

**DEVELOPMENT OF CHICKEN CARUNCLES ADDED WITH BENGAL GRAM
FLOUR**

T H E S I S

Submitted

In partial fulfillment of the requirements for the Degree of

**MASTER OF VETERINARY SCIENCE
IN
LIVESTOCK PRODUCTS TECHNOLOGY**

BY

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Enrolment No: V/16/325

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(INDIA)**

2024

DECLARATION OF STUDENT

I hereby declare that the experimental research work and interpretation of the Thesis entitled “**DEVELOPMENT OF CHICKEN CARUNCLES ADDED WITH BENGAL GRAM FLOUR**” or part there of has not been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or scientific organization. The sources of materials used and all assistance received during the course of investigation have been duly acknowledged.

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Mr. **SAWANT AKASH DNYANOBA** has satisfactorily prosecuted her course of research for a period of not less than one semester and that the thesis entitled “**DEVELOPMENT OF CHICKEN CARUNCLES ADDED WITH BENGAL GRAM FLOUR**” submitted by her is the result of original research work and is of sufficiently high standards to warrant its presentation to the examination in the subject of **LIVESTOCK PRODUCTS TECHNOLOGY** for the award of **MASTER OF VETERINARY SCIENCE** degree by the Maharashtra Animal and Fishery Sciences University, Nagpur.

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This is to certify that the thesis entitled “**DEVELOPMENT OF CHICKEN CARUNCLES ADDED WITH BENGAL GRAM FLOUR**” submitted by Mrs. **SAWANT AKASH DNYANOBA** to the Maharashtra Animal and Fishery Sciences University in partial fulfillment of the requirement for the degree of **MASTER OF VETERINARY SCIENCE** in the subject of **LIVESTOCK PRODUCTS TECHNOLOGY** has been approved by the student’s advisory committee after oral examination in collaboration with the External Examiner.

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TABLE OF CONTENTS

Sr. No.	Chapter	Page
I	INTRODUCTION	1-2
II	REVIEW OF LITERATURE	3-24
III	MATERIALS AND METHODS	25-3
IV	RESULTS AND DISCUSSION	435-46
V	SUMMARY AND CONCLUSIONS	47-50
VI	BIBLIOGRAPHY	i-xi
A	APPENDIX-I	xii
B	VITAE	xiii
C	THESIS ABSTRACTS	

LIST OF TABLES

Table No.	Title	Page
3.1	Composition of spice mix	25
3.2	Nutritional composition of bengal gram flour (per 100 gm)	26
3.3	Basic formulation of chicken caruncles	27
4.1	Sensory properties of chicken caruncles added with Bengal gram flour	35
4.2	Physio-chemical properties of chicken caruncles incorporated with Bengal gram flour	37
4.3	Proximate composition of chicken caruncles added with Bengal gram flour (BGF)	38
4.4	Sensory properties of chicken caruncles stored at room temperature	40
4.5	Physico-chemical characteristics of chicken caruncles stored at room temperature.	42
4.6	Microbiological properties of chicken caruncles stored at room temperature	44
4.7	Production cost details of chicken caruncles	46

LIST OF PLATES

Sr. No	Particulars	After page
3.1	Raw ingredients used for preparation of chicken caruncles	28-29
3.2	Chicken caruncles emulsion	28-29
3.3	Caruncles maker	28-29
3.4	Chicken caruncles prepared with Bengal gram flours	28-29

LIST OF ABBREVIATIONS

°C	:	Degree Celsius
%	:	Percent
<	:	Lesser Than
>	:	Greater Than
AOAC	:	Association of Analytical Chemists
APHA	:	American Public Health Association
BGF	:	Bengal Gram Flour
Cfu	:	Colony Forming Unit
CMC	:	Chicken Meat Caruncles
EFP	:	Edible Fish Powder
et al	:	et alia (and other people)
Fig	:	Figure
g	:	Gram
g/ml	:	Gram/Milliliter
HCL	:	Hydrochloric acid
hr	:	Hour
i.e.	:	That is
Kg	:	Kilogram
LDPE	:	Low Density Polyethylene
Log ₁₀	:	Logarithm of x to the base 10
MDA	:	Malonaldehyde
mg	:	Milligram
ml	:	Milliliter
min	:	Minutes
NaOH	:	Sodium Hydroxide
ND	:	Non detected
NP	:	Not performed
Nm	:	Nanometer
OD	:	Optical Density
Rs	:	Rupees
Sec	:	Second

TBA	:	Thiobarbituric Acid
TBARS	:	Thiobarbituric Acid Reacting Substances
TCA	:	Trichloroacetic acid
TPC	:	Total plate count
Wt.	:	Weight
L	:	Mili liter
J	:	Jule (unit of energy)
RTE	:	Ready To Eat
FP	:	Fish powder
SHE	:	Shrimp head extrudate



Introduction



CHAPTER - I

INTRODUCTION

In food industry, snack food is one of the fastest growing segments due to its convenience, wide variety with versatile presentations, and few of them are available as functional foods (Bulut and Candogan, 2022). In recent era, snacks consumption increased steadily, which is categorized as a “titbit”, a small meal between two or more major meals.

In Indian market, cereals-based snacks available which is rich in carbohydrates and less in protein contents. Now a days, people are more conscious about food they are consuming because there is a strong interrelation between health and diet. In modern era, consumer prefer food with adequate nutrients to maintain a healthy lifestyle. In India, daily diet lacks in nutritional content such as protein, vitamins and minerals. However, as per the recommendations, every adult person should consume 1 gm/kg/day bwt of protein while infants 0.8 gm/kg/day bwt of protein. In order to reach this daily body protein requirement, we need to develop snacks food with ease of convenience, easy to carry, nutritionally sound, self-stable to satisfy short term hunger of person, working women and children (Singh *et al.* 2013). In this regard non-veg foods are rich sources of iron, protein with essential amino acids and B complex vitamins with high bioavailability. The world meat snacks industry is growing at 7% CAGR and expected to reach 14.5 billion USD at the end of 2029, rise in demand for clean label snacks food items (Transparency Market Research, 2021). In global market, delicious, ready to eat, easy to store meat snacks available viz., chips, jerky, chunks, sticks, strips, and cubes.

In India, amongst all type of meats, chicken is easily available and most preferred due to its dietary advantages like high palatability, enhanced flavor and taste, relatively lower price without any religious taboos (Akkara *et al.* 2019). As per the report of Food and Agriculture Organization (FAO), global poultry meat production has been steadily increasing over the past few years. In 2020, global poultry meat production was estimated at around 137 MMT however in India, it is recorded 4253.74 metric ton in 2022 (Global Trade, 2020). The broiler poultry

sector is a versatile industry growing rapidly, contributing significantly in Indian economy in terms of meat production due high demand for poultry products. In India, development of meat-based snacks provides a lucrative opportunity in future. Due to high demand, innovative shelf stable value-added meat products increasing day by day. However, traditional meat products have limited role in our life due to their poor shelf-life at room temperature and bulkiness. Hence, now a days, there is a growing need for convenient, shelf-stable traditional meat products such as snacks and dehydrated meat products (Singh *et al.* 2013).

Shelf stable caruncles is very popular Indian traditional veg snack product, made by mole and bajra (pearl millet) added with spices and herbs. However, market available caruncles are rich in carbohydrate and low in protein content hence needs to enrich with the proteinaceous supplement. To serve the aforementioned purpose, use of chicken and bengal gram flour appropriate combination is an innovative approach to enhance the nutritional quality of caruncles. Chicken meat is widely consumed and sustainable option with low cost which is rich in protein, vitamins, minerals, plays important role in growth, metabolism, and body development. Bengal gram flour known as besan, easily available, is a gluten-free, protein rich, with ample quantity of fiber, iron, and other nutrients, used to prepare vegetarian snacks dishes such as dhokla, pakoras, laddu, and kadhi. Thus, aim of present study is to investigate the use of the suitable combination of chicken meat to bengal gram flour for successful development of chicken caruncles with evaluation of physico-chemical, compositional, sensory properties, shelf life and cost economics of developed products.

Objectives:

1. To study the suitable combination of chicken meat to flour ratio in chicken caruncles.
2. To study the shelf life of chicken caruncles at room temperature.
3. To study the cost economics for development of chicken caruncles.



*Review
of
Literature*

CHAPTER - II

REVIEW OF LITERATURE

Snack food products are important for a number of reasons. They can:

1. **Provide energy and nutrients between meals.** This is especially important for people who have active lifestyles or who need to eat small meals throughout the day.
2. **Help to control appetite and prevent overeating at meals.** When people snack on healthy foods throughout the day, they are less likely to feel hungry and overeat at meals.
3. **Provide extra nutrients to the diet.** Snack foods can be a good way to get essential vitamins, minerals, and antioxidants that people may not be getting enough of in their regular meals.
4. **Help to maintain a healthy weight.** When people choose healthy snacks and eat them in moderation, they can help to maintain a healthy weight or even lose weight.
5. **Be a convenient and portable way to get food on the go.** Snack foods can be easily carried with you in a purse, backpack, or car, making them a convenient option for people who are busy or who don't have time to sit down for a full meal.

Bengal gram plays important role in nutrition as they are rich source of protein and other nutrients. Addition of bengal gram flour in the chicken meat products could help lucrative utilization and production of meat products with low cost.

2.1 Chicken meat products

Atabany *et al.* (2018) stated that the recent approach in food technology focus on finding not only safe and natural biocide, but also being an alternative for the chemical preservatives. Essential oils have the ability to act as bactericidal, antioxygenic, virucidal, fungicidal, antiparasitic besides being flavorings agents. So, it considers a promising new concern to fulfill this purpose. The present study

was designed to express the shelf life of minced meat incorporated with lettuce oil 3%, cumin oil 2 % and marjoram oil 2% throughout a refrigerated period at 4 °C and to screen the bioactivity of the aforementioned essential oils with its different concentrations.

Domingo *et al.* (2019) studied the a three-level Box-Behnken design of response surface methodology was employed to optimize the formulation of bukayo or coconut toffee based on overall acceptability sensory attribute. The independent variables were different levels of young coconut meat (250 – 500 g), sinakob (250 – 500 g), and coconut juice (250 – 500 g) with fifteen different runs of three similar center points. The analysis of variance showed that quadratically, coconut juice and sinakob showed significantly higher effect.

Nayar *et al.* (2021) studied traditional meat products with their unique sensory attributes have known to hold tremendous mass appeal, usually with high nutritional value. Kerala cuisine is a unique blend of indigenous and exotic dishes adapted to local culinary culture. Ethnic meat products from the Northern Malabar region have been described in several popular culinary books. However, there has been limited scientific documentation of these products and the estimation of their nutritive value.

Yang *et al.* (2022) studied process parameters of chicken 3D printing were optimized using response surface methodology (RSM) and genetic algorithm (GA), and the best 3D printing forming accuracy was obtained under 1.3 mm nozzle diameter, 9.8 mm filament diameter, 28.0 °C nozzle temperature, and 2.5% NaCl addition. The results of rheology and gel strength showed that NaCl-treated chicken paste had shear-thinning behavior and sufficient gel strength (>99.85 g mm), indicating that the chicken paste reached the balance between extruding smoothly from the nozzle and supporting the structure after deposition.

Ahmad *et al.* (2023) explored the preservative effect of aqueous coriander extract and butylated hydroxytoluene (BHT) on the shelf life of refrigerated chicken patties for 9 days. For this purpose, BHT (100 ppm) and aqueous coriander extract (1%) was applied to improve the storage stability. The patties were evaluated for their physiochemical characterization including total phenolic

content (TPC), thiobarbituric acid reactive substances (TBARS), peroxide value (PV), total carbonyl, metmyoglobin, and instrumental color, microbial analysis including (total plate count), and sensory attributes including (color and odor).

2.2 Non- meat ingredients

2.2.1 Bengal gram flour

Modi *et al.* (2004) studied the effect of addition of different decorticated legume flours, viz., soya bean, bengal gram, green gram and black gram, on the quality of buffalo meat burger was studied. The burgers consisted of optimized quantities of roasted or unroasted legume flour, spices and common salt. Inclusion of roasted black gram flour registered the highest yield of 95.7%, lowest shrinkage of 5% and lowest fat absorption of 26.6% on frying. Protein content of 18–20% was highest in the soya flour formulation.

Sultana *et al.* (2017) studied addition of jackfruit seeds and bengal gram which are rich of nutrients as protein, crude fibre, minerals etc in chapati. To improve the quality of chapati, jackfruit seed flour and bengal gram flour were used along with whole meal wheat flour (atta). The aims of this study were to enrich the quality of chapaties and to check the shelf life of chapaties in ambient and refrigerated condition (6⁰C). Four types (Rc, R1, R2, R3) of chapaties were prepared adding 100% atta in control; 5, 15, 25 percent white and 10, 15, 20 percent brown jackfruit seed flour with 5, 15, 10 percent bengal gram flour respectively. The spread ratio of R3 (46.25) was more than others. In spite of higher spread ratio of R3 the highest energy (324.73 kcal/100g) containing chapati was R1 type because of its composition. The samples were packed in high density polyethylene and stored at the refrigerated and ambient temperature. The shelf life of chapaties was obtained 3 to 4 days at ambient and 30 days at refrigerated temperature. The sensory attributes of fresh chapaties were also evaluated and found the highest acceptability of R1 sample. This study concluded that the best sample was R1 which had higher energy level and consumer acceptability.

Choudhary *et al.* (2019) reported that experiment carried to develop quail meat nugget using 10% Bengal gram flour. Results showed Japanese quail meat

nuggets with addition of 10% Bengal gram flour were acceptable with regard to physico-chemical and sensory quality attributes.

Doley *et al.* (2019) studied the chicken jalebis- a new snack was prepared by incorporating 23% non-meat ingredients (Bengal gram flour, corn flour, rice flour, semolina flour) at different proportions with 55% chicken (Broiler meat) to find out the best formulation without affecting the physico-chemical, microbial and organoleptic qualities of the product. Non meat ingredients were fermented for 24 hrs with curd at room temperature. Chicken was collected from local market, deboned, minced and processed. Different formulations of chicken jalebi batter were prepared by mixing broiler minced meat with fermented non meat ingredients, spices, oil, salt and ice to form a stable emulsion.

Kushwaha *et al.* (2022) reported that the goal of the current study was to develop chakli using green gramme flour and moth bean flour and determine its acceptability and nutritional value. Salt, red pepper flakes, refined oil, refined flour, green gramme flour, and moth bean flour were used to make chakli. Results revealed that Sample 3 (7.850.81) Chakli's overall acceptability was rated between "like very much" and "like very," whereas Control (7.61.53) was rated between "like moderately" and "like very much" by panelists. Sample 2 Chakli had the highest amounts of energy (520.8 kcal), protein (17.5 g), carbohydrate (65.3 g), and fat (22.2 g), respectively. Green gramme flour, moth bean flour, and refined flour. The various samples were made in the following ratios: (refined flour: green gram flour: moth bean flour): 100, 50:25:25, 50:45:5, and 50:5:45, respectively.

2.3 Preservatives

2.3.1 Chemical preservatives

Schroeder (2013) concluded that Salt is a crucial component in the separation of myofibrillar proteins from meat products. By enhancing actin and myosin's capacity to bind water and fat, salt also enhances the yield and texture of processed meat products.

Saini *et al.* (2018) standardized the processing protocol of fried snack and to evaluate economics of the developed product. Three treatments were prepared

with incorporation of rosemary extract (T1), betel extract (T2) and their 1:1 combination (T3) in product by replacing amount (3%) of chicken powder from formulation to evaluate economics of the fried snack. All treatments and control group were deep fried at 190°C for 45 sec. to make the product. In the cost economics, cost of formulation was found highest for group T2. Maximum total net profit was found for control followed by T2, T4 and T1.

Saad *et al.* (2021) studied that A new preservation approach is presented in this article to prolong the lifetime of raw chicken meat and enhance its quality at 4 °C via coating with highly soluble kidney bean protein hydrolysate. The hydrolysates of the black, red, and white kidney protein (BKH, RKH, and WKH) were obtained after 30 min enzymatic hydrolysis with alcalase (E/S ratio of 1:100, hydrolysis degree 25–29%). The different phaseolin subunits (8S) appeared in SDS-PAGE in 35–45 kD molecular weight range while vicilin appeared in the molecular weight range of 55–75 kD. The kidney bean protein hydrolysates have considerable antioxidant activity as evidenced by the DPPH-scavenging activity and β -carotene-linolenic assay, as well as antimicrobial activity evaluated by disc diffusion assay. BKH followed by RKH (800 μ g/mL) significantly ($p \leq 0.05$) scavenged 95, 91% of DPPH and inhibited 82–88% of linoleic oxidation.

Kim *et al.* (2021) reported that consuming the right amount of salt is crucial for the preservation of good health since salt is a vital component for maintaining human life as it aids in maintaining an optimal water balance in the body.

2.3.2 Natural preservatives

2.3.2.1 Spices

Yadav *et al.* (2016) studied ready-to-Eat (RTE) spiced bengal gram snack (Chana Nibble) with $50.33\pm 0.15\%$ moisture, $17.92\pm 1.12\%$ protein, $9.36\pm 0.56\%$ crude fat, $20.39\pm 1.12\%$ carbohydrate, $2.27\pm 0.05\%$ ash, $16.54\pm 1.25\%$ total dietary fibers was developed. The effect of different heat treatments & preservatives on the RTE Bengal gram snack was evaluated with a view to stabilize the product at ambient storage conditions for more than three months. The process of Chana Nibble was based on soaking, cooking, and seasoning followed by in-pack preservation techniques. The product scored superior acceptability (8.3 ± 0.1) on 9-point hedonic scale.

Andaleeb *et al.* (2023) studied that principal component analysis (PCA) efficiently discriminated the aroma profiles of three chicken formulations. The GC- chromatographs revealed the significant aroma alterations of chicken breast meat after marination with spices. Aldehydes were the major contributors of chicken aroma, while most of the aromatic hydrocarbons were generated by spices.

Yuan *et al.* (2023) studied and evaluated the correlation between the sensory characteristics and spices of 50 commercial meat analogs and selected 4 spices to improve the flavor characteristics of soy protein concentrate (SPC) extrudates. Volatile compounds in extrudates and commercial meat analogs were investigated using headspace solid-phase microextraction and gas chromatography–mass spectrometry.

2.4 Snack meat product

Khare *et al.* (2015) studied the effects of meat level (110–130 g), processing conditions such as steaming time (12–18 min) and drying time (7–9 h) on the water activity, yield, water absorption index, water solubility index, hardness, overall acceptability and total color change of chicken noodles. Based on the response surface and superimposed plots, the ideal development circumstances for chicken noodles with the necessary sensory quality were found to be a meat level of 60%, a steaming duration of 12 minutes, and a drying time

of 9 hours.

Singh *et al.* (2015) observed the effect of different fillers on the physico-chemical and sensory attributes of chicken meat caruncles. Four different batches were prepared as follows - control (35% refined wheat flour), T-1 (22.75% refined wheat flour + 12.25% rice flour), T-2 (14.00% refined wheat flour + 21.00% tapioca starch) and T-3 (35.00% potato starch).

Verma *et al.* (2015) reported that addition of chicken meat in refined wheat flour based noodles improved overall nutritive values, and palatability of noodles. Up to 40% of the noodles' weight in chicken meat resulted in enhanced nutritional value, improved textural parameter, and acceptable microbiological limit and sensory quality.

Kumar *et al.* (2019) reported that study conducted to formulate noodle by incorporating various levels (10-50) % of chicken minced meat (CMM), chicken meat powder (CMP), in refined wheat flour separately. The most popular treatment and control for sensory evaluation during storage were noodles with a 20 percent CMM and 20 percent CMP enrichment. Even after being stored at room temperature for 60 days, the noodles were determined to be safe for ingestion.

Madane *et al.* (2019) investigated the efficacy of Moringa flower (MF) extract to develop a functional chicken product. Three groups of cooked chicken nuggets—control (C), T1 (with 1% MF) and T2 (2% MF)—were elaborated and their physicochemical, nutritional, storage stability and sensory attributes were assessed during refrigerated storage at 4 °C up to 20 days. In addition, MF extracts were characterised in terms of chemical composition, total phenolic content and its components using high-performance liquid chromatography with a diode-array detector (HPLC-DAD), dietary fibre and antioxidant capacity.

Korish *et al.* (2020) assessed the concentrations of Fe, Cu, Zn, Mn, Se, Co, Cr, Pb, Cd, and Ni in chicken meat and meat products, feed, and litter, as well as laying hens' eggs, feed and litter to monitor the quality of products on the market and their safety for human consumption as judged by recommended daily allowance (RDA) and tolerable upper levels. Samples were chosen as the most

popular poultry products in Saudi Arabia. A total of 45 broiler samples of frozen or fresh meat, liver, burger, or frankfurter were chosen from the same brand. Additionally, 60 table eggs from four commercial brands were collected, and the edible parts of these were used to determine levels of minerals and toxic elements.

Tanna *et al.* (2020) studied the development of value-added product (chicken chakli) from spotted seer fish powder. Three flours such as rice flour, wheat flour and bengal gram flours were added with same ratio of edible fish powder (EFP). According to parameter such as proximate analysis, physical analysis and sensory evaluation best combination was choose. Highest sensory score observed in combination (Wheat flours).

Bhosale *et al.* (2021) stated that multigrain extruded product chakli was developed so as to obtain value addition to the traditional fried product and provide healthy food. The goal of the current study was to create two multigrain chakli samples using varied amounts of malted finger millet and amaranth flour in place of typical flour, and to analyses the effects on nutritional composition, sensory perception, and storage properties. For the purpose of studying shelf life, the best fortified Chakli was analyzed. Finally, chakli's nutritional value was discovered to have greatly improved.

Oyeniran *et al.* (2021) stated that the addition of 10% spent hen chicken meat powder in wheat noodles enhances its nutritive value thereby facilitating growth especially of children in poor nations.

2.5 Quality parameters

2.5.1 Proximate composition

Talukder *et al.* (2015) carried out experiment to improve the nutritional quality, storage stability and acceptability of traditional bhujia by incorporation of spent hen meat powder in formulation to supplement high quality protein to consumers. Bhujia (both C and T) were analyzed for physico-chemical properties for 45 days. They observed protein and fat percentage was significantly higher ($P<0.05$) in T (36.49%) and C (37.89%) respectively.

Nayar *et al.* (2015) studied the development and comparison of shelf stable extended and dehydrated goat meat cubes containing four different legume-based binder mixes. Four different formulations containing 80 % meat mince+10 % Bengal gram-based binder mix (HBE), 70 % meat mince+20 % green gram-based binder mix (HGR), 80 % meat mince+10 % black gram-based binder mix (HBL) and 80 % meat mince+10 % lentil-based binder mix (HLE). on the basis of proximate composition Moisture content was highest for HLE (10.37 ± 1.06 %) and lowest for HBL (8.83 ± 0.35 %), which also had the lowest water activity. Protein, fat and ash contents showed significant difference ($p < 0.01$) among all four treatments.

Verma *et al.* (2015) reported that adding chicken meat to noodles made with refined wheat flour enhanced the overall nutritional content and flavor of the noodles. Noodles that contained chicken meat (up to 40%) had improved textural parameters, and had superior nutritional value.

Rindhe *et al.* (2018) observed that hydrated wheat bran affected the physical-chemical, textural, aesthetic, and sensory characteristics of spent hen meat nuggets. Ash, fibre, and water holding capacity increased significantly ($P < 0.05$), but moisture, protein, fat, and aw decreased with the addition of wheat bran, water holding capacity, emulsion stability, and cooking yield all considerably ($P < 0.05$) increased.

Chaudhary *et al.* (2019) developed quail meat nuggets using bengal gram flour with 10% concentrations. In which the boneless meat of Japanese quail was used, while the skin, subcutaneous fat, tendon separable connective tissue were trimmed off. The shelf-life of Japanese quail meat nugget prepared with bengal gram flour was assessed at refrigeration temperature 4 ± 1 oC. During refrigerated storage, the scores for all the sensory attributes, moisture, protein and fat declined but ash content inclined with the progress of storage period. Similarly, pH, TBA number, tyrosine value and microbial counts increased considerably throughout the storage period but were within the spoilage limit up to 20 days.

Raghav and Sharma (2019) studied rice bran was selected and used to supplement the snack by incorporation of processed rice bran by the microwave

heat treatment. The nutritional quality of Microwave Processed Rice Bran (MPRB) was evaluated using AOAC methods. Proximate composition of MPRB for moisture, protein, fat, ash, fiber, carbohydrate and energy were 3.12 g, 10.78 g, 20.57 g, 9.23 g, 18.47 g 37.84 g and 379.57 Kcal per 100 g respectively. Rice bran supplemented gram flour snack was standardized with the different percentage of rice bran (0%, 10%, 15% and 20%) and named as S, A, B and C respectively.

Alamuoye *et al.* (2024) investigated the moisture adsorption behavior was analyzed using a gravimetric method while proximate analysis was performed according to official methods. Sensory results showed that equilibrium moisture content increased as water activity increased from 0.043 to 0.750 but remained relatively constant at 0.843 to 0.973 aw. Proximate analysis revealed that the protein content of chicken jerky was high (76.13) while a low-fat content (1.72%) was obtained in this study.

2.5.2 Physico-chemical parameter

2.5.2.1 pH

Tesoniero *et al.* (2016) studied the impact of white striping and wooden breast myopathies on the technological quality, mineral, and sensory profile of poultry meat. With this purpose, a total of 138 breasts were selected for a control group with normal breasts (N), a group of breasts characterized by white striping (WS) myopathy, and a group of breasts having both white striping and wooden breast myopathies (WSWB). Data revealed that the simultaneous presence of the two myopathies, with respect to the WS lesion individually considered, had a further detrimental effect on pH (6.04 vs. 5.96; $P < 0.05$), yellowness (11.4 vs. 10.3; $P < 0.01$), cooking losses (30.4 vs. 27.6%; $P < 0.05$), toughness instrumental values (22.8 vs. 20.0 N; $P < 0.01$), and perception (6.22 vs. 5.56; $P < 0.01$). In addition, mineral contents suggest that a defective ions regulation is also present in white striping and wooden breast myopathies.

Hashem *et al.* (2023) studied that extra virgin olive oil (EVOO) treatment during the vacuum and aerial packaging affected the sensory, physicochemical, biochemical, and microbiological characteristics of chicken breast meat. The pH

levels varied significantly ($p < 0.05$) amongst the four treatment groups. In the T2 group, the most favorable raw pH was observed.

Chattopadhyay *et al.* (2023) studied the effect of the Chitosan Concentration and gel pH on Physico chemical and Functional Properties of Fish Protein Emulsion Sausages. In chitosan-based studies on food, it is supposed that chitosan at upper low pH gradients (pH exceeding 5.0) forms strong gels because of the existence of the reactive $-NH_2$ moiety at the C2 position of chitosan molecule. A lucid concept in such inferences reveals that pH values greater than chitosan's pK_a values cause deprotonation of the amino groups ($-NH_2$) in chitosan, resulting in an augmented self-aggregation of protein molecules and their enhanced gelation.

Ranade *et al.* (2023) The incorporation of potato starch at increasing level resulted in a significant ($P < 0.05$) decrease in pH values of the treatment spent hen meat spread (SHMP) products. The highest pH values were found in the control product. As the starch level increased in meat spread from 5 to 9%, pH values were decreased.

2.5.2.2 Water absorption index

Aswathi *et al.* (2014) observed that the water absorption index (WAI) of products indicated that amongst all the treated samples T7 showed the highest value. WAI were ranging from 3.5 to 2.9, Show me the significant difference among the treatments. WAI reflects the ability of starch to absorb water and is an indirect measure of amount of impact and pulling gelatinized starch brands which is mobility index shore variation among the treatments and control.

Nowacka *et al.* (2024) studied that drying decreased the water activity and increased the dry matter content, which ensured the safety of the final product. The freeze-dried material exhibited a higher rehydration rate, improved hygroscopic properties, and better meat color compared to the hot air-dried material.

Zhang *et al.* (2023) studied same moisture, the water solubility index increased first and then decreased, while the water absorption index increased with the increase of $NaHCO_3$. With the increase of moisture, the hardness and

crispiness of extrudates generally decreased regardless of the addition of NaHCO₃. Importantly, at 14% moisture content, with NaHCO₃ addition increasing, a more refined cellular structure occurred, sulfide compounds enhanced and the rate of Maillard reaction increased.

Tang *et al.* (2023) studied results showed that the composite flour significantly improved water holding capacity, oil absorbing capacity, and water solubility index. In contrast, no significant change was observed in the water absorption index or swelling power. The incorporation of highland barley flour significantly changed the pasting properties of the composite flour. Compared with the wheat flour, the viscosity and the pickup of the coating batter made with composite flour increased from 4905 Pa·s and 0.53% to more than 12,252 Pa·s and 0.63%, respectively, and its water mobility decreased. These changes were closely related to the substitution rate of highland barley flour.

2.5.2.3 Water solubility index

Ali *et al.* (2016) observed a decrease in WSI (18.05 to 17.99) over a 3-month storage period in extruded products prepared from corn grits – corn starch incorporated with common carp.

Bandral *et al.* (2021) studied the water activity and oil absorption index of nuggets increased from 0.519 to 0.558 and 0.843 to 0.862 g per g, respectively, during three months storage. The study revealed higher values of water absorption index and rehydration ratio in nuggets formulated from higher levels of green leaf powder ; while the oil absorption index, bulk density, pH and water activity of nuggets decreased.

Rajagopal *et al.* (2023) studied the physical characteristics that were studied were expansion ratio, bulk density and water absorption index. The results of the study indicated that with increasing proportions of powdered chicken meat in the feed mix, the extrudates obtained were relatively less expanded, denser and with lesser water absorption capacity. However, T1, T2, T3 were expanded respectively up to 86.0 percent, 88.0 percent and 59.0 percent of that of control.

Deepika and Sutar (2023) revealed that water solubility index of extruded product incorporated with FP and SHE was dropped during storage and found to

be $8.50 \pm 0.08\%$ to $8.10 \pm 0.09\%$, $8.30 \pm 0.06\%$ to $8.02 \pm 0.10\%$ and $8.10 \pm 0.08\%$ to $7.81 \pm 0.09\%$ for T1, T2, and T3 respectively. The decrease in water solubility index during storage is due to an increase in moisture content.

Subbalakshmi *et al.* (2024) studied the water solubility index of control maize flour fryums differed significantly between them. The high water solubility index of control as compared to maize flour fryums could be attributed to higher level of starch with increased fragmentation and starch conversion resulting in higher water solubility characteristics.

2.5.2.4 Cooking yield

Biswas *et al.* (2003) evaluated the effect of applying edible coating and addition of antioxidants (butylated hydroxyanisole (BHA) plus butylated hydroxytoluene (BHT) in a 1:1 ratio) on pork patties to achieve desired physico-chemical, microbiological and sensory qualities. It was observed that the cooking yield of pork patties varied from 85.18 ± 0.68 to 87.42 ± 0.3 . It was also reported that higher cooking yield relates to adhesion of batter mix on products as good adhesion improves the cooking yield.

Raut *et al.* (2011) studied the effect of batter consistency as enrobing on quality of chicken patties. It was observed that cooking yield and moisture percentage of chicken patties decreased significantly ($P < 0.05$) with coating of batter having different consistencies. The highest cooking yield and moisture percentage was noted in chicken patties enrobed with 1:1.0 batter consistency which declined significantly with increase in ratio of flour to water. The batter consistency being used is an important factor which influences the adherence of coating that ultimately resulted in higher or lower cooking yield of the product and higher moisture in enrobe patties with 1:1.0. The cooking yield and moisture content of enrobed chicken patties was reduced significantly ($P < 0.05$) in 1:1.4 ratio of bengal gram flour and water.

Para *et al.* (2015) used green gram flour as enrobing material for papaya pulp-enriched chicken nuggets. Significant increase observed in the cooking yield with increase in levels of green gram flour in batter mix. The nuggets enrobed with 35 % GGF (w/w) had higher cooking yield. The batter consistency being

used is an important factor which influences the adherence of coating that ultimately results in higher or lower cooking yield of the product.

Rajeshwar *et al.* (2018) carried out experiment for development of spent hen meat kachori incorporated with prebiotic fibers. Minced chicken meat was incorporated at 55%, 65% and 75% level in the developed kachori. With increasing levels of inulin powder incorporation in the formulation, the cooking yield of chicken meat kachori rose significantly ($P < 0.05$).

Bhosale *et al.* (2021) developed “multigrain extruded product chakli” so as to obtain value addition to the traditional fried product and ultimately provide healthy food. They stated that the cooking yield of chakli differed significantly ($P < 0.05$) with addition of different flour.

Phopase (2023) observed that cooking yield of chicken chakli differed significantly ($P < 0.05$) due to different levels of wheat flour. However, non-significant gradual decline in cooking yield was noticed with increase in levels of wheat flours up to 40% further increase results decrease in yield of chicken chakli in control (50% flour and 50% chicken). This indicated that wheat flour upto 40% had no any adverse effect on cooking yield.

2.5.3 Sensory quality

Choudhary *et al.* (2019) reported that to create quail meat nuggets using 10% concentrations of Bengal gram flour. The sensory scores for appearance, flavor, juiciness and texture and overall palatability significantly ($P < 0.05$) declines throughout the storage period.

More *et al.* (2019) aimed to develop wheat flour noodles with addition of different levels of quail mincemeat (0%, 40%, 50% and 60%). Birds (quails) were slaughtered and dressed in the department of Livestock Products Technology. The skin, subcutaneous fat, tendon, connective tissue were removed from quail meat and packed in low density poly ethylene (LDPE) and stored overnight at $4 \pm 1^\circ\text{C}$ for ageing and thawed quail meat which was further used for product preparation. The results indicated that, during storage at room temperature ($35 \pm 2^\circ\text{C}$), The sensory scores for all attributes decreased with the advancement of storage period, but the products were acceptable up to 60 days of storage.

Chappalwar *et al.* (2020) found significant decrease in sensory score regarding colour and appearance, flavor, texture, meat flavor intensity and overall palatability except saltiness which decrease non significantly with the incorporation of mango peel powder in chicken patties.

Goswami *et al.* (2020) recorded higher sensory scores for control product than gooseberry seed coat powder (GSCP) and gooseberry pulp powder (GPP) treated spent hen meat nuggets up to 10th days of refrigerated storage. Thereafter a significant linear decline was observed in all sensory characteristics scores with advancement of storage period. However, on the 25th day, 0.5% pulp-added nuggets showed higher sensory characteristics scores than other samples.

Nemade (2019) found that cookies enriched with 50% spent hen meat powder can be safely stored in low-density polyethylene (LDPE) packaging for up to 60 days at room temperature ($37 \pm 1^\circ\text{C}$) without compromising sensory quality.

Akram *et al.* (2022) reported that addition of banana peel powder had significant ($p < 0.05$) effect on sensory parameters of broiler nuggets. The colour and flavour scores were decreased with increase in the concentration of banana peel powder in broiler nuggets. However, addition of 2% banana peel powder significantly ($p < 0.05$) affected on tenderness of the product contributing to the hardness of functional nuggets.

Indumathi *et al.* (2022) reported that study was carried out to assess the keeping quality of aerobically packed functional chicken sausages under refrigeration by using ground vegetable oilseeds on physico-chemical, proximate, microbiological and sensory properties of the product. Sensory attributes showed a significantly decreasing trend ($p \leq 0.05$) for both control as well as low-fat chicken sausages throughout storage period.

Phopase (2023) revealed that sensory scores for all the sensory attributes of chicken chakli differed significantly ($P < 0.05$) due to addition of bengal gram flour. chicken chakli added with 40% bengal gram flour recorded highest scores for flavor as well as appearance.

2.6 Shelf-life parameter

2.6.1 Proximate composition

Cakmak *et al.* (2016) reported that Moisture content and water activity values of the samples during storage. Initial and final moisture contents of the samples were between 2.927 and 8.280%, while at the end of storage they were between 3.608 and 7.537%. pH values are given for each sample were decreased during storage and were between 5.840-6.050 at the beginning of storage and between 5.480 and 5.780 at the end of storage. The final pH values were found to be lower than the initial values for all snacks depending on the storage time, but no significant difference was observed between almost all the snack types.

Pal *et al.* (2017) reported that incorporating exogenous proteins into food products is a better practice for improving nutritional attributes of food commodities. In the search for a way to improve the product and nutritional quality of noodles, this study was aimed to evaluate the impact of the incorporation of poultry-based ingredients egg yolk powder (EYP) and chicken mincemeat (CMM) in noodles at different levels (5%, 10% and 15%, w/w). The incorporated noodles were subjected to evaluation of the cooking, texture, color, sensory and microstructure properties. The results showed that the incorporation of poultry-based food ingredient types and amount influence the nutritional content of noodles.

Rindhe *et al.* (2018) stated that incorporation of wheat bran significantly increased moisture retention and fat retention of spent hen nuggets incorporated with hydrated wheat bran.

Choudhary *et al.* (2019) carried out experiment on shelf life of Bengal gram flour based Japanese quail meat nuggets. Result revealed that ash content of 10 % Bengal gram flour incorporated quail meat nuggets was higher ($P < 0.05$) than that of quail meat nuggets. The moisture content of 10% bengal gram flour incorporated quail meat nuggets were significantly ($P < 0.05$) higher than control quail meat nuggets During storage, the ash content inclined significantly throughout the entire storage period. Significant ($P < 0.05$) decrease in protein of quail meat nuggets was observed with increase in refrigerated storage time.

Saikia *et al.* (2019) study was conducted to assess proximate composition, textural & color profile, and microbiological quality of duck meat patties incorporated with Bengal gram flour (BGF). Three formulations were created with BGF at varying concentrations: 5% (T1), 10% (T2), and 15% (T3). These formulations were compared to the control (CT) sample, which was created without BGF. The proximate composition, texture, and color profile of the duck meat patties were assessed. There was a significantly ($P < 0.01$) decreasing trend in the mean percent moisture, crude protein, and ether extract.

Sharma *et al.* (2022) studied Chakli is a coiled- round, salty, deep-fried snack commonly prepared in different occasion in tribal belt from rice and chickpea flour paste seasoned with turmeric and chili powder. In the present study various cheapest legume dhal flours viz., soybean and field pea were used to make more nutritious chakli. Instant chakli mixes and control were evaluated on sensory, nutritional and storability parameters and standardized as per desired acceptable sensory characteristics. Based upon the sensory evaluation, the optimized level of supplementation was found to be 25% supplementation of legume dhal flour in rice flour.

2.6.2 Thiobarbituric acid values (TBA)

Talukder *et al.* (2015) reported that experiment carried on to improve the nutritional quality, storage stability and acceptability of traditional bhujia by incorporation of spent hen meat powder in formulation to supplement high quality protein to consumers. TBARS value was under acceptable level at the end of storage.

Kumar *et al.* (2016) studied the fiber-enriched chicken meat biscuits incorporated with wheat bran and oat bran at three different levels i.e., 3% (W1/O1), 5.0% (W2/O2) and 7% (W3/O3) were formulated and evaluated. On the basis of sensory quality from each group, W2 and O2 were selected for storage study at ambient temperature for 180 days. The bran incorporation resulted in a significant lowering ($P < 0.05$) in the pH values, fat content, water activity and calorific values whereas moisture content, TBA value, ash and crude fiber content of treatment recorded an increased trend

Tabassum *et al.* (2018) observed that study aimed to investigate the effect of air drying and deep fat drying on quality attributes of chicken ravioli. Whole wheat flour, “refined wheat flour” (maida) and dehydrated chicken powder in the ratio of 40:40:20 was found best for preparation of dough. TBARS values shows increasing trend from 0 to 60 days in both samples.

Choudhary *et al.* (2019) studied development the quail meat nuggets using bengal gram flour with 10% concentrations. During refrigeration temperature TBA value increased significantly but were within spoilage limit upto 20 days.

Sarkar *et al.* (2020) investigated the feasibility of incorporation of spent hen meat powder in traditional bhujia formulation to enrich the nutritional and sensory quality of product. Four treatment combinations i.e. Treatment-A (0% meat powder), Treatment-B (10% meat powder), Treatment-C (15% meat powder) and Treatment-D (20% meat powder) were prepared and analyzed for its physicochemical, nutritional, microbiological, sensory and storage stability for a period of 60 days. The cooking yield, water requirement for dough preparation and oil uptake increased with the increase level of incorporation of meat powder in treated groups. On the other hand factorability and pH of treatments decreased with increased level of incorporation of meat powder. There was also significant and gradual increase of pH and TBA value in subsequent storage period.

Kaur *et al.* (2022) stated that the present study was envisaged to develop high fibre spent hen meat cutlets by utilizing stems and leaves powder of cauliflower (CLSP) at four different levels viz. Control-0%, T1-2%, T2-4% and T3-6%, by replacing lean meat in the basic formulation. The developed meat cutlets were analyzed for various physicochemical, proximate, instrumental colour, texture and sensory attributes. Moisture, TBARS, ash and fibre content differ a significantly ($p < 0.05$).

2.6.3 Tyrosine values

Reddy *et al.* (2020) assessed storage stability of turkey meat sausage incorporated with carrot and radish at refrigeration temperature. They observed a considerable ($P < 0.05$) increase in tyrosine values of turkey meat sausages over the entire refrigerated storage period.

Lonarkar *et al.* (2021) recorded significantly ($p < 0.05$) increased tyrosine (mg/100g) values in control and custard apple (*Annona squamosa*) peel powder treated chicken samosa. However, these values were significantly ($p < 0.05$) lower in custard apple peel powder-treated chicken samosa as compared to the control and BHT treated chicken samosa.

Nemade *et al.* (2021) observed that the tyrosine values were significantly ($P < 0.05$) higher in cookies incorporated with 50% spent hen meat powder as compare to control cookies. The tyrosine values increased significantly in both control cookies and 50% spent hen meat powder cookies from 0.24 and 0.80 to 0.98 to 1.61 respectively during 60th day storage period.

Deshpande (2022) reported increase in pH, TBARS and tyrosine value, while non-significant ($P < 0.05$) decrease in titratable acidity value on addition of carrot (*Daucus carota* subsp. *sativus*) and radish (*Raphanus raphanistrum*) powder in chicken nuggets during the refrigerated storage period.

2.6.4 Sensory quality

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Indumathi *et al.* (2022) reported that study was carried out to assess the keeping quality of aerobically packed functional chicken sausages under refrigeration by using ground vegetable oilseeds on physico-chemical, proximate, microbiological and sensory properties of the product. Sensory attributes showed a significantly decreasing trend ($p \leq 0.05$) for both control as well as low-fat chicken sausages throughout storage period.

2.6.5 Microbial analysis

Prasad *et al.* (2011) developed chicken kofta made with minced meat (72%), oat flour (8%), casein (2.5%), and refined wheat flour (7%), was used (OFC). The product used as the control had 10% refined wheat flour, 7.5% hydrogenated oil, and no oat flour or casein. Microbial analysis indicated that yeast and mould in fresh samples (0 day) not detected. Organism recorded only after 5 days of stored samples. The counts increased gradually ($P < 0.05$) by 1-2 log cfu/g during 15 days storage samples.

Cakmak *et al.* (2016) stated that chicken meat in two different forms (chicken meat and chicken meat powder) were added into white flour and whole wheat blend baguette bread formulations for protein enrichment and finally developing new and healthy snacks. The findings of the yeast-mold count and aerobic plate count of snacks stayed within the quantifiable ranges and no coliform bacteria were found throughout storage.

Raja *et al.* (2014) evaluated the effect of ambient storage on the quality attributes of aerobically packaged fish curls incorporated with optimum levels of different flours. The fish curls containing optimum levels of different flours viz. 20 percent corn flour, 10 percent black gram flour and 10 percent peanut flour were compared with the control snacks containing 30 percent rice flour and assessed for storage quality and shelf life at ambient temperature. Result indicated in the microbial analysis that total plate count (log cfu/g) and yeast and mould count (log cfu/g) for the control as well as treatment samples showed significantly ($p < 0.05$) increasing trend with storage.

Das *et al.* (2015) carried experiment on the treatment of chicken patties with sorghum flour (SF) (10%w/w), finger millet flour (FMF) (10%w/w), and carrageenan (Cgn) (0.5% w/w) as fat replacer affected total plate count in chicken patties. Result revealed that total plate count of raw chicken patties held at 4°C did not change when SF, FMF, or Cgn were added as a fat replacement; however, the storage time had a highly significant ($P < 0.01$) impact on TPC. TPC values over the storage duration significantly increased.

Athawale *et al.* (2019) stated that gluten-free foodstuffs are a challenge for Technologist and Nutritionist since alternative ingredients used in their formulations have poor functional and nutritional properties. A study was lead to standardize an innovative nutritious product for consumer's acceptance. The product designed was a nutritious product for all age groups, gluten allergic people, pregnant and lactating mothers and malnourished or underweight children and adults. Therefore, Gluten-free flat bread stick was formulated which gave high nutrient valued product with best possible combination of bengal gram, black gram, samo, amaranth, oats, arrowroot powder and rice flour.

Choudhary *et al.* (2019) carried study on development of quail meat nuggets using bengal gram flour with 10% concentrations. Microbial counts increased considerably throughout refrigerated storage but were within spoilage limit within 20 days.

Indumati *et al.* (2022) assessed the keeping quality of aerobically packed functional chicken sausages under refrigeration by using ground vegetable oilseeds on physico-chemical, proximate, microbiological and sensory properties of the product. Low-fat chicken sausages incorporated with three different ground vegetable oilseeds (poppy, sesame and peanut) at 10% level were developed and analyzed for their keeping quality along with high fat control under aerobic packaging conditions kept at chilling ($4\pm 1^{\circ}\text{C}$) temperature until spoilage. The formulation and storage period had a substantial ($P<0.05$) impact on the mean values of FFA, TBARS, Tyrosine, standard, psychrophilic, yeast, and moulds plate count for all sausages, and these values grew significantly ($P<0.05$) over the course of storage.



Materials and Methods

CHAPTER - III

MATERIAL AND METHOD

3.1 Source of raw material

3.1.1 Broiler Chicken meat

Chicken meat was procured from a local meat market in Parbhani and slaughtered using the traditional halal method. Care was taken during transportation to the laboratory, where tendons, connective tissue, and body fat were removed. The meat was then packed in LDPE pouches and stored overnight in a deep freezer at $-18 \pm 1^{\circ}\text{C}$ before being used to formulate products.

3.1.2 Spice mix

Composition of spice mix mainly include red chilli powder, coriander powder (Dhania), cumin (zeera), compounded asafetida, turmeric powder (Haldi), ajwain (Bishop's seeds), clove (loang), black pepper (kali mirch), trifala, nutmeg etc. For two and half hours, the components were dried in a hot air oven at 60°C . Grinding and sieving was done to remove foreign particles.

Table 3.1 Composition of spice mix

Sr. No	Ingredients	In grams
1	Black paper (Kali mirch)	10
2	Red Chilli	10
3	Turmeric Powder	5
4	Cumin (jeera)	20
5	Coriander Powder (Dhaniya)	15
6	Badi Iliaychi	5
7	Small Iliyachi	2.5
8	Dalchini	2.5
9	Trifola	5
10	Nutmeg (Jayfal)	5
11	Clove (laung)	5
12	Asofeotida (Hing)	5
13	sauff	10
	Total	100 gm

3.1.3 Other ingredients

Corn starch, Food grade common salt, refined sunflower vegetable oil were purchased from near local market for development of chicken caruncles.

3.1.4 Bengal gram flour

Nutritional composition of bengal gram per 100 gm given in the Table below Grains of bengal gram were ground into fine mesh flour in grinder machine and sieved to remove any foreign stuff. Different levels of Bengal gram flour viz 30%, 40% and 50% were used for preparation of chicken caruncles.

Table 3.2 Nutritional composition of bengal gram flour (per 100 g)

Sr. No	Nutritional component	Amount
1	Energy	378 Kcal
2	Protein	20.47 gm
3	Total fat	6.04 gm
4	Carbohydrates	62.95 gm
5	Fiber	12.2 gm
6	Calcium	57 mg
7	Iron	4.31 mg
8	Magnesium	79 mg
9	Phosphorus	252 mg
10	Potassium	718 mg

(Wallace *et al.* 2016)

3.2 Formulation of chicken caruncles

Chicken caruncles was prepared as per the method used by Singh *et al.* (2013) with slight modification.

Table 3.3 Basic formulation of chicken caruncles

Sr. No	Ingredients	T1	T2	T3
		In gram	In gm	In gm
1	Minced chicken meat	25	30	35
2	Bengal gram flour	25	20	15
3	Warm water	30	30	30
4	Oil	10	10	10
5	Spice mix	3.5	3.5	3.5
6	Red chilli powder	2	2	2
7	Ajwain	2	2	2
8	Salt	2	2	2
9	Baking powder	0.5	0.5	0.5
	Total	100	100	100

T-1 = Caruncles with 50% flour (bengal gram) and 50% chicken,

T-2= Caruncles with 40% flour (bengal gram) and 60% chicken,

T-3= Caruncles with 30% flour (bengal gram) and 70% chicken

3.2.1 Preparation of chicken caruncles

Chicken caruncles was prepared as per the method used by Singh *et al.* (2013) with minor modification. Frozen deboned chicken meat was chopped into small pieces followed by mincing in a meat mincer after thawing at ambient temperature. Bengal gram flour were wrapped in muslin cloth followed by cooking for 10 minutes in pressure cooker. After cooking, bengal gram flour was sieved to remove foreign particles. Other ingredients like vegetable oil, corn starch, spices were added to form dough. Chicken caruncles was prepared as per the following flow diagram.

Flow diagram for the preparation of chicken caruncles

Selection of raw ingredients and deboned meat



Mixing of minced meat, salt, bengal gram flour and other ingredients



Addition of oil and blending (1.5 min.)



Blending (1 Min)



Chicken emulsion



Extrusion of chicken emulsion



Thin long chip like chicken caruncles (5-6 cm x 1 cm)



Cooking by microwave oven for 4 min.



Cooling at room temperature



Packaging in PET Jars



Storage at room temperature



Plate 3.1 - Raw ingredients used for product making



Plate 3.2 - Chicken emulsion



Plate 3.3 - Caruncles makers



Plate 3.4 - Chicken caruncles prepared with Bengal gram flours

3.3 Experimental details

3.3.1 Effect of different levels of bengal gram flour on quality of chicken caruncles.

Chicken caruncles was prepared by incorporating different levels (30%, 40% and 50%) of bengal gram flour in chicken caruncles and stored at room temperature. The best level was selected on the basis of proximate composition, physico- chemical parameter viz. pH, cooking yield, oil absorption and sensory evaluation.

3.3.2 Shelf life of bengal gram flour incorporated chicken caruncles stored at room temperature.

The objective of this experiment was to assess the shelf life of chicken caruncles during storage. Chicken caruncles prepared by using selected level and bengal gram flour was aseptically packed in PET jars and stored at room temperature. The chicken caruncles was assessed for changes in proximate, physico- chemical, microbiological quality and sensory attributes at regular interval of 10 days.

3.3.3 Cost structure of chicken caruncles

The main objective of this experiment was to assess the overall cost of developed chicken caruncles fortified with bengal gram flour.

3.4 Analytical procedures

3.4.1 Proximate composition

The moisture, fat, protein, and ash content of chicken caruncles were measured using the AOAC technique (1995).

3.4.1.1 Moisture

Five gram of chicken caruncles sample was kept in hot air oven and dried at (100±2°C) until constant weight was observed in subsequent weighing and loss in weight was recorded as moisture content.

3.4.1.2 Fat

The fat content of chicken caruncles was calculated using the soxhlet extraction technique. The moisture-free sample was pulverized and extracted in a device with petroleum ether (60 to 80°C). Allow the equipment to run for a sufficient amount of time until all of the fat in the sample has dissolved in the petroleum ether. The ether extract was exposed to a hot air oven to entirely eliminate the petroleum ether from the extract, and it was weighted as fat.

3.4.1.3 Protein

The total nitrogen content of the chicken caruncles was calculated using Kjeldahl's technique, which involved converting nitrogen to ammonia and titrating it. The protein content was calculated by multiplying the nitrogen content by 6.25. These methods consist of three phases –

Digestion

The structure and chemical bonds that keep protein molecules together were broken down during digestion, and amino nitrogen is transformed into ammonium radical. It is a controlled thermal oxidative degeneration of a sample in concentrated sulphuric acid in the presence of Potassium sulphate and Copper sulphate as catalysts. This catalyst combination boosts the boiling point of sulphuric acid and reduces the digesting time.

Distillation

Distillation is the process of separating and isolating nitrogen from a digested mixture. This was accomplished by raising the pH using NaOH. The ammonium radical was converted to ammonia as a result of this. The ammonia was distilled and collected in a trapping medium containing 4% boric acid.

Titration

The amount of nitrogen was determined by titrating with a standard solution of 0.1 N HCl in presence of mixed indicator.

3.4.1.4 Ash

Clean crucibles were placed under a muffle furnace at 600 °C for one hour. Crucibles were moved from the furnace to a desiccator and cooled to room temperature. These crucibles were weighed quickly to prevent moisture absorption. 2.0 gm of chicken caruncles sample was added into dried silica crucibles. Placed in a muffle furnace and the temperature were held at 600 °C for 6 hours. The crucibles were taken to a desiccator and cooled to room temperature. After cooling crucibles, were weighed quickly to prevent moisture absorption.

3.5 Physico-chemical parameter

Following physico-chemical parameter of the samples were analyzed.

3.5.1 pH

The pH of chicken caruncles was tested using the Trout *et al.* (1992) technique. The pH of the samples was measured using a digital pH meter after ten gram of cooked chicken caruncles was combined with 100 ml of distilled water.

3.5.2 Cooking yield

The weight of chicken caruncles was taken before and after frying and expressed in percentage.

$$\text{Cooking yield} = \frac{\text{Weight of chicken caruncles after frying}}{\text{Weight of chicken caruncles before frying}} \times 100$$

3.5.3 Water absorption index

The weight of chicken caruncles was taken before and after frying and expressed in percentage. (Nargis *et al.* 2017)

$$\text{Percent of water absorbed} = \frac{(U - V) \text{ in ml}}{\text{Weight of the chicken caruncles}} \times 100$$

U = Initial volume of the water in the measuring cylinder

V = Final volume of the water in the measuring cylinder

3.5.4 Water solubility index (WSI)

Water solubility index determines the amount of polysaccharides or polysaccharide release from the granule on the addition of excess of water. WSI was the weight of dry solids in the supernatant from the water absorption index test expressed as percentage of the original weight of the sample. (Nargis *et al.* 2017)

$$\text{WSI (\%)} = \frac{\text{WSI Weight of dissolved solid in supernatant}}{\text{Weight of dry solids}} \times 100$$

3.6 Shelf life study of chicken caruncles

3.6.1 Thiobarbituric acid

The value of thiobarbituric acid was estimated by using Witte *et al.* (1970) approach. In a test tube, 5 ml of TCA extract was combined with 5 ml of TBA reagent. The test tubes holding the sample, as well as the control tubes, were placed in a water bath at 100 degrees Celsius for 30 minutes (a blank with 5 ml of 10 percent TCA and 5 ml TBA reagent). Using a spectrophotometer, the optical density was determined at 530 nm.

3.6.2 Tyrosine value

For estimating the tyrosine value of chicken caruncles, the approach of Strange *et al.* (1977) was used with minor modifications. TCA extract was made by combining 20 g of chicken caruncles with 50 ml of precooled 20% TCA solution for 2 minutes. The contents were transferred to a beaker after full blending by washing with 50 ml cold distilled water, mixing, and filtering with Whatman filter paper number 42. In a test tube, 2.5 ml of TCA extract was combined with an equal quantity of distilled water, then 10 ml of 0.5 N NaOH was added, followed by 3 ml of diluted folin and ciocalteus reagent. For color development, the mixture was held at a dark room temperature for 15 minutes after shaking. A spectrophotometer was used to measure the optical density at 730 nm. Using a standard graph, the tyrosine value was estimated as mg per gram of material.

3.7 Microbiological quality

At the end of storage, the microbiological quality of chicken caruncles was determined using the APHA method (1992), which included total plate count (TPC) and yeast and mould count. To obtain a 10^{-1} dilution, ten grams of aseptically packed chicken caruncles and 90 ml of 0.1 percent sterile peptone water were triturated in a sterile mortar for uniform dispersion. In pre-sterilized tubes containing 9 ml of 0.1 percent peptone water, additional serial dilutions were prepared. All of the dilutions were done near a flame, with all aseptic precautions used.

3.7.1 Total plate count

Plate count agar (23.5 gram) of powder was suspended in one liter of distilled water then autoclaved for 15 minutes at 15 lbs of pressure. For plating, 1 ml of inoculum was used in duplicate from suitable dilutions, using the pour plate method. Plates were incubated for 72 hrs at 37°C. Plates with 30 to 300 colonies were chosen for counting after incubation. The colonies were calculated and the result was represented as \log_{10} cfu/g.

$$\text{CFU/gm of sample} = \frac{C}{(n_1 + 0.1 n_2) \times d}$$

C = Total number of colonies from all plates

n_1 = number of plates of lower dilutions.

n_2 = number of plates of next to lower dilution

d = dilution factor corresponding to the lower dilution.

3.7.2 Yeast and mould count

Suspend 65.0 gram of Sabouraud dextrose agar of powder in one liter distilled water then sterilized by autoclaving at 15 lbs for 15 minutes. The medium after cooling at 45° was poured (20-25 ml) over the plates in duplicate previously containing 1 ml inoculum of suitable dilution. The petri dishes were incubated at $25 \pm 1^\circ\text{c}$ for 5 days. Black, White, Red or Greenish black colored colonies appeared on the plates were counted and expressed as \log_{10} cfu/g of sample.

3.8 Sensory evaluation

Using an 8-point descriptive scale (Keeton, 1983), a panel of academic staff members and post graduate students from the College of Veterinary and Animal Sciences, Parbhani were evaluated the quality of chicken caruncles on the basis of sensory attributes such as appearance, flavor, juiciness, texture, and overall acceptability.

3.9 Statistical analysis

The data collected during the study was analyzed using the analysis of variance technique by using software SPSS 20 test as described by Snedecor and Cochran (1994).



Results and Discussion

CHAPTER - IV

RESULTS AND DISCUSSION

The objectives of the present study were to develop chicken caruncles added with bengal gram flour as well as to access shelf life at room temperature and cost structure. The present chapter revealed the results obtained from various experiments carried out with regards to aforementioned objectives and presented in the text with the support of statistically analysed Tables (4.1 to 4.7)

4.1 Quality appraisal of chicken caruncles

Various experiments were conducted to develop acceptable quality chicken caruncles using bengal flour at different levels replacing proportionate amount of chicken. The combination of chicken to Bengal gram flours was selected on the basis of proximate, physico-chemical characteristics and sensory properties.

4.1.1 Quality of chicken caruncles added with bengal gram flour

4.1.1.1 Sensory evaluation

The sensory properties of chicken caruncles with various combination of bengal gram flours and chicken are presented in Table 4.1.

Table 4.1: Sensory properties of chicken caruncles added with Bengal gram flour

Parameters	Bengal gram flour levels		
	BGF-30	BGF-40	BGF-50
Appearance	6.22 ± 0.08 ^a	6.66 ± 0.10 ^c	6.44 ± 0.07 ^b
Flavour	6.86 ± 0.09 ^a	7.78 ± 0.19 ^c	7.10 ± 0.13 ^b
Juiciness	7.17 ± 0.17 ^a	7.89 ± 0.08 ^c	7.49 ± 0.07 ^b
Texture	6.55 ± 0.04 ^a	7.92 ± 0.16 ^b	7.89 ± 0.16 ^b
Overall acceptability	6.93 ± 0.17 ^a	7.89 ± 0.13 ^c	7.28 ± 0.19 ^b

[#]n=21 *Mean ± SE. with different superscripts row wise (small alphabets) differ significantly (p<0.05). **BGF-30**= Caruncles (30% bengal gram flour and 70% chicken) **BGF-40**= Caruncles (40% bengal gram flour and 60% chicken), **BGF-50**= Caruncles (50% bengal gram flour and 50% chicken).

The statistical significance ($p < 0.05$) of these findings highlights the notable impact of BGF concentration on the sensory characteristics. In the facilities where we conducted our sensory evaluation, we observed distinct preferences among consumers for chicken caruncles that were enriched with different levels of bengal gram flour (BGF). Chicken caruncles fortified with 40% BGF displayed superior sensory attributes, including appearance, flavor, juiciness, texture, and overall acceptability, as compared to chicken caruncles added with 30% and 50% BGF content.

Remarkably, the formulation containing 40% BGF showed a well-balanced combination of savory taste, succulent moisture, and appealing consistency, thereby contributing to its heightened overall acceptability. In contrast, although the 30% BGF variation had generally acceptable sensory characteristics, it did not meet the sensory score in terms of appearance. On the other hand, the 50% BGF version had a significantly ($p < 0.05$) reduced overall acceptability as compare to BGF-40. These observations highlight the delicate balance required to optimize the sensory appeal of BGF enriched chicken caruncles, with statistical significance supporting the identified preferences ($p < 0.05$) to BGF-40. Similar findings recorded by Phopase (2023) who observed addition of bengal gram flour in chicken chakli significantly ($p < 0.05$) influence the sensory properties.

4.1.1.2 Physico-chemical attributes:

The table 4.2 provides numerical observation with regards to the physico-chemical properties of chicken caruncles added with different levels of bengal gram flour (BGF).

Table 4.2: Physio-chemical properties of chicken caruncles incorporated with Bengal gram flour

Parameters	Levels bengal gram flour		
	BGF-30	BGF-40	BGF-50
pH	6.78 ± 0.05 ^a	7.01 ± 0.03 ^b	7.13 ± 0.02 ^c
Water absorption (%)	3.44 ± 0.06 ^a	4.06 ± 0.9 ^b	4.18 ± 0.06 ^b
Water solubility (%)	4.38 ± 0.08 ^b	3.50 ± 0.14 ^a	3.34 ± 0.15 ^a
Cooking Yield (%)	62.85 ± 0.22 ^a	63.46 ± 0.40 ^b	63.69 ± 0.49 ^b

n = 6, *Mean ± SE. with different superscripts row wise (small alphabets) differ significantly (p<0.05). **BGF-30**= Caruncles (30% bengal gram flour and 70% chicken) **BGF-40**= Caruncles (40% bengal gram flour and 60% chicken), **BGF-50**= Caruncles (50% bengal gram flour and 50% chicken).

pH differs significantly (p<0.05) with increased level of bengal gram flour in chicken caruncles. Chicken meat content decreases and BGF increased the pH values increased significantly (p<0.05). This might be due to lower pH values of chicken meat and higher buffering capacity of bengal gram flour (Biswas *et al.*, 2003). Similar observation were also recorded by Phopase (2023) for chicken chakli added with bengal gram flour.

Increase in BGF concentration showed significantly (p<0.05) positive correlation with increased water absorption and reduced water solubility, indicating better moisture retention and binding characteristics of chicken caruncles with higher levels of bengal gram flour. However, BGF-40 and BGF-50 did not differ significantly indicating that the higher concentration of bengal gram flour in chicken caruncles did not have any additional benefit. This finding aligns with the results of Verma *et al.* (2015), observed similar enhancements in value-added chicken meat noodles, thereby emphasizing the statistical significance (p<0.05) of BGF supplementation.

In the preparation of meat products, the cooking yield is a crucial factor for the economic point of view. Incorporation of bengal gram flour with decrease in chicken meat significantly (p<0.05) differs the cooking yield of chicken caruncles upto 40% level. However, additional incorporation of BGF upto 50% did not showed any significant variation in cooking yield of chicken caruncles.

This might be due to low amount of chicken in BGF-40 and BGF-50 as compared to BGF-30 results improvement in moisture retention and binding properties of chicken caruncles. Similar results were obtained by Phopase (2023) and Tanna *et al.* (2020) for chicken chakli and fish chakli added with different levels of bengal gram flour.

4.1.1.3 Proximate composition:

Table 4.3 illustrates the proximate composition of chicken caruncles fortified with varying levels of bengal gram flour (BGF).

Table 4.3: Proximate composition of chicken caruncles added with Bengal gram flour (BGF)

Parameters	Levels bengal gram flour		
	BGF-30	BGF-40	BGF-50
Moisture (%)	6.02 ± 0.16 ^c	5.81 ± 0.07 ^b	5.21 ± 0.14 ^a
Protein (%)	16.86 ± 0.11 ^a	19.48 ± 0.05 ^b	20.01 ± 0.19 ^c
Fat (%)	8.91 ± 0.37 ^c	8.28 ± 0.09 ^b	7.45 ± 0.05 ^a
Ash (%)	1.67 ± 0.10 ^a	2.26 ± 0.10 ^b	2.43 ± 0.14 ^c

n = 6, *Mean ± SE. with different superscripts row wise (small alphabets) differ significantly (p<0.05). **BGF-30**= Caruncles (30% bengal gram flour and 70% chicken) **BGF-40**= Caruncles (40% bengal gram flour and 60% chicken), **BGF-50**= Caruncles (50% bengal gram flour and 50% chicken).

As the concentration of BGF increases, significant (p<0.05) reduction in moisture content was observed in chicken caruncles. The highest moisture observed in BGF-30, which might be due to high moisture present in chicken meat and lower in bengal gram flour. This trend is consistent with the findings of Sanjeeva *et al.* (2010) in their study on low-fat pork bologna supplemented with chickpea protein isolates or chickpea starch, showing significance at the (p<0.05) level.

Additionally, the protein content demonstrates a significant (p< 0.05) increase with higher levels of BGF, indicating a significant (p< 0.05) nutritional enhancement. Among the variants, BGF-50 exhibits the highest protein content. This might be due to higher protein content of bengal gram flour results higher

protein in developed products. Similarly, Singh *et al.* (2015) observed this trend in their study on chicken meat caruncles with different fillers, reaching statistical significance at the ($p < 0.05$) level. Phopase (2023) also observed similar increasing trends in protein with addition of bengal gram flour in chicken chakli.

Likewise, as the bengal gram flour (BGF) levels rise, fat content decrease while ash content gradually increases significantly ($p < 0.05$), likely impacting flavor and nutritional characteristics. These results indicate that integrating BGF, especially at elevated concentrations, improves the nutritional content of chicken caruncles, potentially appealing to health-conscious individuals. The higher the ash content observed with addition of higher bengal gram flour which might be due higher mineral content of flour. Similar findings for ash content were observed by Sultana *et al.* (2017) for chapaties enriched with bengal gram flour. This also aligns with the findings of Rindhe *et al.* (2018) in their study on spent hen nuggets enriched with hydrated wheat bran, with statistical significance at the ($p < 0.05$) level.

Based on aforementioned results, it is observed that BGF-40 showed better sensory properties, optimum physico-chemical characteristics and adequate proximate compositional parameters as compared to BGF-30 and BGF-50, hence selected for subsequent storage study.

4.2 Shelf life of developed chicken caruncles at room temperature

4.2.1 Sensory properties

The table 4.4 showed the results of a study on the changes in sensory properties viz., appearance, flavor, texture, juiciness, and overall acceptability of chicken caruncles stored at room temperature. The caruncles were treated with two combination of bengal gram flour and chicken meat i.e T-1 (Caruncles with 50% bengal gram flour and 50% chicken) and T-2 (Caruncles with 40% bengal gram flour and 60% chicken).

Table 4.4: Sensory properties of chicken caruncles stored at room temperature

Treat/ Days	Day 0	Day 10	Day 20	Day 30	Day 40
	Appearance				
T-1	7.50±0.05 ^{Aa}	7.45±0.08 ^{Aa}	7.10±0.07 ^{Ab}	7.00±0.04 ^{Ab}	6.30±0.09 ^{Bc}
T-2	7.46±0.06 ^{Aa}	7.41±0.07 ^{Aa}	7.23±0.09 ^{Ab}	7.10±0.11 ^{Ab}	6.48±0.06 ^{Ac}
	Flavor				
T-1	7.41±0.10 ^{Aa}	7.35 ± 0.12 ^{Aa}	7.10 ± 0.05 ^{Bb}	6.87 ± 0.15 ^{Bb}	6.09 ± 0.10 ^{Bc}
T-2	7.50±0.06 ^{Aa}	7.46±0.08 ^{Aa}	7.15±0.15 ^{Bb}	6.94±0.28 ^{Bb}	6.36±0.13 ^{Ac}
	Texture				
T-1	7.35±0.07 ^{Aa}	7.10±0.04 ^{Ba}	6.58±0.05 ^{Bb}	6.30±0.08 ^{Bc}	5.52±0.09 ^{Bd}
T-2	7.41±0.08 ^{Aa}	7.31±0.10 ^{Aa}	6.80±0.16 ^{Ab}	6.63±0.08 ^{Ab}	6.09±0.05 ^{Ac}
	Juiciness				
T-1	6.70±0.05 ^{Ba}	6.31±0.05 ^{Bb}	6.10±0.09 ^{Bc}	5.95±0.05 ^{Bd}	5.24±0.08 ^{Be}
T-2	7.00±0.05 ^{Aa}	6.92±0.06 ^{Aa}	6.68±0.08 ^{Ab}	6.30±0.06 ^{Ac}	5.90±0.08 ^{Ad}
	Overall Acceptability				
T-1	6.95±0.09 ^{Aa}	6.87±0.08 ^{Aa}	6.30±0.12 ^{Ab}	5.90±0.08 ^{Ac}	5.30±0.04 ^{Bc}
T-2	7.15±0.16 ^{Aa}	6.94±0.17 ^{Aa}	6.43±0.16 ^{Ab}	6.11±0.15 ^{Ac}	5.46±0.05 ^{Ac}

n=21, *Mean ± SE. with different superscripts row wise (small alphabets) and column wise (capital alphabets) differ significantly (p<0.05). **NP**: Not performed
T-1: Caruncles (50% bengal gram flour and 50% chicken), **T-2**: Caruncles (40% bengal gram flour and 60% chicken)

The results show that there were significant (p<0.05) decrease in sensory properties of the chicken caruncles during entire storage period. Appearance scores for T-1 and T-2 decreased gradually from day 0 to day 10, thereafter appearance scores for both the treatments were at par from day 20 to day 30 followed by significant (p<0.05) decreased at day 40. This might be due to surface dehydration of chicken caruncles resulting from pigment breakdown in lipid oxidation with non-enzymatic browning at surface. At the end of storage, T-2 showed highest appearance scores as compared to T-1 might be due to initial

better scores. Similar findings were also recorded by Phopase (2023) for chicken chakli added with bengal gram flour and stored at room temperature.

Similar significant ($p < 0.05$) declining trends were observed in flavour scores of chicken caruncles during 40 days of room temperature storage. This might be due to loss of fat resulting from lipid peroxidation during storage as fat plays important role in flavour development (Pearson and Gillet, 1997). At the end of storage, the T-2 revealed significantly higher scores than T-1 might be due to high chicken content (60%) in the formulation. Similar decline in flavour scores during storage at room temperature were observed by Kapse (2016) and Phopase (2023) for chevon noodles and chicken chakli respectively.

The average scores for texture, juiciness and overall acceptability were decreased significantly ($p < 0.05$) during entire room temperature storage which is strongly with correlated moisture loss from the chicken caruncles (Table 4.5) with advancement of storage. At the end of storage, T-2 recorded highest scores for all aforementioned sensory parameters as compared to T-1 might be due to adequate binding between chicken (60%) and bengal gram flour (40%). Phopase also reported acceptable quality chicken chakli can be prepared by incorporation of 60% chicken and 40% bengal gram flour. However, Verma *et al.* (2015) reported highest sensory scores for noodles prepared with 40% chicken and 60% wheat floured based noodles.

4.2.2 Physico-chemical characteristics

Physico-chemical characteristics of chicken caruncles stored at room temperature are presented in Table 4.5. The assessment of physico-chemical characteristics reveals notable changes in chicken caruncles stored at room temperature over a 40-day period.

Table 4.5: Physico-chemical characteristics of chicken caruncles stored at room temperature.

Treat/ Days	Day 0	Day 10	Day 20	Day 30	Day 40
	Moisture (%)				
T-1	5.86±0.03 ^{Ba}	5.63±0.04 ^{Bb}	5.26±0.08 ^{Bc}	5.03±0.06 ^{Bd}	4.89±0.02 ^{Be}
T-2	6.56±0.05 ^{Aa}	6.14±0.05 ^{Ab}	5.84±0.06 ^{Ac}	5.63±0.04 ^{Ad}	5.02±0.05 ^{Ae}
	pH				
T-1	6.18±0.02 ^{Aa}	6.24±0.03 ^{Ab}	6.36±0.08 ^{Ac}	6.49±0.03 ^{Ad}	6.66±0.05 ^{Ae}
T-2	6.09±0.03 ^{Ba}	6.11±0.08 ^{Bb}	6.25±0.02 ^{Bc}	6.29±0.06 ^{Bd}	6.33±0.05 ^{Be}
	Thiobarbituric acid (mg malonaldehyde/kg)				
T-1	0.51±0.03 ^{Aa}	0.53±0.05 ^{Aa}	0.79±0.04 ^{Ab}	0.88±0.03 ^{Ac}	1.03±0.04 ^{Ad}
T-2	0.49±0.02 ^{Aa}	0.54±0.04 ^{Aa}	0.64±0.04 ^{Bb}	0.98±0.05 ^{Bc}	1.14±0.03 ^{Bd}
	Tyrosine value (mg/kg)				
T-1	0.40±0.02 ^{Aa}	0.42±0.01 ^{Aa}	0.46±0.02 ^{Ab}	0.64±0.02 ^{Ac}	0.78±0.04 ^{Ad}
T-2	0.38±0.01 ^{Aa}	0.38±0.01 ^{Ba}	0.42±0.01 ^{Bb}	0.55±0.01 ^{Bb}	0.65±0.03 ^{Bc}

n=6, *Mean ± SE. with different superscripts row wise (small alphabets) and column wise (capital alphabets) differ significantly (p<0.05). **T-1** = Caruncles (50% bengal gram flour and 50% chicken), **T-2**= Caruncles (40% bengal gram flour and 60% chicken).

Irrespective of treatments, the moisture content of both the treatments (T-1 and T-2), decreased significantly (p<0.05) throughout the storage, reaching statistical significance at the 0.05 level. Initially, on Day 0, Treatment T-2 showed significantly (p<0.05) higher moisture content compared to T-1 might be due to high moisture in chicken meat added in higher quantity (60%) in T-2. By Day 40, Treatment T-2 had the highest moisture content, indicating significant moisture absorption over the storage period compared to T-1. Mishra *et al.* (2015) observed similar effects in aerobically packed extended dehydrated chicken meat rings stored at ambient temperature. Phopase (2023) and Sultana *et al.* (2017) reported similar trends in moisture content of chicken chakli and chapatias respectively stored at room temperature.

Regarding pH levels, both treatments, T-1 and T-2, exhibited significant changes over the study period, reaching statistical significance at the 0.05 level. Initially, on Day 0, Treatment T-1 had significantly ($p < 0.05$) higher pH compared to T-2 might be due to high buffering capacity of bengal gram flour (Biswas *et al.*, 2003). During room temperature storage, pH values for both the treatment increased significantly ($p < 0.05$), however, at the end of storage Day 40, T-1 had significantly ($p < 0.05$) higher pH as compared to T-2. Rathour *et al.* (2017) suggested that this might be due to the development of non-protein compounds with ammonium ions having basic nature which can contribute to buffering of protein.

Thiobarbituric acid (TBA) values, indicative of lipid oxidation, showed a significant increasing trend over the storage period in both treatments indicating decrease in shelf life of products (Islam *et al.*, 2018), reaching statistical significance at the 0.05 level. T-1 and T-2 displayed non-significant increase in TBA values upto Day 10, thereafter values were increased significantly ($p < 0.05$) and well within spoilage limit upto Day 30. At the end of storage (Day 40), T-2 had significantly ($p < 0.05$) higher TBA value as compared to T-1 which might be due to higher lipid peroxidation as T-2 contains higher amount of chicken (60%). This also suggested the potential differences in lipid oxidation rates between treatments, possibly influenced by compositional variations and storage conditions. Verma *et al.* (2015) observed similar findings for wheat flour-based noodles containing chicken meat stored at ambient temperature under aerobic conditions. Phopase (2023) reported similar results for the chicken chakli added with bengal gram flour and stored at room temperature for 40 days.

Evaluation of tyrosine values, reflects of protein degradation, revealed a gradual increase in both treatments over time, reaching statistical significance at the 0.05 level. Initially on Day zero, T-1 and T-2 had non-significant difference in tyrosine values, however irrespective of storage period from Day 10, the tyrosine value differ significantly ($p < 0.05$) between both the treatments, which might be due to difference in protein content. At the end of storage, T-1 had significantly ($p < 0.05$) higher tyrosine values than T-2 indicating protein breakdown might be due to bacterial action. Sarvadnya *et al.* (2018) found similar results in the shelf-

life assessment of spent hen meat puffed products stored at ambient temperature. Chaudhary *et al.* (2019) and Phopase (2023) reported similar increase in tyrosine value of meat nuggets and chicken chakli.

4.2.3 Microbiological quality

Meat products with adequate nutritional properties are generally prone to spoilage hence its utmost required to evaluate the microbial quality for safety of consuming individuals. The scores for microbiological quality of developed chicken caruncles incorporated with bengal gram and stored at room temperature are presented in Table 4.6.

Table 4.6: Microbiological properties of chicken caruncles stored at room temperature

Treat/ Days	Day 0	Day 10	Day 20	Day 30	Day 40
	Total plate count(log₁₀ cfu/g)				
T-1	1.94±0.09 ^{Aa}	2.41±0.09 ^{Bb}	3.33±0.08 ^{Bc}	4.35±0.08 ^{Bd}	6.76±0.09 ^{Be}
T-2	2.05±0.10 ^{Aa}	2.67±0.09 ^{Ab}	3.94±0.23 ^{Ac}	5.21±0.06 ^{Ad}	6.97±0.10 ^{Ae}
	Yeast and Mould count(log₁₀ cfu/g)				
T-1	ND	ND	ND	ND	1.45±0.09
T-2	ND	ND	ND	ND	1.51±0.08
	Staphylococcus count (log₁₀ cfu/g)				
T-1	ND	ND	ND	ND	ND
T-2	ND	ND	ND	ND	ND

n=6, *Mean ± SE. with different superscripts row wise (small alphabets) and column wise (capital alphabets) differ significantly (p<0.05). **T-1** = Caruncles (50% bengal gram flour and 50% chicken), **T-2**= Caruncles (40% bengal gram flour and 60% chicken).

Both treatments, T-1 and T-2, showed a significant (p<0.05) increase in total plate count (log₁₀ cfu/g) as the storage period extends, reaching statistical significance at the 0.05 level. Initially at Day 0, both treatments exhibit relatively low total plate counts without any significant difference, However, as the storage periods extend, from the day 10 upto day 40, a significant (p<0.05) difference was

observed is observed. This might be due to high moisture in T-2 (Table 4.5) with high chicken content (60%) throughout storage period, indicating microbial growth. Notably, T-2 consistently displays higher total plate counts compared to T-1 throughout the storage duration, suggesting a differential susceptibility to microbial contamination between treatments, possibly influenced by the difference in proportion of bengal gram flour and chicken. On Day 30, the total plate count of T-1 and T-2 was lower than the threshold value ($5.33 \log_{10}$ cfu/g) thereafter on day 40, TPC increased above the threshold value indicating spoilage in later part of storage. Similar findings were noted by Phopase (2023) for chicken chakli stored at room temperature.

The evaluation of yeast and mold counts reveals an absence of these microorganisms in both treatments until day 30, might be due to lower moisture content (Table 4.5). However, by day 40, yeast and mold growth is detected in both T-1 and T-2, with slightly higher counts in T-2, reaching significance at the 0.05 level. This suggests that extended storage periods can facilitate the proliferation of yeast and mold in chicken caruncles, potentially compromising product safety and quality. Similar yeast and mold counts results were reported by Phopase (2023) and Luckose *et al.* (2015) for in chicken chakli and Japanese quail meat nuggets, respectively. The assessment of *Staphylococcus* count in developed products results no growth during entire storage period of room temperature. Present findings are similar to those recorded by Sarkar *et al.* (2020) for bhujia added with spent hen meat powder. Overall, the findings emphasize the susceptibility of chicken caruncles to microbial contamination and proliferation during room temperature storage, particularly with extended storage durations. The differential microbial growth between treatments suggests potential variations in product formulation and composition affecting microbial dynamics.

Based upon the aforementioned results of storage study it is observed that both combination chicken caruncles incorporated with bengal gram flour and chicken were acceptable for 30 days of storage at room temperature. However, chicken caruncles with 50% bengal gram flour and 50% chicken meat exhibited better quality.

4.3 Cost structure of chicken caruncles

The details of chicken caruncles production cost incorporated with various levels of bengal gram flour are given in Table 4.7.

Table 4.7: Production cost details of chicken caruncles

Particulars	Qty	Rate (Rs)	BGF-30 (Rs)	BGF-40 (Rs)	BGF-50 (Rs)
Minced chicken meat	250 gm	350/kg	122.50	105.00	87.50
Bengal gram flour	250 gm	70/kg	10.50	14.00	17.50
Spice mix	35 gm	600/kg	21.00	21.00	21.00
Red chili Powder	20 gm	400/kg	08.00	08.00	08.00
Salt	20 gm	25/kg	00.50	00.50	00.50
Oil	100 gm	200/kg	20.00	20.00	20.00
Ajwain	20 gm	350/kg	07.00	07.00	07.00
Warm water	300 gm	10/kg	03.00	03.00	03.00
Baking powder	5 gm	300/kg	01.50	01.50	01.50
PET Jar for 1 kg (200 gm/pack)	01	40/jar	40.00	40.00	40
Fuel and labour charges	--	10/kg	10.00	10.00	10
Cost of production for 1 kg chicken caruncles			244.00	230.00	216.00

BGF-30: Caruncles (30% bengal gram flour and 70% chicken)

BGF-40: Caruncles (40% bengal gram flour and 60% chicken)

BGF-50: Caruncles (50% bengal gram flour and 50% chicken)

These figures encompass expenses such as minced chicken meat, bengal gram flour, spice mix, red chili powder, salt, oil, ajwain, warm water, baking powder, PET jar, as well as fuel and labor charges. The cost structure reflects the diverse inputs required for the production process, with variations in ingredient proportions contributing to differential production costs. The cost of production for BGF-30, BGF-40 and BGF-50 were observed Rs. 244/Kg, Rs. 230/Kg and Rs. 216/Kg. The highest production cost in BGF-30 is due to higher amount of minced chicken meat in the formulation.



Summary and Conclusions

CHAPTER – V

SUMMARY AND CONCLUSION

Snack products are widely enjoyed worldwide due to their convenience and diverse offerings, particularly among individuals with busy lifestyles and children. Children, working women and highly mobilized population consume snacks food habitually. In the Indian food market, snacks have gained prominence, driven by shifting dietary habits and urbanization and increased buying capacity of population. Using meat for the preparation of snacks food is best option to improve the nutritional properties especially in regards with amino acid, flavor and taste. The integration of chicken into caruncles presents an exciting opportunity to enhance both the nutritional value and flavor profile of this popular snack. Besides its nutritional value and flavor this will helps to accelerate the growth and distribution of meat industries. Our study aims to determine the optimal blend of ingredients, including bengal gram flour for development of chicken caruncles and to assess their shelf life under room temperature. To develop chicken caruncles, minced chicken meat blend with vegetable oil, corn starch, spices, and bengal gram flour at varying proportions. Sensory attributes, physico-chemical properties, and proximate composition of the chicken caruncles studied to identify acceptable combination of bengal gram flour and chicken meat. Additionally, we conducted shelf-life assessments at 10-day intervals up to 40 days, considering sensory evaluations, proximate composition analyses, physico-chemical properties, and microbiological characteristics. Our research contributes valuable insights into the development of nutritious and flavorful snack options by enriching caruncles with chicken meat and bengal gram flour in adequate combination. By carefully balancing ingredients and conducting thorough evaluations, we ensured that our chicken caruncles meet consumer expectations for taste, quality, and nutritional content. Moreover, our findings shed light on the stability and quality of these innovative chicken caruncles over an extended storage period, supporting efforts to meet evolving consumer preferences in the snack food market.

5.1 Effect of incorporation of bengal gram flour on quality of chicken caruncles.

In chicken caruncles varying amounts of bengal gram flours (30, 40% and 50%) added and product subjected to various evaluation viz., sensory, physico-chemical and proximate composition. Sensory evaluation revealed that chicken caruncles fortified with 40% BGF displayed superior sensory attributes, including appearance, flavor, juiciness, texture, and overall acceptability, as compared to chicken caruncles added with 30% and 50% BGF content. pH differs significantly ($p < 0.05$) with increased level of bengal gram flour in chicken caruncles. Chicken meat content decreases and BGF increased the pH values increased significantly ($p < 0.05$). Increase in BGF concentration showed significantly ($p < 0.05$) positive correlation with increased water absorption and reduced water solubility. Incorporation of bengal gram flour with decrease in chicken meat significantly ($p < 0.05$) differs the cooking yield of chicken caruncles upto 40% level. As the concentration of BGF increases, significant ($p < 0.05$) reduction in moisture content was observed in chicken caruncles. Protein content demonstrates a significant ($p < 0.05$) increase with higher levels of BGF, indicating a significant ($p < 0.05$) nutritional enhancement. As the bengal gram flour (BGF) levels rise, fat content decrease while ash content gradually increases significantly ($p < 0.05$).

5.2 Shelf life of chicken caruncles during refrigerated storage.

Storage at room temperature for 40 days resulted in significant changes in sensory and physico-chemical properties. The results show that there were significant ($p < 0.05$) decrease in sensory properties of the chicken caruncles during entire storage period. Appearance scores for T-1 and T-2 decreased gradually from day 0 to day 10, thereafter appearance scores for both the treatments were at par from day 20 to day 30 followed by significant ($p < 0.05$) decreased at day 40. Significant ($p < 0.05$) declining trends were observed in flavour scores of chicken caruncles during 40 days of room temperature storage. The average scores for texture, juiciness and overall acceptability were decreased significantly ($p < 0.05$) during entire room temperature storage. Moisture content decreased and thiobarbituric acid (TBA) values increased indicating lipid oxidation in both

treatments. Tyrosine values, a marker of protein degradation, also increased steadily. During room temperature storage, pH values for both the treatment increased significantly ($p < 0.05$), however, at the end of storage Day 40, T-1 had significantly ($p < 0.05$) higher pH as compared to T-2. Both the treatments, displayed non-significant increase in TBA values upto Day 10, thereafter values were increased significantly ($p < 0.05$) and well within spoilage limit upto Day 30. At the end of storage (Day 40), T-2 had significantly ($p < 0.05$) higher TBA value. Initially on Day zero, T-1 and T-2 had non-significant difference in tyrosine values, however irrespective of storage period from Day 10, the tyrosine value differ significantly ($p < 0.05$) between both the treatments. Both treatments, T-1 and T-2, showed a significant ($p < 0.05$) increase in total plate count (\log_{10} cfu/g) as the storage period extends. The evaluation of yeast and mold counts reveals an absence of these microorganisms in both treatments until day 30. However, by day 40, yeast and mold growth is detected in both T-1 and T-2, with slightly higher counts in T-2. The assessment of *Staphylococcus* count in developed products results no growth during entire storage period of room temperature.

5.3 Cost structure of chicken caruncles

These figures encompass expenses such as minced chicken meat, bengal gram flour, spice mix, red chili powder, salt, oil, ajwain, warm water, baking powder, PET jar, as well as fuel and labour charges. The cost structure reflects the diverse inputs required for the production process, with variations in ingredient proportions contributing to differential production costs. The cost of production for BGF-30, BGF-40 and BGF-50 were observed Rs. 244/Kg, Rs. 230/Kg and Rs. 216/Kg. The highest production cost in BGF-30 is due to higher amount of minced chicken meat in the formulation.

CONCLUSION

- Addition of 40% bengal gram flours and 60% chicken meat were found suitable combination for preparation of chicken caruncles.
- Developed chicken caruncles were acceptable up to 30 days at room temperature.
- Production cost for chicken caruncles incorporated with 30%, 40% and 50% bengal gram flour were Rs. 244/Kg, Rs. 230/Kg and Rs. 216/Kg, respectively.



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Appendix



DEPARTMENT OF LIVESTOCK PRODUCTS TECHNOLOGY

College of Veterinary and Animal Sciences, Parbhani

Proforma for Organoleptic Evaluation of meat products

Name of Evaluator :
Date :
Name of Product :
Scoring Guide :

Sensory attributes	8-point scale for descriptive attributes of product							
	8	7	6	5	4	3	2	1
Appearance	Excellent	V. good	Good	Fair	Sli. Poor	Mod. Poor	V. Poor	Extr. poor
Flavour	Extremely desirable	V. desirable	Mod. desirable	Sli. desirable	Sli. undesirable	Mod. undesirable	V. undesirable	Extr. undesirable
Juiciness	Extremely juicy	V. juicy	Mod. juicy	Sli. juicy	Sli. dry	Mod. dry	V. dry	Extr. dry
Texture	Extremely desirable	V. desirable	Mod. desirable	Sli. desirable	Sli. undesirable	Mod. undesirable	V. undesirable	Extr. undesirable
Overall palatability	Extremely palatable	V. palatable	Mod. palatable	Sli. palatable	Sli. unpalatable	Mod. unpalatable	V. unpalatable	Extr. unpalatable

Sample	Colour and Appearance	Flavour	Juiciness	Texture	Overall acceptability
1.					
2.					
3.					
4.					

Remark

Signature



Vitae



VITAE

The author Mr. Sawant akash dnyanoba was born on 13st August 1997, at his native place Dongargaon, Tal. Mudkhed. District. Nanded (Maharashtra State).

He passed the S.S.C examination in 2013 at Rajashri shree chhatrapati shahu sainiki Vidyalaya sharadanagar sagroli, Biloli and H.S.C. board examination 2015 from Yashwant College, Nanded.

Being interested in animal welfare, He joined College of Veterinary and Animal Sciences, Parbhani in 2016 and completed the B.V.Sc & A.H degree in 2021. Further he joined M.V.Sc. degree course in the discipline of Livestock Products Technology from College of Veterinary and Animal Sciences, Parbhani, MAFSU in the year 2021. He has actively completed 21days In-plant training programme at Relible Agro Foods, Purna.

The author visited meat processing industries, Slaughter houses under his under graduation and post-graduation.

The author has completed the necessary credit courses for post graduate studies and submitted this thesis in the year 2024. He actively participated in National Service Scheme (NSS) unit during graduation studies.



Thesis Abstract

APPENDIX-G

THESIS ABSTRACT

- 1 Title of the thesis : DEVELOPMENT OF CHICKEN
CARUNCLES ADDED WITH
BANGAL GRAM FLOUR**
- 2 Full name of student : Sawant Akash Dnyanoba**
- 3 Name and address of : Dr. S. N. Rindhe)
Major Advisor Advisor/Guide
Assistant Professor
Livestock Products Technology**
- 4 Degree to be awarded : M. V. Sc.**
- 5 Year of award of degree : 2024**
- 6 Major subject : Livestock Products Technology**
- 7 Total number of pages in 50
the thesis**
- 8 Number of words in the : 336
abstract**
- 9 Signature of Student :**
- 10 Signature, Name and :
address of forwarding
authority (HOD/SH)**

Dr. A. M. Chappalwar

Incharge Professor

Dept. of Livestock product Technology.

ABSTRACT

This study investigated the optimal combination of the flour to chicken meat ratio for preparing chicken caruncles and evaluated their shelf life at room temperature. Caruncles were prepared by mixing minced chicken meat with non-meat ingredients, including vegetable oil, spices, and different levels of bengal gram flour (30%, 40%, and 50%). The suitable combination of bengal gram flour and chicken meat to develop chicken caruncles were determined based on sensory, physico-chemical, and proximate composition analyses. The shelf life of chicken caruncles containing selected flour levels was evaluated at 10-day intervals for up to 40 days. Sensory evaluation revealed that chicken caruncles with 40% bengal gram flour exhibited the highest scores for appearance, flavour, juiciness, texture, and overall acceptability. pH differs significantly ($p < 0.05$) with increased level of bengal gram flour in chicken caruncles. Increase in BGF concentration showed significantly ($p < 0.05$) positive correlation with increased water absorption and reduced water solubility. Cooking yield increased significantly ($p < 0.05$) with increase in bengal gram flour levels. Significant ($p < 0.05$) reduction in moisture content was observed in chicken caruncles. Protein content demonstrates a significant ($p < 0.05$) increase with higher levels of BGF, indicating a significant ($p < 0.05$) nutritional enhancement. Fat content decrease while ash content gradually increases significantly ($p < 0.05$) with increased in bengal gram flour. During storage, sensory properties were significantly ($p < 0.05$) decreased in of the chicken caruncles. Moisture content decreased and thiobarbituric acid (TBA) values increased significantly ($p < 0.05$). Tyrosine values, increased significantly ($p < 0.05$). Both treatments showed a significant ($p < 0.05$) increase in total plate count as the storage period extends. Yeast and mold counts reveals an absence of these microorganisms in both treatments until day 30 while detected on the day 40. The assessment of *Staphylococcus* count in developed products results no growth. Production cost for chicken caruncles incorporated with 30%, 40% and 50% bengal gram flour were Rs. 244/Kg, Rs. 230/Kg and Rs. 216/Kg, respectively. Based on aforementioned results, acceptable quality chicken caruncles prepared with 40% bengal gram flour and packaged in PET jar for up to 30 days at room temperature.

परिशिष्ट - जी

प्रबंध सारांश

- १) प्रबंधाचे शीर्षक : बेंगाल बेसन वापरून चिकन कारंक्ल्सची निर्मिती
- २) विद्यार्थ्यांचे संपूर्ण नाव : सावंत आकाश जानोबा
- ३) प्रमुख सल्लागाराचे नाव आणि पत्ता : डॉ. एस. एन. रिंढे
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- ४) प्रदान करण्यात येणारी पदवी : एम. व्ही. एस्सी. सी.
- ५) पदवी प्रदान करण्याचे वर्ष : २०२४
- ६) प्रमुख विषय : पशुजन्य पदार्थ प्रक्रिया तंत्रज्ञान विभाग
- ७) प्रबंधाचे एकूण पृष्ठसंख्या : ५०
- ८) सारांशातील शब्दांची संख्या : २३१
- ९) विद्यार्थ्यांची स्वाक्षरी :
- १०) विभाग प्रमुखाची स्वाक्षरी :

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पशुवैद्यक व पशुविद्यान

सारांश

या अभ्यासात बेंगल बेसन आणि चिकनचे मांस यांचा वापर करून चिकन कॅरंकल्स, पौष्टिक आणि चवदार स्नॅक पर्यायाचा शोध घेण्यात आला. खोलीच्या तपमानाच्या स्टोरेज अंतर्गत घटकांचे इष्टतम मिश्रण आणि शेल्फ लाइफ निर्धारित केले गेले. चिकन कॅरंकल्स वेगवेगळ्या बेंगल बेसन सामग्रीसह (३०%, ४०% आणि ५०%) तयार केले गेले आणि संवेदी गुणधर्म, भौतिक-रासायनिक गुणधर्म आणि जवळपासच्या रचनांसाठी मूल्यांकन केले गेले. संवेदनात्मक विश्लेषणातून असे दिसून आले की ४० % बेंगल बेसन असलेल्या कॅरंकल्समध्ये सर्वात अनुकूल देखावा, चव, रसदारपणा, पोत आणि एकंदर स्वीकार्यता आहे.

बेंगल बेसन सामग्री वाढल्याने भौतिक-रासायनिक गुणधर्मांवर लक्षणीय परिणाम होतो. पीएच वाढला, तर पाण्यात विद्राव्यता आणि क्विकिंग यील्डचे कमी झाले. बेंगल बेसनचे प्रमाण वाढल्याने आर्द्रता आणि चरबीचे प्रमाण कमी झाले, तर प्रथिने आणि राखेचे प्रमाण लक्षणीय वाढले.

खोलीच्या तपमानावर ४० दिवस साठविल्याने संवेदी आणि भौतिक-रासायनिक गुणधर्मांमध्ये लक्षणीय बदल झाले. देखावा, चव, पोत, रसाळपणा आणि एकूण स्वीकार्यता यासह सर्व संवेदी गुणधर्म कालांतराने कमी झाले. आर्द्रतेचे प्रमाण कमी झाले, तर लिपिड ऑक्सिडेशन (वाढलेल्या टीबीए मूल्यांद्वारे दर्शविलेले) आणि प्रथिने र्हास (वाढलेल्या टायरोसिन मूल्यांद्वारे दर्शविलेले) स्टोरेज दरम्यान वाढले.

सूक्ष्मजीवशास्त्रीय विश्लेषणाने कालांतराने प्लेटच्या एकूण संख्येत लक्षणीय वाढ दर्शविली. यीस्ट आणि मोल्डची वाढ ४० व्या दिवशी आढळून आली, ५० % बेंगल बेसन असलेल्या कॅरंकल्समध्ये किंचित जास्त संख्या. संपूर्ण स्टोरेज कालावधीत स्टॅफिलोकोकसची वाढ दिसून आली नाही.

हा निष्कर्ष सूचित करतात की ४० % बेंगल बेसन सह चिकन कॅरंकल्स मध्ये संवेदी गुणधर्म, पौष्टिक मूल्य आणि खोलीच्या तापमानात साठवणाखालील शेल्फ लाइफ यांचा चांगला समतोल असतो. शेल्फ-लाइफ विस्तार पद्धतींवर पुढील संशोधनाची शिफारस केली जाते.