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Development of Sorghum (*Sorghum bicolor*) and Almond (*Prunus dulcis*) Flour Bar Cookies Incorporating Pumpkin Seeds (*Cucurbita pepo*)

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ABSTRACT

Bakery products are gaining popularity in new regions and Europe, with sorghum being a crucial staple grain for food security. Almonds are used in various culinary products and traditional medicine, and pumpkin seeds are considered functional diet ingredients. The investigation aims to create bar cookies containing pumpkin seed in 3 variations T_0 (Control), T_1, T_2 and T_3 with sugar. 12 panelists rated T_2 formulationon color, taste, aroma, appearance, flavor, and overall acceptability using a 9-point hedonic scale. Moreover, it has the highest nutritional value possible because almonds, pumpkin seeds, jowar, and carbohydrates are significant sources of protein, fiber, calcium, and magnesium, respectively. So, it can be claimed that jowar flour and pumpkin seeds are the two ingredients that should be used to make healthy, superior cookies as well as almond flour. Due to their high nutrient content, sorghum flour and pumpkin seeds are recommended as a healthy snack for individuals of all ages.

Keywords : Bar cookies, Calium, Magnesium, Sorghum, Prunus, Pumpkin seeds

INTRODUCTION

Once essential for survival, food has evolved into a luxurious product. Over the past few decades, there have been significant changes to the food and food industry (Ganga *et al.*, 2020). A chemically leavened product, a "cookie" is also referred to as a "biscuit". Cookies are distinguished from other baked foods like bread and cakes by their low moisture content, high shelf life, and relative lack of microbial degradation (Sharif *et al.*, 2009).

Sorghum (*Sorghum bicolor* L.), a cereal in the Poaceae family, is native to Africa.Due to its exceptional nutritional and functional potential, sorghum cultivation for human consumption has been conducted in these countries (de Morais Cardoso *et al.*, 2015). Sorghum also goes by the name Moench.Sorghum's makeup includes 8–18% protein, 70–80% carbohydrates, 19% dietary fiber, roughly 3 per cent fiber, and a variety of minerals. Sorghum's complex carbohydrates break down gradually, making it a great source of steady, sustained energy. Fructosan is a trisaccharide that is also found in the carbohydrate content of sorghum grain. These flavonoids are responsible for sorghum's unique flavor and color. One important class of natural compounds are flavonoids. In particular, they are a class of plant-derived secondary metabolites that are frequently found in fruits, vegetables, and some beverages. Sorghum includes minerals such calcium, iron, potassium, magnesium, P, zinc, B complex vitamins, fat-soluble vitamins, and vitamin E (Espitia-Hernandez *et al.,* 2020).

Tannins' contribution to sorghum's growth as a food crop. Buyers prefer goodies made with less sorghum because of the unpleasant color and slightly bitter flavor brought on by the tannin content. Since they can obstruct

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the digestion of protein and carbohydrates, tannins also have antinutritional properties. Still, because tannin possesses antioxidant properties, it is a polyphenol vital to human health.Sorghum may be especially beneficial for people with diabetes or obesity (Widowati and Luna, 2022).

Prunus dulcis is a specialty crop that is both nutritious and lucrative. Almonds belong to the Rosaceae family, more especially to the subgenus Amygdalus and genus Prunus.Almonds and many other edible tree nuts are mostly composed of lipids that are mono- and polyunsaturated fatty acids (Yada *et al.*, 2011). Each 100 grams of almonds contains approximately 575 calories, with fat making up about 50% of its weight. However, the fatty acid composition of almonds is beneficial since it contains monounsaturated fatty acids. (MUFA) predominate, while almonds have the lowest amount of saturated fat (3.7 g per 100 g) of any nut (Richardson *et al.,* 2009). Almonds (*Prunus dulcis*) Rich in nutrients, almonds are a good supply of protein, fiber, riboflavin, copper, phosphorus, manganese, magnesium, and monounsaturated fatty acids. Increasing the consumption of almonds can strengthen low-density lipoprotein's resistance to oxidation, as they are a great source of bioavailable α-tocopherol (Chung *et al.*, 2006). It is capable of being 5 utilized to treat several illnesses. It maintains the wellness of our body and mind. It has been discovered to have several pharmacological qualities, including lipid-lowering, immunostimulant, antioxidant, and anti-stress effects. It is extremely helpful for maintaining brain function, building muscle, and extending life (Javaid *et al.*, 2019).

Pumpkin seeds are regarded as a valuable functional dietary ingredient that makes a substantial contribution to human nutrition. About 6.37%–6.56% moisture, 35%–50% lipids, 25%–37% proteins, 18%–25% carbohydrate, 3%–6% fiber, and 3%–5% ash is found in pumpkin seeds (Singh and Kumar, 2023). It has been determined that pumpkin seeds are a good source of fiber, phytosterols, minerals (iron, zinc, magnesium, and calcium), proteins, calories, carotenoids, tocopherols, and antioxidants. Furthermore, it has been demonstrated that one of the major sources of the essential fatty acid omega 3 and omega 6, which are necessary for both healthy skin and brain function, is pumpkin seeds (Gebremariam *et al.*, 2024). Typically, the seeds have a large size and a high concentration of mono- and polyunsaturated fatty acids. Pumpkin seed oil is mostly composed of linoleic acid, oleic acid, palmitic acid, tocopherols, β-sitosterol, and delta-7-sterols (Batool *et al.*, 2022). Pumpkin seeds have flavonoids and triterpenoids, which may be involved in their putative anticancer effect mechanism. Beta-carotene and phenolic chemicals are responsible for the anti-inflammatory properties of pumpkin seeds. Pumpkin seeds' good antioxidant action is partly attributed to the phenolic chemicals present in them (Thakur and Bhasin, 2023).

METHODOLOGY

The present research was carried out in the Department of Research and Development at Arome Pvt. Ltd., Vashi, Navi Mumbai, Maharashtra.

Materials:

Period of experiment :

The experiment reported was conducted during from the September 2023 to January 2024

Raw materials and ingredients:

Jowar flour and pumpkin seeds is purchased from the local market of Vashi, along with this sugar, roasted almond powder, baking powder, baking soda, wheat flour, milk powder, almond, seeds, unsalted butter, vegetable fat, honey, corn syrup, cinnamon powder, salt is purchased from the local market of Vashi Maharashtra.

Methods:

Preparation of cookie flour :

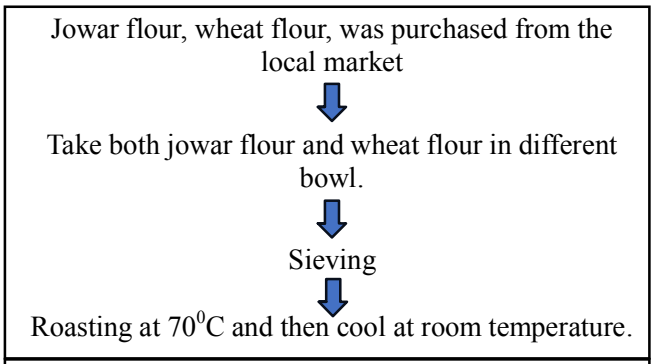
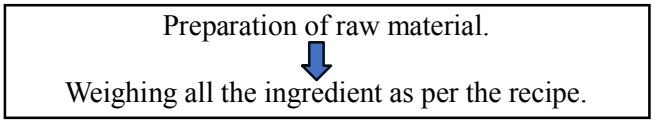


Fig. 1 : Flow diagram of preparation of cookie flour

Flow chart for cookies crust:



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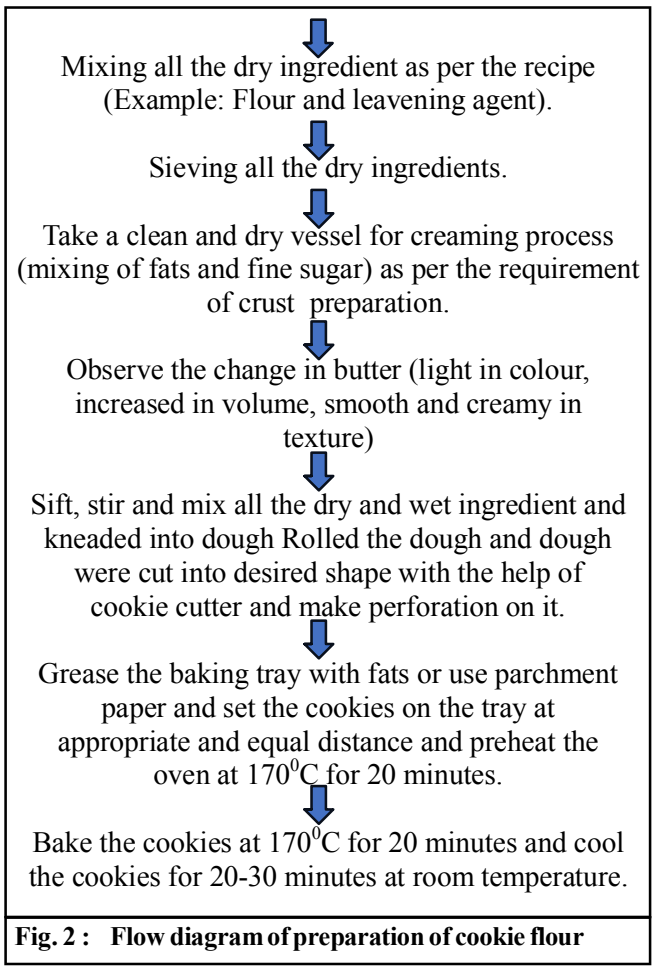

Fig. 2 : Flow diagram of preparation of cookie flour

Preparation of caramel:

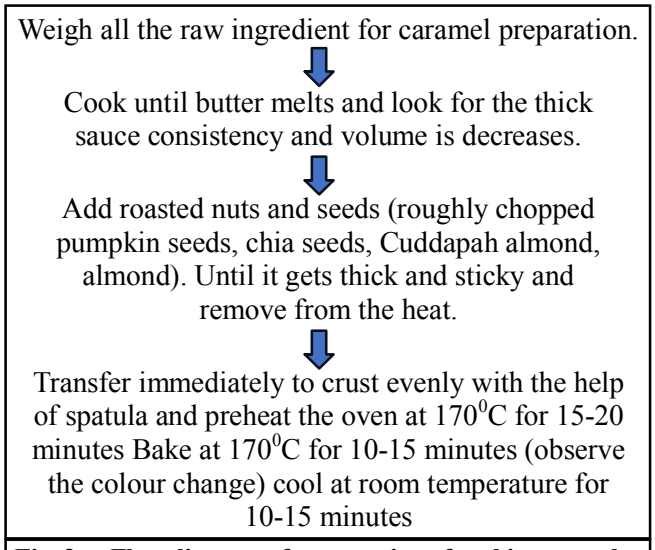

Fig. 3 : Flow diagram of preparation of cookie caramel

Development of bar cookies incorporated with pumpkin seeds:

Three different types of bar cookies were made and coded as T_1, T_2, T_3 were prepared according to given composition in Table 1.

Table 1 : Formulation of sugar variations supplemented cookies

Sr. No.	Ingredients	T_0 (control)	T_1	T_2	T_3
1.	Roasted jowar flour	100g	100g	100g	100g
2.	Roasted almond flour	50g	50g	50g	50g
3.	Sugar powder	0g	50g	55g	60g

Preparation of bar cookies:

Firstly, sift all the dry ingredients including flour, sugar, leavening agent, etc. in a clean and dry vessel. Once all the ingredients are sifted take another bowl for creaming process. Creaming is done until changes are observed in colour mixture turns light in colour, texture turns smooth and fluffy, increased in volume, and incorporation of air into the dough provides natural rise. Then gradually add the dry ingredients into the creaming bowl, knead properly and rest the dough for 8- 12 minutes different types of dough were prepared in different compositions. Three distinct types of dough are prepared for various cookie compositions. T_1 composition was 30:15:10 T_2 composition was 30:15:15 and T_3 composition was 30:15:20 of jowar flour, almond flour and sugar, respectively.

Spread the dough out on a shallow pan. Evenly rolled out the dough on each side. Use a cookie cutter or any other chosen form to cut the cookie. Using a fork, make the perforation on cookie. Place the cookie on a baking tray that has been lined with parchment paper or greased with fat. Place each biscuit on the tray at the same distance apart. Bake for 20 minutes at 180^0 C in a preheated oven, then let the cookies cool at room temperature for 15 to 20 minutes.

For preparation of caramel in a bowl, add unsalted butter, sugar, honey, corn syrup, and milk powder. Cook it at 30-35^{0}C, let the butter melt, boil it, and observe the thick sauce consistency and decrease in volume. Add the roasted seeds and nuts to the pan and stir well until they get sticky and glue-like. Stop cooking and transfer the caramel immediately over the crust with the help of a spatula. Bake at a preheated oven temperature of 170^0 C for 15-20 minutes and observe the colour change of

the cookie. cool down, then bake cookies at RT for 15-20 minutes.

Proximate Analysis of bar cookies:

Moisture content, Protein content, Total Ash content, Fiber content, Fat content, Carbohydrate content, Energy content, Calcium (Ca) and Magnesium (Mg) content was determined using procedure .

Moisture content was determine using hot air oven method, Protein content was determined by using kjeldhal method, Ash content was determined by using muffle furnace, Fat content was estimated by using soxlet method, while Carbohydrate and energy was by the difference method. Calcium (Ca) and Magnesium (Mg) was determined by using standard method (IS 13433) and Total plate count/g was determined by using USP method.

Determination of moisture content:

Precisely weigh five grams of the prepared sample in the moisture dish. The sample should have been dried in an oven at 105°C before being weighed. For a period of 4 hours, keep the dish in an oven kept at 105 ± 2°C. Weigh after cooling in the desiccator. Drying, cooling, and weighing should be repeated every 30 minutes until the difference between Two successive weigh-ins equal less than one milligram. Note the mass that is the lowest.

Calculation:

$$\text{Moisture, \% by mass} = \frac{100\,[M_1 - M_2]}{[M_1 - M]}$$

M_1 = mass (in grams) of the material-filled dish prior to drying;

M_2 = mass (in grams) of the dish containing the material once it has dried to a stationary mass

M = empty dish mass, expressed in grams.

Determination of Protein content

Protein estimation was done by Kjeldhal method digestion flask, with the kjeldhal method given by IS7219.

Determination of Ash content:

Precisely measure out 5 grams of the ready sample into a dried, clean, and tared silica dish. Use the flame to ignite the substance in the dish of an effective burner for approximately sixty minutes. To achieve Irey ash, accomplish the ignition by maintaining the temperature in a muffle furnace at 500 ± 10^0C. Cool in a desiccator and weigh the sample. After one hour, repeat the steps of lighting, cooling, and weighing until the difference in two subsequent weights is less than one milligram. Observe which mass is lowest. Keep this ash preserved so that its acid insoluble content may be determined.

$$\text{Ash (\%)} = \frac{(M_2 - M) \times 1000)}{(M_1 - M)\,(100 - W)}$$

M_2 = Mass of the ash-filled dish in grams

M = Empty dish mass, expressed in grams;

M_1= Mass in grams of the dish containing the test material.

W= Boisture percentage in sample

Determination of fiber content:

Using a Soxhlet or other appropriate extractor, weigh precisely 2 grams of the dry material. Then, extract the fat for approximately 8 hours using food-grade petroleum ether or hexane, or use the residue from the crude fat determination. Put the dry residue that is devoid of fat into a conical flask that holds one liter. 200 ml of diluted sulfuric acid should be heated to boiling in a beaker. Completely transfer the boiling acid to the flask holding the fat-free material. Then, quickly attach the flask to a reflux water condenser and turn on the heat source such that the contents of the flask boil in less than a minute. Bring a certain amount of sodium hydroxide solution to a boil under a reflux condenser. 200 g of the boiling sodium hydroxide solution is used to wash the residue on the linen and transfer it into the flask. Boil for precisely 30 minutes after quickly attaching the flask to the reflux condenser. Take out the flask and immediately pass the mixture through the filter cloth. Transfer the residue to a Gooch crucible that has been prepared with a thin but compact layer of ignited asbestos after giving it a thorough wash with boiling water. Under a reflux condenser, bring a certain volume of sodium hydroxide solution to a boil. The residue on the linen is cleaned and transferred into the flask using 200 grams of the boiling sodium hydroxide solution. Attach the flask to the reflux condenser and boil for 30 minutes. Remove the flask and run the mixture through the filter cloth right away. Transfer the residue to a Gooch crucible that has been prepared with a thin but compact layer of ignited asbestos, after thoroughly cleaning it with hot water. After giving the residue, a good wash with hot water, add around 15 ml of 95% (by

volume) ethyl alcohol. To achieve consistent mass, dry the Gooch crucible and its contents in an air oven at 105 ± 10C. Then cool and weigh. The Gooch crucible's contents should be incinerated at 600–20°C in a muffle furnace until all the carbonaceous materials has burned. Weigh after cooling the Gooch crucible with the ash in a desiccator.

$$\text{Crude fibre \% by mass} = \frac{100\,[M_1 - M_2]}{M}$$

M_1 = mass of the Gooch crucible and its contents in grams prior to ashing.

M_2 = mass in grams of the asbestos and ash-filled Gooch crucible

M = mass (in grams) of the dried specimen used in the examination.

Determination of fat content:

Spoon out approximately 10 g of the precisely weighed material into an appropriate thimble, then extract for roughly 16 hours in a Soxhlet extraction equipment using the solvent. After determining the empty mass of the Soxhlet flask, dry the extract inside it for 30 minutes at 95 to 1000^0C. Weigh after cooling in a desiccator. Drying and weighing should be done alternatively every 30 minutes until the mass loss between two subsequent measurements is less than one milligram. Note the mass that is the lowest.

$$\text{Fat as a percentage of mass} = \frac{100\,[M_1 - M_2]}{M}$$

where, M_1 = mass of the extracted fat in grams in the Soxhlet flask

M_2 = mass (in grams) of the dry, clean, and empty Soxhlet flask

M = Mass of the material used for the test, expressed in grams.

Determination of carbohydrate content:

To determine the proportion of moisture, total protein, total fat, and total ash, the total carbs are calculated as follows. The percentage of mass that is made up of all carbs, including sucrose, dextrose and its derivatives, maltose, and lactose

Calculation: - 100 -(A+B+C+D)

where, A= Percentage by protein mass

B = Percentage of carbohydrates by mass

C = Percentage of fat mass

D= percentage of total ash by mass

Determination of energy content:

A food's calorific value, also known as its energy valve, is determined by the proportions of its three energy-rich nutrients: fats, proteins, and carbs. The determination of this can be achieved using either an experimental method of complete combustion in a colorimeter or a computation based on the primary energy nutrients included in the food, considering that 1 gram of protein, carbohydrate, and fat provides 4, 4, and 9 calories, respectively. The words "calorie" and "joule" can also be used interchangeably with "energy."

Energy (Kcal)=(A+B) + 9 x C

A= percentage by protein mass

B = percentage of carbohydrates by mass

C = percentage of fat mass

Determination of magnesium content:

Weigh out 1.0 g of the sample in the beaker for analysis. Add a drop or two of the concentrated nitric acid together with 40 milliliters of 25% HCI. After a few minutes of boiling, let cool. Fill a 25O-ml volumetric flask with Whatman filter paper No. 41 and filter. Use distilled water to give the filter paper one last wash, then gather the washings in a volumetric flask. Add distilled water to make up the volume and stir well. In another 10OM-ml flask, transfer 25 ml of the solution and adjust the volume with distilled water.

Determination of magnesium :

The test sample mentioned above should be pipetted into a 250 ml conical flask. Dilute the sample with distilled water to a volume of roughly 50 ml. Add 10 drops, or 0.5 ml, of buffer solution to this. After adding three to four drops of Eriochrome T-indicator, titrate with 0.01 N EDTA until the color shifts from wine red to clear blue. The final step involves a gentle titration.

Calculation:

Milliequivalent of magnesium (C) = B-A

B=Total calcium and magnesium milliequivalents

A= Calcium milliequivalent per liter

Expression of result:

Magnesium %= C x 12 x100

where, C= Milliequivalent of magnesium per liter

12= Equivalent weight of magnesium

Determination of calcium content:

About 100 grams of the sample should be ground until it fits through a 1.00 mm IS test sieve. Then, transfer the processed sample to a glass bottle with a cork.

Test segment:

Weigh the test sample into the cremation dish to the nearest 1 mg, or more if needed, weighing around 5 g.

Determination:

Ash the test section in the electric muffle furnace, which is kept at 550±10 until all organic material is gone. (Usually, 4 hours are plenty). If some organic material (black particles) is still present, add a few drops of nitric acid, dry on a hotplate, and re-ash the muffle furnace for 30 minutes at 550 ± 20°C. Continue doing this until no more organic material remains. The ash should be moved to a 250 ml beaker. Add the hydrochloric acid (40 ml). Two drops of nitric acid and 60 ml of water. Boil for 30 minutes. After cooling, move the mixture to a 250 ml one-mark volumetric flask. To obtain the test solution, rinse, dilute with water to the appropriate level, mix, and filter. Transfer an aliquot of the test solution containing 10–40 mg of calcium using a pipette, as directed by the estimated calcium level in a 250 ml beaker. Add 5 ml of the ammonium chloride solution and 1 ml of the citric acid solution. Dilute with water until about 100 ml remains. Add 30 ml of a warm ammonium oxalate solution and 10 drops of the bromocresol green solution after bringing to a boil. If a precipitate does form, add a few drops of hydrochloric acid to dissolve it. Stir the ammonia solution constantly while gently neutralizing it until the pH reaches 4.4 to 4.6. At that point, the indication changes hue. To allow the precipitate to settle, place the beaker over a boiling water bath and leave it there for 30 minutes. Take the beaker out of the bath of water. After an hour, remove and pass through the filter crucible. Rinse the crucible and beaker with water until all surplus ammonium oxalate is gone, as shown by the lack of chloride found in cleaning. The crucible should be placed in a wide-mouth flask or 250 ml beaker. To dissolve the precipitate, add 80 ml of sulfuric acid and boil the mixture to between 70 and 80°C. Titrate the heated solution with the standard volumetric potassium permanganate solution until a pink color is achieved and lasts for one minute.

The amount of calcium, measured in grams per kilogram of sample

$$= \frac{20.4 \times V \times c}{m} \times \frac{250}{V_1}$$

V= Volume, expressed in milliliters, of the titration's standard volumetric potassium permanganate solution.

C= Precise quantity of potassium permanganate in moles per liter of the standard volumetric solution.

m = Mass (in grams) of the test segment

V_1= Volume of the aliquot portion in milliliters

Total plate count /g:

Plate count method :

Use the mean count of the results after doing plate counting techniques for each media, at least twice.

Pour plate method :

When filling 9 cm diameter Petri plates, add 1 mL of the sample that was prepared according to the instructions under Sample Preparation, Inoculation and Dilution, and Neutralization/Removal of Antimicrobial Activity and 15–20 mL of Sabouraud Dextrose Agar or Soybean–Casein Digest Agar, both media were kept at a maximum temperature of 45^0 C. An increase in the size of the agar medium is necessary when using larger Petri dishes. At least two Petri dishes are utilized for each microorganism. Let the plates incubate. Determine how many cfu were in the initial inoculum by taking the arithmetic mean of the counts per medium.

Surface spread method:

To solidify, add 15 to 20 mL of Soybean–Casein Digest Agar or Sabouraud Dextrose Agar to each 9 cm diameter Petri dish, and let it sit at 45^0 C. The volume of the agar is raised in proportion to the size of the Petri dishes utilized.

Sensory evaluation:

The sensory evaluation of different organoleptic properties *viz,* colour, aroma, taste, flavour, appearance and overall acceptability were carried out by a panel of 12 judges on the basis of Nine Point Hedonic Scale. The average score was calculated for individual organoleptic property. The overall acceptability of the product was taken as the average score of all these organoleptic properties.

RESULTS AND DISCUSSION

Proximate Analysis of Bar cookies:

Proximate analysis of selected T_2 sample showed the following result as per the 3.1.Moisture content of cookies was 4.50 g, the total ash content was 1.73 g, protein content was 11.5g, Crude fiber content was 0.62gm, Fat content was 35.57g, Carbohydrate content was 46.08g, Energy content was 550Kcal,among the Calcium (Ca) and Magnesium (Mg) content was 176mg and 129mg per 100gram of cookies respectively and Total plate count /g was 60cfu/g (Table 2).

Table 2 : Physico- chemical result of prepared flour- based bar cookies

Nutritional value of cookies (100gm)		
Sr. No.	Chemical attribute	Result
1.	Moisture	4.50g
2.	Total ash	1.73g
3.	Protein	11.5g
4.	Crude fiber	0.62g
5.	Fat	35.57g
6.	Carbohydrate	46.08g
7.	Energy	550Kcal
8.	Calcium (Ca)	176mg
9.	Magnesium (Mg)	129mg
10.	Total plate count/g	60cfu/g

Sensory Evaluation:

Sensory evaluation of prepared cookies was done by 9 point hedonic scale, 10 semi-trained panel members were employed for this sensory evaluation. The product was evaluated on the basis of colour, taste, texture, flavour, appearance and overall acceptability. Overall result were observed as sample T_2 has maximum score in each sensory attribute, so it selected for further study (Fig. 4).

It was noted sample T_2 has obtained the greatest overall acceptability score since it received favorable results for its color, aroma, taste, flavor, appearance, and overall acceptability. T_2 sample thus chosen for further examination based sensory data.

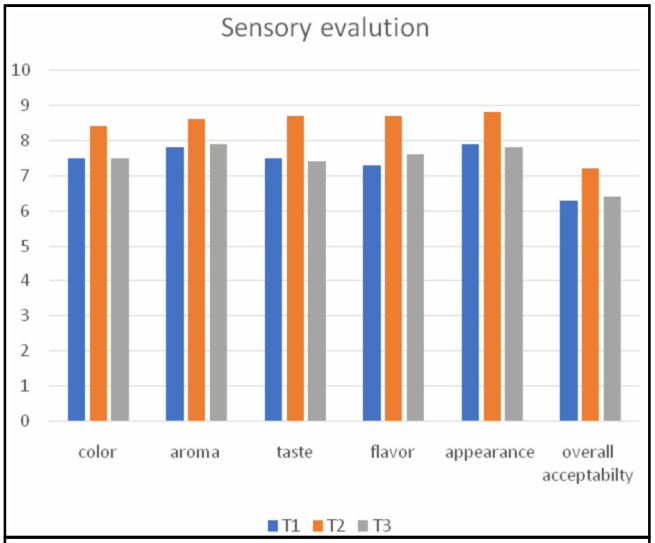

Fig. 4 : Organoleptic evaluation of flour based bar cookies

Conclusion :

The goal of the current study was to develop "jowar (*Sorghum bicolor*) and almond (*Prunus dulcis*) flour bar cookies incorporating pumpkin seeds" for physio-chemical, microbiological, sensory, and proximate analyses. Wheat flour, sorghum flour, almond flour, and sugar powder are used in the manufacture of the four variations' samples. All tests were conducted at room temperature, with treatments T_1, T_2, T_3, and T_0 serving as controls. Phase 9 involved physicochemical investigation, microbiological analysis of the product, and determination of shelf life. Over the same time frame, a sensory examination was conducted. All the variations were pleasant in terms of sensory qualities. The outcome was favourable, and the cookies' moisture, ash, fat, protein, carbs, calories, and fiber content were all of good quality. With T_2, general acceptance was discovered. According to recent research, sorghum and almond flour have a lot of potential for use in baked goods. T_2 was more well-liked than the other sample. It has been noted that for flavor, an equal amount of wheat flour and almond flour are acceptable. Almond flour has more of fiber, calcium, magnesium, and protein. All age groups are attracted to products with almond flour, sorghum flour, and pumpkin seeds. Pumpkin seeds are very nutrientdense, palatable, and abundant in polyunsaturated fatty acids and antioxidants

Table 3 : Organoleptic evaluation of flour bar-based cookies

Sample	Color	Aroma	Taste	Flavor	Appearance	Overall acceptability
T_1	7.5	7.8	7.5	7.3	7.9	6.3
T_2	8.4	8.6	8.7	8.7	8.8	7.2
T_3	7.5	7.9	7.4	7.6	7.8	6.4

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