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Preparation of sugar-free multigrain biscuits

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Abstract
Multigrain sugar free biscuits were developed using whole wheat, soya and finger millet flour and by incorporating various levels of sucralose and stevia as substitute of sugar. The incorporation of 3% sucralose or 0.1% stevia as a substitute of 40% sugar in the formulation of biscuits made with wheat, soya and ragi flour was acceptable. No remarkable change in colour of low-calorie biscuits was observed in both cases of sucralose and stevia. The diameter of biscuits was decreased but the thickness was increased. With increase in level of both the sweeteners, hardness of biscuits was observed to be decreased than that of control sample. From the sensory analysis of data, it was observed that the overall acceptability of control biscuits was more than the biscuits made with sucralose and stevia. Thus, these low-calorie biscuits made with multigrain flour and artificial sweeteners were found to be suitable for diabetic patient only.

Keywords: multigrain, sugar-free, sucralose, stevia

1. Introduction
In recent studies, the daily routine diet of the human being is inappropriate. Obesity and diabetes have been considered as the common risk due to inappropriate diet. Changes in the quality, quantity, and source of food consumed along with a high level of mental stress and inactive lifestyle have led to an increase in these non-communicable diseases. The recent published IDF Diabetes Atlas [30] reports that there are 425 million people living with diabetes in the world and it is expected that it may rise to 629 million in 2045. There is a vital fact that lifestyle modification (unhealthy diet rich in calories and saturated fat, physical inactivity) has a sustained effect in expanding these diseases. In order to limit the frequency of diabetes, it is suggested to reduce the calorie intake through sugars and saturated fatty acids.

The food business has targeted on the assembly of low-fat/low-calorie foods in response to public interest. Biscuits are the foremost well-liked bakeshop things attributable to their high nutritious value, ready-to-eat nature, and simple accessibility in numerous shapes and sizes at an affordable price. Diabetic friendly biscuits ready by incorporation of non-nutritive sweeteners are getting popular recently. High-intensity sweeteners (HIS) and low-calorie sweeteners are employed in the formulation of reduced-in sugar or sugar-free product, together with cookies. Although these compounds might give calories, they're used at an awfully low concentration creating their caloric contribution negligible. Additionally, to provide no calories, these sweeteners are thought-about safe for diabetics (ADA, 2004) and are non-cariogenic. Limitations that exist once victimization HIS in cookies embrace no Maillard browning, no effect on water activity, no role in product structure and problem in dispersing the ingredient within the product. Further, some HIS shows bitter and/or lingering sweet aftertastes and are heat sensitive.

Sucralose is that the 1st non-calorie sweetener made of natural sucrose. Sucralose is 600 times sweeter than sugar and this sweetness is due to structure of the sucralose molecule in which 3 hydrogen atoms of sucrose are replaced by 3 chlorine atoms. In step with Deutsch and Hansch, the generation of a sweet style comes from the hydrophobic bonding from one space on a molecule with electronic bonding from another space [32] extremely intense sweeteners are a lot of hydrophobic and so produce to multiply absorption to the taste buds, in distinction to a lot of deliquescent easy sugars. Sucralose is originally approved in North American country on September 5, 1991. Associated Food and Drug Administration (FDA) defines an ADI (acceptable daily intake) for sucralose of five mg/kg weight. It is stable below heat and over a broad varies of pH condition and hence used in baking. The sucralose with 0.05% combination employed in place of 30% sugar in biscuit formulation and it ascertained that sweetness of the sugar-replaced biscuits was acceptable [26].

Another sort of sweetener may be a natural sweetener plant called “stevia”, “sweet weed”, “sweet leaf”, “sweet herb” and “honey leaf” that is calculable to be 200-300 times sweeter than sugar [31]. It offers sweetness precisely like sugar with lesser calorie and don't show any aspect effects when consumption on human health. Stevia leaves have sensory and purposeful properties higher to those of the many different high-potency sweeteners and is probably going to become a serious supply of natural sweetener for the budding food market. The only species is that the Stevia rebaudiana Bertoni that is adopted as a sweetener around the world. It comes from two primary steviol glycosides – stevioside and rebaudioside. Rebaudioside is that the sweetest (350-450 times the sweetness of table sugar) and least bitter a region of the leaf, whereas stevioside (250-300 times the sweetness of table sugar) has that bitter memory

image. Stevia will secrete some a lot of internal secretion – however it will increase sensitivity to internal secretion and rids a lot of sugar from the blood stream to the cells that, again, is very helpful for the bar and treatment of polygenic disorder type-II.

2. Materials and Methods

2.1 Materials

The raw materials such as whole wheat flour, finger millet flour and soybean flour were procured from Aapang Bal Vikas Sanstha Nagpur. Other ingredients such as fat, sodium bicarbonate, ammonium bicarbonate, milk powder, salt were purchased from local market of Nagpur. Elita sucralose was procured from India foods, Gujarat. Stevia was procured from Herboveda India. The low density polyethylene (LDPE) packaging material was used for packaging.

2.2 Preparation of blends

Two flour blends were prepared using whole wheat grain flour, soya flour and finger millet flour. The first sample had the combination of whole wheat grain flour and soya flour. The ratio of 1:4 was used for soya and wheat flour respectively. This was considered as flour A. Another combination was of soya flour, whole wheat flour and finger millet flour with the ratio of 1:4:7.5. This was considered as flour B. Biscuit samples were prepared, using creamery method for making biscuit dough. The 3 % sucralose was used for biscuits making while 0.1 % stevia was used for biscuits making instead of sugar.

2.3 Preparation of biscuits

All ingredients were weighed accurately. The hydrogenated fat and powdered sugar or sweetener and salt were creamed until light and fluffy. The composite flour was slowly added to the cream. The traditional creaming method was used for the preparation of biscuits. The dough was thoroughly kneaded by adding required amount of water dissolved with sodium bicarbonate, ammonium bicarbonate. After kneading the dough was rolled having thickness of 0.4-0.5 cm and pieces cut using cookie cutter. The pieces were placed in baking tray smeared with fat and baked at 180-200°C, for 14 minutes in baking oven. The biscuits were allowed to cool, packed in various packages and stored at ambient temperature.

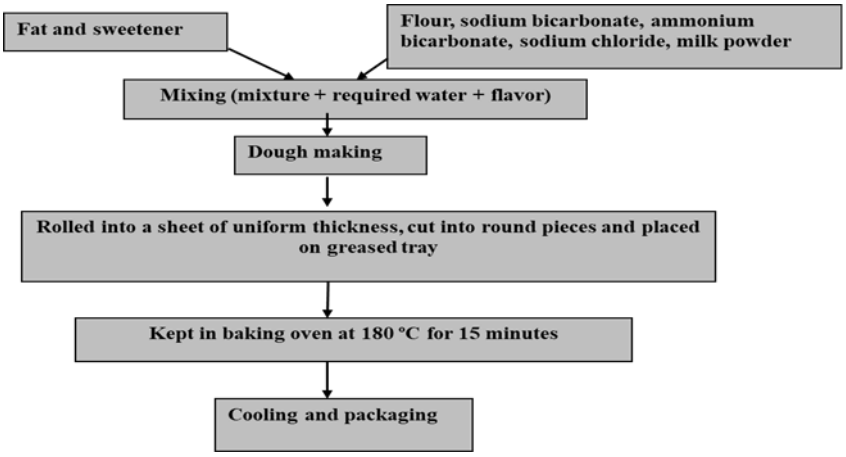

Fig 1: Flowchart for biscuits making

2.4 Analytical methods

Physical properties of biscuits

The various physical properties such as a diameter, weight, thickness, spread ratio and colour measurement was determined. [4] In order to determine diameter of biscuits, four biscuits were placed next to each other and total diameter was measured. Then all four biscuits rotated by 90º and the new diameter were measured. The average of two measurement divided by four was taken as the final diameter of biscuit. Weight in terms of grams was measured using electronic weighing balance. The thickness of biscuits was measured by stacking four biscuits and the total height was measured. After restacking them in different order, the height was re-measured and the height of biscuits was calculated from the mean of two height measurements. Spread ratio was calculated from diameter and thickness. The colour measurement of biscuits was done by Lovibond (RT) reflectance Tintometer. It gave the L*, a*, and b* values. Measurements were conducted in quadruplicate and the considered results are mean values.

Textural properties of biscuits

The texture of the samples was evaluated using a TA-XT plus texture analyser (Stable Micro Systems, UK). Each biscuit was placed on loading cell and compressed. The conditions employed were as follow: speed 3 mm/sec and distance of 5 mm. test type compression. 3-point bending rig (HDP/3PB) was used for analysis of texture of biscuits. A force ± penetration distance diagram was taken for every test. Measurements were conducted three times and the results are mean values.

Sensory analysis

The biscuits were evaluated for the sensory parameters using standard procedure. The biscuits were evaluated for sensory attributes by a panel of 5 semi-trained judges, using a 9-point Hedonic scale ranging from like extremely to dislike extremely for different parameters. The mean values of score for colour, flavour, taste, texture and overall acceptability were calculated.

Storage studies

The biscuits were packed in low density polyethylene (LDPE) and stored at ambient temperature. The moisture content and free fatty acids test of biscuits was carried regularly at an interval of 10 days for a period of 2 months.

3. Result and discussion

Effect of sugar replacement on biscuits properties

The results showed that the diameter of biscuits was decrease after addition of sweeteners. The result was approximately equivalent for the addition of 40 % sugar as well as for addition of 3% sucralose and 0.1% stevia. The thickness of biscuits increases from 4 to 6 mm after addition of sweeteners like sucralose and stevia. Faridi (1994) reported that decrease in the diameter of cookies usually occurs during baking due to CO_2 produced by leavening agents and water evaporation of cookies expand in both width and height early in baking. Thickness of cookies increased with addition of soy flour up to 20 per cent level and with further increase in the level of soy flour, the increase in thickness was observed. [7] Spread ratio of biscuits made with ragi flour was more than biscuits made with soya flour. Spread ratio of biscuits was decreased in biscuits on incorporation of soy flour up to 50 percent. [27] The decrease in spread ratio on substitution of soy flour could be because of occurrence of hydrophilic sites of rapid partitioning of free water during dough mixing and increase in dough viscosity, thus limiting biscuits spread and top grain formation during baking.

The colour measurement of biscuits is done by Lovibond (RT) reflectance Tintometer. In case of biscuits made with ragi, the a* values are higher, while biscuits made with soya shows higher b* values. The sucralose and stevia do not participate in Malliard reactions, as they are not reducing sugars, and did not affect the colour of the biscuits. Sucralose and stevia incorporation resulted in the production of lighter biscuits with higher L* and b* values. But the results in figure 2 show that the browning of biscuits is less when stevia is used as a sweetener. Results showed that the sweeteners like sucralose and stevia substitution in biscuit formulation had less effect on fat and protein contents of biscuit but moisture content increased slightly. Complete replacement of 40% sucrose with 3 % sucralose or 0.1% stevia reduced calorie levels in biscuit formulation.

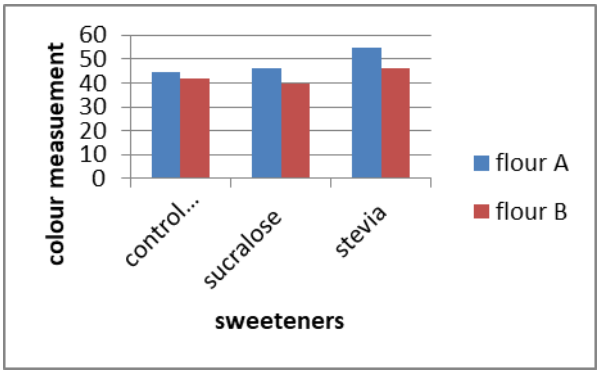

Fig 2: Graph for colour measurement

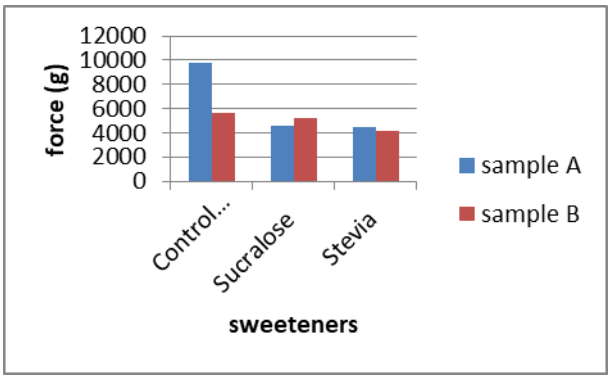

Fig 3: Graph for hardness of biscuits

Table 1: sensory analysis of biscuits

Treatments	Type of flour	Appearance	Colour	Texture	Taste	After taste	Overall acceptability
Control sample	Ragi	7±0.18	7±0.19	7.5±0.16	6.5±0.15	6.5±0.15	6.75±0.18
	Soya	6.5±0.22	6.5±0.16	6.5±0.15	6.5±0.16	6.5±0.18	6.5±0.21
Sucralose	Ragi	6.5±0.15	6.5±0.22	6.5±0.14	6.5±0.15	6.5±0.22	6.5±0.16
	Soya	6.5±0.22	6±0.21	5.5±0.14	6±0.16	6±0.19	6±0.15
Stevia	Ragi	6±0.29	6±0.19	6±0.15	5±0.18	5.5±0.22	5.75±0.18
	Soya	7±0.18	7±0.18	5±0.22	5.5±0.18	5.5±0.15	5.5±0.21

Sensory evaluation is very essential factor in evaluating the acceptability of the product. Table 1 showed the results of sensory analysis of biscuit. It was observed that there was no major variation in the sensory scores for all the sensorial attributes. However, control biscuit showed higher values than the biscuits made with sucralose and stevia. According to results presented, sucralose and stevia is found to be considerable and both the samples are "liked slightly" by the panel members as shown in Table 1. Biscuits made with sucralose give the sweeter taste as sucrose. Savitha *et al.* (2008) observed that the sweetness of the biscuits with sucralose (0.05%) and 30% MD was perceptible and similar in intensity to that of the control biscuits. Biscuits made with stevia give slightly bitter flavour after taste Abouarab *et al.* (2010) [26] reported that bitter taste, common to many stevia species, is probably due to volatile aromatic or essential oils, tannins and flavonoids, which contribute to flavour associated with stevia [1].

The texture of the biscuits was evaluated by applying a force through a 3-point bending rig (HDP/3PB) until breaking of the sample. A force/deformation curve was obtained which presented a peak at the breaking point. Hardness of the biscuits can be estimated from the peak force. Sucrose shows high value of peak force, and accordingly hardness, then sucralose and stevia. Addition of stevia in the various biscuit formulations reduced the texture hardness. Biscuits made up of sucralose have hardness more than the biscuits made with stevia as shown in figure 3. Gallagher *et al.* (2003) replace sugar by 20–30% raftilose, an oligofructose in short dough biscuits. They reported that the sugar replacer decreased peak force values of the sugar-replaced biscuits, indicating lower breaking property and

therefore softer characteristics [12].

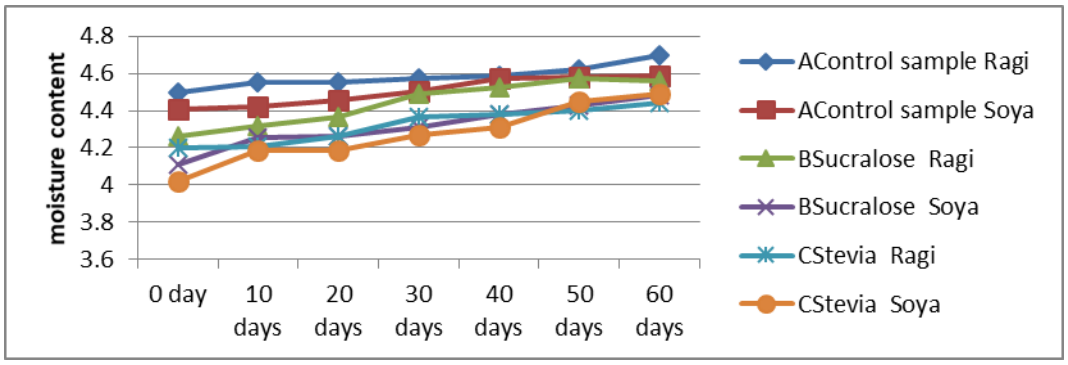

Fig 4: Graph for moisture content verses storage period

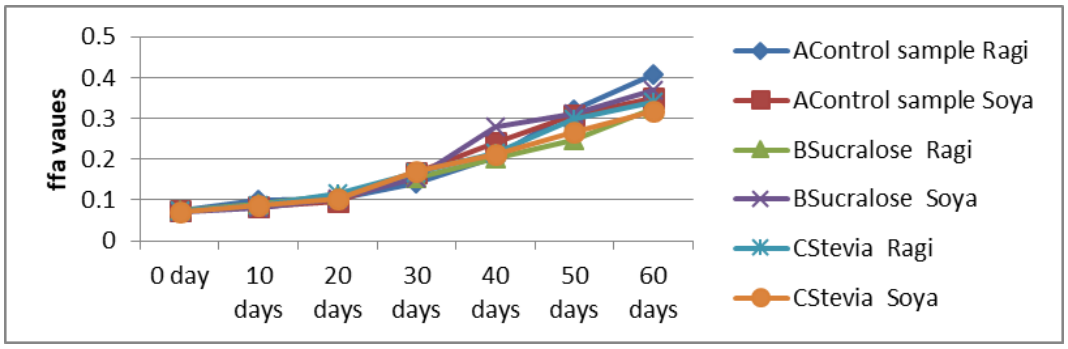

Fig 5: Graph for FFA verses storage period

The storage trials were conducted for 60 days at ambient temperature (32ºC±5). Low density polyethylene packaging material was used in the study. All the samples were analyzed periodically after 0, 10, 20, and up to 60 days for moisture content and free fatty acid content. As shown in figure 4 indicated that the significant increase is observed in moisture content of the multigrain biscuits during storage in the packaging material. The data revealed that moisture content of multigrain biscuits has an initial value of 4.4% which is increased gradually up to 4.59 to 4.69 at the end of the storage period. Generally, moisture percent of biscuits ranges from 1 to 5% for the initial period of storage. Rancidity of food occurs due to the amount of free fatty acid in food product which is due to the hydrolysis of free fatty acids. The value of free fatty acid observed in sample is 0.074% which is increased up to 1.01% after three months of storage as shown in figure 5. The value of free fatty acids is almost same for each type of sample i.e. biscuits made up of sucralose and stevia in soya and ragi biscuits.

Conclusion

It can be concluded from the present study that the use of 40% sugar in biscuit formulation could be replaced by using a sucralose (3%) or stevia (0.1%) give low calorie product with satisfactory properties but lower sweetness. The diameter of biscuits decreased due to water evaporation and CO_2 production due to leavening agents but the thickness of biscuits increased from 4 to 6 mm. Use of sucralose and stevia give the lighter color of biscuits because these sweeteners does not take part in maillard reaction. Sucrose shows high value of peak force, and accordingly hardness, then sucralose and stevia. Moisture content and free fatty acids increased slightly as the storage period increased.

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