

Herbal functional confection: Nutritional characterization of Shatavari (*Asparagus racemosus*) based chocolate

Samarth Thorve, Viraj Mohite, Ayush Ghotkule, Nitin G. Suradkar*

Department of Food Safety, Quality and Nutrition School of Food Technology, MIT Art, Design and Technology University, Pune, Maharashtra, India

Abstract

This study focuses on the formulation and nutritional characterization of chocolate enriched with *Asparagus racemosus* (Shatavari), a medicinal herb known for its adaptogenic and health-promoting properties. Various formulations were developed by incorporating Shatavari powder at different concentrations (1%, 3%, 5%, and 7%), and their sensory attributes were evaluated using a nine-point hedonic scale. The T2 formulation (3% Shatavari) emerged as the optimal choice, demonstrating high acceptability in terms of color, taste, flavor, texture, and overall sensory appeal. Further analysis of the T2 sample revealed a favorable nutritional profile, with 58.35% carbohydrates, 32.50% fat, 5.74% protein, 1.66% ash, and 1.75% moisture, and an energy value of 548.8 kcal/100g. The incorporation of Shatavari significantly enhanced the micronutrient content, with 5.82 mg/100g calcium, 65.91 mg/100g iron, and 65.86 IU/100g vitamin A, making it a nutritionally enriched functional food. Microbiological analysis confirmed the safety of the product, with a total plate count of 2.0×10^3 CFU/g and a yeast and mold count of <10 CFU/g, complying with both Indian (FSSAI) and international regulatory standards. The findings demonstrate that Shatavari can be successfully integrated into chocolate without compromising its sensory properties, offering a novel functional food with potential health benefits. This study highlights the feasibility of combining traditional medicinal herbs with modern food products to create innovative, health-promoting alternatives.

Keywords: *Asparagus racemosus*, Shatavari, functional chocolate, sensory evaluation, nutritional analysis

Introduction

Chocolate, one of the most widely consumed confectionery products globally, has evolved from a traditional treat to a functional food with potential health benefits. Its primary ingredients, such as cocoa powder, sugar, milk powder, and fats, contribute to its unique sensory properties and nutritional profile. However, the growing demand for healthier food options has led to the development of functional chocolates enriched with bioactive ingredients that offer additional health benefits beyond basic nutrition (Ortiz-Rodriguez *et al.*, 2021) [9]. Functional chocolates fortified with plant-based extracts, such as Shatavari (*Asparagus racemosus*), have gained significant attention due to their potential to combine indulgence with wellness (Patel & Patel, 2020).

Shatavari, a perennial herb native to India, is renowned in Ayurvedic medicine for its adaptogenic, antioxidant, and immunomodulatory properties. The plant is rich in bioactive compounds, including saponins, flavonoids, and polyphenols, which contribute to its therapeutic effects (Singh *et al.*, 2021) [11]. Traditionally, Shatavari has been used to support reproductive health, enhance immunity, and improve digestive function. Recent studies have also highlighted its potential as a functional food ingredient due to its ability to mitigate oxidative stress and inflammation (Sharma & Kumar, 2022) [10]. Incorporating Shatavari into chocolate not only enhances its nutritional value but also aligns with the growing consumer preference for natural and health-promoting products.

The formulation of Shatavari-based chocolate involves the integration of traditional chocolate ingredients, such as sugar, hydrogenated fat, cocoa powder, milk powder, and

soy lecithin, with Shatavari extract. This combination aims to create a product that retains the sensory appeal of conventional chocolate while offering the added health benefits of Shatavari. The use of soy lecithin as an emulsifier ensures a smooth texture, while cocoa powder provides the characteristic flavor and antioxidant properties associated with chocolate (Aprotosoaie *et al.*, 2020) [2]. The inclusion of Shatavari introduces adaptogenic and nutraceutical properties, making the product a potential functional food for health-conscious consumers.

Recent advancements in functional food development have demonstrated the feasibility of incorporating plant-based extracts into chocolate matrices. Studies have shown that such formulations can enhance the nutritional profile of chocolate without compromising its sensory attributes (Granato *et al.*, 2020) [4]. Moreover, the growing body of research on Shatavari's health benefits, including its role in stress reduction, immune support, and hormonal balance, underscores its potential as a valuable ingredient in functional chocolates (Kumar & Pandey, 2021) [7]. The development of Shatavari-based chocolate represents an innovative approach to combining traditional confectionery with modern health trends.

This study aims to formulate and nutritionally characterize Shatavari-based chocolate, focusing on its bioactive composition, sensory properties, and potential health benefits. By leveraging the therapeutic properties of Shatavari and the sensory appeal of chocolate, this research seeks to contribute to the growing field of functional foods and provide consumers with a healthier alternative to conventional chocolate products.

Materials and Methods

The material was procured from Pune city.

Formulation of Chocolate

Chocolate was prepared with varying concentrations of *Asparagus racemosus* (Shatavari) powder, replacing sugar partially in the formulations. The formulations included a control sample (0% Shatavari) and four experimental treatments (T1–T4) with 1%, 3%, 5%, and 7% Shatavari powder, respectively.

The preparation of Shatavari-based chocolate begins with the mixing of cocoa powder and milk powder in a dry mixing bowl to ensure uniform distribution. Following this, hydrogenated fat is added to the mixture and thoroughly mixed to create a smooth and consistent base. The mixture is then subjected to gentle heating at 50 °C to melt the fat and achieve a homogeneous consistency. Once the base is prepared, sugar, Shatavari powder, and soy lecithin are incorporated into the mixture. The soy lecithin acts as an emulsifier, enhancing the texture and stability of the chocolate. For flavor enhancement, vanilla essence is added and mixed well. The prepared mixture is then poured into chocolate moulds, and the moulds are gently tapped to remove any air bubbles. The moulds are left to set at room temperature for 2 hours, allowing the chocolate to solidify. After solidification, the chocolate is demoulded and packaged in airtight containers. Finally, the chocolate is stored at 4 °C to maintain its quality and extend its shelf life. This step-by-step process ensures the production of a high-quality, functional chocolate enriched with the health benefits of Shatavari.

Flow chart for chocolate preparation-

- Mixing of coco powder and milk powder
- Addition of hydrogenated fat
- Gentle Heating (50 °C)
- Addition of sugar, shatavari and lecithin
- Addition of vanilla essence
- Pour the mixture into mould
- Set at room temperature for 2 hours
- Chocolate
- Packaging & Storage at 4 °C

Table 1: Formulation of *Asparagus racemosus* based chocolate

Treatments Ingredients (g/100g)	Control	T1	T2	T3	T4
Sugar (powder)	40	39	37	35	33
Hydrogenated fat	30	30	30	30	30
Cocoa Powder	15	15	15	15	15
Milk Powder	14.55	14.55	14.55	14.55	14.55
Soy Lecithin	0.40	0.40	0.40	0.40	0.40
Vanilla	0.05	0.05	0.05	0.05	0.05
Shatavari	00	01	03	05	07

- **Sensory Evaluation:** A panel of trained judges assessed the samples for color & appearance, taste, flavor, texture, mouthfeel, and overall acceptability using a 9-point hedonic scale (Garcia & Lee, 2020).
- **Physicochemical Analysis:** The selected sample (T2) was analyzed for total carbohydrates, fat, protein, ash content, moisture, and energy value using standard AOAC methods (AOAC, 2019) [1].

- **Mineral and Vitamin Content Analysis:** Calcium, iron, and vitamin A content were determined through spectrophotometric methods (Wilson *et al.*, 2021).
- **Microbial Analysis:** The total plate count and yeast & mold count were assessed to ensure microbiological safety (Jones *et al.*, 2022).

Results and Discussion

Sensory Evaluation:

The sensory evaluation of Shatavari (*Asparagus racemosus*)-based chocolate was conducted using a nine-point hedonic scale to assess the impact of Shatavari powder incorporation on various sensory attributes, including color and appearance, taste, flavor, texture, mouthfeel, and overall acceptability. The results, as presented in Table 2, reveal that the addition of Shatavari powder influenced the sensory properties of the chocolate, with varying degrees of acceptability across different formulations.

Table 2: Sensory evaluation of *Asparagus racemosus* based chocolate

Treatments	Colour & Appearance	Taste	Flavour	Texture	Mouthfeel	Overall acceptability
Control	9	8.5	8	8.5	9	8.6
T1	8.5	8	7.4	8.4	8	8.0
T2	8.5	8.3	7.8	8.5	8	8.3
T3	8.3	8.1	7.5	8.3	7.5	7.8
T4	8	7.9	7.2	7.8	7	7.5

Sensory Scores and Interpretation

The control sample, which contained no Shatavari powder, received the highest overall acceptability score of 8.6, indicating its superior sensory profile. This is consistent with the findings of Ortiz-Rodriguez *et al.* (2021) [9], who reported that conventional chocolate formulations typically score higher in sensory evaluations due to their familiar taste and texture. Among the Shatavari-enriched formulations, T2 (3% Shatavari) emerged as the most acceptable, with an overall score of 8.3, closely followed by T1 (2% Shatavari) with a score of 8.0. The sensory scores for T3 (4% Shatavari) and T4 (5% Shatavari) were lower, at 7.8 and 7.5, respectively, suggesting that higher concentrations of Shatavari may negatively impact the sensory attributes of the chocolate.

The sensory evaluation of Shatavari (*Asparagus racemosus*)-based chocolate revealed that the T2 formulation, containing 3% Shatavari powder, achieved the highest overall acceptability score on the 9-point hedonic scale. This formulation scored well across all attributes—color, taste, flavor, texture, and mouthfeel—compared to other treatments. As the concentration of Shatavari increased beyond 3%, a noticeable decline in sensory appeal was observed. T4 (7%) showed lower scores, likely due to the strong herbal undertones interfering with chocolate's natural flavor profile.

This trend is consistent with findings by Monteiro *et al.* (2023), who observed that dark chocolate enriched with 3% baobab pulp received the highest sensory ratings, while higher inclusion levels negatively affected flavor and texture. The sensory balance at moderate fortification levels appears to be a common pattern in functional chocolate development.

Moreover, Gore *et al.* (2024) noted similar results in multivitamin herbal chocolate formulations, where the use

of herbs like Tulsi, Moringa, and Beetroot improved the taste up to a certain level but caused bitterness or aftertaste when added excessively

The overall acceptability scores clearly indicate that the control sample was the most preferred, followed by T2 (8.3). The gradual decline in scores with increasing Shatavari concentration (T3: 7.8, T4: 7.5) highlights the importance of optimizing the concentration of bioactive ingredients to maintain sensory appeal. This is consistent with the findings of Guinard and Mazzucchelli (2022) [5], who emphasized that sensory acceptability is a critical factor in the success of functional food products.

Based on the sensory evaluation, T2 (3% Shatavari) was identified as the optimal formulation, as it maintained high scores across all sensory attributes while incorporating the health benefits of Shatavari. This formulation achieved a balance between functionality and sensory acceptability, making it suitable for further analysis and potential commercialization.

Physicochemical Properties

The physicochemical properties of the optimal Shatavari-enriched chocolate formulation (T2) were evaluated to determine its macronutrient composition and energy value. The results, as presented in Table 3, reveal that the incorporation of Shatavari powder did not significantly alter the fundamental nutritional profile of the chocolate. The selected T2 formulation contained 58.35% carbohydrates, 32.50% fat, 5.74% protein, 1.66% ash, and 1.75% moisture, with an energy value of 548.8 kcal/100g. These values are consistent with the typical composition of conventional chocolate, indicating that Shatavari can be incorporated without compromising the product's nutritional integrity.

Table 3: Physico-chemical evaluation of *Asparagus racemosus* based chocolate

Sr. No.	Parameters	Values
1	Total Carbohydrates	58.35 %
2	Total Fat	32.50 %
3	Total Protein	5.74 %
4	Total Ash	1.66 %
5	Moisture	1.75 %
6	Energy	548.8 Kcal/100g

- **Carbohydrates (58.35%):** The carbohydrate content of T2 is comparable to that of conventional chocolate, which typically contains 50–60% carbohydrates, primarily from sugar and cocoa solids (Aprotosoie *et al.*, 2020) [2]. The inclusion of Shatavari did not significantly increase or decrease the carbohydrate content, suggesting that it does not interfere with the chocolate's energy-providing properties.
- **Fat (32.50%):** The fat content of T2 is within the range observed in standard chocolate formulations, which usually contain 30–40% fat, primarily from cocoa butter and milk fat (Ortiz-Rodriguez *et al.*, 2021) [9]. The presence of Shatavari did not alter the fat content, ensuring that the chocolate retained its desirable mouthfeel and texture.
- **Protein (5.74%):** The protein content of T2 is slightly higher than that of conventional chocolate, which typically contains 4–6% protein, mainly from milk

powder and cocoa solids (Granato *et al.*, 2020) [4]. The slight increase may be attributed to the protein content of Shatavari, which is known to contain small amounts of bioactive peptides (Sharma & Kumar, 2022) [10].

- **Ash (1.66%):** The ash content, which represents the mineral content of the chocolate, is consistent with that of conventional chocolate (1–2%). This indicates that Shatavari incorporation did not significantly alter the mineral composition of the product.
- **Moisture (1.75%):** The moisture content of T2 is within the acceptable range for chocolate products (1–2%), ensuring its stability and shelf life. The low moisture content also suggests that the addition of Shatavari did not introduce excessive water activity, which could affect the product's texture and microbial stability.
- **Energy Value:** The energy value of T2 was calculated to be 548.8 kcal/100g, which is comparable to that of conventional chocolate (500–550 kcal/100g) (Martini *et al.*, 2023) [8]. This indicates that the incorporation of Shatavari did not significantly alter the caloric density of the chocolate, making it a suitable option for consumers seeking a balance between indulgence and health benefits.
- **Nutritional Implications:** The physicochemical evaluation of T2 demonstrates that the incorporation of Shatavari does not significantly alter the macronutrient profile or energy value of chocolate. This is consistent with the findings of Patel and Patel (2020), who reported that the addition of plant-based bioactive ingredients to chocolate can enhance its functional properties without compromising its nutritional composition. The results also align with the growing trend of developing functional chocolates that retain their sensory and nutritional appeal while offering additional health benefits (Granato *et al.*, 2020) [4].

Mineral and Vitamin Content

The mineral and vitamin content of the optimal Shatavari-enriched chocolate formulation (T2) was evaluated to assess the impact of Shatavari (*Asparagus racemosus*) incorporation on the micronutrient profile. As shown in Table 4, the T2 chocolate contained 5.82 mg/100g calcium, 65.91 mg/100g iron, and 65.86 IU/100g vitamin A. These values indicate that the inclusion of Shatavari significantly enhanced the micronutrient content of the chocolate, making it a potential functional food with added nutritional benefits.

Table 4: Mineral and Vitamin content of *Asparagus racemosus* based chocolate

Sr. No.	Parameters	Values
1	Calcium	5.82 mg/100g
2	Iron	65.91 mg/100g
3	Vitamin A	65.86 IU/100g

Mineral Content

- **Calcium (5.82 mg/100g):** The calcium content of T2 is higher than that typically found in conventional chocolate, which usually contains 2–4 mg/100g of calcium (Granato *et al.*, 2020) [4]. This increase can be

attributed to the presence of Shatavari, which is known to contain bioavailable calcium in its natural form (Sharma & Kumar, 2022) ^[10]. Calcium is essential for bone health, muscle function, and nerve signaling, and its inclusion in chocolate enhances the product's nutritional value.

- **Iron (65.91 mg/100g):** The iron content of T2 is significantly higher than that of conventional chocolate, which typically contains 1–3 mg/100g of iron (Aprotosoaie *et al.*, 2020) ^[2]. This substantial increase is likely due to the high iron content of Shatavari, which is a rich source of bioavailable iron (Patel & Patel, 2020). Iron is crucial for oxygen transport in the blood and energy metabolism, making this formulation particularly beneficial for individuals at risk of iron deficiency.

Vitamin Content

- **Vitamin A (65.86 IU/100g):** The vitamin A content of T2 is notably higher than that of conventional chocolate, which generally contains negligible amounts of this vitamin. This enhancement can be attributed to the presence of Shatavari, which contains carotenoids and other precursors of vitamin A (Singh *et al.*, 2021) ^[11]. Vitamin A is essential for vision, immune function, and skin health, and its inclusion in chocolate adds to the product's functional properties.

Nutritional Implications

The enhanced mineral and vitamin content of T2 highlights the potential of Shatavari as a functional ingredient in chocolate. The significant increase in iron and vitamin A content is particularly noteworthy, as these micronutrients are often lacking in modern diets. The findings are consistent with recent studies that emphasize the role of plant-based ingredients in improving the nutritional profile of functional foods (Granato *et al.*, 2020; Patel & Patel, 2020) ^[4]. The incorporation of Shatavari not only enhances the micronutrient content of chocolate but also aligns with the growing demand for nutrient-dense food products.

Comparison with Conventional Chocolate

Conventional chocolate is primarily valued for its macronutrient content (carbohydrates, fats, and proteins) and sensory properties, with limited contributions to micronutrient intake. However, the incorporation of Shatavari in T2 significantly improves its micronutrient profile, making it a more nutritionally balanced product. This is particularly relevant in the context of functional food development, where the goal is to combine indulgence with health benefits (Ortiz-Rodriguez *et al.*, 2021) ^[9].

Microbial Analysis

The microbial analysis of the optimal Shatavari-enriched chocolate formulation (T2) was conducted to evaluate its microbiological safety and stability. The results confirmed that the T2 sample met the safety standards for food products, with a total plate count (TPC) of 2.0×10^3 CFU/g and a yeast and mold count of <10 CFU/g. These findings indicate that the chocolate is microbiologically stable and safe for consumption, aligning with the regulatory limits for confectionery products.

Table 5: Microbial count of *Asparagus racemosus* based chocolate

Sr. No.	Parameters	Values
1	Total Plate Count	2.0×10^3 CFU/g

▪ Total Plate Count (TPC)

The total plate count of 2.0×10^3 CFU/g in the T2 sample is well within the acceptable limits for chocolate and cocoa-based products, which typically allow a maximum TPC of 10^4 CFU/g (Granato *et al.*, 2020) ^[4]. This low microbial load can be attributed to the inherent properties of chocolate, such as its low moisture content (1.75%) and high sugar concentration, which create an unfavorable environment for microbial growth (Aprotosoaie *et al.*, 2020) ^[2]. Additionally, the use of hygienic processing practices and the antimicrobial properties of Shatavari may have contributed to the low TPC. Shatavari is known to contain bioactive compounds, such as saponins and flavonoids, which exhibit antimicrobial activity (Sharma & Kumar, 2022) ^[10].

▪ Yeast and Mold Count

The yeast and mold count of <10 CFU/g in the T2 sample is significantly below the regulatory threshold of 10^2 CFU/g for chocolate products (Ortiz-Rodriguez *et al.*, 2021) ^[9]. This low count reflects the product's stability and safety, as yeasts and molds are common spoilage microorganisms in confectionery products. The low moisture content of the chocolate, combined with the antimicrobial properties of Shatavari, likely inhibited the growth of these microorganisms. This finding is consistent with the results of Patel and Patel (2020), who reported that plant-based ingredients with antimicrobial properties can enhance the microbiological stability of functional foods.

▪ Microbiological Stability and Safety

The microbial analysis results confirm that the T2 formulation is microbiologically stable and safe for consumption. The low microbial counts are indicative of effective quality control measures during processing and packaging, as well as the inherent stability of chocolate as a food matrix. These findings are supported by recent studies on the microbiological safety of functional chocolates, which emphasize the importance of maintaining low microbial loads to ensure product safety and shelf life (Martini *et al.*, 2023) ^[8].

▪ Comparison with Regulatory Standards

The microbial counts observed in the T2 sample are well within the limits set by FSSAI and international food safety standards, such as those established by the International Commission on Microbiological Specifications for Foods (ICMSF) and the Food and Agriculture Organization (FAO). For example, the ICMSF recommends a maximum TPC of 10^4 CFU/g and a yeast and mold count of 10^2 CFU/g for chocolate products (Granato *et al.*, 2020) ^[4]. The T2 sample's compliance with these standards underscores its suitability for commercial distribution and consumption.

Conclusion

The development and characterization of Shatavari (*Asparagus racemosus*)-based chocolate represent a significant step forward in the field of functional foods. This study successfully formulated a chocolate product enriched with Shatavari powder, optimizing its concentration to achieve a balance between sensory acceptability and

nutritional benefits. The sensory evaluation revealed that the T2 formulation (3% Shatavari) was the most preferred, with high scores for color, taste, flavor, texture, and overall acceptability. This formulation retained the indulgent qualities of conventional chocolate while incorporating the health-promoting properties of Shatavari.

The physicochemical analysis demonstrated that the T2 chocolate maintained a macronutrient profile similar to conventional chocolate, with 58.35% carbohydrates, 32.50% fat, 5.74% protein, 1.66% ash, and 1.75% moisture, and an energy value of 548.8 kcal/100g. The incorporation of Shatavari did not significantly alter the fundamental nutritional composition, ensuring that the product remained a familiar and enjoyable treat for consumers.

Furthermore, the mineral and vitamin analysis highlighted the enhanced micronutrient content of the T2 chocolate, with 5.82 mg/100g calcium, 65.91 mg/100g iron, and 65.86 IU/100g vitamin A. These values indicate that Shatavari significantly improved the nutritional profile of the chocolate, making it a functional food with added health benefits. The microbial analysis confirmed the product's safety, with a total plate count of 2.0×10^3 CFU/g and a yeast and mold count of <10 CFU/g, well within the limits set by the Food Safety and Standards Authority of India (FSSAI) and international standards.

In conclusion, the Shatavari-enriched chocolate developed in this study is a promising functional food product that combines the sensory appeal of conventional chocolate with the therapeutic properties of Shatavari. Its compliance with regulatory standards, enhanced nutritional profile, and microbiological stability make it a viable option for commercialization. Future research could explore the bioavailability of Shatavari's bioactive compounds in the chocolate matrix, long-term storage stability, and consumer acceptance in diverse markets. This study contributes to the growing body of knowledge on functional foods and underscores the potential of integrating traditional medicinal plants into modern food products to promote health and wellness.

References

1. AOAC. Official Methods of Analysis. Association of Official Analytical Chemists, 2019.
2. Aprotosoae AC, Luca SV, Miron A. Cocoa and chocolate Chemistry, bioavailability, and health effects. *Antioxidants*,2020;9(5):413.
3. Food Safety and Standards Authority of India, FSSAI Food Safety and Standards, Food Products Standards and Food Additives. Regulations, 2011.
4. Granato D, Barba FJ, Bursac Kovačević D, Lorenzo JM, Cruz AG, Putnik P, *et al.* Functional foods Product development, technological trends, efficacy testing, and safety. *Annual Review of Food Science and Technology*,2020;11:93–118.
5. Guinard JX, Mazzucchelli R. Sensory evaluation of functional foods Challenges and opportunities. *Food Quality and Preference*,2022;96:104432.
6. International Commission on Microbiological Specifications for Foods, ICMSF. Microorganisms in Foods 8, Use of Data for Assessing Process Control and Product Acceptance. Springer, 2018.
7. Kumar S, Pandey AK. *Asparagus racemosus* as a functional ingredient in food products A review. *Trends in Food Science & Technology*,2021;112:1–12.
8. Martini S, Conte A, Tagliazucchi D. Functional chocolate A review of bioactive ingredients and health benefits. *Food Research International*,2023;167:112689.
9. Ortiz-Rodriguez MA, Prinyawiwatkul W, No HK. Development of functional chocolate A review. *Journal of Food Science and Technology*,2021;58(10):3711–3722.
10. Sharma K, Kumar V. *Asparagus racemosus* A review on its phytochemical and pharmacological properties. *Phytotherapy Research*,2022;36(4):1456–1470.
11. Singh A, Sharma P, Kumar R. Phytochemical profiling and therapeutic potential of *Asparagus racemosus* A comprehensive review. *Journal of Ethnopharmacology*,2021;267:113593.