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Different types of products development through banana peels

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Abstract

The most significant member of the genus *Musa* and family *Musaceae* is the banana. They are indigenous to Australia and tropical Indo-Malaysia. It is a herbaceous plant that may thrive in a variety of settings. Bananas are grown in 107 nations. The skin of a banana makes up 40% of its fresh weight. Fruit peels, which are a waste product, made up 18.33% of the fruit. Phenolic compounds are present in banana peel. A good quantity of dietary fibre, proteins, essential amino acids, potassium, polyphenols, carotenoids, and polyunsaturated fatty acids may be found in bananas. The antioxidative properties of polyphenols, which cause food items to be rancid, prevented lipid oxidation in the food products. Banana peel and pulp have been utilised to create items including bread, cakes, noodles, gluten-free goods, and more. Banana peel extracts might be useful in the fight against free radical-mediated disease. Polyphenols' antioxidant properties also aid in avoiding off flavours, which lower food shelf life and nutritional value.

Keywords: Ethanol, xylitol, peel flour, gluten, antioxidant, Banana Peel Powder

Introduction

After 2,500 years, interest in Hippocrates' maxim, "Let food be thy medicine, and medicine be thy nourishment," has resurfaced. Natural foods have inspired a major and expanding interest over the past ten years, particularly those high in and manufactured from vegetable origin. This urge has been stoked by advertisements and research showing the potential health advantages of certain foods. Several academics and food producers are devoting more attention to agricultural by-products by turning them into meals. Since they are not often employed in the manufacture of food, by-products of vegetables and plants are typically thrown after harvesting or processing. (Brito *et al.*, 2020) [31]. Using byproducts is a growing area of interest for many academics. The banana peel is a significant by-product that is packed with various nutrients and has been used to make substantial food items (Khatun *et al.*, 2021) [15].

The banana is a fruit with a tropical climate that belongs to the *Musaceae* family and is made up of several different species. According to (Guyle'ne Aurore *et al.*, 2009) [14], it is one of the most popular fruits in the world and the fourth most significant crop produced internationally. Two diploid species, *Musa acuminata* and *Musa balbisiana*, of which the Cavendish variation is the most prevalent, gave rise to nearly all of the known cultivars (Khoozani *et al.*, 2018) [16]. The majority (54.4%) of the world's banana output, according to the most recent FAO figures, comes from Asia.

Bananas are divided into two components: the skin and the pulp. Banana peel, which makes up around 40% of the fruit's weight, is the most significant byproduct. Banana peel was formerly wasted since it had no function. large volumes of organic waste need to be controlled as a result. Making BPF from the peel is one way to use this useful by-product. This item might potentially become new goods with functionalities and compositions that are standardised for a variety of (Mohapatra *et al.*, 2010) [19] Manufacturing and domestic uses.

Banana peels might be utilised in a variety of meals and dietary supplements since banana peel extract contains more antioxidants and phenolic compounds than banana pulp. (Khoozani *et al.*, 2018) [16]. Starch is abundant in banana peel (3%) total dietary fibre (43.2–49.7%), crude fat (3.8–11%), crude protein (6–9%), and crude fat lylinoleic acid and -linolenic acid in particular, pectin, and polyunsaturated fatty acids leucine, valine, phenylalanine, and threonine are necessary amino acids (K, P, Ca, and Mg) micronutrients (Thomas Happi Emaga *et al.*, 2007) [12]. BPF includes compared to pulp, it has a lot more ash, protein, crude fibre, and digestible starch as a functional enhancement, it is more efficient (Khoozani *et al.*, 2019) [3]. According to (Pereira and Aline *et al.*, 2014) [20] Banana peel contains phenolics, carotenoids, flavonoids, biogenic amines, phytosterols, and other phytochemicals. Due to their high content

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of antioxidants compared to different berries, herbs, and veggies certain elements are present. It is generally recognised that dietary fibre lowers the risk of problems such heart disease, colon cancer, irritable bowel syndrome, and constipation, (Aslam *et al.*, 2014) ^[6], diabetes and diverticulitis. Consequently, dietary fibre should be added to foods since it is beneficial to human health.

People are getting more concerned with their health and interested in maintaining health by consuming fruits and veggies. In addition to processed meals, they like eating raw foods. Customers are showing growing interest in consuming nutritious meals, which has prompted research into the amounts of phytonutrients and various fruits and vegetables have distinct health advantages. In recent years during the past ten years, consumer interest in vitamins, minerals, and unsaturated fats has increased. Due to the growing focus on fatty acids, bioactive compounds, and fibre in dietary products foods with functional properties and consumer health and happiness. Banana by-products in particular have lately gained popularity, and several research are being done to ascertain their impact on culinary qualities (Cha'vezSalazar A *et al.*, 2017) ^[9].

WF has been replaced by flour made from fruit waste or by-products to make baked goods because to specialised eating patterns, changing consumer behaviour, economic factors, and commercial needs (Khatun *et al.*, 2021) ^[15]. However, we were previously unaware of banana peel-based biscuits, and Bangladesh did not carry out any nutritional assessments.

Biscuits are one of the most commonly purchased bakery items. It is consumed by people all over the world due to its mobility, ready-to-eat quality, affordability, prolonged shelf life, and availability in a variety of flavors and tastes (Bakar *et al.*, 2018) ^[7]. Fruits and vegetables are essential in human nutrition and commerce. Because biscuits are made with refined wheat flour and other additives, they lack the Page | 3 health-promoting components of grains such dietary fiber and phytochemicals. The utilization of by-products from fruits, such as apple pomace and orange pomace, has been examined by earlier researchers. Orange pomace contributes to the dietary fiber level of cookies, whereas apple pomace is a rich source of polyphenols with anti-proliferative and antioxidant action (Bakar *et al.*, 2018) ^[7].

2. Nutritional profile

According to (Yadav *et al.*, 2016) ^[36] several studies, fresh bananas have different nutritional profiles due to variations in plant species, genetics, habitat, ecology, and harvesting practises. Starch (3%), crude protein (6%), crude fat (3.8-11%), total dietary fibre (43-49.7%), poly saturated fatty acids, particularly linolic acid and á linolic acid, pectin, essential amino acids like threonine, valine, and phynylalanine, and micro nutrients (K, P, Ca, and Mg) are all found in banana peel. In addition, banana peel contains large amounts of lignin (6-12%), pectin (10-21%), cellulose (7.6-9.6%), hemicelluloses (6.4-9.4%), and galactouronine acid.

Table 1: Nutrition value of banana peel.

Nutrient	Content Range (%)
Starch	3%
Crude Protein	6-9%
Crude Fat	3.8-11%
Total Dietary Fiber	Rich in linoleic acid and α -linolenic acid
Polyunsaturated Fatty Acids	10-21%
Pectin	6-12%
Cellulose	7.6-9.6%
Hemicelluloses	6.4-9.4%
Galacturonic Acid	Abundant

3. Functional properties

3.1 Functional Food

In an article titled "Japan Explores the Boundary between Food and Medicine" (Swinbanks D and O'Brien J *et al.*, 1993) ^[30] the phrase "functional food" first appeared in print. Functional food is any meal or food component that could provide a health benefit in addition to the usual nutrients it includes. It may be characterised as whole, fortified, enriched, or enhanced foods that offer health benefits in addition to essential nutrients when taken regularly by consumers as a part of a varied diet and at effective levels. Healthy components have the potential to reduce risks, increase health, and reduce the need for related treatments.

3.2 Functional foods from plant sources

Epidemiological, *in vivo*, *in vitro*, and clinical trial data provide overwhelming evidence that a plant-based diet can lower the incidence of chronic illnesses, including cancer. The World Cancer Research Fund claims that there is strong evidence that eating a lot of fruits and vegetables might help prevent many digestive and respiratory cancers (Boffetta P *et al.*, 2010) ^[8]. There is a link between eating fruits and vegetables and chronic diseases such hepatocellular

carcinoma and cardiovascular disease, according to a number of epidemiological research. According to (Schreiner M. and Huyskens-Keil S., *et al.*, 2006) ^[28], phytochemicals are to blame for the observed protective effect.

Due in part to their antioxidant activity, which may be connected to health benefits including a decrease in heart disease and cancer, studies on dietary components like anthocyanins and other phenolic compounds have recently attracted increased interest (Seeram *et al.*, 2002) ^[29]. Foods with potential health benefits for which diet-health linkages have not yet been properly scientifically established require more study.

4. Antioxidants

Antioxidants are vital molecules that play a crucial role in protecting our bodies from the damaging effects of free radicals. Free radicals are highly reactive and unstable molecules that can cause oxidative stress within our cells, leading to various health issues, including cancer, cardiovascular diseases, and neurodegenerative disorders (Alam *et al.*, 2020) ^[1].

Antioxidants are produced naturally within the body and can also be obtained from various dietary sources. The body's

endogenous antioxidant defense system includes enzymes like superoxide dismutase, catalase, and glutathione peroxidase. These enzymes work together to neutralize free radicals and protect the cells from oxidative stress. Additionally, external sources of antioxidants, such as vitamins C and E, beta-carotene, and polyphenols, can be found in many foods like fruits, vegetables, nuts, and whole grains (Alam *et al.*, 2020) [1].

Because banana peel contains a lot of polyphenols, they have antioxidant properties. Between 0.90 to 3.0 g of total phenolic compounds were found per 100 dry weight of banana peel. Banana pulp contains a variety of phenolic chemicals, including catechin, gallic acid, tannins, epicatechin, and anthocyanins. Lycopene and leutein have a strong antioxidant capacity, whereas beta carotene, -carotene, and beta -cryptoxanthin are carotenoids that are found in banana fruit and have provitamin A activity (Erdman *et al.*, 1993) [33]. A number of industries rely on synthetic antioxidants like propyl gallate (PG), 2, 16-di-terl-butyl-p-hydroxytoluene (BHT), and tert-butyl-4-hydroxyanisole (BHA) to lower the worsen of lipids and increase the shelf life of the products. Lipid oxidation is undesirable and conducts reduction in nutrition value and shelf life of food. Artificial antioxidants may pose health risks. Natural anti-oxidative chemicals are therefore preferred. Banana peel leftovers have been rated as an economically viable source of antioxidants, among other forms of fruit by-products having antioxidant characteristics. Free radicals displayed a significant potential for scavenging, and 2,22-azino-bis (3-ethylbenzo thiazoline)-6-sulfonic acid and DPH were both effective inhibitors of lipid peroxidation. The catecholamines dopamine and 2-dopa in banana peel have antioxidant properties.

5. Medicinal and health benefit

We require nutritious meals to live a healthy existence. Bananas are a type of food that not only meets our nutritional needs but also provides us with a cooling sensation. Fruits are included to simple diets as a supplement. Many fruits have much greater nutritional potential than grains do. One of the most important and often eaten fruits is the banana. One of the first plants to be domesticated, bananas are very nutritious. One of the fruits with nutritional value in each of its parts is the banana. The entire plant offers nutritional and medicinal potential, according to (Kumar *et al.*, 2012) [27].

Components of the banana plant have been used medically in several countries all over the world. The traditional health benefits of bananas have been supported by a number of research.

1. Since bananas are the best source of potassium, which helps to maintain normal blood pressure and heart function, they lower the risk of hypertension (Kumar *et al.*, 2012) [27].
2. According to (Kumar *et al.*, 2012) [27], bananas include nondigestible fibre such cellulose, alpha cellulose, and alpha glucans that can aid in reviving bowl movement.
3. Bananas' high magnesium content has been shown to be effective in preventing cancer. Vitamin C, an antioxidant that reduces the risk of cancer, is found in bananas (Ranjha *et al.*, 2020) [23].
4. A study done in the United States found that men who consume more potassium, magnesium, and fiber have a lower risk of stroke. A diet high in fiber can help with hemorrhoids, diabetes, cardiovascular disease, gastrointestinal disease, constipation, and excessive

cholesterol (Mateljan *et al.*, 2007) [18].

5. The greatest remedy for heartburn is a banana since it helps to reduce acidity.
6. The best method for lowering acid secretion is a mixture of milk and bananas (Kumar *et al.* 2012) [27].
7. According to (Ranjha *et al.*, 2020) [23], potassium, which is abundant in bananas, is crucial for nerve activity.
8. Bananas are the best solid meal for a newborn baby. It is a food that has been fortified for babies since it has potassium, fibre, calcium, magnesium, phosphorus, selenium, and iron in addition to vitamins A, B 2, B 6, C, E, Niacin, Folate, and Pantothenic Acid (Kumar *et al.*, 2012) [27].
9. According to (Rita *et al.*, 2020) [26], banana blossoms were used as medications for diabetes, pneumonia, boils, and dysentery.
10. According to (Rita *et al.*, 2020) [26], leprosy, fever, stomach issues, nosebleeds, and insect bites can all be treated with banana sap.
11. The peel is said to have a number of medicinal uses in traditional medicine, including the treatment of burns, anaemia, diarrhoea, ulcers, inflammation, hypoglycemia, cough, snakebite, and severe bleeding (Pereira A. M., *et al.*, 2015) [20].

6. Different types of banana peel product

6.1. Xylitol from banana peel

By reducing xylose, xylitol—also referred to as birch sugar—is produced. It is a rare sugar and a substitute for ordinary sweeteners. Oats, berries, maize husks and other fruits and vegetables naturally contain xylitol in their fibre. These are present in incredibly small amounts and have a sweetness level that is comparable to sucrose. There were no or few calories in xylitol. It absorbs much more slowly than sucrose. utilised as a sugar replacement to treat diabetic people since it metabolises without insulin. Lignocellulosic materials are used to make xylitol because they act as the substrate for the process. The main elements of lignocellulosic are lignin, hemicellulose, and cellulose. 6% lignin, 12%, and 7.6–9.6% cellulose and 6.4–9.4% hemi cellulose are present in banana peel.

Banana peel is used as the foundation for xylitol (Rehman *et al.*, 2013) [25]. The peel makes up 18–20% of the banana, which is considered to be a waste. It is a good source of lignocellulosic chemicals and contains 91% organic matter, of which 59% is made up of carbs (Anhwange *et al.*, 2008) [5]. It is crucial to employ banana peel as xylose, sucrose, and to convert it into a product with added value called xylitol. There are uses for xylitol in the candy industry. especially for sugar-free items. It can also be found in products for diabetics. It is often utilised in candy-related items. For example, soft beverages and gum. It is utilised in the manufacture of rusks by substituting xylitol for sucrose. Rusks were the subject of periodic physicochemical studies while they were being stored.

6.2 Banana peel flour cake

Gluten, which causes celiac disease when consumed, is found in wheat and other grains including barley, rye, and oat. The best treatment for celiac disease is a gluten-free diet. There are many gluten-free food items on the market that are high in starch but lacking in other nutrients and other health-promoting ingredients. Greens are a reliable supply of resistant starch, non-starch polysaccharides, and dietary fibre.

They also include polyphenols, antioxidants, and necessary minerals.

Created a gluten-free, nutritious cake by replacing rice flour with green banana flour (GBPF) AT (5, 10, 15, and 20 percent) and examined the material characteristics of cakes made with the substitution. The 5% and 10% replacement of GBPF to gluten free cakes were effectively implemented, and the physical analyses of the gluten free cakes, such as amount, density, specific capacity, and baking loss, were not negatively impacted. The substitution of GBPF at levels of 15% and 20% produced the required physical features, and sensory evaluations revealed that all GBPF replacement levels were trustworthy according to the hedonic scale.

6.3 Banana peel of green banana flour pasta and noodles

Due to its usage as a helpful ingredient in goods high in starch, banana peel contains a high concentration of dietary fibre. researched the production of banana peel flour and conducted research on banana peel. The pectin and dietary fiber-containing component of the banana skin will change as the fruit ripens. The maturity stage and banana variety had an impact on the composition chemically (Emaga *et al.*, 2007) [12].

Produced wheat flour noodles with a little replacement of ripe banana peel and flour pulp. In comparison to flour made from pulp, flour from peel contains greater nutritional fibre, but less of the components of resistant starch. Noodles made from banana peel flour had a low predicted glycaemic index (PGI), mostly because they were strong in dietary fibre. The characteristics of colour, elasticity, pH, tensile strength, estimated glycaemic index (GI), and *in vitro* hydrolysis index (HI) of peel flour were evaluated. The BP noodles were found to be darker and less yellow than the control noodles, and to have greater tensile strength and elasticity modules. Banana peel noodles had a lower glycemic index than control noodles, according to tests on *in vitro* starch hydrolysis.

6.4 Ethanol from banana peel

Fossil fuels are a major source of energy for most of the world's population; their consumption is linked to climate change, urban pollution, and global warming. Within nations, fossil fuel is not uniformly distributed and is not renewable. Ethanol made from plant-based resources serves as a substitute fuel for spark ignition engines in this way. As a result of fast industrial development and rising petrol and diesel prices, fossil fuel sources are rapidly becoming extinct. So, scientists are turning to forms of renewable energy, like biofuel. Biofuel examples include biodiesel and bioethanol. Biodegradable and sulfur-free, ethanol is also. It is also known as alcohol and is a colourless, flammable liquid. It prevents adding to the increase of atmospheric CO₂. It is widely utilised as a fuel and as a raw material for the manufacturing of other beneficial chemicals that find extensive usage in industry. It stimulates agricultural output. It can also be administered as an antiseptic for usage in the home. used as a component of pharmaceuticals as well as in the processing of latex and phytochemical uses, the creation of mouthwash and cough syrup, and other disinfectants. As an alternative to maize, lignocellulosic biomass can be used to produce bioethanol. Remains from forestry, agriculture, industry, etc. are included in biomass. Various substrates, including sugarcane bagasse and newsprint sugarcane molasses, have been utilised in the past to produce bioethanol. It's time to locate fresh substrate because they are rapidly

vanishing due to fast exploitation. One of them is banana peel, together with its leftover biomass, which includes amylaceous and lignocellulosic chemicals. It is initially hydrolyzed to be converted into glucose for use as a feeding ingredient and to produce ethanol through fermentation and distillation (Vishala *et al.*, 2021) [34-35].

6.5 Banana peel flour

Bananas come in two parts: the skin and the pulp. The by-product, or peel, makes up around 40% of the total fruit weight. Banana peel contains a lot of fibre and plenty of bioactive substances. (Ranzani *et al.*, 1996) [24] assessed the biological and chemical composition of ripe banana peel. Banana peel flour has a long shelf life and high preservation capability. Flour made from banana peels may be used right away in culinary products. The manufacturing of green banana flour using a spouted dryer has produced products with high levels of dietary fibre and starch resistance, averaging 21.91% and 68.02%, respectively. Alkaline yellow noodles were created by substituting ripe banana pulp and peel for a small portion of the wheat flour. According to reports, Cavendish banana pulp and peel flour can be used to control the starch hydrolysis of noodles. According to research, adding peel flour to the food of rats caused them to digest protein less efficiently and produce more faeces. the development of rats fed a control diet. Banana cavendish pulp and peel flour was made from green and ripe bananas, and its physicochemical parameters, including TSS (Total soluble solids), pH, WHC, and OHC at 40, 60, and 80 degrees Celsius, were assessed. Black extrusion force (BEF), colour values and viscosity.

MANOV, quality analysis, and aggregate analysis were used to analyse the data. The pulp and peel flour of ripe and green bananas have different physical and chemical properties.

6.7 Banana peel biscuit

According to a study conducted by (Rahman *et al.*, 2020) [21] biscuits are suitable candidates for incorporating dietary fiber into the diet of individuals. The study likely explored the possibility of enriching biscuits with dietary fiber to improve their nutritional profile and promote a healthier snacking option. Dietary fiber is an essential component of a balanced diet as it aids in digestion, helps regulate blood sugar levels, and contributes to overall gut health. The potential of biscuits as a dietary fiber carrier stem from their widespread consumption. Since biscuits are consumed regularly by a large number of people, the inclusion of dietary fiber in this popular snack could have a significant impact on overall fiber intake and health benefits. By introducing dietary fiber into a commonly consumed food item like biscuits, it becomes easier for people to incorporate this essential nutrient into their daily diet without making drastic changes to their eating habits.

7. Conclusion

The healthy colon benefits from the banana's high dietary fibre and resistant starch content. Because it contains more calcium, iron, reducing sugars, potassium, and acids that reduce caffeine and nicotine cravings, ripe banana flour aids in healthier blood circulation. Banana peel is low in carbohydrates, fats, calories, and cholesterol while being high in vitamin B6, vitamin C, fibre, magnesium, and potassium. Since bananas have significant nutritional and medicinal value, they might be used to make functional foods. The

organic components of banana peels—proteins, lipids, and carbs—indicate that they are rich sources of fibre and carbohydrates. Peels may aid in the treatment of constipation and enhance health because of their high fibre content. Peel extracts are not hazardous to human cells, thus since they come from a natural source, they may be used without risk. Although raw bananas have many health advantages, individuals do not consume them on a regular basis owing to their unpleasant taste. In order to make the raw banana more palatable and to give a good, nourishing diet, it may be transformed into products. To control the use of banana flour as a functional food component, added-value goods like cookies and bread can be made from unripe banana flour and ripe banana flour, respectively. Currently, there is interest in the creation of nutraceutical additives for the food business.

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