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## **BANANA FLOUR: A DIABETES-FRIENDLY OPTION FOR HEALTH-CONSCIOUS CONSUMERS WITH THE POWER OF RESISTANT STARCH**

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*"together we can and we will make a difference"*

# BANANA FLOUR: A DIABETES-FRIENDLY OPTION FOR HEALTH-CONSCIOUS CONSUMERS WITH THE POWER OF RESISTANT STARCH

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## ABSTRACT

Resistant starch (RS) is a type of carbohydrate that isn't broken down in the small intestine. It moves to the large intestine, where it undergoes fermentation, encouraging the growth of beneficial bacteria. This process promotes gut health and can help alleviate constipation by increasing the number of healthy bacteria. Risk of cancer, lower cholesterol levels, weight loss, and a reduced chance of gas pains. Research found that consuming 30 gm of resistant starch per day for six weeks helps decrease hunger hormones and reduce appetite in overweight adults. It also lowers blood sugar levels after a meal helps in reducing appetite, is anti-inflammatory and may even help prevent colon cancer. Research's claim that starch is not beneficial in diabetes but another thing resistant starch is good for diabetes because resistant starch escapes from digestion in the small intestine and does not release glucose in the small intestine and improves insulin sensitivity and insulin resistance. When we digest regular starches, they are broken down into sugars, which can cause a spike in insulin levels. A human study revealed that eating foods high in resistant starch (RS) reduced the post-meal insulin surge by up to 55%. While the cholesterol-lowering effects of resistant starch are not yet fully understood, there is some evidence of its potential benefits. In one study, consuming resistant starch-enriched flour for 12 weeks resulted in a 7% reduction in total cholesterol compared to a control group. Resistant starch is fermented by gut bacteria, producing butyrate, a short-chain fatty acid. This byproduct is absorbed by intestinal cells and used as energy, while also helping prevent the reproduction of mutated cells, reducing the risk of colon cancer.

**Keywords:** Resistant starch, blood sugar level, physical activity, lifestyle, food habits etc.

## INTRODUCTION

The worldwide food sector is currently experiencing a profound transformation as consumers increasingly seek functional foods that offer more than just basic nutrition. This shift in dietary preferences is largely driven by a growing awareness of the connection between diet and chronic diseases, as well as a heightened interest in sustainable and traditional food sources. As health issues such as obesity, diabetes, heart disease, and gastrointestinal disorders continue to rise globally, more and more people are beginning to recognize the power of food as medicine. This awareness has led to a fundamental change in how individuals perceive food, prompting them to make more informed decisions about what they eat and how it impacts their health [1].

In recent years, people have become more health-conscious and increasingly focused on foods that support their long-term well-being, rather than just providing calories. Nutrient-dense ingredients are gaining popularity as consumers move away from highly processed foods and embrace products that offer other health advantages including better

digestion, a strengthened immune system, and improved blood sugar control [6]. This shift is not just about managing health but preventing disease and improving quality of life. The demand for functional foods that contribute to a holistic approach to health is at an all-time high, and one of the key drivers of this trend is the growing awareness of the link between diet and chronic health conditions [2].

As this trend continues, consumers are becoming more aware of the importance of foods that support not only their physical health but also their mental and emotional well-being. There is an increasing desire for foods that are both nutrient-dense and able to deliver functional benefits—foods that work to prevent diseases like diabetes, heart disease, and cancer, while also supporting digestive health, mental clarity, and immune function. For many, this has led to a growing preference for natural, plant-based, and minimally processed foods that are rich in fiber, healthy fats, and antioxidants [4].

Additionally, many consumers are prioritizing foods that can support sustainable agriculture and ethical

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food production practices. Banana flour, made from green bananas, is emerging as a popular ingredient in the rapidly changing food sector, especially within the bakery industry. This flour is produced by transforming unripe bananas into a fine powder and offers numerous nutritional advantages that cater to the growing demand for functional foods. With its distinct composition, banana flour provides various health benefits. It is abundant in resistant starch and serves as a great source of dietary fiber, particularly soluble fiber, which is essential for promoting digestive health [2].

### 1.1 Other Names and Types of Resistant Starch

Resistant starch is typically divided into four categories based on its source and structure:

**RS1:** Present in whole grains, seeds, and legumes, this type of resistant starch is physically inaccessible to digestive enzymes due to its tough cell walls [1].

**RS2:** Found in raw potatoes and green bananas, this starch has a natural crystalline structure that resists digestion until it undergoes cooking or processing [2].

**RS3:** Known as retrograded starch, it forms when foods like potatoes, rice, and pasta are cooked and then cooled. The cooling process changes the structure of the starch, making it less digestible [1].

**RS4:** This type is chemically altered to resist digestion and is commonly incorporated into processed foods to increase fiber content [1].

Resistant starch can be a powerful tool for improving gut health, blood sugar control, and overall well-being when included in a balanced diet [2].

### 1.2 Nutritional Properties of Resistant Starch

#### Stable Blood Sugar Levels

Resistant starch has little effect on blood sugar, making it helpful for people managing diabetes or those who need consistent energy throughout the day. It can improve insulin sensitivity and lower the glycemic load of meals [1].

#### Gut Health Benefits

Since resistant starch is not digested in the small intestine and passes to the colon, it serves as a prebiotic, promoting the growth of healthy gut bacteria. This aids digestion and supports the production of short-chain fatty acids (SCFAs), which are beneficial for colon health [2].

#### Increased Feelings of Fullness

Resistant starch helps increase satiety, making you feel fuller for longer after meals. This can assist with

appetite control and may help prevent overeating, potentially supporting weight management [1].

#### Enhanced Mineral Absorption

Research indicates that resistant starch may improve the absorption of key minerals such as calcium and magnesium, which are vital for maintaining strong bones and supporting various bodily functions [2].

#### Reduced Cholesterol Levels

Consuming resistant starch regularly has been associated with a reduction in LDL (bad) cholesterol levels and better overall heart health [1].

### 1.3 Functional Properties of Resistant Starch

#### Prebiotic Effects

Resistant starch acts as nourishment for beneficial gut bacteria, which is essential for supporting a healthy and balanced microbiome. This prebiotic action aids in promoting gut health and bolstering immune function [2].

#### Fermentation and SCFA Production

When gut bacteria ferment resistant starch, they generate short-chain fatty acids such as butyrate, propionate, and acetate. Butyrate, in particular, plays a vital role in maintaining colon health and may help lower the risk of inflammatory bowel diseases and colorectal cancer [1].

#### Contribution to Weight Management

Thanks to its ability to curb hunger and improve feelings of fullness, resistant starch can be an effective addition to weight management plans. It may aid in reducing overall caloric intake by enhancing satiety after meals [1].

#### Regulation of Blood Sugar

As a type of dietary fiber, resistant starch slows down the digestion and absorption of carbohydrates, which leads to a more gradual release of glucose into the bloodstream. This helps to prevent blood sugar spikes and maintains steady energy levels [2].

#### Impact on Fat Metabolism

Research has shown that resistant starch can positively influence fat metabolism by promoting fat oxidation and decreasing fat storage. This contributes to better body composition over time. Banana flour are rich sources of resistance starch [1].

### 2 Advantages of Banana Flour

Banana flour, rich in resistant starch, has gained recognition for its remarkable health advantages. Unlike conventional carbohydrates, resistant starch doesn't get fully digested in the small intestine.

Instead, it moves to the colon, where it serves as a prebiotic, nourishing beneficial gut bacteria and promoting a healthier gut microbiome. This process not only supports digestion but also helps regulate blood sugar levels by slowing down glucose absorption. This makes banana flour an excellent option for those managing diabetes or seeking to maintain stable blood sugar [3]. Additionally, the gut health benefits linked to resistant starch may reduce the risk of colorectal cancer and enhance overall digestive function [4].

But the benefits don't end there! Banana flour is also packed with vital nutrients. Its high potassium content plays a key role in regulating blood pressure, while magnesium is essential for muscle and nerve function [5]. The vitamin B6 in banana flour supports metabolism and boosts immune health. With its fiber-rich composition, these nutrients combine to make banana flour a highly nutritious and functional ingredient, offering much more than just basic nourishment [6].

### **2.1 Banana Flour in the Bakery Sector**

Incorporating banana flour into treats like cookies, muffins, and bread has become a game-changer for the bakery industry. One major advantage of using banana flour in cookies is its ability to improve texture. When swapped for wheat flour, banana flour creates a soft, moist consistency while contributing a natural sweetness [7].

This makes it a popular choice for producing healthier treats that require less added sugar. As banana flour naturally contains some sugars, it can provide the desired sweetness without the need for extra refined sugar, appealing to consumers who wish to reduce their sugar intake for health reasons [8].

Additionally, banana flour is gluten-free, making it an excellent option for people with celiac disease or gluten sensitivity [9]. Unlike traditional wheat flour, which can lead to blood sugar spikes and inflammation in certain individuals, banana flour helps maintain a more stable blood sugar level, making it a great choice for those managing diabetes or looking to improve their metabolic health [1]. The low glycemic index of treats made with banana flour ensures a slow and steady release of glucose into the bloodstream, supporting better blood sugar control and improve insulin sensitivity [10].

As a result, the inclusion of banana flour in cookies and other baked goods offers a healthier alternative to traditional recipes, catering to a wide range of dietary needs. Whether it's people managing diabetes, those with gluten intolerance, or anyone looking to reduce their sugar intake, banana flour provides a versatile and beneficial ingredient that can help meet the growing demand for functional, health-supporting foods [11].

### **2.2 Sustainability and Banana Flour's Role in Reducing Food Waste**

Another compelling reason for the rise of banana flour in the food industry is its contribution to sustainability. Green bananas, which are typically discarded in many banana-producing regions due to their lack of ripeness or commercial value, can be transformed into banana flour, helping to reduce food waste [3]. By utilizing these bananas, which would otherwise go unused, banana flour presents a sustainable option that contributes to a circular economy. This approach not only helps mitigate food waste but also provides a valuable income source for banana farmers in tropical regions where banana cultivation is an essential part of the agricultural industry [9].

The environmental benefits of banana flour extend beyond its role in food waste reduction. As banana cultivation is often a key part of the agricultural economy in tropical regions, the demand for banana flour has the potential to create new economic opportunities for local farmers [4]. In addition, banana flour production has a relatively low environmental impact compared to the production of other flours, such as wheat or rice, which require more intensive farming practices and larger land areas [3]. Therefore, banana flour can contribute to a more sustainable food system by promoting agricultural practices that are both environmentally responsible and economically beneficial for farming communities [12].

### **2.3 Nutritional composition:**

Banana flour, made from green bananas, is a nutrient-dense flour that offers a variety of benefits. It is primarily composed of carbohydrates, particularly resistant starch, along with moderate amounts of fiber, protein, and essential vitamins and minerals. Table 1 is an in-depth look at the nutritional composition of banana flour:

**Table 1:** Nutritional composition of banana flour

S.No.	Nutrients	Content per 100 gm
1	Carbohydrates	75-85 g
2	Dietary Fiber	7-10 g
3	Protein	1-2 g
4	Sugars	30-35 g
5	Fat	0.5-1 g
6	Saturated fat	0.1 g
7	Calories	350-360 kcal
8	Vitamin C	12-15 mg
9	Vitamin B6	0.3-0.5 mg
10	Calcium	20-25 mg
11	Iron	1-1.3 mg
12	Magnesium	30-40 mg
13	Potassium	450-500 mg

### 2.3.1 Macronutrients Carbohydrates:

**Complex Carbohydrates:** Banana flour is a rich source of complex carbohydrates, which are digested at a slower rate, offering a consistent release of energy [13]. This slow digestion helps maintain stable blood sugar levels and provides sustained energy over time [14].

#### Resistance starch

A prominent feature of banana flour is resistant starch, a carbohydrate that resists digestion in the small intestine and acts similarly to dietary fiber. It passes into the large intestine, where it is fermented by gut bacteria, producing short-chain fatty acids (SCFAs) like butyrate, acetate, and propionate [4]. These SCFAs contribute positively to gut health, reduce inflammation, and may improve insulin sensitivity [15]. Resistant starch also plays a role in regulating blood sugar levels, benefiting those managing diabetes or looking to prevent blood sugar spikes after meals [8].

Banana flour is a good source of dietary fiber, primarily from resistant starch. Fiber is essential for maintaining digestive health, supporting regular bowel movements, and preventing constipation. It also nurtures the growth of beneficial gut bacteria, promoting a healthy microbiome. The fiber in banana flour serves as a prebiotic, encouraging the growth of beneficial bacteria in the large intestine. These bacteria produce SCFAs, which help nourish colon cells and regulate inflammation throughout the body [16].

Fiber helps induce a sense of fullness, which may assist in appetite control and weight management by delaying gastric emptying, extending the feeling of satisfaction after meals [16].

### Protein: Moderate Protein Content:

Although banana flour is not a significant protein source, it provides a moderate amount—around 2–3 grams per 100 grams [17]. Protein is vital for tissue repair, muscle maintenance, and immune function. Individuals seeking higher protein intake may need to pair banana flour with other protein-rich foods [18].

The protein in banana flour contains several essential amino acids. While it may not offer a complete protein profile like animal products or legumes, it still contributes to overall protein intake within a well-balanced diet [19].

### Fat:

**Low Fat Content:** Banana flour is very low in fat, generally containing less than 1 gram of fat per 100 grams. This makes it an ideal choice for those looking to lower their fat consumption or adhere to low-fat diets [20]. Despite its low fat content, it still provides the essential energy needed for the body, primarily through carbohydrates.

**Minimal Impact on Caloric Intake:** Because banana flour contains little to no fat, it is unlikely to significantly contribute to calorie intake from fats, making it a low-fat ingredient for various recipes [3].

### 2.3.2 Micronutrients:

#### Vitamins and Minerals:

Banana flour retains some of the potassium content found in bananas. Potassium is a key mineral that helps regulate fluid balance, muscle function, and nerve signals. It is particularly beneficial for maintaining healthy blood pressure levels and preventing hypertension [5].

Banana flour also contains magnesium, though in smaller amounts. This mineral is crucial for various bodily functions, such as muscle and nerve function, protein synthesis, and blood sugar regulation [11]. It also contributes to maintaining strong bones and teeth. Banana flour provides small amounts of B-vitamins, particularly vitamin B6, which plays a key role in metabolism, brain function, and the production of neurotransmitters. Vitamin B6 is essential for converting food into energy, making it an important nutrient for overall health [3].

### 2.3.3 Other Nutritional Benefits: Mild, Neutral Flavor:

Banana flour has a light, neutral taste that complements both sweet and savory dishes. It does not dominate the flavor of other ingredients, making it a versatile addition to a variety of recipes, from baked goods to sauces and soups [21].

### **Versatility in Cooking:**

With its neutral flavor and texture, banana flour can be incorporated into a wide range of culinary uses. It can be used in baking (such as for bread, muffins, and cookies), as a thickener in soups and sauces, or added to smoothies and shakes to boost fiber and nutrient content [20].

Banana flour, made from unripe green bananas, has emerged as a popular alternative to traditional flour in the health and wellness community. It is especially beneficial for those managing diabetes due to its low glycemic index (GI) and high resistant starch content [3]. Resistant starch functions as a type of fiber, slowing the absorption of glucose and helping to manage blood sugar levels more effectively [4]. This makes banana flour a promising ingredient in a variety of diabetic-friendly snacks, including cookies, pancakes, and other baked goods. This paper explores the benefits of banana flour for people with diabetes, how it can be used in snack recipes, and the future of banana flour in the food industry [7].

### **2.4 Health Benefits of Banana Flour for Diabetics**

#### **Low Glycemic Index**

One of the primary advantages of banana flour is its low glycemic index. Foods with a low GI are absorbed more slowly by the body, which helps prevent spikes in blood sugar levels [10]. This is especially important for people with diabetes, as it helps maintain stable energy levels and reduces the risk of hyperglycemia (high blood sugar). Banana flour, when used in recipes like cookies and other snacks, provides a more sustainable energy release without the sudden blood sugar spikes often associated with high-GI foods [3].

#### **Rich in Resistant Starch**

Banana flour contains high levels of resistant starch, a carbohydrate that resists digestion in the small intestine. Instead, it acts as a prebiotic, nourishing beneficial gut bacteria and supporting overall digestive health [3]. For diabetics, resistant starch helps manage blood sugar levels by slowing the digestion and absorption of glucose. As a result, foods made with banana flour contribute to better blood sugar control, making them a great option for those with type 2 diabetes or those looking to prevent insulin resistance. Another significant health benefit of banana flour is its high fiber content. Fiber plays a crucial role in managing diabetes by improving

insulin sensitivity and promoting healthy digestion. Additionally, fiber helps with satiety, reducing the likelihood of overeating and promoting healthy weight management. Since banana flour is a good source of both soluble and insoluble fiber, it can be an effective tool in managing not only blood sugar levels but also digestive health [4].

### **Nutrient-Rich**

Beyond its blood sugar and digestive benefits, banana flour is rich in several essential nutrients, including potassium, magnesium, and vitamin B6. Potassium helps regulate blood pressure, which is particularly important for diabetics, as they are at higher risk for hypertension. Magnesium plays a key role in enhancing insulin sensitivity, and vitamin B6 is important for nerve health, which is crucial for people with diabetes who may be at risk for neuropathy [5].

### **2.5 Banana Flour Snacks: A Delicious and Diabetes-Friendly Options**

Given its health benefits, banana flour is increasingly being used to create a range of diabetes-friendly snacks. These snacks are designed to provide satisfying flavors and textures while supporting blood sugar regulation. Below are some popular snack options made with banana flour, perfect for people with diabetes:

#### **2.5.1 Banana Flour Cookies**

Banana flour cookies are one of the most popular snack options for those managing diabetes. These cookies are typically made with low-glycemic sweeteners such as stevia, monk fruit, or erythritol, which do not cause rapid spikes in blood sugar [1]. They also contain healthy fats from coconut oil or butter, ensuring moisture and flavor. The addition of natural flavorings like vanilla extract, cinnamon, or cocoa powder can enhance the taste without compromising blood sugar control [7]. The cookies are soft, chewy, and slightly dense due to the absence of gluten, making them a satisfying and nutritious treat [3].

#### **2.5.2 Banana Flour Pancakes**

For a healthy breakfast or snack, banana flour pancakes are an excellent option. These pancakes are made with banana flour, which gives them a light and fluffy texture [3]. They can be sweetened with monk fruit or stevia and topped with fresh berries or sugar-free syrup. These pancakes provide a good source of fiber and resistant starch, keeping blood sugar levels

stable and providing long-lasting energy throughout the day [4].

### 2.5.3 Banana Flour Muffins

Banana flour muffins are another diabetes-friendly snack option. Packed with fiber and essential nutrients, these muffins can be made with a variety of healthy ingredients, such as unsweetened applesauce, coconut oil, and low-glycemic sweeteners [10]. They can be flavored with spices like cinnamon or nutmeg and filled with sugar-free chocolate chips or chopped nuts for added texture and richness. Banana flour muffins offer a delicious, moist treat while supporting digestive health and blood sugar regulation [9].

### 2.5.4 Banana Flour Crackers

For those looking for a savory snack, banana flour crackers provide a great option. These can be made by combining banana flour with healthy fats such as olive oil or coconut oil, as well as seasonings like rosemary, garlic, or sea salt. The resulting crackers are crunchy and satisfying, making them a perfect snack for individuals looking for a low-glycemic, high-fiber alternative to traditional crackers made with refined flour [15].

## 2.6 The Future of Banana Flour in the Food Industry

As awareness of the health benefits of banana flour continues to grow, its use in food production is likely to expand. Below are several areas where future research and innovation could unlock new potential for banana flour, particularly in the development of diabetes-friendly snacks [3].

### 2.6.1 Nutritional Enhancements

Future innovations in banana flour production could focus on enhancing its nutritional profile. For example, banana flour could be fortified with additional vitamins, minerals, or functional ingredients like omega-3 fatty acids, antioxidants, or probiotics. These fortifications would make banana flour snacks even more beneficial for individuals looking to improve their overall health and well-being [3, 9, 24-25].

### 2.6.2 Improved Processing Methods

Advances in food technology could lead to more efficient and sustainable processing methods for banana flour. Techniques such as freeze-drying or solar-powered drying could preserve more of the natural nutrients and flavor of the bananas, resulting in a superior product [4]. Additionally, further research into reducing anti-nutrients like tannins and

phytic acid could improve the bioavailability of the nutrients in banana flour, making it even more effective for those with diabetes [17].

### 2.6.3 Scaling Up Production

As demand for healthier, diabetes-friendly snacks increases, there will be a need to scale up banana flour production. Automation and advancements in manufacturing processes could help meet this demand, making banana flour cookies and other snacks more accessible and affordable for a wider audience [3]. These innovations could help reduce the cost of banana flour, making it more competitive with other gluten-free and low-glycemic ingredients in the market [4].

### 2.6.4 Flavor and Texture Enhancements

One challenge with banana flour is its distinct taste, which may not be to everyone's liking. Future research could explore flavor modification techniques to make banana flour more versatile in different recipes. Combining banana flour with other alternative flours, such as almond flour or oat flour, could improve the texture and flavor profile of snacks, making them even more appealing to a broader range of consumers [7, 20-23].

## CONCLUSION

Banana flour cookies have gained popularity as a healthier and tastier alternative to conventional baked goods. Derived from green bananas, these cookies offer a distinct flavor along with a range of nutritional benefits, particularly for individuals managing diabetes.

A standout health benefit of banana flour is its high resistant starch content. This starch resists digestion in the small intestine, acting as a prebiotic that nourishes beneficial gut bacteria [15]. By supporting gut health, resistant starch aids digestion, nutrient absorption, and may help lower the risk of metabolic diseases. For those with diabetes, resistant starch plays a crucial role in blood sugar regulation. It is absorbed slowly, leading to a gradual increase in blood glucose, thus preventing the rapid spikes that can be harmful for individuals with diabetes [10]. As such, banana flour cookies are an excellent choice for those aiming to maintain stable blood sugar levels.

In addition to its effects on blood sugar, banana flour is a good source of potassium, an essential mineral for heart health and blood pressure regulation [5]. Potassium helps counterbalance the effects of sodium,

which can be particularly beneficial for people with diabetes, who are at an increased risk of heart disease. The high fiber content of banana flour also boosts the cookies' ability to promote digestive health, assist with weight management, and stabilize blood sugar levels. [11].

The flavor of banana flour cookies is another appealing factor. The natural sweetness of green bananas gives the cookies a mild, earthy taste, which pairs well with ingredients such as nuts, dried fruits, or chocolate chips [7]. These cookies offer a satisfying and nutritious treat without the added sugars common in many traditional baked goods. Additionally, the use of banana flour contributes to a soft, chewy texture that will likely appeal to a wide range of preferences.

Beyond their health benefits and flavor, banana flour cookies are also an eco-friendly choice. By utilizing

green bananas, which might otherwise be discarded, banana flour helps reduce food waste and supports sustainable agricultural practices [6]. This makes banana flour cookies a not only nutritious but also environmentally responsible option, aligning with the growing push for sustainable food production.

In summary, banana flour cookies offer an ideal combination of taste, nutrition, and sustainability. They provide numerous health advantages, especially for individuals with diabetes, by helping regulate blood sugar levels, enhance gut health, and support heart health. With their delightful flavor, versatility, and environmentally-friendly production, these cookies are a fantastic choice for anyone seeking a healthier snack. Whether you're managing diabetes, striving for stable energy, or simply enjoying a tasty treat, banana flour cookies offer a nutritious, diabetes-friendly alternative to traditional cookies.

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