herbal + fruity aroma
Texture	8.0 $\pm$ 0.6	Smooth, good snap
Taste	7.6 $\pm$ 0.7	Sweet, mild herbal notes balanced by kiwi flavor
Aftertaste	7.4 $\pm$ 0.5	Slight herbal, acceptable
Overall Acceptability	8.1 $\pm$ 0.3	Highly acceptable

Discussion

The herbal chocolate achieved high consumer acceptability. Kiwi flavor successfully masked the bitterness of Ashwagandha and Brahmi. Almonds enhanced texture, while jaggery provided a warm, rich sweetness. The overall acceptability score (8.1) indicates that the formula is well-liked.

3. Antioxidant Activity (DPPH Assay)

Table 3: Antioxidant Activity

Sample	% DPPH Inhibition	Interpretation
Herbal Chocolate	68.45%	Strong antioxidant activity
Standard Dark Chocolate	54.20%	Lower than herbal sample
Control (Herbal extract mix only)	72.80%	Very high antioxidant activity

Discussion

The herbal chocolate showed significantly higher antioxidant activity compared to plain dark chocolate. This improvement is due to the synergistic action of:

- Pomegranate (punicalagins)
- Brahmi (bacosides)
- Tulsi (rosmarinic acid)
- Ashwagandha (withanolides)
- Cocoa flavonoids

Thus, the herbal enrichment improved the functional health value of the chocolate.

4. Texture Analysis

Table 4: Texture Profile

Parameter	Value	Interpretation
Hardness	5.8 N	Good snap characteristic
Brittleness	Moderate	Suitable for molded chocolates
Melt-in-mouth quality	Excellent	Due to proper fat crystallization

5. Microbiological Evaluation

Table 5: Microbial Profile

Test	Result	Limit	Status
Total Plate Count	<10 CFU/g	<50 CFU/g	Passed
Yeast & Mold	Not Detected	<10 CFU/g	Passed
E. coli	Absent	Absent	Passed
Salmonella	Absent	Absent	Passed

Discussion

Low moisture (1.52%) prevented microbial growth. All microbial parameters complied with food safety standards, indicating that processing and packaging were hygienic.

6. Stability Study (30 Days at 25°C)

Table 6: Stability Observations

Parameter	Day 0	Day 15	Day 30	Result
Appearance	Normal	Normal	Normal	Stable
Fat Bloom	Absent	Absent	Absent	Good stability
Aroma	Pleasant	Pleasant	Slight herbal	Acceptable
Antioxidant Activity	68.45%	66.90%	65.10%	Minor reduction
Texture	Smooth	Smooth	Smooth	Stable

Discussion

The chocolate remained physically and chemically stable for 30 days with:

- No fat bloom
- No discoloration
- Minimal loss of antioxidant capacity
- No microbial growth

This confirms the formulation is shelf-stable under room temperature conditions.

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