Evaluation of the Cookies Formulated with Finger Millet Plant Material for Antidiabetic Property

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ABSTRACT

Cookies are the most popular bakery food consumed worldwide. Development of reduced-sugar soft cookies by using Finger Millet, Syzygium cumini L. (Jamun), stevia extract was investigated. In addition to it Buttermilk powder was used as a bulking agent and to improve the flavor, color and texture of the cookies along with other ingredients like flour, margarine, salt, sodium bicarbonate and water. Creamery method of production was used for cookie preparation. Amounts of water, stevia and buttermilk powder and baking duration for each formulation was determined by preliminary experiments.

Different formulation using different ratio to find out the best composition for cookies on the basis of palatability. After selection of the best composition, cookies were prepared for the physiochemical, sensory and nutritional analysis. Sensory analysis was evaluated based on organoleptic property: color, taste, aroma and overall acceptability on the basis of 9-pointhedonic scale. Physiochemical evaluation included total ash value, total water and alcoholic extraction, total moisture content. On the basis of nutritional value comparison, it was found that protein content is higher in our formulation than other marketed product. Due to high antioxidant potential and phenolic content of the Finger Millet cookie, it can be used as a therapeutic or functional food source for the treatment of overweight, obesity and diabetes.

Keywords: Cookies, Polyherbal, Finger Millets, Diabetes, Nutrition

INTRODUCTION

This study highlights the use of cookies, which are the most used form of nutraceuticals for pre-diabetic or type-2 diabetic patients (Derosa Giuseppe et al., 2014). Diabetes mellitus is an alarming situation in the world that should be taken care of on a priority basis. It is a metabolic disorder in which insulin hormone, secreted from an endocrine gland (the pancreas) which assists the uptake of glucose into the tissue and uses it as energy to perform daily life activities; if the insulin hormone gets destroyed or reduced then it causes diabetes (H. King et al., 1998). It is concerned with the endocrine glands and their secretions. India is facing severe growth in diabetic patients in both rural and urban areas (Yeung Sharon et al., 2018, Zeilinski, H et al., 2001). Recent studies show that diabetes is prevalent among adults, about 20% in urban areas and about 10% in rural populations (Y. Huang et al., 2016). Studies showed that 77 million individuals have been battling this chronic disease which is expected to get a spike to over 134 million by the year 2045(H. King et al., 1998). Diabetes affects 8.5 percent of persons 18 years of age. Diabetes has been the causative factor of 1.5 million fatalities in 2019, with 48 percent of all diabetes-related deaths occurring before age of 70 (Rajendra Pradeepa et al., 2021). Diabetes caused a 5% spike in untimely mortalities (death before the age of 70) between 2000 and 2016 (Aarohy Kapoor, 2020, WHO, 2016). The diabetes-related proportion of deaths declined in high-income nations from 2000 to 2010 but then climbed from 2010 to 2016. Diabetes-related premature mortality grew in lower-middle-income nations over both eras (C. Boomer et al., 2017, Laveena M Tahilramani et al., 2013).

Nutraceuticals have a prominent role to overcome this issue. The concept of nutraceutical therapy is taking food as a drug.

Due to a sedentary lifestyle and consumption of unhealthy diet people have become more prone to various diseases (Derosa Giuseppe et al., 2014). Nutraceuticals are non-specific biological medicines that are used to improve overall health, reduce spikes of glucose levels and manage symptoms. Traditional medicinal herbs are utilized for a variety of diabetic symptoms all around the world. Herbal medications are often prescribed due to their effectiveness, lack of adverse effects, and inexpensive cost.

However, a person's vulnerability to disease is mostly determined by genetic susceptibility and lifestyle issues. As a result, nutraceutical responses differ between individuals. Nutraceuticals have the power to help people manage their diabetes (Bornare, D.T et al., 2015).

Nutraceutical cookies

A healthy mid-morning appetizer can give you the boost you ought to maintain focus till it's time to leave. A decent snack can also serve as a mental break and a delight for your tastes. Biscuits were once thought to be a sick diet. It has now been one of the most popular fast-food products for everyone (Nimesh S et al., 2018). Cookies are a beloved confectionery product with people of all ages, particularly youngsters, and can therefore function as a medium for providing vital nutrients if made broadly accessible. In the baking business, the introduction of fortified flour blends in baked goods including biscuits and cookies is the latest phenomenon (Kajal Pathak et al., 2018).These foodstuffs can be employed in the management of prediabetes or can also be used in massive feeding programs and humanitarian projects after natural catastrophes due to their improved nutritional composition and other comfort aspects such as

easier packaging, storage stability, and fully prepared composition. Biscuits are convenient to transport, delicious to eat, cholesterol-free, and low in calories. In terms of price, it is reasonable.

Diabetics and heart patients should avoid junk and greasy foods, but they can be offered healthy snacks that will improve their health and fulfill their cravings at any moment (Egede E. Leonard et al., 2002). The quality and nutritional value of biscuits can be improved by substituting refined flour or low fiber flour with the enriched source of dietary fiber and minerals, sugar or fats can be replaced by various substitutes which result in a reduction of glucose level, carbs, and hasn't any harmful health effects.

In the present paper, a new creative idea for manufacturing anti-diabetic cookies is presented. The ingredients can be multigrain flour like wheat flour, kodo or madua flour also known as ragi flour, bajra, and jowar. Cereal grains have become a dietary staple all throughout the globe since prehistoric times. Stevia leaf is a sweetening ingredient that comes from plants. It also helps to maintain glycemic control in the body (Liu Dongying et al., 2020). Functional foods which are beneficial in these cookies can be sesame seeds, chia seeds, flax seeds oil or powder, and black pepper. Carbohydrate consumption goals must be decided on a case-by-case approach with the assistance of your medical physician (Liu Dongying et al., 2020).

Nutraceuticals that can be used in a cookie without altering taste, texture, appearance and flavor are:

Jamun seed powder: Jamun seeds (*Syzygium cumin* belongs to the family Myrtaceae)have a variety of qualities, including antioxidant, anti-diabetic, anti-cancer, cardiovascular protection, and anti-microbial (N. Elanchezhian et al., 2017). The most important components in seeds are alkaloids, jambosine, flavonoids, saponins, and glycoside jambolin which prevents starch from being diastatically converted into sugar and aids in the alleviation of diabetic symptoms such as continuous thirst and often urination. Jamun seeds include the substances jambosine and jamboline, which limits the rate of sugar in the blood. Furthermore, jamun seeds aid in the manufacturing of insulin, which is beneficial to those with diabetes (N. Ahmed et al., 2010). On the other hand, seeds are high in fiber and can help the digestion process (Priyanka et al., 2015, N. Elanchezhian et al., 2017, A. V. Thorat et al., 2013). Erectile dysfunction and a lack of sexual desire are common among diabetic men. Jamun seeds might naturally improve your libido if consumed on a regular basis. Jamun fruit or seed can be employed in nutraceutical supplement formulations as a substantial source of natural antioxidants as phenolic and flavonoid compounds are present.

Moringa powder- *Moringa oleifera* derives from the word 'moringa' and 'oleum' meaning 'twisted pod' and 'oil' respectively. It's widely utilized as both food and medicinal all throughout the world. Its leaves can be crushed and once they have dried, they can be used as a healing ailment for the treatment of diabetes, cancer, hypertension, malaria, and fever (G. Mishra et al., 2011, Gasi S et al., 2000). Leaves of moringa are a good source of antioxidants like ascorbic acid, tocopherol, and other nutrients like minerals (potassium, calcium, and vitamins such as vitamin A) which aids in the maintenance of good vision, immunity, and fetal growth, and vitamin E is an antioxidant, also vitamin C content of the leaves is seven times that of oranges (A. Adelaja et al., 1999). Quercetin, an antioxidant that aims to minimize blood

pressure, and Chlorogenic acid, another antioxidant that assists to stabilize blood sugar levels, are both found in Moringa leaves. Moringa's chlorogenic acid may aid in the body's sugar processing and influence insulin levels. Leaves are very low in calories and can be incorporated into an obese person's diet. Moringa leaf powder contains several compounds, indicating its value as a nutritional supplement (F. Nikkon et al., 2009, Sissoko Lasaana et al., 2020).

Quinoa seeds- Quinoa's popularity has exploded in recent decades, owing to a surge in demand for easy-to-grow, rich in fiber and protein and gluten-free grain alternatives. Most grains lack all of the amino acids required to create protein (Kam Jason et al., 2016). Quinoa, on the other hand, is a complete protein since it includes all of the essential amino acids. DPP IV inhibitory activity was discovered in bioactive peptides derived from quinoa protein hydrolysates (Kam Jason et al., 2016).

Flax seeds oil- Flaxseed oil is extracted from matured flax seeds that have been cold-pressed or solvent extracted by manufacturers. Sustaining healthy blood sugar levels is critical for diabetics, and fibers play an essential role in this. Flax seeds are regarded as a low-glycemic food owing to their high fiber content. This means that eating them will not cause your blood sugar levels to rise significantly but will instead end up causing them to rise gradually, going to promote glycemic control.

Stevia- The candy leaf, *Stevia rebaudiana* belongs to the family Asteraceae, known for its natural sweetness. Eight glycosides make up stevia. These are the sweet components that have been extracted and refined. These glycosides include Rebaudiosides A, C, D, E, and F, Stevioside, Steviolbioside, Dulcoside A. Stevia is utilized as a sugar substitute in a variety of foods and beverages as natural sweeteners have 200 to 300 times the sweetness of table sugar. Many people question if stevia can heal or cure diabetes because of the attention on it for diabetics. Type 2 diabetes and its consequences, such as heart and kidney problems, are linked to being overweight (Marjan Ajami et al., 2020).
Stevia's adaptability is another advantage. It may be used in both hot and cold drinks, and it can also be sprinkled over oatmeal or fruit (Abo Elnaga et al., 2016).

Ragi flour- Ragi, also termed as finger millet or Eleusine coracana, is a nutrient-dense, adaptable grain that thrives in dry, hot regions and at high elevations. It has been a key source of nutrients for millions around the world for centuries. Diabetologists claim that consuming a diet rich in finger millets lessens blood glucose levels in the serum (Hou Qingtao et al., 2015). Because of the high fiber level in the diet it has numerous advantages, such as it is gluten-free, has low glycemic properties, high in calcium, vitamin D and rich in antioxidants, has antimicrobial properties, known to lower the risk of heart disease caused by artherosclerosis.
The substitution of processed carbs, sugary, fuel dense, and nutrient low foods for whole grains and conventional healthful diets in India has made a significant contribution to this issue (Kam Jason et al., 2016).

Insulin plant: Spiral flag or sugar plant, also recognized as Costus igneous Nak and Costus pictus D. Don, is a Costaceae plant that was recently brought from South and Central America

to India as it is commonly planted in South India. It's a two-foot-tall perennial with spirally arranged leaves and lovely blossoms that grows erect and spread out and its fruits are small, green, and unobtrusive, with a diameter of fewer than 0.5 inches. Its anti-diabetic properties make it a popular treatment for diabetes, and it is widely acknowledged that diabetic patients are reported to consume one leaf per day to keep their hyperglycemia low.

Murraya konigii leaves: It is often recognized as curry leaves or meethi neem as a name of folklore in India, is a member of the Rutaceae family, which has over 150 genera and 1600 species which is well recognized for its distinctive fragrance and pharmaceutical potential. Murraya plant is utilized as an antioxidant, oxygen radical's scavenger, hepatoprotective, antibacterial, antifungal, and hypoglycemic agent. It protects against dental cavities, anticancer, anti-inflammatory, antipyretic immunomodulatory, a pancreatic lipase inhibitor, kidney protection, anti-obesity, and so on.

MATERIALS AND METHODOLOGY:

1.Collection of Sample:

Jamun seed powder, ragi flour (also called as mandua or kodo), moringa leaves powder, flax seeds oil, baking powder, baking soda, almonds, oats flour, Milk, Flavoring agent (vanilla), salt, baking soda, butter, stevia (sweetening agent) were acquired from Prem Nagar, Dehradun local market. The raw materials were kept in a warehouse for use in studies at room temperature.

2. Processing of samples:

Leaves of Murraya konigii and Insulin plant were collected from the local area, washed and cleaned and dried in shade. Quinoa seeds were roasted in a dry saucepan until it turns brown and crackle then gives a strong nutty aroma then grinded on a high-powered blender. Sieve the millet mixture in a tiny mesh sieve over a plate.

Jamun powder were prepared from the seeds kept over to dry in a tray at 60-65° C for 48 hours to ensure thorough drying, then milled into a fine powder with a 60mesh screen size in a cyclone mill and stored.

3. Cookie preparation:

The modified cookies with a particular percentage of Jamun seed powder, moringa leaf powder, curry leave powder, and quinoa seed powder were made. All of the essentials, such as ragi flour, stevia, almonds, milk, vanilla essence, flaxseed oil, and oats flour have been used.

Measure the appropriate amount, given in the Table 1 step by step as shown in Figure 8, Jamun seed powder, insulin plant, moringa leaf powder, and curry leaf powder. Add different quantities of this power to the dry ingredients bowl, wet and dry ingredients were mixed together to end up making a dough. The cookie balls should be rolled out and punched. Place on a baking tray that has been buttered. Preheat the oven and bake for 20 minutes.

For the control sample:

1. Set the temperature of the oven to 375° Fahrenheit and assemble all of the materials and supplies which are required, along with a mixer and calculating utensils. Mix together the particular amount of wheat flour, ragi flour, oatmeal powder, quinoa seeds powder, baking soda and powder, almond powder, and vanilla essence in a separate basin until well combined. Make a note of it and come back to it later.
2. Combine the flaxseed oil and stevia powder in a small bowl. Blend it until it is well combined and form a creamy mixture. In a separate bowl, combine the vanilla essence and the water. Cookie dough should really be rich and creamy when completed.
3. Gradually add the wet mixture to the dry ingredient mixture, about 1/3 at a time until fully incorporated, then the last third. When all of the dry ingredients have been combined with the remaining ingredients in your mixing bowl, knead it slowly with the help of milk. Cookie dough should really be rich and creamy when completed.
4. Allow the dough to rest for a few minutes. After that, using a cookie scoop, remove some cookies from the cookie batter. Re-roll the cookies into balls and shape them and set them on a cookie sheet coated with butter or oil.
5. Set a reminder for 20 minutes and place the baking sheet with the unbaked cookies on a baking pan in the oven at 160°.
6. Remove the cookies out from the oven and leave them to set on the baking tray for 5 - 10 mins. Store them in a cold, dry place or in the refrigerator. Now the cookies are ready.

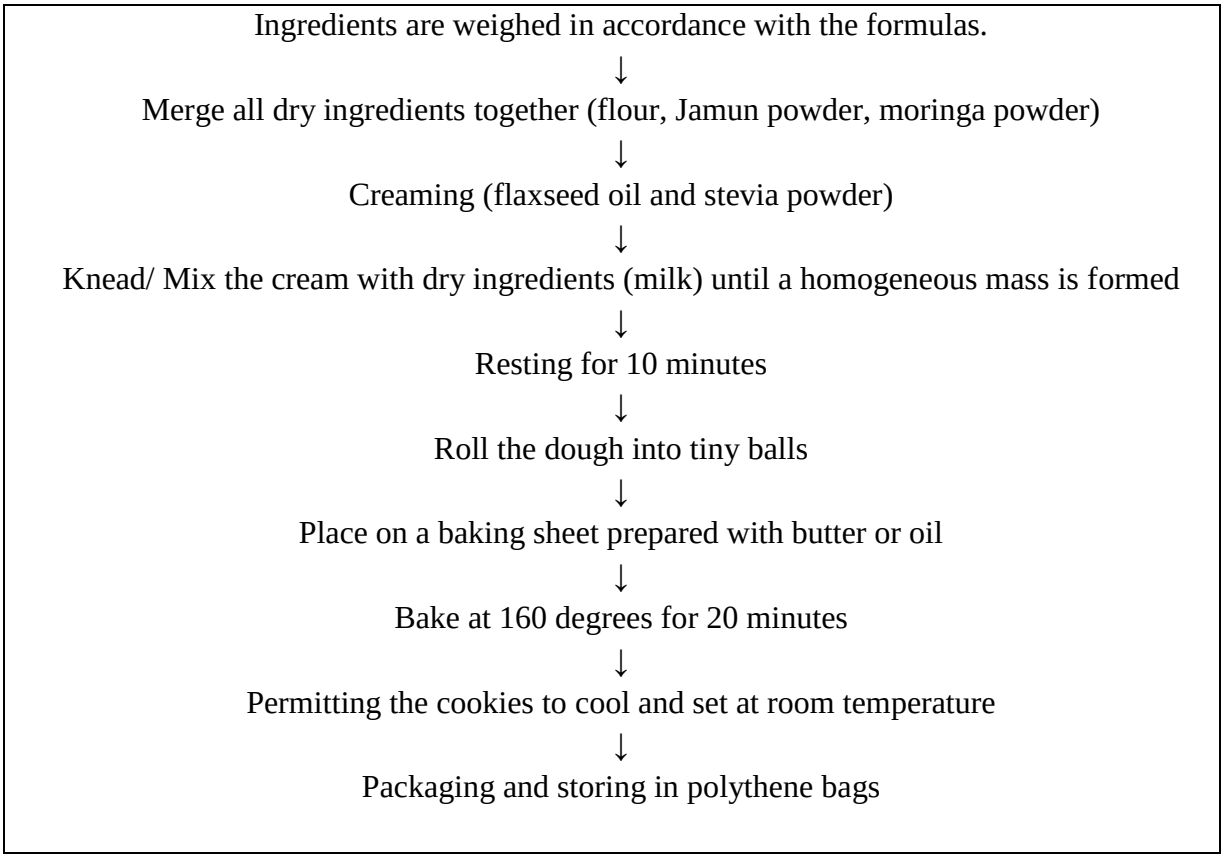

Figure 1: A flowchart of the steps involved in making cookies.

Ingredients	Control	Formulation 1	Formulation 2	Formulation 3	Formulation 4
Ragi flour	_	8gm	10gm	12gm	17gm
Oatmeal flour	_	8gm	10gm	14gm	15gm
Wheat flour	50gm	5gm	7gm	9gm	10gm
Quinoa seed powder	_	5gm	7gm	7gm	10gm
Jamun seed powder	_	_	1gm	2gm	5gm
Moringa powder		_	1gm	2gm	5gm
Murraya koniggi	Pinch size	Pinch size	Pinch size	Pinch size	Pinch size
Insulin leaf powder	_	0.4gm	0.5gm	0.6gm	0.8gm
Stevia	1.5gm	1.5gm	1.6gm	1.6gm	1.8gm
Almond powder		3gm	3.5gm	3.7gm	4gm
Baking powder	2gm	2gm	2gm	2gm	2.5gm
Baking soda	Pinch size	Pinch size	Pinch size	Pinch size	Pinch size
Flaxseed oil	2tbsp	2tbsp	2 tbsp	2 tbsp	3tbsp
Vanilla Essence	1-2 drops	1-2 drops	3-4 drops	3-4 drops	4-5 drops
Milk	10gm	10gm	12gm	12gm	15gm

Table 1: Formulation of cookies.

Evaluation of fortified cookies:

1.) Analytical Chemistry

The proximal analysis entails determining the total moisture content, total solids, total ash value, fat content, protein concentration, carbohydrates level, and volatile matter of samples with normal techniques.

In a moisture analyzer, the sample's moisture content and solid content were determined. The moisture analyzer simply measures a sample, heats it to dry it, and then weighs it again after it's getting dry. A standard procedure for assessing moisture is termed a loss on drying. Basically, the working principle is to weigh the sample, then heat it, dry it, then weigh it once again. Also, moisture concentration can be determined using the hot air oven technique at 105°C for 4 hours.

- The total ash percentage was calculated by using the muffle furnace process up to a fixed weight by burning the material. First, take a clean porcelain crucible and place it in an oven to dry it properly at 105°C for 20 minutes for avoiding false weighing. Now cool the crucible in a desiccator, then keep it on the weighing balance to weigh the blank crucible. Take 2-6g of sample in a crucible and weigh it again. After weighing, the sample is covered with the lid of the crucible. The sample is ready for combustion, place the crucible inside a muffle furnace. Set the temperature at 550°C for 4 hrs. (after finishing the burning make sure to drop the temperature of the furnace below 250°C). After this pull out the crucible from the furnace (transfer to the desiccator for cooling if it is hot) and take the final weight of the crucible containing ash and take a note of it. Determination of ash content:

$$\frac{W2\ (\text{weight of sample})-W1(\text{weight of crucible})}{W3(\text{Weigh of the crucible with ash})} * 100 = \text{Ash content}\%$$

-The material is separated in a Soxhlet device by using petroleum ether for fat determination. Make a narrow thimble out of square filter paper for analysis, then place it on a machine and tare its weight. Now crush the sample in a mortar and pestle. Fill the thimble with 4-5g of sample and weigh it again. Place a small bit of cotton in a thimble and fold it over the sample to completely encapsulate it. Take a sample holder (cellulose thimble) and insert the thimble into it. Use a balance machine to weigh a sanitized and dried flat bottom flask of the apparatus. We now extract fat content from the sample using the Soxhlet apparatus. Place the prepared sample in the Soxhlet extraction unit. Run the water through the condenser of the Soxhlet extractor after adding enough petroleum ether. Start the extractor by turning on the power. Because maintaining a 5 drop per second reflux rate is crucial for complete fat extraction, set the temperature in such a way that it is maintained. Petroleum ether is employed as a fat solvent, evaporating the fat from the sample into the flask. After 6 hours, remove the thimble from the solvent and collect the waste petroleum ether in a glass bottle. To reclaim petroleum ether and achieve apparent dryness, distill the solvent as much as possible from the flask. Rotate the flask to evaporate the surplus petroleum ether and collect the residual petroleum ether by condensation. The extracted fat or oil can be seen inside the flask. Now dry the flask in a hot air oven at 110°C for 30 minutes, then remove it and cool it in a desiccator. Take the weight of the flask with the fat content after it has cooled.

Determination of crude fat: $\frac{W2-W1}{WS}*100$ W1=weight of the flask
W2=weight of the flask with fat content
WS=weight of sample

-The nitrogen value was observed using the Kjeldahl method. The Kjeldahl system comprises of three steps that must be taken carefully in order:
1. Digestion method: The sample is initially digested in strong sulfuric acid with a catalyst present to aid in the transition of amine nitrogen to ammonium ions.
2. Distillation method: The ammonium ions are then heated and distilled into ammonia gas. The ammonia gas is drawn into a trapping mixture, in which it disperses and returns to its original state as an ammonium ion.
3. Titration method: Finally, the amount of trapped ammonia is calculated using titration with a reference solution and a computation.

Determination of nitrogen- $\frac{V1*n1*F1*MWn}{Ws*10}$

Ws- sample weight, V1(volume of 0.1N HCL) = Final burette reading - Initial burette reading, n1(Normality of HCL) = 0.1N, F1=Acid factor, MWn= Molecular weight of nitrogen
Meanwhile, the protein concentration was calculated by multiplying the nitrogen figure by 6.25.
-Total alcoholic and water extractive values: For whole alcohol/water extraction valuation, 5 gramme of biscuits powder were placed in 250 ml volumetric flasks containing 90% ethyl alcohol or distilled water and left for 24 hours. After 24 h our distilled samples were taken in china dishes. All alcoholic and water extract specimens were examined. Mixture was heated to 100°C to evaporate, then chilled and further computations were made. Completed using the method
Calculation: A sample of 5 gm yields 4x alcohol extract, hence a sample of 100 gm yields = 80 x/4.
Where x represents the dried sample.

2.) Sensory evaluation-:
A panel of 10 postgraduate students and faculty members assessed the cookies' sensory qualities. The panel members were asked to assist in the measurement of concepts indicating sensory features such as taste, texture, appearance, mouthfeel, taste, overall acceptability as well as the application of the result. The scoring approach was evaluated on the basis of representative quality indicators. A 5-point scoring system was used. The appropriateness of fortified cookies was standardized for sensory evaluation all through initial trials. This was discovered that Jamun seed powder, moringa, insulin plant, and curry leaves were unacceptable in the given recipes when used at over high concentrations. This was due to the fact that introducing these powders at these levels changed the flavor (bitterness) and appearance

(darker). Because the inclusion of 30 percent Jamun seed powder generated positive results in the present research, these powders were used.

2.) Physical examination-:

Cookies' physical properties, such as weight breadth, thickness, and spreading ratio, were assessed using the methods outlined below: Weight (W): An electronic weighing balance was used to measure weight. Diameter(D): For duplicate readings, the diameter of cookies was determined by arranging 6 cookies horizontally and rotating them at a 90-degree angle. Thickness (T): The thickness of cookies was determined by stacking six cookies on top of each other and recording the equivalent reading. Spread Ratio (SR): The spread ratio is a ratio of diameter to the thickness that was computed using the equation.

SR = (10 x (Diameter/Thickness x CF)

where CF is the correction factor at steady air pressure.

RESULT AND DISCUSSION

1. Chemical analysis

The nutrient composition of cookies is classified using proximate analysis. Table 1 summarizes the proximate components evaluated in the Jamun seed powder and moringa powder enhanced cookies. The water content of cookies rises from 3.2 to 5.6 percent as the proportion of powders tends to intensify. Whereas the high protein composition rises from 3.8 to 5.14 percent. The remaining fat and ash percentages range from 20 to 31% and 2.1 to 3.5% respectively.

The high protein content of cookies helps bodybuilding, growth management, electrolyte levels, and robust immunological function, among other things. The cookies are also rich in fiber level, which may aid with digestion.

Table 2: Chemical analysis of enriched biscuits with Jamun seed powder, moringa powder, and curry leaves powder.

Samples	Moisture content	Ash content	Protein content	Fat content
Control	3.2±0.2	2.1±0.1	3.8±0.5	20±0.3
Formulation 1	4.9±0.1	2.9±0.5	4.9±0.1	25±0.18
Formulation 2	5.6±0.19	3.5±0.3	5.14±0.28	31±0.6
Formulation 3	5.9±0.6	3.9±0.4	5.67±0.12	39±0.7
Formulation 4	5.4±0.19	3.4±0.3	5.24±0.28	32±0.6

2. Sensory analysis

Table No.3 contains information on how different treatments affected the organoleptic assessment of various herbs enhanced cookies. The texture data shows that there were considerable variations across treatments. Cookies flour fortified with 30 percent herbal powder received a much higher texture score (6.47), however, 40 percent Jamun seed powder received the lowest score (6.36). A considerably higher rating for flavor was obtained in cookies flour fortified with 30% powder (6.56), which was comparable to the control (7.18), but the least value was achieved in 40% inclusion (5.93).

There were substantial differences between the treatments when it came to the general acceptability of herbal powder-enhanced cookies. Overall acceptance was significantly greater in cookies flour fortified with 30 percent powder (7.10), which was comparable to the control (7.45). The lowest score was achieved in 40 percent incorporation (6.31).

Table 3: Color and look, taste, texture, and general acceptance of herbal powder enhanced cookies (score out of 10)

Samples	Color and appearance	Texture	Taste	Acceptability
Control	7.91±0.12	7.39±0.6	7.18±0.11	7.45±0.5
Formulation 1	6.94±0.1	6.46±0.6	5.83±0.5	6.41±0.6
Formulation 2	7.19±0.5	6.47±0.5	6.56±0.9	7.10±0.12
Formulation 3	6.90±0.1	6.36±0.6	5.93±0.5	6.31±0.6
Formulation 4	6.13±0.4	5.98±0.2	5.13±0.4	5.89±0.3

Figure 9: Formulated Cookies

3. Physical Characteristics

The physical parameters of the cookies made are shown in Table 4. The breaking toughness of the fortified cookies seemed to rise as the number of herbal powders and multigrain flours were raised. The rise in the degree of herbal powders and multigrain floor affects physical evaluations such as diameter, height, and spread ratio. Control cookies had an average diameter of 3.49, while integrated cookies had an average diameter of 4.69. The mean thickness of the control sample was 1.12, and other augmented level cookies were 0.91 cm. As when the quantity of fortification rose, the spread ratio of the cookies elevated, ranging from 3.11 to 6.35. As the amount of herbal powder and flour in the cookies increased, the thickness of the cookies decreased, whereas the diameter of the cookies increased, and therefore the spread ratio of the cookies increased. Cookies with a higher spread ratio are thought to be more attractive.

Table 4: Physical characteristics of cookies.

Samples	Diameter	Thickness	Spread ratio
Control	4.49±0.3	1.12±0.2	3.11±0.2
Formulation 1	4.21 ±0.12	0.96±0.1	4.39±0.3
Formulation 2	4.52 ±0.5	0.94±0.3	4.80±0.1
Formulation 3	5.34±0.2	0.84±0.9	6.35±0.2

CONCLUSION

The results showed that herbal powders like curry leaves, moringa leaves, insulin plant leaves, and Jamun seed powders with multigrain flours can be used as a partial substitution for refined flour in cookies and stevia can be used as a replacement material for refined sugar in fortified cookies without impacting the physical or sensory character. The results of this study demonstrate that baked goods can benefit from the addition of herbal powders and stevia for antidiabetic patients. Herbal powder and multigrain flours are high in fat, crude fiber, minerals, and calories. They're high in widely accessible carbohydrates and dietary fiber. They often include antioxidants, which aid with blood sugar regulation. When 30 percent Jamun seed powder is incorporated into the cookies, the cookies become more palatable. Color, taste, and texture are all deemed to be acceptable sensory qualities; therefore, they can be devoured by anyone, including diabetics. As a result, new formulations might be evaluated with the goal of developing and consuming food with larger concentrations of functional and nutritious nutrients.

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REFERENCE

1. Aarohy K., "Diabetic supplements to help you manage your blood sugar levels", The Times Of India, Feb 24, 2020, 17:23 IST.
2. Abo Elnaga N., Massoud M.I, Yousef M.I., Mohamed H.H.A., Effect of stevia sweetener consumption as non-caloric sweetening on body weight gain and biochemical's parameters in overweight female rats. *Ann Agr Sci.* 2016;61:155–163.
3. Adelaja A.O., Schilling BJ. Nutraceutical: blurring the line between food and drugs in the twenty-first century. *Mag Food Farm Resour Issues.* 1999;14:35–40.
4. Ahmed F, Huded S., Malik F.A., (2010) In vitro study on the radical scavenging and anti- lipid peroxidative effects of Eugenia jambolana aqueous extracts. J Pharm Res 3:198- 200.
5. Bommer C, Heesemann E, Sagalova V, et al. "The global economic burden of diabetes in adults aged 20-79 years: a cost-of-illness study". *Lancet Diabetes Endocrinol* 2017; 5:423–30. {PubMed}
6. Bornare, D.T., Khan, K. S. A., (2015). "Physical and Sensory Evaluation of Cookies Incorporated with Oats and Honey". International Journal of Engineering Research & Technology, 4(8), 2278-0181.
7. Dongying Liu, Qing wen, Min Liu et al, "Dietary supplements for prediabetes", Medicine (Baltimore): 2020 May 15; 99(20): e20347.
8. Gasi S, Nwodobo E, Ofili JO. Hypocholesterolemic effect of crude extract of leaf of *Moringa oleifera* lam in high-fat diet fed wistar rats. *J Ethnopharmacol.* 2000;69:21–25. doi: 10.1016/S0378-8741(99)00106-3.
9. Giuseppe Derosa, Celina Preciado Limas, Pamela Maffioli, "Dietary and nutraceutical approach to type 2 diabetes", National Library of medicine, 2014 May 12; 10(2): 336–344.
10. Huang Y, Cai X, Mai W, et al. "Association between prediabetes and risk of cardiovascular disease and all-cause mortality: systematic review and meta-analysis" . *BMJ* 2016;355: i5953.
11. Jason Kam, Swati Puranik, Rama Yadav, Hanna R Manwaring, Sandra Pierre, Rakesh K Srivastava, and Rattan Yadav S. Dietary Interventions for Type 2 Diabetes: How Millet Comes to Help. Frontiers in Plant Science, 2016; 7: 1454.
12. Kajal Pathak, Salman Khan, Shubham Sen et al, Formulation of Polyherbal Antidiabetic Cookies, Journal of Chemical and Pharmaceutical Research, 2018, 10(2):91-97
13. King H, Aubert RE, Herman WH. "Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections". *Diabetes Care.* 1998; 21:1414–31.
14. Krutika S. Mule , Ajay G. Pise, Ujwala Mahajan, Nutraceutical Supplements and Sedentary Lifestyle to improve Heart Patients: Development and Characterization of Instant Soup Formulations, YMER, 21 (11):41-58

15. Laveena M Tahilramani, Rupali Sengupta, Multigrain Healthy Cookies for Diabetes Mellitus, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14 : 6.391
16. Leonard E. Egede, Xiaobou Ye, Deyi Zheng, Marc D. Silverstein, "The prevalence and pattern of complementary and alternative medicine use in individuals with diabetes / diabetes care", American Diabetes Association, 1 (Feb. 2002), Web. 5 Nov. 2017
17. Marjan Ajami, Maryam Seyfi, Fatemeh Abdollah Pouri Hosseini et al, Effects of stevia on glycemic and lipid profile of type 2 diabetic patients: A randomized controlled trial, National Library Of medicine, Avicenna J Phytomedicine 2020 Mar-Apr; 10(2): 118–127.
18. Misha G, Singh P, Verma R, Kumar S, Srivastav S, Jha KK, Khosa RL. Traditional uses, phytochemistry and pharmacological properties of *Moringa oleifera* plant: an overview. *Der Pharm Lett.* 2011;3(2):141–164.
19. N. Elanchezhian, S.Kasthuri, P. K. mandal, U. K. Pal et al, "Effect of Incorporation of Drumstick Leaf and Jamun Seed Powder on Sensory Quality of Functional Chicken Chips, J.Meat Sci., 2017, 12 (2) : 14 – 18.
20. Nikkon F, Hasan S, Salam KA, Mosaddik MA, Khondkar P, Haque ME, Rahman M. Benzyl carbamothioethionate from root bark of *Moringa oleifera* lam. And its toxicological evaluation. *BLACPMA.* 2009;8(2):130–138.
21. Nimesh S, Nimesh VD. Nutraceuticals in the management of diabetes mellitus. *Pharm Pharmacol Int J*. 2018;6(2):114-120, April 6, 2018.
22. Pradeepa, Rajendra; Mohan, Viswanthan" Epidemiology of type 2 diabetes in India, Indian Journal of Ophthalmology: November2021 volume-69 issue 11
23. Priyanka, A.A.Mishra, "Development and quality Evaluation of jamun powder fortified biscuits using natural sweeteners", Volume3 Issue3:2015.
24. Qingtao Hou, Yun Li, Ling Li, Gaiping Cheng, Xin Sun, Sheyu Li, and Haoming Tian. The Metabolic Effects of Oats Intake in Patients with Type 2 Diabetes: A Systematic Review and Meta-Analysis. Nutrients, 2015; 7(12): 10369–10387.
25. Sissoko Lasaana, Diarra Nouhoum, Merlin luke Willcox et al, " Moringa Oliefera leaf powder for type 2 diabetes: a pilot clinical trial", J. Complement Altern Med.(2020)17 (2):29-36.
26. Thorat A. V. , Khemnar M. B., Development and Sensory Evaluation of Jamun Seed Powder Fortified Cookies, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14 | Impact Factor (2014): 5.611
27. World Health Organization. Global Report on Diabetes, WHO Press, Printed in France, 2016, 1-88.
28. Yeung's Sharon , Soliternik Jane, Mazzola Nissa, "Nutritional supplements for the prevention of diabetes complication", Journal of nutrition and intermediary metabolism, Volume14 December 2018.
29. Zeilinski, H., Kozlowska, H., Lewczuk, B., Bioactive compounds on cereal grains before and after hydrothermal processing". Innovative Food Science & Emerging Technologies, (2001) 2(3), 159-169.