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DEVELOPMENT AND QUALITY EVALUATION OF CARROT CRACKERS

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***Abstract* – The present study focuses on the development and quality evaluation of nutrient-rich Carrot Crackers to enhance consumer convenience and dietary intake. The standard formulation (T0) comprised 60 g refined wheat flour and 20 g Bengal gram flour, with varying carrot content across samples. Physical properties such as color, texture, and appearance were assessed visually, while sensory evaluation revealed that the T2 sample received the highest scores for color, taste, texture, and overall acceptability. The product was packaged in high-density polyethylene (HDPE) and remained organoleptically acceptable for up to 20 days at room temperature. A techno-economic feasibility analysis indicated that the production cost of Carrot Crackers is low, including raw materials and processing costs, making it a profitable alternative to commercially available crackers. The study concludes that carrot incorporation can enhance the nutritional and sensory attributes of crackers while ensuring economic viability.**

***Keywords* – Carrot Crackers, Nutrient rich, Sensory evaluation, Attributes, Economic**

I. INTRODUCTION

Traditional Indian snacks play an essential role in driving nutritional innovation, especially with the growing consumer preference for health-oriented foods. Take Chavala Phalli, for instance, a popular Gujarati snack typically made during the Diwali festival. This deep-fried, puffed cracker-like treat is usually crafted from gram flour (Cicer arietinum) and refined wheat flour (Triticum aestivum), making it not only tasty but culturally significant. As the interest in healthier modifications of traditional foods rises, adding nutrient-rich vegetables like carrots into these snacks has become increasingly popular.

Carrots (Daucus carota subsp. sativus), with their vast agricultural diversity and nutritional benefits, stand out as a top choice. Known for their high levels of carotenoids (like β-carotene and α-carotene), dietary fiber, and phenolic compounds, carrots offer antioxidant, anti-inflammatory, and even anticarcinogenic effects (Kumar et al., 2011; Bjarnadottir, 2008). They help combat oxidative stress, lower the risk of chronic diseases such as cardiovascular illnesses, and can alleviate issues like night blindness because of their vitamin A content. The various phytochemicals in carrots, including isoprenoid carotenoids and phenolics produced through specific metabolic pathways, contribute significantly to these health benefits.

On the other hand, refined wheat flour is widely used for its baking qualities but falls short in nutrition. Composed mainly of the endosperm, it's high in gluten proteins (approximately 13.2%), carbohydrates (about 72%), and offers moderate fiber (roughly 10.7 g/100 g), along with essential B vitamins and minerals (Arnarson, 2019). However, its high glycemic index and lack of bioactive compounds compared to whole grain options highlight the need to diversify ingredients, incorporating legumes and vegetables.

With consumers increasingly looking for nutritious snacks with functional advantages, this study aims to create a carrot-fortified version of Chavala Phalli. By using dehydrated carrot powder in the flour base, the goal is to enhance the snack's antioxidant properties, fiber, and micronutrient levels while preserving its taste and shelf life. To achieve this, a thorough analysis of the raw materials will be conducted, focusing on their proximate composition, functional properties, and flow behavior to standardize the formulation. Previous studies have shown that including vegetable and legume flours in cereal-based snacks can improve fiber content and lower glycemic indices, all without sacrificing consumer appeal (H.M.T. Herath et al., 2018; Singh et al., 2017).

Ultimately, this investigation aims to connect traditional cooking methods with modern nutritional science, resulting in a functional, carrot-enriched cracker. The intent is to not only refine the recipe for taste and longevity but also to highlight the importance of indigenous snacks in promoting better public health nutrition.

II. MATERIAL AND METHODS

The present research work entitled **"Preparation of Carrot Crackers"** was conducted in the Department of Food Technology, Ballarpur Institute of Technology, Ballarpur in the Chandrapur District , Maharashtra, India. This chapter outlines the materials used and the methodologies adopted, structured under appropriate headings and subheadings.

2.1 Materials

Procurement of Materials for Carrot Crackers The following raw materials were procured from the local markets of Ballarpur and Chandrapur.

a) Carrot: Used to enhance the nutritional value of crackers. Carrots are rich in antioxidants, beta-carotene, anthocyanins, and vitamins.
b) Refined Wheat Flour: A primary source of carbohydrates, it contributes to the texture and crispiness of crackers.
c) Bengal Gram Flour (Besan): Known for its high protein, fiber, and folic acid content. It aids in improving the nutritional profile.
d) Salt: Used for taste enhancement.

2.2 Equipment

The equipment used in the preparation of carrot crackers included a mixer grinder for blending ingredients and grinding carrots to a fine consistency, and a dough kneader to ensure uniform mixing and proper dough development. A rolling board and pin were used to flatten the dough evenly, while a cutter helped shape the crackers uniformly. Frying was done using a deep fryer maintained at a consistent temperature, monitored using a thermometer. A weighing balance was used to accurately measure ingredients, and a deep freezer was utilized to store raw or finished samples when required during the process. This combination of equipment ensured precision, consistency, and quality in the preparation of carrot crackers.

2.3 Utensils

Common kitchen utensils were utilized throughout the preparation of carrot crackers to facilitate various processing steps. A gas stove was used as the primary heat source for frying, while frying pans served for holding and cooking the dough portions. Mixing bowls were employed to combine and prepare the dough ingredients, ensuring uniform mixing. Measuring cups and spoons were used for accurate measurement of ingredients to maintain consistency in formulations. Plates and spatulas aided in handling, transferring, and arranging the crackers during preparation and post-frying stages. These basic kitchen tools played a crucial role in supporting the overall workflow efficiently.

Table I: Variation in Refined Wheat Flour (with Constant Bengal Gram Flour 20 gm)

Sample	*Refined Wheat Flour (gm)*	*Bengal Gram Flour (gm)*
Sample A	75	20
Sample B	70	20
Sample C	65	20
Sample D	60	20
Control Sample	80	20

2.4 Packaging Materials

High-Density Polyethylene (HDPE) pouches were used for packaging the finished product. These materials were procured from the local market in Ballarpur.

2.5. Optimization of Ingredients

The study involved the optimization of two main ingredients—**refined wheat flour** and **carrot powder**—while keeping the quantity of **Bengal gram flour** constant (20 gm) in all formulations.

2.5.1 Optimization of Refined Wheat Flour

Five samples were prepared by varying the quantity of refined wheat flour (60–80 gm), as shown below:

2.5.2 Optimization of Carrot Powder

After selecting the optimal quantity of refined wheat flour (70 gm), five more samples were prepared by varying the amount of carrot powder:

Table II: Variation in Carrot Powder (Refined Wheat Flour 70 gm, Bengal Gram Flour 20 gm)

Sample	*Refined Wheat Flour (gm)*	*Bengal Gram Flour (gm)*	*Carrot Powder (gm)*
Sample A	70	20	5
Sample B	70	20	10
Sample C	70	20	15
Sample D	70	20	20
Control Sample	80	20	0

2.6. Preparation of Carrot Crackers

The preparation process followed the standardized method with slight modifications from Yang (1985). The process is depicted in the flow chart and described below.

Flow Chart for Preparation of Carrot Crackers

Selection of carrots
↓
Washing
↓
Peeling
↓
Cutting into pieces
↓
Grinding
↓
Mixing with refined wheat flour, Bengal gram flour, spices, salt
↓
Addition of water and oil
↓
Dough kneading
↓
Rolling and cutting into shapes
↓
Frying at 160–180°C
↓
Cooling
↓
Packaging in HDPE pouches

2.7. Procedure

1. Select fresh carrots. Wash, peel, and cut into small pieces.
2. Grind the carrots to a fine paste.
3. Prepare a dry mix of refined wheat flour, Bengal gram flour, onion powder, coriander powder, and salt.
4. Add the carrot paste to the dry mix and knead into a dough using water and oil.
5. Roll out the dough into thin sheets and cut into desired shapes.
6. Fry the shaped dough at 160–180°C until golden and crisp.
7. Allow the fried crackers to cool at room temperature.
8. Package the cooled crackers in HDPE pouches for storage and further analysis.

Table III: Final formulation

Sr. No.	Ingredient	Quantity (gm)
1	Refined Wheat Flour	70
2	Bengal Gram Flour	20
3	Carrot Powder	10
4	Onion Powder	5
5	Coriander Powder	5
6	Salt	5

The formulation of carrot crackers was carried out by combining specific proportions of refined wheat flour, Bengal gram flour, carrot powder, and selected spices. The standardized formulation included 70 grams of refined wheat flour, which provided the base texture and structure to the crackers. To enhance the protein and fiber content, 20 grams of Bengal gram flour was incorporated. Additionally, 10 grams of carrot powder was added to enrich the product with natural antioxidants and beta-carotene. A spice mix comprising 5 grams each of onion powder, coriander powder, and salt was used to impart flavor and palatability to the final product. This formulation aimed to balance nutritional value with sensory appeal.

III. RESULT AND DISCUSSION

The proximate composition of the raw materials used in cracker formulation reveals significant nutritional variations. Bengal gram flour had the highest protein content at 22.50%, making it a valuable source of plant-based protein. In contrast, carrot powder, although relatively low in protein (5.50%), contributed significantly to the product's fiber, vitamin A, and antioxidant content. Moisture content was highest in refined wheat flour (14.00%), indicating its susceptibility to microbial spoilage if not stored properly. Carrot powder, with only 4.20% moisture, enhances shelf stability. The ash content, a measure of total mineral content, was most prominent in refined wheat flour (2.00%), while carrot powder had the lowest ash value (0.0083%), possibly due to its low inorganic residue.

Among the formulations tested, the control sample consistently scored high across all sensory parameters, especially in taste and overall acceptability (score: 8). Sample T2 closely matched the control in color, texture, and appearance, suggesting that a moderate inclusion level of alternative ingredients can maintain sensory quality. However, T3, despite acceptable taste and texture, scored lower in flavor and appearance, indicating that higher substitution levels might negatively influence product desirability. T1 was penalized for texture and appearance, possibly due to suboptimal ingredient integration or lack of structural crispness.

Table IV: Nutritional analysis of raw material

Parameter	Refined Wheat Flour	Bengal Gram Flour	Carrot Powder
Moisture (%)	14.00	11.00	4.20
Ash (%)	2.00	0.41	0.0083
Fat (%)	2.50	5.20	1.60
Protein (%)	13.00	22.50	5.50

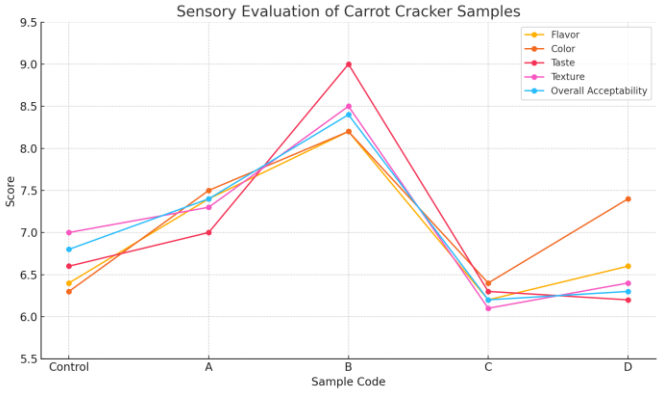
Crackers enriched with varying levels of carrot powder displayed distinct sensory profiles. Sample B, containing 10g of carrot powder, achieved the highest overall acceptability (8.4) and outperformed the control in all attributes, especially taste (9) and texture (8.5). This indicates an optimal balance between nutrition and palatability at moderate carrot powder inclusion. Sample A also showed improvement over the control, while higher levels of carrot powder (Samples C and D) resulted in a notable decline in all sensory scores, likely due to the overpowering flavor or textural imbalance introduced by excessive carrot content. These findings suggest that 10g carrot powder is the ideal level for enhancing both nutritional and sensory quality.

The final optimized carrot cracker formulation (presumably Sample B) demonstrated a moisture content of 8.60%, indicating satisfactory shelf stability. The ash content (1.90%) reflects a moderate mineral presence. A significant increase in fat content (19.00%) may be attributed to the inherent oil content of Bengal gram flour or added fats during processing, contributing to better mouthfeel. The protein level at 7.60% confirms the nutritional enhancement, largely supported by Bengal gram flour and carrot powder. Collectively, the final product presents a balanced nutritional profile with appealing sensory attributes, ideal for health-conscious consumers.

Table V: Sensory attributes of carrot crackers

Sample	Flavor	Color	Taste	Texture	Overall Acceptability

Control	6.4	6.3	6.6	7	6.8
A	7.4	7.5	7	7.3	7.4
B	8.2	8.2	9	8.5	8.4
C	6.2	6.4	6.3	6.1	6.2
D	6.6	7.4	6.2	6.4	6.3



The analyzed sample exhibits a composition of **8.60% moisture**, **1.90% ash**, **19.00% fat**, and **7.60% protein**, each reported with low standard deviations (SD) indicating high measurement precision (± 0.03%, ± 0.02%, ± 0.05%, and ± 0.04%, respectively). The relatively high fat content (19.00%) suggests the sample is lipid-rich, while the moderate protein (7.60%) and low ash (1.90%) levels reflect its organic and mineral composition. The moisture content (8.60%) is typical for semi-dry or processed materials. Together, these components account for **37.10%** of the sample, implying the remaining **~62.90%** likely consists of carbohydrates (e.g., fiber, starches) or other unmeasured constituents. Such data are useful for nutritional evaluation, quality control, or product development in food science and agriculture.

Table VI: Nutritional analysis of carrot crackers.

CHARACTERISTIC	VALUE (%) ± SD
MOISTURE	**8.60 ± 0.03**
ASH	**1.90 ± 0.02**
FAT	**19.00 ± 0.05**
PROTEIN	**7.60 ± 0.04**

The cost estimation for the production of carrot-based crackers was conducted using standard economic evaluation procedures.

Table VII: Cost Estimation of Carrot Crackers (for 1 Kg)

Ingredient	Quantity (gm)	Cost (Rs)	Cost (Rs/Kg)
Refined wheat flour	420	18.48	44
Bengal gram flour	140	5.60	40
Carrot	300	24.00	80
Onion powder	30	4.50	150
Salt	30	0.60	20

The formulation used a total of 1500 grams of raw ingredients, yielding approximately 743 grams of final product, which equates to a product yield of 49.53%. The cost of raw ingredients amounted to Rs 115.00, and the utility cost, calculated at 20% of raw materials, was Rs 23.08.

The total production cost including packaging (Rs 5.00/kg) and labelling (Rs 20.00/kg) was Rs 211.08. The calculated cost of the product per kilogram was Rs 186.00. Upon pricing the crackers at Rs 250.00 per kilogram, a net profit of Rs 38.92 was achieved, reflecting a profit margin of approximately 15.57%. These findings suggest that carrot crackers offer a reasonably economical and profitable value-added product with potential for commercialization, especially in the functional snack segment.

IV. CONCLUSION

The development and standardization of carrot-based crackers were successfully accomplished using carrot, refined wheat flour, Bengal gram flour, and other complementary ingredients. The inclusion of carrot not only enriched the product with nutritional benefits—particularly in terms of protein, fat, and energy content—but also contributed positively to its sensory appeal. Among the tested formulations, the sample containing 10g of carrot powder (Sample B) achieved the highest overall acceptability, demonstrating an ideal balance between nutrition and palatability. Nutritional analysis confirmed the product's health benefits, with satisfactory levels of moisture (8.60%), fat (19.00%), protein (7.60%), and ash (1.90%), all measured with high precision.

Moreover, the cost analysis revealed the product to be economically viable, with a production cost of Rs 211.08/kg and a potential selling price of Rs 250/kg, yielding a profit margin of approximately 15.57%. With a product yield of 49.53%, these carrot crackers represent a promising functional snack that caters to both health-conscious consumers and the growing demand for value-added, nutrient-enriched food products. The study underscores the potential for commercial-scale production.

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