Concepts and Analysis of a Floral based Functional Hibiscus Beverage for Enhanced Health Benefits and Future prospects

K. Pavithra[1], O. Aswathy [2], A.R. Aneesh Fathima[3], J. Thiruppavai [4], G. Nageswari [5], K. Mishab Mehaboob[6]
Department of Food Technology, Sri Shakthi Institute of Engineering and Technology, L& T Bypass, Coimbatore, Tamil Nadu, India – 641 062.

***Abstract*—Hibiscus sabdariffa L., is known as roselle, has gained increasing attention as a base for functional beverages due to its rich phytochemical profile and associated health benefits. The calyces of H. sabdariffa contains large amount of anthocyanins, flavonoids, and organic acids, which contribute to its characteristic deep red colour, refreshing taste, and potent antioxidant activity. Functional beverages formulated from hibiscus extracts are known to exhibit antihypertensive, hypolipidemic, hepatoprotective, and antimicrobial properties, making them suitable as natural health-promoting drinks. Moreover, consumer demand for plant-based, caffeine-free, and nutritionally enriched beverages has accelerated the development of hibiscus-based drinks in both traditional and commercial markets. This paper reviews the chemical composition, functional properties, processing methods, and potential applications of H. sabdariffa drinks as natural functional beverages. The review highlights their significance in preventive nutrition and their promising role in the development of sustainable and value-added products in the beverage industry.**

***Index Terms*—Hibiscus sabdariffa, functional beverage, antioxidants, anthocyanins, health benefits, phytochemicals**

I. INTRODUCTION

Functional beverages is rapidly growing product of the global food and beverage industry, offering health-promoting benefits beyond basic. beverage is further supported by innovations in formulation technologies and the increasing popularity of plant-based and fermented beverages, which contribute additional antioxidant and probiotic benefits. nutrition [18]

Functional beverages cover a wide range of categories, including flower-based drinks, dairy-based drinks, energy and sports drinks, probiotic beverages, and fruit or vegetable based formulations. As consumers increasingly prioritize natural, convenient, and healthoriented options, the demand for such drinks continues to grow. Developing a successful functional beverage depends on several factors, including the selection of raw materials, processing methods, sensory properties, compliance with health regulations, and consumer acceptance. [1]

1.1 Flower-Based Drinks: A Growing Trend in Functional Beverages

Flower-based drinks are gaining remarkable attention as functional beverages because of their rich bioactive compounds, appealing Flavors, and health benefits. beverages are often prepared by extracting natural pigments, antioxidants, flavonoids, and polyphenols from edible flowers, enhancing both their nutritional and sensory qualities. Depending .[19]

The development of these drinks involves optimizing extraction methods, flavour balance, and shelf-life stability. Flower based drink have become especially popular among health-conscious consumers seeking natural, refreshing beverages with antioxidant and glycemic regulating properties. [2]

The blue pea flower (Clitoria ternatea) beverage, which has demonstrated strong antioxidant activity, favourable taste characteristics, and high Shelf life . Similarly, floral fermented wines made from indigenous flowers like Mahua (Madhuca longifolia) provide nutritional benefits through their polyphenols and flavonoids and contain lower alcohol content. traditional beverages like Blue pea flower beverage also hold economic importance for local communities. [2]

1.2 Hibiscus sabdariffa Drink (Roselle Juice)

The Hibiscus sabdariffa drink known for its distinctive tart flavour and vibrant red colour. The drink is prepared from the calyces of the Hibiscus sabdariffa plant, it is also studied for its functional properties and health-promoting effects. [3]

The hibiscus drink is Rich in natural antioxidants and helps combat oxidative stress and supports cardiovascular and metabolic health. Rosella is also known for its blood pressure lowering, anti-inflammatory, antidiabetic, and

cardioprotective properties. As a functional beverage, hibiscus contributes valuable bioactive compounds to the diet making it not only a refreshing drink but also a natural health supplement [4]

Hibiscus sabdariffa beverages, commonly known as hibiscus or roselle drink. The main objectiveabout their nutritional composition, phytochemical properties, processing techniques, sensory qualities, health benefits, and market relevance. [11]

1.2.1Health Significance of Hibiscus sabdariffa

Research has shown that hibiscus tea effectively lowers blood pressure in adults, offering a natural dietary approach to managing hypertension without significant dietary changes.[5] The active compounds of hibiscus is responsible for these benefits are anthocyanins and polyphenols. [6].

Hibiscus sabdariffa possesses antihypertensive, antioxidant, antidiabetic, anti-inflammatory, cardioprotective, antibacterial, antiviral, and other biological activities and phytochemicals. [4] hibiscus extracts and teas have been reported to lower cholesterol, reduce inflammation, and support weight management by aiding metabolic regulation. [7]

1.2.2 Functional Roles of Hibiscus sabdariffa

The hibiscus flower serves multiple functions in beverage formulation are Natural Colorants Its rich anthocyanin content gives a colour of red to purple. Also Flavour It gives a tart, fruity, cranberry-like flavour appreciated in both hot and cold drinks. Health Benefits are the infusion is packed with phenolic compounds that provide antioxidant, hypotensive (blood pressure-lowering), and anti-atherosclerotic effects.

Consumption of hibiscus tea has reduced oxidative stress, improved lipid profiles (lower LDL cholesterol and triglycerides), and lower blood pressure .[4] Clinical trials have confirmed that hibiscus tea offers effects comparable to some conventional antihypertensive drugs, thanks to its polyphenols and other phytochemicals, which contribute to cardiovascular protection.

II. REVIEW OF LITERATURE:

2.1. Hibiscus sabdariffa:

Hibiscus sabdariffa (roselle; commonly called bissap, zobo, roselle, sorrel) is grown for its fleshy red calyces, which are dried and used to make hot or cold beverages. The calyx is the principal commercial part used for infusion-based drinks because of its intense red colour, tart cranberry-like flavour and high content of phenolic pigments (anthocyanins) and organic acids. [7]

2.2 Chemical Constituents of Hibiscus sabdariffa:

Anthocyanins delphinidin-3-sambubioside and cyanidin-3-sambubioside are present. they give the characteristic red color and also contribute antioxidant capacity [8]. This pigment (~50-60 % of anthocyanins), (~30-35 %) in calyces. These give the deep red color typical of roselle drinks.[11] Phenolic compounds and flavonoids contribute to antioxidant activity and astringency which may increase the flavor of Drink .[9] Organic acids (citric, malic, hibiscus acid) responsible for tartness and influence pH and shelf stability. The presence of Citric acid (12-20 %), hibiscus acid (13-24 %), malic acid (2-9 %), tartaric acid (~8%) in some calyxes. These contribute to the tart flavour and influence pH of beverage.[11]Vitamins like c and minerals present in various amount. Also soluble solids (Brix): Brix and sweetness are key sensory/quality parameters for commercial drinks. Calyxes of Roselle was found to be rich in ascorbic acid and minerals, especially Calcium and iron. [10] Polysaccharides /carbohydrates the calyces contain fibre, pectin-chain such as arabinogalactans, rhamnose/galacturonic acid chains. These may affect viscosity or mouthfeel in drinks.[10]

Figure 1: Hibiscus sabdariffa plant

Source: (*Shinde et al., 2024)*[20]

2.3. Nutritional value of Hibiscus drink:

The table 2.1 shows that a Specific amount of hibiscus sabdariffa Calyces (250g) which is obtained from 100 ml of brewed hibiscus drink. By consuming this drink the health benefits are improved where the blood pressure is reduced and systolic/diastolic is level is normal. Increases antioxidant capacity, Blood Sugar is controlled, helps in lowering Cholesterol level. Vitamin C content and anthocyanins make hibiscus drinks potent antioxidants, which support immune function and tissue repair.The beverage is naturally

caffeine-free and may be consumed by a broad population for hydration and health benefits. High fiber and low caloric value are beneficial for weight management and gut health

Hibiscus tea is extremely hydrating, with almost 100 grams of water in each cup. The energy (calorie) value is quite low, at just 28 kcal per serving, so it's a good fit for people seeking flavourful beverages with minimal calories. Protein and fat levels are very low, typical of floral or herbal teas, so this drink is not a major source of those macronutrients. The beverage supplies small amounts of minerals such as calcium, magnesium, phosphorus, potassium, and iron. [12]

Table 2.1 Chemical Composition of Dried Hibiscus Calyces which is Brewed Hibiscus Drink, approx. per 100mL)

Chemical composition	Amount* (250g)	Reference
Water	99.6 g	(Barode.,2022)
Energy	28 kcal/cup	(Megan Ware and Amy Murnan., 2024)
Protein	0.5 g	(Anel et al., 2016)
Total Fat	0 g	(Anel et al., 2016)
Carbohydrate	10 g	(Izquierdo-Vega et al., 2020)
Calcium	8-20 mg	(Barode.,2022)
Magnesium	3 mg	(Barode.,2022)
Phosphorous	1 mg	(Barode.,2022)
Potassium	20 mg	(Barode.,2022)
Iron	0.08 mg	(Barode.,2022)
Vitamin C	High	(Anel et al., 2016)
Anthocyanins	(pigments)	(Anel et al., 2016)

2.4 Varies product obtained by Hibiscus sabdariffa:

2.4.1 Hibiscus tea:

Hibiscus tea is made from the dried calyces of Hibiscus sabdariffa, tea is a brightly colored, tart-tasting beverage enjoyed both hot and cold. The drying process helps retain its distinctive anthocyanin pigments and natural organic acids, which not only give the drink its appealing color and tangy flavor but also contribute to potential health benefits such as antioxidant activity and blood pressure regulation[13].The preparation method is simple steeping the dried petals in hot water making it a popular choice for home brewing as well as for commercial herbal tea products.

Figure 2: Hibiscus Tea frm sabdariffa
Source: Hibicus tea (*Shinde et al., 2024)*[20]

2.4.2 Powdered drink mixes:

Instant drink powders made from hibiscus extract or finely ground calyces offer both convenience and a long shelf life. products are often enhanced with flavors like lemon, salt, or sweeteners to balance hibiscus's natural tartness. The manufacturing process usually involves extraction, spray-drying and blending with carriers to improve solubility and preserve color. Mixes dissolve water and Refreshing drinks.[14] Its rich profile of bioactive compounds including phenolics, flavonoids, and tannins. These phytochemicals are known for their antioxidant, cardioprotective, and anti-inflammatory properties, making *H. sabdariffa* an ideal base for nutraceutical formulations. The processed hibiscus calyces powder retains significantly higher concentrations of total phenolic, flavonoids and antioxidant activity.[21]

2.4.3 Syrup of Hibiscus Sabdariffa:

Hibiscus syrups are created by concentrating hibiscus extract with added sugar, acids, or flavor stabilizers to form a richly colored and tangy base for cocktails, mocktails, and sodas.[11] The syrup form offers both visual appeal and utility. It can be easy to transport, store, and mix into different beverages. However, factors like pigment stability, sweetness balance, and microbial safety to ensure quality and shelf life should be maintained.

2.4.4 Ready-to-drink bottled beverages:
Bottled hibiscus drinks are designed for immediate consumption and often marketed as herbal or wellness beverages. ready-to-drink (RTD) formulations are typically pasteurized or sterilized after combining hibiscus extract with water, sweeteners, and sometimes preservatives. [15] Maintaining flavor, color, and freshness during storage is critical, as is packaging that protects the beverage's vivid hue and characteristic tang.

2.4.5 Fermented hibiscus drink:
Hibiscus infusion is a base for fermentation, commonly used in kombucha-style or probiotic beverages. During fermentation, natural yeasts and bacteria transform sugars into organic acids and beneficial compounds, enhancing both the nutritional and sensory profile of the drink. A mildly beverage with a complex, tangy flavor. Controlling of fermentation conditions such as microbial balance, timing, and temperature is necessary to ensure a consistent, safe, and appealing product. [16]

The Hibiscus drink starts by drying the hibiscus flowers and grinding them into a fine powder. This powder is then soaked in water mixed with sugar and salt. After that, the mixture is left to ferment naturally at room temperature with the help of Lactobacillus bacteria for a few days. The final product is a vibrant red drink with a clear, water-like consistency. It carries a pleasant tangy taste that comes from the fermentation process, complemented by subtle hints of lemon and ginger. Not only is this refreshing beverage flavorful, but it is also valued for its potential health benefits.[26]

2.4.6 Functional beverages:
Hibiscus-based drinks can also be developed as functional beverages by enriching them with vitamins, minerals. [17] Product hibiscus provides a natural color, refreshing acidity, and antioxidant compounds, while fortification adds extra nutritional or health-promoting properties. For Functional Beverages ingredient compatibility, especially in the acidic environment of hibiscus to maintain stability, flavor and nutritional value the product's shelf life.

2.5 Methodology:

Dried roselle calyces
↓
Hot water
↓
Calyces/Hot water mixing at different ratios
↓
Hot water extraction
↓
Filtration
↓
Cooling
↓
Unsweetened beverage
↓
Sweetening
↓
Final product (Sweetening beverage)

Figure 3: Methodology of preparation of hibiscus drink(common)

Source: (Bolade et al., 2009)[27]
The preparation of beverage begins with the selection of fresh or dried calyces, known for their rich anthocyanin content and antioxidant properties. The calyces are thoroughly washed. Next the calyces are either used directly for infusion or it is extraction processes. Hot infusion involves steeping the calyces in water at temperatures around 90–100°C for 10–15 minutes, while cold extraction may involve soaking them in water at ambient temperature for several hours. The extract is filtered and can be blended with other fruit pulps or flavouring agents to enhance sensory appeal and nutritional value. Sweeteners such as sucrose or natural alternatives may be added to balance the tartness of hibiscus. The beverage is then cooling and stored under refrigeration to maintain quality and shelf life. [2]

III. ANALYSIS AND DISCUSSION

3.1 Hibiscus sabdariffa Calyces:
The table 2.2 shows that High fibre content (36.10%) supports digestive health and Energy intake regulation. Low fat (1.16%) makes it suitable for heart-healthy diets. Rich in carbohydrates (54.13%) provides energy in 100 ml of calyces drink. (Salami& Afolayan,2020)

Table: 2.2 Nutritional value of Hibiscus sabdariffa Calyces Drink(100ml)

Nutritional value (100ml)	Percentage
Moisture	9.7
Protein	5.7
Fat	1.16
Carbohydrates	54.13
Fiber	36.10
ash	13.74

3.2 Hibiscus sabdariffa Seeds:

The table 2.3 shows that high fiber content (36.10%) promotes digestive health and helps regulate energy intake. Low fat (1.16%) supports dietary plan. Rich carbohydrate content (54.13%) ensures a strong energy supply, particularly it's healthier in dried form dried form in 100 ml of hibiscus drink using their seeds. (Hounkpè et al., 2019.)

Table :2.3 Nutritional value of Hibiscus sabdariffa Seeds Drink (100ml)

Nutritional value(100ml)	Percentage
Moisture	6.0
Protein	27.06
Fat	13.09
Carbohydrates	26.93
Fiber	15.75
ash	6.08

3.3 Hibiscus sabdariffa Leaves:

The table 2.4 shows that high protein content (21.4%) supports muscle growth, repair, and metabolic health. Moderate fiber (12.0%) promotes digestion and helps regulate appetite. Ash content (7.1%) indicates a good supply of essential minerals in 100 ml of by using their leaves. (Balarabe, M. A.,2019)

Table: 2.4 **3** Nutritional value of Hibiscus sabdariffa Leaves Drink(100ml)

Nutritional value (100 ml)	Percentage
Moisture	8.5
Protein	21.4
Fat	1.2
Carbohydrates	58.3
Fiber	12.0
Ash	7.1

IV. CONCLUSION

The development of a functional beverage using Hibiscus sabdariffa, the vibrant potential of hibiscus calyces, seeds and Leaves as a source of natural color and flavor. The antioxidants property and Nutritional composition that support health and wellness. The importance of plant-based innovations in consumer demand for clean label, health forward products. Hibiscus, with its rich phytochemical profile and global heritage, it provides for future research, product development, and sustainable nutrition strategies. Beyond its antioxidant richness, hibiscus exhibits antihypertensive, antidiabetic, anti-inflammatory, and antimicrobial activities, reinforcing its value in preventive nutrition and integrative health strategies. The successful formulation of a hibiscus based drink demand for plant-derived wellness products including herbal teas, fermented beverages, jams, syrups, and nutraceutical supplements.

REFERENCE

[1] Anushree, R. K., & Saho, S. S. (2023). Functional Beverages—A Trend in Beverages. Just Agriculture, Vol. 3 Issue-10.

[2] A Commercial Potential Blue Pea (Clitoria ternatea L.) Flower Extract Incorporated Beverage Having Functional Properties Journal: Evidence-Based Complementary and Alternative Medicine, 2019, Article ID 2916914.

[3] Kumar, P. Y., Singh, N., Sagar, P., & Nanda, A. (2024). Development of floral based fermented drink with Mahua flowers. Asian Journal of Food Research and Nutrition, 4(1), 12–18.

[4] Montalvo-González, E., Villagrán, Z., González-Torres, S., Iñiguez-Muñoz, L. E., Isiordia-Espinoza, M. A., Ruvalcaba-Gómez, J. M., Arteaga-Garibay, R. I., Acosta, J. L., Gonzalez-Silva, N., & Anaya-Esparza, L. M. (2022). Physiological effects and human health benefits of Hibiscus sabdariffa: A review of clinical trials. Pharmaceuticals, 15(4), 464.

[5] Okereke, C. N., Iroka, F. C., & Chukwuma, M. O. (2015). Phytochemical analysis and medicinal uses of Hibiscus sabdariffa. International Journal of Herbal Medicine, 2(6), 16–19.

[6] Edo, G. I., Samuel, P. O., Jikah, A. N., Oloni, G. O., Ifejika, M. N., Oghenegueke, O., Ossai, S.,

Ajokpaoghened, M. O., Asaah, E. U., Uloho, P. O., Akpoghelie, P. O., Ugbune, U., Ezekiel, G. O., Onoharigho, F. O., Agbo, J. J., & Essaghahh, A. E. (2023). Proximate composition and health benefit of Roselle leaf (Hibiscus sabdariffa): Insight on food and health benefits. Food Chemistry Advances, 3, 100437.

[7] V. H. Shruthi, C. T. Ramachandra, Udaykumar Nidoni, Sharanagouda Hiregoudar, Nagaraj Naik, and A. R. Kurubar (2016). "ROSELLE HIBISCUS SABDARIFFA L. AS A SOURCE OF NATURAL COLOUR: A REVIEW." ,Plant Archives, 16(2), 515–522.

[8] Kouakou, T. H., Konkon, N. G., Ayolie, K., Obouayeba, A. P., Abeda, Z. H., & Koné, M. (2015). Anthocyanin production in calyx and callus of Roselle (Hibiscus sabdariffa L.) and its impact on antioxidant activity. Journal of Pharmacognosy and Phytochemistry, 4(3), 1–5.

[9] Riaz, G., Naik, S.N., Garg, M., & Chopra, R. (2021). Phytochemical Composition of an Underutilized Plant Sorrel/Roselle (Hibiscus Sabdariffa L.) Cultivated in India. Applied NanoBioScience, 10(2), 2138–2147.

[10] Vikhe, D.N., Kamble, R.S., & Bhone, V.V. (2023). Phytochemical Potential of Hibiscus Sabdariffa: A Systematic Review. International Journal of Innovative Research in Technology, 10(6), 1–6.

[11] Da-Costa-Rocha, I., Bonnlaender, B., Sievers, H., Pischel, I., & Heinrich, M.(2014). Hibiscus sabdariffa L. – A phytochemical and pharmacological review. Food chemistry,165,424-443.

[12] Singh, P., Khan, M., & Hailemariam, H. (2017). Nutritional and health importance of Hibiscus sabdariffa: A review and indication for research needs. Journal of Nutritional Health & Food Engineering, 6(5), 00212.

[13] Ali, B. H., Al Wabel, N., & Blunden, G. (2015). Hibiscus sabdariffa L.: A phytochemicaland pharmacological review. Journal of Food Science & Technology, 52(11),6791–6805.

[14] Srivastava, P., Kumar, P., & Singh, A. (2019). Development and evaluation of spray-driedhibiscus extract powder as a natural beverage mix. Journal of Food Processing andPreservation, 43(8), e13994.

[15] Ajiboye, B. O., & Ojo, O. A. (2018). Physicochemical stability of ready-to-drink hibiscus beverages during storage. Beverages, 4(4), 101.

[16] Adepoju, A. O., & Olubamiwa, A. O. (2020). Production and sensory evaluation offermented hibiscus drink using mixed cultures of lactic acid bacteria and yeast. AfricanJournal of Biotechnology, 19(2), 76–83.

[17] Eze, J. I., & Okoye, C. O. (2021). Formulation of functional hibiscus-based beveragesfortified with vitamins and adaptogens. Journal of Functional Foods, 82, 104493.

[18] Jain, P. K., Parashar, A. K., & Shrivastava, V. (2025). A review on exploring the health benefits and antioxidant properties of bioactive polyphenols. Discover Food, 5, 367.

[19] A comprehensive review on edible flowers: Phytochemical profile and its food application. The Pharma Innovation Journal, 12(5)

[20] Shinde, S., Wadhai, S., Prajapati, D., Tade, M., & Singh, V. (2024). Hibiscus sabdariffa: The tropical plant with a wealth of health benefit. International Journal of Pharmaceutical Sciences, 2(11), 1046–1064

[21] Hamwenye, K., Shindaadhi, H., Sivhute, E., Hiwilepo-Van Hal, P., & Samundengu, C. (2021). Phytochemical evaluation of Hibiscus sabdariffa powder, jam and yoghurt. International Journal of Herbal Medicine, 9(2), 18–22.

[22] Anel, T. C., Thokchom, R., Subapriya, M. S., Thokchom, J., & Singh, S. S. (2016). Hibiscus sabdariffa – A natural micro nutrient source. International Journal of Advanced Research in Biological Sciences, 3(4), 243–248

[23] Barode,S. Hibiscus Tea: Uses, Benefits, Side Effects. PharmEasy.

[24] Ware, M., & Murnan, A. (2024). Hibiscus tea benefits and nutrition. Medical News Today.

[25] Izquierdo-Vega, J. A., Arteaga-Badillo, D. A., Sánchez-Gutiérrez, M., Morales-González, J. A., Vargas-Mendoza, N., Gómez-Aldapa, C. A., Castro-Rosas, J., Delgado-Olivares, L., Madrigal-Bujaidar, E., & Madrigal-Santillán, E. (2020). Organic acids from Roselle (Hibiscus sabdariffa L.)—A brief review of its pharmacological effects. Biomedicines, 8(5), 100.

[26] Shukla, I., & Mhalaskar, S. R. (2021). Preparation of China rose fermented drink. International Journal of Research in Engineering and Science, 9(7), 29–31.

[27] Bolade, M. K., Oluwalana, I. B., & Ojo, O. (2009). Commercial practice of roselle (Hibiscus sabdariffa L.) beverage production: Optimization of hot water extraction and sweetness level. World Journal of Agricultural Sciences, 5(2), 204–208.