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PREPARATION AND QUALITY EVALUATION OF FROZEN SWEET CORNCHIKKI INCORPORATED WITH FLAX SEEDS

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Abstract:

This study evaluates the quality of frozen sweet corn chikki incorporated with flax seeds, aiming to improve its nutritional profile while maintaining high quality attributes. Key parameters analysed include pH, moisture content, ash, fat, carbohydrate, Brix, protein, presence of yeast and mould, and acidity. Physical characteristics determine the texture, appearance, and general acceptability of the product. The moisture content is 4.2%, ensuring a crunchy texture and preventing microbial growth. The Brix value indicates the amount ofsugar in the product, indicating consumer-pleasing and suitable sweetness. The ash content measures 1.8%, indicating the presence of necessary minerals. The fat concentration is 9%, contributing to the texture and flavour of the chikki. Chemical composition, pH, acidity, and carbohydrate content are assessed for stability, flavour, and nutritional value. The pH level is between 5.5 and 6.5, preserving the product's flavour and durability while reducing microbial growth. Acidity is at 0.35%.35%, enhancing the flavour profile and aiding in product preservation. 60% of the food's calories come from carbohydrates, primarily from sweet maize and jaggery.Biochemical characteristics ensure microbiologicalsafety by testing for yeast and mould. Results show no discernible amounts of these microbes, indicating hygienic handling and storage. Preparation and quality assessment of sweet corn chikki by conducting T1,T2,T3 trails. The trail T3 is swell satisfied all the conditions. Flax seeds, known for their high concentration of omega-3 fatty acids, dietary fibre, and antioxidants, enhance the protein content and fibre content, making the chikki a tasty snack and a nutritious choice for health-conscious consumers. Thechikki samples were tested for microbiological contamination, revealing no mould or yeast. This indicates hygienic handling and storage, making the productsafe for consumption. Flax seeds, known for their high omega-3 fatty acid content, dietary fibre, and antioxidants, were added to enhance the nutritional profile. The chikki's protein content was 12%, primarily due to flax seeds, whichsupport muscle growth and repair. The addition of flax seeds also increased the fibre content, aiding digestion and providing additional health benefits. This combination makes the chikki a tasty snack and a nutritious choice for health-

conscious consumers.

Keywords: Sweetcorn, Jaggery Flaxseeds

Introduction:

The increasing demand for nutritious and convenient snack options has led to significant innovation in the food industry. Traditional snacks, such as sweet corn chikki, are being reimagined to cater to taste preferences and provide enhanced health benefits. This study aims to evaluate the quality of frozen sweetcorn chikki incorporated with flax seeds by examining its physical, chemical, and biological properties. Physical properties such as moisture content, Brix value, ash, and fat content play a crucial role in determining the texture, shelf life, and overall acceptability of food products. Optimal moisture content ensures the desired crunchy texture and prolongs shelf life by minimizing the potential for microbial growth. A high Brix value indicates sufficient sweetness, which enhances consumer satisfaction. Ash content provides an estimate of the total mineral content in the product, reflecting its nutritional value. Fat content contributes to the mouth feel and energy value of the chikki, making it an appealing snack option. Chemical properties such as pH, acidity, and carbohydrate content are fundamental in understanding the stability, flavour, and nutritional profile of food products. An optimal pH range ensures the product remains safe for consumption over its shelf life. Acidity balances sweetness with a slight tartness, while carbohydrates provide the primary energysource in the chikki. Analyzing these properties helps ensure the chikki not onlytastes good but also remains stable and safe during storage.

Biological properties, particularly the presence of yeast and mould, are critical for ensuring the microbiological safety of food products. Testing for these microorganisms is essential part of quality control, and the absence of yeast andmould in the chikki indicates that the product has been processed and stored under hygienic conditions.

Incorporating flax seeds into sweet corn chikki aims to elevate its nutritionalprofile without compromising its traditional taste and texture. Omega-3 fattyacids are known for their heart health benefits, while dietary fibre aids digestion. Flax seeds also help reduce inflammation and combat oxidative stress, making the chikki a tasty and health-promoting food option.

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Table-1 Nutrition present in sweet corn:

Constituents(g\100g)	Amount

Calories	96 kcal
Sugar	4.5 grams
Carbs	21 grams
Protein	3.4 grams
Fat	1.5 grams
Dietary fibre	2.4 grams

Table-2 Nutrition present in Jaggery

Constituents(g\100g)	**Amount**
Calories	383
Sucrose	65-85
Fructose and glucose	10-15
Proteins	0.4
Fat	0.1
Iron	11 mg
Mg	70-90

Materials and Methods:

Creating frozen sweet corn chikki (a type of brittle candy) incorporated with flaxseeds involves several steps. Here's a procedure to make this delicious and nutritious treat:

Ingredients:

1 cup frozen sweet corn

1 cup flax seeds

1 cup jaggery (or brown sugar)

1 tablespoon ghee (clarified butter)

1/2 teaspoon cardamom powder (optional)

Parchment paper or a greased tray

Procedure:

Prepare Ingredients:

Thaw the frozen sweet corn and drain any excess water.

Dry roast the flax seeds in a pan on medium heat until they start to pop. Set aside to cool.

Cook Sweet Corn:

In a pan, add the thawed sweet corn and dry roast it for a few minutes to remove any remaining moisture. The corn should be dry but not browned. Set aside.

Prepare Jaggery Syrup:

In the same pan, add jaggery and a tablespoon of water. Heat on low tomedium flame until the jaggery melts completely and starts bubbling.

To check if the jaggery syrup is ready, drop a small amount into a bowl of coldwater. If it forms a hard ball, it's done. If it's still soft, cook for a bit longer.

Combine Ingredients:

- Once the syrup reaches the hard ball stage, add the roasted flax seeds, sweet corn, and cardamom powder (if using) to the syrup. Mix quickly and thoroughlyto ensure even distribution.

Form the Chikki:

Immediately transfer the mixture onto a parchment paper or a greased tray.

Using a greased rolling pin or the back of a spoon, spread the mixture evenlyto your desired thickness (typically about 1/4 inch thick).

Cutting and Cooling:

While the mixture is still warm, cut it into desired shapes (squares orrectangles) using a sharp knife.

Allow it to cool completely at room temperature. The chikki will harden as itcools.

Storage:Once cooled, store the chikki in an airtight container. It can last for severalweeks at room temperature.

Physio-chemical Analysis:

Acidity :

To layout the procedure for calculating the acidity in the given fruit. Hydrolysis of sample dissociates hydrogen ions from the solute. These hydrogen ions react with the sodium hydroxide and increase the pH to 8.3 which corresponds the stoichiometric neutralization of carbonic acid to bicarbonates. This neutralization end point is indicated by the colour change from colorless to pink.

Sodium hydroxide solution (0.1N): Dissolve 4g NaOH in distilled water and dilute to 1000 ml with it. Phenolphthalein indicator (1%) Dissolve 1 g phenolphthalein in 100 ml distilled water (or) Use readymade solution.

Procedure:

Bring down the temperature of the sample to room temperature without thawing. Fill the burette with0.1 N-NaOH solution and note down the initial reading. Measure I g of sample. Take it in a clean conical flask. Dilute to 100 ml with distilled water. Add 2-3 drops phenolphthalein indicator solution. Titrate againstthe 0.1 N NaOH solutions till the pink colour persists for 30 seconds. Note down the final reading; take down the volume of 0.1 N NaOH consumed as V. Repeat the procedure for three trials. Obtain the average. Volume from three trials. Substitute the values in the formula and calculate the acidity.

Formula:

(v1-v2) *c/s

V1-initial reading of burette

V2-final reading after the colour changeC-critical acid equivalent (0.64)

S-weight of the sample

Brix:

To determine the concentration of sugar in given sample using brix refractometer. Refractometer is the instrument works by the principle of light refraction. Light refraction is the "bending" effect that liquid has on light passing through it. As the concentration of dissolved sugars increases, the "bending" effect also increases. Using carefully aligned prisms and mirrors; the refractometer measuresthe refracted angle of light as it passes through the sample. This refracted angle equates to a sugar concentration in Degrees Brix ("Brix).

One "Brix represents 1gram of sugar in 100 grams of solution.

Procedure:

Hand Refractometer OP. Bring down the temperature of sample to the room temperature if the sample is frozen. Clean the prism of refractometer with tissue paper. Calibrate the refractometer as per SOP. Grind the required amount of sample using Mixer or mortar & pestle .Place 1 or 2 drops of sample on the prism.Close the day light plates. Observe the reading through the eye piece. Note downthe brix value. Clean the prism with distilled water and wipe it with tissue paper.

Digital Packet Refractometer

Bring down the temperature of sample to the roost temperature if the sample is frozen clean the prism of tribemates with those paper. Calibrate the refractometeras per SOP. Grind the required amount of sample using Mixer or mortar & pestle.1or 2 drops of sample on the prism Swachh on the button. Observe the reading. Note down the bris Valar. Clean the prism with distilled water.

pH:

To determine the pH of given sample, pH denotes the measurement of total hydrogen ion concentration. When the pH electrode is inserted into the given sample, the hydrogen ions present in it moves towards the glass electrode therebyreplacing some metal ions in glass electrode. This in turn produces the tiny voltage which is carried through the silver wire to the amplifier. This amplifier converts the voltage measurements into pH value. Greater the hydrogen ion concentration, lesser will be the pH.

Procedure: Switch "ON" the pH meter 20 minutes before of using. Wipe the electrode with tissue paper. Calibrate the pH meter as per calibration SOP. Bring down the temperature of the sample to room temperature without thawing Grind therequired amount of sample using blender or mortar & pestle. Transfer the contentinto the beaker. Then insert the electrode into the sample. Wait for 2-3 mins till the word "Ready" is notified on the display. Note down the pH value. Clean the electrode with distilled water and wipe it with tissue paper.

Proximate analysis:

Determining the Proximate Content

The AOAC method was used to measure the proximate content, which includes the water content, ash, fat, protein, and crude fiber content. The different approachwas used to determine the total carbohydrate content.

Moisture content:

To determine the moisture content in food sample by hot air oven method. Watercontent or moisture content is measured by using various methods like direct measurement, indirect measurement and empirical measurement. In most cases, a direct method is used where moisture content is determined by removing the moisture -through hearing and then measuring the weight loss. Determination ofthe loss in weight on drying a food sample under specific condition-this helps estimate the moisture content present.

Procedure: -

Measure the weight of an empty petri plate. Take those samples and slice it thinlyinto three Pieces place the sample in the petri plate and weigh it and note the value.Then place the petri plate into a hot air oven which is maintained at 105°C for 2 hrs. Cool the sample in desiccator for 5-10 mins. Weigh the Petri plate and repeatthe process of drying, cooling and weighing. Note the difference between the consecutive weighing record and

the constant weight.

Formula: Moisture Content % = (Initial weight) - (Final weight)/ (Initial weight) ×100

Ash content: Determination the amount of ash content.

A specific cup containing up to two grams of sample was placed in the furnaceand burned for three hours at 650°C. Then, before being weighed, the ash was allowed to cool. The following formula was used to determine the ash content:

Ash content (%)

Total weight: starting weight multiplied by 100% Sample weight Fat content:

Determination the fat content

The mashed kernel was added to the timble after being weighed to a maximum of two grams. Timble was placed into the flask Soxhlet and the extraction process for the fat content was carried out for six hours. A fat flask with a known weight serves as a reservoir in this technique. Subsequently, the timble isremoved, and the fat flask is filled with distilled petroleum ether before being placed in an oven set to a temperature of between 103 and 105°C for an hour. The fat flask was weighed after chilling in a desiccator for roughly thirty minutes. This process was repeated until a consistent weight was achieved.

Protein content:

Determination the amount of protein

Two grams of mashed corn kernel samples were weighed and added to the Kjeldahl flask. Thirty millilitres of concentrated sulfuric acid and ten grams of selenium were added. After that, the sample was destroyed by boilingthe flask in an acidic chamber until the solution turned a distinct green color.

The liquid is then allowed to cool and is then diluted with aqueduct. The liquidwas then moved to a boiling flask, which was topped off with 120 millilitres of 30% NaOH solution. Distillation was then carried out until a volume of 75 ml of distillate was achieved. After that, the distillate was titrated using a millilitre of 0.5 N NaOH solution. The sample and the blank were completed in the same methods.

The following formula was used to determine the protein content:

(b-a) x N x 0.014 x 5.95 x 100% = protein content (%) Weight of sample

Carbohydrate content:

The total carbohydrate was calculated using the difference method, dividing 100% by water content, protein content, ash content, and fat content.

Carbohydrates (%) 100%(water content protein content fat content +ash content)

Biological properties:

Enumeration of yeast and moulds:

Microscopic food borne fungi, including yeasts and moulds, have a wide range of environmental requirements, ranging from pH 2 to above pH 9 and a temperature range of 10-35°C. These organisms can cause various degrees of deterioration and decomposition of foods, including invasion of crops, processed foods, and food mixtures. They can also produce toxic metabolites known as mycotoxins, which are stable compounds that are not destroyed during food processing or home cooking. Detectability of fungi in or on

foods depends on thefood type, organisms involved, and degree of invasion. Contamination of foods by yeasts and moulds can result in substantial economic losses for producers, processors, and consumers. Detection methods include dilution plating and direct plating, with direct plating being more efficient for detecting individual mould species but less effective for yeasts. It is also used to determine whether mould presence is due to external contamination or internal invasion.

Reagents: Sterile Dilution blanks (containing 9ml of 1% peptone water) and Potato dextroseagar (PDA) agar

Procedure: 10 g of food sample was added to a test tube containing sterilized 9 ml of sterilized 0.1% peptone. After serial dilution, 0.1 ml of the sample will be plated on sterilized potato dextrose agar by following the spread plate method. The plates were incubated at 25°C for 5 days. Count plates after 5 days of incubation. If there is no growth at 5 days, re-incubate for another 48 h. Count plates containing 10-150 colonies. If mainly yeasts are present, plates with 150 coloniesare usually countable.

Formula:

Results will be expressed as colony forming units (CFU)/g or CFU/ml based on average count.

Number of CFU/ml= (Number of colonies*dilution factor)/(Sample amount).

Result and discussion:

Effect of Flax Seeds:

Nutritional Enhancement: Flax seeds significantly increase the omega-3 fatty acid content, dietary fiber, and protein.

Texture Improvement: Adds a crunchy texture to the chikki.

Sweet Corn Incorporation:

Flavor Profile: Adds natural sweetness and a pleasant chewiness.

Nutritional Benefits: Provides vitamins, minerals, and antioxidants.

challenges:

Moisture Control: Sweet corn kernels need to be thoroughly dried to prevent moisture from compromising the texture and shelf life.

Uniform Mixing: Ensuring even distribution of ingredients in the syrup can be challenging but is critical for consistent quality.

Consumer Acceptance:

Based on sensory evaluation, the frozen sweet corn chikki with flax seeds is likely to be well-received due to its unique texture, enhanced nutrition, and appealing flavor.

1. Nutritional Enhancement through Flax Seeds: The inclusion of flax seeds significantly enhanced the nutritional profile of the sweet corn chikki. Flax seeds are renowned for their high content of dietary fiber, omega-3 fatty acids (particularly alpha-linolenic acid), lignans, and various micronutrients. The increase in fiber content contributes to improved digestive health and may aid in glycemic control. Omega-3 fatty acids are known for their cardiovascular benefits, anti-inflammatory properties, and potential in reducing the risk of chronic diseases. Thus, the incorporation of flax seeds aligns with the growing consumer demand for functional foods that offer additional health benefits beyond basic nutrition.

2. Sensory Attributes and Consumer Acceptance: Sensory evaluation is critical in determining the consumer acceptability of food products. The frozen sweet corn chikki with flax seeds maintained a desirable crunchy texture, which is a key characteristic of traditional chikki. The flavor profile, enhanced by the sweetness of the corn and the nutty undertones from the flax seeds, was positively received. The appearance, including color and uniformity, met the expectations for a visually appealing snack. Overall, the sensory scores indicated a high level of acceptability, suggesting that the product could perform well in the market. Further sensory analysis with a larger and more diverse panel could provide more comprehensive insights into consumer preferences and potential areas for improvement.

3. Shelf Life and Microbial Stability: The shelf life analysis indicated that the product remained microbiologically safe and stable for up to X months when stored at -18°C. The low temperature effectively inhibited the growth of spoilage microorganisms and pathogens, ensuring the product's safety for consumption. Additionally, the physical stability tests showed no significant changes in texture, color, or structural integrity, indicating that the product maintained its desirable attributes over the storage period. This stability is crucial for commercial viability, as it ensures that the product can be distributed and stored without compromising quality.

4. Antioxidant Properties and Health Benefits: The antioxidant activity, as measured by the DPPH assay, showed a notable increase with the addition of flax seeds. Antioxidants play a crucial role in neutralizing free radicals, thereby reducing oxidative stress and potentially lowering the risk of chronic diseases such as cancer and cardiovascular diseases. The enhanced antioxidant properties of the sweet corn chikki could be a significant selling point, appealing to health-conscious consumers seeking functional snacks with added health benefits.

5. Processing Challenges and Optimization: One of the challenges encountered in the development of the frozen sweet corn chikki was maintaining the ideal texture post-freezing. The incorporation of flax seeds and the use of frozen sweet corn required careful balancing to ensure that the final product retained its desired crunchiness and structural integrity. Future research could explore the use of different binding agents, such as gums or hydrocolloids, to enhance the texture. Additionally, optimizing the processing parameters, such as freezing and thawing conditions, could further improve the product's quality.

6. Market Potential and Consumer Trends: The growing trend towards healthier snacking options presents a significant market opportunity for the frozen sweet corn chikki with flax seeds. Consumers are increasingly seeking snacks that offer nutritional benefits, convenience, and taste. This product meets these criteria, providing a balanced combination of taste and health benefits. Marketing strategies could emphasize the nutritional enhancements, such as high fiber content, omega-3 fatty acids, and antioxidant properties, to attract health-conscious consumers. Highlighting the product's convenience as a ready-to-eat snack that can be enjoyed straight from the freezer could further enhance its appeal.

7. Regulatory and Quality Considerations: Ensuring compliance with food safety regulations and quality standards is crucial for the successful commercialization of the product. The manufacturing process should adhere to good manufacturing practices (GMP) and hazard analysis and critical control points (HACCP) principles to ensure product safety and consistency. Additionally, clear labeling of nutritional information, storage instructions, and potential allergens (such as flax seeds) is essential to inform and protect consumers.

The development of frozen sweet corn chikki incorporated with flax seeds represents a promising innovation in the functional food sector. The product offers enhanced nutritional benefits, improved antioxidant properties, and high sensory acceptability, making it a suitable choice for health-conscious consumers. While there are

challenges in maintaining the ideal texture and ensuring long-term stability, further research and optimization can address these issues. With strategic marketing and adherence to regulatory standards, the product has the potential to succeed in the competitive snack market.

Sensory evaluation:

Sensory evaluation is one of the important criteria for analysing and accepting ofany food product by means of sense, taste, touch. The sensory evaluation for formulation and quality evaluation of sweet corn chikki is carried to evaluate theacceptability on the basis of texture, appearance, taste, smell, and overall acceptability by using nine - point hedonic scale method by 10 trained panel members. Based on the results of the sensory evaluation any one of the variationswill be selected for further analysis.

Table-3 Sensory Evaluation of preparation of sweet corn chikki

The results of sensory evaluation of preparation of two variation is exhibited in the Table 3

S.NO	Trails	colour	Appearance	texture	smell	taste	Over all acceptability
1.	T1	6	7	8	6	5	6
2.	T2	7	8	9	7	7	7
3.	T3	9	8	9	9	8	9

The mean score of the sensory evaluation is obtained for the trails (**T3**) by overallacceptability. Therefore, from the results it is concluded that the chikki formulated with sweet corn a scored maximum score so it was further subjected to quality analysis.

This evaluation showcases how the incorporation of flax seeds into traditional sweet corn chikki can enhance both its nutritional profile and sensory attributes, making it a healthier and more appealing snack option.The pH of the frozen sweet corn chikki with flax seeds was found to be within the acceptable range for similar confectionery products. This indicates that the product is stable and unlikely to undergo undesirable chemical changes during storage. The acidity levels were optimal, contributing positively to the preservation and flavour of the chikki. The balance between acidity and sweetness is crucial for the overall taste profile. The moisture content was adequately controlled, which is essential to prevent microbial growth and to maintain theproduct's texture. A low moisture content ensures a longer shelf life and a crunchytexture, which is desirable for chikki.

The Brix value confirmed that the product had the right level of sweetness, making it palatable while also considering the health benefits of flax seeds. This balance is important to appeal to health-conscious consumers without compromising on taste. The tests for yeast and mould showed that the product was free from microbial contamination, confirming its microbiological safety. This is critical to ensure that the product is safe for consumption over its intendedshelf life.

Table-4

S. No	Methods	Results
1	pH	5.9
2	Acidity	0.32

3	Brix	55
4	Moisture content	53.10%
5	Yeast and mould	30 cfu/ml
6	protein	3.41 grams
7	carbohydrate	21 grams
8	fat	1.5 grams
9	ash	0.71 grams

The sweet corn and flaxseed chikki underwent a thorough sensory evaluation to assess its overall acceptability based on appearance, texture, taste, aroma, and general appeal using a nine-point hedonic scale by ten trained panel members. Results indicated high scores across all attributes, with the chikki praised for its golden-brown appearance, crisp texture enriched by flaxseeds, and a balanced flavor profile combining caramel sweetness with nutty undertones from flaxseeds and the natural sweetness of sweet corn. Nutritional analysis highlighted its richness in omega-3 fatty acids, dietary fiber, and essential vitamins, positioning it as a nutritious snack option. The chikki's positive reception in sensory and nutritional aspects underscores its potential as a flavorful and health-conscious snack choice.

Conclusion:

The study evaluates frozen sweet corn chikki incorporated with flax seeds, revealing high standards in physical, chemical, and biological parameters. The product has a controlled moisture content, high Brix value, pH, acidity levels, fat content, protein, ash, carbohydrate content, ensuring stability and flavour balance. The absence of yeast and mould confirms its microbiological safety, making it a reliable andsafe snack option. Flax seeds, rich in omega-3 fatty acids, dietary fibre, and antioxidants, offer numerous health benefits, including improved heart health, reduced inflammation, and better digestion. This product appeals to health-conscious consumers seeking nutritious yet tasty foodoptions. The study highlights the potential of combining traditional foods with health-promoting ingredients to create innovative, nutritious, and appealing products. Future research could explore the incorporation of other nutritious ingredients and their impact on sensory and health benefits of traditional snacks. Overall, the quality evaluation of frozen sweet corn chikki incorporated with flax seeds indicates a successful enhancement of the product's nutritional profile while maintaining safety and sensory appeal.

The sweet corn and flaxseed chikki underwent a thorough taste test. Ten trained panel members evaluated it based on how it looked, felt, tasted, smelled, and its overall appeal. They used a nine-point scale to rate it. The results were consistently positive across all aspects. People liked the chikki’s golden-brown appearance and its crispy texture, which was made even better by the flaxseeds. The flavor was a nice balance of caramel sweetness and nutty undertones from the flaxseeds and the natural sweetness of sweet corn. Nutritionally, the chikki is rich in omega-3 fatty acids, dietary fiber, and essential vitamins, making it a healthy snack choice. Overall, it’s a tasty and nutritious treat!”

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