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Development of innovative bakery product chia seed enriched cookies

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Abstract
Chia seed enriched cookies is a kind of bakery food product, have a high nutritional value as it contains Chia seeds, date syrup and jaggery. It also contains refined wheat flour, margarine, rava, cocoa powder, baking powder, milk powder, etc. Each ingredient has a different function effect in human. Chia seeds are the richest source of protein, fiber, omega-3 fatty acids and antioxidants. It helps to balance blood sugar levels, improve cardiovascular diseases, all cancer types, allergies, lower cholesterol and promote weight loss. Dates are rich in several vitamins, minerals, and fiber. Date syrup contains oil, calcium, sulfur, iron, potassium, phosphorous, manganese, copper and magnesium, which are all beneficial for health. Jaggery prevents constipation, Detoxes the liver, Blood purifier, Boosts immunity, Cleanses the body, Prevents anemia, Boosts intestinal health, Weight loss, Controls blood pressure. Chia seed enriched cookies prepared with appropriate proportions of ingredients and baked. Chia seed enriched cookies were placed before semi-trained sensory panel for sensory analysis. Cookie enriched with 10% Chia seed has more sensory score. Therefore, this product fetched for proximate composition shown the moisture content (2.02%), Carbohydrate (48.38%), Protein (6.2%), Fat (28.9%), Ash (1.75%), Calcium (80 mg) and Iron (1.5 mg). Chia seed enriched cookies have about three month's shelf life in aluminum pouch as a packaging material. Keeping the interest and health in mind, this investigation tried to compensate the demand of consumers. The developed product has great market potential and can commercialize with low investment and more profitable.

Keywords: chia seed, date syrup, omega-3 fatty acid, quality analysis

Introduction
The development of new products or innovation in any product is a strategic area of the food industry. Consumers are demanding foods that show two main properties: the first one deal with the traditional nutritional aspects of the food and the second feature is, expected additional health benefits from its regular ingestion. Functional foods are in high demand because of the changing lifestyle. A healthier lifestyle is necessary for overcoming various diseases like cardiovascular diseases (CVDs), high blood pressure, obesity, diabetes, etc. These conditions are common for a person having busy lifestyle and improper diet where the daily food consumed contains high amounts of saturated fatty acids. The total dietary fiber (TDF) intake in the daily diet is important to overcome various health problems. Some of them include reduction of cholesterol, modification of the glycemic and insulin emic responses, changes in intestinal function and antioxidant activity (Abdul-Hamid and Luan, 2000; Esposito *et al*., 2005) [4, 5]. Recently, Chia has regained its popularity by becoming one of the main oil sources that contain high levels of PUFA. Chia has identified as *Salvia Hispanica L. or Salvia Columbariae Benth.* Chia seeds are the richest source of protein, fiber, omega-3 fatty acids and packed with antioxidants. Another key feature of chia seeds is that it does not contain gluten. Chia can help cut cravings, balance blood sugar levels, improve cardiovascular diseases, all cancer types, allergies, lower cholesterol, and triglycerides blood pressure and can promote weight loss. Chia seeds contain all the essential amino acids, partially lysine, leucine, isoleucine, and valine. Chia seeds are rich in the dietary fiber of branched-chain polysaccharides, which absorb more water and allow slower sugar absorption in the body. Chia seeds have a great beneficial effect in humans because of their rich fiber, omega-3 fats, protein, vitamins, and minerals. For example, one ounce (28 grams) of Chia seeds contains about: 137 calories, 12.3 grams carbohydrates, 4.4 grams protein, 8.6 grams fat, 10.6 grams fiber, 0.6 milligram manganese (30 percent DV), 265 milligrams phosphorus (27 percent DV), 177 milligrams calcium (18 percent DV), 1 milligrams zinc (7 percent DV), milligram copper (3 percent DV), 44.8 milligrams potassium (1 percent DV) (*Rachael Link*). Cookies are to be the major bakery product. Among the different bakery products, cookies constitute the most popular group. Cookies are confectionery dried product, having low moisture content. Cookies have nutritive value, palatability, compactness, and convenience. It has low moisture content than cakes and bread; cookies are safer from microbiological spoilage and have a long shelf-life. Cookies are a lot more loaded in terms of ingredients and flavors as compared to biscuits. Cookies can differentiate from biscuit by their moisture and texture of the product. Biscuit is not as dense and sugary as a cookie; it is light in texture with a crusty exterior (Divya, M., 2012) [3]. Chia seed enriched cookies have enhanced with added nutrients through chia seed and date syrup. Chia seed enriched cookies are the good source of protein, fiber, omega-3 fatty acids, and antioxidants. Chia seed enriched cookies can be a good choice instead of regular cookies as it is healthy and controls obesity. Obesity is becoming a common threat today because of lifestyle and consumption pattern and habits. Chia seed enriched cookies are ready to eat the product which needs none time for preparation. It can consume directly anytime anywhere. Chia seed enriched cookies are a best healthy way to satisfy hunger. Dates syrup is rich in calcium, sulfur, iron,

potassium, phosphorous, manganese, copper and magnesium, which are all beneficial for health. Jaggery helps in Preventing constipation, Detoxifies liver. It also acts as a Blood purifier, Boosts immunity, Prevents anemia, and promotes Weight loss. Margarine is a human-made product and contains no saturated fat. Stick margarine has high levels of Tran's fats, which increase LDL cholesterol. If the margarine is more solid than it has more trans-fat in it. Therefore, this research was carried out to develop a healthy bakery product and its quality evaluation.

Materials and Methods

Innovative Aspect

Cookies are enriched with chia seeds, with the replacement of date syrup and jaggery instead of sugar. Date syrup and jaggery adds low calories and Chia seeds are the richest source of protein, fiber, omega-3 fatty acids, and antioxidants.

Raw Materials

The ingredients used for the production of chia seed enriched cookies are Refined Wheat Flour, Margarine, Date Syrup, Chia Seed, Milk Powder**,** Jaggery, Baking Powder, and Cocoa Powder Rava was purchased from the local market of Loni-Kalbhor, Pune. The chia seeds were roasted and other powdered ingredients were shifted properly.

Methodology

1. Creaming: (Fat and syrup, jaggery) Cream the fat, dates syrup and jaggery. Till it becomes creamy. Proper creaming is very important for getting good texture in cookies. Therefore, gentle mashing by mash the butter with the tines of a fork. With your wooden spoon, stir the butter and syrup until they are light and fluffy. Rubber spatula was used to scrape the mixture from the bowl periodically.
2. Addition of ingredients: Add all the ingredients (Jaggery**,** Refined flour**,** Milk powder**,** Baking powder, Coco powder**,** and rava) in the creamed fat and syrup.
3. Mixing: Mix all the ingredients properly and avoid lump formation. As it will destroy the overall texture of the cookies.
4. Kneading: Knead the mixture to form dough. The dough should be of proper consistency and thickness to facilitate easy preparation of cookies and allow it to rest for 15 minutes.
5. Rolling & Cutting: Roll the dough and cut it in desired shapes and size. All the cookies should be same in shape and size for uniform baking of cookies.
6. Tray greasing: Grease the tray before keeping the cut pieces of cookies to avoid a sticking of cookies and easy removal.
7. Baking: Bake the cookies at 140 ºC for 15 min and avoid over the burning of cookies.
8. Cooling: After baking, cool the cookies for few minutes.

Analysis of Physico-chemical parameters

The following physic-chemical parameters were analyzed: moisture (dried at 105 ºC) (AACC, 2010) [7], fat (Soxhlet apparatus), total protein (Kjeldahl method, N x 6.25), ash and crude fibers, in accordance with A.O.A.C (1990) methods of analysis, carbohydrates by anthrone method. To estimate the total energy value of each bar formula, the conversion used was 4 kcal g^{-1} of protein, 4 kcal g^{-1} of carbohydrates, and 9 kcal g^{-1} of fat.

Determination of moisture

Wash the dishes with a detergent dry the dishes in the 105 ºC oven overnight. Place in a desiccator, for cooling and weigh. Weigh by difference 5.0 g of sample into a weighed dish. Place it in the 105º C oven overnight (with lids open until a constant weight loss. Remove the dishes, place in desiccators and cool. Remove from desiccators and weigh as quickly as possible.

Moisture content (%) =

$$\frac{\text{Weight of fresh sample} - \text{Weight of dry sample}}{\text{Weight of the fresh sample}} \times 100 - - - (1)$$

Determination of ash

Place clean crucible in the muffle furnace at 600 ºC for 1 hour. Transfer crucible from the furnace to desiccators and cool to room temperature. Weigh as quickly as possible to prevent moisture absorption. Weigh by difference 5.0 g of sample into the tarred silica crucible. Place in a muffle furnace and adjust the temperature at 600 ºC for 6 hours. Transfer the crucible to desiccators and cool to room temperature. When cool, weigh crucible as quickly as possible.

$$\textbf{Ash}(\%) = \frac{\text{weight of ash}}{\text{weight of the sample}} \times 100 - - - (2)$$

Estimation of protein by the micro-Kjeldahl method

Weigh about 40-100 mg of finely powdered homogenous sample into 30 ml digestion flask. Add 1.9±0.1 g K_2SO_4 and 80±10 mg of Hugo, 2 ml of conc. H_2SO_4 and mix well. If the sample size is larger than 20 mg, dry weight, add 0.1 ml of H_2SO_4 for each 10 mg of dry material. Add boiling chips and digest the sample over digestion rack. Cool and add minimum quantities of water along the sides of the flask to dissolve solids and transfer quantitatively to the distillation apparatus with successively rinsing with water. Place a 100 ml conical flask containing 5 ml of boric acid solution with a few drops of the mixed indicator in such a way that the tip of the condenser dipping inside the solution. Add 10 ml sodium hydroxide–sodium thiosulphate solution to the digest in the apparatus through the funnel and rinse with water. Distill and collect the ammonia in boric acid. The color changes from violet to green is an indication of ammonia absorbed. Rinse the tip of the condenser with water and titrate the distilled sample against the standard HCl or H_2SO_4 (0.02 N) until the appearance of original violet color as the endpoint. Run a blank digested similarly with an equal volume of water after washing the distillation apparatus by back suction with an excess of water.

$$\%\ \mathbf{N} = \frac{(\text{ml HCl in the sample}) - (\text{ml HCl in the blank}) \times \text{N} \times 14.01 \times 100}{\text{weight of the sample(g)}} - - - (3)$$

$$\text{Protein\%} = \%\ \text{N} \times 6.25 \text{ - - - } (4)$$

Determination of crude fat

Rinse all the collection vessels and place them in the oven with the temp about 100 ºC and also the samples. If all moistures were removed from the collection vessels them in a desiccator to bring to room temperature. Now weigh the empty collection vessels and let the weight be W1 (initial

weight). Now insert the thimble in the S.S. spring thimble holder and place it on the collection vessels. Weigh the sample and transfer them to the thimble. Let the sample weight may be 0.50 to 25 g to be W. Pour the solvent in the collection vessels and the volume may be 90 ml. Load all the collection vessels in the system. Switch on the system and set the boiling point of solvent as the boiling temp. The boiling temp may be 100 ºC, 20 ºC more than the solvents maximum boiling point. Leave the process about 45 to min. After the process time, increase the temperature to solvent recovery temperature Now do the rinsing about 2 times in order to collect the remaining fat that may present in the sample. Now takeout all the collection vessels from the system and put them in a hot air oven. After 15 to 20 min, take out all the beakers and place them in a desiccator about 5 min. Take out all thimble holders and weigh the collection vessels this is the final weight of the collection vessels W2. By submitting W, W1, and W2 in the following formula, the amount of fat present in the sample can be calculated.

$$\text{Crude fat(\% dry basis)} = \frac{(W2 - W1) \times 100}{\text{Weight of the sample}} - - - (5)$$

Estimation of carbohydrate by anthrone method

Weigh 100 mg of the sample into a boiling tube. Hydrolyze by keeping it in a boiling water bath for 3 hours with 5 ml of 2.5 N HCl and cool to room temperature. Neutralize it with solid sodium carbonate until the effervescence cease. Make up volume to 100 ml and centrifuge. Collect the supernatant and take 0.5 and 1 ml aliquots for analysis. Prepare the standards by taking 0, 0.2, 0.4, 0.6, 0.8 and 1 ml of working standards. Make up the volume to 1 ml in all tubes including the sample tubes by adding D/W and add 4 ml of anthrone reagent. Then heat it for 8 min in a boiling water bath. Cool rapidly and read the green to dark green color at 630 nm. Draw a standard graph by plotting concentration of the standards on the X-axis Vs absorbance on the Y-axis. From the graph, calculate the amount of carbohydrates present in the sample tube.

$$\textbf{Amount of CHO present(\% mg)} = \frac{\text{sugar value from graph(mg)}}{\text{Aliquot sample used}\left(\frac{0.5}{1\text{ml}}\right)} \times \frac{\text{total volume of extract(ml)}}{\text{weight of sample(mg)}} \times 100 - - - (6)$$

Estimation of crude fiber

1 g of moisture and fat free sample was weighed and kept in the fiber bags. The glass spacer was put into the bags. The bag in the sample carousel was loaded at the previewed positions (positions 1-12).The sample carousel was put into the glass container carefully. The glass container was placed axial on the previewed position of the hot plate. A method was created to estimate crude fiber. The programme was started in the fiber them. After completion of the programme, the fiber bags were removed. The residue was transferred to weighed crucible (W_1) and drier over night at 80 ºC- 100 ºC and weighed (W_2).The crucible was heated in muffle furnace at 600ºC for 2-3 hours. Cooled in a desiccator and weight of the crucible was taken after cooling (W_3).

Estimation of calcium

$$\textbf{Crude fibers (g \%)} = \frac{100 - (\text{moisture} + \text{fat}) \text{ X weight of fiber}}{\text{Weight of the sample (Moisture and fat free) (W1)}} - -(7)$$

Pipette an aliquot (20 ml to 100 ml) of the ash solution obtained by dry ashing to 250 ml beaker. Add 25 to 50 ml of water, if necessary. Add 10 ml of saturated ammonium oxalate solution and 2 drops of methyl red indicator. Make the solution slightly alkaline by the addition of dilute ammonia and then slightly acid with a few drops of acetic acid until color is faint pink (pH 5.0). Heat the solution to boiling point. Allow to stand at room temperature for at least 4 hrs. Or preferably overnight. Filter through Whattman No. 42 paper and wash with water, till the filtrate is oxalate free. Break the point of filter paper with platinum wire or pointed glass rod. Wash the precipitate first using hot dilute H_2SO_4 from Wash bottle into the beaker in which the calcium was precipitated. Then wash with hot water and titrate while still hot (temp 70 to 80 ºC) with 0.01 N KMnO4 to the first permanent pink color. Finally, add filter paper to solution and complete the titration.

$$\textbf{Calcium}\left(\frac{\textbf{mg}}{\textbf{100g}}\right) = \frac{\text{Titre x 0.2 x total volume of ash solution x 100}}{\text{Vol. taken for estimation x Wt. of sample taken for ashing}} - (8)$$

Estimation of iron

Use the ash solution of the sample prepared by dry ashing for color development.

Color Development

In each of the above cases, make-up the volume to 15 ml with water and details of the solution preparation given in the table 1. Measure the color at 480 nm setting the blank at 100% transmission.

$$\textbf{Iron}\left(\frac{\textbf{mg}}{\textbf{100g}}\right) = \frac{\text{OD of sample x 0.1 x Total volume of ash solution x 100}}{\text{OD of standard x 5 x Wt. of sample taken for ashing}} - (9)$$

Table 1: Preparation of analyzing solutions for estimation of iron.

	Blank (ml)	Standard (ml)	Sample (ml)
Standard iron solution	0.0	1.0	0.0
Sample ash solution	0.0	0.0	5.0
Water	5.0	4.0	0.0
Conc H_2SO_4	0.5	0.5	0.5
Pot. Persulphate	1.0	1.0	1.0
Pot. Thiocyanate	2.0	2.0	2.0

Results and Discussions

Standardization of recipe for the preparation of chia seed enriched cookies

The trials were taken for the formulation of the ultimate recipe, the prime ingredient i.e. Chia seed. Trials are made with a change in the quantity of ingredients creating an impact on sensorial parameters of the final product. The trial samples were nominated as T1, T2, and T3, whose

formulations are depicted in the following Table 2:

1. T1: 30% CHIA SEED
2. T2: 20% CHIA SEED
3. T3: 10% CHIA SEED

Table 2: Standardization of the recipe of Chia seed enriched cookies

Trials	Refined Wheat Flour(g)	Chia Seed (g)	Margarine (g)	Date Syrup (g)	Jaggery (g)	Rava (g)	Milk Powder (g)	Cocoa Powder (g)	Baking Powder (g)
T1	25	30	15	15	10	2	1	1	1
T2	25	20	15	15	15	5	2	2	1
T3	25	10	15	20	20	4	2	2	2

Sensory evaluation of products

The sensory quality characteristics of four products (color, taste, texture, flavor and overall acceptability) were evaluated by a panel of judges using nine-point hedonic scale. Scores were given on hedonic scale ranging from 9 to 1 representing like extremely to dislike extremely respectively. The rating was given as per the hedonic rating as mentioned in Table 3.

Table 3: Hedonic rating of Chia seed enriched cookie

S. No.	Remark	Score
1	Like extremely	9
2	Like very much	8
3	Like moderately	7
4	Like slightly	6
5	Neither like nor dislike	5
6	Dislike slightly	4
7	Dislike moderately	3
8	Dislike very much	2
9	Dislike extremely	1

Statistical Analysis

The data obtained for sensory evaluation is the average obtained from 10 observations. The physic-chemical analysis values are the mean values of 3 replicates performed. The results for physic-chemical parameters regarding moisture, ash, carbohydrates, proteins, fats, carbohydrates and micro-nutrients such as calcium and iron are presented in Table 4. Table 4 and Figure 1 show the comparative result of the nutritional composition of formulations using different composition of Chia seed in each sample. The results indicated that the cookies with 10% Chia seed contain good amount of protein (6.2%) and fibers (16.2%) as compared to control and the rest of the formulation. The results are clear that formulation T1 is nutritionally rich, containing a good amount of protein (6.2%), and dietary fibres (16.2%) (Reyes-Caudillo *et al*., 2008) [8], polyunsaturated fatty acid (omega 3 and omega 6) and mineral such as calcium and iron. Being rich in proteins and fibers, it will provide the feeling of satiety and promote weight loss. Table 4 represents the average sensory scores for all the four formulations of Chia seed enriched cookies. The results showed higher acceptance for formulation T1, compared to control and other formulations (T1 & T2).

The overall acceptance of formulation T3 is high as compared to others. Hence, all formulations scored between 6 'liked slightly' to 8. 'Liked very much' *(*Anonymous, *1971)*. The results represented in above Table 5 indicate the trials are made with change in quantity of ingredients creating an impact on sensorial parameters of the final product. The color of any kind of food is an important parameter which gives the first sight impression on consumers and effects on its acceptability. According to the score given by panelists, the T2 AND T3 samples found more appropriate color than sample T1 shown in Figure 2. The appearance of food product is one of the important sensorial parameters, which decides the quality of the final product. The sample T2 and T3 got an equal score for appearance. Panelist recorded the highest score to the sample T3 for taste as compared to other samples i.e. T1 and T2. Consequently, the panelists scored the formulations for texture parameter showed that the sample T3 is superior to T1 and T2. The overall acceptability of the product justifies the final judgment on products. The score for overall acceptability from the Table 4 depict that the sample T3 is highly acceptable than other two samples and also shown in Figure 3. Conferring to sensory evaluation of various formulations of Chia seed enriched cookies, it could be visualized and confirmed that the sample T3 founds better and hence, the same one was finalized for production and further investigation.

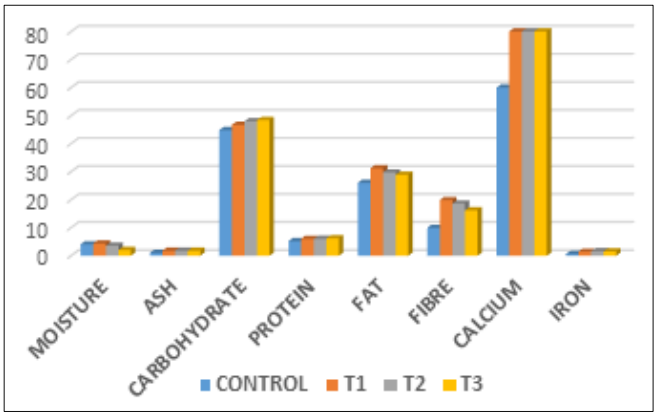

Fig 1: Graph representing proximate analysis of all samples along with the control

Table 4: Chemical composition of Chia seed enriched cookies

Nutrients	Control	T1	T2	T3
Moisture (%)	4.03	4.32	3.56	2.02
Ash (%)	1.01	1.80	1.78	1.75
Carbohydrate (g)	44.8	46.7	48	48.38
Protein (g)	5.2	6	6.01	6.2
Fat (g)	26	31.2	29.7	28.9
Fibres (g)	9.92	19.8	18.6	16.2
Calcium (mg/100g)	60	80	80	80
Iron (mg/100 g)	0.6	1.4	1.6	1.5

Fig 2: Colour development of prepared cookie (a) Control and (b) Cookies containing 10% (T3), 20% (T2), 30% (T3) Chia seed

Table 5: Average score awarded by panelist for sensory acceptance of Chia seed enriched cookies formulations.

Sample	Color And Appearance	Texture	Taste	Flavor	Overall Acceptability
Control	7	7	8	7	7
T1	6	7	6	6	6
T2	7	6	7	7	7
T3	7	8	8	8	8

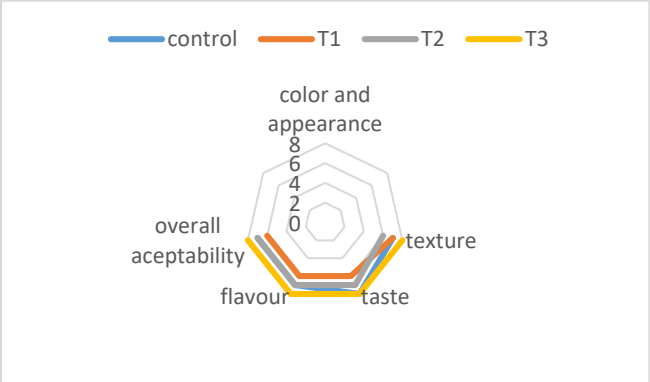

Fig 3: Radar diagram representing average sensory scores

Conclusion

Chia seed enriched cookies are new product developed within the framework of bakery products. Cookies containing 10% Chia seed are highly accepted by the consumers. As it is good in taste and Flavor and have appropriate texture. Chia seed enriched cookies are capable of controlling obesity if consumed in limit. In terms of nutrition, it is collected source of nutrients with longer shelf life. Supplementation of Linoleic acid present in Chia seed showed significant body fat reduction over six months and prevented weight gain among overweight adults.

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