

Assessment of Physiochemical Characteristic and Nutritional Analysis of Cupcakes Made by Incorporating Hibiscus in Whole Wheat Flour

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ABSTRACT

In order to help anemic people, this article offers a health-conscious cupcake recipe that uses components high in vital minerals. Known for its iron content and antioxidant qualities, hibiscus is infused to help produce hemoglobin, which may improve blood health for people who are iron deficient. By providing a natural sweetener that is high in iron, minerals, and complex carbohydrates, Jaggery helps improve the body's absorption of nutrients and energy levels. It can be used in place of refined sugar. Because of its strong antioxidant profile and pleasing bitterness, dark chocolate is added to cupcakes to balance their flavor and promote heart health. Additionally, the recipe creatively incorporates banana peel powder into a composite flour blend, adding fiber, potassium, and vitamins that support healthy digestion and a consistent flow of energy. These components work together to provide a tasty, iron-rich cupcake substitute that is nutrient-dense and pleasurable, meeting the nutritional requirements of anemic patients while providing vital minerals, antioxidants, and fiber.

Keywords: Complex Carbohydrates, Nutrient Absorption, Dark Chocolate Antioxidants, Heart Health, Banana Peel Powder, Composite Flour Blend, Fiber and Potassium, Healthy Digestion, Steady Energy Release, Nutrient-Dense Cupcakes, Iron-Rich Substitute, Vital Minerals and Fiber, Cupcake for Anemia.

INTRODUCTION

Anemia is a disease condition where the hemoglobin level is less than 13 g/dL and 12 g/dL in males and women, respectively, are indicative of anemia. The World Health Organization (WHO) claims that one-fourth of the world's population is affected by this epidemic. One of the main types of anemia is nutritional anemia, which is brought on by a lack of one or more vital nutrients needed for the synthesis of erythrocytes and hemoglobin (Tandon, & Pal, 2017). Several discarded agricultural waste by-products provide phenolic compounds, which have potential applications as antioxidants and disease prevention agents. Because fruit and vegetable by-products are rich in polyphenols, carotenoids, and other bioactive substances, recent studies have suggested using them as natural food additives. The peel and pulp are the two components that make up a banana fruit. Approximately 40% of the fruit's weight is made up of the peel, which is its main byproduct. Banana peels had no use until recently and were thrown away as waste, producing a lot of organic material that needed to be treated. Many possible uses have emerged since scientists began looking into the chemical composition of banana peels. Banana peel powder (BPP) has been demonstrated in numerous studies to be a useful dietary source. Phenolic chemicals, which are abundant in banana peels, function as antioxidants and guard against cancer and heart disease (Ahmed, Z., El- Sharnouby M. A. 2021). Hibiscus is indigenous to India and Malaysia and is also referred to as Roselle, Jamaica, red sorrel, Indian sorrel, wonjo, and karkade. In tropical and subtropical regions, such as China, Thailand, Indonesia, Egypt, Sudan, Saudi Arabia, Taiwan, Vietnam, Nigeria, and Mexico, the plant, which is a member of the Malvaceae family, is widely grown and disseminated. The annual plant HS is well-known for its tasty red calyxes. HS calyxes are mostly used in cooking, as a source of colors for food and cosmetic applications, and in traditional medicine to treat a variety

of illnesses. Generally speaking, the presence of bioactive and functional elements including phenolic acids, flavonoids, anthocyanins, organic acids, and others has been linked to the therapeutic benefits of HS. (Montalvo- González, E., Villagrán 2022).

The aim of this study is to provide a dessert that appeals to customers looking for unusual, nutrient- rich sweets without sacrificing flavor by fusing decadence with health advantages. This product is aimed at health-conscious people who value cutting-edge products and like sampling new flavors. The cupcakes are a balanced choice that fulfills cravings while promoting wellbeing since they contain whole foods like banana peel powder, Jaggery, and hibiscus, which are a source of iron, fiber, natural antioxidants, and vital nutrients. The objective is to produce a unique, tasty, and sustainable treat anemic patients and that fits well with contemporary wellness and environmentally conscious eating patterns.

METHODOLOGY

Preparing Hibiscus-Infused Cupcakes for Healthy Hemoglobin (Anemia Relief)

(STEP 01) Ingredient Preparation:

Begin by preparing banana peels and composite flour. Incorporate hibiscus powder and whole wheat flour to enhance the nutrient profile.

(STEP 02) Mixing Ingredients:

Combine the dry and wet ingredients separately. Ensure proper consistency for an even texture.

(STEP 03) Cream Butter and Sweetener:

Cream together the butter and jaggery until light and fluffy. This step improves the cupcake's texture and adds natural sweetness.

(STEP 04) Add Flavor and Enrichment:

Gradually add eggs, vanilla essence, and dark chocolate to the creamed mixture. These ingredients contribute to flavor, richness, and nutritional value.

(STEP 05) Baking Process:

Mix the batter well to achieve a uniform texture. Pour the mixture into cupcake molds and bake at 180°C until done.

(STEP 06) Cooling and Finalization:

Allow the cupcakes to cool completely in the pan before serving. This ensures a firm structure and better taste.

CONCLUSION

The development of hibiscus-infused cupcakes using composite flour enriched with banana peel powder, jaggery, and dark chocolate represents a pioneering approach to creating nutrient-dense functional bakery products. This study effectively addresses the critical issue of iron deficiency anemia, a global health concern, by leveraging natural and bioactive ingredients that enhance both nutritional value and sensory appeal. Hibiscus, a rich source of antioxidants and organic acids, has been scientifically proven to aid in iron absorption, making it an ideal ingredient for improving hemoglobin levels. Additionally, banana peel powder contributes significant dietary fiber, minerals, and antioxidants that enhance gastrointestinal health and overall well-being. The inclusion of jaggery as a natural sweetener further enriches the product with essential micronutrients such as iron, calcium, and potassium, promoting a healthier alternative to refined sugar while catering to individuals with dietary restrictions. Dark chocolate, with its antioxidant and polyphenolic properties, not only enhances the flavor profile but also provides cardiovascular benefits, ensuring that these cupcakes appeal to health-conscious consumers. Sensory evaluations conducted during this study revealed high levels of consumer acceptance, indicating that the Fe(erro) Cupcakes successfully balance taste, texture, and

nutritional functionality. The positive response from the sensory panel underscores the potential of these cupcakes to bridge the gap between indulgence and nutrition, offering a delicious and health-conscious dessert option suitable for diverse consumer groups. Moreover, this innovative recipe aligns with sustainable food practices by incorporating underutilized banana peel, a common food processing byproduct, thereby reducing waste and contributing to environmental sustainability. This highlights the dual benefit of creating functional food products that address public health issues while promoting sustainable resource utilization. In conclusion, the Fe(ero) Cupcakes stand as a testament to the potential of innovative food formulations to combat micronutrient deficiencies such as iron deficiency anemia. By combining nutrient-dense, sustainable, and functional ingredients, these cupcakes offer a holistic approach to improving health outcomes. This study not only opens avenues for the development of similar functional bakery products but also aligns with modern trends toward sustainable, health-focused dietary solutions, making it a valuable contribution to both nutrition science and the food industry.

RESULT & DISCUSSION

The Fe(ero) cupcake, designed as a nutrient-rich snack, provides a health-focused approach targeting iron deficiency, especially beneficial for people with anemia. Each ingredient contributes essential nutrients and bioactive compounds. Banana peel powder is especially rich in iron, dietary fiber, and polyphenol antioxidants, which support both antioxidant defenses and iron absorption. Studies show that banana peels contain a range of essential minerals, such as iron, potassium, zinc, and magnesium, along with bioactive compounds like flavonoids, polyphenols, and tannins, offering antioxidant properties. The antioxidants from these compounds help neutralize free radicals, potentially reducing cellular damage and supporting immune function, which is particularly beneficial for anemic individuals with compromised health. Hibiscus powder adds another layer of health benefits with its rich anthocyanin content, known for strong antioxidant activity. Anthocyanin's, the compounds responsible for the vibrant red color of hibiscus, help combat oxidative stress and may support improved vascular function, which is often impaired in anemia. Additionally, hibiscus provides vitamin C, which enhances iron absorption from other dietary sources, making it an excellent addition to an iron-focused product like the Fe(ero) cupcake. Dark chocolate, high in flavonoids, magnesium, and iron, contributes additional antioxidant and anti-inflammatory benefits, enhancing the cupcake's nutritional profile. These antioxidants not only help reduce inflammation but also support overall cardiovascular health, which can be compromised in individuals with anemia. The magnesium in dark chocolate further aids in maintaining energy levels and muscle function, adding a holistic boost to the cupcake's health profile. Whole wheat flour also enhances the content while providing B vitamins and dietary fiber, essential for energy production and maintaining digestive health. Whole wheat flour contributes iron, B-vitamins, and fiber, supporting digestion and helping maintain stable energy levels, while jaggery offers unrefined sugar that retains micronutrients like iron, calcium, and phosphorus. Jaggery, an unrefined sugar source, brings additional trace minerals like iron and calcium, along with a natural sweetness, and is traditionally used to improve hemoglobin levels and manage symptoms of anemia due to its relatively high iron content.

Together, these ingredients deliver a balanced nutrient profile, potentially beneficial in managing anemia and reducing fatigue. Overall, sensory evaluation revealed high consumer acceptance, with an average rating of 8 to 8.5 out of 10, indicating that the product is both health-promoting and enjoyable.

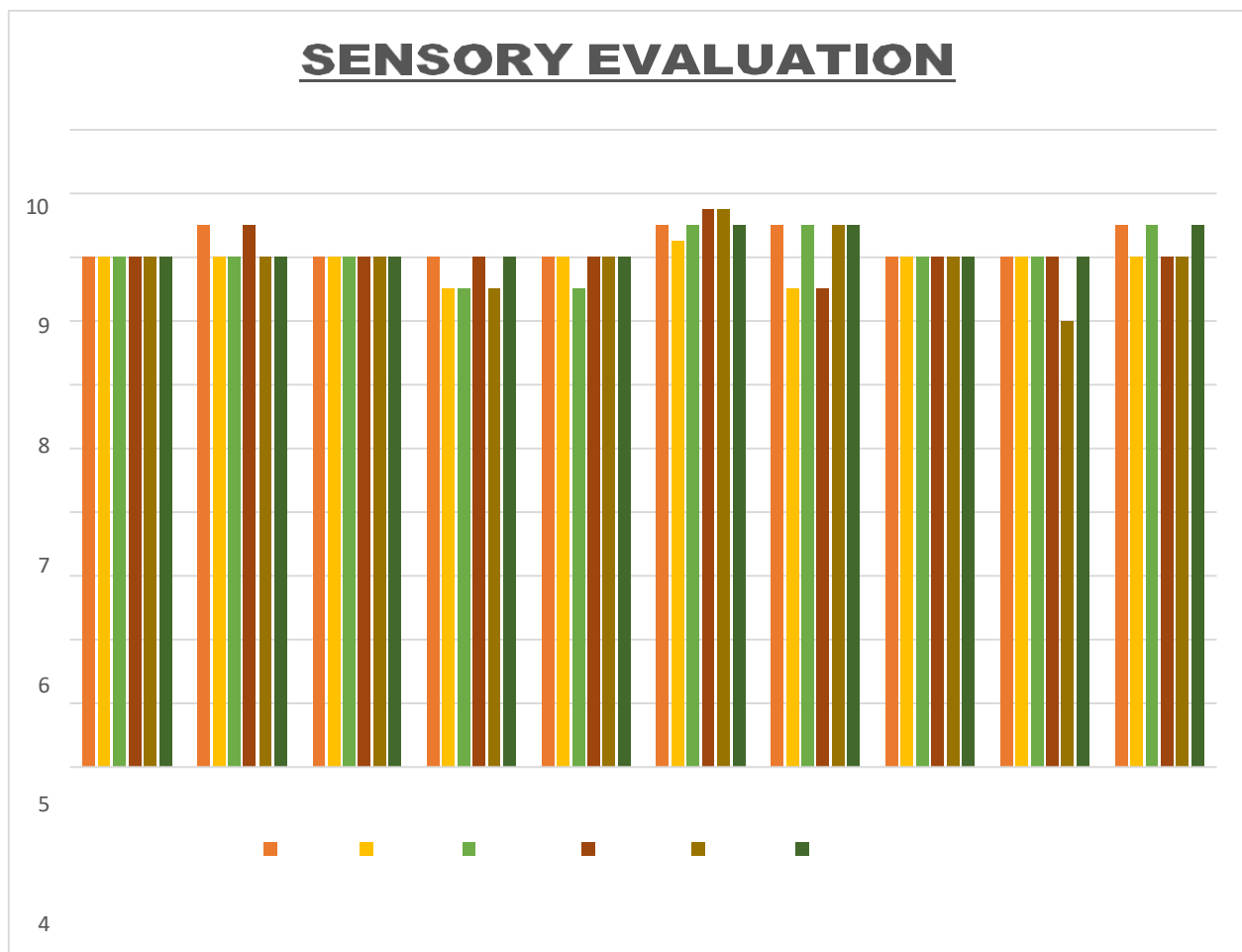
Table 1. Proximate Analysis on Batter of Cupcakes.

Parameter on Flour	Measured Value	Reference
Moisture Analysis	10.5%	Standard AOAC method
Texture Analysis	Flowability (45%), Cohesiveness (0.25%)	AOAC International
Fat Content	15.2%	AOAC 996.06
Sugar Content	1.0%	AOAC 2001.02
Ash Content	0.5%	Journal of Food Science
Protein Content	13%	Food Chemistry

Table 2. Proximate Analysis on Cupcakes.

Parameter on Cake	Measured Value	Reference
Moisture Analysis	28.5%	Standard AOAC method
Texture Analysis	Firmness (115g), Consistency (0.85)	AOAC International
Fat Content	1.1%	AOAC 2020
Sugar Content	23.0%	AOAC 2020
Ash Content	0.4%	Food Chemistry
Protein Content	8.5%	Journal of Food Science

The proximate analysis of an iron-rich cake with hibiscus reveals notable changes during baking across key nutritional parameters. Moisture content increases from 10.5% in the flour batter to 28.5% in the cake due to liquid incorporation and the hygroscopic nature of jaggery, enhancing softness. Texture improves as the flour batter, with 45% flowability and 0.25% cohesiveness, transforms into a cake with 115g firmness and 0.85 consistency, influenced by starch gelatinization, protein coagulation, and the fiber content of banana peel powder. Fat content remains stable, showing a slight decrease from 1.2% in the batter to 1.1% in the cake. Sugar content rises significantly from 1.0% to 23.0% with the addition of jaggery, contributing sweetness and nutritional value. Ash content reduces slightly from 0.5% to 0.4%, reflecting minor thermal degradation of minerals, while protein content decreases from 13% to 8.5% due to heat-induced denaturation, maintaining nutritional significance. These findings demonstrate that the inclusion of hibiscus, jaggery, and banana peel powder produces a nutrient-dense, functional, and palatable iron-rich cake suitable for anemic patients.



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