

**FORMULATION AND EVALUATION OF THEOBROMA COCOA AND ARJUNA BARK CAPSULE FOR CANCER TREATMENT****Mr. Amin Shadul Shaikh^{*1}, Ms. Pratiksha Rajkumar Ravankole²**

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ABSTRACT

Cancer remains one of the leading causes of mortality worldwide, necessitating the development of safer and more effective therapeutic alternatives. Herbal medicines have gained significant attention due to their minimal side effects and therapeutic potential. The present study focuses on the formulation and evaluation of a capsule containing Theobroma cacao powder and Terminalia arjuna (Arjuna bark) powder for potential anticancer activity. Theobroma cacao is rich in flavonoids and polyphenols, known for their antioxidant and cytotoxic properties, while Terminalia arjuna possesses strong anti-inflammatory, antioxidant, and cardio protective effects. The combination of these herbal components is expected to exhibit synergistic effects against cancer cells. The capsules were formulated using standard pharmaceutical techniques and evaluated for various parameters such as weight variation,

disintegration time, moisture content, and dissolution profile. Additionally, in-vitro studies including cytotoxicity assays and cell viability tests were considered to assess anticancer potential. The results indicated that the formulated capsules met pharmacopeial standards and showed promising characteristics, suggesting their potential as a natural and effective anticancer formulation. Further studies are recommended to validate their clinical efficacy and safety.

INTRODUCTIONCocoa, scientifically referred to as *Theobroma cacao*, is a remarkable and highly valued plant species with significant ecological, cultural, and economic importance. Celebrated for its rich flavour and aroma, cocoa has been cherished by human societies for centuries and remains a key ingredient in numerous culinary applications. Beyond its gastronomic appeal, cocoa contains a diverse array of biologically active components that contribute to its unique properties and multifunctional uses.^[1]

Theobroma cacao belongs to the Sterculiaceae family and is native to the tropical regions of Central and South America. It is an evergreen tree, typically growing 4–8 meters in height, and thrives in warm, humid environments. The tree is characterized by large, glossy leaves, and its canopy provides shade for the delicate cocoa pods, which develop directly from the trunk and branches. The pods, which are oval or elongated and vary in colour from yellow to red to purple depending on the cultivar, house 30–50 seeds, commonly known as cocoa beans, surrounded by a sweet, tangy pulp. These seeds are the primary source of cocoa products, including chocolate, cocoa powder, and cocoa butter.^[2]

Cocoa beans are rich in alkaloids, particularly theobromine and caffeine. Theobromine imparts a mild stimulating effect and a characteristic bitterness, whereas caffeine contributes additional stimulation, though in smaller amounts compared to coffee. These alkaloids influence both the sensory qualities of cocoa and its physiological effects upon consumption. In addition, cocoa beans contain high levels of bioactive compounds such as polyphenols, flavonoids, and antioxidants. These compounds have been associated with a range of health benefits, including anti-inflammatory effects, cardiovascular support, and potential anticancer properties. Consequently, moderate consumption of cocoa is often considered beneficial as part of a healthy diet. The biological significance of cocoa extends beyond its seeds. The cocoa tree plays a vital role in tropical agroforestry systems, enhancing biodiversity and supporting ecosystem health. Its dense foliage provides habitat and shelter for numerous organisms, including birds, insects, reptiles, and mammals. Moreover, sustainably managed cocoa plantations can promote environmentally friendly farming practices, contributing positively to ecological conservation and the overall health of tropical environments.^[3]

Botanical Details of *Theobroma cacao*^[4]

- **Scientific Name:** *Theobroma cacao* L.
- **Family:** Malvaceae

- **Common Names:** Cocoa tree, Cacao, Chocolate tree
- **Origin:** Native to tropical regions of Central and South America; widely cultivated in West Africa, Asia, and Latin America.



Figure 1: Cocoa (Theobroma Cacao).

Morphological Description^[5]

- **Plant Type:** Small evergreen tree, typically 4–8 m tall; can reach up to 12 m in optimal conditions.
- **Leaves:** Simple, alternate, oblong-elliptic, 10–40 cm long Glossy green above, lighter green below; entire margin.
- **Flowers:** Small, pinkish-white, hermaphroditic. Borne directly on the trunk and older branches (cauliflory). Pollinated mainly by tiny midges (insect-pollinated).
- **Fruit (Cacao Pod):** Large, oblong, 15–30 cm long, 5–10 cm wide. Colour varies from green to yellow, red, or orange at maturity. Contains 20–50 seeds (cocoa beans) embedded in sweet mucilaginous pulp.
- **Seeds:** Elliptical, 1–2 cm long, covered by a thin seed coat. Rich in fat (cocoa butter), polyphenols, and methylxanthines.

Ecology and Cultivation^[6]

- **Climate:** Tropical; requires temperature 18–32°C, high humidity, and rainfall 1,500–2,500 mm/year.
- **Soil:** Well-drained, fertile soils with good organic content.
- **Propagation:** Mainly by seeds; vegetative propagation also used for improved varieties.
- **Shade Requirement:** Young trees need partial shade; mature trees tolerate full sun.

- Parts Used
- **Seeds:** Primary source of cocoa powder, cocoa butter, and chocolate.
- **Leaves and Pods:** Sometimes used for extracts or traditional medicinal purposes.

Phytochemical Importance: Seeds and pods are rich in bioactive compounds such as flavanols, methylxanthines (theobromine and caffeine), phenolic acids, and proanthocyanidins.

Bioactive Compounds of Cocoa and Their Detailed Biological Activities^[7]

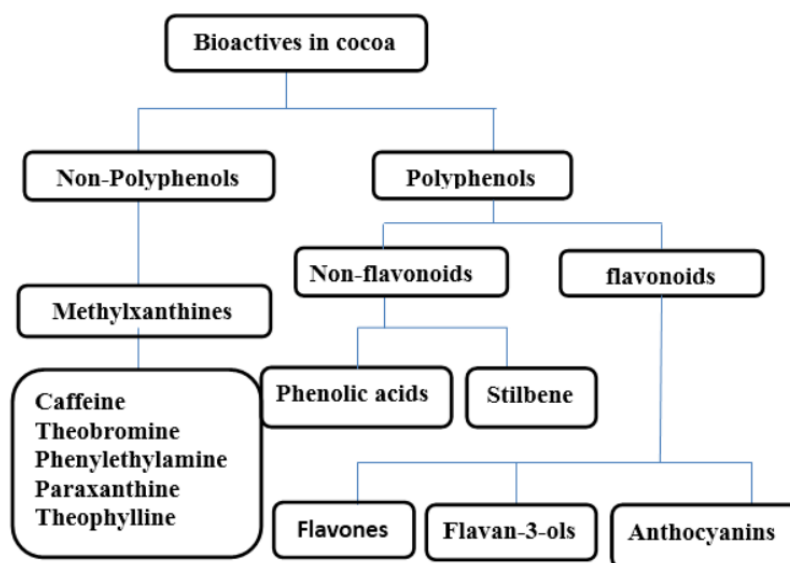


Figure 2: Bioactive Compounds of Cocoa (*Theobroma cacao*)

1. Flavanols (Flavonoids)Major Compounds

- Epicatechin
- Catechin
- Procyanidins (oligomeric flavanols)

Type: Polyphenols (Flavonoid subclass)

Source in Cocoa: Found in high concentrations in raw cocoa beans; levels vary by cocoa variety and processing.

Biological Activities & Mechanisms

- **Antioxidant Activity:** Flavanols scavenge reactive oxygen species (ROS) and reactive nitrogen species (RNS).

- **Cardiovascular Protection:** Increase endothelial nitric oxide (NO) production → vasodilation → lowers blood pressure.
- **Anti-inflammatory Effects:** Reduce pro-inflammatory cytokines (TNF- α , IL-6, IL-1 β).
- **Neuroprotective Effects:** Improve cerebral blood flow.
- **Metabolic Effects / Anti-diabetic:** Improve insulin sensitivity.

Summary: Flavanols are the most important health-promoting compounds in cocoa.

2. Theobromine Type: Methyl xanthine alkaloid'

Source in Cocoa: Abundant in cocoa beans; higher in dark chocolate than milk chocolate.

Biological Activities & Mechanisms

- **CNS Stimulant:** Mild stimulant effect, improves alertness, mood, and cognitive function.
- **Cardiovascular Effects:** Acts as a vasodilator → improves blood flow.
- **Respiratory Benefits:** Bronchodilator → relaxes airway smooth muscles → may aid in asthma.
- **Diuretic Activity:** Mildly increases urine production, supporting renal function.

Summary: Theobromine contributes mainly to mood enhancement, mild stimulation, cardiovascular support, and bronchodilation.

3. Caffeinen Type: Methylxanthine alkaloid.

Source in Cocoa: Present in smaller amounts compared to coffee or tea.

Biological Activities & Mechanisms^[8]

- **Central Nervous System Stimulation:** Improves alertness and reduces fatigue.
- **Metabolic Effects:** Enhances lipolysis and thermogenesis → minor weight management support.
- **Synergistic Effects with Theobromine:** Together with theobromine, enhances mood, energy, and cognitive function.
- **Phenolic Acids Major Compounds:** Gallic acid, Ferulic acid, Coumaric acid

Type: Polyphenols

Source in Cocoa: Present in cocoa solids and cocoa powder.

Biological Activities & Mechanisms

- **Antioxidant:** Neutralize free radicals, prevent oxidative damage.
- **Anti-inflammatory:** Inhibit inflammatory pathways (e.g., COX-2, NF- κ B).
- **Anti-cancer:** Protect DNA from oxidative stress; inhibit cancer cell proliferation.
- **Anthocyanins Type:** Flavonoid pigments.

Source in Cocoa: Found mainly in cocoa bean husks and unfermented cocoa beans.

Biological Activities & Mechanisms

- **Antioxidant:** Protects cells and tissues from ROS-induced damage.
- **Cardiovascular Protection:** May reduce blood pressure, improve lipid metabolism, and prevent vascular inflammation.
- **Neuroprotective:** Supports brain function; improves cognition and mood.

Biological Activities of Cocoa (*Theobroma cacao*)^[9]

Cocoa is a rich source of bioactive compounds like flavanols, theobromine, caffeine, phenolic acids, Anthocyanins, and proanthocyanidins. These compounds interact with various biological pathways to produce a wide range of health benefits. Below is a detailed explanation:

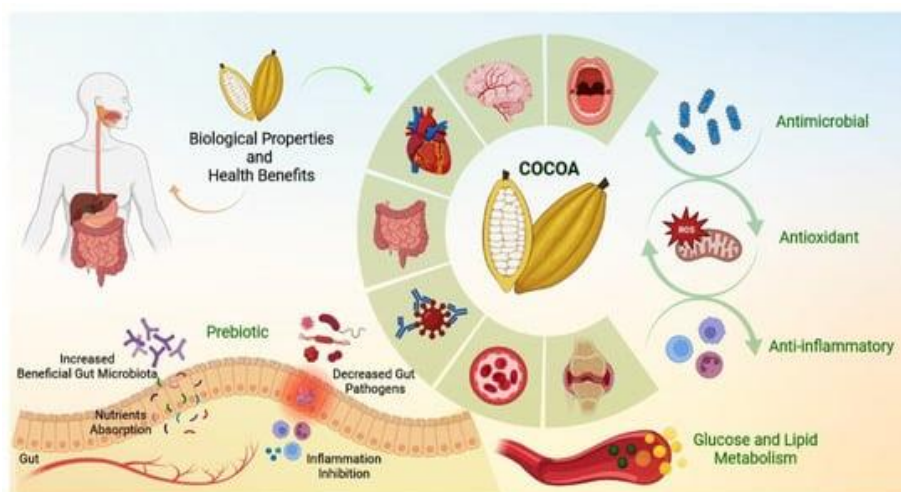


Figure 3: Biological Activities of Cocoa (*Theobroma cacao*).

Table 1: Biological Activities of Cocoa (Theobroma cacao).

No.	Activity	Key Components	Mechanism	Health Epact
1	Antioxidant activity	Flavanols, phenolic acids, Anthocyanin	Scavenge ROS/RNS	↓ Oxidative stress
2	Neuroprotective Effect	Flavanols, Caffeine	↑ Memory & cognition	↑ Memory & cognition
3	Anti-cancer potential	Flavanols,	↓ Proliferation, ↑ apoptosis	↓ Cancer risk
4	Gut health	Flavanols	Prebiotic action ↑ Gut microbiota	↑ Gut microbiota
5	Skin health	Flavanols	UV protection, ↑ circulation	Anti-aging effect
6	Mood and cognitive enhancement	Theobromine, caffeine	CNS stimulation	↑ Mood & alertness

Characterization of Theobroma cocoa and arjuna bark powder^[10]**1) Moisture content**

The moisture content of theobroma cocoa and arjuna bark mpowder was determined using water analysis. Sugar weighing 3 gm was poured into the mixed water and divided into strips. The machine was set at $130 \pm 1^\circ\text{C}$. Measurements were made when the machine was stopped. The test was repeated twice and the moisture content was taken as the average of three measurements.

2) Angle of repose

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

Where, h= height of the heap and r= radius of the Circular heap. The experiment was repeated twice and The average of the three readings was taken as the Angle of repose.

3) Bulk density

The bulk density of each powder / granule sample was determined by pouring 10 g (M) of the powder into a 50 ml glass measuring cylinder and the bulk volume (Vo) determined. The bulk density (Db) was then calculated from the relationship:

$$D_b = M/V_o$$

Triplicate determinations were made and the mean values reported.

4) Tapped density

The tapped density of each powder was determined using Stampf Volumeter (model STAV 2003, JEF Germany). The ten grams (M) of each powder/granules sample after the bulk

density determination was subjected to 250 taps mechanically and the volume V₂₅₀ of the powder column determined and applied to evaluate tapped density (Dt) using the relationship:

$$Dt = M / V_{250}$$

Triplicate determinations were made and the mean values reported.

5) Relative density

Relative density and porosity of powder /granules bed after 250 taps were determined respectively:

$$RD = TD_{250} /$$

$$\rho_s \epsilon = 1 - RD$$

Where RD = relative density, ρ_s = particle density, ϵ = porosity.

6) Determination of Carr's Index

Carr's index CI, was calculated from the results obtained from bulk and tapped densities above using the relation;

$$CI = (Td - Bd) \times 100 / Td$$

7) Determination of Hausner's Ratio

Hausner's Ratio HR, was determined using the results Obtained from both bulk and tapped densities. It Was calculated using the formula

$$HR = Td / Bd$$

8) Ash value

A 2 g sample of powder was cast into solid nickel, preheated to 105°C to constant weight, and then cooled. The solid and its contents are slowly heated until they become moisture-free and saturated. The temperature is gradually increased until most of the carbon is burned to °C. The sample was then superheated to 600°C until residue no longer contained any carbon (i.e., was almost white). Its essence and ingredients are cold and wet approved. The heating and cooling steps were then repeated until residue (ash) was formed always. The weight of the ash was then determined and the percentage ash value calculated:

$$\% \text{ Ash value} = W_a \times 100 / W_p$$

Where W_a and W_p are weight of ash formed and initial weight of Moringa powder respectively.

Characterization Result of Theobroma cacao and arjuna bark Powder

Sr. no	Parameters	Theobroma cocoa powder	Arjuna bark powder
1.	Moisture content (%)	4.5 ± 0.5	6.0 ± 0.6
2.	Angle of repose (°)	28.5 ± 1.2	32.0 ± 1.5
3.	Bulk density (g/ml)	0.45 ± 0.03	0.50 ± 0.04
4.	Tapped density (g/ml)	0.55 ± 0.04	0.65 ± 0.05
5.	Carr's index (%)	18.2 ± 1.0	23.0 ± 1.2
6.	Hausner's ratio	1.22 ± 0.05	1.30 ± 0.06
7.	Ash value (%)	3.2 ± 0.4	12.5 ± 1.0
8	Percentage yield (%)	85.0 ± 2.0	78.0 ± 3.0

MATERIALS AND MEHODS

Table of ingredients

Table 1: ingredients.

SR. NO	INGREDIENTS	ROLE
1	Theobroma cocoa	API
2	Arjuna bark powder	API
3	Lactose	Filler
4	Sodium starch glycolate	Super disintegrant
5	Povidone K30	Solubilizer
6	Colloidal silicon dioxide	Glidant
7	Magnesium Stearate	Lubricant
8	Talc	Anti adherent

Formulation table

SR. NO	INGREDIENTS	QUANTITY
1	Theobroma cocoa	200 mg
2	Arjuna bark powder	150mg
3	Lactose	70mg
4	Sodium starch glycolate	25mg
5	Povidone K30	20mg
6	Colloidal silicon dioxide	25mg
7	Magnesium Stearate	05mg
8	Talc	05mg

METHODOLOGY

1. Preparation of Theobroma cocoa and arjuna bark Powder

- **Collection:** Seeds of Theobroma cacao and bark of Terminalia arjuna were collected from healthy plants and carefully cleaned to remove dust, dirt, and other impurities.
- **Drying:** The collected materials were cut into smaller pieces and dried either under sunlight or in a hot air oven at 40–50°C until complete moisture removal was achieved, preventing degradation of active compounds.

- **Pulverization:** The dried cocoa seeds and bark were then finely powdered using a grinder or mortar and pestle.
- **Sieving:** The powdered material was sieved through an appropriate mesh (e.g., 50 μm) to obtain a uniform particle size.

2. Mixing the Ingredients

- **Binder Addition:** Add starch or suitable binder (e.g., PVP or starch solution) to the Arjuna bark powder to enhance cohesiveness.
- **Disintegrants:** Add sodium starch glycolate or starch to ensure proper disintegration of tablets in the stomach.
- **Lubricants:** Add magnesium stearate to prevent sticking during compression.
- **Fillers:** Add cellulose or lactose to increase bulk and improve tablet size.

3. Granulation Process

- **Wet Granulation**
- A small quantity of binder solution is added to the powder mixture to form a wet mass.
- The wet mass is passed through a sieve (e.g., sieve no. 16 or 22) to form granules.
- The granules are dried in an oven (around 60–65°C) or air-dried.
- The dried granules are sieved again to obtain uniform size.^[12]

4. Capsule Filling Process

- **Sizing of Granules:** The dried granules are passed through a sieve (e.g., sieve no. 20–40) to obtain uniform size suitable for capsule filling.
- **Lubrication:** Add a small quantity of lubricant such as magnesium stearate (≈ 0.5 –1%) to improve flow properties and prevent sticking.
- **Blending:** The granules are mixed uniformly in a blender to ensure even distribution of all ingredients.
- **Capsule Shell Selection:** Select appropriate hard gelatin capsules (e.g., size 0 or size 00) depending on the required dose.
- **Filling Process**
- The prepared granules were filled into empty capsule shells either manually or with the help of a capsule filling machine.
- Each capsule was filled to ensure a consistent and uniform weight of granules.

- After filling, the capsule bodies were securely closed by locking them with their corresponding caps.



Finger 4: capsule of Theobroma cocoa powder and arjuna bark powder.

Evaluation Parameter for Formulated capsule^[14]

1. Weight Variation Test

- capsules are selected randomly and weighed individually.
- The average weight is calculated.
- Individual capsule weights are compared with the average weight.

Result: The weight variation of capsules was found within $\pm 5\text{--}10\%$, which is within acceptable pharmacopeial limits.

2. Disintegration Test

Six tablets were randomly selected and placed on their Handles in six channels on the shelf of the folding Machine. The metal is raised and lowered at a constant Rate in deionized water in a glass beaker suspended in A water bath whose temperature is maintained at $37 \pm 1^\circ\text{C}$. The time required for the final mass or part of it To pass through a 2 mm mesh in water (depleted water) Is recorded as the settling time.^[15]



Figure 5: Disintegration test.

Result: The capsules disintegrated within 20–30 minutes, which is within the normal acceptable range.

3. Dissolution Test

Capsules were subjected to *in vitro* dissolution using USP dissolution apparatus in suitable medium at $37 \pm 0.5^\circ\text{C}$. Samples were withdrawn at specific time intervals and analysed.^[15]



Figure 6: Dissolution test.

Result: More than 75% of drug release ($Q \geq 75\%$) was observed within the specified time, indicating good dissolution.

4. Moisture Content (Loss on Drying)

Capsules were weighed and dried in a hot air oven at 105°C until constant weight was obtained. The loss in weight was calculated as percentage moisture content.^[16]

Result: The moisture content was found to be $\leq 5\%$, indicating good stability and suitability of the formulation.

Evaluation parameters of anticancer activity

1. Cytotoxicity Assay Procedure (MTT Assay)^[17]

Procedure

1. C Cancer cells are cultured in a 96-well plate and incubated at 37°C in an atmosphere containing 5% CO₂ .
2. Various concentrations of the formulation (such as cacao and arjuna extract) are then added to the wells.
3. The cells are further incubated for 24–48 hours.
4. After incubation, MTT reagent is introduced into each well and allowed to react for 3–4 hours.
5. Viable cells convert the reagent into purple formazan crystals.
6. DMSO is added to dissolve these crystals.
7. Finally, the absorbance is measured at 570 nm using a UV spectrophotometer.

Result: Calculate % cell inhibition and IC₅₀ value.

2. Cell Viability Test Procedure (Trypan Blue Method)^[18]

Procedure

1. Take Cells are cultured and then harvested to prepare a cell suspension.
 2. An equal volume of the cell suspension is mixed with Trypan blue dye.
 3. The mixture is then loaded onto a hemocytometer.
 4. It is observed under a microscope.
 5. The cells are counted accordingly.
- **Live cells** → colorless
 - **Dead cells** → blue

Result: (Number of viable cells / Total cells) × 100

RESULTS AND CONCLUSION

The formulation of Theobroma cacao powder and Terminalia arjuna (Arjuna bark) powder capsules demonstrated favorable outcomes in both physicochemical properties and pharmaceutical performance. The prepared granules exhibited good flow characteristics,

ensuring uniform capsule filling. The evaluation studies revealed that the capsules complied with pharmacopeial standards for weight variation, disintegration time, dissolution, and content uniformity. The capsules showed consistent drug release patterns and maintained stability under different storage conditions without significant changes in their physical and chemical properties.

The results from this study suggest that the combination of *Theobroma cacao* and *Terminalia arjuna* powders in capsule form could be a promising herbal formulation for supportive cancer management. Both components are known to possess antioxidant and potential anticancer properties, which may contribute to reducing oxidative stress and improving overall therapeutic outcomes. The formulation exhibited good physicochemical characteristics, uniform drug distribution, and satisfactory release profile, indicating its suitability as an oral dosage form.

The findings highlight the potential of this herbal capsule as a natural and cost-effective alternative in cancer therapy. However, further studies including *in vitro* anticancer assays, *in vivo* investigations, and clinical trials are required to establish its efficacy and long-term safety in cancer patients.

FEATURE SCOPE

1. Conduct comprehensive *in vitro* anticancer studies using various cancer cell lines to assess cytotoxic effects.
2. Carry out *in vivo* experiments on appropriate animal models to evaluate pharmacological activity and safety.
3. Analyze the bioavailability and pharmacokinetic profile of compounds present in *Theobroma cacao* and *Terminalia arjuna*.
4. Investigate the underlying mechanisms of action of the bioactive constituents from both plants.
5. Examine the antioxidant properties and their role in cancer prevention.
6. Assess the ability of the formulation to induce apoptosis in cancer cells.
7. Study its potential to inhibit the proliferation of cancer cells.
8. Optimize formulation variables such as dosage, component ratio, and drug release characteristics.
9. Design and develop modified or sustained-release capsule formulations to enhance therapeutic efficacy.

10. Explore targeted drug delivery approaches to improve treatment effectiveness.
11. Evaluate long-term toxicity and stability of the formulation.
12. Investigate its possible application as a supportive and adjunct therapy in cancer treatment.

REFERENCES

1. Jean-Marie, E.; Bereau, D.; Robinson, J.C. Benefits of Polyphenols and Methylxanthines from Cocoa Beans on Dietary Metabolic Disorders. *Foods*, 2021; 10: 2049.
2. Goya, L.; Kongor, J.E.; de Pascual-Teresa, S. From Cocoa to Chocolate: Effect of Processing on Flavanols and Methylxanthines and Their Mechanisms of Action. *Int. J. Mol. Sci.*, 2022; 23: 14365.
3. Verna, R. The History and Science of Chocolate. *Malays. J. Pathol*, 2013; 35: 111–121.
4. Kim, J.; Kim, J.; Shim, J.; Lee, C.Y.; Lee, K.W.; Lee, H.J. Cocoa Phytochemicals: Recent Advances in Molecular Mechanisms on Health. *Crit. Rev. Food Sci. Nutr.*, 2014; 54: 1458–1472.
5. Martin, M.Á.; Ramos, S. Impact of Cocoa Flavanols on Human Health. *Food Chem. Toxicol.*, 2021; 151: 112121.
6. Katz, D.L.; Doughty, K.; Ali, A. Cocoa and Chocolate in Human Health and Disease. *Antioxid. Redox Signal.*, 2011; 15: 2779.
7. Badrie, N.; Bekele, F.; Sikora, E.; Sikora, M. Cocoa Agronomy, Quality, Nutritional, and Health Aspects. *Crit. Rev. Food Sci. Nutr.*, 2015; 55: 620–659.
8. Andújar, I.; Recio, M.C.; Giner, R.M.; Ríos, J.L. Cocoa Polyphenols and Their Potential Benefits for Human Health. *Oxid. Med. Cell. Longev.*, 2012; 2012: 906252.
9. Martin, M.A.; Goya, L.; Ramos, S. Potential for Preventive Effects of Cocoa and Cocoa Polyphenols in Cancer. *Food Chem. Toxicol.*, 2013; 56: 336–351.
10. Martin, M.Á.; Goya, L.; Ramos, S. Antidiabetic Actions of Cocoa Flavanols. *Mol. Nutr. Food Res.*, 2016; 60: 1756–1769.
11. Edo, G.I.; Samuel, P.O.; Oloni, G.O.; Ezekiel, G.O.; Onoharigho, F.O.; Oghenegueke, O.; Nwachukwu, S.C.; Rapheal, O.A.; Ajokpaoghene, M.O.; Okolie, M.C.; et al.⁰ Review on the Biological and Bioactive Components of Cocoa (*Theobroma cacao*). *Insight on Food, Health and Nutrition. Nat. Resour. Hum. Health*, 2023; 3: 426–448.
12. Guaadaoui, A.; Benaicha, S.; Elmajdoub, N.; Bellaoui, M.; Hamal, A. What Is a Bioactive Compound? A Combined Definition for a Preliminary Consensus. *Int. J. Nutr. Food Sci.*, 2014; 3: 174–179.

13. Cooper, K.A.; Campos-Giménez, E.; Alvarez, D.J.; Nagy, K.; Donovan, J.L.; Williamson, G. Rapid Reversed Phase Ultra-Performance Liquid Chromatography Analysis of the Major Cocoa Polyphenols and Inter-Relationships of Their Concentrations in Chocolate. *J. Agric. Food Chem.*, 2007; 55: 2841–2847.
14. Di Mattia, C.D.; Sacchetti, G.; Mastrocola, D.; Serafini, M. From Cocoa to Chocolate: The Impact of Processing on in Vitro Antioxidant Activity and the Effects of Chocolate on Antioxidant Markers in Vivo. *Front. Immunol.*, 2017; 8: 1207.
15. Cheng, C.M.; Jalil, A.M.M.; Ismail, A. Phenolic and Theobromine Contents of Commercial Dark, Milk and White Chocolates on the Malaysian Market. *Molecules*, 2009; 14: 200–209.
16. Othman, A.; Ismail, A.; Abdul Ghani, N.; Adenan, I. Antioxidant Capacity and Phenolic Content of Cocoa Beans. *Food Chem.*, 2007; 100: 1523–1530.
17. Aprotosoiaie, A.C.; Luca, S.V.; Miron, A. Flavor Chemistry of Cocoa and Cocoa Products—An Overview. *Compr. Rev. Food Sci. Food Saf.*, 2016; 15: 73–91.
18. Melo, T.S.; Pires, T.C.; Engelmann, J.V.P.; Monteiro, A.L.O.; Maciel, L.F.; Bispo, E. Da S. Evaluation of the Content of Bioactive Compounds in Cocoa Beans during the Fermentation Process. *J. Food Sci. Technol.*, 2021; 58: 1947–1957.