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RESEARCH ARTICLE

Development of chicken nuggets by incorporation of vegetables

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ABSTRACT

Chicken nuggets are a popular convenience food enjoyed by people of all ages. However, concerns about the nutritional content and overall healthfulness of these products have led to an increased demand for healthier alternatives. This project focuses on the development of chicken nuggets that are not only delicious but also fortified with the goodness of leafy vegetables, offering improved nutritional value without compromising taste and texture. Chicken and fenugreek, raw materials, were procured from a public market and given the essential pre-treatments like washing, grading, and sorting. A 0.2% citric acid solution was applied to fenugreek leaves for 30 minutes. The fenugreek was dried by applying sun-drying and tray-drying methods after being treated with citric acid and other raw materials. First, boneless chicken breast was weighed, cleaned, and chopped into 8mm small pieces. Further, it was ground to make breadcrumbs. Ground spices and dehydrated vegetable powder were added to the mixture, and dough was made. Further, the dough was cut into small pieces and dipped into the breadcrumbs. The product can be kept in the freezer at a temperature of 0 to 4°C for up to two months to be used later. It should be cooled and packed in polyethylene bags. Storage should be at -18°C. Sensory and nutritional analysis were done. Finally, the product was checked for microbial safety and quality assurance. Various sensory attributes were studied for fiber-rich chicken nuggets enriched with fenugreek powder. Sensory evaluation during storage was done for over 45 days at room temperature. Sensory attributes such as appearance, flavor, taste, and overall appropriateness showed a decreasing trend during the storage period. Sensory attributes decreased during a storage period of 90 days. The developed chicken nuggets were more acceptable till the 60th day, showing an overall acceptability of 8.2±0.21. The sensory scores were least on the 90th day. The overall acceptability of the product on the 90th day was 7.8±0. The findings from this study may be invaluable to food technologists, researchers, and the food industry, ultimately fostering innovation and encouraging the development of new, healthier food products. As consumers continue to seek balanced and nutritious choices, the outcome of this project can potentially influence the way chicken nuggets and similar products are formulated, produced, and perceived in the market.

Keywords: Chemical analyses, chicken nuggets, fenugreek powder.

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INTRODUCTION

The increasing demand for readily available, pre-cooked foods is a response to the time constraints in food preparation. However, the consumption of such foods has raised health concerns (Oliveira et al., 2013). To address these concerns, the meat industry has been exploring food additives and ingredients with nutritional benefits, like fibers, minerals, and bioactive compounds that can reduce product fat levels (Selgas et al., 2005). For fibers to be ideal, they should have a high concentration, a balanced ratio of soluble and insoluble fibers, and a pleasant sensory quality. Consideration for their positive impact on human health is also crucial for consumers. Anti-nutritional compounds should be absent, and factors like availability, affordability, and cost are critical for the industry. Multiple fiber types have been studied and combined with other ingredients in developing low-fat meat products (N Mehta et al., 2013). Consumers are increasingly seeking products that mimic meat in nutritional and sensory qualities, without relying on actual meat. Non-meat sources, such as soy, beans, peas, and lentils, have been used as meat substitutes, binders, and extenders in ground meat products due to their nutritional value and functional properties, sometimes even reducing production costs (Younis et. al., 2022). Products derived from chicken meat are well-received and offer excellent digestibility, taste, and nutrition for people of all age groups. The advancement in meat processing technology has led to the creation of various convenient and value-added chicken products like nuggets, pane, minced meat, meatballs, burgers, frankfurters, and luncheons. Among these, chicken nuggets stand out as ready-to-eat or ready-to-cook products, gaining popularity due to their simplicity in preparation. Non-meat ingredients play a significant role in altering and enhancing the appearance, texture, and palatability of the final product. Creating new food products is a continuous challenge that demands scientific and applied research. Optimizing key ingredients to formulate the best product is critical for new food development (Jousse, 2008).

In response to consumer demands for low-fat, high-fiber meat products, incorporating fruits and vegetables as non-meat ingredients has emerged as a potential solution. These ingredients provide natural antioxidants, fiber, and nutrients (Yue, 2001).

The processing and cooking methods used also influence the quality of the final product. Yet, limited publications are available on the effects of frying temperature and time on the physical and sensory quality of chicken nuggets. Therefore, this study aims to assess the physical and sensory quality of chicken nuggets prepared using spent layer meat as the primary raw material (Mellema, 2003).Deep fat frying is an intense heat transfer process that generates internal vaporization and pressure due to the product's porous structure (Ni and Datta, 1999). Oil absorption is a complex process with physical, chemical, and structural transformations taking place at high temperatures within a short timeframe. Therefore, deep fat frying can be considered a high-temperature, short-time process (Ziaiifar et al., 2008).

As per the American Association of Cereal Chemists (AACC) report from 2001, dietary fiber is the edible part of plants or analogous carbohydrates that cannot be digested or absorbed in the small intestine but can be partially or wholly utilized for fermentation in the large intestine. A diet rich in dietary fiber has the potential to reduce the risk of coronary heart disease, colorectal cancer, diabetes, and more (Montonen et al., 2003).

Incorporating dietary fiber into meat products serves as an alternative to fat substitution as it enhances water binding capacity and positively affects texture without compromising the quality of the product, leading to cost reductions (Shimokomaki and Olivo, 2006). The use of dietary fibers in meat products is of interest for the partial replacement of meat due to their functional and nutritional benefits (Younis et al., 2022).

The nutritional value of chicken nuggets

Chicken is a rich source of high-quality protein, particularly in lean cuts, and is relatively low in fat. In addition to its protein content, chicken is also a good source of essential nutrients such as Vitamin B12, Tryptophan, Choline, Zinc, Iron, and Copper.

On the other hand, chicken nuggets, a popular choice among both children and adults, undergo breading and frying. While the fundamental concept of chicken nuggets, involving breaded and cooked chicken, is not inherently unhealthy, the nutritional value of these nuggets can vary significantly. Fast food options, including chicken nuggets, are typically not regarded as healthful choices. For instance, a serving of six chicken nuggets contains 225 calories, 14 grams of fat, and 345 milligrams of sodium (as per Health). Considering that six chicken nuggets may not be particularly filling, this nutrient profile is less than ideal.

This highlights that while chicken itself is a nutritious and protein-rich option, the preparation and ingredients used in chicken nuggets, which often involve deep frying and may include additives like sugar, fat, and preservatives, can significantly impact their overall nutritional value. Therefore, it's important to be mindful of the choices made when it comes to enjoying chicken nuggets, especially if they are a frequent part of one's diet.

MATERIAL AND METHODS

This prospective study was carried out on the development of chicken nuggets with the incorporation of leafy vegetables in the Food Technology laboratory of the Department of Technology at Shivaji University, Kolhapur, during the year 2022-23.

Study Design: Materials: Chicken and fenugreek, raw materials, were procured from a public market and given the essential pre-treatments like washing, grading, and sorting. A 0.2% citric acid solution was applied to fenugreek leaves for 30 minutes. The fenugreek was dried by applying sun-drying and tray-drying methods after being treated with citric acid as other raw materials.

Study Location: The development of chicken nuggets by incorporation of vegetables-based study was done in the Food Technology laboratory of the Department of Technology at Shivaji University, Kolhapur, Maharashtra.

Study Duration: October 2022 to October 2023.

Procedure methodology

1. **Ingredient Selection and Preparation:** Chicken: Begin by selecting high-quality boneless chicken meat. Trim excess fat and connective tissue, and then cut the meat into small pieces. Fenugreek Powder: Procure fenugreek seeds and grind them into a fine powder. Ensure the quality and purity of the fenugreek powder. Leafy Vegetables: Choose leafy vegetables (e.g., fenugreek) for incorporation. Clean, wash, and finely chop the vegetables. Binding Agents: Select binding agents like egg, breadcrumbs, and flour. Seasonings and Spices: Gather a range of seasonings and spices for flavor enhancement Oil: Prepare a suitable cooking oil for frying.

2. **Formulation and Recipe Development:** Develop the chicken nugget formulation by determining the optimal ratios of chicken, fenugreek powder, leafy vegetables, and other ingredients. Experiment with different recipes to achieve the desired taste and texture.

3. **Preparation of Chicken Nugget Mix:** Combine the chicken pieces, fenugreek powder, chopped leafy vegetables, binding agents, and seasonings. Mix thoroughly to create a uniform mixture.

4. **Portioning and Shaping:** Portion the chicken nugget mix into uniform portions and shape them into nugget forms. Ensure consistent sizes for even cooking.

5. **Breading:** Coat each chicken nugget with breadcrumbs to provide a crispy texture when fried.

6. **Cooking Methods:** Investigate various cooking methods, such as deep frying, baking, or air frying, to determine which method yields the best results in terms of taste and texture while ensuring the fenugreek powder is fully incorporated into the nuggets.

7. **Sensory Analysis:** Conduct sensory analysis to evaluate taste, texture, aroma, and overall acceptability of the chicken nuggets. Consider panel evaluations and consumer testing.\

8. **Nutritional Analysis:** Perform a nutritional analysis to determine the nutritional content of the chicken nuggets, including fiber, protein, fat, and micronutrient content. Compare this to standard chicken nuggets.

9. **Microbial Safety:** Ensure the product's safety by conducting microbiological testing to assess microbial counts and food safety parameters.

10. **Quality Assurance:** Implement quality control measures to maintain consistent product quality. Monitor factors such as moisture content, water activity, and shelf stability.

11. **Shelf Life** Assessment: Conduct shelf-life studies to determine the product's storage conditions, including temperature, humidity, and packaging. Monitor changes in quality over time.

12. **Optimization:** Fine-tune the formulation, production process, and cooking methods based on the sensory, nutritional, and microbial analysis results.

13. **Documentation:** Maintain thorough records of the entire process, including ingredient specifications, formulation variations, cooking parameters, and analytical results.

14. **Packaging:** Select appropriate packaging materials and techniques to maintain product quality and extend shelf life.

15. **Final Product Evaluation**: Evaluate the final chicken nuggets for their sensory attributes, nutritional profile, microbial safety, and shelf stability. Ensure they meet predetermined quality standards.

16. **Conclusion and Recommendations:** Summarize the research findings, provide recommendations for product improvements or modifications, and assess the feasibility of large-scale production.

This methodology provides a structured approach to developing chicken nuggets incorporated with fenugreek powder, emphasizing product quality, safety, and nutrition. It allows for experimentation and optimization to create a final product that meets both sensory and nutritional expectations.

Proximate analysis

Swelling power (SP) and solubility

One gram of Fenugreek powder (F.P.) and ten ml of distilled water were added to a pre-weighed 50-ml centrifuge tube. This centrifuge tube was heated to 80°C and continuously shaken for 30 minutes. After the tube was taken out of the bath, it was dried off, allowed to cool to ambient temperature, and then centrifuged for 15 minutes at 2200 rpm. The supernatant prepared in the process was evaporated, and the solubility was calculated from the weight of the dry residue:

Solubility % = Weight of dried sle in supernatant × 100 / Weight of original sle

To calculate the swelling power (S.P.), the swollen sle (paste) obtained by decanting the supernatant was also weighed.

Swelling power (S.P.) = Weight of wet mass sediment / Weight of dry matter in the gel

(Elaveniya & Jayamuthunagai, 2014)

Foaming capacity (F.C.) and foaming stability (F.S)

In a 100 ml measuring cylinder, 50 ml of distilled water and 2 grams of fenugreek powder were added. The mixture was shaken vigorously until froth formed. The volume of foam (ml) after mixing was used to represent foam capacity, whereas the volume of foam after 60 minutes of shaking was used to express foam stability (Elaveniya &; Jayamuthunagai, 2014).

Water and the oil absorption capacity (W.A.C.) and (O.A.C)

In a pre-weighed 50 ml centrifuge tube, 1 g of fenugreek powder (F.P.) sle was mixed with 10 ml of oil or distilled water. After shaking for an hour, the suspension was centrifuged at 2200 rpm for 15 mins. The separated oil was removed with a pipette and the sle was reweighed. Amounts of water or oil absorbed per unit of sle weight were used to determine the substance's capacity to absorb (Elaveniya & Jayamuthunagai, 2014).

Bulk Density (B.D.)

The dried fenugreek powder (F.P) was poured into a 25 ml measuring cylinder to a maximum of 5 ml. To achieve a constant volume, the measuring cylinder was then tapped repeatedly on a table. The equation was used to calculate the bulk density (B.D.) (g/ml or g/cm3).

Bulk density (g/m3) = Weight of sle/Volume of sle after tapping

(Elaveniya & Jayamuthunagai, 2014).

Physico-chemical properties of raw materials and finished products

With the help of the following techniques, various physicochemical properties of raw materials like fenugreek powder, the control sle (chicken nuggets), and the finished product like fiber-rich fenugreek powder-enriched chicken nuggets were calculated.

Moisture content

This technique was applied to calculate the total amount of water content present in the food. A hot air oven was used to evaluate the moisture content. In a pre-weighed empty Petri plate, add a 5g sle of the fenugreek powder and developed chicken nuggets. The sle was then dehydrated in a hot air oven at 105°C until a steady weight was attained. Desiccators should be used to cool the plates. The following formula was used to estimate the amount of water (Ranganna, 1986).

% Moisture Content = Initial Weight of Sle-Final Weight of SleInitial Weight of Sle × 100

Ash content

The ash content of food was studied using the muffle furnace. 2 and 3 grams of sle were poured into the crucible, which was then heated at a low flame until it completely burned and cooled to room temperature. After that, it was heated in a muffle furnace to 550°C for up to 5 or 6 hours. Take it out of the muffle furnace after that, then put it in a desiccator to cool. The final result was calculated using the differences between the sles' prior and posterior weights (A.O.A.C., 1990).

Ash content (%) = Weight of crucible after Ashing - Weight of empty crucible × 100 / Weight of Sle

Fat content

To determine the fat content, the sle must be dry. An exactly measured 5g crushed sle was defatted using ether extract in a Soxhlet mechanical assembly for 6–8 hours at 80°C. After evaporating the resulting ether extract, the lipid content was determined (A.O.A.C., 1990).

Crude fat (%) = Weight of soluble extract × 100 / Weight of Sle

Protein content

The micro-Kjeldahl technique was used to determine the protein content in food products. The protein content was determined by digesting the material for 3 to 4 hours at 340 to 400°C using a catalyst mixture containing concentrated sulfuric acid (H_2SO_4). During the distillation process, the free ammonia was collected in 4% boric acid, as well as the product was titrated with 0.1N HCL using a mixed indicator (Methyl red: Bromocresol green: 1:5). The nitrogen content and protein content of the sles were determined by multiplying by 6.25 (A.O.A.C., 1990).

Crude fibre content

Take 2 to 3 g of fat and moisture-free sles to calculate crude fibre in the food product. For acidic treatment, the weighted sle takes into a 500ml measuring utensil and 200ml (1.25%) H_2SO_4 is added to it. The blend is bubbled for 30 minutes. At the end of this process, the blend is filtered through a muslin cloth. Add tap water to the flask and filter it again. After filtration, give alkali treatment to the same sle. For alkali treatment, 200ml of (1.25%) NaOH is added to the sle. Boil the sle for 30 minutes. After the treatment, the sle is filtered via Watman filter-paper and dried in an oven. It is then transferred to a pot and dried for 2-3 hours at 80-100°C. It is then moved to a pot and dried at 80-100°C for 2-3 hours. The method followed is by Rangana (A.O.A.C. 2000).

% Crude fibre (%) = Residue Weight - Ash remains × 100 / Weight of Sle

Mineral estimation by ICP OES method

Inductively coupled plasma optical emission spectrometry (ICP OES) is applied in almost all areas of analytical chemistry. Iron and calcium content are measured by the ICP-OES method. To prepare the stock solutions of the elements (1000 mg/L) and H_2O_2 (35%, 1.13 g/mL), HCl, HNO_3, $NaBH_4$, KI, ascorbic acid, and $KMnO_4$ are used. For the digestion of a variety of organic materials, microwave-assisted, closed-vessel digestion techniques are applied because they offer quick material breakdown and little sle contamination before the elemental analysis stage (Karacan & Cagran, 2008).

pH values Determination

Ten grams of fenugreek powder are combined with 100 ml of water and allowed to settle for 30 minutes. The solution is filtered and the pH of the filtrate is determined using a pH meter (Elaveniya & Jayamuthunagai, 2014).

Colour Analysis

A color analyzer, Hunter Lab, is used to measure the color of Fenugreek Powder and Chicken nuggets enriched with Fenugreek powder. The parameters determined are L* (L* = 0 [blank] and L* = 100 [white]), a* (-a* = greenness and +a* = redness), and b (-b* = blueness and +b* = yellowness) (Elaveniya & Jayamuthunagai, 2014).

Anthocyanin-content

The method described by Rangana (2003) was used to determine the anthocyanin content.

Process flowchart for Dehydration of the fenugreek:

Creating a process flowchart for the dehydration of fenugreek involves outlining the key steps and stages involved in the dehydration process. Here’s a simplified flowchart for the dehydration of fenugreek leaves:

1. **Harvest Fenugreek Leaves:** Fenugreek leaves are harvested at the peak of freshness.
2. **Wash and Clean:** The harvested leaves are thoroughly washed and cleaned to remove dirt and impurities.
3. **Preparation:** Trim and remove any damaged or discolored leaves.

4. **Blanching:** The leaves are briefly blanched in hot water to preserve color, texture, and remove any surface contaminants.

5. **Drain:** After blanching, the leaves are drained to remove excess water.

6. **Drying:** The drained fenugreek leaves are spread out evenly on drying trays or belts.

7. **Dehydration Process:** Heat and airflow are applied to remove moisture from the leaves gradually. This can be done using various methods, including air drying, sun drying, or using a food dehydrator.

8. **Monitoring:** Constant monitoring of temperature and humidity levels to ensure proper drying without overcooking.

9. **Cooling:** After dehydration, the leaves are allowed to cool down to room temperature.

Process flowchart for the development of the chicken nuggets:

Weighing Chicken breast boneless

↓

Cleaning

↓

Chopping chicken into 8mm pieces

↓

Grinding

↓

To make bread slices

↓

Grinding

↓

Adding spices to mixture

↓

Adding dehydrated vegetable powder to the mixture

↓

Making dough of all mixture

↓

Cut into small pieces

↓

Dip into breadcrumbs

↓

It can be kept in the freezer at temp 0 to 4°c for up to two months to be used later

↓

Cooling at 4°c for 10 min

↓

Packaging in Polyethylene bags

↓

Storage at -18°c F

Process flowchart of Chicken Nuggets Incorporated with Leafy Vegetables (Barros et al., 2019)

1. **Sensory evaluation:** Sensory evaluation of food is a scientific discipline that relies on statistical analysis and experimental design principles. The senses of taste, smell, sight, hearing, and touch are all used for sensory evaluation, and it is performed by recording the responses of different panel members when they test a product. After a thorough analysis, the results from the panelists' responses would give more insight and inferences regarding the tested product. A panel of 10 semi-trained panel members evaluated the prepared sles for sensory qualities such as appearance, taste, texture, color, and overall acceptability using a 9-point hedonic scale.

2. **The storage study of fiber-**rich chicken nuggets enriched with fenugreek powder: The storage study was carried out by continuously evaluating the product's sensory quality, physicochemical composition, and microbiological characteristics. The storage study was carried out at room temperature every 15 days. Color, flavor, and appearance were assessed visually and with the help of sensory organs. To determine the yeast and mold count, developed products were microbiologically analyzed in a laboratory environment. The storage study lasted for up to 90 days and was acceptable. After 90 days, the prepared product began indicating declining sensory parameter scores.

3. **Serial Dilution:** Pipette out the 1 mL food homogenate into a test tube containing 9 milliliters of diluents after preparing diluents up to 105. Transfer 1 ml to the second dilution tube from the first dilution tube. 1ml from the first dilution to the second dilution tube, which contained nine milliliters of diluents. Continue using a third, fourth, or even fifth tube until the required dilution is attained (USFDA, 2001).

4. **Microbiological analysis:** Yeast and mold count - Potato dextrose agar was used to count the amount of yeast and mold in the sle. 39g of PDA powder was suspended in 1000 ml of distilled water and then heated until completely dissolved to rehydrate the medium. Then, it was transferred to conical flasks that had been autoclaved at 15 psi pressure (121°C) to ensure sterilization. Following the technique specified by Indian Standards (IS28021964), yeast and mold were counted. Yeast and mold were enumerated following the standard protocol delineated in Indian Standards (IS2802 1964). The plates were incubated at 30°C for 48 hrs, and counts were expressed as cfu/g of the product.

5. **Statistical analysis:** The data was analyzed and presented graphically.

RESULT

1. **Dehydration of fenugreek using different drying methods:**
   i) **Effect of different drying methods on moisture content for the development of fenugreek powder**

Table. 1: Effect of different drying methods on moisture content for the development of fenugreek powder

Drying time (Hrs.)	Sun Drying (Moisture content %)	Tray drying (Moisture content %)
0	80	80
2	70	60
4	60	40
6	50	30
8	40	20
10	30	15
12	20	10

The above table shows the relationship between the time and temperature required for the dehydration of banana blossom. Drying of fenugreek powder was done by two methods: sun drying and tray drying. This drying experiment was conducted at a temperature of 37°C for sun drying and 55°C for tray drying. The relative humidity was 54.9%.

Figure 1 represents the relationship between time and temperature required for the dehydration of fenugreek powder. Drying of fenugreek powder was done using two methods: sun drying and tray drying. This drying experiment was conducted at a temperature of 37°C for sun drying and 55°C for tray drying. The relative humidity was 54.9%. The sun-drying method required 12 hours for dehydration, whereas the tray-drying method needed only 7-8 hours. Additionally, the results indicated that the quality and appearance of the tray-dried powder were more satisfactory than those of the natural sun-dried fenugreek powder. These results were compared with earlier results from Wickramarachchi & Ranamukhaarachchi (2005) and Veeramanipriya et al. (2019).

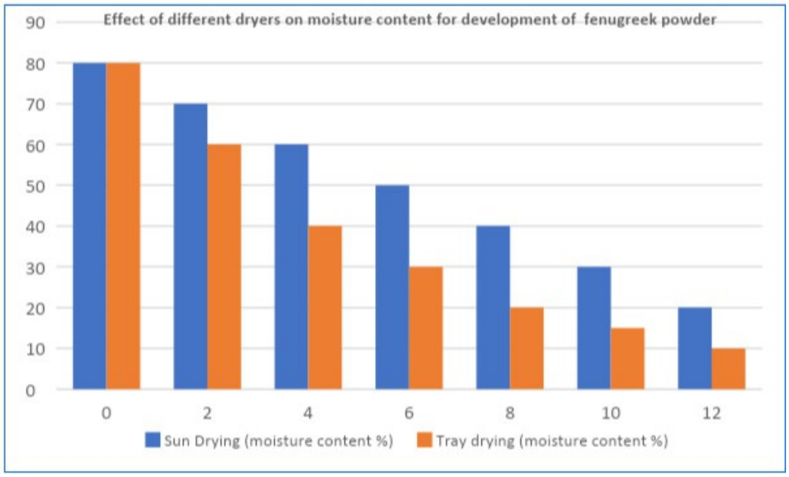

Fig. 1: Moisture content vs drying time for drying fenugreek powder by sun drying and tray drying.

ii) Effect of different drying methods on the development of fenugreek powder and with respect to water activity

Table. 2: Effect of different drying methods on the development of fenugreek powder with respect to water activity.

Drying time (Hrs.)	Sun Drying (water activity)	Tray Drying (water activity)
0	0.95	0.95
2	0.89	0.60
4	0.75	0.40
6	0.65	0.25
8	0.60	0.15
10	0.55	0.10
12	0.50	0.08

The above table represents the relationship between the time required for dehydration of fenugreek powder and water activity at different temperatures after particular intervals. The calculated water activity is for both sun drying and tray drying methods.

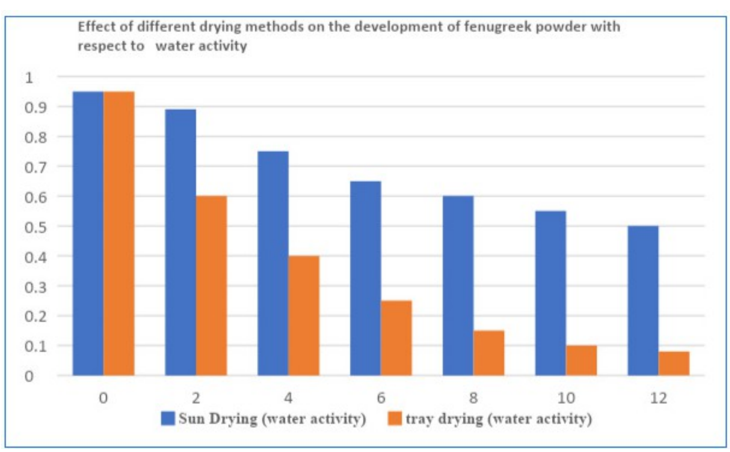

Fig. 2: Water activity vs. drying time of fenugreek powder by sun drying and tray drying method.

Physicochemical analysis of chicken nuggets incorporated with fenugreek powder.

Table 3: Physicochemical analysis of developed fibre rich chicken nuggets before cooking.

Sle	Control	A	B	C
Moisture %	55	54.5	54.2	54.8
Ash %	1.5	1.8	1.7	1.6
Protein %	15	16.5	16.2	16.8
Fat %	10	9.5	9.8	9.2
Carbohydrate %	17	16	16.5	15.8
Crude Fiber %	2.5	2.8	2.7	2.6
pH	6	6.2	6.1	6.3
Iron (mg/100g)	2	2.2	2.1	2.3
Total Sugar (%)	3.5	3.8	3.7	3.9
Water Activity	3.2	3	2.8	3.3
Color (1-10)	7.5	7.8	8	7.5

Table- 4: Physicochemical analysis of developed fibre rich chicken nuggets after cooking.

Sle	Control	A	B	C
Moisture %	51	50.5	50	51.2
Ash %	1.2	1.3	1.4	1.5
Protein %	14.5	15.8	15.5	15.2
Fat %	8.5	8.2	8	8.4
Carbohydrate %	20	19.5	19.8	20.5
Crude Fiber %	2	2.2	2.1	2.3
pH	5.5	5.6	5.4	5.7
Iron (mg/100g)	1.8	1.9	1.7	1.6

Effect of different dryers on the development of fenugreek powder concerning water activity:

The interaction between the time required for dehydration of fenugreek powder and water activity at different temperatures and times was demonstrated in the above Figure 3. Water activity during the dehydration of fenugreek powder was calculated for both sun-drying and tray-drying methods. As the moisture content decreases in fenugreek powder, the water activity as well as the microbial load also decreases. The sun drying method requires more time compared to tray drying methods. Sun drying method require more time as compared to tray drying method. While using the tray drying method, water activity reduced from 0.95 to 0.50 rather than decreasing gradually from 0.95 to 0.50 when using the sun drying method. The above method and results were compared with earlier results of Maltinia et al. (2003) and Wickramarachchi & Ranamukhaarachchi (2005), respectively.

DISCUSSION

The incorporation of leafy vegetables into chicken nuggets represents a promising avenue for developing a healthier and more nutritionally enriched product. The project aimed to balance the nutritional profile of the nuggets without compromising the sensory aspects that are crucial for consumer acceptance.

The results demonstrated that the addition of leafy vegetables led to a notable improvement in the nutritional content of the chicken nuggets. The selected vegetables brought essential vitamins, minerals, fiber, and antioxidants to the formulation, contributing to a more balanced and healthful profile. This aligns with the growing consumer demand for food products that not only satisfy taste preferences but also offer nutritional benefits. Sensory evaluations conducted by trained panels indicated that the introduction of leafy vegetables did not compromise the overall acceptability of the chicken nuggets. The balance achieved in taste, texture, and appearance suggests that such formulations can be well-received by consumers. This is a crucial aspect, as consumer preferences ultimately dictate the success of any food product in the market.

The project's comprehensive approach to ingredient selection, preparation techniques, and cooking methods contributes valuable data to the existing body of knowledge on product development. The results support the hypothesis that chicken nuggets can be transformed into a more nutritious and appealing food item by incorporating leafy vegetables. The study also highlights the importance of innovation in the food industry to meet the evolving demands of health-conscious consumers.

CONCLUSION

The development of chicken nuggets incorporated with fenugreek powder for the enrichment of fiber content represents a significant advancement in the field of food technology. This M. Tech. Food Technology project has explored various aspects of product development, focusing on enhancing both the nutritional profile and sensory attributes of chicken nuggets. Throughout this dissertation, we have meticulously documented the research, experimentation, and analysis conducted to achieve the project's objectives. In this concluding section, we will summarize the key findings, implications, and future directions of this research.

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