PROTEIN –ENRICHED CRACKERS USING VINGA RADIATA AND CICER ARIETINUM

(LENTIL CRACKERS) LENS ESCULENTA

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Abstract

The increasing demand for healthy and protein-rich snack foods has encouraged the use of legumes in snacks product development. This study was carried out to formulate and evaluate crackers prepared from Vigna radiata (moong dal) flour and Cicer arietinum (chickpea) flour. Both flours are rich in protein, dietary fiber, and essential micronutrients, making them suitable alternatives to refined wheat flour. Crackers were prepared using different proportions of moong and chickpea flour blends and analysed for their nutritional, physicochemical, and sensory characteristics. Proximate analysis showed that the incorporation of legume flours significantly improved protein and fiber content compared to conventional wheat-based crackers. Functional properties such as dough handling and spread ratio were also positively influenced by the flour blends. Sensory evaluation indicated good overall acceptability, particularly in terms of flavour, crispness, and texture, with formulations containing balanced ratios of both flours receiving the highest scores. The results suggest that moong and chickpea flour can be successfully utilized in crackers production to enhance nutritional quality while maintaining consumer acceptability. This approach highlights the potential of legume-based crackers as a sustainable and health-oriented snack option for wider commercialization.

Keywords: moong dal, chickpea, sensory evaluation etc.

Introduction:

The growing demand for healthier snack alternatives has led to the exploration of legume-based ingredients in food product development. The rising consumer awareness about the importance of health and nutrition has driven the exploration of innovative food products that provide convenience without compromising nutritional quality. Among these, snack foods represent a rapidly growing sector, particularly due to busy lifestyles and increasing demand for on-the-go nutritious options. Traditional crackers, typically made from refined wheat flour, are often low in protein and fiber, contributing minimally to daily nutritional requirements.

Among these, Vigna radiata (moong or mung bean) and Cicer arietinum (chickpea) are widely recognized for their high protein content, dietary fiber, complex carbohydrates, and essential micronutrients. Both flours are naturally gluten-free, making them suitable for consumers with celiac disease or gluten intolerance. (Smith et al., 2021; Lee & Park, 2022).

Crackers, traditionally made from refined wheat flour, are a popular snack worldwide but often lack nutritional balance due to their high starch and low protein content. Incorporating moong flour and chickpea flour in cracker formulations not only enhances their protein and fiber levels but also provides functional benefits such as improved satiety, lower glycemic response, and the presence of bioactive compounds with antioxidant properties. (Patel & Desai, 2023).

Moreover, the use of legume flours supports sustainable food systems by promoting crop diversification and reducing reliance on refined cereals. Therefore, developing crackers from moong and chickpea flour presents a promising avenue for creating nutrient-dense, functional snack products that align with consumer preferences for health, wellness, and sustainability. Affordable, and nutritionally balanced products, while also contributing to improved dietary diversity and sustainability. This research explores the potential of combining moong and chickpea flour in cracker preparation, focusing on their nutritional, functional, and sensory attributes to establish their viability as a superior alternative to conventional wheat-based crackers.

As many consumers now seek for high protein snacks, the enrichment of crackers with protein is of pivotal importance. Proteins can be derived from different sources such as plant and animal. Although animal proteins, especially whey, are considered excellent sources of essential amino acids, plant proteins are gaining more attention for their high nutritional value, including a relatively balanced amino acid profile and a moderate digestibility (Anyiam et al., 2025).

Lentils contain protein 23gm, fiber,12gm, carbohydrates 54gm, total fats 3.2gm, calories 360kcal.

Benefits-

Lentil crackers offer significant health benefits, acting as a good source of plant-based protein and fiber, which aid in digestion and promote satiety. They provide essential vitamins and minerals, support blood sugar management, and are a healthier alternative to traditional fried snacks, often containing less fat and salt. Additionally, many lentil crackers are gluten-free and vegan, making them suitable for various dietary needs.

Key Health Benefits-

High in Protein: Lentils are a great source of plant-based protein, contributing to muscle health and offering a snack.

Rich in Fiber: The fiber in lentils supports digestive health, prevents constipation, and helps you feel fuller for longer, which can reduce overall calorie intake.

Nutrient-Dense: Lentil crackers are packed with essential nutrients like iron, folate, and other vitamins and minerals that support the immune system and energy levels.

Blood Sugar Management: Their low glycemic index helps maintain balanced blood sugar levels.

Antioxidant Properties: Lentils contain beneficial compounds with high antioxidant activity, contributing to overall wellness.

Dietary Advantages-

Healthier Alternative: Lentil crackers are often baked or made with minimal oil, providing a crispy alternative to deep-fried potato chips high in unhealthy fats.

Gluten-Free Options: Many brands and homemade recipes are gluten-free, making them a safe choice for individuals with gluten sensitivities.

Vegan-Friendly: As a plant-based food, lentil crackers are an excellent option for vegans and vegetarians.

Versatile and Delicious

Satiating Snack: The combination of protein and fiber makes them a satisfying snack that can be enjoyed on the go.

Accompaniment: They pair well with dips like hummus or salsa or can be eaten on their own.

Materials and Methods:

Moong flour (Vigna radiata) and chickpea flour (Cicer arietinum) were used as the main raw materials. Other ingredients included condiments

Developing crackers using moong flour and chickpea flour therefore represents an innovative approach to creating healthier snack alternatives. Such formulations can meet consumer demand for convenient, edible oil, salt and water. All ingredients were procured from the local market and stored under dry conditions.

Requirements of raw materials -

1. Chickpea flour
2. Moog dal flour
3. Sunflower oil
4. Green chilli
5. Coriander
6. Turmeric powder
7. Pumpkin seeds
8. Sesame seeds
9. Dry onion garlic powder
10. Garlic
11. Chilli powder

Materials used:

1.Moong dal flour-

Prepared from cleaned, dehulled, and finely milled moong dal.

Rich in protein, dietary fiber, vitamins, and minerals.

Used to improve the nutritional value and digestibility of crackers.

2.Chickpea flour-

Obtained by grinding dried chickpeas into fine powder.

High in protein, essential amino acids, and resistant starch.

Contributes nutty flavour, texture, and nutritional enrichment

3. Edible oil-

Acts as a shortening agent to improve crispiness and mouthfeel.

Helps in reducing hardness of crackers.

4. Spices-

Green chilli, Garlic, Coriander, Chilli powder, Turmeric powder, Coriander powder. Dry onion garlic powder,

Spices add unique taste and aroma making crackers more appealing.

5.Fortification ingredients-

1.Seasame seeds-

Rich in protein, health fats, calcium, iron, magnesium and zinc.

Rich in dietary fibre for digestive health.

2. Pumpkin seeds-

High in plant protein, omega-3 fatty acids, vitamins E, and minerals (zinc, magnesium, phosphorus)

May help regulated blood sugar and provide satiety due to protein and fiber.

6. Water(distilled / filtered)-

Essential for dough formation and hydration of flour protein and starch.

7. Salt-

Enhance flavour and improve dough structure.

Preparation of flour dough:

Moong dal flour and chickpea flour were blended in different proportions (e.g. 50:50, 60:40, 70:30w/w) to obtain composite flour. The dry ingredients (flour blend, salt, and spices) were mixed uniformly, followed by incorporation of fat (oil/) into the mixture. Water was gradually added to form a firm and pliable dough. The dough was kneaded until smooth and allowed to rest for 10–15 minutes at room temperature under a moist cloth to ensure proper hydration and gluten-like network development. (Lee & Park, 2022).

Cracker preparation:

The crackers were prepared according to a standard procedure which included mixing of dry and liquid ingredients, resting of dough for 10 min, sheeting and laminating of dough, and cutting into circular shapes. The crackers were deep-fried in refined vegetable oil at 170–180 °C for 2–3 minutes until golden brown and crisp. The fried crackers were drained on absorbent paper and cooled to room temperature. (Smith et al., 2021).

Proximate composition:

Flour samples (moong dal and chickpea flours) and prepared crackers were analyzed for their moisture (gravimetric method), starch (Simsek et al., 2009), proteins (Kjeldahl method), fat (Soxhlet extraction), and ash content (Kaur et al., 2007). The pH of samples was determined with a pH meter using a 10% (w/v) suspension (Ibanoglu et al., 1999)

Determination of functional properties :

The functional properties of moong dal flour and chickpea flour, both individually and in composite blends, were evaluated using standard analytical procedures (Patel & Desai, 2023)

Bulk density - Determined by carefully weighing a known quantity of flour and transferring it into a graduated cylinder without tapping, and the ratio of sample weight to occupied volume was calculated.

Water absorption capacity (WAC) and oil absorption capacity (OAC)- Evaluated by dispersing 1 g of flour in 10 mL of distilled water or refined oil, respectively, followed by vortexing, standing, and centrifugation at 3000 × g for 15 min. The amount of water or oil retained in the sediment was recorded and expressed as grams of water or oil bound per gram of flour.

Swelling power and solubility- assessed by heating 0.5 g of flour in 10 mL of water at predetermined temperatures (60–90 °C) for 30 min, centrifuging, and measuring both the weight of sediment and the soluble solids in the supernatant; swelling power was calculated as the weight of hydrated sediment per gram of flour, while solubility was expressed as a percentage of dry matter leached into the supernatant.

Water solubility index (WSI) -Determined from the dried residue of the supernatant and expressed as a percentage of the initial dry weight.

Emulsifying capacity (EC) and emulsion stability (ES) -Determined by homogenizing a slurry of flour and water with oil at equal ratios, transferring to a measuring cylinder, and recording the volume of the emulsified layer immediately after homogenization and after heating or centrifugation; EC was expressed as the proportion of emulsified volume to total volume, while ES indicated the percentage of emulsion retained after treatment.

The sensory evaluation:

The crackers prepared from moong dal flour and chickpea flour was carried out to determine their consumer acceptability and to analyze how the substitution and blending of these two flours influenced the sensory characteristics of the final product. Sensory analysis is a critical component in the development of novel food products, as it helps to establish the suitability of a product for consumer preferences and provides insights into its market potential. For this study, a semi-trained panel consisting of 20 members was selected to evaluate the crackers. The panelists were instructed to judge the samples on the basis of appearance, color, texture, flavor, taste, aroma, and overall acceptability using a nine-point hedonic scale, where 9 denoted “like extremely and 1 represented dislike extremely. Crackers prepared from 100% moong dal flour, 100% chickpea flour, and different blend ratios (such as 70:30, 60:40, and 50:50) were subjected to sensory testing. This comparative evaluation provided an understanding of how the individual and combined functional properties of the two flours affected the sensory outcome.

The appearance and color of the crackers varied significantly depending on the flour composition. Crackers made from pure moong dal flour displayed a lighter golden color and smooth surface, which was appealing to many panelists. In contrast, chickpea flour crackers had a slightly darker shade due to the inherent pigments in chickpea and developed a more rustic appearance. The blended formulations showed intermediate color values, with the 70:30 moong dal to chickpea flour ratio producing the most uniform and attractive surface. Panelists indicated that visual appeal played a strong role in the overall perception of product quality, and the blended samples were generally rated higher for appearance than the single-flour formulations.Texture, which is a defining quality of crackers, also varied with flour composition. Moong dal flour crackers were rated as crispier and lighter due to the higher starch content and lower oil absorption during frying or baking. On the other hand, chickpea flour crackers exhibited a denser and harder texture, which some panelists found less appealing. However, when blended, the combination of moong dal and chickpea flour provided a balanced crispness with good bite and crunch. The 60:40 and 70:30 formulations, in particular, received favorable ratings for texture, as they retained the crispness of moong dal while incorporating the binding strength of chickpea flour. Flavor and aroma were other critical parameters that influenced consumer preference.

Crackers made solely from chickpea flour had a distinct nutty and earthy flavor, which was appreciated by some but found too strong by others. Moong dal flour crackers had a milder flavor, with a subtle beany note, which while pleasant, was considered less distinctive. Interestingly, the blended crackers exhibited the most balanced flavor profile, as the nuttiness of chickpea flour complemented the mildness of moong dal. The addition of spices and seasonings further enhanced the overall sensory perception, but the natural taste imparted by the flour blend was the dominant factor in acceptability.Taste evaluation followed a similar pattern. Panelists reported that crackers with 100% chickpea flour were slightly bitter after prolonged chewing, whereas moong dal flour crackers lacked depth of flavor despite their crispness. The blended samples again emerged as superior, as the proportions mitigated the negative aspects of each flour while

enhancing their positive attributes. The 70:30 ratio was particularly well-received, as it combined crispness, pleasant nutty notes, and overall balance. In terms of overall acceptability, the sensory scores indicated that blended flour crackers were preferred over single-flour crackers. The statistical analysis of mean scores revealed that the 70:30 moong dal to chickpea flour formulation achieved the highest overall acceptability, followed closely by the 60:40 blend. Pure moong dal flour crackers were rated moderately high due to their crispness and light appearance, while 100% chickpea flour crackers received lower scores because of their denser texture and slightly bitter aftertaste. Overall, the sensory evaluation demonstrated that blending moong dal flour with chickpea flour significantly improved the quality and consumer appeal of crackers. The complementary characteristics of the two flours resulted in products that were visually appealing, crisp in texture, and well-balanced in flavor and taste. These findings suggest that composite flour formulations not only enhance sensory acceptability but also provide an avenue for nutritional diversification and product innovation. Thus, crackers made from optimized proportions of moong dal and chickpea flour have the potential to be developed into a popular, nutritious, and sensory-pleasing snack suitable for a wide range of consumers.

Nutritional Analysis:

1.protein content-

lentils, chickpea flour, moong flour, and seeds contribute high plant-based protein

Helps in muscle growth and repair; makes crackers suitable as a protein-rich snack.

2.Carbohydrates -

Provide quick energy.

Balanced with dietary fiber from lentils and seeds, reducing glycemic index.

3.Dietary Fiber -

Present in lentils, chickpeas, and seeds.

Improves digestion, satiety, and supports gut health.

4.Fat Content-

From sunflower oil, sesame, and pumpkin seeds.

Rich in healthy unsaturated fats that support heart health.

5.Micronutrients-

Iron, magnesium, zinc, and B-vitamins from lentils and seeds.

Contribute to immunity and metabolic functions

6.Energy Value (Calories) –

Combination of protein, carbs, and fats provides sustained energy

Demand for Chickpea Flour Crackers:

1. Health-Conscious Consumers- Growing demand among fitness enthusiasts, diabetics, and weight-watchers for high-protein, low-calorie snacks.

2. Gluten-Free Market- Rising popularity of gluten-free foods has increased the demand for crackers made from moong dal and chickpea flour.

3. Plant-Based & Vegan Trend- Increasing preference for plant-based, vegan-friendly snacks boosts their demand worldwide.

4. Snack Industry Growth- Ready-to-eat, healthy snacks are in high demand due to busy lifestyles, making such crackers a preferred choice.

Process Of lentil crackers-

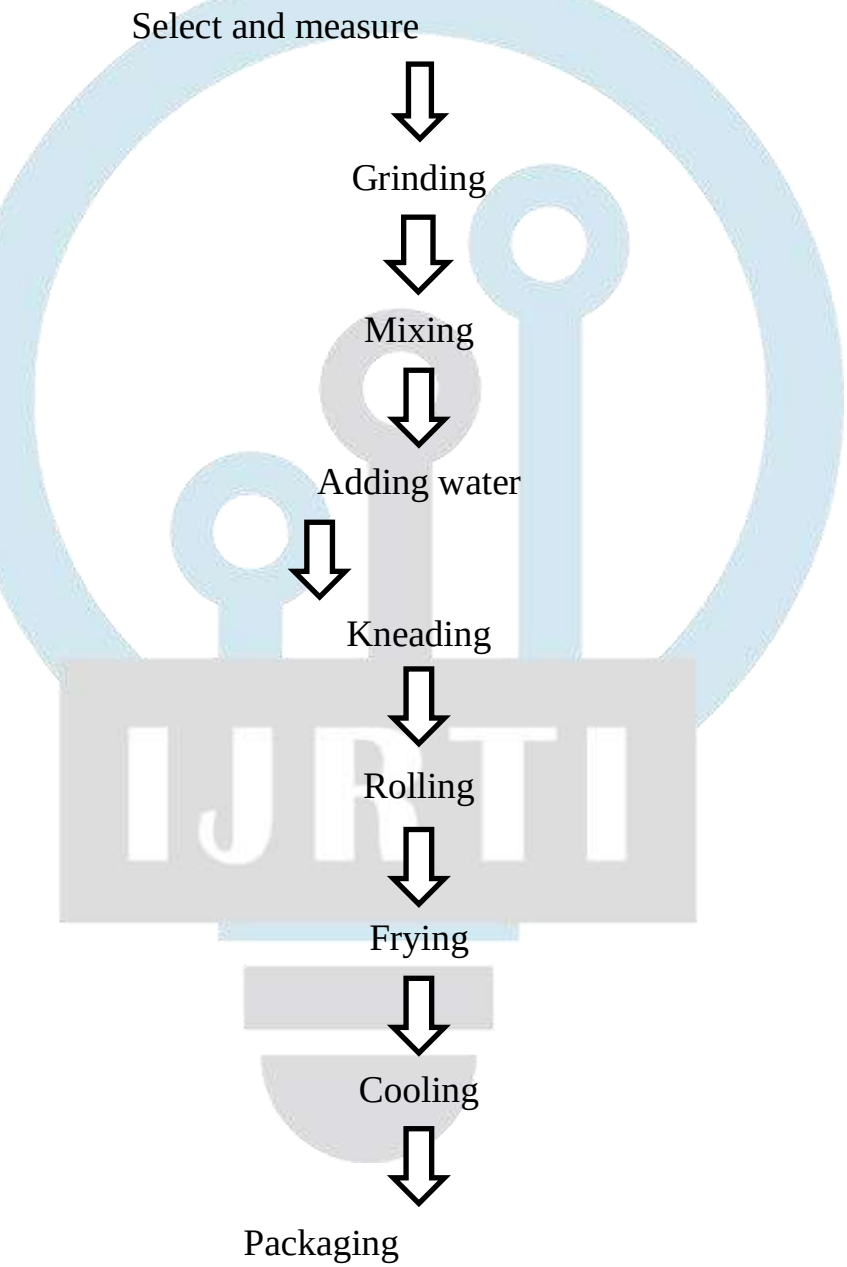


Fig: Lentil Crackers

Nutritional Enrichment:

Lentils provide significant amounts of protein, dietary fiber, and essential micronutrients, making them a valuable ingredient for health-conscious snack products.

Incorporating lentil flour into crackers can increase their crude protein, total phenolics, and flavonoid content, thereby enhancing their antioxidant properties and overall nutritional value. (smith et al.,2021)

Functional Food Development:

Researchers are developing "functional crackers" that go beyond basic nutrition, with studies exploring the use of germinated lentil extracts to increase antioxidant and bioactive compound levels.

The goal is to create snacks with potential health benefits, such as improved cardiovascular health or better diabetes management, as lentil consumption is linked to these positive effects.

Processing and Ingredient Effects:

Hull Content- The inclusion of lentil hull, a source of minerals, significantly affects the texture, color, and mineral content of baked lentil products.

Germination- Germination is a process used to enhance the nutritional quality of legumes, increasing their phenolic content, flavonoid levels, and antioxidant activity, making them more suitable for functional foods.

Lentil Variety- Different lentil varieties have varying protein and starch structures, leading to differences in the textural properties (e.g., hardness, cohesiveness) of the final cracker product.

Textural and Sensory Properties-

Using lentil flour can result in a harder texture compared to traditional crackers, which needs to be managed through formulation.

Research aims to balance the positive nutritional attributes with desirable sensory qualities, including taste, texture, and overall consumer acceptance, to ensure marketability.

Gluten-Free Applications-

Lentil flour serves as a promising gluten-free ingredient for bakery products, making it a valuable component in creating gluten-free crackers for individuals with celiac disease.

Results and Discussion:

Results of Nutritional analysis-

Nutritional composition of lentils crackers per 100gm (by using AOAC, 1980)

Sr . No	Parameters	Values
1	Calories	360kcal
2	Fat	3.2g
3	Sodium	800mg
4	Carbohydrates	54g
5	Protein	23g
6	Fiber	12g

Table : Nutritional Composition

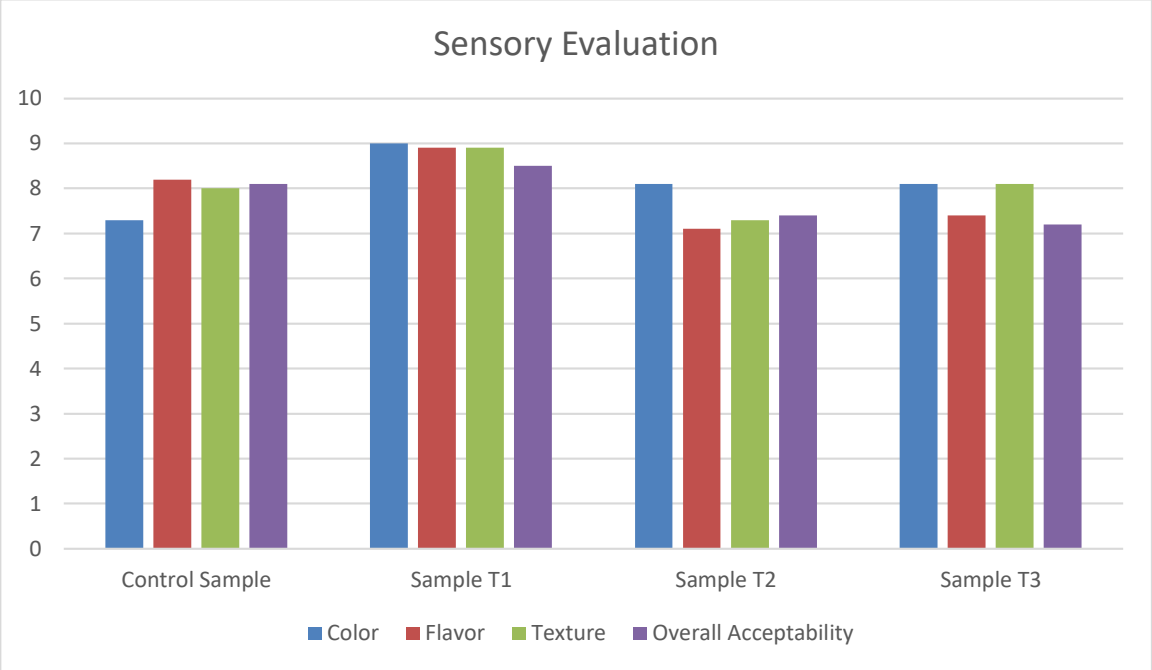
Sensory evaluation chart:

Results of sensory analysis-

Sample	Organoleptic Score				
	Color	**Flavor**	**Texture**	**Overall Acceptability**	**Remark**
A	7.3	8.2	8.0	8.1	Like moderately
B	9	8.9	8.9	8.5	Like very much
C	8.1	7.1	7.3	7.4	Like moderately
D	8.1	7.4	8.1	7.2	Like slightly

Table : Average of sensory evaluation chart

Sensory Evaluation -



Conclusion:

The present study on the development of crackers using moong dal flour and chickpea flour highlights the significant potential of incorporating pulse-based ingredients into traditional snack formulations. Crackers are widely consumed as convenient and light snacks, but their conventional versions, generally prepared with refined wheat flour, often lack balanced nutrition and sufficient protein content. By utilizing nutrient-rich legumes such as moong dal (Vigna radiata) and chickpea (Cicer arietinum), it is possible to improve both the nutritional composition and the functional qualities of the product. The formulated crackers demonstrated enhanced protein levels due to the high protein content of both moong dal and chickpea flour. In addition, the presence of complex carbohydrates, essential amino acids, and dietary fiber contributed to better nutritional balance compared to traditional crackers. These nutritional improvements make the product a promising alternative snack that can support the dietary protein needs of children, adolescents, and adults alike. Moreover, the inclusion of moong dal and chickpea flour not only enriched the crackers with macronutrients but also with micronutrients such as iron, magnesium, potassium, and B-vitamins, which are critical for metabolic and immune functions. In terms of functional properties, the combination of moong and chickpea flour improved dough handling, texture, and product expansion during preparation. The final crackers showed desirable crispiness, appealing color, and acceptable sensory attributes, indicating that the incorporation of these flours does not compromise product quality. Instead, it enhanced the overall acceptability, making them attractive for wider consumer acceptance. The blend ratio of moong dal and chickpea flour proved to be critical in balancing the textural and organoleptic properties, ensuring the product was both nutritious and palatable. From a health perspective, these crackers offer significant advantages. Moong dal is known for its easy digestibility and low glycemic index, making it suitable for diabetic and weight-conscious individuals. Chickpea flour, on the other hand, provides satiety, supports gut health due to its fiber content, and plays a role in lowering cholesterol levels. Together, the synergy of these two flours makes the crackers not only a

tasty snack but also a functional food with potential health benefits. The study also emphasizes the scope of such pulse-based snacks in addressing malnutrition and protein-energy deficiency, particularly in developing countries where affordability and accessibility are major concerns. Since moong dal and chickpea are locally available, cost-effective, and culturally acceptable, their utilization in cracker preparation represents a sustainable approach to food fortification and value addition. Additionally, their incorporation into snack products may encourage wider consumption of pulses among children and younger populations who often prefer convenient ready-to-eat foods

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