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Studies the effect of germination to develop the chickpea based cookies

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Abstract
The research focused on the comparative analysis of nutritive, anti-nutrient and sensory characteristics of germinated chickpea made cookies with refined wheat flour made cookies. The germinated chickpea flour addition in 20%, 40% and 60% proportion in refined wheat flour can raise the fiber, protein, fat and carbohydrate content with the reduction of anti-nutrient factors value in cookies. The proximate components such as reducing sugar, non-reducing sugar, and starch digestibility were higher except glycemic index. However, the presence of phytonutrients such as saponins, tannins, terpenoids, cardiac glycosides, oxalates except steroids and phytates indicate the health benefits properties of chickpea cookies. Finally, sensory attributes evaluation using a 9-point hedonic rating scale gave an overall acceptability score value of 7.35 and 4.1, respectively for chickpea cookies and refined wheat flour cookies.

Keywords: Germination, cookies, chickpea, nutritive value, anti-nutrients, sensory attributes

1. Introduction
Pulses have been one of humanity's earliest cultivated food crops. Grain pulses, also known as legumes, are part of the Leguminaceae family, specifically belonging to the subfamily Papilionaceae. Pulses hold significant importance in the global food system. Grain legumes play a crucial role in providing protein for a significant portion of the Indian population (Anton *et al*. 2008) [3]. Unfortunately, in the past two decades, the production and productivity of most pulse crops have witnessed a stagnant position which is fluctuating between 11 and 14 million tonnes. To date Malo and Hore, (2020) [15] supported India as one of the biggest importers of pulses thereby; this unavoidable situation highlights the country's ongoing reliance on imported sources to meet pulse demands. In this context growing Indian population has led to an increased demand for pulses, prompting efforts to boost pulse production and enhance availability (Parenti *et al*., 2020) [17]. One approach involves exploring untapped potential in new and underexploited grain legumes.
The Asia Pacific region, in particular, boasts a rich diversity of resilient and tolerant plants that survive even in adverse conditions. Additionally, many of them offer superior nutritional value compared to conventionally grown pulses. In this context Kotsiou *et al*., (2022) [11] reported that the addition of chickpeas flour had led to improved the quality of bakery products like bread. Harnessing the potential of these nutritionally rich chickpea to prepare nutritionally bearing cookies and hold the promise of promoting better health and nutrition (Kaur and Prasad 2021) [10]. Considering the aforementioned points, the objective of the present study was to create value-added cookies by incorporating germinated chickpea flour and analyzing the physicochemical, sensory, and nutritive characteristics of cookies. Moreover, this study involved to germinate chickpea flour and comparing it to wheat flour, as germination is known to reduce anti-nutritional factors.
Cookies are baked goods that typically have the following three components: flour, sugar, and fat. These three ingredients are combined with additional minor ingredients to produce dough. Wheat is primarily employed in baking items because of its valued rheological properties. The main structural ingredient in most batter and dough products is wheat flour. Due to the gluten presence, which enables air cell expansion and provides stiffness after baking, it may carry out these textural duties. However, compared to oilseeds and pulses, wheat protein is weak in key crucial amino acids and has lower protein levels (Murugkar *et al*., 2014) [16]. Since more people consume cookies, they have a longer shelf life, are more convenient, and taste excellent, making them a suitable candidate for protein fortification and other nutritional enhancements.

The nutritional value of cookies can be improved by combining refined wheat flour (RWF) with oilseeds and pulses, including soybean, moth bean, and chickpea. One of the most significant protein and oil crops in the world is soybean. Soybeans are a rich source of all essential amino acids and have a protein content of 30 to 45 percent. Defatted soy flour (DSF) is the most abundant, traditional, and affordable source of protein for the world's rapidly growing population (Kulthe *et al*. 2011) [13].

2. Materials and Methods

2.1 Procurement of raw materials

Chickpea (*Cicer arietinum* L) and refined wheat flour was procured from a local departmental store of Meerut city market.

2.2 Preparation of germinated chickpea flour

The present study was conducted in the Research laboratory of ICAR- IIFSR Modipuram Lab, (FDA-LAB). Before being made into flour, the chickpeas sprouted. In this procedure, dust, dirt, stubble, and foreign material were carefully removed from the seeds. At room temperature, the seeds were steeped in distilled water for 4 hours. The extra water was then removed, the samples were washed with distilled water, and they were then immersed in water once more for 4 hours, during which time the seeds and cotyledons were used for subsequent operations and the hulls were discarded (Kulkarni *et al*., 2018) [12].

2.3 Formulation of germinated chickpea seed flours

Chickpea flour was utilized in the preparation of value-added cookies. Cookies were made by combining germinated chickpea seed flour with refined wheat flour in different proportions (20%, 40%, 60%), as illustrated in Table 1.

2.4 Cookies preparation and evaluation

Cookies were prepared (shown in Fig.1) using sieving baking powder (2 g), shortening (40 g), milk powder (10 g) and vanilla essence (1ml) with germinated chickpea and refined wheat flour twice. Creamed butter and (50 g) powdered jaggery, were then blended with the flour to form a dough, which was rolled and cut using a cookie cutter. The cookies were prepared using the following method shown in Fig.1

The cookies were baked at 160 °C for 25 minutes, subsequently cooled and evaluated for sensory attributes. Cookies made from wheat serve as a control batch without the addition of chickpea flour. The baked cookies were cooled to room temperature and packed in air-tight containers for further analysis.

Table 1: Composition of chickpea incorporated cookies

Items included	Control	Incorporation level		
		20%	40%	60%
Refined wheat flour	100	80	60	40
Chickpea flour	-	20	40	60
Powdered jaggery	50	50	50	50
Butter	30	30	30	30
Baking powder	2	2	2	2

2.5 Nutraceutical analysis of formulated cookies

The AOAC methods were employed to determine the proximate composition of the flours, which includes moisture, crude ash, crude fat and crude protein as described by Shafi *et al*. (2016) [19]. The crude fat content of the flour was determined by the Soxhlet extraction method (AOAC, 2000) [4], crude protein by the micro-Kjeldahl method (AOAC-960.52), crude ash by drying ashing method (AOAC, 2001) [5]. An estimated amount of carbohydrate was calibrated by subtracting the values of crude ash, fat, and protein content with 100% of the dry matter. The energy value per 100 g was determined and expressed in kilocalories using the at water system, where 1 g of carbohydrate provides 4 kcal, 1 g of protein provides 4 kcal, and 1 g of fat provides 9 kcal.

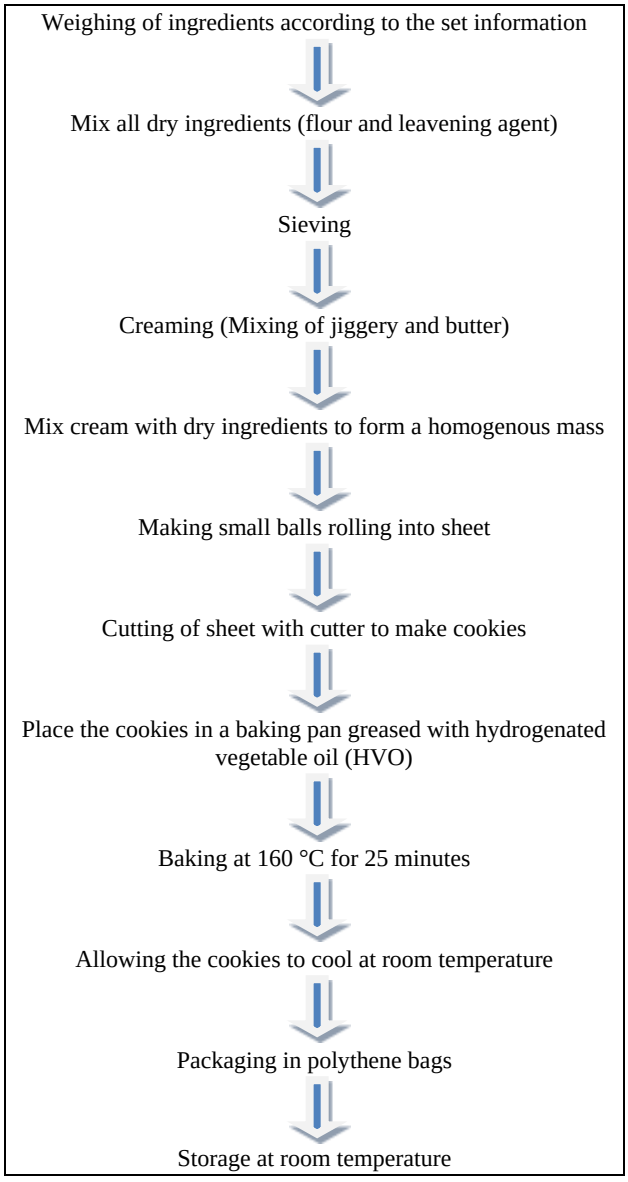

Fig 1: Flow sheet for preparation of cookies

2.6 Physical characterization of formulated cookies

The diameter and weight of the developed cookies as bakery products was determined after cooking.

2.7 Phyto-chemical evaluation of formulated cookies

The phytochemical content of cookies made with chickpea flour was evaluated. The assessed phytonutrients and antioxidant properties include phytates, tannins, saponins, oxalates, triterpenoids, steroids and cardiac glycosides as specified by AOAC, (2000) [4] method.

2.8 Sensory attributes evaluation

The sensory evaluation of cookies made from germinated chickpea flour was judged by thirty semi-trained panelists to select initially the most acceptable product. The cookies quality was demonstrated as per score ratings on a 9-point hedonic scale ranging from 9-(like extremely) to 1- (dislike extremely) to assess their colour & appearance, flavour, taste, crispness and overall acceptability.

2.9 Statistical analysis

All the relevant experiments of the study were statistically evaluated and obtained triplicate result values were expressed as mean and standard deviation values. T-test and ANOVA was carried out to set the p-values and significant differences.

3. Results and Discussion

3.1 Developed cookies characteristics

Table 2 shows the proximate compositional analysis of formulated cookies made from germinated chickpea flour and refined wheat flour. On comparative analysis the germinated chickpea flour made cookies were found better in terms of moisture (8.92%), ash (3.66%), fat (5.03%), fiber (18.01%) and carbohydrate (66.76%) compared to refined wheat cookies. As per table.2 and findings have close agreement with Amir *et al*., (2015) [2]. On the other hand, increment in germinated chickpea addition in wheat flour significantly raises the fiber content but lowers the moisture value as it imparts greater firmness and decreased cohesiveness to cookies recipes. Millar *et al*., (2019) [14] reported a similar kind of trend when the pea germ flour was added into the wheat flour to prepare bread recipes.

Table 2: Proximate compositional analysis of formulated cookies on % dry basis

Parameters	Crude Ash (%)	Crude Moisture (%)	Crude Fat (%)	Crude Protein (%)	Crude Fiber (%)	Crude Carbohydrate (%)
Chickpea cookies	3.66±1.34^{a}	8.92±1.12^{c}	5.03±1.24^{a}	28.11±1.24^{d}	18.01±1.38^{d}	66.76±1.31^{a}
Refined wheat cookies	3.62±1.11^{a}	11.05±1.44^{b}	1.64±1.12^{a}	21.85±1.10^{c}	4.89±1.51^{d}	62.77±1.77^{b}
p<0.05	NS	S	S	S	S	NS

*All expressed values were represented as mean ± SD of three independent determinations $^{a, b, c, d}$. S= significant values; NS=Non-significant

Similarly in table 3 data showed the germination resulted in increment in the reducing sugar 40.11%, non-reducing sugar (21.27%), starch digestibility (31.23%) and total energy (531.05% kcal/100g) except glycemic index (31.23%) compared to refined wheat flour made cookies. On the other hand, the levels of the proximate components of germinated chickpea flour were significantly differed except crude ash and carbohydrate. This could be on account of increment in germination timing and composite flour combination where most of the dietary fiber, protein, fat and other nutrients were also increased. Obtained results were found in line with Thakur *et al*., (2021) [20] work. Similar kind of trend was observed by Bajka *et al*., (2021) [6] as in the case of glycemic index and starch digestibility when the wheat flour is replaced with legume powder for bread recipe preparation.

Table 3: Proximate evaluation of cookies developed from germinated chickpea and refined wheat flour on % dry basis

Parameters	Reducing sugar (%)	Non-reducing sugar (%)	Starch digestibility (%)	Glycemic index (%)	Total Energy (% kcal/100 g))
Germinated chickpea cookies	40.11±1.19^{a}	21.27±0.68^{d}	47.56±1.18^{c}	31.23±1.31^{b}	531.05^{a}
Refined wheat cookies	23.13±1.11^{c}	10.16±1.04^{b}	20.22±0.02^{d}	52.02±1.01^{c}	353.04^{b}
p<0.05	S	S	S	S	S

Table 4 presents the presence or absence and higher concentration of anti-nutrients components in formulated chickpea and refined wheat cookies. As a result of germination and flour combination reduction in anti-nutrients components in cookies made from germinated chickpea was occurred and found comparable to the refined wheat flour cookies. Similar kind of study was reported by Samtiya *et al*., (2020) [18] and supported the findings in terms of reduction of anti-nutrients factor by adopting various processing techniques like germination alone or in combination with composite flours.

Table 4: Anti-nutrients analysis of formulated cookies

Parameters	Tannin (%)	Phytate (%)	Saponin (%)	Oxalate (%)	Steroids	Triterpenoids	Cardiac glycosides
Germinated chickpea cookies	++	-	+	+	-	++	+
Refined wheat cookies	+	++	+	+	+	+	++
p<0.05	S	S	S	S	S	S	**S**

*Presence (+), absent (-) and (++) presence at high concentration

3.2 Cookies physical characterization

Cookies produced with chickpea flour that has been germinated show an improvement in physical properties over those made with refined wheat flour. It was seen when there was a 60% increase in the amount of chickpea flour that had germinated compared to wheat flour. The study's most recent findings, which are shown in Table 5, show that cookies with a 60% addition of germinated chickpea flour to wheat flour had increased porosity, a lighter weight, and beautiful colours and shapes. However, it was shown that further combining germinated chickpea flour with wheat flour might decrease the gluten network and limit carbon dioxide retention, which gives cookies a softer texture (Felix *et al*., 2020) [9]. A similar trend, in the sense that the size of the pores had increased, was also reported by Cardone *et al*. (2020) [7] for bread samples with sprouted wheat addition to wheat flour. Marti *et al*., (2018) [7] findings were in support of the current study work.

Table 5: Physical properties of formulated cookies

Parameters	Colour	Shape	Wtg/g	Diameter (cm)	Porosity (g/100g)
Germinated chickpea cookies	Brown	Angular	6.6±0.08d	1.0	31.11±0.08
Refined wheat cookies	Light yellow	Oval	10.27±1.12a	1.5	35.95±0.43
$p<0.05$	S	S	S	S	S

3.3 Sensory evaluation of developed cookies

Using a 9-point hedonic scale and a panel of 30 professional tasters, 30 cookies were evaluated sensory-perceptually. Additionally, as shown in Table 6, criteria for the overall acceptability of formed cookies were based on ratings for colour and appearance, flavour, taste, and crispness. Overall acceptance scores for refined wheat cookies and germinated chickpea cookies were 7.35 and 4.1, respectively. Gomez *et al*. (2022) [8] and Al-Ansi *et al*. (2022) [1] showed similar trends in values and suggested that adding some germinated components to a bread recipe may greatly enhance the bread's sensory appeal.

Table 6: Sensory evaluation score

Parameters	Color & Appearance	Flavor	Taste	Crispness	Overall acceptability
Germinated chickpea cookies	7.5	6.5	7.2	7.36	7.35
Refined wheat cookies	4.5	3.9	4.6	4.78	4.1

4. Conclusion

According to the findings of the current investigation, adding germinated chickpea seed flour to wheat flour changed the nutritional and anti-nutritional properties as well as the sensory characteristics of the generated cookies. Additionally, germination processing and the addition of chickpea flour to refined wheat flour together raise the level of nearby ingredients in cookies. Processing after germination greatly lowers the amount of anti-nutrient components in chickpeas. The overall nutritive value of the chickpea made cookies had increased considerably compared to the wheat flour made cookies. At last, received chickpea made cookies had a high acceptable score upon sensory analysis. Further studies are still required to determine alteration in the anti-nutritional factor of the cookies, their bioavailability and health beneficial properties.

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