

Formulation and Evaluation of Medicated Chocolates Using Nuts (Almonds, Cashews, Walnuts, Pistachios)

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ABSTRACT

Chocolate, a universally cherished treat, captivates people worldwide with its rich flavor and comforting properties, often evoking feelings of happiness and indulgence. This study focuses on the formulation and evaluation of chocolates enriched with nutrient-dense nuts, including almonds (*Prunus dulcis*), cashews (*Anacardium occidentale*), walnuts (*Juglans regia*), and pistachios (*Pistacia vera*). The primary objective was to enhance the nutritional profile of chocolate while maintaining its sensory appeal. The nuts were selected for their proven health benefits, including improved heart health, brain function, and antioxidant capacity. A systematic approach was followed, involving the roasting of nuts, melting and tempering of chocolate, and the incorporation of nuts into dark and milk chocolate bases. The final product was assessed for general appearance, texture, taste, and stability.

The results revealed that the nut-enriched chocolates exhibited excellent sensory qualities, including a glossy surface, creamy sweetness, and a satisfying crunch. Tests confirmed the absence of fat or sugar blooming, ensuring product stability. Nutritional analysis highlighted the enhanced value provided by the nuts, including healthy fats, antioxidants, and plant-based proteins. This study demonstrates the feasibility of creating a functional food that combines indulgence with health benefits. Nut-enriched chocolates have the potential to appeal to health-conscious consumers and find applications in the nutraceutical and functional food industries, offering an innovative alternative to traditional confections.

Keywords: Medicated chocolates, Chocolate formulation, Healthy Chocolates, Antioxidant rich chocolates, Nutritional chocolates, Almonds in chocolate, Cashews in chocolate, Walnuts in chocolate, Pistachios in chocolate.

I. INTRODUCTION

Chocolate is widely recognized not only for its delightful taste but also as an ideal medium

for delivering active ingredients, offering a unique combination of flavor and functionality. Due to its anhydrous nature, chocolate is resistant to microbial growth and the degradation of water-sensitive compounds, making it an excellent carrier for various active agents. It is particularly popular across age groups, from children to adults, who find it one of the most acceptable and enjoyable foods. In addition to its inherent sweetness, chocolate's smooth, creamy texture effectively masks undesirable flavors of medicinal ingredients, providing a palatable means of administration. Traditionally made from cocoa, cocoa butter, and sugar, chocolate serves as a versatile base for a range of medicinal formulations. By incorporating nuts such as almonds (*Prunus dulcis*), cashews (*Anacardium occidentale*), walnuts (*Juglans regia*), and pistachios (*Pistacia vera*), the functional and nutritional properties of chocolate can be further enhanced. These ingredients bring a host of health benefits, such as improved heart health, brain function, and bone strength, while simultaneously making the medicated chocolate more enjoyable. This study explores the use of these nutrient-rich nuts in chocolate as a method for improving the sensory qualities and medicinal value of the confection, offering both a tasty and health-conscious alternative in the realm of medicated food products. "Chocolate, beloved across cultures for its indulgent taste and comforting qualities, also serves as a potent vehicle for incorporating health-enhancing ingredients. Beyond its pleasing flavor, chocolate's stable, anhydrous structure preserves active compounds and offers a longer shelf life, making it suitable for creating functional foods. The addition of nutrient-dense nuts—such as almonds, cashews, walnuts, and pistachios—further enhances chocolate's appeal. These nuts are not only rich in essential vitamins and minerals but also contain high levels of bioactive compounds like antioxidants, healthy fats, and plant sterols, which have been shown to support heart health, reduce inflammation, and improve brain function.

1.1 Introduction to Nuts

1. Almonds (*Prunus dulcis*)



- Almonds are seeds from the *Prunus dulcis* tree, a species native to the Middle East and South Asia, and are well-regarded for their significant health benefits. Almonds are an excellent source of vitamin E, an antioxidant that helps reduce oxidative stress, supports skin health, and protects against UV damage. They also provide essential minerals, such as magnesium and calcium, which are crucial for bone health, as well as monounsaturated fats that help manage cholesterol levels. In chocolates, almonds contribute a rich, nutty flavor and a crunchy texture, enhancing the sensory appeal of the product. Their natural sweetness complements the cocoa in chocolate, while their high fiber content supports digestive health, making almond-enriched chocolates a more satiating option. Additionally, almonds contain phenolic compounds and flavonoids, which, along with the flavonoids in cocoa, may produce a synergistic antioxidant effect. This combination can potentially reduce inflammation and support cardiovascular health, making almonds an ideal choice for functional chocolate formulations.
- Source:** Almonds are seeds of the *Prunus dulcis* tree, native to the Middle East and South Asia.
- Biological Classification:**
 - Kingdom: Plantae
 - Phylum: Angiosperms
 - Class: Eudicots
 - Order: Rosales
 - Family: Rosaceae
 - Genus: *Prunus*
- Medicinal Uses:** Almonds are high in vitamin E, antioxidants, and healthy fats, supporting heart health, skin, and blood sugar regulation.

- Therapeutic Uses:** They are used to reduce cholesterol levels, enhance cognitive function, and improve digestion due to their fiber content.

2. Cashews (*Anacardium occidentale*)



- Cashews, derived from the *Anacardium occidentale* tree native to Brazil, are popular for their creamy texture and subtly sweet flavor, which pairs harmoniously with chocolate. Rich in heart-healthy monounsaturated fats, cashews contribute to improved cardiovascular health and help maintain balanced cholesterol levels. Cashews are also high in copper and magnesium—two minerals essential for energy production, brain health, and bone strength. Copper supports iron metabolism and collagen formation, benefiting the skin and immune system, while magnesium plays a critical role in nerve function and blood pressure regulation. Cashews contain important bioactive compounds, such as anacardic acids, which have antioxidant and antimicrobial properties, potentially enhancing the shelf life of chocolate products. Their inclusion in chocolate not only improves the taste and texture but also adds a creamy mouthfeel that appeals to consumers seeking rich yet balanced flavors. Additionally, cashews provide a slight natural sweetness, which can reduce the need for added sugars in chocolate formulations, making it an appealing choice for health-conscious consumers.
- Source:** Cashews are seeds from the *Anacardium occidentale* tree, native to Brazil but now widely grown in tropical regions.
- Biological Classification:**
 - Kingdom: Plantae
 - Phylum: Angiosperms
 - Class: Eudicots
 - Order: Sapindales

- Family: Anacardiaceae
- Genus: Anacardium
- **Medicinal Uses:** Cashews are rich in magnesium and copper, supporting cardiovascular health, improving bone density, and boosting immunity.
- **Therapeutic Uses:** Cashews help in managing blood pressure, improving skin health, and maintaining nerve function due to their nutrient-rich profile.

3. Walnuts (*Juglans regia*)

- Walnuts, from the *Juglans regia* tree, are often considered a "brain food" due to their high concentration of omega-3 fatty acids, particularly alpha-linolenic acid (ALA), which is rare in plant-based foods. This essential fatty acid supports brain health, reduces inflammation, and benefits cardiovascular health by helping to lower blood pressure and reduce triglyceride levels. Walnuts are also rich in antioxidants, such as polyphenols, which play a crucial role in combating oxidative stress and may reduce the risk of neurodegenerative diseases. Their robust flavor and slightly bitter, earthy taste complement the sweetness of chocolate, creating a complex and satisfying flavor profile. Walnuts also contain melatonin, a hormone that regulates sleep, which may further enhance the calming effects associated with chocolate consumption. Including walnuts in chocolate provides a unique combination of texture and health benefits, positioning walnut-enriched chocolate as a functional food that supports brain and heart health. This nut-chocolate pairing caters to consumers interested in snacks that benefit cognitive function and overall wellness.
- **Source:** Walnuts come from the *Juglans regia* tree, native to Central Asia and widely cultivated in temperate regions around the world.
- **Biological Classification:**
 - Kingdom: Plantae
 - Phylum: Angiosperms
 - Class: Eudicots
 - Order: Juglandales
 - Family: Juglandaceae
 - Genus: *Juglans*
- **Medicinal Uses:** Walnuts are rich in omega-3 fatty acids, which help reduce inflammation, support brain health, and improve heart health.

- **Therapeutic Uses:** They are used to lower cholesterol, improve cognitive function, and reduce oxidative stress due to their polyphenolic content.

4. Pistachios (*Pistacia vera*)

- Pistachios, from the *Pistacia vera* tree, are unique for their green hue, attributed to the presence of chlorophyll, and their mildly sweet, buttery taste, which pairs beautifully with chocolate. Known for their high antioxidant content, pistachios contain lutein and zeaxanthin, carotenoids that support eye health and protect against age-related macular degeneration. Additionally, they are rich in fiber, protein, and healthy fats, making them a well-rounded choice for heart health, weight management, and blood sugar control. Pistachios have a favorable fatty acid profile, being high in monounsaturated and polyunsaturated fats that help reduce LDL cholesterol levels while supporting HDL cholesterol. They also contain bioactive compounds, such as tocopherols and phytosterols, which contribute to their cholesterol-lowering and anti-inflammatory effects. The addition of pistachios to chocolate provides a vibrant color, unique flavor, and a crunchy texture that appeals to consumers. Their low glycemic index makes them particularly valuable for formulating chocolates that offer sustained energy and better blood sugar regulation, catering to individuals seeking nutritious yet indulgent snack options.
- **Source:** Pistachios are seeds of the *Pistacia vera* tree, native to Central Asia and the Mediterranean region.
- **Biological Classification:**
 - Kingdom: Plantae
 - Phylum: Angiosperms
 - Class: Eudicots
 - Order: Sapindales
 - Family: Anacardiaceae
 - Genus: *Pistacia*
- **Medicinal Uses:** Rich in antioxidants, fiber, and healthy fats, pistachios support heart health, regulate blood sugar, and promote digestive health.
- **Therapeutic Uses:** They are traditionally used for weight management, lowering blood pressure, and improving gut health due to their high fiber and nutrient content.

II. MATERIAL AND METHOD

1. Ingredients and Their Uses

Table 1: List of Ingredients

Ingredient	Uses
1.Almonds	High in vitamin E, antioxidants, and healthy fats, supports heart health, skin, and blood sugar regulation.
2.Cashews	Rich in magnesium and copper, supports heart health, bone strength, and immune function.
3.Walnuts	Rich in omega-3 fatty acids, supports brain function, reduces inflammation, and promotes cardiovascular health.
4.Pistachios	High in antioxidants and fiber, improves heart health, regulates blood sugar, and aids digestion.
5. Dark Compound	
6. Milk Compound	

Table 2: Composition of Chocolate

Content	F1	F2
Dark Compound	50 gm.	50 gm.
Milk Compound	100 gm.	100 gm.
Almonds	10 units	10 units
Cashews	10 units	10 units
Walnuts	10 units	10 units
Pistachios	10 units	10 units



2. Procedure

- **Roasting the Nuts** = Begin by preheating the oven to 150°C. Spread almonds, cashews, walnuts, and pistachios on a baking tray in an even layer. Roast them for 10-15 minutes until they turn lightly golden and fragrant. Once roasted, allow the nuts to cool completely before chopping them into small, uniform pieces.

Why this step is necessary: Roasting enhances the flavor and aroma of nuts by releasing natural oils, creating a more intense and appealing taste. This process also makes nuts crunchier, which improves the overall texture of the chocolate. Cooling and chopping the nuts ensures they distribute evenly in the chocolate, providing a balanced texture and flavor in each bite.

- **Melting the Chocolate** = Break the dark and milk compound chocolate into small, even pieces for uniform melting. Use a double boiler method by placing a heat-safe bowl with the chocolate over a pot of simmering water. Stir occasionally until smooth and fully melted. Alternatively, melt in the microwave in 15-second increments, stirring between each interval to prevent burning.

Why this step is necessary: Melting chocolate gently using a double boiler or microwave ensures that it doesn't overheat, which can cause it to seize and lose its creamy consistency. This step allows the chocolate to reach a smooth, pourable state, which is essential for an even texture and proper setting in the final product.

- **Tempering the Chocolate** = Once the chocolate is melted, cool it to around 27-28°C, then gently heat it back to 31-32°C for dark chocolate or 29-30°C for milk chocolate. This process, called tempering, can be done by stirring the chocolate on a cool marble slab or by adding small amounts of solid chocolate (called seed chocolate) to bring the temperature down gradually.

Why this step is necessary: Tempering stabilizes the chocolate's crystals, which is crucial for achieving a glossy finish, smooth texture, and a firm snap when the chocolate is broken. Properly tempered chocolate resists blooming (the formation of white spots on the surface) and has a longer shelf life.

- **Mixing in the Nuts** = Once tempered, add the cooled, chopped nuts to the melted chocolate. Stir the mixture gently but thoroughly to ensure even distribution of the nuts throughout the chocolate.

Why this step is necessary: Mixing the nuts evenly in the tempered chocolate ensures each piece will contain a balanced amount of chocolate and nuts, enhancing the sensory experience. Gently stirring also prevents the formation of air bubbles, which can affect the appearance and texture of the final product.

- **Pouring into Molds** = Pour the nut-filled chocolate mixture into silicone or chocolate molds, filling each cavity evenly. Tap the molds gently on the counter several times to release any trapped air bubbles, which could otherwise create holes or uneven surfaces in the chocolate.

Why this step is necessary: Pouring the chocolate into molds gives it a consistent shape and makes it easier to portion. Tapping the molds is important to release any air bubbles, as trapped air can affect both the appearance and structural integrity of the chocolate, resulting in an uneven or crumbly texture.

- **Setting the Chocolate** = Place the filled molds in a cool, dry area or refrigerate them for 1-2 hours to set. Once the chocolate is fully hardened, remove it from the molds by gently flexing or tapping them to release each piece.

Why this step is necessary: Allowing the chocolate to set in a controlled, cool environment ensures it hardens evenly and retains its tempered structure, resulting in a smooth, glossy surface and satisfying snap. Removing the chocolate carefully from the molds helps preserve its shape and prevents breakage, maintaining the integrity and presentation of the final product.

- **Storing the Chocolate Properly** = Store the finished chocolates in an airtight container in a cool, dry place away from direct sunlight to prevent melting or blooming.

Why this step is necessary: Proper storage maintains the chocolate's texture, flavor, and appearance. Exposure to heat and moisture can

cause blooming or melting, which affects the chocolate's quality. The airtight container prevents moisture and odors from affecting the chocolate's taste and texture, ensuring it stays fresh longer.

III. EVALUATION

- ✓ General Appearance Test = The general appearance of chocolate, including its color, odor, taste, and texture, is crucial for consumer appeal and quality assessment. The color should be rich and even, indicating proper tempering and uniform mixing of ingredients. A glossy surface reflects good tempering, while a smooth and solid texture suggests effective molding and setting. Aroma, or odor, is another essential factor, as fresh chocolate should emit a pleasant, chocolatey scent with nutty undertones if nuts are included. Taste evaluation includes analyzing sweetness, creaminess, and overall balance, which are influenced by the quality of ingredients, such as cocoa and nuts. Finally, texture is judged for its smoothness, melt-in-the-mouth quality, and any added crunch from inclusions like nuts, providing a satisfying sensory experience.
- ✓ Blooming Test = Blooming is a common quality issue in chocolate, occurring when fat or sugar crystals rise to the surface, forming a whitish or dull layer. This test determines whether fat bloom, sugar bloom, or texture bloom has formed on the chocolate, typically due to temperature fluctuations or improper tempering. Fat bloom appears when cocoa butter migrates to the surface, usually as a result of inadequate tempering or storage in warm conditions. Sugar bloom occurs when moisture dissolves sugar on the chocolate's surface, leading to a grainy appearance when it recrystallizes. Texture bloom, often due to prolonged storage, results in a loss of smoothness and can affect the chocolate's sensory quality. Blooming affects the chocolate's appearance, texture, and appeal, so this test is vital for ensuring visual and textural consistency.
- ✓ Carbohydrate Test = The carbohydrate test in chocolate is often performed to confirm the presence of sugars and other carbohydrate compounds. One common method involves adding Molisch's reagent followed by sulfuric acid, which helps to identify carbohydrates by producing a characteristic color change. This reaction occurs because the reagent reacts with sugars, resulting in a visible color shift. Carbohydrates play a significant role in the taste and texture of chocolate, contributing to sweetness and influencing mouthfeel. Detecting carbohydrates helps verify ingredient quality and ensures the chocolate meets its nutritional specifications.
- ✓ Protein Test = Proteins are present in chocolate in trace amounts, especially when milk compounds or nuts are included in the formulation. The protein test often uses reagents like sodium hydroxide and copper sulfate, which cause a color change if proteins are present. This reaction is based on the biuret test principle, where proteins form a complex with copper ions, resulting in a distinct color. Testing for protein content is valuable for nutritional labeling and quality control, especially in chocolates with added nuts, which are a source of plant-based proteins. This test ensures that the chocolate's protein content aligns with its ingredient profile and nutritional claims.
- ✓ Melting Point Test = To determine the temperature at which the chocolate melts, ensuring it meets the standard for texture and storage stability. Place a small piece of chocolate in a temperature-controlled water bath. Gradually increase the temperature and record when the chocolate starts melting.
- ✓ Moisture Content Analysis = To ensure the chocolate has minimal moisture to prevent microbial growth and maintain quality. Use an oven-drying method to measure water content.
- ✓ Antioxidant Test = To quantify the antioxidant properties, especially due to the flavonoids in chocolate and nuts. Perform a DPPH (1,1-diphenyl-2-picrylhydrazyl) assay tests to determine antioxidant levels.
- ✓ Hardness Test = To measure the hardness of chocolate, which is affected by tempering and ingredient composition. Use hardness texture analyzer to evaluate the force needed to break the chocolate.

IV. RESULT

1) General Appearance :-

Color:- Uniform Dark Brown

Odour :-Pleasing aroma withNuttty Scents

Taste :- Sweeter, Creamier

Texture :- Smooth melt-in-mouth quality

2) Blooming test :-To evaluate whether fat bloom or sugar bloom has formed on the surface of the chocolate after storage

Test	Result
1. Fat bloom	No
2. Sugar bloom	No
3. Texture bloom	No

3) Test for Carbohydrate :-Place 2–3 drops of the sample solution in a test tube. Add 2–3 drops of **Molisch's reagent** to the test tube. Add **concentrated sulfuric acid** along the sides of the test tube to form a layer beneath the solution. Appearance of purple color indicates the presence of Carbohydrate.

4) Test for Protein :-Add 1–2 ml of the sample solution into a clean test tube. Add 2ml of sodium hydroxide solution to it. To that add 5 to 6 drops of copper sulphate solution to it.Appearance of bluish

violet colour indicate the presence of protein.

5) Test for Melting Point :- The chocolate melted at 31°C, demonstrating good tempering and suitability for storage in cool conditions.

6) Test for Moisture Content :- Low moisture level (below 1%), ensuring long shelf life and microbial safety.

7) Test for Antioxidants :- High antioxidant levels due to flavonoids in cocoa and phenolic compounds in nuts.

8) Test for Hardness :-

Formulation	Hardness(Force in Kg)
F1	2.5 kg
F2	2.6 kg

V. CONCLUSION

The study focused on developing and evaluating chocolates enriched with nutrient-rich nuts—almonds, cashews, walnuts, and pistachios—demonstrating their potential as a functional food. The chocolates exhibited excellent sensory characteristics, including a glossy appearance, nutty aroma, creamy sweetness, and a satisfying crunch. Quality assessments confirmed that the chocolates were free from blooming issues, ensuring a visually appealing and stable product. Analytical tests further validated the presence of carbohydrates and proteins, aligning with the nutritional profile expected from the inclusion of nuts and milk-based compounds.

The incorporation of these nuts significantly enhanced the chocolates' health benefits. Almonds provided antioxidants, heart-friendly monounsaturated fats, and skin-nourishing vitamin E; cashews contributed essential minerals like magnesium and copper for bone and nerve health; walnuts added omega-3 fatty acids and polyphenols to support brain and cardiovascular health; and pistachios offered a rich source of fiber, antioxidants, and compounds beneficial for eye

health and blood sugar regulation. Together, these nuts transformed the chocolate into a nutrient-packed confection with potential therapeutic and preventive health benefits.

This study demonstrates the feasibility of creating a product that merges indulgence with health-consciousness. By combining the rich taste and texture of chocolate with the medicinal properties of nuts, a unique offering is achieved, appealing to consumers seeking both pleasure and wellness. The findings highlight the potential of nut-enriched chocolates to serve not only as a treat but also as a functional food, paving the way for further innovation in nutraceuticals and health-oriented confectionery. These chocolates could find applications in various markets, from health-focused consumers to individuals seeking energy-boosting snacks or dietary supplements.

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