JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Banana pseudostem and ragi cookies for diabetic and obese patients

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Abstract: Banana is a widely used plant and is a treasure of various nutrients and minerals like proteins, carbohydrates, dietary fibres, magnesium, phosphorus etc. All the parts of the banana plan have nutrients and shows different beneficial health effects. In this research project pseudostem of banana plant is used to make nutritious cookies which have various nutrients like proteins, starch, soluble and insoluble dietary fibres. Ragi is used as binder that has antidiabetic properties. The prepared pseudostem cookies are targeted towards the diabetic and obese patients due to their low sugar and high fibre content. The physical and chemical analysis of the prepared cookies was also performed that indicated the presence of cardiac glycosides, flavonoids and tannins.

Index Terms **– Banana pseudostem, ragi, fibre, diabetes, obese patients.**

I. INTRODUCTION

Banana plant is the cultivated varieties of genus *Musa*, made of two sub groups, sweet plantain. Different parts of banana plant such as fruit, peels, leaves, roots, and pseudo stem have shown various pharmacological effects. Banana is of great use both traditionally and medicinally and this is attributed to the presence of its diverse phyto - constituents as the pulp and peel extracts of banana are shown to have fatty acids, steryl esters, and sterols besides oleic acid and linoleic acids. The banana fruit is also a rich source of valuable phytonutrients phenolic compounds and vitamins. The different bioactive compounds produced by secondary metabolism in addition to the elements like potassium and phosphorous have various pharmacological activities. (Afam *et al)*

Pseudo stem is the part of the banana plant that looks like a trunk. It is formed by tightly packed overlapping leaf sheaths. It is very fleshy but contains mostly water. It is quite sturdy and can support a bunch that weighs 50 kg or more. The pseudo stem continues to grow in height as the leaves emerge one after the other and reaches its maximum height when the inflorescence emerges at the top of the plant. (IPGRI, 1996)

Banana pseudostem has very high content of dietary fibre. It has caught the attention of food scientists in recent years. It could be used more in food rather than in the feed industry. Aziz *et al*. (2011) and Bhaskar *et al.* (2011) researched the proximate composition of banana pseudostem. Table 1 shows the proximate nutrient values from previous studies.

Table 1: Nutrient Composition of Banana Pseudo Stem

Nutrients	Content (%)
Protein	2.5
Fat	3.4
Soluble dietary fibre	1.4
Insoluble dietary fibre	27.4
Starch	27.3
Ash	0.3
Moisture	15.1
Free sugar	3.4

Source: Bhaskar *et al.*

Health Benefits of Banana Pseudostem

1. Banana stem is a rich source of fibre and helps in weight loss (Chandrasekaran, 2012).
2. Pseudo-stem have low glycemic index and have a high content of dietary fibre and antioxidant which is good for diabetes (Bhaskar *et al*., 2011).
3. Banana stem is rich in potassium and vitamin B6. Vitamin B6 helps in production of haemoglobin and insulin. It improves the ability of the body to fight infection.
4. Potassium helps in the proper functioning of muscles, including the cardiac muscles. It also helps prevent high blood pressure, and maintain fluid balance within the body.
5. Banana stem is said to be a diuretic and helps detoxify the body. It is used prevent and treat kidney stones. It has been reported that a high dietary fibre intake has beneficial effects on human health. (Dawn *et al* , 2016b)
6. Banana stem is known to treat anemia. This is because it is packed with vitamin B6 and iron, both of which are responsible for increasing the content of hemoglobin in the blood. This is why anemic patients are usually recommended to add banana stem or banana stem juice in their diet.
7. It is rich in vitamin B6 and also iron and thus increases the hemoglobin count. Banana stem is also packed with potassium and that is the reason why it is quite effective in treating cholesterol and also high blood pressure.
8. Banana stem juice is known to be diuretic and it helps in flushing away the toxins and also cleansing up the urinary tract. So, drinking the juice of banana stem at least 3 times in a week can actually prevent UTI or the Urinary tract infections.
9. Banana stem juice is known to prevent kidney stones. (2) Mixing lemon juice with the banana stem juice could be a real effective method of combating renal stones. The presence of potassium and the diuretic properties in the banana stem along with the citric acid of lemon together work to stall the formation of calcium crystals or calcium lumps from the kidney and thus it is great for kidney stones. It helps you reduce the pain because of kidney stones and also makes you feel fresh
10. This is more effective when the juice is taken without straining. The juice does not have any sugar and thus it does not increase the blood sugar levels. Moreover, it has also got a low glycemic index and this is quite an important factor for any diabetic patient
11. It is rich in fiber content and this act as a laxative so as to ease constipation. In order to have maximum intake of fiber, you need to take the juice of banana stem without straining it.
12. It provides relief from hyperacidity and heartburn by regulating the acid levels in your body. Banana stem works best when consumed on an empty stomach. (Sheetal Decaria)

Utilization of Banana Pseudostem in Food Applications

1. **Pseudostem flour/powder** (Thorat *et al*, 2018)
2. **Pseudostem fruit juice**(Manisha *et al*, 2017)
3. **Pseudo stem candy** (Desai *et al*, 2016)
4. **Pseudostem biscuits(**R.Chakraborty *et al*,2021)

To date, very few attempts have been made to transform the pseudostem into edible baked forms. Therefore, the utilization of banana pseudostem into baked products demands special attention. Among the baked products, biscuit or cookie preparations are quite popular due to their ready-to eat form, palatability, aroma, texture quality and relatively longer shelf life(Kathy.W, 2020)

II. MATERIALS AND METHODS

2.1 Collection of the plant

The banana plant of *Musa saba* species was collected from a farm in Nashik, Maharashtra, India

2.2 Preparation of Pseudostem flour

The stem of the plant was cleaned and the outer sheath was removed and the inner core was obtained. The stem was cut in round slices and then boiled in water for 15-20 min to kill the microorganisms. Then the boiled slices were sundried for 2 days to remove the moisture. The dried pseudostem slices were milled to obtain a fine powder and then passed through sieve of mesh size 40. Thus fine pseudostem powder was obtained that was stored at 4ºC in air tight container for further use.

Fig 1: Preparation of pseudostem powder

2.3 Raw materials

1. **Wheat flour**
   Wheat flour named 'Aashirvaad Atta' manufactured by Geofast Flour Mills Pvt. Ltd., Hyderabad, India was used for biscuit making. The Atta was purchased from a local market in Nashik.

2. **Banana pseudostem *(Musa saba)***
   A common variety of fresh banana pseudostem after harvesting fruit, *Musa saba* were obtained from a farm in Nashik, India.

3. **Ragi flour**
   Ruchira ragi flour manufactured by Ruchira Anna Company, Nashik bought from a local market.
   Ragi: Finger millet or ragi is one of the ancient millets in India (2300 BC), and this review focuses on its antiquity, consumption, nutrient composition, processing, and health benefits. Of all the cereals and millets, finger millet has the highest amount of calcium (344mg %) and potassium (408mg %). It has higher dietary fiber, minerals, and sulfur containing amino acids compared to white rice, the current major staple in India. Despite finger millet's rich nutrient profile, recent studies indicate lower consumption of millets in general by urban. In vitro and in vivo (animal) studies indicated the blood glucose lowering, cholesterol lowering, anti ulcerative, wound healing properties, etc., of finger millet.

4. **Butter**
   Butter named 'Amul Pasteurized butter' manufactured by Kaira District Co-operative milk producers Union Ltd., Anand, India was used as shortening agent.

5. **Sugar (Stevia)**
   Natural sweetener named Zindagi Stevia Nature's Sweetener manufactured by Jhanil healthcare Pvt.Ltd. Sunam, Punjab.
   Stevia: It is a sugar substitute made from the leaves of the Stevia plant. It's about 100 to 300 times sweeter than table sugar, but it has no carbohydrates, calories, or artificial ingredients. Not everyone likes the way it tastes. Some people find it bitter, but others think Stevia tastes like menthol. Stevia is natural, unlike other sugar substitutes. If you have diabetes, Stevia could be a way to sweeten your food without adding carbohydrates. One gram is equivalent in sweetness to 2 teaspoon of sugar and gives negligible calories instead of 32 calories provided by 2 teaspoon of sugar

6. **Milk powder**
   Milk powder of Nestle EveryDay Dairy Whitener manufactured by Nestle India Ltd. was used.

7. **Baking powder**
   Pik baking powder manufactured by Twilite Products, Nashik, India

2.4 Formulation of cookies - Banana pseudostem (BPS) cookies were prepared following the procedure of Pradeep (2018) with slight modifications

Table 3: Formulation of Pseudostem Cookies(for 300g)

Ingredients	Wt (g)
Wheat	30
Pseudostem flour	120
Ragi flour	60
Milk powder	20
Baking powder	3
Butter	50
Sugar	12
Salt	2
Cardamom powder	3
Water	q.s

2.5 Process involved in preparation of cookies

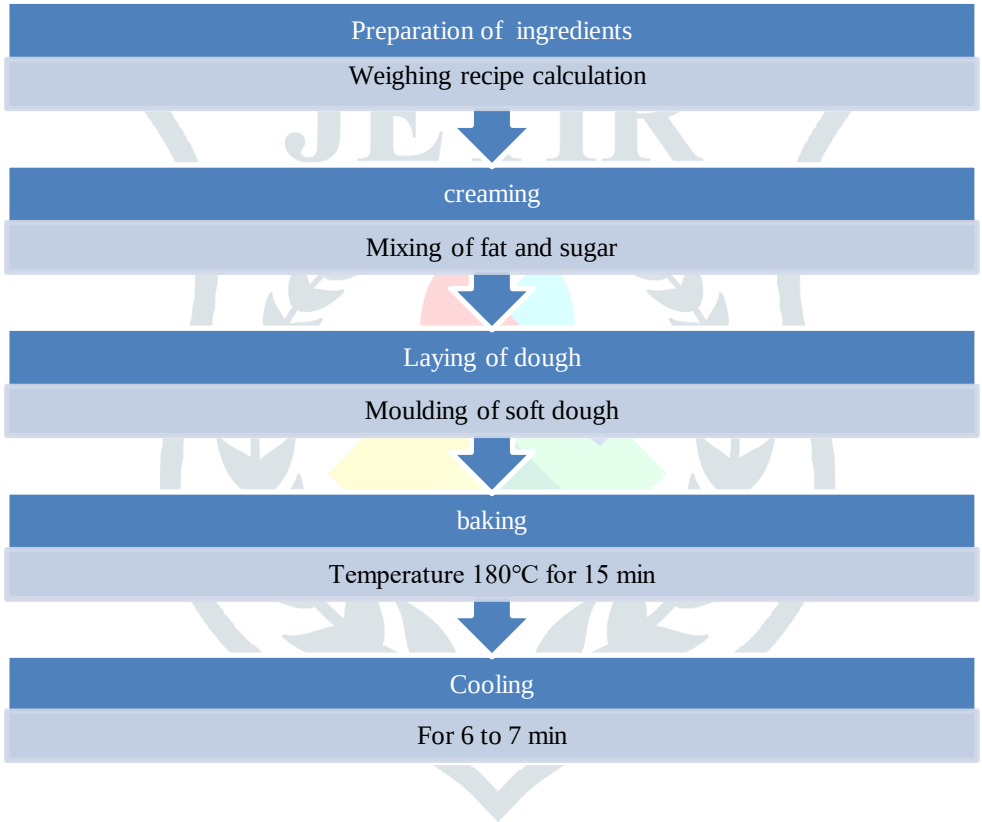

Fig. 2: Flow chart of method of preparation

2.6 Prepared Pseudostem Cookies

Fig 3: Pseudostem Cookies

2.7 Evaluation of the Cookies

Physical analysis of cookies :

The weight of the cookies was measured by weighing on an electronic balance with an accuracy of 0.01 mg.

2.7.1 Diameter:

Six cookies were placed edge to edge to calculate the diameter (D). Using a ruler, the overall diameter of the six cookies was measured in millimeters. For duplicate reading, the cookies were turned at a 90-degree angle. This was done again, and the average diameter was measured in millimeters. (Dawn *et al*, 2016)

2.7.2 Thickness:

Six cookies were stacked on top of one another to ascertain the thickness (T). With the use of a ruler, the entire height was measured in millimeters. The technique was done three times to obtain an average value, and the findings were expressed in millimeters. (Dawn *et al*, 2016)

2.7.3 Spread factor:

The spread factor was calculated using the approach proposed by Ayo et al. (2007). Three rows of two well-formed cookies were manufactured, and the thickness was measured, as well as the total of the diameters of the identical cookies arranged horizontally. (Dawn et al, 2016)

Spread factor (SF) was determined from the diameter and thickness, with the help of following Formula:

$SF = D/T \times CF \times 10$

where CF is a correction factor at constant atmospheric pressure

2.7.4 Volume

Volume of the biscuit was determined by the area of biscuit multiplied by thickness as per AOAC (2005). (Pradeep, 2018)

$$\textbf{Volume (cm3)} = \frac{\pi d^2 t}{2}$$

Where, t = Average thickness of biscuit (mm) d = Diameter of biscuit (mm)

2.7.5 Density

Density of biscuit was obtained by the ratio of mass to the volume of the biscuit as per AOAC (2005). (Pradeep, 2018)

$$\text{Density (g/cm3)} = \frac{\text{Mass (g)}}{\text{Volume (cm3)}}$$

2.7.6 Sensory analysis of banana pseudostem cookies

The sensory analysis for overall quality was carried out with ten semi-trained panelists who consisted of students of Matoshri College of Pharmacy. The parameters for sensory evaluation were texture, crispiness, color, taste, and overall acceptability. Sensory evaluation was performed according to the 9- Point Hedonic Scale (Pradeep, 2018) as below:

Like extremely – 9	Like slightly – 6	Dislike moderately – 3
Like very much – 8	Neither like nor dislike – 5	Dislike very much – 2
Like moderately – 7	Dislike slightly – 4	Dislike extremely – 1

Physicochemical analysis of cookies

As per the procedure suggested in the book Practical Pharmacognosy by Dr. K.R. Khandelwal following physicochemical tests were performed on the pseudostem cookies:

2.7.7 Swelling Index

Swelling index is the volume occupied by 1g of swollen material. The test for swelling index was carried out separately for the pseudostem stem flour and the cookies to determine the swelling property of pseudostem as ragi and wheat flour were also added in the cookies.

2.7.8 Total Ash Value

Ash contains inorganic radicals like phosphates, carbonates and silicates of sodium, potassium, calcium, etc. these are present in definite amount in crude drug hence, quantitative determination of ash values helps in their standardization.

Total ash value of sample (%) = $\frac{100(z-x)}{y}$

Where x= weight of empty dish

y = weight of crude drug taken

z = weight of the dish + ash (after incineration)

2.7.9Acid Insoluble Ash Value

Sometimes inorganic variables like calcium oxalate, silica, carbonate content of the crud e drug affects crude drug value and so such variables are removed by treating with acid as they soluble in acid and thus acid insoluble ash value is determined.

Total acid insoluble ash value (%) = $\frac{100\ (a)}{y}$

Where y = weight of drug taken and y is the a

a = weight of acid insoluble ash

2.7.10Crude Fibre Content

Crude fiber content is the residue of resistant tissues which can be obtained after giving treatment with acid or alkali.

Chemical analysis of the pseudostem cookies

10 g of the ground sample was weighed into three (3) different labelled conical flasks. 100 ml of the two (2) different solvents (distilled water and 50% methanol) were poured into the three different conical flasks to extract the phytochemicals. After 24 hrs, the mixtures were filtered into conical flasks using whatmann filter paper (No.1). The filtrates were concentrated by placing the flasks into water bath at 100°C. The resulting filtrate were cooled to room temperature, Qualitative test was then carried out on the cool solution (extract) using.(Harbone J.B,1998; Trease and Evans,1989) (books) to ascertain the presence of the different phytochemicals in banana pseudostem.

2.7.11 Test for Alkaloids

1.0 ml of the above extract was pipetted into a test tube followed by 5.0 ml of 2% HCl and heated on a water bath (Memmert) for 10 minutes. The solution was filtered using Whatmann No 1 filter paper and used for Wagner's reagent test. For the test, 1.0 ml of filtrate was pippetted into a test tube followed by 1.0 ml of Wagner's reagent. A reddish brown precipitate indicated the presence of alkaloids

2.7.12 Test for Cardiac Glycosides

1 ml of the extract was added to 10 ml of 50% H_2SO_4 and was heated in boiling H_2O for 5 minutes. 10 ml of Fehling's solution (5 ml of each solution A and B) was added and boiled. A brick red precipitate indicating presence of glycosides was observed.

2.7.13 Test for flavonoids

1.0 ml of filtrate was pippetted into a test tube followed by 1.0 ml 10% ferric chloride. Greenish brown or black colour/precipitate is an indication of presence of phenolic nucleus an indicator of the presence of flavonoids.

2.7.14 Test for tannins

3.0 ml of the extract was added to 2.0 ml of 1% HCl. The observation of a red colour or precipitate indicated the presence of phlobotannins.

2.7.15 Test for proteins

To a little portion of the filtrate in a test tube, 2 drops of Million's reagent were added. A white precipitate indicated the presence of protein.

IV RESULTS AND DISCUSSION

This work was carried out for the preparation of pseudostem cookies formulation with varying proportion of banana pseudostem powder and ragi flour. As biscuit is a product widely flavoured and consumed by general population, banana pseudostem incorporated cookies as a functional food was chosen for the study.

The findings of this inquiry, as well as pertinent debate, have been grouped under the following headings:

- **Physical properties of cookies prepared from banana pseudostem**

Physical characteristics of cookies such as thickness, diameter, spread ratio, weight, volume and density were affected by the substitution increment of the level of pseudostem powder according to the study done by Pradeep Sangroula (2018)

1. **Diameter**

Results disclosed that the average diameter of the six cookies was found to be 44.5 mm. the evaluation suggested that there is a variance of almost ± 2.5 mm.

2. **Thickness**

The average thickness of the cookies was found to be 2.08 mm and there was no much variance observed.

3. **Spread factor**

Spread factor is the ratio that depends on the values of the thickness and diameter of the cookies. The spread factor was calculated and found to be 21.34. High value of spread factor is attributed to the use of wheat and ragi flour otherwise as the pseudostem flour is level increased, spread ratio for different treated biscuits gradually decreases. These results are on the line with the findings of Ganorkar and Jain (2014) who reported that the reduction in spread ratio might be due to increase in dietary fibre and protein percentage with increasing level of pseudostem flour because dietary fibre and protein has more water binding power.

4. **Volume**

The volume of the pseudostem cookies was found to be 3218.8mm^3or 3.21$cm^{3.}$

5. **Density**

Density of the cookies was found to be 2.96g/cm^3 .

6. **Sensory analysis of the cookies**

Statistical analysis of the sensory scores was obtained from 10 semi-trained panelists using 9- point hedonic rating scale (9=like extremely, 1= dislike extremely) for pseudostem biscuits. Sensory analysis was performed with the aid of different panelists evaluating texture, crispiness, color, taste and overall acceptability of banana pseudostem powder incorporated biscuit.

Table 4: Scores for Sensory Analysis of the Pseudostem Cookies

Person	Colour	Texture	Crispness	Taste	Overall acceptability
1	7.5	8	7	8.7	8
2	7	8	6.5	9	8
3	7.5	8.2	7.2	9	8.2
4	7.8	8.1	7.1	8.8	8
5	7.3	8	6.7	8.8	8.5
6	7.2	8.5	6.5	8.7	8.3
7	7.6	8.3	7.2	9	8.3
8	7.4	8.3	7	8.9	8.2
9	7.7	8.1	6.8	9	8
10	7.5	8.2	7	8.8	8

The colour was brown and appearance of the cookies was pliable. The effect of higher amount of incorporation of the pseudostem flour may be the cause of dark brown color. The result is in accordance with Masoodi and Bashir (2012) who found that the

colour of the fortified biscuits attained darker colour as the supplementation was increased. Moreover the use of ragi flour as a binder also adds to the brown colour of the cookies. However, the texture was slightly decreased with supplementation but described no undesirable change. The reduced water content increases the glass transition temperature of the crust and contributes to the development of the crust crispiness. A glassy state of the solids would provide brittleness to the product, but the porous structure of the product and the solid, thin pore membranes may significantly contribute to the sensory properties of the product as stated by Roos (1995). With the increase in proportion of pseudostem flour texture score is decreased which may be due to tougher texture and cracks on the crust. Texture is an important factor of comparing the biscuit as it greatly affects consumer acceptance of the product (Eisa, 2006).the overall acceptability of the cookies had an average score of 8 which suggests that they are consumable and appreciable.

- **Physicochemical properties of cookies prepared from banana pseudostem**

1. Swelling index

There was no change observed in the volume of the pseudostem flour. While the powdered cookies showed 3ml increase in the volume. This suggests that pseudostem does not have swelling properties. Increase in the volume of powdered cookies indicates the swelling property which is attributed to the use of ragi flour.

Table 5: Swelling Index

	Initial volume	Final volume
Pseudostem flour	7 ml	7ml
Powdered cookies	5ml	8ml

2. Total ash value

From 2g of powdered cookies 0.05g of ash was obtained. The total ash percentage was found to be 2.5%. The cookies showed an increase in ash content when banana pseudostem powder concentration was increased which might be due to the use of low protein soft wheat flour. The high ash content in the wheat banana pseudostem and ragi supplemented food would be of nutritional importance.

3. Acid insoluble ash value

The weight acid insoluble ash was observed to be 0.008g and the percentage was calculated to be 0.04% which is in accordance of the requirements for the flour given by Aroma (1980).

4. Crude fibre content

The percentage of crude fibre content of the pseudostem flour was observed to be 18.2% and for powdered cookies it was found to be 22.5%

- **Chemical analysis of the pseudostem cookies**

Table 6: Qualitative Analysis of Banana Pseudostem Cookies.

Phytochemical	**Water extract**	**50% ethanol**
Cardiac glycosides	Absent	Present
Flavonoids	Present	Present
Tannins	Present	Absent
Proteins	Present	Present

From Table 6 we can generally conclude that, water extract fared better with respect to amount of phytochemicals found in it except for Cardiac glycoside where it was notably absent. The banana pseudo stem contains phytochemicals in relative abundance

with percentage comparative measure following the trend: Tannin>Alkaloids>Flavonoids>>Cardiac glycosides (Onyema *et al*, 2016)

V CONCLUSION

Cookies are the low cost, processed food which offers good taste along with nutritional value at affordable price with convenient availability. Since, cookie is a kind of dry food having a long shelf life, the problem of deterioration is very low in comparison to other bakery products. Further value of the cookies can be enhanced by incorporating banana pseudostem powder. Incorporation of wheat flour and ragi flour with banana pseudostem powder to make cookies provides a good opportunity to improve the nutritional quality of the fibre and minerals consumed by many people especially growing children and old people due to which helps to raise the nutritional status of all age groups. The pseudostem also has anti diabetic properties and high fibre content which makes it much suitable for diabetic and obese patients.

Banana pseudostem is crop waste, which cause economic loss and environment issues after harvest. However, pseudostems are rich in dietary fibre, mineral content and have health benefits. So preservation and utilization of banana pseudostem is very important. In this case banana pseudostem can be dried and converted into powder from which can be used for fortification in baked products like biscuits, bread, cookies, etc.

Banana pseudostem has anti diabetic, anti ulcer, diuretic properties. It also contains high fibre content. The chemical evaluation done also marks the presence of cardiac glycosides, tannins, flavonoids and some amount of which make them highly nutritive and healthy. Also the ragi flour utilized in the preparation adds on to the nutritive value of the cookies along with being a binder as it high amount of dietary fibre, calcium, potassium and minerals. Ragi also adds on to the anti diabetic, anti ulcer properties of banana pseudostem. These properties make the cookies suitable for use in people of all age groups and can be highly recommended for diabetic and obese patients.

Moreover the physical analysis suggests that the cookies are having highly pliable appearance and an appreciable color and taste which make it consumable and recommendable.

The study also suggests further recommendations for quantitative analysis of the phytochemical constituents of the cookies.

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