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Calcium and Magnesium Rich Cookies, Fortified with Pumpkin (*Cucurbita moschata*) and Sunflower Seed (*Helianthus annus* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The study of cookie development was carried out at the Department of Food Technology, Parul Institute of Applied Sciences, Parul University, Vadodara. The main objective of the study was to develop cookies. The main goal of the study was to develop cookies which provide enough calcium and magnesium which are found in pumpkin and sunflower seeds and which are rich in antimicrobial and antioxidant properties and rich in protein. Cookies were developed by using pumpkin and sunflower seed flour which was first ground and ground into powder and combined with wheat flour and other ingredients where butter and sugar were used. The pumpkin and sunflower flour and wheat were taken into different variations during dough preparation. The dough was prepared first and sheeting of dough and making shapes with shaper and cookies were made. Five different formulations T_1, T_2, T_3, T_4, T_5 and T_0 were prepared. T_4 was found to be the best

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formulation after sensory evaluation with 9 Point Hedonic Scale. Then developed cookies were further analyzed for sensory evaluation. The cookies showed 14.2 % of moisture content, 2.4% Ash content, 13.62g protein content , 36.25 g fat content, 46.97 % carbohydrates content, 0.76 g fiber and energy value 563.57 kcal/ 100 g. The Fourier transform infrared spectroscopy (FTIR) of developed cookies shows spectra 3301.74 cm^{-1} which represent O-H group, 2927.81 and 2859.54 cm^{-1} are observed which shows C-H group in developed cookies. The developed cookies were packed in polyethylene pouches (PEP), and stored under ambient (18-38^{o}C) and refrigeration temperature(4^{o}C) conditions for 3 months. The moisture content of the cookies significantly increased from 14.2 to 14.44 per cent. Ash, fat and protein decreased to 2.4 to 2.24 per cent, 36.25 to 36.11 per cent and 13.62 to 13.51 per cent, respectively. At refrigeration temperature, the rise in moisture from 14.2 to 14.27 per cent. In addition, the amount of fat, protein, and ash fell from 36.25 to 36.19 per cent, 13.62 to 13.13.56 per cent, and 2.4 to 2.36 per cent, respectively. Thus, it shows that refrigeration temperature is best storage temperature and it retains nutrients.

Keywords: Cookies; FT-IR; pumpkin seed; sunflower seed.

1. INTRODUCTION

It makes sense to enrich food products to address certain nutritional deficiencies. Food enrichment improves human health and helps prevent chronic diseases. Nutritionists face technical and scientific hurdles in the identification and development of enriching agents that would ensure optimum product quality and increase the bioavailability of vital nutrients [1]. Fortification is a technique that can be used to treat or prevent widespread nutrient deficits and, as a result, corrects associated micronutrient deficiencies. Fortification can be used to control the complete nutritional profile of diets, recover nutrients destroyed in food processing, or produce goods more appealing to consumers. The nutritional content of refined grains can be restored by enriching them with elements, which recover the nutrients dropped while processing (thiamine, niacin, riboflavin, and iron) (Rosenberg et al., 2004). Due to their widespread use, baked goods are seen to be the greatest option for enhancing refined wheat products that contain high protein oilseed flour [2] Cookies are goods manufactured from wheat flour, oil, milk powder, salt, sugar, water, and a few minor ingredients like sodium bicarbonate, ammonium bicarbonate, and emulsifiers to improve the colour, flavour, texture, and consistency [3]. Because of its low cost, simplicity, shelf stability, and nutritious content, it has become a favourite snack meal for both young and old people [4].

The Cucurbitaceae is the family that includes pumpkins. A plant that has historically been used as medicine in underdeveloped nations has seen a resurgence in popularity in Europe and the United States [5]. Cucurbita, also known as "pumpkin," is a trailing plant that is grown from sea level to high altitudes [6]. China and India are the world's major pumpkin producers, accounting for 48.42% (nearly 11 million tons per year) of total pumpkin production. Over 90% of total production in these countries is used for oil extraction, leaving a significant amount of residue as pumpkin powder, which provides 60-70% protein [7]. The plant's blooms, fruit, leaves, roots, and seeds are all edible components. Due to their high nutritional content and medicinal qualities, pumpkin seeds are utilized for therapeutic purposes throughout the world. In Arab nations, pumpkin seeds are frequently consumed as a snack after being roasted and salted [8]. Pumpkin seeds are regarded as valuable oil seeds packed with protein sources and are a high natural source of proteins with a range of 25 to 37% and oil with a range of 37 to 45% [9]. Additionally, a great source of fibre, these seeds. 31.48% of them are crude fibre [10]. Additionally, because pumpkin seeds are high in iron and amino acid like tryptophan, lysine, methionine, and tyrosine, they are helpful to adolescents in treating anaemia brought on by iron deficiency [11,12]. Furthermore, pumpkin seeds are high in magnesium, potassium, and phosphorus, as well as other trace minerals including zinc, manganese, iron, calcium, sodium, and copper [13,14]. According to claims, foods enriched with pumpkin are a strong source of anti-inflammatory ingredients, which can help with a variety of illnesses including arthritis [15].

Sunflower is one of the three most widely produced oil crops in the world (*Helianthus annuus* L.) [16]. Turkey is one of the world's top ten sunflower producing countries. Turkish sunflower acreage and crop production have recently ranged from 500,000 to 600,000 ha and

650,000 to 950,000 t, respectively. The average sunflower output is approximately 1700 kg ha1 [17]. Oil seed crops have recently attracted attention for their positive impact on health promotion and sickness prevention. Sunflower seeds have also gained popularity due to their important contribution to health [18]. Caffeic, chlorogenic, and ferulic acids are three sunflower polyphenols with high antioxidative capability and potential for technical and biological applications [19]. Sunflower oil is high in both oleic acid (C18:1) and linoleic acid (C18:1). These fatty acids lower the risk of cardiovascular disease by reducing total cholesterol and LDL cholesterol [20].

Infrared (IR) or Fourier transform infrared (FTIR) spectroscopy has a wide range of applications, from analyzing tiny molecules or chemical complexes to analyzing cells or tissues. Tissue imaging is a recent advancement in infrared spectroscopy that takes advantage of infrared microscopy and the utilization of synchrotron IR radiation. It is used to identify aberrant cells by mapping cellular components (carbohydrates, lipids, proteins) [21,22].

Creating healthier cookies by incorporating various flours and seeds powder can boost the nutritional content of the product. The goal behind including pumpkin and sunflower powder in the cookies is to make them more nutrient-dense and accessible to all. The primary goal of the research is to create nutrient-dense cookies using wheat and seed powder (pumpkin and sunflower).

2. MATERIALS AND METHODS

The Present study entitled “Calcium and magnesium rich cookies, fortified with pumpkin(*Cucurbita moschata*) and sunflower seed(*Helianthus annus* L.)” was carried out in Department of Food Technology, Parul university, Vadodara. This section enlists the material used and elaborate the processing technique, organoleptic evaluation and analytical procedure following during the research.

2.1 Procuring of Raw Materials

The ingredients used in the preparation of the cookies were wheat flour, pumpkin, and sunflower seeds were bought from the Vadodara, Gujarat, neighbourhood market. These vegetable and cereal flours were selected at random and brought to the lab for the current study. Moreover, ingredients like butter and sugar were purchased from the Vadodara, Gujarat, local market.

2.2 Roasting of Seeds

Pumpkin seeds and Sunflower seeds were roasted in an open pan. The seeds were cooked for 2 minutes on a low burner.

2.3 Preparation of Flour

After roasting, the seeds were allowed to cool at room temperature. The seeds were then ground individually in a grinder and sieved by hand to produce a fine (uniform) powder.

2.4 Preparation of Cookies

The ingredients were used to standardize the recipe for cookies: 25 g of wheat, 25 g sunflower seed powder, 50 g pumpkin seed powder, 30 g sugar and 30 g butter. The components listed above are needed to make 100 g of cookies. The dry ingredients were weighed and combined with cream then the dough was correctly kneaded for 5-10 minutes. The dough was then flattened with a rolling pin and cut into the required form (circular), before being placed in the oven the oven has preheated for 10 minutes at 180ºc. The cookies were then baked for 10 minutes in the oven until they had a smooth texture. The cookies were cool before being placed in polypropylene (PP) pouches. For shelf-life evaluation, the cookies were stored at ambient and refrigeration temperatures.

2.5 Formulations of Cookies

Following the above-mentioned varied procedures, numerous flour mixes were standardized. By using sensory evaluation, our professionals, including Dean Sir, institutional faculty, and mentor, chose the best treatment (Table 1).

2.6 Chemical Analysis

Moisture, Ash, Fiber and carbohydrate were determined as per method explained by [23]. Protein and fat were determined by [24]. Energy value determined and measured by bomb calorimeter. Mineral content was determined by [25]. Fourier Transform-Infrared Spectroscopy was determined as per method of [26] (Fig. 1).

Table 1. Formulation of cookies

Sr no.	Wheat flour (gm)	Pumpkin flour (gm)	Sunflower Flour (gm)	Butter (gm)	Sugar (gm)
T_0	100	-	-	30	30
T_1	33.3	33.3	33.3	30	30
T_2	50	25	25	30	30
T_3	25	25	50	30	30
T_4	**25**	**50**	**25**	**30**	**30**
T_5	60	20	20	30	30
T_6	27.5	45	27.5	30	30
T_7	27.5	27.5	45	30	30
T_8	45	27.5	27.5	30	30
T_9	70	15	15	30	30
T_{10}	15	70	15	30	30
T_{11}	15	15	70	30	30
T_{12}	80	10	10	30	30
T_{13}	10	80	10	30	30
T_{14}	10	10	80	30	30
T_{15}	44	28	28	30	30
T_{16}	28	44	28	30	30
T_{17}	28	28	44	30	30

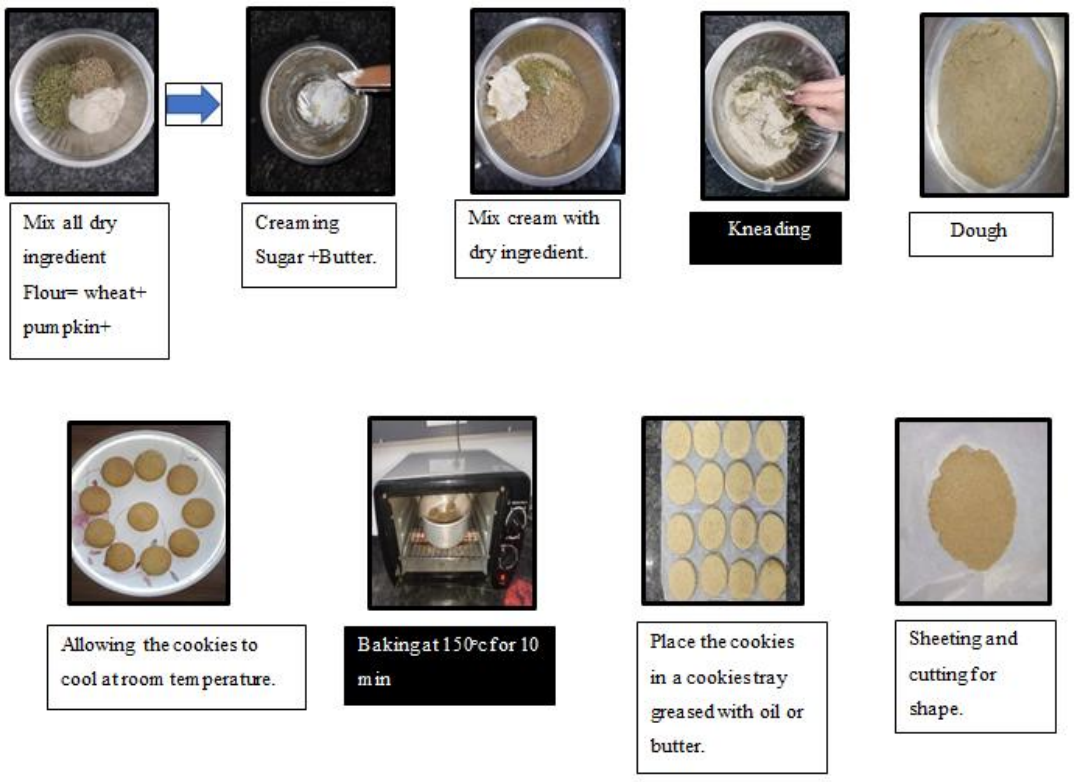

Fig. 1. Preparation of cookies

3. RESULTS AND DISCUSSION

The current study, titled "Calcium and magnesium rich cookies, fortified with pumpkin(*Cucurbita moschata*) and sunflower seed(*Helianthus annus* L.)", was carried out in Department of Food Technology, Parul Institute of Applied Sciences, Parul University, Vadodara, Gujarat, India during the years 2023. The results

of the study are presented and discussed under different heads and sub heads:

3.1 Proximate Composition of cookies

Table 2 shows Protein, fat, carbohydrate and fibre values are 13.62 per cent, 36.25 per cent, 46.97 per cent, 0.76 percent respectively. The energy value was 563.57kcal/100 g. Ash content was 2.4 per cent and moisture content was 14.2 per cent, respectively. These values are closely related to the (Garsa Ali Alshehry, 2020).

Table 3 shows the developed cookies had 37.47 mg/100 gm magnesium, 4.68 mg/100 gm, 3.74 mg/100 gm and 3.74 mg/100 gm. (Glew, 2006) who reported a similar range of mineral content.

3.2 Fourier Transform – Infrared Spectroscopy (FT-IR).

Fourier Transform Infrared spectroscopy (FT-IR) is a long-wave infrared radiation spectral measurement method that records absorbance in a time field and converts it to a frequency field using the Fourier transform algorithm. Because of its ability to recognize functional groups of chemical compounds such as carbohydrates, esters, and chemical bonds between atoms, FTIR has been used to analyze a wide range of samples (Fig. 2).

Table 2. Chemical composition of developed functional cookies

Sr no.	Parameters	Amount (%)
1.	Moisture	14.2
2.	Ash	2.4
3.	Protein	13.62
4.	Energy	563.57 Kcal/100g
5.	Fiber	0.76
6.	Fat	36.25
7.	Carbohydrates	46.97

Table 3. Mineral content of developed functional cookies

Sr. no.	Minerals	Amount (mg/100 g)
1.	Calcium	4.68
2.	Magnesium	37.47
3.	Iron	3.74
4.	Zinc	3.74

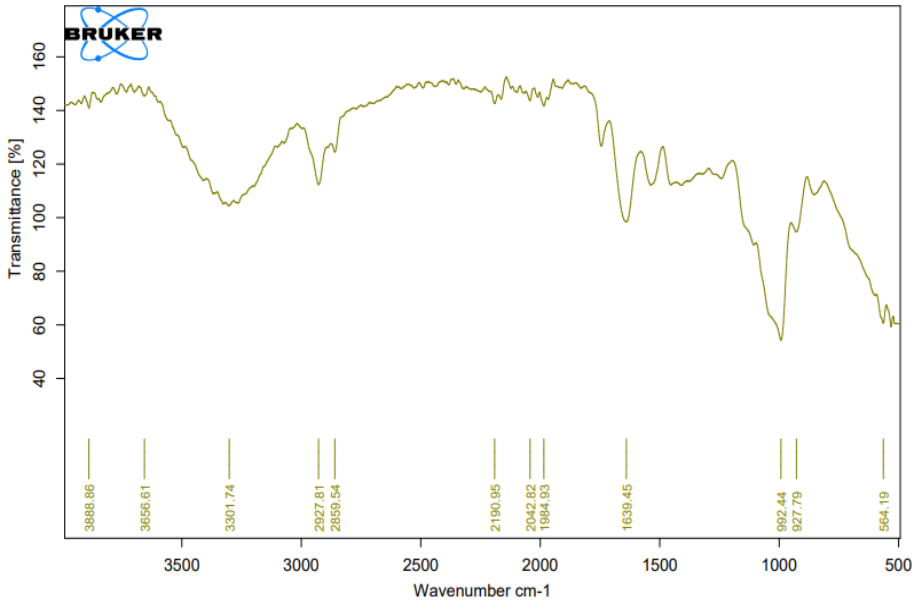

Fig. 2.

The results obtained in Fig. 1 shows FT-IR spectra at spectra 3301.74 cm^{-1} which represent O-H group, 2927.81 and 2859.54 cm^{-1} are observed which shows C-H group in developed cookies. Similar observations have been recorded by [27].

3.3 Quality Evaluation of Cookies during Storage

After the product is developed then cookies are then packed into a polyethylene pouch and kept at a different temperature to study the changes in developed cookies during intervals of 0^{th} to 3^{rd} months.

The moisture content of the cookies significantly increased from 14.2 percent to 14.44 per cent. The increase in moisture content could be brought on by air permeability. Ash, fat and protein decreased to 2.4 per cent to 2.24 percent, 36.25 g to 36.11 g/100 g, and 13.62 g to 13.51 g/100 g, respectively. Fat deterioration or the onset of rancidity may be to blame for the drop in fat content (Table 4).

At refrigeration temperature, the rise in moisture from 14.2 percent to 14.27 percent. In addition, the amount of fat, protein, and ash per 100 grams fell from 36.25 g to 36.19 g, 13.62 g to 13.13.56 g, and 2.4 per cent to 2.36 per cent, respectively. Thus, it shows that refrigeration temperature is the best storage temperature and it retains nutrients (Table 5).

3.4 Microbial Analysis

The microbiological analysis results for the cookies, According to the microbiological assessment test results, the total plate count(TPC) was discovered to be 2500 cfu/g. Total plate count (TPC) was determined by aseptically inoculating 0.1 g of serially diluted samples in total plate count/ standard plate count agar medium prepared according to [23].

The result of the sensory analysis was based on the taste, texture, Color, appearance and overall acceptability presented in Table 6. It was showed, that cookies with only wheat flour (T0) had low rank for all the attributes indicating the preference was low. There was no significant difference among the T3 and T4 cookies with regard to the appearance, overall acceptability, taste and Color. Smooth and crunchy texture was observed by the panel list. The texture of the T_1 and T_2 sample was almost similar and was least preferred by the panel list. However, the T_3 sample showed significant difference in the terms of texture as compared to T_1 and T_2 sample. T_4 was the highest preferred sample with all the attributes approved and ranked by the panel list. The best and most liked cookies with the highest overall acceptability was T_4 with rating of 8.5.

Table 4. Storage studies of developed cookies at ambient temperature (25-27ºC)

Sr. no.	Parameter	0^{th} day	1^{st} month	2^{nd} month	3^{rd} month
1.	Moisture	14.2	14.33	14.38	14.44
2.	Ash	2.4	2.31	2.29	2.24
3.	Protein	13.62	13.59	13.55	13.51
4.	Fat	36.25	36.21	36.16	36.11

Table 5. Storage studies of developed cookies at refrigeration temperature (4ºC)

Sr. no.	Parameter	0^{th} day	1^{st} month	2^{nd} month	3^{rd} month
1.	Moisture	14.2	14.23	14.26	14.27
2.	Ash	2.4	2.39	2.37	2.36
3.	Protein	13.62	13.60	13.58	13.56
4.	Fat	36.25	36.23	36.21	36.19

Table 6. Sensory evaluation of developed cookies

Sensory Evaluation	T0	T1	T2	T3	T4	T5
Appearance	8	8	7	7	**8**	8
Colour	8	7	7	7	**8**	5
Texture	7	7	8	7	**8**	7
Taste	6	6	7	7	**9**	8
Overall Acceptability	8	7	8	8	**9**	8

3.5 Cost of Production

Table 7. Cost of production of developed cookies

Ingredients	Rate / 100g	Quantity required (g)	Amount (₹)
Wheat	55	25 g	13.75
Sunflower	100	25 g	25
Pumpkin	150	50 g	75
Sugar	44	30 g	12
Butter	53	30 g	13.25
Additional charge	-	-	10
Processing charge	@ 10 percent of total cost	-	14.9
Total Cost = ₹ 163.9			

The price of each input was taken into account while calculating the cost associated with producing functional food products. The entire cost is increased by the processing fee and additional costs, such as depreciation. After accounting for 10 percent of the processing costs, the sale price per 100 g of the items was computed. The cost of cookies that are significantly more enriched with sunflower and pumpkin seed flour than the control sample cookies. The designed cookies cost roughly ₹ 163.9 to produce 100 g. The higher cost is due to pumpkin seeds.

4. CONCLUSION

According to the findings presented in this study, created cookies were more nutritionally dense than regular wheat flour cookies. It was possible to establish that T_4 was the most recommended formulation of sunflower seed, pumpkin seed, and wheat flour. The T_4 formulation of created cookies contains 14.2% moisture, 2.4% ash, 13.62% protein, 46.97% carbohydrates, 36.25% fat, 37.47 mg magnesium, 3.74 mg iron, 4.68 mg calcium, and provides up to 563.57 kcal/100 g energy. The contents in the produced cookies were carefully chosen to give ample energy, high protein, and minerals such as magnesium, calcium, iron, and zinc. During FT-IR we found that the peak in the absorbance wavenumber spectrum range vibration was observed at 3301.74 cm^{-1} which represents O-H group, 2927.81 cm^{-1} and 2859.54 cm^{-1} was observed which showed C-H group present in the cookies. During storage the moisture content of the cookies significantly increased from 14.2 to 14.44 per cent. Ash, fat and protein decreased to 2.4 to 2.24 per cent, 36.25 to 36.11 per cent and 13.62 to 13.51 per cent, respectively. At refrigeration temperature, the rise in moisture from 14.2 to 14.27 per cent. In addition, the amount of fat, protein, and ash fell from 36.25 to 36.19 per cent, 13.62 to 13.13.56 per cent, and 2.4 to 2.36 per cent, respectively. Thus, it shows that refrigeration temperature is the best storage temperature and it retains nutrients. The cookies are safe to eat for both adults and children. The cookies might be an outstanding healthier alternative and the greatest replacement for unhealthy cookies.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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