FORMULATION AND EVALUATION OF DIABETIC-FRIENDLY HERBAL ENERGY BAR USING HIBISCUS

[1]Aher Manjusha B.,[2] Nehe Anushka S., [3] Itkar Pragati P.,
[1] Vidya Niketan Institute of Pharmacy, Bota.
[2,3] Vidya Niketan Institute of Pharmacy, Bota, Sangmner,Ahilyanagar,India.

Abstract:
The rising prevalence of diabetes mellitus necessitates the development of functional snacks that balance nutrition with glucose control. This study formulate a diabetes-friendly herbal energy bar utilizing hibiscus sabdariffa, a botanical rich anthocyanins and organic acids. The base consisted of oats, nuts, seeds, sweetened with low-glycemic alternatives.
Physicochemical analysis revealed optimal moisture levels for self-stability and a texture profile comparable to commercial energy bar. Sensory panels rated the bar highly for flavor and texture, nothing that the tartness of the hibiscus effectively balance the sweetness of the sugar substitutes. These findings suggest that the hibiscus-based energy bar is a viable functional food for diabetic dietary intervention.
Nutritional evaluation indicated a high fiber content and the presence of bioactive compounds contributing to antioxidant activity. The formulated product exhibited promising results in terms of total phenolic content and free radicals scavenging capacity, suggesting its potential role in reducing oxidative stress associated with diabetes. Microbial analysis confirmed the safety and stability of the product over a defined storage period. The incorporation of natural ingredients enhances its acceptability among health-conscious consumers.
Hibiscus is well-documented for its high content of anthocyanins, organic acids, and vitamin C, which contribute to improved cardiovascular health, enhanced immunity, and reduced oxidative stress. The energy bar was prepared using a blend of oats, nuts, seeds, natural sweeteners, and dried hibiscus calyces to achieve a balance of macronutrients and bioactive compounds. Sensory evaluation indicated favorable acceptability in terms of taste, texture, and color, while proximate analysis confirmed significant levels of dietary fiber, protein, and essential micronutrients. Antioxidant assays demonstrated that hibiscus fortification enhanced free radical scavenging activity compared to conventional formulations.
Keywords: Hibiscus sabdariffa, diabetes, herbal energy bar, functional food, anthocyanin, phenolic compounds, low glycemic index.

INTRODUCTION:

Hibiscus:

Numerous kinds of bioactive chemicals found in plants have been linked to the prevention and treatment of chronic health conditions such cancer, inflammation, cardiovascular disease, and hypertension. Additionally, plants are being investigated as natural pigment sources for food coloring that are safer, less harmful, and exhibit advantageous qualities like antioxidant activity. Anthocyanins are chemicals found in plants that show promise for usage as coloring components. Hibiscus sabdariffa L., is an annual herbaceous medicinal plant that is a member of the Malvaceae family. Although it is indigenous to Asia, it is also extensively grown in numerous regions, including as Africa and Central America. This plant has three distinct genotypes: green, red (the most often used variety), and dark red. It is typically grown for its fibers and cycles.

Diabetic Mellitus

Persistent hyperglycemia brought on by deficiencies in insulin secretion, action, or both is a hallmark of diabetes mellitus, a chronic metabolic disease. The world health organization reports that the prevalence of diabetes has significantly increased globally, impacting over 800 million people, making it a serious public health issue. Growing interest in the creation of functional meals that can help with glycemic management while offering sufficient nutrition has resulted from the rising prevalence of diabetes. Because of its abundance of bioactive substances like anthocyanins, flavonoids, and organic acids, Hibiscus sabdariffa has become one of the most promising natural ingredients. According to studies, hibiscus may aid in lowering blood sugar levels, enhancing insulin sensitivity, and avoiding oxidative stress linked to consequences from diabetes. The delivery of such medicinal chemicals is made convenient and acceptable by functional food products, especially energy bars. For those with diabetes, energy bars made with low-GI ingredients like oats, almonds, and seeds together with herbal additions like hibiscus can be a good food choice. Including hibiscus in an energy bar improves its nutritional profile and offers additional health advantages due to its antidiabetic properties. Thus, the creation and assessment of a diabetes-friendly herbal energy bar enhanced with hibiscus is the main objective of this study.

In the food business, the calyx plays a significant commercial role in the manufacturing of meals and drinks such tea, juices, jams, jellies, and syrup. Around the world, hibiscus herbal tea is frequently used as the only component of herbal infusions. The leaves are also eaten as a leafy green vegetable in several nations. The intake of the fresh or dried calyces, seeds, and leaves of H. sabdariffa, which are used to make fermented drinks, herbal medications, and even cooked raw, has been documented in a number of studies. Some publications have already examined the phenolic compound content of H. sabdariffa. These substances have demonstrated bioactive qualities like antioxidant, anti-inflammatory, antibacterial, antitumor, and hepatoprotective potential in addition to their well-known coloring potential. As a result, they can serve as both natural colorants and health-promoting substances. Therefore, H. sabdariffa's multifunctional qualities (colorant and bioactive properties) can be investigated in the food and pharmaceutical industries as natural ingredients to be added to food products (e.g., as a multifunctional ingredient) and pharmaceutical industries (e.g., as a natural colorant and for its bioactive properties).[1]

Healthy Benefits of Hibiscus:

The dietary habits of society have altered due to the trend of healthy lifestyles. In addition to taking into account sensory qualities like flavor, taste, and sight, the populace chooses to eat foods that offer extra health benefits. Because edible flowers are so appealing, the market for functional foods is experiencing a rise in demand . Roselle (Hibiscus sabdariffa L.) is one of the most popular edible flowers. The floral calyx, which has therapeutic value, is the most commonly used portion of the roselle plant. Roselle is traditionally infused with its petals and offered hot or cold as a nutritious beverage. Roselle is currently used in a variety of products, such as meals, cosmetics, and medications.[2]

Numerous phytochemical substances have been found in the calyx, but phenolics are thought to be the most important in offering a variety of health benefits. Flavonoids and phenolic acids are among the phenolic chemicals present in roselle calyces. Numerous health advantages, including lipid-lowering action and antihypertensive, antibacterial, antidiabetic, antioxidant, nephroprotective, hepatoprotective, renal/diuretic, and anti-cholesterol effects, have been demonstrated for these substances. The majority of roselle's functional qualities that guarantee population health advantages have been described in earlier reviews and meta-analyses.[3]

Energy Bar:

Energy bars are ready-to-eat, portable food items that provide a nutritious snack. However, the majority of commercially available energy bars are unsuitable for people with diabetes due to their high sugar content. Thus, employing hibiscus to create a herbal energy bar that is suitable for those with diabetes may be a useful strategy. The creation and assessment of a hibiscus-based energy bar utilizing natural components and low-glycemic sweeteners is the main objective of this study. This product seeks to improve blood glucose control while offering diabetics a wholesome, nourishing, and practical snack alternative. A multimodal strategy is necessary for the effective management of diabetes, involving medication, consistent exercise, and above all dietary control. Maintaining ideal blood glucose levels is mostly dependent on diet. Eating foods with a high glycemic index causes blood glucose levels to surge quickly, which can make the disease worse. As a result, eating diets that are nutritionally balanced, high in dietary fiber, and low in glycemic index is becoming more and more important. The idea of functional foods has received a lot of attention lately in relation to the treatment of long-term conditions like diabetes.[4]

Table: Taxonomical Classification[5]

Kingdom	Plantae
Subkingdom	Tracheobionota
Division	Magnoliophyta
Class	Magnoliopsida
Order	Malvales
Family	Malvaceae
Genus	Hibiscus
Species	Hibiscus sabdariffa/ H. rosa-sinensis

Hibiscus Flower[6]

Common Names:

The plant commonly known as hibiscus has many everyday names depending on the species, region, and use. Here are some of the most common ones.

Roselle (especially for Hibiscus sabdariffa, used in drinks and food) China rose (for Hibiscus rosa-sinensis, a popular ornamental plant).[7]

Geographical distribution:

Hibiscus is a genus of flowering plants that is mainly distributed in tropical and subtropical regions of the world. Its natural range includes Asia, Africa, and the Pacific Islands, with some species also found in the Americas. For example, Hibiscus rosa-sinensis is

widely cultivated in Asia, while Hibiscus sabdariffa is native to Africa and commonly used for food and beverages. Certain species, such as Hibiscus moscheutos, can also grow in temperate regions. Hibiscus plants generally prefer warm climates, adequate rainfall, and plenty of sunlight, which is why they thrive best in tropical environments.[8]

Parts used:

Different parts of the Hibiscus plant are used for various purposes, especially in food, medicine, and traditional practices. The flowers are the most commonly used part; they are used to make herbal teas, juices, and natural dyes, particularly in species like Hibiscus sabdariffa. The leaves are also edible in some species and are used in salads, soups, or traditional remedies. The calyx (the fleshy part surrounding the flower) is widely used for making beverages, jams, and jellies due to its tangy flavor. In addition, the roots are sometimes used in traditional medicine for their potential health benefits, and the seeds can be used for oil extraction or occasionally consumed.[9]

Pharmacological Activities:[10]

Antidiabetic activity:

Numerous experimental and clinical studies have demonstrated the promise antidiabetic efficacy of hibiscus flowers, especially those from Hibiscus rosa-sinensis and Hibiscus sabdariffa. The presence of bioactive substances with potent antioxidant qualities, such as flavonoids, anthocyanins, polyphenols, and organic acids, is largely responsible for its positive effects.

Antioxidant Activity:

Because of its high concentration of bioactive substances like anthocyanins, flavonoids, phenolic acids, and vitamin C, hibiscus, particularly species like Hibiscus sabdariffa and Hibiscus rosa- sinensis, is widely known for having potent antioxidant activity.

Antihypertensive activity:

Numerous studies have examined Hibiscus sabdariffa's antihypertensive properties, which are ascribed to the plant's abundance of bioactive substances such anthocyanins, flavonoids, and organic acids.

Anti-inflammatory activity:

Because of its abundance of bioactive substances including flavonoids, anthocyanins, and phenolic acids, hibiscus, especially Hibiscus rosa-sinensis and Hibiscus sabdariffa, has been extensively researched for its anti-inflammatory properties. By blocking important inflammatory mediators like prostaglandins, nitric oxide, and pro-inflammatory cytokines like interleukins and tumor necrosis factor-alpha (TNF-α), these substances significantly reduce inflammation.

Hypolipidemic activity:

Hibiscus, especially Hibiscus sabdariffa (sometimes called roselle), has been extensively researched for its hypolipidemic action, or capacity to reduce blood lipid levels. The plant's lipid- lowering properties are attributed to bioactive substances like anthocyanins, flavonoids, polyphenols, and organic acids. These substances are thought to improve the liver's overall lipid metabolism, increase the excretion of bile acids, and prevent the intestines from producing and absorbing cholesterol.

MATERIAL AND METHODS

This is prepared by materials used include Hibiscus sabdariffa powder as the main antidiabetic ingredient, along with oats and ragi as low glycemic base materials. Nuts and seeds provide protein, fiber, and healthy fats. Stevia act as sweeteners, while dates serve as binding and texture-enhancing agents.[11]

Ingredients include are:

1. **Hibiscus powder**
2. **Cinnamon powder**
3. **Ragi flour**
4. **Dates**
5. **Almonds**
6. **Flaxseeds**
7. **Oats**
8. **Stevia**

Botanical Profile of Hibiscus

Botanical Name	*Hibiscus sabdariffa*
Family	Malvaceae
Common name	Roselle, red sorrel, gongura (in some regions).
Origin	Tropical Africa, Northeast and central Africa, India, Southeast Asia.

Method of preparation:

1. **Dry roasting (flavor & stability)**
   Roast ragi flour, oats, and flaxseed separately on low flame. Continue until aromatic (do not burn).
   Cool completely.
2. **Prepare natural binding paste**
   Soak dates in warm water for 10–15 minutes.
   Blend into a smooth paste (this acts as the main binder and sweetener).

3. Mixing dry ingredients

In a large bowl, combine:
Roasted ragi flour, Oats, Almonds, Flaxseed, Hibiscus powder, Cinnamon powder, Mix evenly.

4. Forming the dough

Add date paste gradually to dry mix.
Add stevia for extra sweetness
Mix until a thick, sticky dough forms.
Add small amounts of water only if required. Add ghee if needed for softness.

5.Shaping

Transfer mixture into a lined tray.
Press firmly using a flat spoon or roller to compact it. Thickness: ~1–1.5 cm.

6.Setting

Choose one method:
Refrigeration method: Chill for 2–3 hours
Baking method (optional): Bake at 160°C for 10–12 minutes for firmer bars

7.Cutting & storage

Cut into rectangular bars once set. Store in airtight container
Refrigerator: up to 10 days

EVALUATION TEST[12]

1) Organoleptic Evaluation:

An organoleptic (sensory) test evaluates a product using the human senses- appearance, aroma, taste, texture, and overall acceptability. For diabetic-friendly hibiscus energy bar, the test should focus not just on enjoyment but also on how well the product balances sweetness, flavor and texture without high sugar.

2)Physicochemical evaluation:

Parameters:

1.Weight variation

Weigh 3–5 bars individually using a digital balance and compare their weights.

2.Moisture content

Weigh a sample, dry it in a hot air oven, then reweigh. Difference in weight indicates moisture. Result: Low moisture content for better shelf life.

3)Nutritional Evaluation:

Carbohydrate content

Calculate from ingredient composition or by standard nutritional analysis. Result: Controlled carbohydrate level.

Protein content

Estimate from ingredient composition (nuts, seeds, flour). Result: Moderate protein content.

Fat content

Estimate mainly from almonds and flaxseeds using nutritional calculation. Result: Healthy fat from nuts/seeds.

Fig. Final Product

RESULT AND DISCUSSION:

Result:

The hibiscus-containing diabetic-friendly energy bar exhibited acceptable physical and sensory qualities. The bars had a compact appearance, no obvious flaws, and a consistent weight and shape. The presence of roasted ragi and hibiscus was primarily responsible for the reddish-brown hue. It had a good, slightly distinctive smell. The texture was firm, chewy, and non-sticky, while the flavor was slightly tangy and sweet.

Additionally, the formulation demonstrated good nutritional appropriateness for usage by people with diabetes. Stevia helped lessen the need for extra sugar, and ingredients like flaxseed, almonds, and oats provided dietary fiber and healthy fats. In terms of quality, palatability, and anticipated nutritional content, the prepared bar was deemed acceptable overall.

Discussion:

The current recipe was created to create an energy bar that is nutritionally balanced and appropriate for diabetics. The formulation's functional and sensory qualities were enhanced by the addition of hibiscus. A distinctive reddish hue, a slight acidity, and bioactive substances like anthocyanins, flavonoids, and phenolic compounds all of which are extensively researched for their antioxidant properties were contributed by hibiscus. The natural organic acids found in hibiscus are responsible for the product's modest acidity. In addition to enhancing flavor balance, this slight acidity may partially aid in preservation. The energy bar's fiber content was greatly increased by the addition of ragi and oats. Because it can decrease stomach emptying and lower the rate of glucose absorption, dietary fiber is particularly crucial in diabetic-friendly goods. This could lessen the blood glucose response after meals.

In conclusion, by offering regulated sweetness, reduced glycemic effect, and improved functional advantages, the diabetic-friendly hibiscus energy bar provides a nutritionally superior substitute for traditional marketed energy bars. Hibiscus reduces the need for excessive sugar while promoting general health by adding natural antioxidants and a delightful tart flavor. Better satiety and prolonged energy release are also encouraged by the usage of fiber-rich and minimally processed products. As a result, this formulation is a promising functional food product that is better suited for people with diabetes and those looking for healthier snack options.

Additionally, using healthy foods like whole grains, nuts, and seeds boosts the fiber and good fat content, which improves digestion, prolongs satiety, and releases energy over time. Because of this, the bar is especially appropriate for people who have diabetes, prediabetes, or who want to manage their weight and lead better lifestyles. Commercial energy bars frequently lack the targeted health advantages and balanced nutrition included in this formulation, despite the fact that they may be more convenient and have a longer shelf life.

CONCLUSION:

In conclusion, by offering regulated sweetness, reduced glycemic effect, and improved functional advantages, the diabetic-friendly hibiscus energy bar provides a nutritionally superior substitute for traditional marketed energy bars. Hibiscus reduces the need for excessive sugar while promoting general health by adding natural antioxidants and a delightful tart flavor. Better satiety and prolonged energy release are also encouraged by the usage of fiber-rich and minimally processed products. As a result, this formulation is a promising functional food product that is better suited for people with diabetes and those looking for healthier snack options.

Additionally, using healthy foods like whole grains, nuts, and seeds boosts the fiber and good fat content, which improves digestion, prolongs satiety, and releases energy over time. Because of this, the bar is especially appropriate for people who have diabetes, prediabetes, or who want to manage their weight and lead better lifestyles. Commercial energy bars frequently lack the targeted health advantages and balanced nutrition included in this formulation, despite the fact that they may be more convenient and have a longer shelf life.

REFERENCES:

1) Ines Jabeur, Eliana Pereria, Lillian Barros,Ricardo C. Calhella, Marina Sokovic, M. Beatriz P.P Oliveira, Isabel C.F.R. Ferreira. Hibiscus sabdariffa L. as a source of nutrients, bioactive compounds and colouring agent. Journal of Food research international. doi: 10.1016/j.foores.2017.07.073

2) Bety W. Hapsari,Manikharda and Widiastuti Setyaningsih. Methodologies in the analysis of phenolic compunds in roselle (Hibiscus sabdariffa L.) Composition, Biological activity, and Beneficial effects on human health. Multidisciplinary Digital publishing institute (MDPI). doi:10.3390/horticulturae7020035

3) Hassan Raza, Muhammad Tauseef Sultan, Khali Ahmad, Muhammad Maaz, Shehnshah Zafar, Ahmad Mujtaba Noman, Entessar Mohammad AI Jbawi. Hibiscus rosa-sinensis: A Multifunctional Flower Bridging Nutrition, Medicine, and Molecular Therapeutics. Journal of Food Science and Nutrition13 (12), e71254, 2025. doi:10.1002/fsn3.71254

4) Mohammed Bule, Ahmad Hassan Albelbeisi, Shekoufeh Nifarr, Mohsen Aminni Mohammad. The antidiabetic and antilipidemic effects of hibiscus sabdariffa: A systemic revuew and meta analysis of randomized clinical trials. journal of food research international. Doi: 10.1016/j.foodres.2020.108980.

5) Ghazala Riaz, Rajni Chopra. A review on phytochemistry and therapeutic uses of hibiscus sabdariffa L. journal of Biomedicine and Pharmacotherapy 102, 575-586, 2018. Doi: 10.1016/j. biopha.therapy 2018.03.023.

6) Subhashinie Sanadheera, Deepanjana Subasinghe, Melissa Nethmi Solangaarachchi, Manju Suraweera, Noshara Yushanthi Suraweera, Nadeesha Tharangika. Hibiscus rosa-sinensisL.(red hibiscus) Tea, Can it be used as A Home-Remedy to control Diebeties and Hypercholesterolemia? Journal of Biology, Medicine, & National Product Chemustry volume10, Number1, April 2021/Pages: 59-*65/DOI:10.14421/biomedich.2021.101.59-65.*

7) Efiigenia Montalvo-Gonzalez, Zuuami Villagran, Aughey Gonzalez-Torres, Laura Elena Iniguez-Munozo. Physiological Effects and Human Health Benefits of Hibiscus sabdariffa: A Review of Clinical Trials. Journal of Pharmaceuticals 202,(MDPI). DOI:10.3390/ph15040464.

8) Hassan Raza, Muhammad Tauseef Sultan, Khali Ahmad, Muhammad Maaz, Shehnshah Zafar, Ahmad Mujtaba Noman, Entessar Mohammad AI Jbawi. Hibiscus rosa-sinensis: A Multifunctional Flower Bridging Nutrition, Medicine, and Molecular Therapeutics. Journal of Food Science and Nutrition13 (12), e71254, 2025. doi:10.1002/fsn3.71254

9) Ines Da-Costa-Rocha, Bernd Bonnlaender, Hartwig Sievers, Ivo Pischel, Michael Heinrich. Hibiscus sabdariffa L. A Phytichemical and Pharmacologucal review. Journal of Food Chemistry 165, 424-443, 2014. Doi: 10.1016/j.foodchem.2014.05.002

10)Hassan Raza, Muhammad Tauseef Sultan, Khali Ahmad, Muhammad Maaz, Shehnshah Zafar, Ahmad Mujtaba Noman, Entessar Mohammad AI Jbawi. Hibiscus rosa-sinensis: A Multifunctional Flower Bridging Nutrition, Medicine, and Molecular Therapeutics. Journal of Food Science and Nutrition13 (12), e71254, 2025. doi:10.1002/fsn3.71254

11)Zaema Yasin, Moazzam Rafiq Khan, Muhammad Asim Shabbir and Beenish Israr. Exploring the Therapeutic Potential of Matricaria Chamomilla and Hibiscus Rosa-Sinensis Against Diabetes Mellitus. Journal of Pakistan Veterinary Journal. Doi: 10.29261/pakvetj/2025.146

12)Samakradhamrongthai, R. S., Jannu, T., & Renaldi, G. (2021). Physicochemical properties and sensory evaluation of high energy cereal bar and its consumer acceptability. Heliyon, 7(8), e07776. DOI: 10.1016/j.heliyon. 2021.e07776