

**DEVELOPMENT AND STORAGE STABILITY OF CHICKEN  
NUGGETS INCORPORATED WITH CARROT (*Daucus carota*  
*subsp. Sativus*) AND RADISH (*Raphanus Raphanistrum*)  
POWDER**

**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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**2022**

## DECLARATION OF STUDENT

I hereby declare that the experimental research work and interpretation of the thesis entitled “**DEVELOPMENT AND STORAGE STABILITY OF CHICKEN NUGGETS INCORPORATED WITH CARROT (*Daucus Carota subsp. Sativus*) AND RADISH (*Raphanus Raphanistrum*) POWDER**” or part thereof 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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We also certify that the thesis or part thereof has not been previously submitted by her for a degree of any other University.

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## CERTIFICATE

This is to certify that the thesis entitled “**DEVELOPMENT AND STORAGE STABILITY OF CHICKEN NUGGETS INCORPORATED WITH CARROT (*Daucus Carota subsp. Sativus*) AND RADISH (*Raphanus Raphanistrum*) POWDER**” submitted by Miss. **DESHPANDE SAYALI PRASHANT** to the Maharashtra Animal and Fishery Sciences University in partial fulfillment of the requirement for the degree of M.V.Sc has been approved by the Student's Advisory Committee after examination in collaboration with the External Examiner.

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# Acknowledgement

## ACKNOWLEDGEMENT

**“Gratitude is the inward feeling of kindness received. Thankfulness is the natural impulse to express that feeling.”**

*“It is a paradoxical but profoundly true and important principle of life that the most likely way to reach goal is to be aiming not at that goal itself but at some more ambitious goal beyond it.”*

*First and foremost, I would like to express my very great appreciation to my research guide and chairman of Advisory Committee, **Dr. S. N. Rindhe**, Assistant Professor, Dept. of Livestock Products Technology, College of Veterinary and Animal Sciences, Parbhani for his valuable and constructive suggestions during the planning and development of this research work. His willingness to give his time so generously has been very much appreciated. I'm deeply grateful to him for his continuous support, patience, motivation, enthusiasm and immense knowledge. His guidance helped me in all the time of research and writing of the thesis. I could not have imagined having a better mentor and guide for my research work.*

*I would like to acknowledge and give my warmest thanks to the members of my advisory committee **Dr. A. M. Chappalwar**, Assistant professor and Head Department of Livestock Products Technology, **Dr. S. V. Londhe**, Assistant Professor, Department of Livestock Products Technology, **Dr. V. V. Deshmukh**, Professor of Dept. of Veterinary Public Health and **Dr V. K. Munde**, Assistant Professor of Dept. of Animal Nutrition who made this work possible. Their guidance and advice carried me through all the stages of my research work.*

*I am highly obliged to **Dr. N. M. Markandey**, Associate Dean, College of Veterinary and Animal Sciences, Parbhani for providing necessary facilities during the study.*

*Getting through my thesis required more than academic support and I have many, many people to thank for listening to and at times having to tolerate me over the past two years. I cannot begin to express my gratitude and appreciation for their friendship. **Dr. Priyanka Londhe, Dr Akshay Kamble, Dr. Kajal More and Dr. Nisha Plabita Baruah** have been unwavering in their personal and professional support during my research work.*

*I owe my special gratitude to my Departmental colleagues, **Dr. Shubhangi Nagre** and **Dr. Rupali Pathade** for helping me throughout my research work and providing a moral support. .*

*I am extremely thankful to my juniors **Dr. Anand Jevughale, Dr. Ravi Phopse, Dr. Darshana Satdiwe, Dr. Sneha Jagdale, Dr. Sneha Swami, Dr. Seema Pathan, Dr. Shridhar Gadewar** and **Dr. Dinesh Chilkewar** for generously offering their time, help and goodwill throughout my thesis work.*

*I express my special thanks to **Dr. Kiran Lahane, Dr. Sangeeta Bele, Dr. Rutuja Randhwan** and **Dr. Pooja Kachave** for their genuine support and help during my research work.*

*My gratitude extends to **Swapnil Pawde** for his assistance at every stage of my research project.*

*I have reserved whole hearted thanks to my fiancé **Mr. Harshal Pargaonkar** for his encouragement, valuable suggestion, special advice and moral support.*

*I express my profound gratitude to my family for providing me with unfailing support and continuous encouragement throughout the process of researching and writing the thesis. This thesis stands as a testament to their unconditional love and encouragement.*

*Finally I offer my praises and thanks to god, the almighty for his showers of blessings throughout my research work to complete the research successfully.*

*Place : Parbhani*

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*(Deshpande Sayali Prashant )*

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## LIST OF ABBREVIATIONS

%	:	Percent
/	:	Per
@	:	At the Rate of
°C	:	Degree Centigrade
<	:	Lesser Than
>	:	Greater Than
AOAC	:	Association of Official Analytical Chemists
APHA	:	American Public Health Association
CD	:	Critical Difference
Cfu	:	Colony Forming Unit
FAO	:	Food and Agriculture Organization
gm	:	Gram
HDPE	:	High Density Polyethylene
hrs	:	Hours
i.e.	:	That is
kg	:	Kilogram
log <sub>10</sub>	:	Logarithm of x to the base 10
Meq	:	Milliequivalents
Mg	:	Milligram
ml	:	Milliliter
N	:	Normality
NaOH	:	Sodium Hydroxide
No.	:	Number
NS	:	Non-Significant
PPC	:	Psychrophilic Count
ppm	:	Parts Per Million
PUFA	:	Polyunsaturated Fatty Acids
PV	:	Peroxide Value
S.E	:	Standard Error
STPP	:	Sodium Tripolyphosphate
TBA	:	2-Thiobarbituric Acid
TBARS	:	Thiobarbituric Acid Reactive Substances
TCA	:	Trichloroacetic Acid
TPC	:	Total Plate Count
WHC	:	Water Holding Capacity
WHO	:	World Health Organisation
CP	:	Carrot Powder
RP	:	Radish Powder
Rs	:	Rupees
Kcal	:	Kilocalorie



# Introduction



## CHAPTER - I

### INTRODUCTION

The production of poultry meat has increased worldwide significantly and poultry industry is one of the highly growing industries in India. Over the last three decade, Indian poultry has seen tremendous changes and transition from unstructured family businesses to highly organized entrepreneurial activity, contributing to national GDP and providing employment to millions of people. Furthermore the proliferation of fast food parlors and entry of few fast food chains like Kentucky fried chicken, Mc Donald and pizza hut etc in Indian market created a favorable atmosphere for growth of poultry industry. The broiler and egg industries are expanding at a fantastic pace of 8 to 10% each year. During the year 2019, poultry supplied 50% of India's total meat output (FAO, 2020). During the year 2019-2020, the nation exported 3, 50,817.80 MT of poultry products valued Rs 830.34 USD million (APEDA 2020). Poultry is the most efficient industry in the livestock sector for boosting the supply of Desi red proteins, fats, minerals, and vitamins in a short period of time (Vetrivel and Chandrakumarmangalam S, 2013). With increasing urbanisation, changing customer food preferences, and increased exposure to international cuisines, the Indian population is opting for a non-vegetarian diet over a vegetarian one, and poultry meat is preferred over other meat products because it is more hygienic and available throughout the country at a low price throughout the year. Consumption of chicken meat and products, which are high in all important nutrients, can lower the occurrence of numerous prevalent metabolic illnesses linked to deficiencies in vital dietary minerals, vitamins, and amino acids. It is considered to be a leaner meat with no social stigma linked to its intake, making it India's preferred meat.

Changes in socioeconomic status have boosted customer appetite for ready-to-eat meals, especially meat products, in recent years. Chicken nuggets are a popular ready-to-eat meat product among customers and may be a decent alternative for a quick supper. Due to a characteristics flavour and pronounced chewy texture, chicken nugget has occupied a predominant place among the meat

based products (Suradkar, 2013). Meat often lacks in potential component fibre, which might be added during the preparation of goods to make them healthier.

Fiber provides a variety of health benefits in addition to boosting the technological features of the product. Colon cancer, obesity, cardiovascular disease, and a variety of other ailments are all reduced by eating rich fibre foods. Consumers have been more health-conscious in recent years, and they are attempting to reduce their intake of high-calorie foods. To counteract the effects of high-fat, high-energy foods, food manufacturers have used a variety of tactics, including changes in meat ingredient selection, the introduction of useful qualities in meat, and the inclusion of non-meat ingredients which are rich in fibers. Vegetables have a crucial part in human nutrition because they give critical minerals and vitamins, as well as a high quantity of dietary fibre and phytochemicals, which act as natural antioxidants. In the meat system, vegetables might act as fillers, binders, fat replacers, and sources of nutritional fibre and natural antioxidants. Fibres in the form of vegetables and fruits have been discovered to improve the functional value, increase the cooking yield, improve the texture of the product, and lower the formulation cost in this respect. In the creation of fiber-fortified meat products, a variety of vegetable fibre sources have been used. Meat and meat products that are supplemented with veggies may have a higher nutritional value. Vegetables like Carrot and radish can be a good option for incorporation in chicken meat product.

Carrot (*Daucus carota*) is a rich source of vitamin A (beta carotene) and dietary fiber. Beta carotene present in carrot is a strong anticarcinogenic factor and also prevents heart attack, ulcers, gum diseases, colitis and stroke (Kumar et al., 2015). Beta carotene in carrot also regulates sugar level and has laxative, antiseptic and vermifugal action (Kaur et al., 2015). Carotenoids present in carrot have been linked to the prevention of cancer, cardiovascular disease (CVD), and human immunodeficiency virus (HIV) and cataracts. Carrot is a good source of iron, pectin, dietary fibres, complex carbohydrates and various materials. It is a good source of antioxidants which helps body to remove free radicals; unstable molecules that can lead to cell damage if too many accumulate in the body. The

antioxidant property of carrot is due to presence of alpha carotene, beta carotene and vitamin E. one medium raw carrot contains 1.7 gm dietary fiber, 2120 mcg of alpha carotene, 5050 mcg of beta carotene and 0.4 mg of vitamin. Radish is a member of the Brassicaceae family, which was cultivated in Asia before the Roman era. Antioxidants like as catechin, pyrogallol, vanillic acid, and other phenolic compounds are abundant in it. These root vegetables are also high in iron, calcium, and vitamin C (0.7mg in a medium-sized radish), which acts as an antioxidants. *Raphanus Raphanistrum* (radish) is high in proteins, glucosinolates, flavonoids, carotene, and minerals (Gamba *et al.*, 2021). The nitrate concentration of radish ranges from 1,878 to 6,260 ppm. Bioactive substances such as ascorbic acid, polyphenols, and flavonoids are also present in it. Furthermore, because radish roots are often white their impact on the colour of the final meat product is less pronounced than that of other green vegetables ( Bae *et al.*, 2020).

The incorporation of vegetables like carrot and radish in meat will surely help to fulfil consumer's demands regarding more healthy meat product with more fiber and less fat. It will not only increase the nutritive value of meat product but will also help in the cost reduction in the formulation of meat product. Thus, the present study is envisaged with incorporation of carrot and radish in different levels on quality of chicken nuggets with following objectives:

### **Objectives**

1. To optimize the incorporation level of carrot and radish powder in emulsion
2. To study the effect of carrot and radish powder on sensory and physico-chemical characteristics of chicken nuggets.
3. To elucidate the storage stability of developed chicken nuggets at  $4 \pm 1^{\circ}\text{c}$ .
4. To study the cost structure of chicken nuggets.



# **Review of Literature**

## **CHAPTER - II**

### **REVIEW OF LITERATURE**

The demand for ready to eat food is increasing day by day due to increased urbanization, high income and increased exposure to global cuisines. Amongst the ready to eat meat products nuggets are ready to eat products having a simple method of preparation which makes nuggets popular within consumers and can be a good option for quick meal. Poultry meat has great potential for delivering important nutrients like proteins, minerals and vitamins and chicken meat as a human food has no major social taboo like beef or pork so it is the most preferred meat for consumption.

Vegetables like carrot and radish play a crucial role in human nutrition as they are rich source of carbohydrates and other nutrients. Further, addition of vegetables in meat products could help in production of meat products with reduced cost.

#### **2.1 Chicken meat**

Dowarah (2013) reviewed that chicken meat is healthier than chevon or mutton. The breast meat of chicken contains less than 3 gm fat per 100 gm of meat whereas red meat contains about on an average 5 to 7 gm of fat per 100 gm of meat.

Devi *et al.*, (2014) stated that consumption of different kind of meat largely depends upon the religion of individual where pork is prohibited to Muslims and beef is forbidden to Hindus which makes chicken meat highly preferred meat due to its acceptance by peoples of all religions.

Marangoni *et al.*, (2015) revealed that chicken meat can play a crucial role in the diet of individuals of specific age group (pregnant women, children and elderly) because of ample amount of essential nutrients and also consumption of chicken meat reduces the risk of developing cardiovascular diseases and the risk factors associated with it like overweight and insulin resistance and tumors.

## **2.2 Non –meat ingredients**

### **2.2.1 Wheat flour**

Yadav *et al.*, (2011) reported that wheat has many medicinal virtues; starch and gluten in wheat fulfills the need of energy and provides heat, the inner bran coats provide phosphates and other mineral salts while the outer bran the much needed roughage the indigestible portion helps easy movement of bowels. The germ layer contains vitamin B and vitamin E and proteins of wheat help to build and repair muscular tissue.

Jamaly *et al.*, (2017) concluded that 5% wheat flour can be incorporated as a source of dietary fiber and functional ingredients as prebiotic in meat ball.

Dutta *et al.*, (2018) stated that maida (refined flour) has maximum wet gluten content than the chakki flour and resultant flour.

Zang (2020) stated that in the process of production of wheat products the water absorption, water solubility and radical expansion rate of flour products depends upon the quality of wheat flour.

Gomez *et al.*, (2020) stated that consumption of wheat products meets the demand of carbohydrates dietary fiber, proteins and bioactive compounds.

### **2.2.2 Carrot**

Kumar *et al.*, (2015) reported that when different levels of carrot pomace dried powder were incorporated in chicken cutlets the moisture content, ash, crude fiber, cooking yield, PH, water holding capacity and beta carotene content of the chicken cutlets were increased significantly while the protein, fat, and cholesterol were found to be decreased.

Singh *et al.*, (2015) reported that when chicken meat cutlets were prepared by incorporating four levels of carrot powder viz 0% (control), 2.0% (T1), 4.0% (T2), and 6.0% (T3), the moisture, dietary fiber, cooking yield of the product increased and fat content decreased with increasing level of carrot powder.

Zargar *et al.*, (2017) concluded that fiber enriched chicken sausages could be successfully developed by adding minced carrot in the formulation at a level up to 12% without altering the sensory attributes and acceptability of the chicken sausage.

Stefi (2017) reviewed that carrot is a rich source of wide variety of nutrients which can be helpful in improving the overall health of an individual by providing preventive and protective factors. The vitamins and minerals of carrot promote longevity; decrease the risk of chronic diseases, cancer, heart diseases and stroke.

Que *et al.*, (2019) reported that carrot is a rich source of carotenoid. Carrot root also contain many other beneficial contents including vitamins, carbohydrates and minerals. In addition carrot root is a good source of ascorbic acid and vitamin E.

### **2.2.3 Radish**

Mendiratta *et al.*, (2013) concluded that when radish is incorporated in mutton nuggets the dietary fibers and biochemically active compounds such as beta carotene and carotenoid content of mutton nuggets were increased.

Bae *et al.*, (2020) stated that radish powder can be used as an alternative to nitrite or nitrate in meat processing and also if concentration of radish powder is increased in meat the quality characteristics of the product can become comparable to the products treated with synthetic nitrite.

Ozaki *et al.*, (2020) reported that addition of 1% radish turned out to be the best option for nitrite substitution regarding Ph, color, nitrite and nitrate contents in fermented dry sausage.

Reddy *et al.*, (2020) concluded that addition of 10% raw radish paste has higher physicochemical and proximate characteristics and superior sensory scores scored than control and other levels of raw radish paste added turkey meat sausage.

Gamba *et al.*, (2021) reported that *Raphanus sativus* (Radish) is a source of nutrients and phytochemicals particularly proteins, glucosinolates, flavonoids, beta carotene and minerals.

#### **2.2.4 Egg**

Dowarah (2013) reported that eggs are not detrimental to human health especially for those are in below poverty line, eggs are very important for their good health and well being and the consumption of eggs should be encouraged.

Adzitey *et al.*, (2014) concluded that egg in the formulation of beef burger has no negative effect on the eating qualities of processed meat products when used in quantities of 50 gram to 150 gram.

Zaheer (2015) stated that egg proteins, about 6.5 gram per egg contain a balanced supply of 9 amino acids essential to human health: histidine; isoleucin; leucine; lysine; methionine; phenylalanine; threonine; tryptophan; valine. Protein quality, a measure of the efficiency of use of the consumed protein by human body is determined by presence and proportions of these amino acids of proteins.

Ossom. *et al.*, (2016) studied that the use of egg albumen as a binder at inclusion levels of 200 gram, 250 gram and 300 gram per kilogram of meat had no adverse effect on the eating quality and acceptability of beef burgers but raised the ph of the test product.

Réhault-Godbert *et al.*, (2019) reported that the perfect balance and diversity in the nutritional content along with its high digestibility and affordable prize has put the egg in the spotlight as a basic food for humans.

## **2.3 Preservatives**

### **2.3.1 Chemical preservatives**

#### **2.3.1.1 Salt**

Salt is crucial for life in general and saltiness is one of the basic human tastes. It is essential for the health of humans and other animals. In meat salt is present in very small quantity which adds flavor to the meat and also acts as a preservative. Salt inhibits the bacterial growth in the food by lowering the water activity in the food.

Schroeder (2013) concluded that in the extraction of myofibrillar proteins of the meat products salt is an essential ingredient. Salt also improves the texture and yield of processed meat products by increasing the ability of actin and myosin to bind water and fat.

Bae *et al.*, (2020) studied that addition of salt along with STPP followed by storing and cooking at fast rate inhibits the pink color defect which sporadically occurs in cooked ground chicken breast.

Kim *et al.*, (2021) reported that salt is very essential component for maintaining human life as it helps to maintain adequate water balance in the body therefore consuming an appropriate amount of salt is essential for the maintenance of good health.

#### **2.3.1.2 Sodium tripolyphosphate**

Erdogdu *et al.*, (2007) reviewed that sodium tripolyphosphates are important functional additives used in meat products. It reduces cooking losses and improves textural properties especially by increasing the water holding capacity of proteins.

Glorrieux *et al.*, (2016) reported that when STPP was used in emulsified chicken sausage the pH of chicken sausage was increased also the structural properties were improved. The emulsion stability of the product was highest with

lowest cooking loss and had very little effect on structural properties of chicken sausage.

Choi *et al.*, (2020) stated that when salt and phosphates are added in the meat products it improves the functionality, textural and physico-chemical properties of meat products.

### **2.3.2 Natural preservatives**

#### **2.3.2.1 Spices**

Spices are used as substances that increase the taste and variation of food. Furthermore some spices are reported to have bactericidal or bacteriostatic activities.

Delaquis *et al.*, (2002) observed that essential oil of cilantro was particularly effective against *Listeria monocytogenes* likely due to presence of long chain alcohol and aldehyde.

Rajkumar and Berwal (2004) reported that clove has antimycotic and antioxidant properties which is helpful for the preservation of pastirma from boneless chevon where in the shelf life was increased up to 15 days.

.Agaoglu *et al.*, (2007) studied that cinnamon, cloves and cumin exhibit important antimicrobial activities and also natural preservatives like spices and their volatile compounds can be used in food product instead of using chemical additives.

## **2.4 Chicken nuggets**

A chicken nugget is a food product consisting of small piece of deboned chicken meat that is breaded or battered then deep fried or baked. Invented in 1950s chicken nuggets have become a very popular fast food restaurant item, as well as widely sold and home used product. (Wikipedia)

Dhanasekar (2004) concluded that acceptable dietary fiber-enriched low-fat chicken nuggets can be made with the addition of up to 10% OF over and above the amount of chicken meat.

Ngadi *et al.*, (2007) Observed that when degree of oil hydrogenation was increased while frying the chicken nugget samples the surface color of fried chicken nugget sample were lighter, texture increased, oil and moisture content decreased.

Hafid *et al.*, (2018) stated that nugget is one of the results of meat processing. Nugget is a food made from seasoned meat and wrapped in a mixture, fried half cooked and then temporarily frozen to maintain quality.

Anany *et al.*, (2020) reported that Chicken nugget products are a reformulated meat product with breaded coatings.

Binti *et al.*, (2021) studied that chicken nuggets with improved texture, increased dietary fiber and with appealing sensory properties were obtained when incorporated with green peas.

## **2.5 Quality parameters**

### **2.5.1 Proximate composition**

Mehta *et al.*, (2013) reported decreased moisture content of chicken patties with increasing the level of psyllium husk in patties which was due to replacement of lean meat by psyllium husk that contained comparatively less moisture (9.68%) than meat.

Dhanasekar *et al.*, (2014) concluded that when the oat flour was added in the chicken nugget at the level of 0%, 10% and 20% the crude protein and fat

Pereira *et al.*, (2016) studied that when rice flour was incorporated in reduced fat emulsified pork sausage at a level of 2%, 4%, and 6% the moisture content of pork sausage was significantly increased as compared to control.

Selani *et al.*, (2016) stated that conventional burgers had a significantly higher fat content compared to the burgers prepared by incorporating pineapple byproduct and canola oil as fat replacers.

Sharma and yadav (2020) reviewed that addition of pomegranate peel and aril bagasse powder in chicken meat patties contributed to significant decline in moisture content of patties.

El-Anany *et al.*, (2020) concluded that when chicken nuggets were formulated by incorporating 5%, 10%, 15% and 20% frozen white cauliflower as a fat replacer instead of chicken skin the ash content of the nuggets was found to be higher than the control nuggets.

## **2.5.2 Physicochemical characteristics**

### **2.5.2.1 pH**

Mendirratta *et al.*, (2013) observed no significant difference in pH values of control and carrot, radish and capsicum incorporated mutton nuggets. But slightly higher pH was observed for mutton nuggets incorporated with radish.

Yogesh *et al.*, (2013) stated that PH affects the water holding capacity of meat and meat products. Water holding capacity of meat is minimal when the PH is just at the isoelectric point of meat proteins.

Mir *et al.*, (2017) reported that PH has direct bearing on the meat quality attributes such as tenderness, water holding capacity, color, juiciness and shelf life. The broiler breast meat with high PH has higher water holding capacity than meat with lower ph.

Gupta *et al.*, (2017) stated that when chicken cutlets were prepared by incorporating carrot and oats at the level of 10% and 5% respectively it was observed that the average ph of fresh, cooked, conventionally packed functional chicken meat cutlets containing carrot and oat increased significantly from 6.62 to 6.83.

Ismail and Joo (2017) said that chicken meat discoloration is closely related to the decrease in muscle pH postmortem. Rapid postmortem decline in pH results in PSE like meat (pale, soft, exudative characteristics) with pale appearance and lower water holding capacity.

Reddy *et al.*, (2018) observed no significant difference in the pH of chicken nuggets extended with flax seed (*Linum usitatissimum*) flour.

#### **2.5.2.2 Emulsion stability**

Arslan (2006) reviewed that emulsion stability of frozen meats was significantly lower than fresh meat.

Das *et al.*, (2008) reviewed that when goat meat nuggets were prepared using soy granules and reduced beany flavor full fat soy paste the emulsion stability of the product did not affect significantly.

Ponsingh *et al.*, (2010) reported that when buffalo meat sausage were prepared by incorporating 3 different levels of potato flour (3, 5 and 7% ) 7% potato flour recorded better emulsion stability compared to other levels.

Shin *et al.*, (2021) reported that emulsion stability of meat batters with pork back fat tend to decrease with increasing the cooking temperature.

#### **2.5.2.3 Water holding capacity**

Water holding capacity is defined as the ability of meat and meat products to bind water during slicing, mincing and also during transport, storage, processing and cooking. Water holding capacity refers to both the bound water contained within the meat and also to water added during various operations connected with meat processing.

Mehta *et al.*, (2015) stated that a good water holding capacity is essential as it provides desirable characteristics to meat products. Fiber is suitable for addition to meat products and helps to increase water holding capacity of meat products.

Syuhairah *et al.*, (2016) reported that when vegetables like capsicum, carrot, spinach, purple cabbage and grey oyster were added in the chicken meat sausage the water holding capacity of chicken meat sausage was affected significantly.

Mir NA *et al.*, (2017) reviewed that water holding capacity has the direct bearing on the color and tenderness of meat, and is among the most important functional properties of raw meat.

Ghimire and Parajuli (2020) revealed that freezing of broiler chicken meats for prolonged period adversely affects the water holding capacity of meat.

#### **2.5.2.4 Cooking yield**

Ponsingh *et al.*, (2010) observed better cooking yield for buffalo meat sausage when prepared by incorporating 7% potato flour.

Mendiratta *et al.*, (2013) reported that no significant difference was observed in cooking yields of control and vegetable incorporated mutton nuggets. However the cooking yield was found to be comparatively higher for radish incorporated nuggets. This increase in cooking yield of extended nuggets over the control could be attributed to the higher moisture retention during cooking by radish fiber.

Zargar *et al.*, (2017) observed that as the level of carrot was increased in the chicken sausage the cooking yield of the chicken sausage was decreased significantly. This could be due to formation of comparatively less stable emulsion in the formulations containing carrot.

#### **2.5.2.5 Moisture retention**

Moisture retention is one of the crucial cooking parameter in ground meat products because the eating quality of ground meat products depends upon the retained moisture in the product.

Verma *et al.*, (2016) reported that the moisture retention values of chicken meat increased significantly as the incorporation of green cabbage percentage increased in chicken meat ball.

Serdaroglu *et al.*, (2017) studied that after preparing beef patties by incorporating gelled emulsion (olive oil 46%, inulin 9%, gelatin 3%) as a fat replacer at a level of 0%, 25%, 50% and 100% the highest moisture retention was found in beef patties formulated with 50% gelled emulsion and showed similarity with control sample.

Serdaroglu *et al.*, (2018) reviewed that when beef patties were formulated with incorporating dried pumpkin pulp and seed mixture the moisture retention of the beef patties decreased as compared to control.

#### **2.5.2.6 Fat retention**

Retaining fat within the matrix of meat products during processing is important to ensure the sensory quality and acceptability

Ergezer *et al.*, (2014) observed the increased fat retention in the beef meat balls when incorporated with 20% potato puree.

M. Serdaroglu *et al.*, (2017) reported that increased fat retention values were observed when beef patties were prepared by incorporating gelled emulsion (olive oil 46%, inulin 9%, and gelatin 3%) as a fat replacer at a level of 0%, 25%, 50% and 100%. This could be attributed to the stabilizing effects of the oil in the established emulsion system.

Serdaroglu *et al.*, (2018) stated that incorporation of dried pumpkin pulp and seed mixture lead to increase in fat retention of the sample.

## 2.6 Sensory quality

Sensory evaluation may be described as a scientific discipline which measures the properties of a product with the use of human senses.

Bhosale *et al.*, (2011) reported that when ground raw carrot and mashed sweet potato were added in chicken nugget at the level of 0%, 5%, 15 and 20% as a functional ingredient, the appearance and color scores was significant only when they are added at higher level.

Polizer *et al.*, (2015) found that after developing the chicken nuggets with partial substitution of meat or fat by pea fiber with 3 formulations i.e. control (c) – commercial formulation, fiber less meat (FLM) – reduction of 10% meat and addition of 2% pea fiber and fiber less fat (FLF) – reduction of 10% fat and addition of 2% pea fiber no differences were observed amongst the treatments for aroma, texture, flavor and overall acceptability, indicating that partial replacement of meat (10%) or fat (10%) by pea fiber (2%) and water did not change the product acceptance by consumer.

Al Mamun *et al.*, (2017) said that there was no effect of corn flour on sensory quality parameters of chicken meatballs when corn flour was added at the level of 5%, 10%, and 15%.

Tamsen *et al.*, (2018) reported that lightness of the outer layer of nuggets decreased by increasing the amaranth amount in nuggets as a substitute to wheat flour due to presence of bran and betacyanin pigment in amaranth flour which makes it darker than wheat flour.

Anany *et al.*, (2020) noted that when chicken nuggets were formulated with 5%,10%,15% and 20% of frozen white cauliflower as a fat replacer instead of chicken skin , the nugget samples incorporated with 20% of frozen cauliflower showed the lowest score of appearance. However no significant differences were observed in appearance value between control samples and those nugget samples formulated with 5%, 10% and15% of frozen white cauliflower

## 2.7 Shelf life parameters

### 2.7.1 Proximate and pH

Rao and Reddy (2000) observed increase in the pH, moisture and crude protein of chicken meat loaves incorporated with Bengal gram flour and black gram flour when stored at refrigeration temperature up to 12 days.

Patil *et al.*, (2003) studied that chicken patties added with different milk protein binders showed decrease in moisture, protein and fat content during the storage period.

Patil *et al.*, (2004) observed decreased moisture, protein and fat content during storage of chicken patties.

Kalaikannan *et al.*, (2007) reported increased moisture content in chicken patties with addition of egg powder or liquid egg as compared to control during refrigerated storage.

Naveen *et al.*, (2016) reported that refrigerated storage of duck meat sausage at  $7 \pm 1^\circ\text{C}$  increased the crude protein and ether extract up to 10<sup>th</sup> day of storage but decreased upon further storage up to 14<sup>th</sup> day.

Zargar *et al.*, (2017) observed significant ( $P < 0.05$ ) decreasing trend in the crude protein, ether extract and ash content of the chicken sausage with increasing the level of incorporation of carrot during storage.

### 2.7.2 Thiobarbituric acid value

Hugo *et al.*, (2009) observed that TBARS values of chicken thighs and breast that were vacuum sealed and stored at  $-18^\circ\text{C}$  for 100 days seemed to be lower than that of thighs and breast that were stored under oxygen permeable overwrap film at  $4^\circ\text{C}$  for seven day.

Kaczmarek *et al.*, (2015) concluded that TBARS value of emulsified pork sausages increased during the storage and this increase was closely connected

with temperature. The amount of MDA increased as the storage temperature increased.

Hawthorne *et al.*, (2019) observed no significant difference in TBARS values of ground pork meat and boneless pork loin when used different packaging materials.

Chatepa *et al.*, (2021) studied the effect of 10% aqueous extracts of ginger, garlic and onion on the quality and shelf life of frozen chevon and pork. The study revealed that the TBARS values of 10% aqueous ginger, garlic and onion extracts mixed with chevon and pork samples were lower as compared to those of the control samples from day 0 to day 14 of frozen storage.

### **2.7.3 Tyrosine value**

Devadason *et al.*, (2012) observed linear increase of tyrosine value from 0.35 to 0.74 mg per 100 mg of buffalo meat with increase of storage period.

Thamizhannol *et al.*, (2017) concluded that tyrosine value of meat product increases with increase in storage period irrespective of packaging material.

### **2.7.4 Peroxide value**

Peroxide value is a useful method to determine the early stages of fat oxidation and the product is considered rancid when peroxide value of 20-40 meq/kg is reached.

Biswas *et al.*, (2017) observed that poultry meat samples showed a gradual significant increase in peroxide value with advancement of storage period.

Arshad *et al.*, (2017) noted that the peroxide value of chicken nuggets were lower when the diet of chicken was supplemented with combination of alpha lipoic acid and wheat germ oil.

Jouki *et al.*, (2020) concluded that storage time had significant effect on the peroxide value of chicken sausage.

Ahmad *et al.*, (2020) reported that peroxide value in chicken sausages incorporated with purple cabbage significantly delayed lipid oxidation compared to control from 1.62meq/kg to 0.58meq/kg. Control sausage had significantly highest peroxide value compared to sausage containing 40% vegetables as the storage time increased from 2.89 at day 0 to 6.00 at day 21 indicating that lipid oxidation was most extensive in this sample.

#### **2.7.5 Titratable acidity**

Karabıyıklı *et al.*, (2015) reported that the titratable acidity of traditionally produced pastrami was in the range of 0.73 to 1.15% (Lactic acid %).

Çiçek and polat (2016) concluded that the titratable acidity values of bez sucuks were between 1.02 and 2.25% lactic acid and the titratable acidity values of bez sucuks showed significant increase during storage period.

#### **2.7.6 Sensory quality**

Plantharayil *et al.*, (2014) reported that for measures such as colour, appearance, flavour, texture, crispiness after tasting, and overall acceptability, poultry meat finger sticks enriched with oat flour and maize flour outperformed the control.

Goswami *et al.*, (2019) reported decreased sensory attributes in all samples of chicken nuggets incorporated with gooseberry pulp powder and gooseberry seed coat powder during storage period at refrigeration temperature.

#### **2.7.7 Microbial quality**


Verma *et al.*, (2015) stated that when chicken meatballs were prepared by incorporating green cabbage at various levels ( 0%, 15% and 25%) by replacing lean meat in formulation the value of total plate count increased during storage study from 0 to 9 days however yeast and mould appeared only after 6<sup>th</sup> day of storage.

Kumar *et al.*, (2018) stated that when mutton nuggets were prepared by incorporating the blend of essential oil (treatment-1) and combination of essential

oil and 4% flaxseed flour (treatment-2) it was observed that total plate count showed significant increase in both control and treatment products with increase in storage

Goswami *et al.*, (2019) observed no coliform count during the whole storage period of chicken meat nuggets incorporated with gooseberry pulp powder and gooseberry seed coat powder at refrigeration temperature ( $4 \pm 1^{\circ}\text{c}$ ).

Nawarathne *et al.*, (2021) reported that when chicken nuggets were prepared by incorporating roasted sesame seeds the total plate count values increased over the frozen storage period irrespective of the level of roasted sesame seeds incorporated. Salmonella and E coli were not detected in any chicken nugget during frozen storage period.



# **Materials and Methods**

## CHAPTER - III

### MATERIAL AND METHODS

#### 3.1 Source of raw material

##### 3.1.1 Chicken meat

The chicken meat was procured from local meat market of parbhani, slaughtered by traditional halal method. Adequate care has been taken while bringing the meat from the meat market to the laboratory. The tendons, connective tissue and body fat were separated and the meat was packed in high density polyethylene pouches (HDPE) followed by overnight storage in deep freezer at  $-18 \pm 1^{\circ}\text{C}$  and then used for the formulation of products

##### 3.1.2 Spice mix

Spice ingredients viz., aniseed (Soanf), caraway seed (Ajowan), cloves (Laung), capsicum (Lal mirch), cumin seeds (Zeera), black pepper (Kali mirch), dried ginger (Sunth), cardamom (Badi elaichi), coriander powder (Dhania), Mace (Jaypatry), Nutmeg (Jayfal), green cardamom dry (choti elaichi) and cinnamon (Dalchini) were purchased from local market and washed to remove any foreign stuff. For two and a half hours, the components were dried in a hot air oven at 60 degrees Celsius. The ingredients were ground in a grinder with the appropriate blade, then sieved through a fine mesh. The powdered combination with the appropriate proportions of each component as given in the table 3.1 (Kumar et al., 2011 with slight modification) was employed as a spice mix for preparing chicken nuggets

**Table 3.1 Composition of spice mix**

<b>Sr No.</b>	<b>Spice ingredients</b>	<b>Quantity percent (by weight)</b>
1	Aniseed (Soanf)	12
2	Black pepper (Kali mirch)	12
3	Caraway seed (Ajowan)	12
4	Red chilli (Mirch powder)	06
5	Cardmom (Badi elaichi)	04
6	Cinnamon (Dalchini)	04
7	Cloves (Laung)	05
8	Coriander (Dhania)	12
9	Cumin seeds (Zeera)	12
10	Dried ginger (Sunth)	10
11	Mace (Jaypatry)	05
12	Nutmeg (Jayfal)	03
13	Green cardmon dry (Chhoti elaichi)	03
<b>Total</b>		<b>100</b>

### **3.1.3 Chemicals**

All the chemicals which are required were procured from standard firm

### **3.1.4 Condiments mix**

After removing the exterior covers, the condiments, such as onion and garlic, were chopped into small pieces and a fine paste was made in a blender.

### **3.1.5 Other ingredients**

Maida (refined wheat flour), food-grade common salt, whole egg and refined vegetable sunflower oil were purchased from a local store for the development of chicken nuggets.

### **3.1.6 Carrot and Radish powder**

Carrot and radish powder were supplied by Earth Expo Company as per the information provided by industry the characteristics are given in table 3.2 and 3.3.



**Plate 3.1. Raw ingredients**



**Plate 3.2. Deboned meat**



**Plate 3.3. Chicken emulsion**

**Table 3.2 Nutritional facts of carrot powder (Per 10 g )**

<b>Nutrient content</b>	<b>Amount per serving</b>
Calories	<b>35</b>
Saturated fat	<b>0g</b>
Total fat	<b>0g</b>
Saturated fat	<b>0g</b>
Cholesterol	<b>0g</b>
sodium	<b>45g</b>
Total carbohydrates	<b>8g</b>
Dietary fiber	<b>1g</b>
Sugar	<b>4g</b>
Vitamin A	-
Calcium	-
Beta carotene	-
Vitamin C	-
Iron	-

**Table 3.3 Nutritional facts of radish powder (per serving)**

<b>Nutritional content</b>	<b>Amount per serving</b>
Calories	9
Fat	1g
Carbohydrates	2g
Fiber	1g
sugar	1g
Cholesterol	0mg
Sodium	23mg
Vitamin C	15.1mg

### **3.2 Formulation of chicken nuggets**

Chicken nuggets will be prepared from emulsion in the manner as described by Rindhe *et al.*, (2018), with minor modifications.

**Table 3.4 Basic formulation of chicken nuggets**

<b>Sr no.</b>	<b>Particular</b>	<b>Quantity (% by weight)</b>
1	Deboned meat	67.00
2	Oil	08.00
3	Salt	1.50
4	STPP	0.20
5	Water	8.00
6	Flour(Maida)	4.00
7	Spice mix	2.50
8	Condiments	4.00
9	Sugar	0.30
10	Eggs	4.50
	<b>Total</b>	<b>100</b>

**3.2.1 Preparation of chicken nuggets**

Frozen deboned meat was chopped into pieces and minced in a meat mincer after thawing at room temperature. Salt and sodium tripolyphosphate were added to minced meat and chopped in a bowl chopper for the required time as shown in flow diagram then mixed with vegetable oil, refined wheat flour, condiments, and spices to get a perfect emulsion. As shown in the flow chart, chicken nuggets were prepared from emulsion.



**Plate 3.4. Chicken nuggets prepared with Carrot powder**  
**A- Control ( without carrot powder) B- 4% Carrot powder**  
**C- 8% Carrot powder D – 12% Carrot powder**



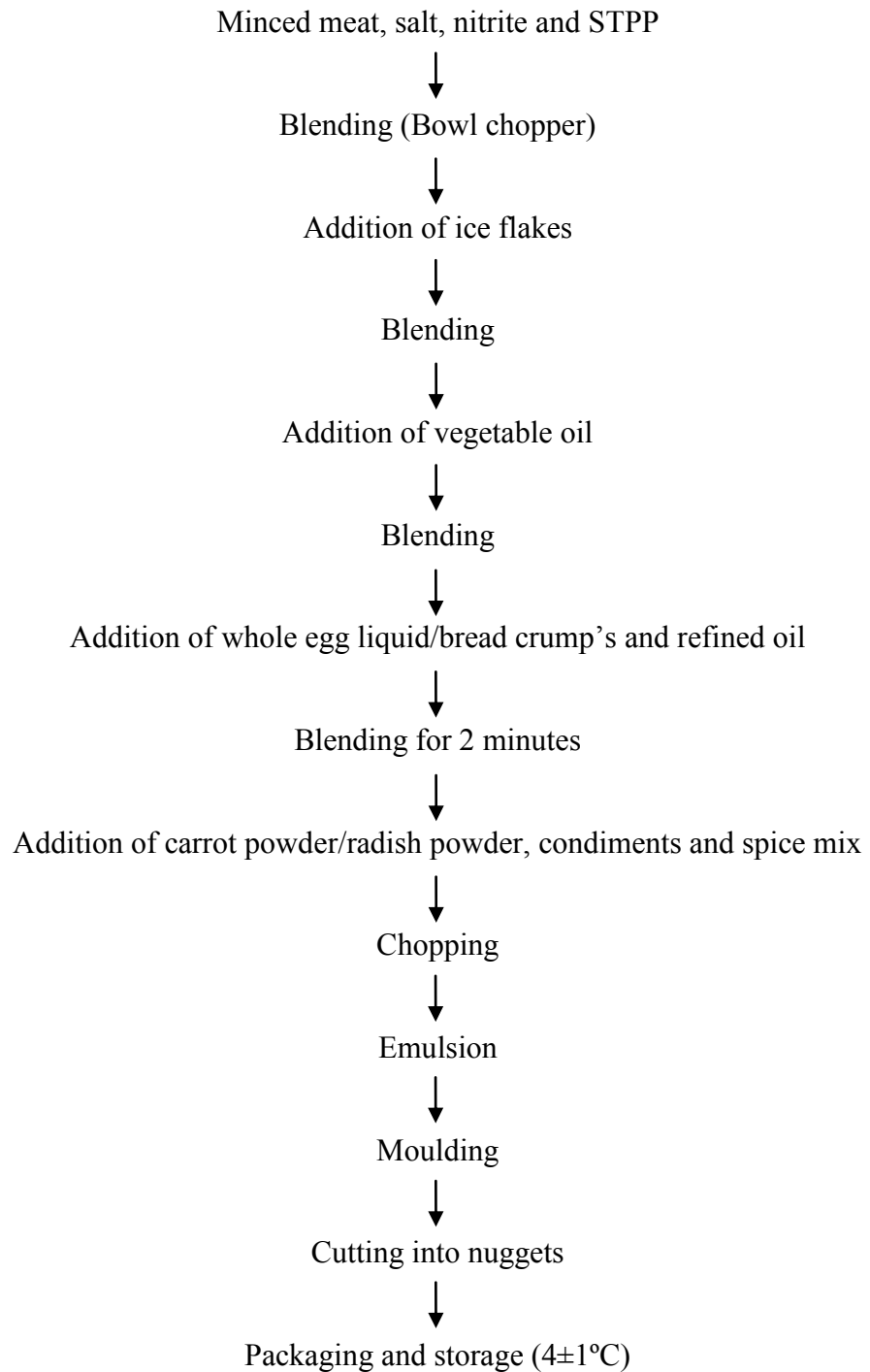
**Plate 3.5. Chicken nuggets prepared with radish powder**

**A- Control (without radish powder) B – 4% Radish powder**

**C – 8% Radish powder**

**D – 12% Radish powder**

### Flow diagram for the preparation of chicken nuggets



### **3.3 Experimental details**

#### **3.3.1 Effect of incorporation of carrot powder on quality of chicken emulsion**

During this experiment chicken emulsion was prepared by incorporating different levels of carrot powder (4, 8, and 12%) and stored at refrigeration temperature. Different physico-chemical measures, such as pH, emulsion stability, water holding capacity, moisture: protein ratio, energy, proximate composition (moisture, fat, protein, and ash), and sensory assessment, were used to evaluate the quality of the chicken emulsion at regular interval of 03 days. To determine the optimal level of carrot powder, the emulsion with various levels of carrot powder was compared to the control.

#### **3.3.2 Effect of incorporation of radish powder on quality of chicken emulsion**

During this experiment, varying amounts of radish powder were used to make chicken emulsion (4, 8, and 12 percent) and stored at refrigeration temperature. The quality of the chicken emulsion was assessed using physico-chemical metrics such as pH, emulsion stability, water holding capacity, moisture: protein ratio, energy, proximate composition (moisture, fat, protein, and ash), and sensory assessment at regular interval of 03 days. The emulsion with various quantities of radish powder was compared to the control to identify the best level of radish powder.

#### **3.3.3 Effect of carrot powder on quality of chicken nuggets**

During this experiment, varying levels of carrot powder were used to make chicken nuggets (4 percent, 8 percent, and 12 percent). The optimal level is chosen based on proximate composition, physico-chemical features such as pH, cooking yield, moisture retention, fat retention, moisture: protein ratio, energy, and sensory assessment.

### **3.3.4 Effect of radish powder on quality of chicken nuggets**

In this study, different amounts of radish powder were utilized to develop chicken nuggets (4 percent, 8 percent, and 12 percent). The appropriate level is determined based on proximate composition, physico-chemical characteristics such as pH, cooking yield, moisture retention, fat retention, moisture: protein ratio, energy, and sensory evaluation.

### **3.3.5 Shelf life of carrot and radish incorporated chicken nuggets during refrigerated storage**

Chicken nuggets prepared with incorporation of selected levels of carrot and radish powder were aseptically packaged in HDPE and kept refrigerated to determine the shelf life. The samples were tested for physico-chemical characteristics, sensory qualities, and microbiological quality at 7-day intervals.

### **3.3.6 Cost structure of chicken nuggets**

The cost of control chicken nuggets (without antioxidants) and experimental nuggets (with carrot and radish powder) were calculated as per the method described by Kumar (2009).

## **3.4 Analytical procedure**

### **3.4.1 Physico-chemical properties**

The following physico-chemical parameters of the samples were analyzed.

#### **3.4.1.1 pH**

The pH of chicken emulsion and nuggets was tested using the Trout *et al.*, (1992) technique. The pH of the suspension was measured using a digital pH meter after ten gram of cooked chicken nuggets/emulsion was combined with 50 ml of distilled water.

#### **3.4.1.2 Emulsion stability**

The Baliga and Madaiah (1970) approach was used to test the emulsion stability of chicken emulsion.

A plastic bag (size 12 × 10 cm) was filled with 20 g of emulsion and sealed airtight. The bags were heated for 30 minutes in a thermostatically regulated water bath at 80 degrees Celsius. The bags were taken out of the water bath, slit at one end, and the cooked liquid poured out before being weighted. After heating, the weight of the emulsion was determined and given as a percentage of emulsion stability.

$$\text{Emulsion stability (\%)} = \frac{\text{Weight of cooked mass}}{\text{Initial weight}} \times 100$$

#### **3.4.1.3 Water holding capacity**

Water holding capacity was calculated as per the method prescribed by Wardlaw *et al.*, (1973). In a 100 ml polycarbonate centrifuge bottle, finely minced sample (20g) was taken and then 30 ml of 0.6 M NaCl solution was added to it. Mixed with glass rod and stirred for 2 minutes on a mechanical shaker. After holding for 15 minutes at 4°C in order to allow the effect of salt to reach equilibrium, the meat slurry was again stirred for 1 minute on a shaker and immediately centrifuged at 500 rpm for 10 minutes at -9°C in a centrifuge. The supernatant volume was measured and the difference between the added and decanted solution was expressed as percentage of the initial weight of sample.

#### **3.4.1.4 Moisture: protein ratio**

The moisture: protein ration is calculated as per the procedure described by Singh (2013). Mathematical division of moisture percent to protein percent in the sample used for the estimation.

#### **3.4.1.5 Energy**

The total calories content of chicken nuggets were calculated as per the method used by Rindhe *et al.*, (2018). For 100 – g portion using at water values for fat (9 Kcal/g), carbohydrates (4 Kcal/g) and protein (4.02 Kcal/g).

### 3.4.1.6 Cooking yield

The weight of chicken nugget was taken before and after cooking and expressed in percentage.

$$\text{Cooking yield} = \frac{\text{Weight of cooked nugget}}{\text{Weight of uncooked nugget}} \times 100$$

### 3.4.1.7 Moisture retention

The moisture retention in chicken nuggets was calculated as per the equation used by Kumar *et al.*, (2007).

$$\text{Moisture retention (\%)} = \frac{\text{Cooking yield (\%)} \times \text{Moisture in nuggets (\%)}}{100}$$

### 3.4.1.8 Fat retention

Retention of fat in chicken nuggets was calculated as per the equation used by Kumar and Sharma (2003) as follows

$$\text{Fat retention} = \frac{(\text{Cooked weight}) \times \text{Fat (\%)} \text{ in cooked nuggets}}{(\text{Uncooked weight} \times \text{Fat (\%)} \text{ in uncooked nuggets)}} \times 100$$

## 3.5 Shelf life study of chicken nuggets

### 3.5.1. Thiobarbituric acid

The value of thiobarbituric acid was estimated 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.

### **3.5.2 Tyrosine value**

For estimating the tyrosine value of nuggets, the approach of Strange *et al.*, (1977) was used with minor modifications. TCA extract was made by combining 20 g of nuggets 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.

### **3.5.3 Titratable acidity**

The titratable acidity is calculated as per the method given by Shelef and Jay (1970). Titrations were performed by mixing 10-g samples of chicken nuggets in 100 ml of deionized water for 2 minutes and then sifting through cheesecloth to remove connective tissue. Samples of the homogenate in duplicate. Each titration contained 2 g of chicken nugget and was titrated with 0.02 N HCl utilising an autotitrator. The amount of acid necessary to raise the pH of the homogenates to 5.00 was taken down. The pH of the homogenates at the start was on the titrator, read both sides at the same time.

### **3.5.4 Peroxide Value**

Peroxide value of the sample is calculated as per the procedure of Koniecko (1979). Five gram of sample was blended with 30 ml acetic acid and chloroform solution (3:2) in 250 ml glass stoppered Erlenmeyer flask. Slurry obtained was gently swirled to extract lipid and then 0.5 ml saturated potassium iodide solution was added and allowed to stand for 1 min with occasional shaking

(swirling), 30 ml of distilled water and 0.5 ml of freshly prepared 0.5 percent starch solution were added. Flask contents were titrated immediately against 0.01N sodium thiosulphate until intense blue colour disappeared. The peroxide value (meq/kg of sample) was calculated as per the following formula.

$$\text{PV (meq/kg sample)} = \frac{\text{N of sodium thiosulphate} \times \text{ml sodium thiosulphate used}}{\text{Wt. of sample (g)}} \times 100$$

#### **3.5.4 Proximate composition**

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

##### **3.5.4.1 Moisture**

Five gram of chicken nuggets 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.

##### **3.5.4.2 Fat**

The fat content of chicken nuggets was calculated using the soxhlet extraction technique. The moisture-free sample was pulverized and extracted in a soxhlet 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.

##### **3.5.4.3 Protein**

The total nitrogen content of the chicken nuggets 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.

The method consist of three phases –

### **Digestion**

The structure and chemical bonds that keep protein molecules together are 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 is accomplished by raising the pH using NaOH. The ammonium radical is converted to ammonia as a result of this. The ammonia is distilled and collected in a trapping medium containing 4% boric acid.

### **Titration**

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

#### **3.5.4.4 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 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 as quickly as possible to prevent moisture absorption.

#### **3.5.5 Microbiological quality**

At the end of storage, the microbiological quality of chicken nuggets was determined using the APHA method (1992), which included total plate count (TPC), psychrophilic count, coliform count, yeast and mould count.

### **Preparation of serial dilution:**

To obtain a  $10^{-1}$  dilution, ten grams of aseptically packed nuggets 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.

#### **3.5.5.1 Total plate count**

The pH was adjusted to  $7.0 \pm 0.2$  and plate count agar (23.5 gram) was suspended in one liter of distilled water. It was heated until totally dissolved, then autoclaved for 15 minutes at 15 pounds of pressure.

For plating, 1 ml of inoculum was used in duplicate from suitable dilutions, using the pour plate method. The plates were incubated for 72 hours at  $37^{\circ}\text{C}$ . Plates with 30 to 300 colonies were chosen for counting after incubation. The number of colonies was multiplied by the reciprocal of the dilutions, and the result was represented as  $\log_{10}$  cfu/g of sample.

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

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

#### **3.5.5.2 Psychrophilic count**

For psychrophilic count, the protocol indicated for total plate count was followed, except the plates were incubated at  $4 \pm 1^{\circ}\text{C}$  for 7 days. The colonies were enumerated, with the findings represented as  $\log_{10}$  cfu/g of material.

### **3.5.5.3 Coliform count**

In 1 liter of distilled water, 41.5 g of Violet Red Bile Agar (VRBA) was suspended and heated to thoroughly dissolve the medium. The final pH of the medium was adjusted to  $7.4 \pm 0.2$ . The medium was not autoclaved as a precaution. In sterilized Petri plates, one ml of suitable dilutions were inserted and molten agar was topped. The plates were incubated at  $37^{\circ}\text{C}$  for 24 hours following solidification. The number of red or purple colonies with a diameter of 0.5 mm were counted and represented as  $\log_{10}$  cfu/g of sample.

### **3.5.5.4 Yeast and mold count**

Sabour and Dextrose agar (65.0 g) was added in one liter distilled water then sterilized by autoclaving at 15 lbs for 15 minutes. The medium after cooling at  $45^{\circ}\text{C}$  was poured (20-25 ml) over the plates in duplicate previously containing 1 ml inoculum of suitable dilution. The petridishes 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.

### **3.6 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 evaluated the quality of chicken nuggets on the basis of sensory criteria such as appearance, flavor, juiciness, texture, and overall acceptability.

### **3.7 Statistical analysis**

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



# **Results and Discussion**

## CHAPTER - IV

### RESULTS AND DISCUSSION

The present study conducted to ascertain the qualitative and quantitative changes in chicken nuggets incorporated with carrot and radish powder in respect of sensory, physico-chemical and microbial quality. Optimization of carrot and radish powder levels in chicken emulsion with development of extended shelf life chicken nuggets were attempted. Storage stability of developed chicken nuggets assessed at refrigeration temperature under aerobic packaging conditions. Cost of chicken nuggets prepared by using selected levels of carrot and radish powder compared to control (without antioxidant). The data from the present study are categorized as under:

- Quality evaluation of chicken emulsion incorporated with different levels of carrot and radish powder.
- Development and analysis of chicken nuggets incorporated with different levels of carrot and radish powder.
- Shelf life of developed chicken nuggets at  $4 \pm 1$  °C.
- Cost structure of developed chicken nuggets.

The detail results of the present chapter observed in various experiments carried out as per the mentioned objectives in chapter 1 are presented in the text along with Tables (4.1 to 12) and Figures (1 to 16).

#### **4.1 Quality appraisal of chicken meat emulsion incorporated with carrot and radish powder**

Chicken emulsion was prepared by adding different levels of carrot and radish powder. The best level of carrot and radish powder was selected on the basis of various sensory and physico-chemical attributes.

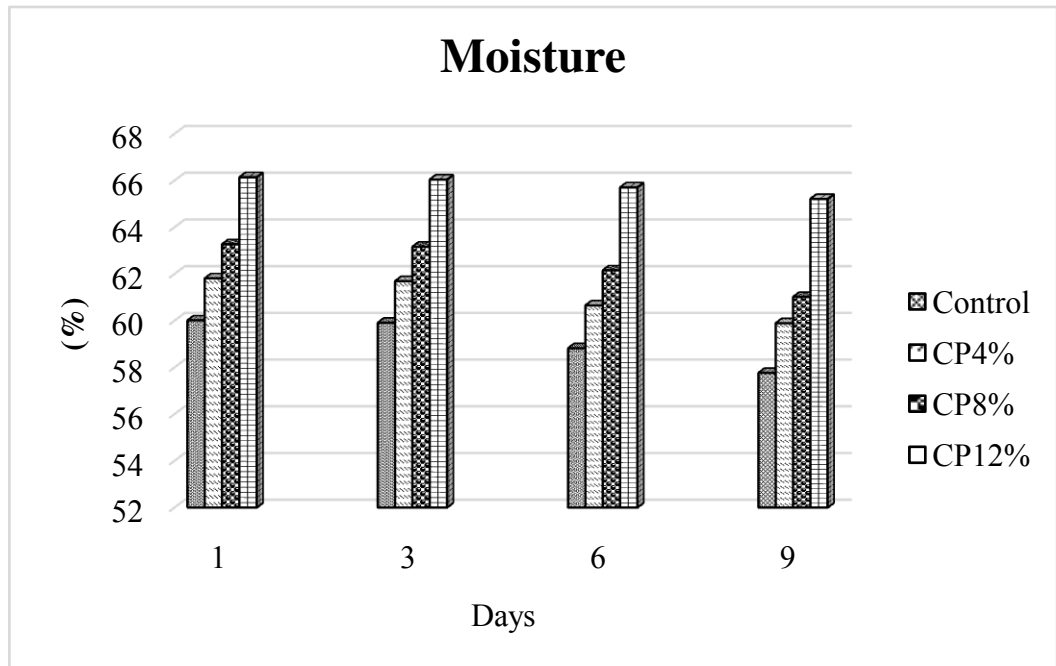
#### **4.1.1 Quality of chicken emulsion incorporated with carrot powder**

Chicken emulsion was prepared by incorporating different levels of carrot powder and subsequently stored at (4±1°C). The emulsion quality was assessed at regular interval of 3 days by using following parameters.

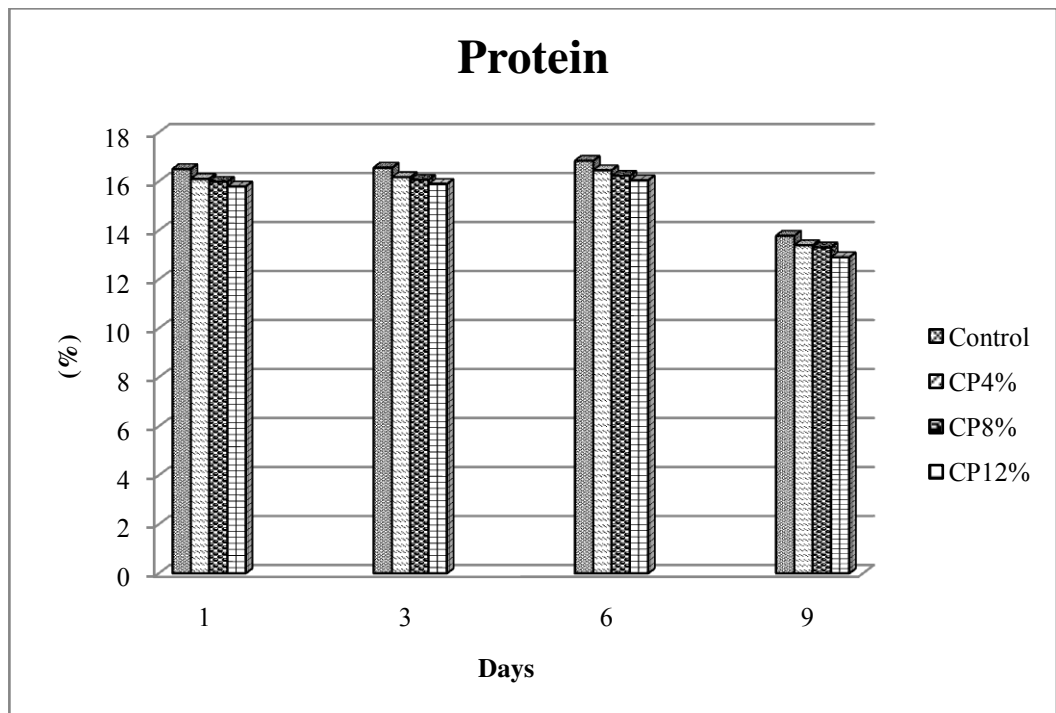
##### **4.1.1.1 Proximate composition**

The mean score for proximate composition of chicken emulsion incorporated with different levels of carrot powder (4, 8 and 12%) is presented in Table 4.1

It was revealed from the table that the moisture percentage of control and that of carrot incorporated chicken emulsion differed significantly ( $P < 0.05$ ). With increasing the level of carrot powder the moisture percentage also increased. This might be due to better moisture retention by carrot incorporated chicken emulsion owing to presence of adequate amount of fibers in it which are having better water holding capacity. Similar observations were reported by Singh *et al.*, (2015). They studied that with increasing the level of carrot powder in chicken meat cutlets the moisture increased significantly. The moisture percentage of control and carrot incorporated chicken emulsion did not differ significantly ( $P > 0.05$ ) up to 3<sup>rd</sup> day of storage but from 3<sup>rd</sup> day onwards significant decrease ( $P < 0.05$ ) in moisture percentage was observed during further storage irrespective of treatment. Gupta *et al.*, (2017) also observed decreased moisture in chicken meat cutlets during frozen storage of 60 days. Denaturation of protein during storage and cooking might be a reason for decrease in moisture during storage period.



**Fig 4.1** Moisture of chicken emulsion added with carrot powder.



**Fig 4.2** Protein of chicken emulsion added with carrot powder.

**Table 4.1: Effect of different levels of carrot powder on proximate composition of chicken emulsion during refrigerated (4±1°C) aerobic storage (Mean±S.E.)\*.**

Treatments/ Days	Refrigerated storage period (Days)			
	Day 1	Day 3	Day 6	Day 9
<b>Moisture (%)</b>				
<b>C</b>	60.01 ± 0.14 <sup>aC</sup>	59.91 ± 0.13 <sup>aC</sup>	58.82 ± 0.09 <sup>aB</sup>	57.76 ± 0.12 <sup>aA</sup>
<b>T-1</b>	61.81 ± 0.16 <sup>bC</sup>	61.69 ± 0.14 <sup>bC</sup>	60.65 ± 0.11 <sup>bB</sup>	59.89 ± 0.13 <sup>bA</sup>
<b>T-2</b>	63.27 ± 0.23 <sup>cC</sup>	63.16 ± 0.22 <sup>cC</sup>	62.15 ± 0.13 <sup>cB</sup>	61.01 ± 0.14 <sup>cA</sup>
<b>T-3</b>	66.14 ± 0.13 <sup>dC</sup>	66.04 ± 0.14 <sup>dC</sup>	65.70 ± 0.12 <sup>dB</sup>	65.21 ± 0.11 <sup>dA</sup>
<b>Protein (%)</b>				
<b>C</b>	16.50 ± 0.13 <sup>cC</sup>	16.56 ± 0.07 <sup>cBC</sup>	16.84 ± 0.37 <sup>cB</sup>	13.78 ± 0.21 <sup>cA</sup>
<b>T-1</b>	16.10 ± 0.10 <sup>bC</sup>	16.17 ± 0.09 <sup>bBC</sup>	16.45 ± 0.20 <sup>bB</sup>	13.39 ± 0.18 <sup>bA</sup>
<b>T-2</b>	15.98 ± 0.14 <sup>bC</sup>	16.06 ± 0.13 <sup>bBC</sup>	16.22 ± 0.17 <sup>bB</sup>	13.30 ± 0.09 <sup>bA</sup>
<b>T-3</b>	15.79 ± 0.12 <sup>aC</sup>	15.89 ± 0.11 <sup>aBC</sup>	16.04 ± 0.16 <sup>aB</sup>	12.90 ± 0.11 <sup>aA</sup>
<b>Fat (%)</b>				
<b>C</b>	9.22 ± 0.06 <sup>dC</sup>	9.18 ± 0.05 <sup>dC</sup>	9.11 ± 0.04 <sup>dB</sup>	8.90 ± 0.07 <sup>dA</sup>
<b>T-1</b>	8.93 ± 0.04 <sup>cC</sup>	8.89 ± 0.04 <sup>cC</sup>	8.82 ± 0.05 <sup>cB</sup>	8.65 ± 0.10 <sup>cA</sup>
<b>T-2</b>	8.62 ± 0.05 <sup>bC</sup>	8.59 ± 0.05 <sup>bBC</sup>	8.55 ± 0.05 <sup>bB</sup>	8.45 ± 0.07 <sup>bA</sup>
<b>T-3</b>	8.05 ± 0.04 <sup>aC</sup>	8.03 ± 0.05 <sup>aBC</sup>	7.99 ± 0.06 <sup>aB</sup>	7.90 ± 0.07 <sup>aA</sup>
<b>Ash (%)</b>				
<b>C</b>	1.91 ± 0.06 <sup>aC</sup>	1.86 ± 0.05 <sup>aC</sup>	1.71 ± 0.06 <sup>aB</sup>	1.50 ± 0.11 <sup>aA</sup>
<b>T-1</b>	2.51 ± 0.05 <sup>bC</sup>	2.47 ± 0.04 <sup>bC</sup>	2.37 ± 0.05 <sup>bB</sup>	2.19 ± 0.10 <sup>bA</sup>
<b>T-2</b>	2.74 ± 0.04 <sup>cC</sup>	2.71 ± 0.05 <sup>cC</sup>	2.62 ± 0.04 <sup>cB</sup>	2.47 ± 0.08 <sup>cA</sup>
<b>T-3</b>	2.95 ± 0.03 <sup>dC</sup>	2.93 ± 0.04 <sup>dC</sup>	2.86 ± 0.05 <sup>dB</sup>	2.73 ± 0.05 <sup>dA</sup>
<b>Moisture: Protein Ratio</b>				
<b>C</b>	3.64 ± 0.02 <sup>aB</sup>	3.62 ± 0.03 <sup>aB</sup>	3.49 ± 0.04 <sup>aA</sup>	4.19 ± 0.04 <sup>aC</sup>
<b>T-1</b>	3.84 ± 0.03 <sup>bB</sup>	3.82 ± 0.02 <sup>bB</sup>	3.67 ± 0.05 <sup>bA</sup>	4.47 ± 0.05 <sup>bC</sup>
<b>T-2</b>	3.96 ± 0.03 <sup>cB</sup>	3.93 ± 0.03 <sup>cB</sup>	3.83 ± 0.06 <sup>cA</sup>	4.59 ± 0.06 <sup>cC</sup>
<b>T-3</b>	4.19 ± 0.03 <sup>dB</sup>	4.16 ± 0.03 <sup>dB</sup>	4.10 ± 0.05 <sup>dA</sup>	5.05 ± 0.01 <sup>dC</sup>
<b>Energy (Kcal)</b>				
<b>C</b>	184.75 ± 0.14 <sup>dD</sup>	183.72 ± 0.24 <sup>dC</sup>	181.67 ± 0.44 <sup>dB</sup>	178.60 ± 0.48 <sup>dA</sup>
<b>T-1</b>	166.10 ± 0.12 <sup>cD</sup>	165.07 ± 0.20 <sup>cC</sup>	163.02 ± 0.30 <sup>cB</sup>	159.95 ± 0.33 <sup>cA</sup>
<b>T-2</b>	164.33 ± 0.11 <sup>bD</sup>	163.30 ± 0.15 <sup>bC</sup>	161.25 ± 0.25 <sup>bB</sup>	158.18 ± 0.55 <sup>bA</sup>
<b>T-3</b>	161.74 ± 0.10 <sup>aD</sup>	160.71 ± 0.13 <sup>aC</sup>	158.66 ± 0.23 <sup>aB</sup>	155.59 ± 0.42 <sup>aA</sup>

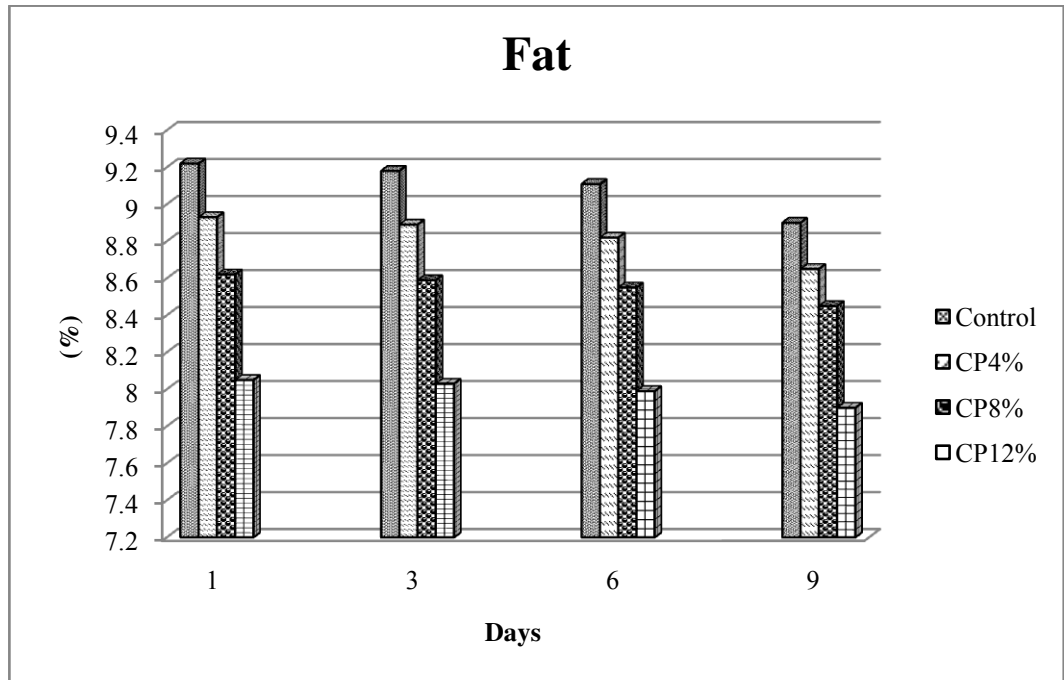
n=6; C= Control (without carrot powder); **T-1**= 4% carrot powder, **T-2**= 8% carrot powder; **T-3**= 12% carrot powder. \*Mean±S.E. with different superscripts row wise (capital alphabets) and column wise (small alphabets) differ significantly (P<0.05).

Decrease in protein and fat percentage was observed with increase in the level of carrot powder in chicken emulsion. The difference was significant ( $P < 0.05$ ) when compared to control. Kumar et al., (2015), observed similar results. The protein percentage differed significantly ( $P < 0.05$ ) with advancement of storage period. Protein percentage increased as the storage period increased up to day 6<sup>th</sup> of storage period but later a significant decrease ( $P < 0.05$ ) in protein is observed compared to 1<sup>st</sup> day of storage. This could be due to loss of moisture from emulsion during the period of storage.

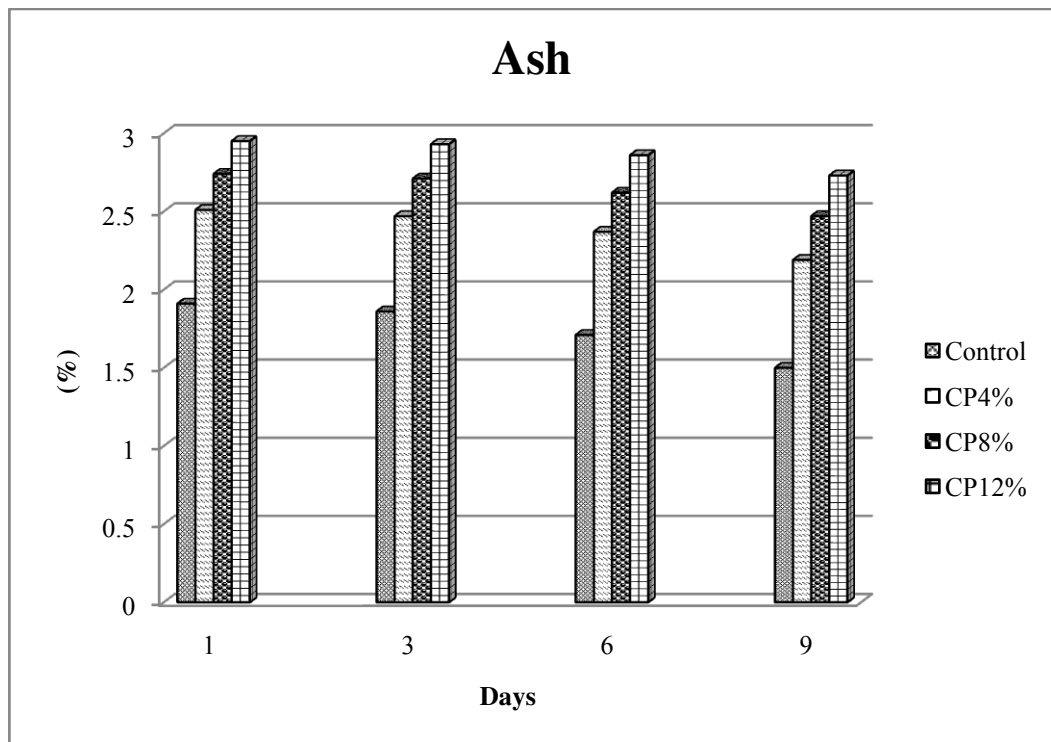
It was observed from the table that the ash percentage decreased as the storage period progressed irrespective of the treatment. However, the difference was non-significant ( $P > 0.05$ ) up to 3<sup>rd</sup> day of storage. With increased carrot powder percentage the ash percentage also increased significantly ( $P < 0.05$ ). The highest ash percentage was found in 12% carrot incorporated chicken emulsion. This result is similar with the findings observed by Kumar *et al.*, (2015). They reported that when chicken cutlets were prepared by addition of carrot pomace dried powder the ash% also increased with increase in carrot pomace dried powder.

A significantly increasing ( $P < 0.05$ ) trend is observed in the moisture: protein ratio of chicken emulsion with increasing the amount of carrot powder. Chicken emulsion with 12% carrot powder showed highest moisture: protein ratio. A non-significant decrease in the moisture: protein ratio is observed up to 3<sup>rd</sup> day of emulsion storage but thereafter moisture: protein ratio differed significantly.

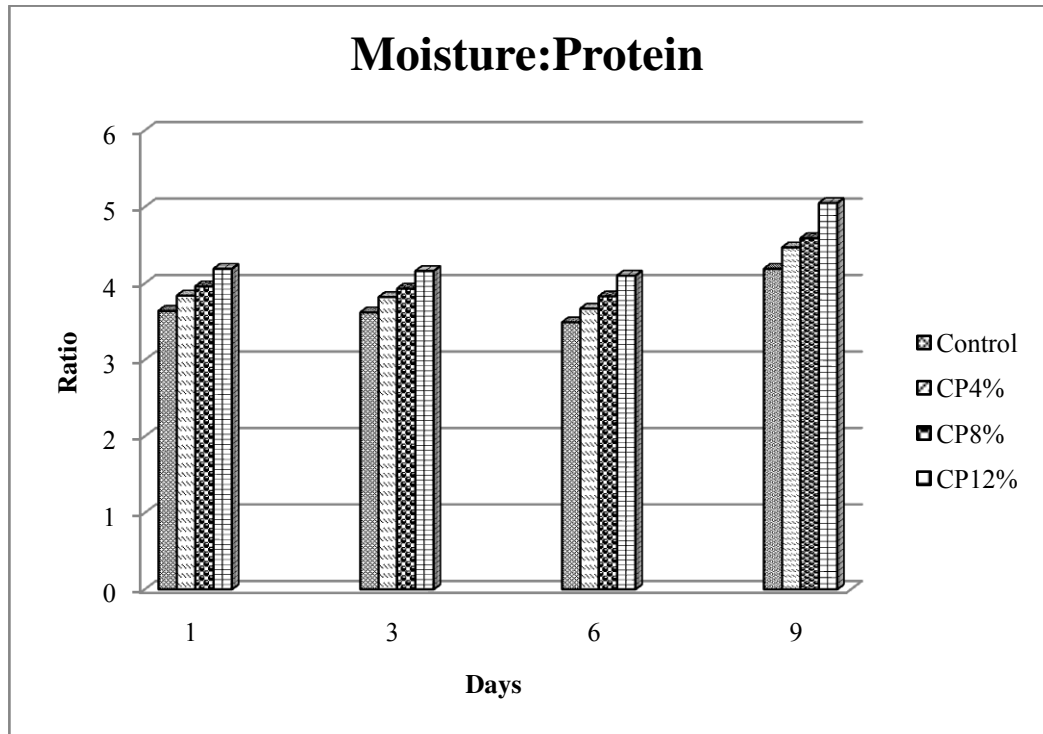
Significant decrease ( $P < 0.05$ ) was found in the energy of chicken emulsion with progressing storage period. Similarly the energy of chicken emulsion decreased significantly ( $P < 0.05$ ) as the level of carrot powder incorporated in chicken emulsion increased. Chicken emulsion of control group showed highest energy value as compared to emulsion added with carrot powder. This was because the carrot contain low amount of fat which was the most concentrated dietary energy source. Similar finding was observed by Biswas *et al.*, (2011). They reported high value of energy for control group of chicken



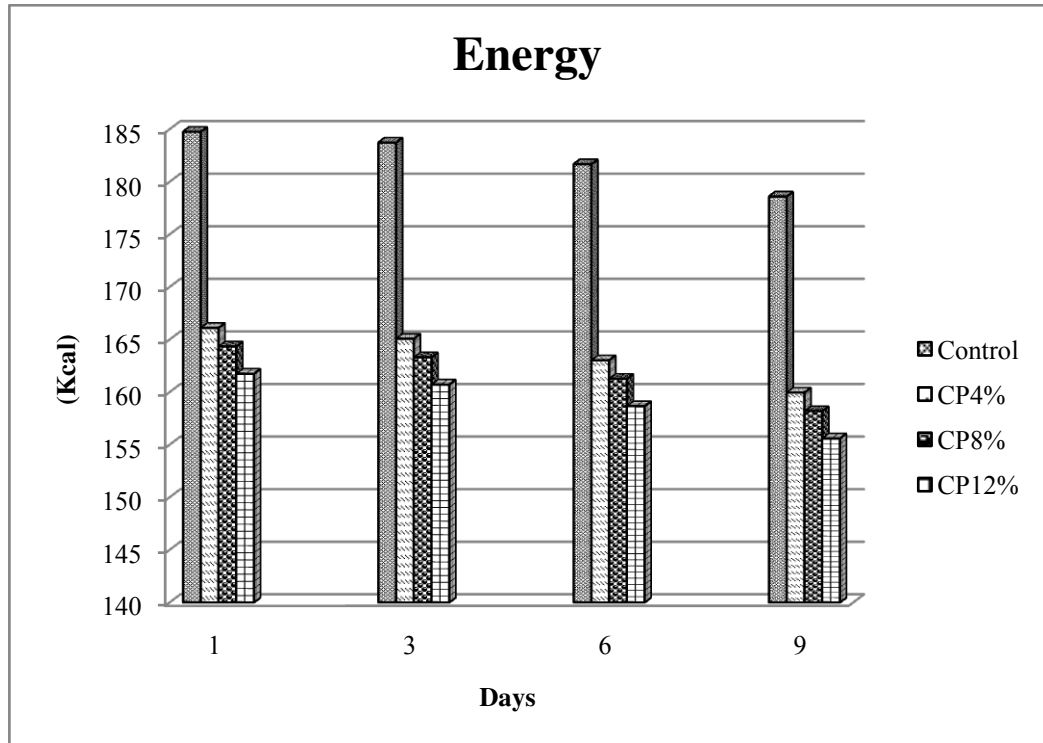
**Fig 4.3 Fat of chicken emulsion added with carrot powder.**



**Fig 4.4 Ash of chicken emulsion added with carrot powder.**



**Fig 4.5** Moisture:protein ratio of chicken emulsion added with carrot powder.



**Fig 4.6** Energy of chicken emulsion added with carrot powder.

nuggets than ground carrot and mashed sweet potato incorporated nuggets.

#### 4.1.1.2 Physico-chemical attributes

The data regarding physico-chemical attributes of chicken emulsion incorporated with different levels of carrot powder during refrigerated ( $4\pm 1^\circ\text{C}$ ) aerobic storage is shown in Table 4.2.

**Table 4.2: Effect of different levels of carrot powder on physico-chemical attributes of chicken emulsion during refrigerated ( $4\pm 1^\circ\text{C}$ ) aerobic storage (Mean $\pm$ S.E.)\*.**

Treatments/ Days	Refrigerated storage period (Days)			
	Day 1	Day 3	Day 6	Day 9
<b>pH</b>				
<b>C</b>	5.74 $\pm$ 0.05 <sup>aA</sup>	5.84 $\pm$ 0.05 <sup>B</sup>	5.98 $\pm$ 0.03 <sup>bC</sup>	6.12 $\pm$ 0.05 <sup>cD</sup>
<b>T-1</b>	5.81 $\pm$ 0.02 <sup>bA</sup>	5.86 $\pm$ 0.03 <sup>B</sup>	5.91 $\pm$ 0.02 <sup>aC</sup>	6.01 $\pm$ 0.01 <sup>bD</sup>
<b>T-2</b>	5.84 $\pm$ 0.06 <sup>bA</sup>	5.88 $\pm$ 0.04 <sup>AB</sup>	5.91 $\pm$ 0.03 <sup>ab</sup>	5.96 $\pm$ 0.02 <sup>aC</sup>
<b>T-3</b>	5.84 $\pm$ 0.05 <sup>bA</sup>	5.88 $\pm$ 0.03 <sup>AB</sup>	5.90 $\pm$ 0.03 <sup>ab</sup>	5.95 $\pm$ 0.02 <sup>aC</sup>
<b>Emulsion Stability (%)</b>				
<b>C</b>	88.50 $\pm$ 0.33 <sup>aD</sup>	86.50 $\pm$ 0.43 <sup>aC</sup>	84.00 $\pm$ 0.53 <sup>ab</sup>	80.00 $\pm$ 0.63 <sup>aA</sup>
<b>T-1</b>	90.50 $\pm$ 0.65 <sup>bD</sup>	89.50 $\pm$ 0.64 <sup>bBC</sup>	87.00 $\pm$ 0.69 <sup>bB</sup>	83.50 $\pm$ 0.64 <sup>bA</sup>
<b>T-2</b>	91.00 $\pm$ 0.59 <sup>bC</sup>	90.00 $\pm$ 0.60 <sup>bBC</sup>	88.50 $\pm$ 0.64 <sup>bB</sup>	85.50 $\pm$ 0.70 <sup>cA</sup>
<b>T-3</b>	94.00 $\pm$ 0.56 <sup>cC</sup>	93.50 $\pm$ 0.55 <sup>cBC</sup>	92.50 $\pm$ 0.65 <sup>dB</sup>	90.50 $\pm$ 0.71 <sup>dA</sup>
<b>Water Holding Capacity (%)</b>				
<b>C</b>	44.90 $\pm$ 0.53 <sup>aC</sup>	44.65 $\pm$ 0.63 <sup>aC</sup>	44.65 $\pm$ 0.63 <sup>ab</sup>	42.43 $\pm$ 0.41 <sup>aA</sup>
<b>T-1</b>	49.30 $\pm$ 0.51 <sup>bC</sup>	49.12 $\pm$ 0.47 <sup>bC</sup>	48.01 $\pm$ 0.46 <sup>bB</sup>	45.74 $\pm$ 0.44 <sup>bA</sup>
<b>T-2</b>	49.70 $\pm$ 0.42 <sup>bC</sup>	49.56 $\pm$ 0.39 <sup>bC</sup>	48.45 $\pm$ 0.28 <sup>bB</sup>	46.04 $\pm$ 0.43 <sup>bA</sup>
<b>T-3</b>	50.60 $\pm$ 0.21 <sup>cC</sup>	50.48 $\pm$ 0.18 <sup>cC</sup>	49.37 $\pm$ 0.17 <sup>cB</sup>	47.14 $\pm$ 0.29 <sup>cA</sup>

n=6; C= Control (without carrot powder); **T-1**= 4% carrot powder, **T-2**= 8% carrot powder; **T-3**= 12% carrot powder. \*Mean $\pm$ S.E. with different superscripts row wise (capital alphabets) and column wise (small alphabets) differ significantly (P<0.05).

It can be seen from the table that pH values differed significantly (P<0.05) during the period of 9 days. The pH values increased with advancement in storage period irrespective of treatment. Sallam *et al.*, (2004) also reported that a significant impact on pH of products occur during storage period. Increase in pH was observed due to addition of carrot powder. Similar trend was observed by Gupta *et al.*, (2017) they reported that in chicken cutlets prepared with addition of 10% carrot the pH increased significantly (P<0.05).

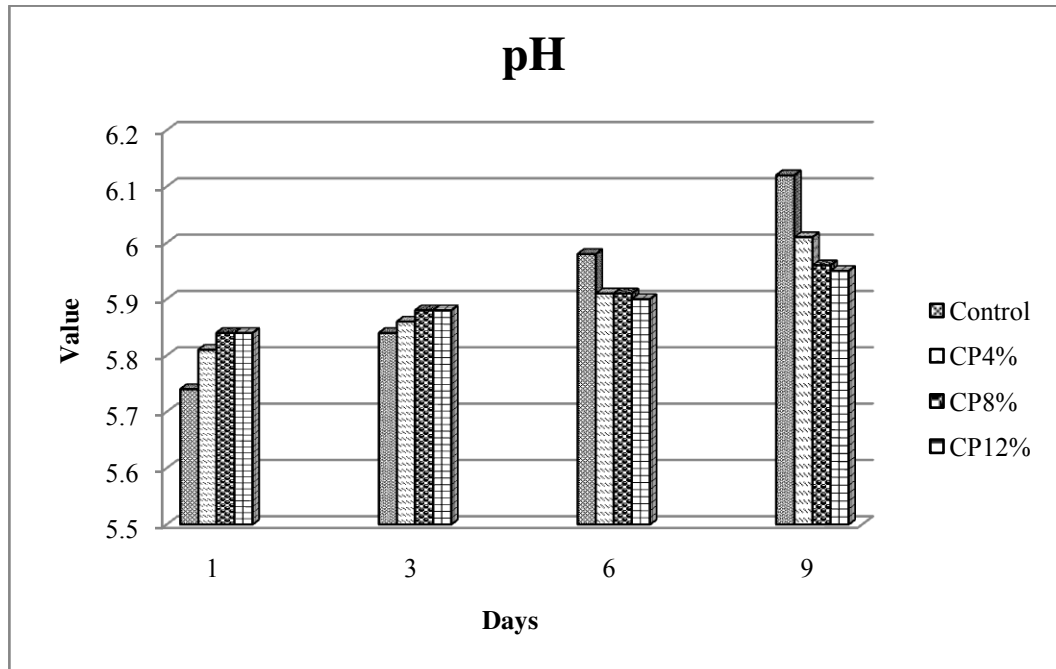
The emulsion stability of chicken emulsion found to be increased as the level of carrot incorporated increased. This finding was similar with Ponsingh *et al.*, (2010). They concluded that increase in the level of potato flour in buffalo meat sausage showed better emulsion stability compared to control. The emulsion stability decreased during storage period. The lowest emulsion stability was observed on day 9 of storage period. Chandralekha *et al.*, (2012), observed similar finding. They observed that the emulsion stability of chicken meatballs prepared by incorporating pomegranate rind powder decreased significantly during the refrigerated storage of 8 days.

A gradual decline in water holding capacity of chicken emulsion was observed during the storage period of 9 days irrespective of the level of carrot powder. The difference was non-significant ( $P>0.05$ ) up to 3<sup>rd</sup> day of storage but on 6<sup>th</sup> day and 9<sup>th</sup> day a significant difference ( $P<0.05$ ) in water holding capacity of chicken emulsion is observed when compared with control. It can be concluded from the Table that with increasing the level of carrot powder in chicken emulsion the water holding capacity also increased significantly ( $P<0.05$ ) when compared with control. Syuhairah *et al.*, (2016) reported that vegetables like carrot, spinach, capsicum, purple cabbage when added in chicken meat sausage the water holding capacity was affected significantly. Mehta *et al.*, (2015) also stated that fiber if added in meat product could help to increase the water holding capacity of meat product.

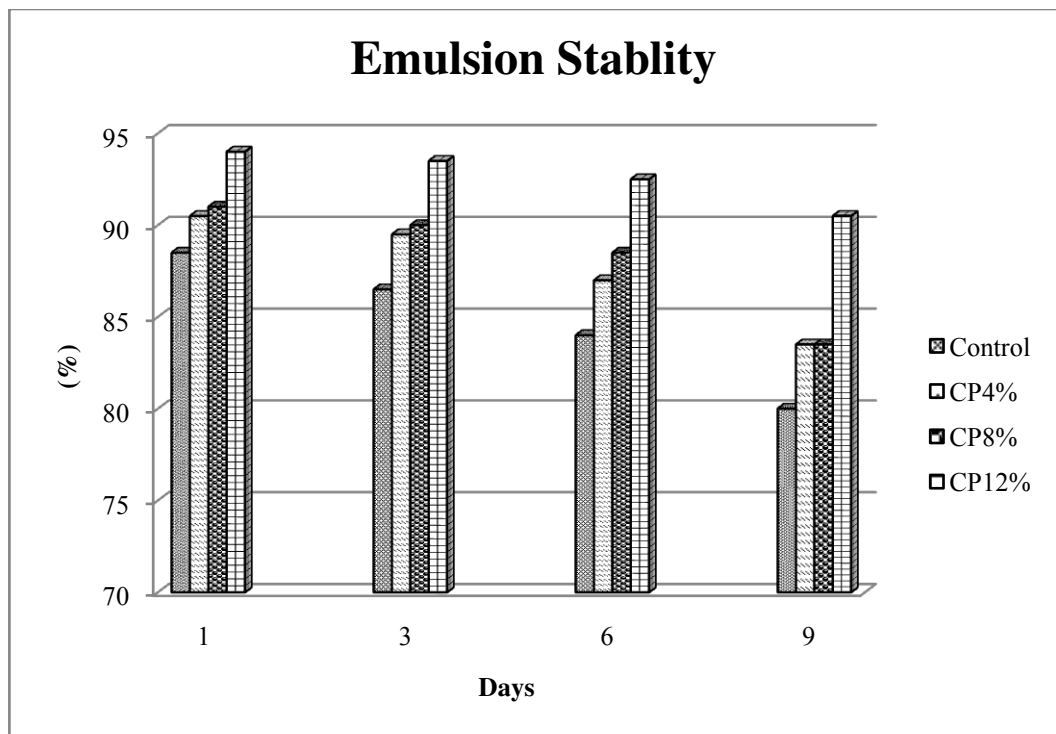
#### **4.1.1.3 Sensory Evaluation**

The observations in respect to sensory attributes of chicken emulsion incorporated with different levels of carrot powder (4, 8 and 12%) during refrigerated ( $4\pm 1^{\circ}\text{C}$ ) aerobic storage is shown in Table 4.3.

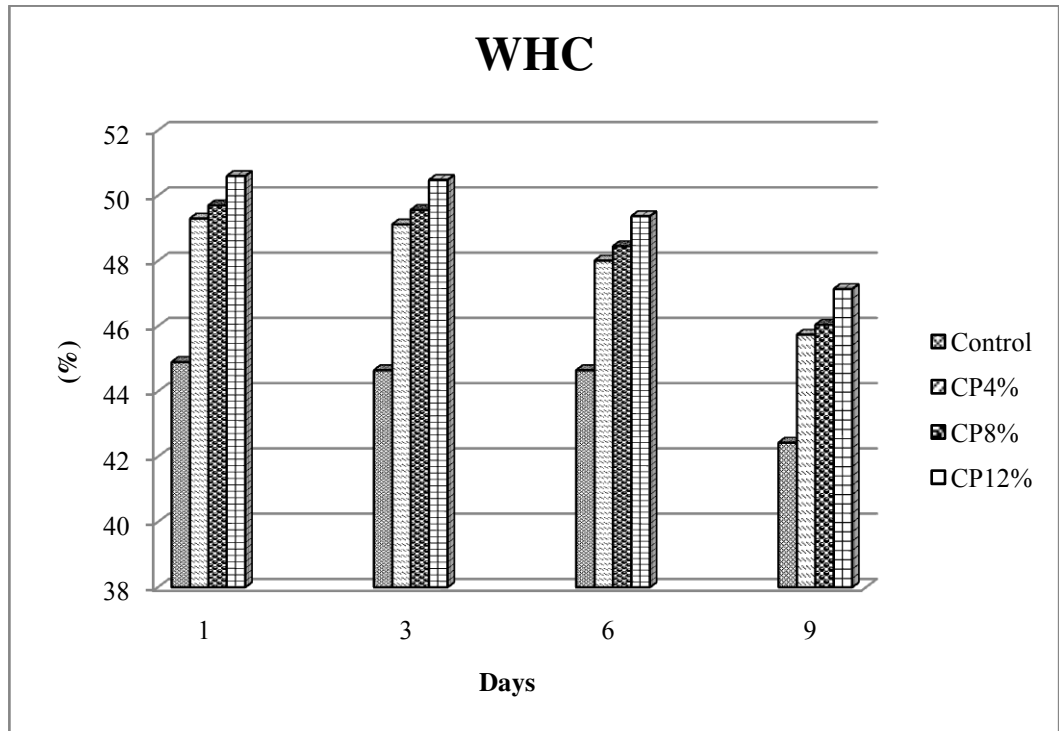
The appearance score for the chicken emulsion of control group and that of 12% carrot incorporated chicken emulsion decreased significantly ( $P<0.05$ ) during the storage period of 9 days. A non-significant difference ( $P>0.05$ ) in appearance score was observed for 4% and 8% carrot incorporated chicken emulsion up to 3<sup>rd</sup> day of storage then the difference was significant. Addition of



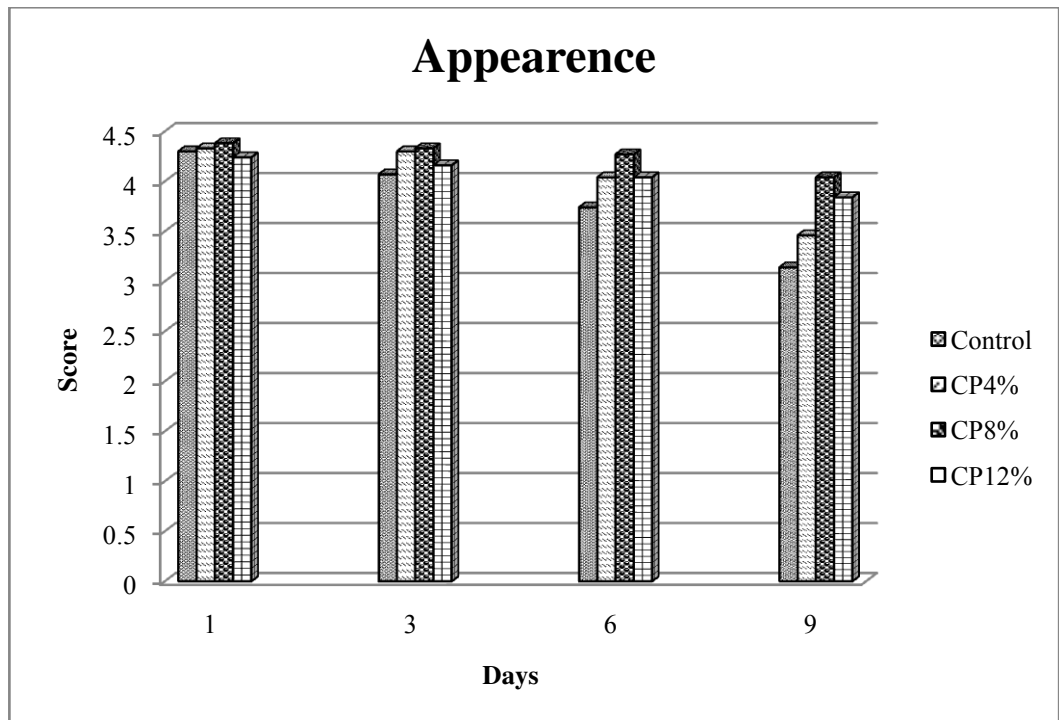
**Fig 4.7 pH of chicken emulsion added with carrot powder**



**Fig 4.8 Emulsion stability of chicken emulsion added with carrot powder.**



**Fig 4.9** Water holding capacity of chicken emulsion added with carrot powder.



**Fig 4.10** Appearance of chicken emulsion added with carrot powder

12% carrot powder in chicken meat emulsion significantly ( $P<0.05$ ) lowered the appearance score. This could be due to darker color of chicken nuggets due to carrot powder. While 8% carrot powder incorporated chicken emulsion showed optimum score for appearance when compared with control group. Enhanced reddish tint due to color pigment carotenoid present in carrot might be a reason of optimum score of appearance of 8% carrot incorporated chicken emulsion. (Bhosale 2009). The findings were in relevance with Singh *et al.*, (2015). They reported that carrot powder added chicken meat cutlets scored higher than control in sensory evaluation carried out by sensory panelist. The odor score of chicken emulsion decreased progressively during the storage period of 9 days.

**Table 4.3: Effect of different levels of carrot powder on sensory attributes of chicken emulsion during refrigerated ( $4\pm 1^{\circ}\text{C}$ ) aerobic storage (Mean $\pm$ S.E.)\*.**

Treatments/ Days	Refrigerated storage period (Days)			
	Day 1	Day 3	Day 6	Day 9
<b>Appearance</b>				
C	4.30 $\pm$ 0.08 <sup>bD</sup>	4.07 $\pm$ 0.09 <sup>aC</sup>	3.74 $\pm$ 0.08 <sup>aB</sup>	3.14 $\pm$ 0.05 <sup>aA</sup>
T-1	4.33 $\pm$ 0.05 <sup>bC</sup>	4.30 $\pm$ 0.07 <sup>bC</sup>	4.04 $\pm$ 0.07 <sup>bB</sup>	3.46 $\pm$ 0.07 <sup>bA</sup>
T-2	4.38 $\pm$ 0.10 <sup>bB</sup>	4.33 $\pm$ 0.06 <sup>bB</sup>	4.27 $\pm$ 0.12 <sup>cB</sup>	4.04 $\pm$ 0.09 <sup>dA</sup>
T-3	4.24 $\pm$ 0.04 <sup>aD</sup>	4.16 $\pm$ 0.05 <sup>cC</sup>	4.04 $\pm$ 0.04 <sup>bB</sup>	3.84 $\pm$ 0.09 <sup>cA</sup>
<b>Odour</b>				
C	4.34 $\pm$ 0.07 <sup>aD</sup>	4.11 $\pm$ 0.08 <sup>aC</sup>	3.77 $\pm$ 0.07 <sup>aB</sup>	3.07 $\pm$ 0.06 <sup>aA</sup>
T-1	4.41 $\pm$ 0.06 <sup>aC</sup>	4.34 $\pm$ 0.08 <sup>bC</sup>	4.07 $\pm$ 0.06 <sup>bB</sup>	3.51 $\pm$ 0.08 <sup>bA</sup>
T-2	4.46 $\pm$ 0.11 <sup>aC</sup>	4.37 $\pm$ 0.07 <sup>bB</sup>	4.31 $\pm$ 0.11 <sup>cB</sup>	4.07 $\pm$ 0.08 <sup>dA</sup>
T-3	4.27 $\pm$ 0.05 <sup>bD</sup>	4.21 $\pm$ 0.06 <sup>cC</sup>	4.07 $\pm$ 0.05 <sup>bB</sup>	3.75 $\pm$ 0.07 <sup>cA</sup>
<b>Overall quality</b>				
C	4.18 $\pm$ 0.07 <sup>aD</sup>	4.00 $\pm$ 0.05 <sup>aC</sup>	3.77 $\pm$ 0.06 <sup>aB</sup>	3.24 $\pm$ 0.05 <sup>aA</sup>
T-1	4.24 $\pm$ 0.08 <sup>aC</sup>	4.11 $\pm$ 0.05 <sup>bB</sup>	4.04 $\pm$ 0.09 <sup>bB</sup>	3.51 $\pm$ 0.04 <sup>bA</sup>
T-2	4.55 $\pm$ 0.06 <sup>cC</sup>	4.38 $\pm$ 0.06 <sup>dB</sup>	4.33 $\pm$ 0.08 <sup>dB</sup>	4.16 $\pm$ 0.05 <sup>dA</sup>
T-3	4.38 $\pm$ 0.06 <sup>bD</sup>	4.27 $\pm$ 0.06 <sup>cC</sup>	4.16 $\pm$ 0.08 <sup>cB</sup>	3.81 $\pm$ 0.05 <sup>cA</sup>

n=6; C= Control (without carrot powder); T-1= 4% carrot powder, T-2= 8% carrot powder; T-3= 12% carrot powder. \*Mean $\pm$ S.E. with different superscripts row wise (capital alphabets) and column wise (small alphabets) differ significantly ( $P<0.05$ ).

With incorporation of carrot level the odor of chicken emulsion also improved. Optimum odour score was observed in 8% carrot incorporated chicken emulsion. Syuhairah *et al.*, (2016) reported that addition of vegetables like

capsicum, carrot, spinach, purple cabbage and grey oyster mushroom improved the odor score of sausage. The overall quality of chicken emulsion deteriorated with progression of storage period. Incorporation of carrot powder in chicken emulsion improved the overall quality of emulsion as compared to control. Optimum overall quality score was observed in 8% carrot incorporated chicken emulsion.

#### **4.1.2 Quality of chicken emulsion incorporated with radish powder.**

Chicken emulsion was prepared, assess at regular interval of 3 days by incorporating different levels of radish powder, and subsequently stored at ( $4\pm 1^{\circ}$  C).

##### **4.1.2.1 Proximate composition**

The effect of different levels of radish powder on proximate composition of chicken emulsion during refrigerated storage is shown in Table 4.4.

It was found that the moisture percentage was decreased significantly ( $P<0.05$ ) with increase in storage period. However, the difference was non-significant up to 3<sup>rd</sup> day when compared to control. Similar findings were reported by Naveen *et al.*, (2016). They reported that the mean score of moisture percentage of duck meat sausage decreased during the refrigerated storage of 14 days. The moisture evaporation from meat and drip loss could be the possible reasons for the decreased moisture content. However the difference was non-significant up to 3<sup>rd</sup> day of storage but then a significant difference ( $P<0.05$ ) in moisture percentage of chicken emulsion is observed when compared to day 1. A significant decrease ( $P<0.05$ ) in moisture percentage is observed with increase in level of incorporation of radish powder. Mendiratta *et al.*, (2016) reported that the moisture percentage of mutton nuggets incorporated with radish was numerically less than control nuggets. On the contrary Reddy *et al.*, (2020) observed increase in moisture of turkey meat sausage with increase in level of raw radish paste.

**Table 4.4: Effect of different levels of radish powder on proximate composition of chicken emulsion during refrigerated (4±1°C) aerobic storage (Mean±S.E.)\*.**

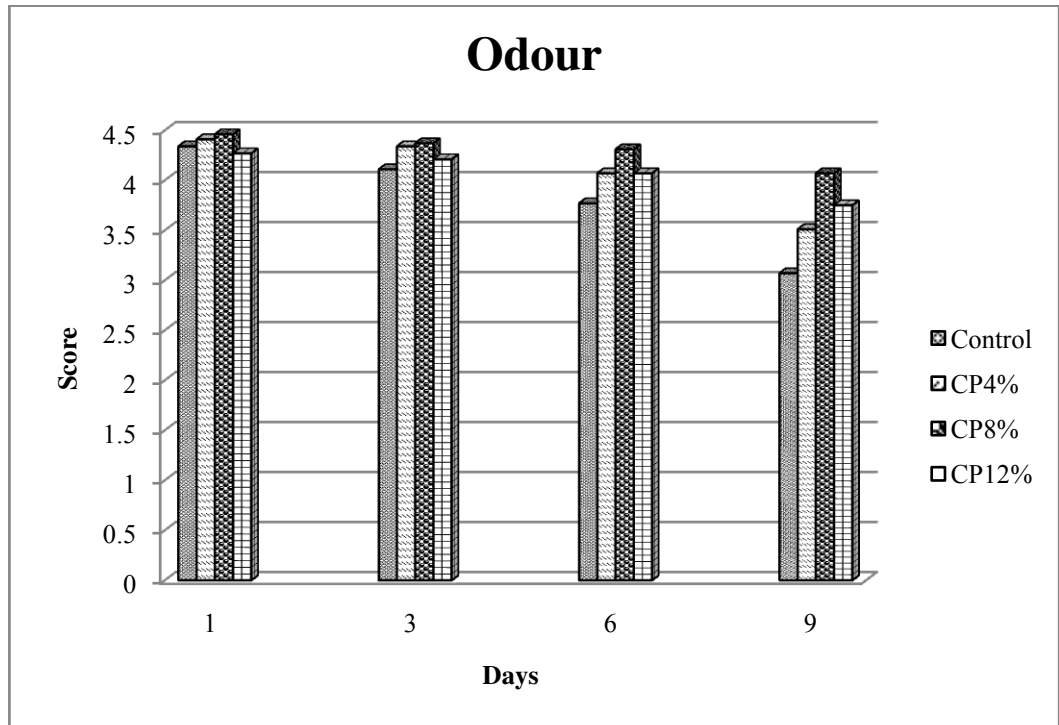
Treatments/ Days	Refrigerated storage period (Days)			
	Day 1	Day 3	Day 6	Day 9
<b>Moisture (%)</b>				
<b>C</b>	67.15 ± 0.14 <sup>dC</sup>	67.05 ± 0.15 <sup>dC</sup>	66.71 ± 0.13 <sup>dB</sup>	66.22 ± 0.12 <sup>dA</sup>
<b>T-1</b>	64.28 ± 0.24 <sup>cC</sup>	64.17 ± 0.23 <sup>cC</sup>	63.16 ± 0.14 <sup>cB</sup>	62.02 ± 0.15 <sup>cA</sup>
<b>T-2</b>	62.82 ± 0.17 <sup>bC</sup>	62.70 ± 0.15 <sup>bC</sup>	61.66 ± 0.12 <sup>bB</sup>	60.90 ± 0.14 <sup>bA</sup>
<b>T-3</b>	61.02 ± 0.15 <sup>aC</sup>	60.92 ± 0.14 <sup>aC</sup>	59.83 ± 0.10 <sup>aB</sup>	58.77 ± 0.13 <sup>aA</sup>
<b>Protein (%)</b>				
<b>C</b>	17.51 ± 0.14 <sup>cC</sup>	17.57 ± 0.08 <sup>cBC</sup>	17.85 ± 0.37 <sup>cB</sup>	14.79 ± 0.22 <sup>cA</sup>
<b>T-1</b>	17.11 ± 0.11 <sup>bC</sup>	17.18 ± 0.10 <sup>bBC</sup>	17.46 ± 0.21 <sup>bB</sup>	14.40 ± 0.19 <sup>bA</sup>
<b>T-2</b>	16.99 ± 0.15 <sup>bC</sup>	17.07 ± 0.14 <sup>bBC</sup>	17.23 ± 0.18 <sup>bB</sup>	14.31 ± 0.10 <sup>bA</sup>
<b>T-3</b>	16.80 ± 0.13 <sup>aC</sup>	16.90 ± 0.12 <sup>aBC</sup>	17.05 ± 0.17 <sup>aB</sup>	13.91 ± 0.12 <sup>aA</sup>
<b>Fat (%)</b>				
<b>C</b>	9.32 ± 0.05 <sup>dC</sup>	9.28 ± 0.06 <sup>dC</sup>	9.21 ± 0.05 <sup>dB</sup>	9.01 ± 0.08 <sup>dA</sup>
<b>T-1</b>	9.03 ± 0.05 <sup>cC</sup>	8.99 ± 0.04 <sup>cC</sup>	8.92 ± 0.06 <sup>cB</sup>	8.75 ± 0.12 <sup>cA</sup>
<b>T-2</b>	8.72 ± 0.06 <sup>bC</sup>	8.69 ± 0.05 <sup>bBC</sup>	8.65 ± 0.04 <sup>bB</sup>	8.55 ± 0.08 <sup>bA</sup>
<b>T-3</b>	8.15 ± 0.05 <sup>aC</sup>	8.13 ± 0.04 <sup>aBC</sup>	8.09 ± 0.05 <sup>aB</sup>	7.95 ± 0.06 <sup>aA</sup>
<b>Ash (%)</b>				
<b>C</b>	1.89 ± 0.05 <sup>aC</sup>	1.84 ± 0.06 <sup>aC</sup>	1.68 ± 0.05 <sup>aB</sup>	1.46 ± 0.10 <sup>aA</sup>
<b>T-1</b>	2.48 ± 0.04 <sup>bC</sup>	2.44 ± 0.05 <sup>bC</sup>	2.33 ± 0.06 <sup>bB</sup>	2.10 ± 0.14 <sup>bA</sup>
<b>T-2</b>	2.70 ± 0.05 <sup>cC</sup>	2.67 ± 0.04 <sup>cC</sup>	2.52 ± 0.06 <sup>cB</sup>	2.37 ± 0.07 <sup>cA</sup>
<b>T-3</b>	2.91 ± 0.04 <sup>dC</sup>	2.88 ± 0.05 <sup>dC</sup>	2.77 ± 0.04 <sup>dB</sup>	2.63 ± 0.10 <sup>dA</sup>
<b>Moisture: Protein Ratio</b>				
<b>C</b>	3.83 ± 0.03 <sup>dB</sup>	3.82 ± 0.02 <sup>dB</sup>	3.73 ± 0.03 <sup>cA</sup>	4.48 ± 0.05 <sup>cC</sup>
<b>T-1</b>	3.75 ± 0.02 <sup>cB</sup>	3.74 ± 0.03 <sup>cB</sup>	3.62 ± 0.04 <sup>bA</sup>	4.31 ± 0.06 <sup>bC</sup>
<b>T-2</b>	3.69 ± 0.03 <sup>bB</sup>	3.67 ± 0.02 <sup>bB</sup>	3.58 ± 0.05 <sup>abA</sup>	4.26 ± 0.05 <sup>abC</sup>
<b>T-3</b>	3.63 ± 0.02 <sup>aB</sup>	3.60 ± 0.02 <sup>aB</sup>	3.51 ± 0.04 <sup>aA</sup>	4.23 ± 0.01 <sup>aC</sup>
<b>Energy (Kcal)</b>				
<b>C</b>	189.81 ± 0.19 <sup>dD</sup>	188.77 ± 0.29 <sup>dC</sup>	186.72 ± 0.49 <sup>dB</sup>	183.65 ± 0.53 <sup>dA</sup>
<b>T-1</b>	171.15 ± 0.17 <sup>cD</sup>	170.12 ± 0.25 <sup>cC</sup>	168.07 ± 0.35 <sup>cB</sup>	165.05 ± 0.38 <sup>cA</sup>
<b>T-2</b>	169.38 ± 0.16 <sup>bD</sup>	168.35 ± 0.20 <sup>bC</sup>	166.30 ± 0.30 <sup>bB</sup>	163.24 ± 0.60 <sup>bA</sup>
<b>T-3</b>	166.79 ± 0.15 <sup>aD</sup>	165.76 ± 0.18 <sup>aC</sup>	163.71 ± 0.27 <sup>aB</sup>	160.64 ± 0.47 <sup>aA</sup>

n=6; C= Control (without radish powder); T-1= 4% radish powder, T-2= 8% radish powder; T-3= 12% radish powder. \*Mean±S.E. with different superscripts row wise (capital alphabets) and column wise (small alphabets) differ significantly (P<0.05).

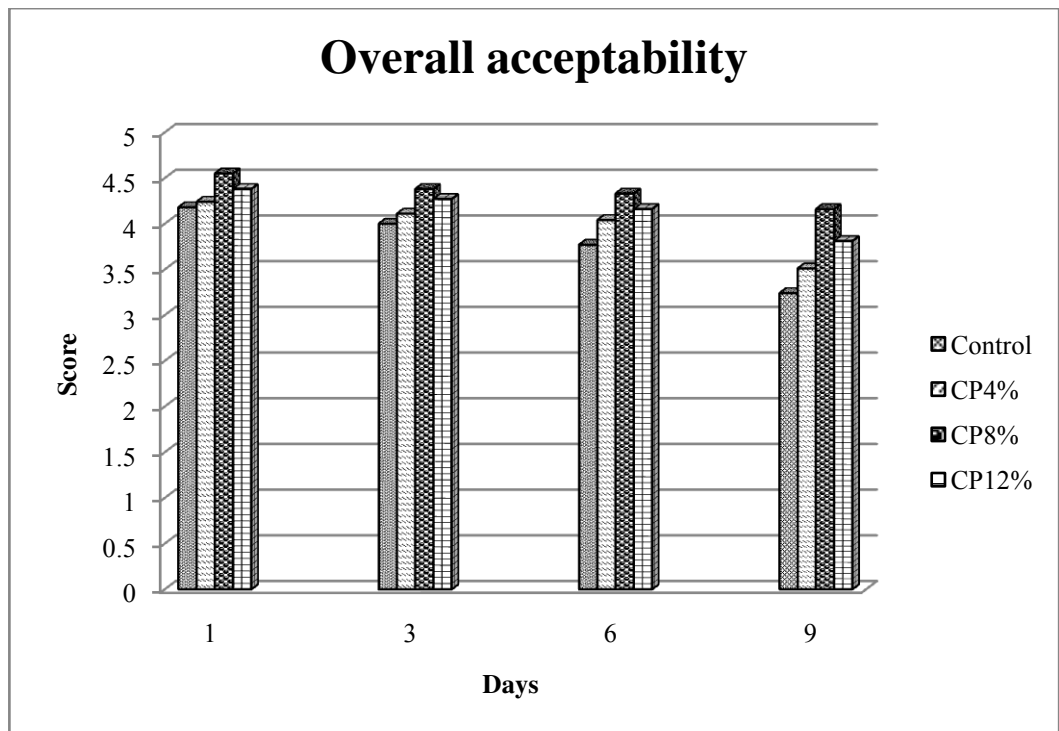
It was found that the protein percentage of chicken emulsion increased up to day 6<sup>th</sup> of storage irrespective of treatment but on 9<sup>th</sup> day a significant (P<0.05) decline in protein percentage is observed. Increase in protein percentage up to day

6<sup>th</sup> might be due to decreased protein of emulsion during storage and the rapid decline up to day 9<sup>th</sup> could be due to protein decomposition. Naveen et al., (2016), observed similar findings. They reported that when duck meat sausage was stored at refrigeration temperature the crude protein increased up to 10<sup>th</sup> day of storage but decreased upon further storage up to 14 day. The protein percentage of chicken emulsion decreased as the level of radish incorporated increased. This might be due to very less amount of protein is present in radish. The finding is similar with Reddy *et al.*, (2020). They also reported decrease in protein content of turkey meat sausage with increase in raw radish paste. The finding is also in accordance with Mendiratta *et al.*, (2013). It is revealed from the Table that the fat percentage of chicken emulsion decreased with increase in storage period. Similar results were observed by Patil *et al.*, (2004). They observed that the fat percentage of chicken patties decreased during the period of storage. While a significant decrease in moisture percentage is observed with increased amount of radish powder. The finding is in agreement with Reddy *et al.*, (2020).

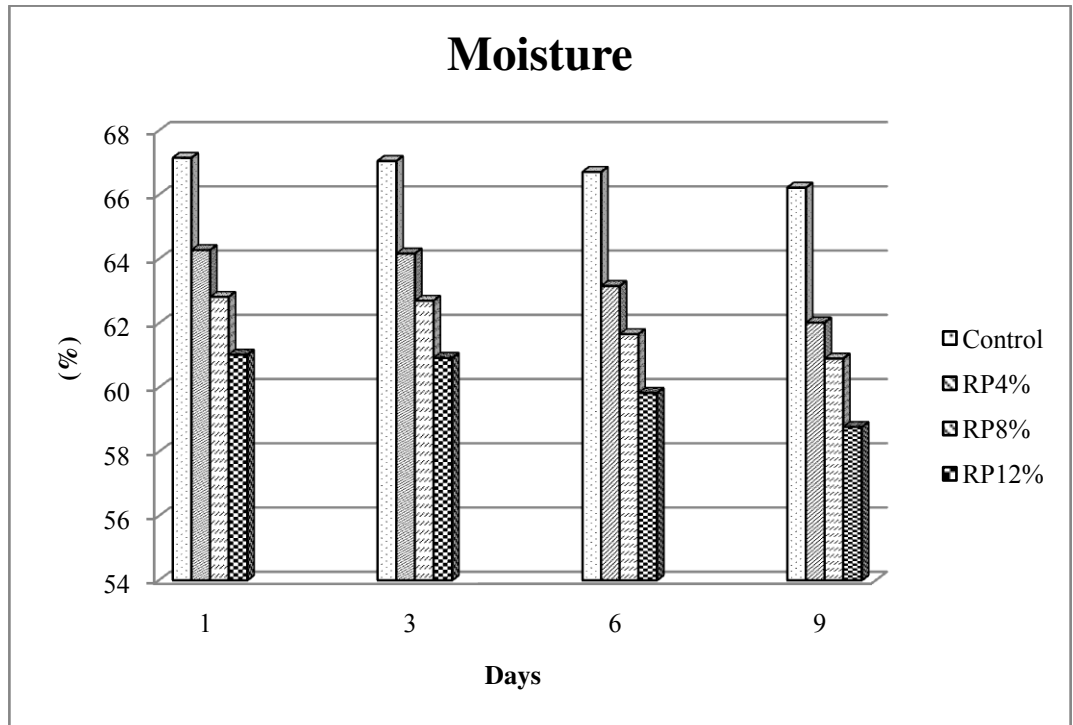
The ash percentage also decreased with storage period. A significant difference in ash percentage is observed on day 6<sup>th</sup> and day 9<sup>th</sup> as compared to day 1. While as the level of radish powder incorporated increased the level of ash percentage also increased significantly ( $P < 0.05$ ). Similar finding is observed by Ahn *et al.*, (2018). They noticed that pork patties contain dry radish leaves and root showed increase in ash percentage as the level of radish leaves and root incorporated increased. It can be seen from the table that the moisture: protein ratio of chicken emulsion decreased during the storage period. The difference was not significant up to 3<sup>rd</sup> day of storage but thereafter a significant difference ( $P < 0.05$ ) is observed. A significant ( $P < 0.05$ ) decrease in Moisture: protein ratio is observed with increase in radish powder incorporation. Lowest moisture: protein ratio is observed in 12% radish incorporated chicken emulsion. A significantly ( $p < 0.05$ ) decreasing trend is observed in the energy of chicken emulsion during the storage period of 9 days. Similarly a significant difference is observed in the energy of control and radish incorporated chicken emulsion. As the level of radish incorporated increased the energy decreased .this is due to the fact that radish contain less amount of fat which is the major source of energy.



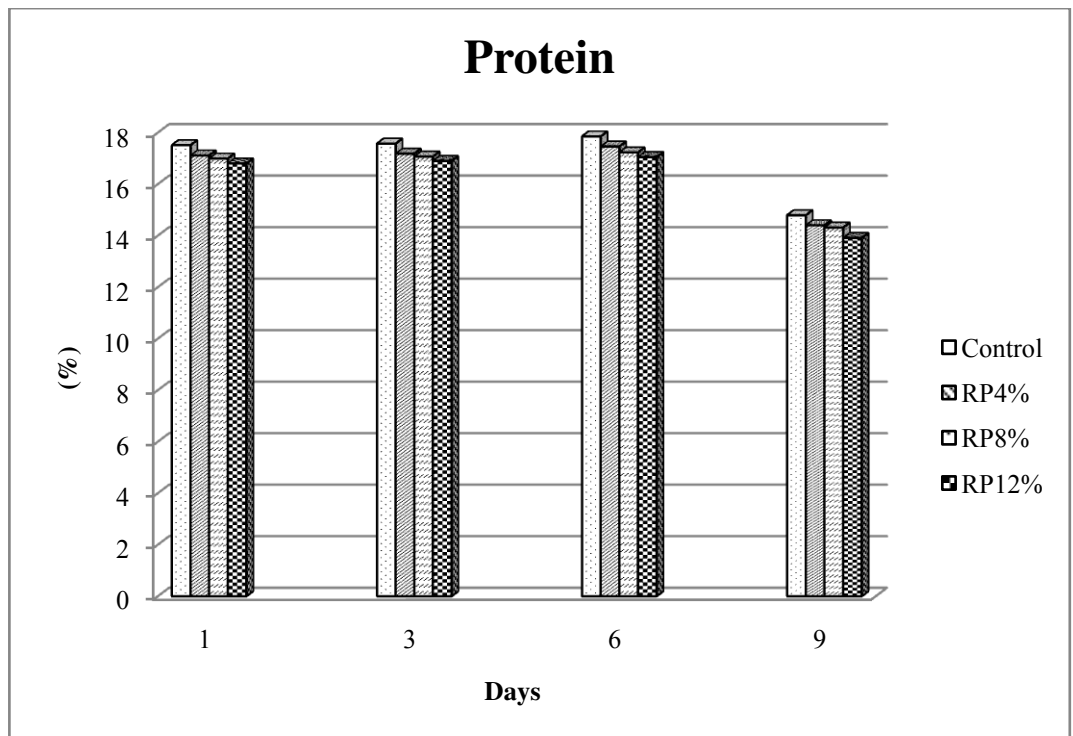
**Fig 4.11 Odour of chicken emulsion added with carrot powder**



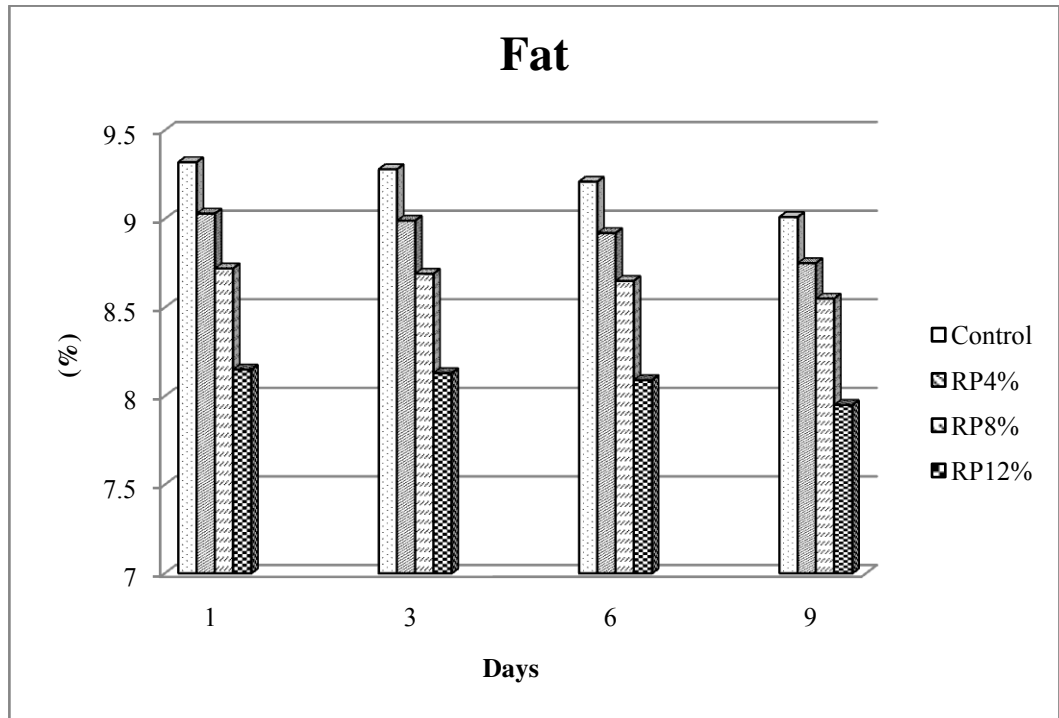
**Fig 4.12 Overall acceptability of chicken emulsion added with carrot powder**



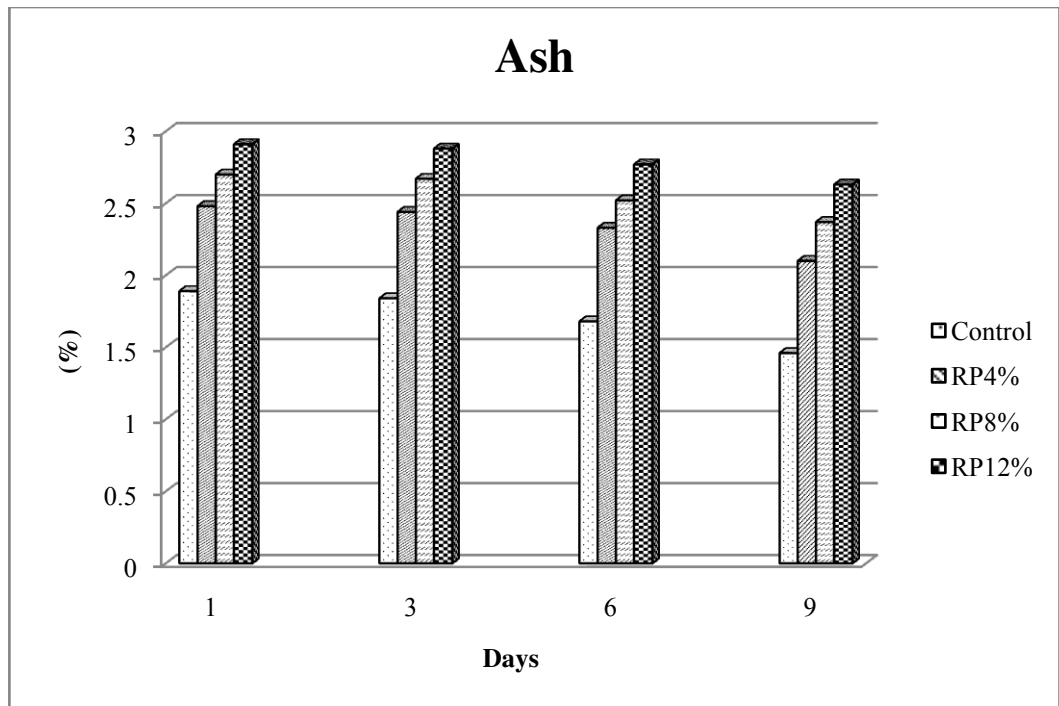
**Fig 4.13** Moisture of chicken emulsion added with radish powder



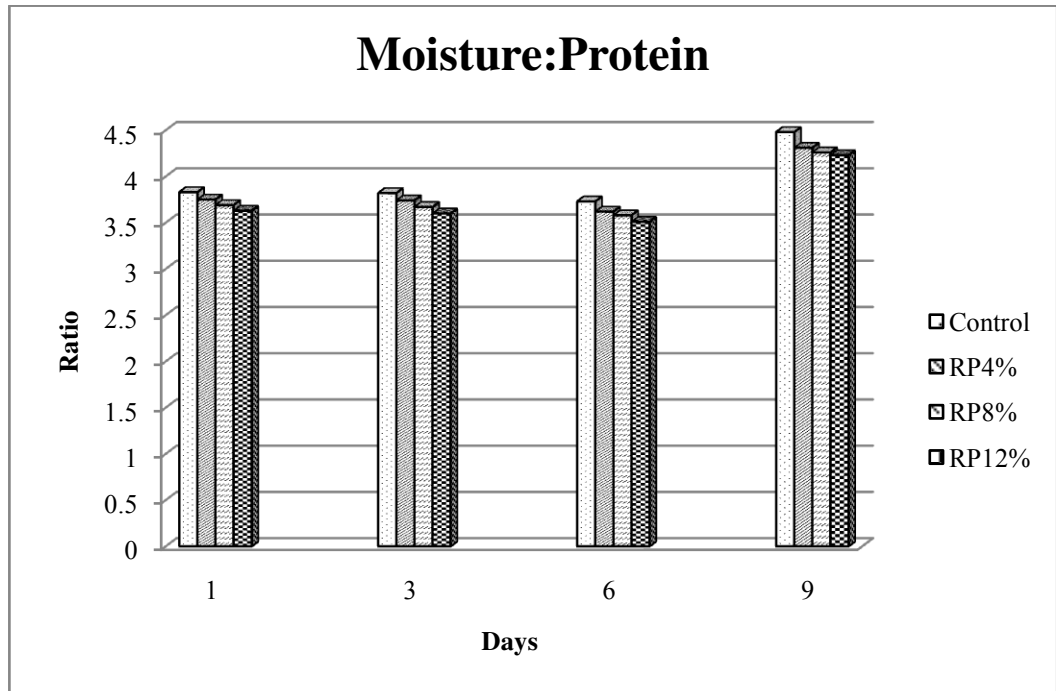
**Fig 4.14** Protein of chicken emulsion added with radish powder



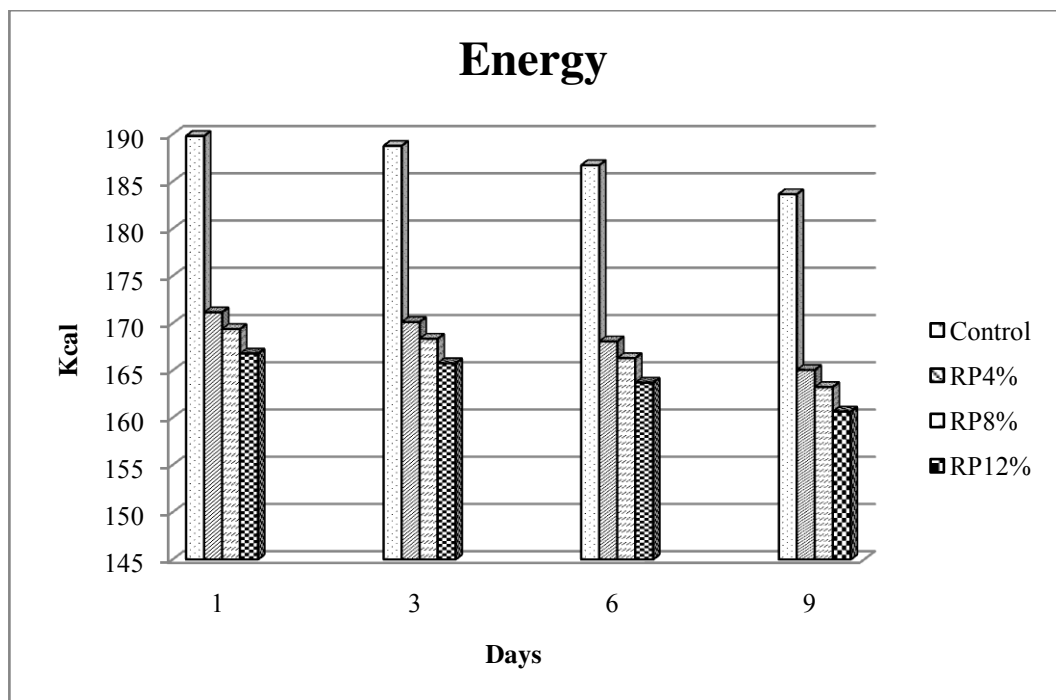
**Fig 4.15 Fat of chicken emulsion added with radish powder**



**Fig 4.16 Ash of chicken emulsion added with radish powder**



**Fig 4.17** Moisture:Protein ratio of chicken emulsion added with radish powder



**Fig 4.18** Energy of chicken emulsion added with radish powder

#### 4.1.2.2 Physico-chemical attributes

Physico- chemical properties of chicken emulsion incorporated with different levels of radish powder are presented in Table 4.5.

The pH of chicken emulsion incorporated with radish powder increased progressively during the storage period of 9 days. Rao and Reddy (2000) also reported increased pH of chicken meat loaves incorporated with Bengal gram flour and black gram flour when stored at refrigeration temperature up to 12 days. As the level of radish powder incorporated in chicken meat emulsion increased the pH also increased. It is observed from the table that the emulsion stability of chicken emulsion decreased significantly ( $P<0.05$ ) with storage irrespective of treatment. The result is comparable with Naveen *et al.*, (2016). They reported that the mean emulsion stability of duck meat sausage was decreased during refrigerated storage up to 14 days.

**Table 4.5: Effect of different levels of radish powder on physico-chemical attributes of chicken emulsion during refrigerated ( $4\pm 1^\circ\text{C}$ ) aerobic storage (Mean $\pm$ S.E.)\*.**

Treatments/ Days	Refrigerated storage period (Days)			
	Day 1	Day 3	Day 6	Day 9
<b>pH</b>				
<b>C</b>	5.76 $\pm$ 0.04 <sup>aA</sup>	5.87 $\pm$ 0.04 <sup>B</sup>	6.01 $\pm$ 0.04 <sup>bC</sup>	6.15 $\pm$ 0.04 <sup>cD</sup>
<b>T-1</b>	5.84 $\pm$ 0.03 <sup>bA</sup>	5.89 $\pm$ 0.02 <sup>B</sup>	5.94 $\pm$ 0.03 <sup>aC</sup>	6.04 $\pm$ 0.02 <sup>bD</sup>
<b>T-2</b>	5.87 $\pm$ 0.05 <sup>bA</sup>	5.91 $\pm$ 0.03 <sup>AB</sup>	5.93 $\pm$ 0.02 <sup>aB</sup>	5.99 $\pm$ 0.02 <sup>aC</sup>
<b>T-3</b>	5.87 $\pm$ 0.06 <sup>bA</sup>	5.92 $\pm$ 0.04 <sup>AB</sup>	5.93 $\pm$ 0.02 <sup>aB</sup>	5.98 $\pm$ 0.02 <sup>aC</sup>
<b>Emulsion Stability (%)</b>				
<b>C</b>	93.50 $\pm$ 0.54 <sup>cC</sup>	93.00 $\pm$ 0.53 <sup>cBC</sup>	92.00 $\pm$ 0.62 <sup>dB</sup>	90.00 $\pm$ 0.69 <sup>dA</sup>
<b>T-1</b>	90.50 $\pm$ 0.56 <sup>bC</sup>	89.50 $\pm$ 0.58 <sup>bBC</sup>	88.00 $\pm$ 0.62 <sup>bB</sup>	85.00 $\pm$ 0.65 <sup>CA</sup>
<b>T-2</b>	90.00 $\pm$ 0.60 <sup>bC</sup>	89.00 $\pm$ 0.61 <sup>bBC</sup>	86.50 $\pm$ 0.66 <sup>bB</sup>	83.00 $\pm$ 0.62 <sup>bA</sup>
<b>T-3</b>	88.00 $\pm$ 0.32 <sup>aD</sup>	86.00 $\pm$ 0.41 <sup>aC</sup>	83.50 $\pm$ 0.55 <sup>aB</sup>	79.00 $\pm$ 0.58 <sup>aA</sup>
<b>Water holding capacity (%)</b>				
<b>C</b>	48.40 $\pm$ 0.21 <sup>cC</sup>	48.28 $\pm$ 0.18 <sup>cC</sup>	47.17 $\pm$ 0.17 <sup>cB</sup>	44.94 $\pm$ 0.28 <sup>CA</sup>
<b>T-1</b>	47.50 $\pm$ 0.41 <sup>bC</sup>	47.36 $\pm$ 0.37 <sup>bC</sup>	46.25 $\pm$ 0.49 <sup>bB</sup>	43.84 $\pm$ 0.45 <sup>BA</sup>
<b>T-2</b>	47.10 $\pm$ 0.49 <sup>bC</sup>	46.92 $\pm$ 0.45 <sup>bC</sup>	45.81 $\pm$ 0.48 <sup>bB</sup>	43.54 $\pm$ 0.40 <sup>BA</sup>
<b>T-3</b>	42.69 $\pm$ 0.43 <sup>aC</sup>	42.45 $\pm$ 0.61 <sup>aC</sup>	42.45 $\pm$ 0.41 <sup>aB</sup>	40.23 $\pm$ 0.35 <sup>AA</sup>

n=6; C= Control (without radish powder); **T-1**= 4% radish powder, **T-2**= 8% radish powder; **T-3**= 12% radish powder. \*Mean $\pm$ S.E. with different superscripts row wise (capital alphabets) and column wise (small alphabets) differ significantly ( $P<0.05$ ).

Similarly decrease in emulsion stability was observed with increase in radish powder incorporation. It could be due to water molecules of radish interact with meat proteins and thus reduces the emulsion stability. Water holding capacity of chicken emulsion decreased with the storage period of 9 days. A decrease in water holding capacity was non-significant up to 3<sup>rd</sup> day of storage but from 6<sup>th</sup> day onwards a significant (P<0.05) decrease in water holding capacity of chicken emulsion was observed. As the level of radish powder added in chicken emulsion increased the water holding capacity decreased. The lowest water holding capacity was observed in 12% radish powder incorporated chicken emulsion.

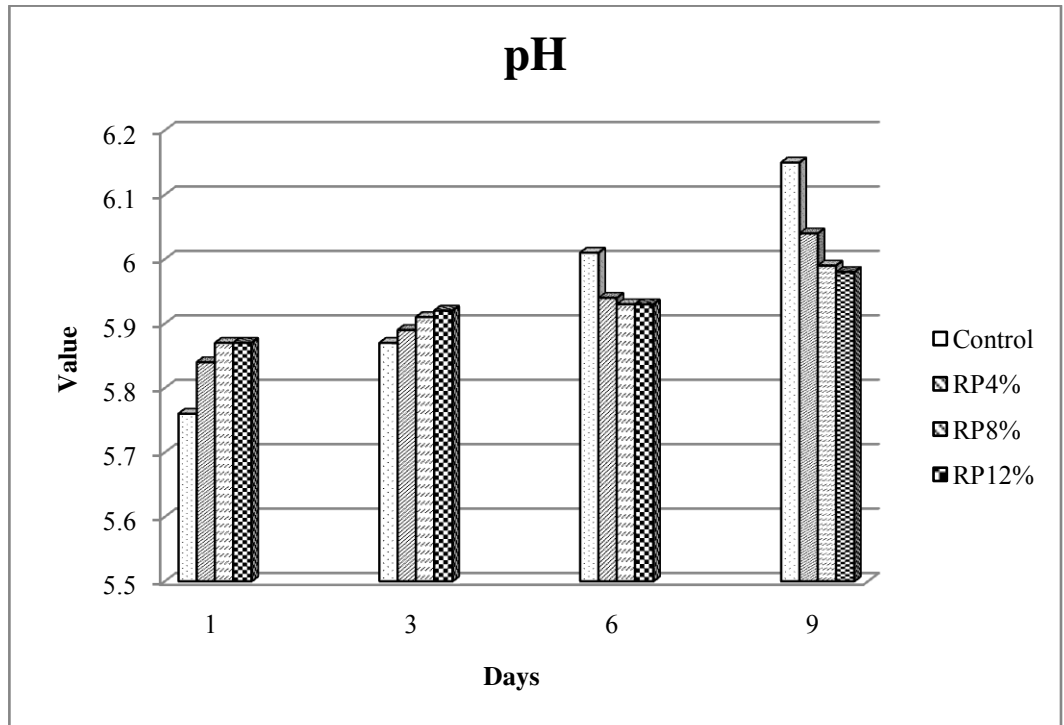
#### 4.1.2.3 Sensory Evaluation

The data with respect to sensory attributes of chicken emulsion incorporated with different levels of radish powder during refrigerated (4±1°C) aerobic storage is shown in Table 4.6.

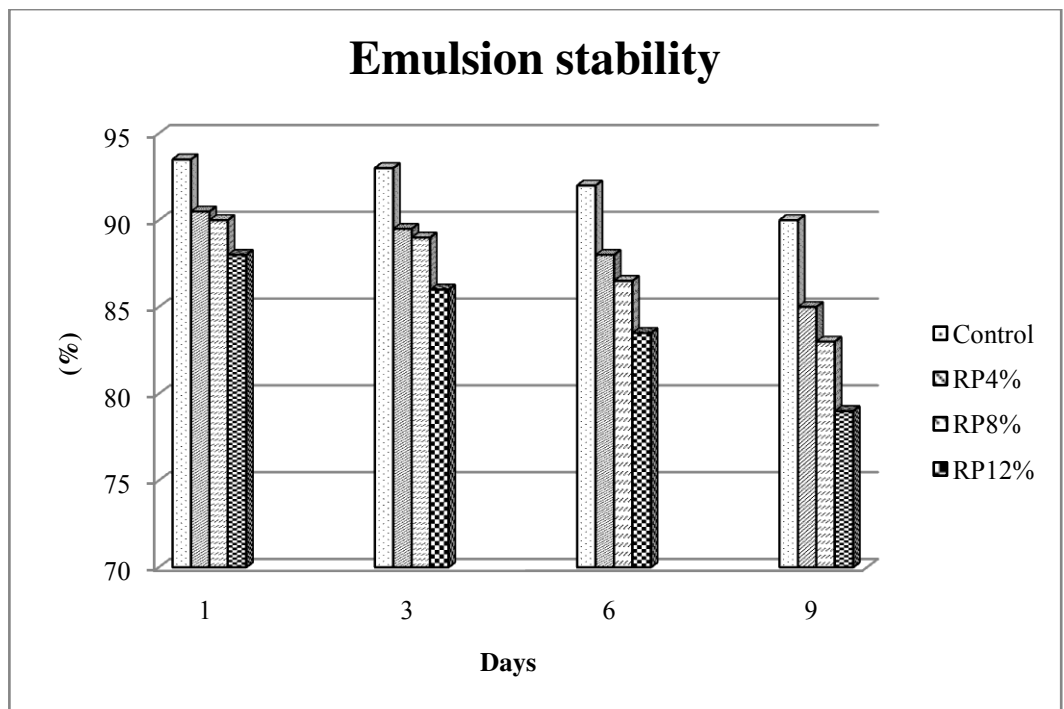
**Table 4.6: Effect of different levels of radish powder on sensory attributes of chicken emulsion during refrigerated (4±1°C) aerobic storage (Mean±S.E.)\*.**

Treatments/ Days	Refrigerated storage period (Days)			
	Day 1	Day 3	Day 6	Day 9
<b>Appearance</b>				
<b>C</b>	4.24±0.07 <sup>bD</sup>	4.01±0.10 <sup>aC</sup>	3.66±0.10 <sup>aB</sup>	3.07±0.07 <sup>aA</sup>
<b>T-1</b>	4.27±0.06 <sup>bC</sup>	4.24±0.02 <sup>bC</sup>	3.95±0.09 <sup>bB</sup>	3.33±0.09 <sup>bA</sup>
<b>T-2</b>	4.30±0.09 <sup>bB</sup>	4.27±0.07 <sup>bB</sup>	4.16±0.10 <sup>dB</sup>	3.95±0.11 <sup>dA</sup>
<b>T-3</b>	4.10±0.04 <sup>aD</sup>	4.04±0.06 <sup>cC</sup>	3.84±0.03 <sup>cB</sup>	3.51±0.13 <sup>cA</sup>
<b>Odour</b>				
<b>C</b>	4.27±0.07 <sup>aD</sup>	4.04±0.08 <sup>aC</sup>	3.65±0.07 <sup>aB</sup>	3.00±0.06 <sup>aA</sup>
<b>T-1</b>	4.34±0.06 <sup>aC</sup>	4.27±0.08 <sup>bC</sup>	4.00±0.06 <sup>bB</sup>	3.44±0.08 <sup>bA</sup>
<b>T-2</b>	4.38±0.11 <sup>aC</sup>	4.30±0.07 <sup>bB</sup>	4.24±0.11 <sup>cB</sup>	4.00±0.08 <sup>dA</sup>
<b>T-3</b>	4.21±0.05 <sup>bD</sup>	4.07±0.06 <sup>cC</sup>	3.95±0.05 <sup>bB</sup>	3.71±0.07 <sup>cA</sup>
<b>Overall quality</b>				
<b>C</b>	4.11±0.08 <sup>aD</sup>	3.95±0.06 <sup>aC</sup>	3.65±0.07 <sup>aB</sup>	3.16±0.06 <sup>aA</sup>
<b>T-1</b>	4.16±0.09 <sup>aC</sup>	4.04±0.06 <sup>bB</sup>	3.95±0.10 <sup>bB</sup>	3.24±0.05 <sup>bA</sup>
<b>T-2</b>	4.47±0.07 <sup>cC</sup>	4.30±0.07 <sup>dB</sup>	4.27±0.09 <sup>cB</sup>	4.04±0.06 <sup>dA</sup>
<b>T-3</b>	4.30±0.07 <sup>bD</sup>	4.16±0.07 <sup>cC</sup>	4.04±0.09 <sup>bB</sup>	3.87±0.06 <sup>cA</sup>

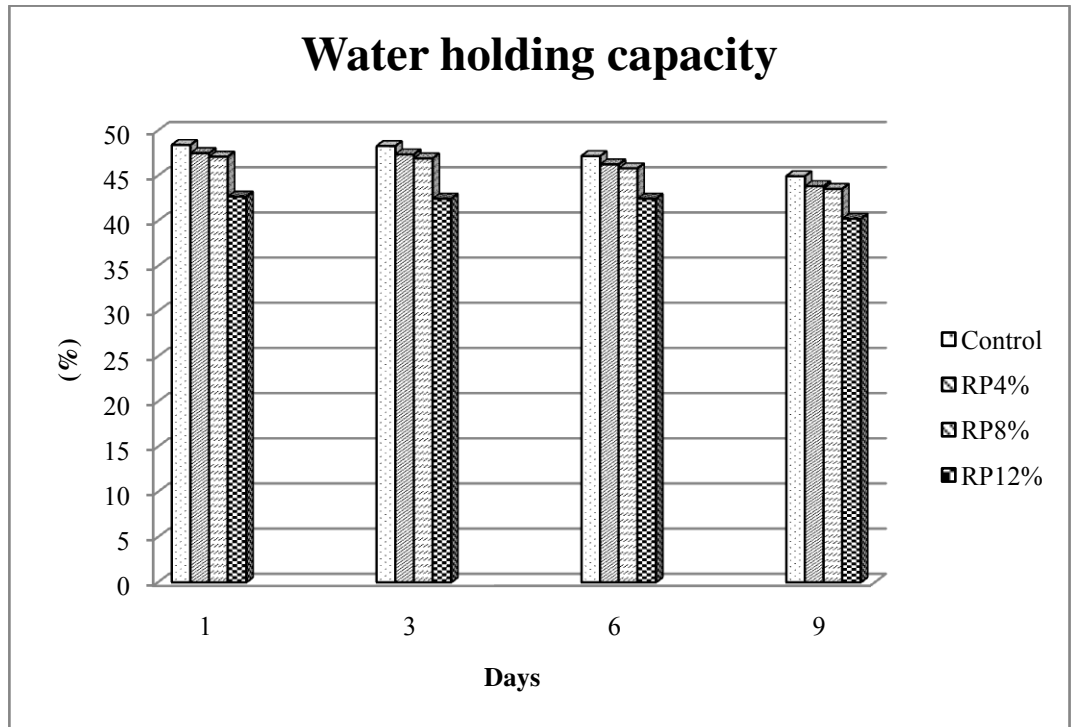
n=6; C= Control (without radish powder); T-1= 4% radish powder, T-2= 8% radish powder; T-3= 12% radish powder. \*Mean±S.E. with different superscripts row wise (capital alphabets) and column wise (small alphabets) differ significantly (P<0.05).



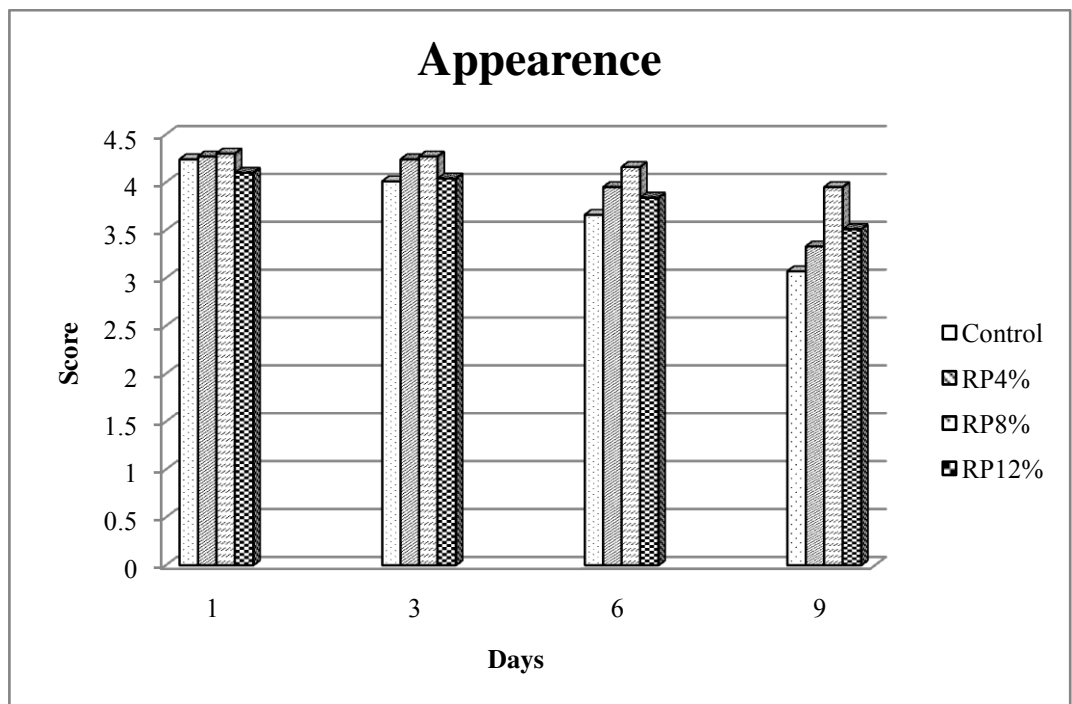
**Fig 4.19** pH of chicken emulsion added with radish powder



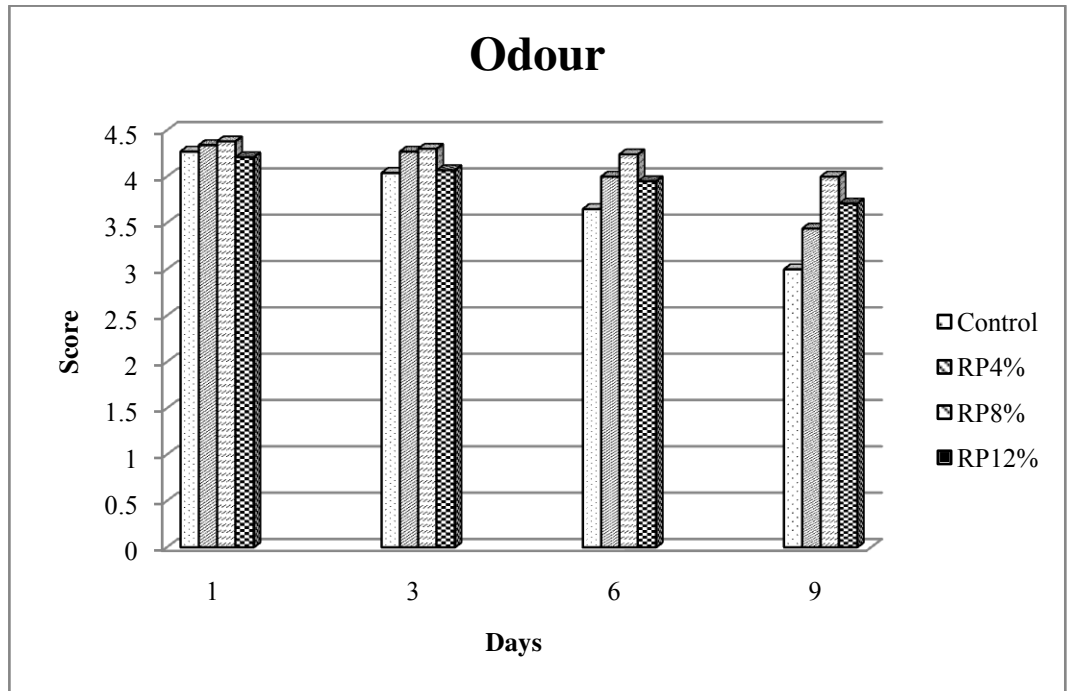
**Fig 4.20** Emulsion stability of chicken emulsion added with radish powder



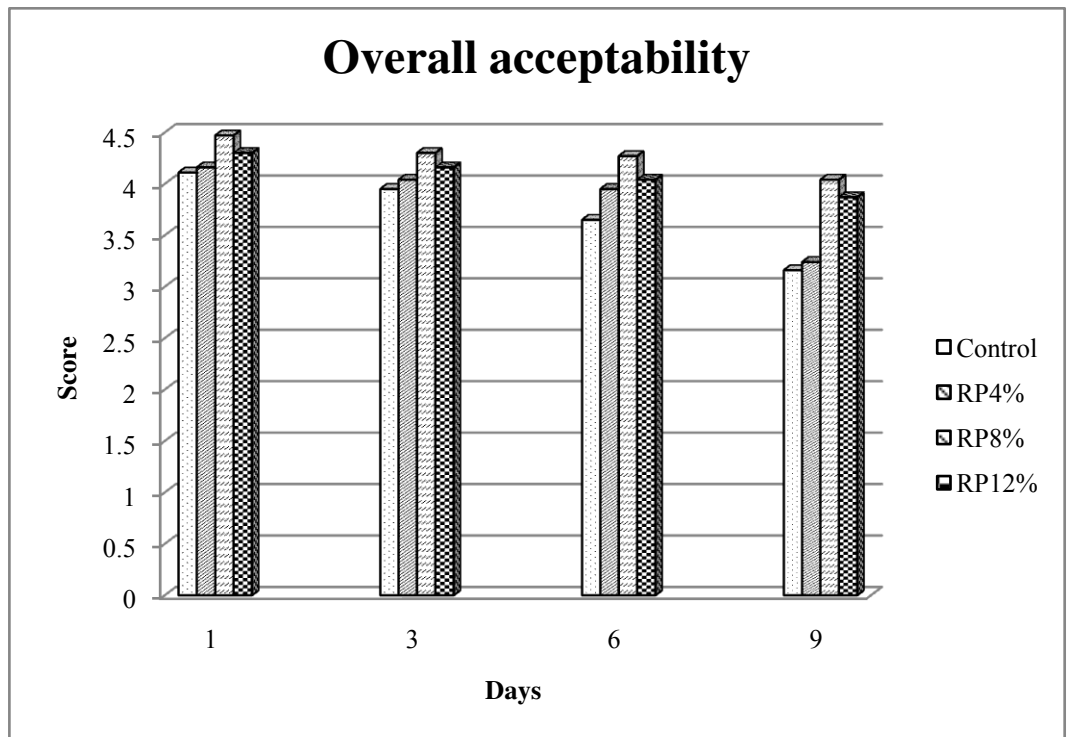
**Fig 4.21** Water holding capacity of chicken emulsion added with radish powder



**Fig 4.22** Appearance score of chicken emulsion added with radish powder



**Fig 4.23 Odour of chicken emulsion added with radish powder**



**Fig 4.24 Overall acceptability of chicken emulsion added with radish powder**

The appearance score of chicken emulsion incorporated with radish powder decreased progressively during the storage period of 9 days. Better score for appearance was observed in radish incorporated chicken emulsion as compared to control. Optimum score for appearance was observed in 8% radish incorporated chicken emulsion. Similar findings were observed for odour and overall quality of chevon emulsion during refrigerated storage by Jagtap (2018).

## **4.2 Effect of carrot and radish powder on quality of chicken nuggets**

Chicken nuggets were prepared by incorporating different levels of carrot and radish powder. The best level was selected based on composition, physico-chemical characteristics and sensory evaluation.

### **4.2.1 Quality of chicken nuggets incorporated with carrot powder.**

The data regarding proximate composition, physico-chemical and sensory properties of chicken nuggets added with carrot powder is presented in Table 4.7.

It is revealed from the table that with increase in the level of carrot powder incorporation in chicken nuggets it was observed that the moisture percentage also increased significantly ( $p < 0.05$ ). Similar finding was observed by Devatkal *et al.*, (2004). They observed higher moisture percentage of buffalo liver vegetable loaf prepared by addition of carrot paste. Singh *et al.*, (2015) also reported that with increasing the level of carrot powder in chicken meat cutlets the moisture percentage of the product increased. A significant increase ( $P < 0.05$ ) in moisture percentage is observed in chicken nuggets prepared by adding carrot powder when compared to control. Optimum moisture was observed in 12% carrot powder incorporated chicken nugget as compared to control. The protein and fat content of chicken nuggets prepared by adding carrot powder showed significantly ( $P < 0.05$ ) declining trend with increase in carrot powder incorporation. The finding is in relevance with Kumar *et al.*, (2015) they reported that the protein and fat percentage of chicken cutlets decreased with increase in the level of carrot pomace dried powder. The ash percentage also differed significantly ( $P < 0.05$ ) due to incorporation of carrot powder. The ash percentage increased with increase in level of carrot powder. The finding was in relevance

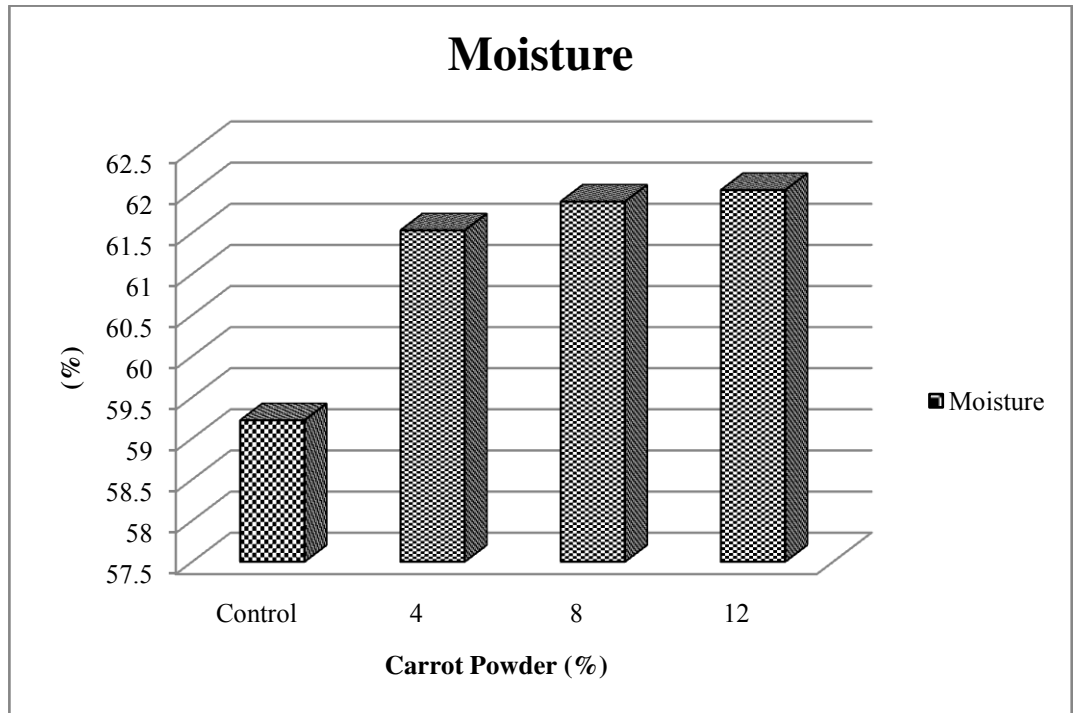
with El Anany *et al.*, (2020). They reported that chicken nuggets prepared by addition of different levels of frozen white cauliflower had higher level of ash content as compared to control.

**Table 4.7: Proximate composition, physio-chemical and sensory properties of chicken nuggets added with carrot powder (CP) (Mean±S.E.)\*.**

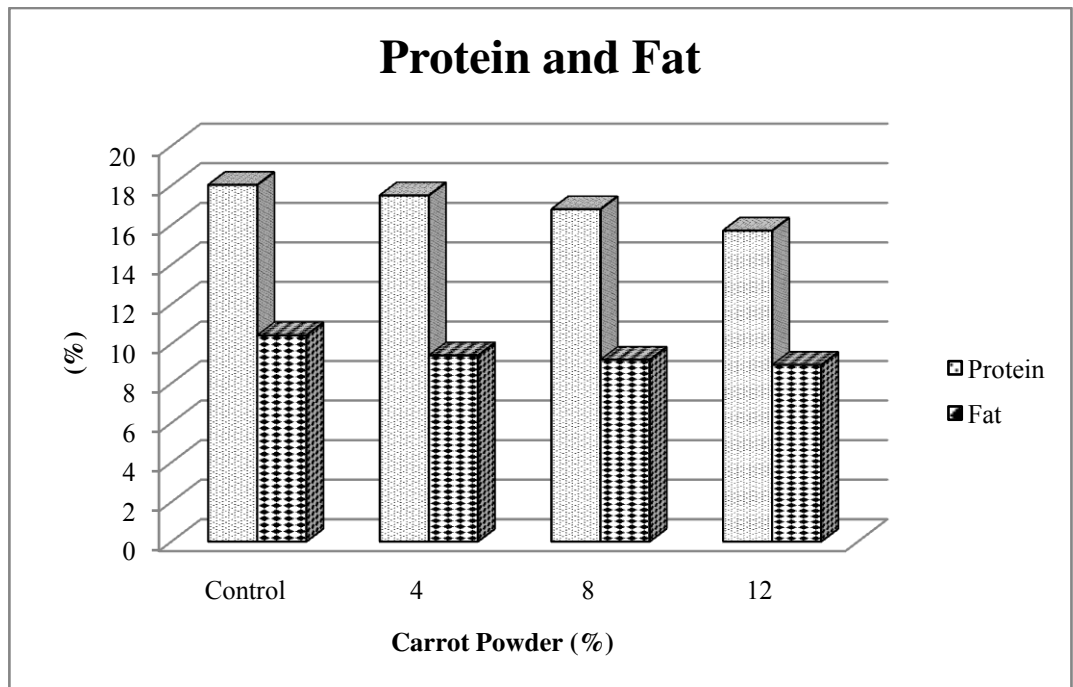
Parameters	Control	Carrot powder (CP) levels		
		CP-4	CP-8	CP-12
<b>Proximate composition</b>				
<b>Moisture (%)</b>	59.22±0.20 <sup>a</sup>	61.53±0.36 <sup>b</sup>	61.88±0.35 <sup>bc</sup>	62.02±0.13 <sup>c</sup>
<b>Protein (%)</b>	18.03±0.15 <sup>d</sup>	17.50±0.12 <sup>c</sup>	16.80±0.27 <sup>b</sup>	15.72±0.33 <sup>a</sup>
<b>Fat (%)</b>	10.43±0.46 <sup>d</sup>	9.41±0.12 <sup>c</sup>	9.19±0.11 <sup>b</sup>	8.93±0.09 <sup>a</sup>
<b>Ash (%)</b>	1.88±0.08 <sup>a</sup>	2.34±0.14 <sup>b</sup>	2.70±0.18 <sup>c</sup>	3.03±0.13 <sup>d</sup>
<b>Moisture: Protein ratio</b>	3.28±0.06 <sup>a</sup>	3.52±0.07 <sup>b</sup>	3.68±0.03 <sup>c</sup>	3.95±0.10 <sup>d</sup>
<b>Energy (Kcal)</b>	188.51±0.19 <sup>d</sup>	185.18±0.23 <sup>c</sup>	183.78±0.53 <sup>b</sup>	181.91±0.61 <sup>a</sup>
<b>Physico-chemical attributes</b>				
<b>pH</b>	6.15±0.03	6.16±0.04	6.17±0.03	6.17±0.03
<b>Cooking Yield (%)</b>	89.28±0.30 <sup>a</sup>	91.35±0.31 <sup>b</sup>	92.15±0.34 <sup>c</sup>	92.38±0.32 <sup>c</sup>
<b>Moisture Retention (%)</b>	34.26±0.34 <sup>a</sup>	36.47±0.84 <sup>b</sup>	38.63±0.52 <sup>c</sup>	39.07±0.54 <sup>c</sup>
<b>Fat Retention (%)</b>	89.63±0.27 <sup>a</sup>	91.24±0.51 <sup>b</sup>	93.44±0.61 <sup>c</sup>	93.81±0.48 <sup>c</sup>
<b>Sensory evaluation<sup>#</sup></b>				
<b>Appearance</b>	7.28±0.01 <sup>c</sup>	7.21±0.02 <sup>b</sup>	7.20±0.01 <sup>b</sup>	7.17±0.02 <sup>a</sup>
<b>Flavour</b>	7.28±0.01 <sup>c</sup>	7.19±0.02 <sup>b</sup>	7.17±0.02 <sup>b</sup>	7.06±0.03 <sup>a</sup>
<b>Texture</b>	7.33±0.01 <sup>c</sup>	7.18±0.04 <sup>b</sup>	7.17±0.02 <sup>b</sup>	7.01±0.05 <sup>a</sup>
<b>Juiciness</b>	7.30±0.02 <sup>c</sup>	7.21±0.05 <sup>b</sup>	7.19±0.04 <sup>b</sup>	7.06±0.06 <sup>a</sup>
<b>Overall Acceptability</b>	7.21±0.01 <sup>c</sup>	7.18±0.01 <sup>b</sup>	7.17±0.02 <sup>b</sup>	7.06±0.04 <sup>a</sup>

n = 6, <sup>#</sup>n=21 \*Mean ± SE. with different superscripts row wise (small alphabets) differ significantly ( $p<0.05$ ) **CON** = Chicken nuggets without carrot powder (CP), **CP-4** = nuggets with 4.0 % CP, **CP-8** = nuggets with 8.0 % CP and **CP-12** = nuggets with 12.0 % CP.

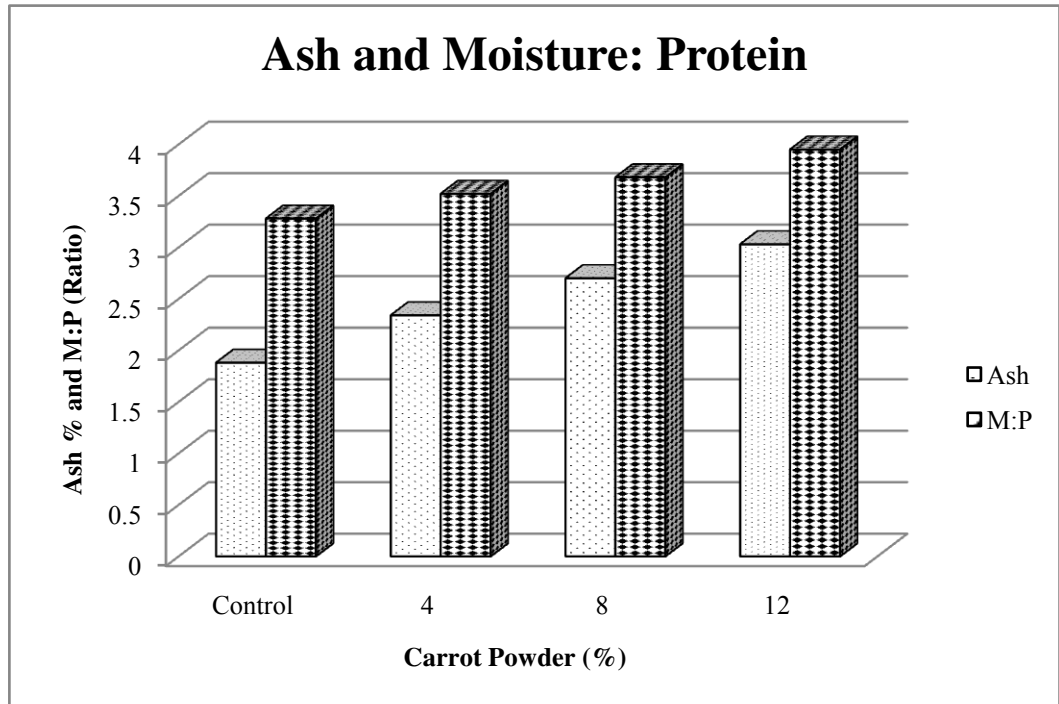
It was observed from the table that the moisture: protein ratio showed significantly ( $P<0.05$ ) higher trend with addition of higher amount of carrot powder. The energy showed significantly ( $P<0.05$ ) declining trend with increasing the level of carrot powder. Similar findings were reported by El Anany *et al.*, (2020). Keenan *et al.*, (2014) studied that when different types of meat products were formulated by adding dietary fiber the fat content and energy of the product



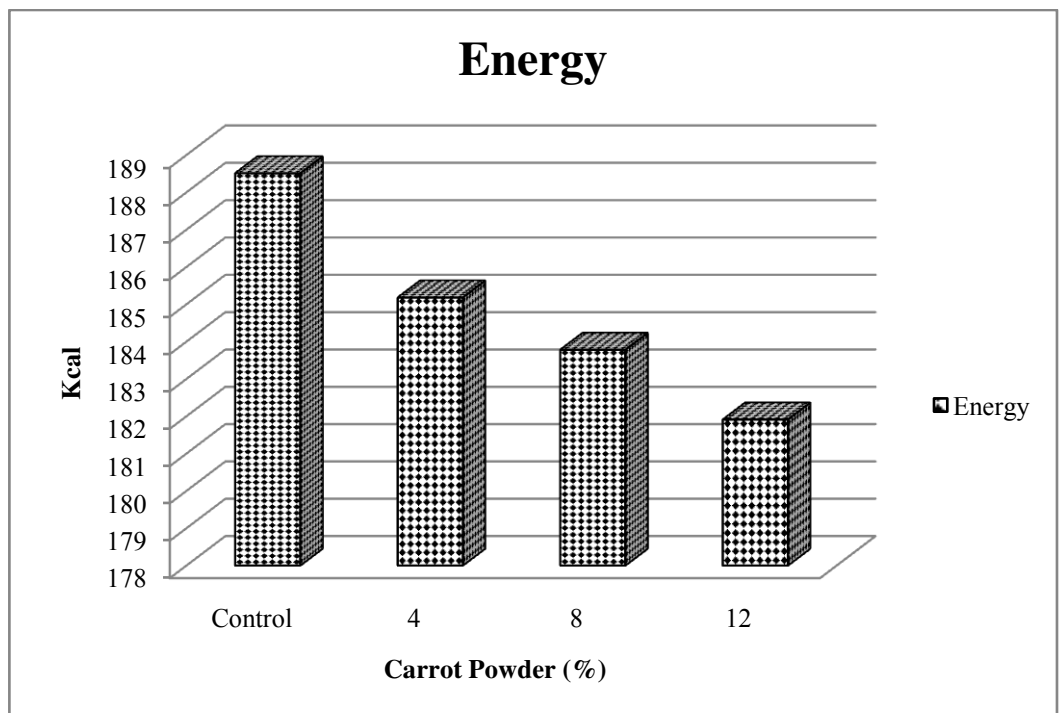
**Fig 4.25 Moisture of chicken nuggets added with carrot powder.**



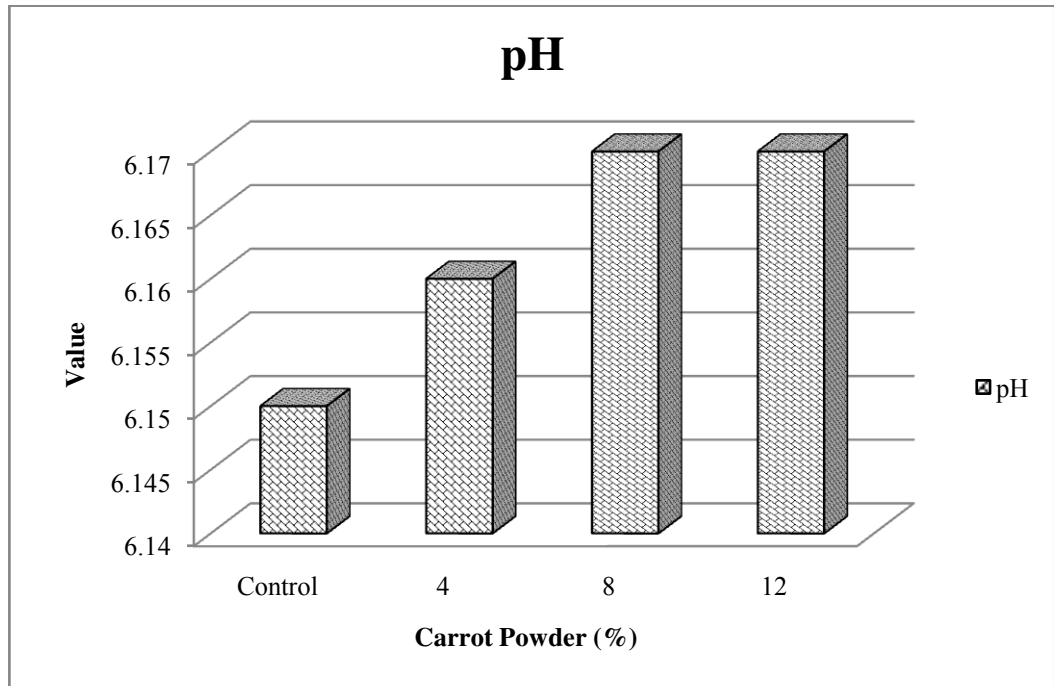
**Fig 4.26 Protein and Fat of chicken nuggets added with carrot powder**



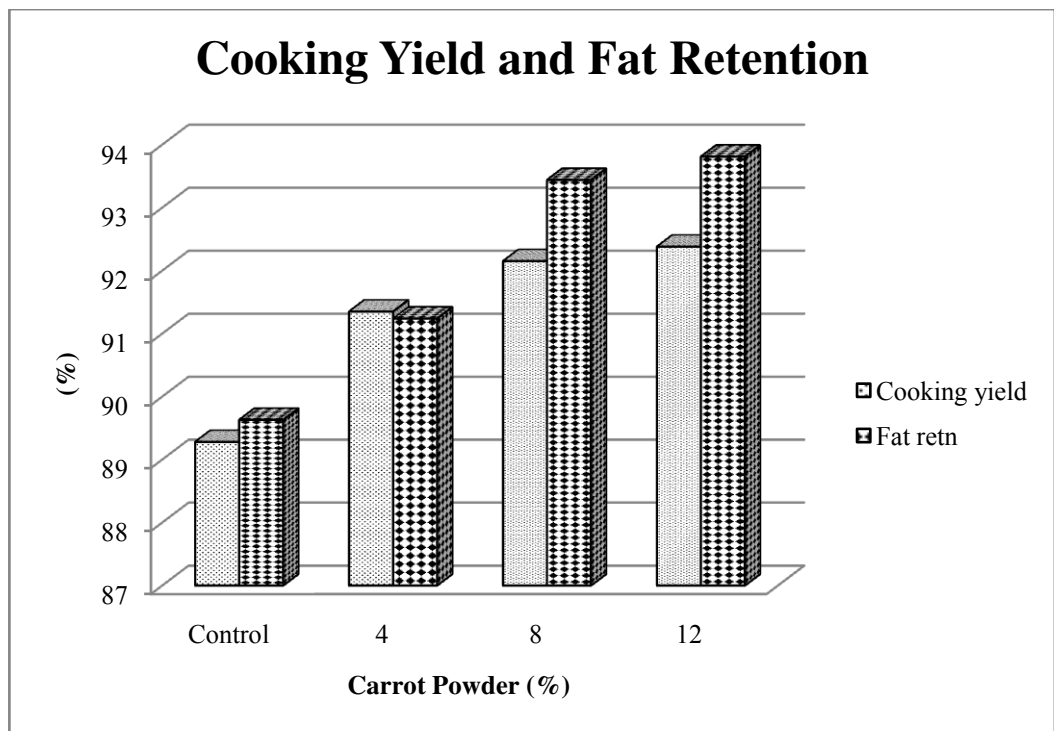
**Fig 4.27** Ash and moisture:protein ratio of chicken nuggets added with carrot powder



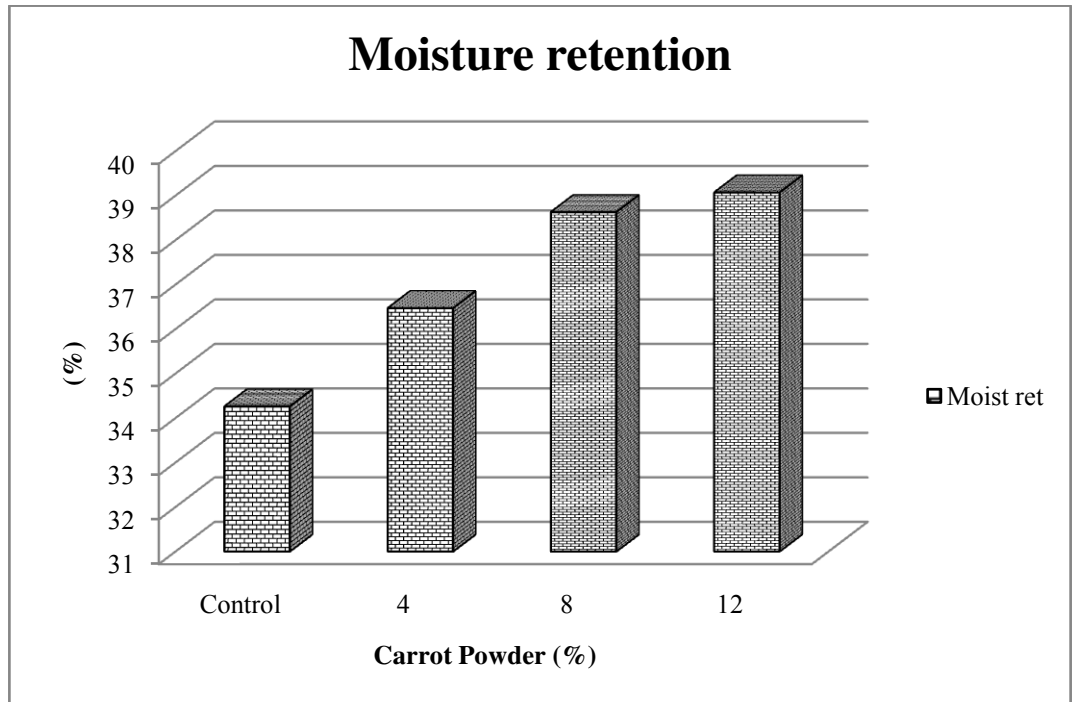
**Fig 4.28** Energy of chicken nuggets added with carrot powder



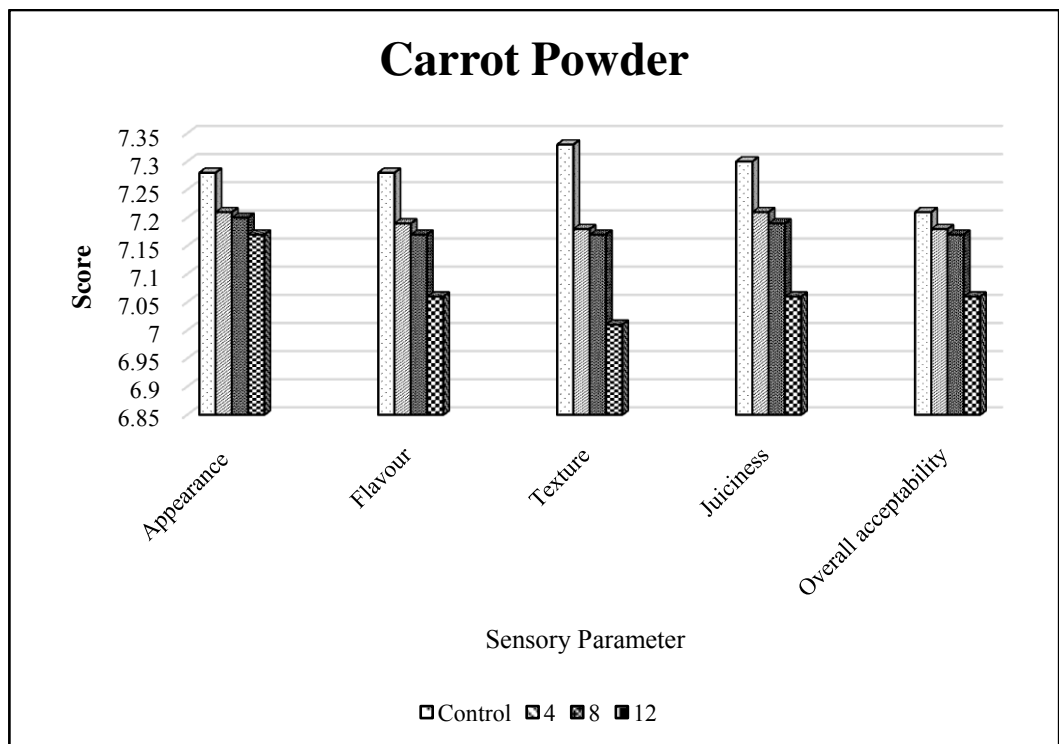
**Fig 4.29 pH of chicken nuggets added with carrot powder**



**Fig 4.30 Cooking yield and fat retention of chicken nuggets added with carrot powder**



**Fig 4.31** Moisture retention of chicken nuggets added with carrot powder



**Fig 4.32** Sensory score of chicken nuggets added with carrot powder

were inversely related. It was observed from the table that the pH increased slightly with addition of carrot powder. However the increase in pH was non-significant ( $p>0.05$ ). Mendiratta *et al.*, (2013) also observed non-significant difference in pH values of control and carrot, radish and capsicum incorporated mutton nuggets. The cooking yield increased significantly ( $P<0.05$ ) with increase in level of carrot powder. Ponsingh *et al.*, (2017) observed better cooking yield for buffalo meat sausage when prepared by incorporating 7% potato flour. In contrary Zargar *et al.*, (2017) observed that as the level of carrot was increased in chicken sausage the cooking yield of chicken sausage decreased significantly. A significantly ( $P<0.05$ ) increasing trend is observed in the moisture retention of chicken nugget prepared with carrot powder incorporation as compared to control. Similar findings were observed by Verma *et al.*, (2016). They reported that moisture retention values of chicken meat increased significantly ( $P<0.05$ ) as the green cabbage percentage increased in chicken meat ball. However, non-significant ( $P>0.05$ ) difference is observed between 8% and 12% carrot powder incorporated chicken nuggets. Similar findings are observed for the fat retention values of chicken nuggets. As the level of carrot powder incorporated increased in chicken nuggets the fat retention percentage also increased. The finding is in relevance with Serdaroglu *et al.*, (2018). They reported that incorporation of dried pumpkin pulp and seed mixture lead to increase in fat retention of sample.

It can be seen from the table that the sensory score for all the parameters like appearance, flavor, texture, juiciness differed significantly with varying amount of carrot level. A significantly decreasing trend is observed for all the sensory parameters with increase in carrot powder incorporation. However a non-significant difference is observed between 4% and 8% carrot powder incorporated chicken nuggets. Chicken nuggets with 12% carrot powder scored lowest for all the sensory parameters.

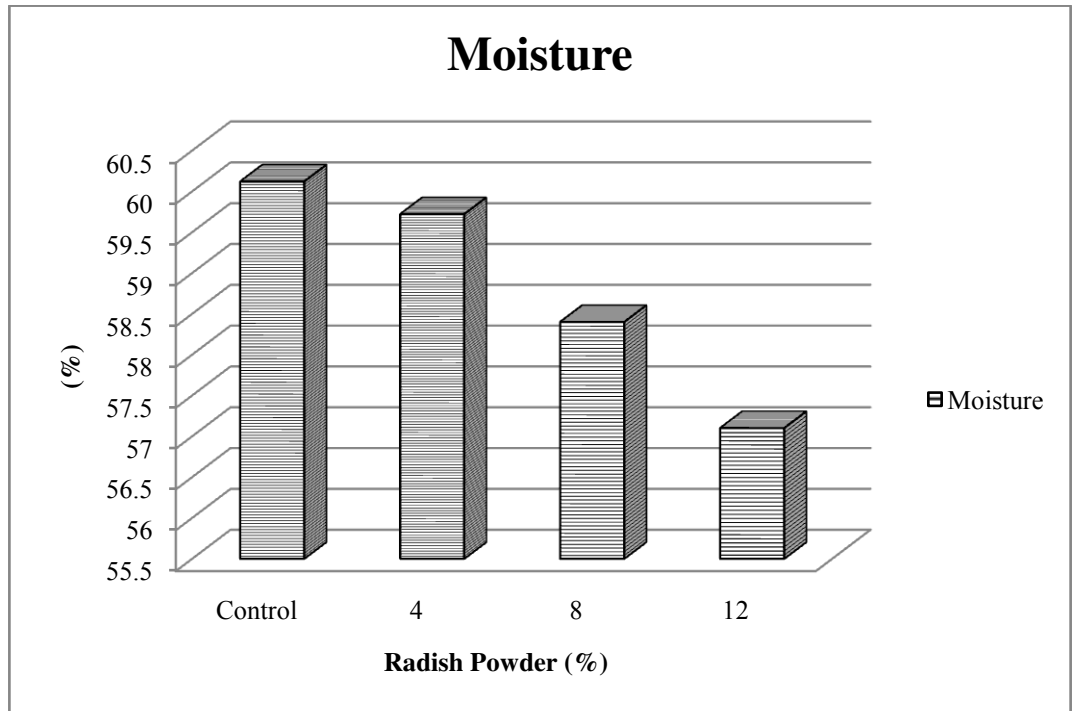
On the basis of data of proximate composition, physic-chemical and sensory attributes 8% carrot incorporated chicken nugget was selected for further study.

#### **4.2.2 Quality of chicken nuggets incorporated with radish powder.**

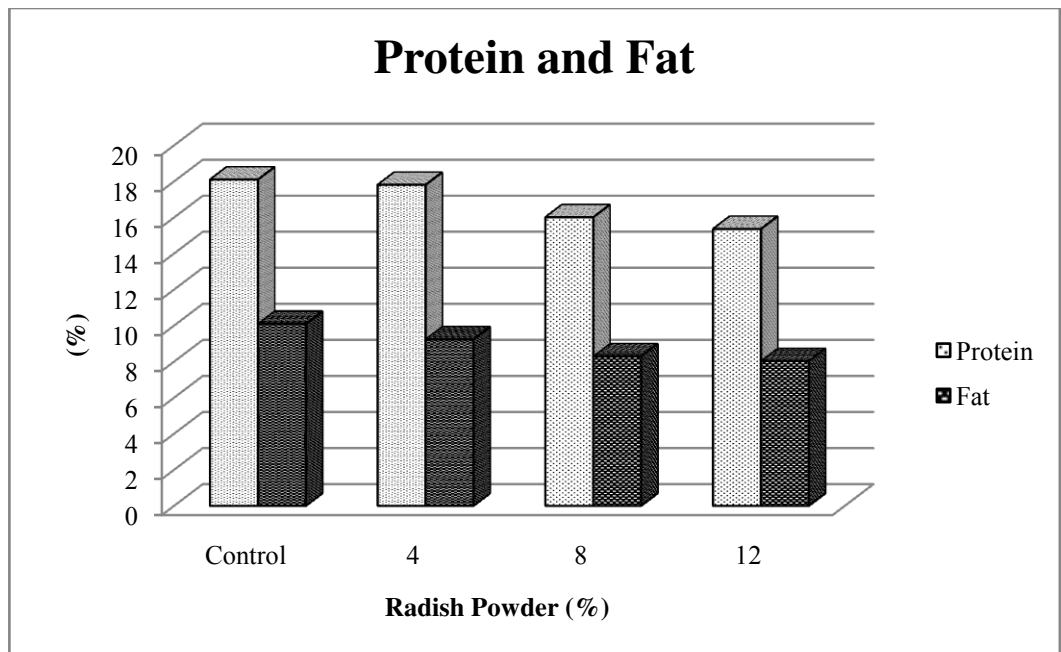
The data regarding proximate composition, physico-chemical and sensory properties of chicken nuggets incorporated with radish powder is presented in Table 4.8.

A significant ( $P < 0.05$ ) difference in moisture was observed between radish incorporated chicken nuggets and that of the control group. The moisture percentage decreased with incorporation of higher amount of radish powder. The present finding is in agreement with Ozaki *et al.*, (2021). They reported that when radish or beetroot powder were added in fermented dry sausage the moisture content affected significantly and when vegetables were incorporated in sausage moisture content of the sausage was influenced. A significantly ( $P < 0.05$ ) declining trend was observed for the protein and fat percentage of chicken nuggets incorporated with radish powder as compared to control. Decrease in protein content of radish incorporated chicken nuggets may be due to less amount of protein present in radish. The findings were in relevance with Mendiratta *et al.*, (2013). The moisture: protein ratio showed significantly ( $P < 0.05$ ) increasing trend with addition of radish powder. A significant ( $P < 0.05$ ) difference was observed in the energy of chicken nuggets with radish powder as compared to control. The energy decreased with increase in level of radish powder.

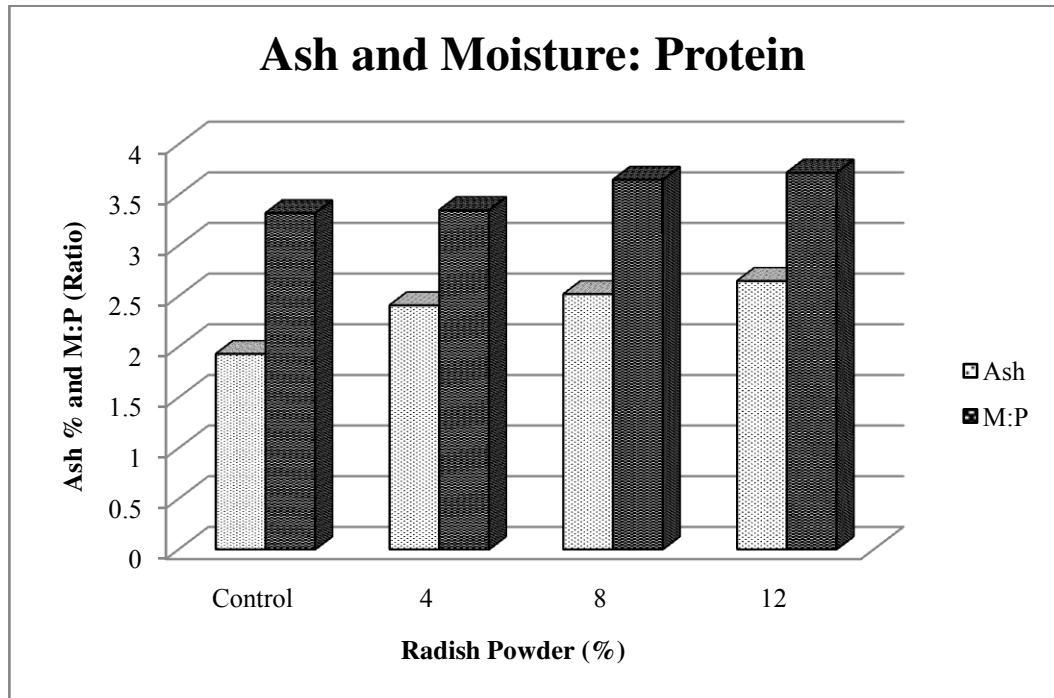
The pH of chicken nuggets incorporated with radish powder did not differ significantly ( $P > 0.05$ ). The pH found slightly increased with increase in the level of radish powder. The findings were in relevance with Mendiratta *et al.*, (2013). They reported that mutton nuggets incorporated with carrot and radish showed no significant difference in pH values when compared with control.



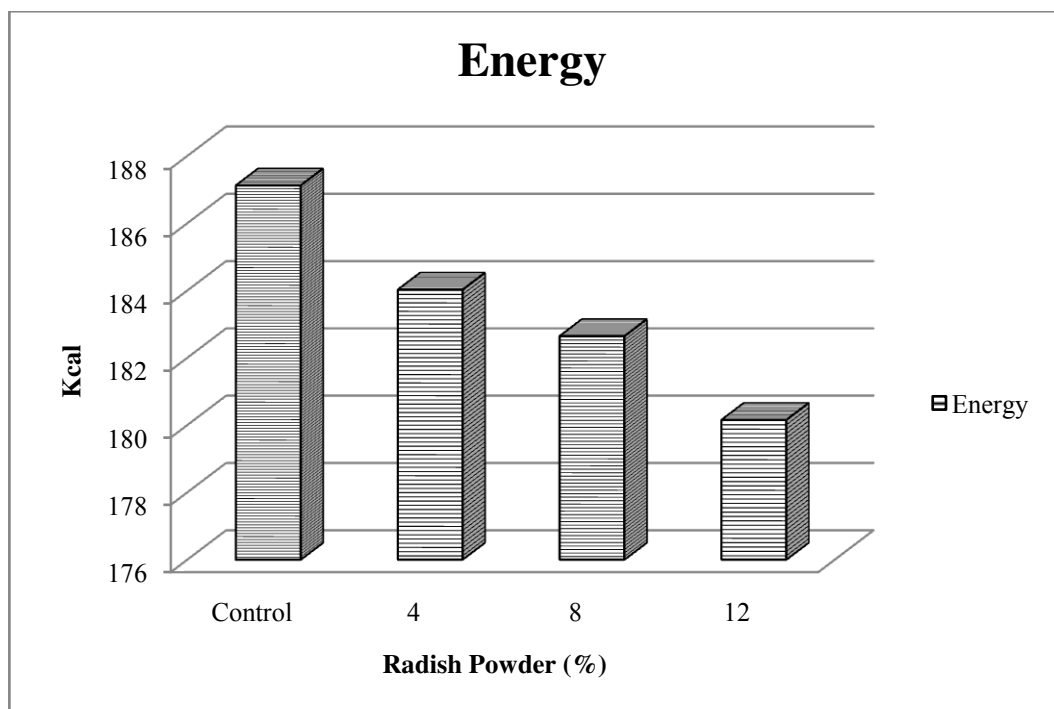
**Fig 4.33 Moisture of chicken nuggets added with radish powder**



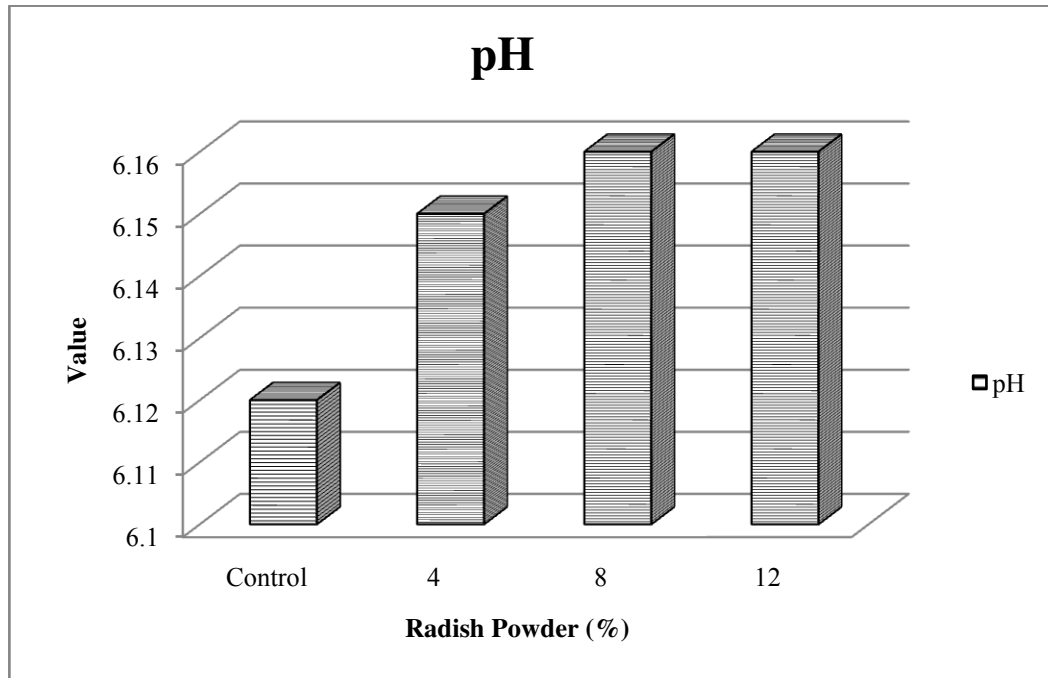
**Fig 4.34 Protein and fat of chicken nuggets added with radish powder**



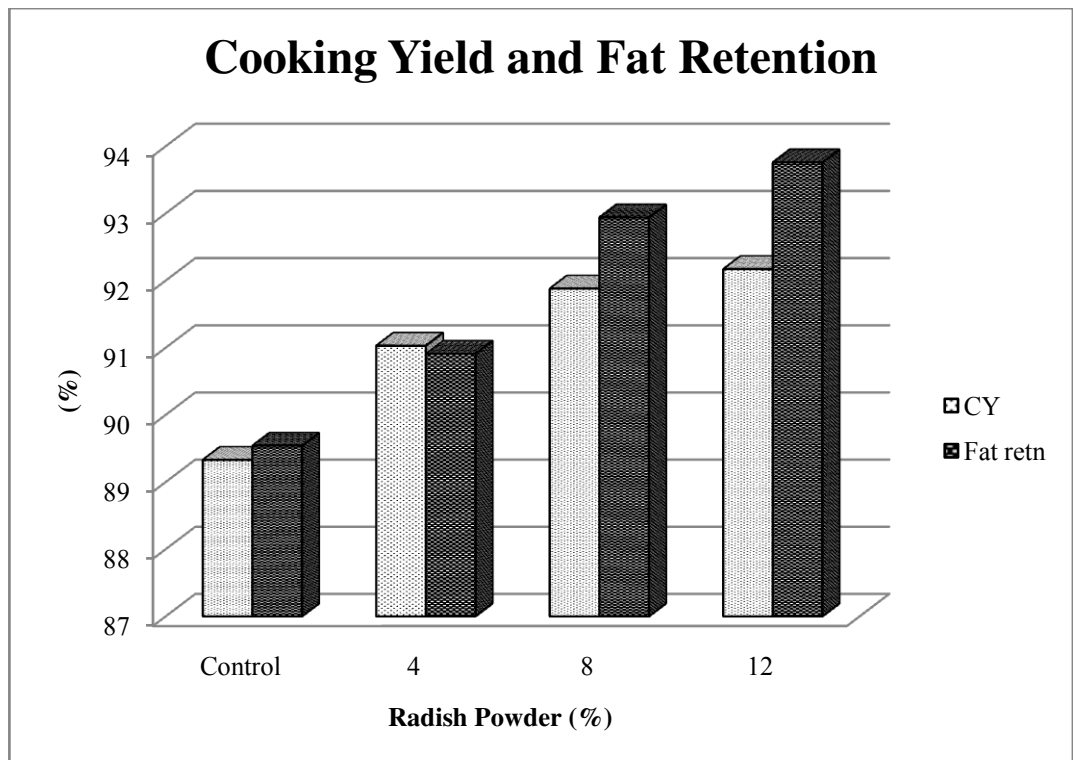
**Fig 4.35 Ash and moisture:protein ratio of chicken nuggets added with radish powder**



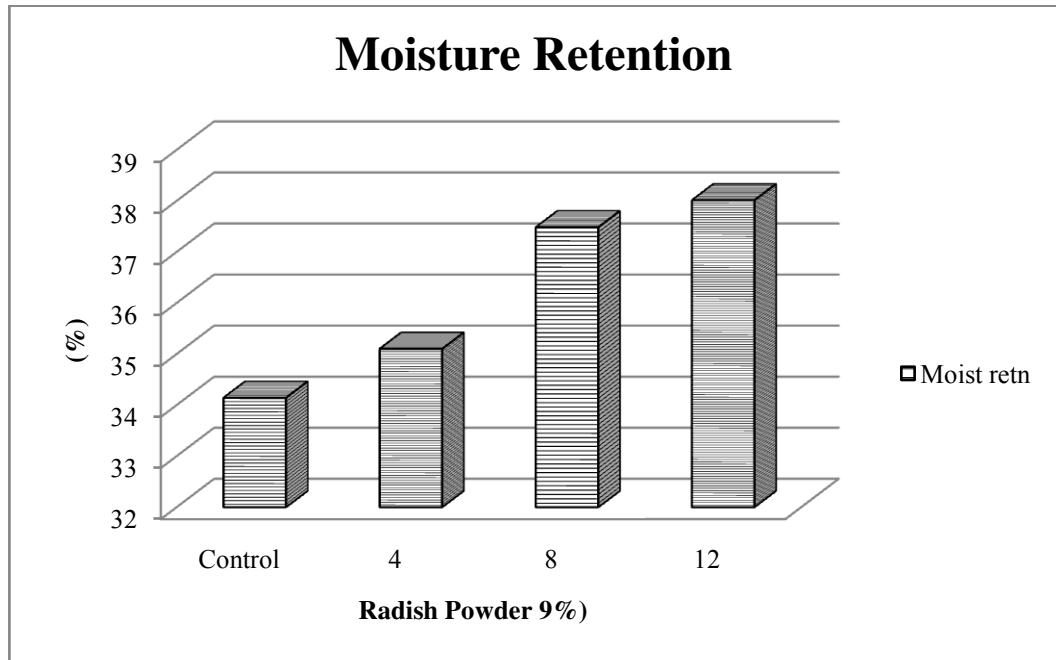
**Fig 4.36 Energy of chicken nuggets added with radish powder**



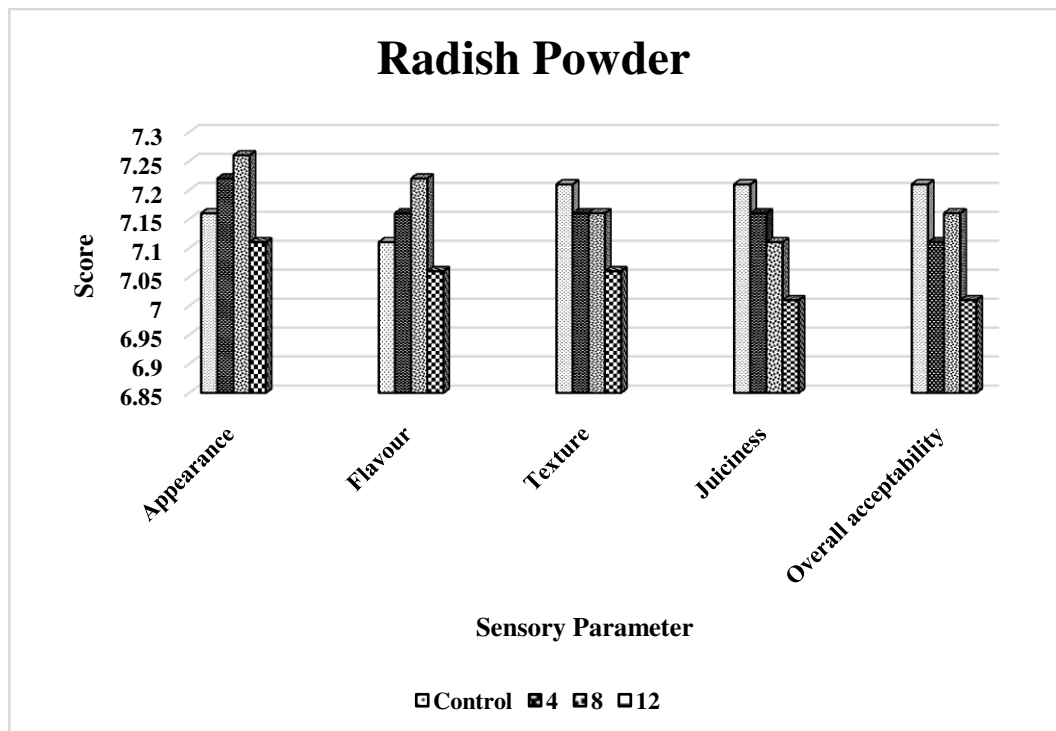
**Fig 4.37** pH of chicken nuggets added with radish powder



**Fig 4.38** Cooking yield and fat retention of chicken nuggets added with radish powder



**Fig 4.39** Moisture retention of chicken nuggets added with radish powder



**Fig 4.40** Sensory score of chicken nuggets added with radish powder

**Table 4.8: Proximate composition, physio-chemical and sensory properties of chicken nuggets added with radish powder (RP) (Mean±S.E.)\*.**

Parameters	Control	Radish powder (RP) levels		
		RP-4	RP-8	RP-12
<b>Proximate composition</b>				
<b>Moisture (%)</b>	60.12±0.07 <sup>d</sup>	59.72±0.06 <sup>c</sup>	58.40±0.07 <sup>b</sup>	57.10±0.04 <sup>a</sup>
<b>Protein (%)</b>	18.10±0.06 <sup>d</sup>	17.81±0.04 <sup>c</sup>	16.01±0.08 <sup>b</sup>	15.36±0.05 <sup>a</sup>
<b>Fat (%)</b>	10.10±0.07 <sup>d</sup>	9.24±0.03 <sup>c</sup>	8.29±0.02 <sup>b</sup>	8.03±0.03 <sup>a</sup>
<b>Ash (%)</b>	1.93±0.03 <sup>a</sup>	2.41±0.05 <sup>b</sup>	2.52±0.02 <sup>c</sup>	2.65±0.61 <sup>d</sup>
<b>Moisture: Protein ratio</b>	3.32±0.06 <sup>a</sup>	3.35±0.07 <sup>a</sup>	3.65±0.08 <sup>bc</sup>	3.72±0.11 <sup>c</sup>
<b>Energy (Kcal)</b>	187.12±0.18 <sup>d</sup>	184.02±0.22 <sup>c</sup>	182.64±0.52 <sup>b</sup>	180.15±0.59 <sup>a</sup>
<b>Physico-chemical attributes</b>				
<b>pH</b>	6.12±0.04	6.15±0.04	6.16±0.04	6.16±0.04
<b>Cooking Yield (%)</b>	89.33±0.28 <sup>a</sup>	91.03±0.29 <sup>b</sup>	91.88±0.38 <sup>c</sup>	92.17±0.34 <sup>c</sup>
<b>Moisture Retention (%)</b>	34.14±0.31 <sup>a</sup>	35.10±0.64 <sup>b</sup>	37.48±0.62 <sup>c</sup>	38.01±0.65 <sup>c</sup>
<b>Fat Retention (%)</b>	89.54±0.29 <sup>a</sup>	90.91±0.42 <sup>b</sup>	92.94±0.91 <sup>c</sup>	93.76±0.87 <sup>c</sup>
<b>Sensory evaluation<sup>#</sup></b>				
<b>Appearance</b>	7.16±0.02 <sup>b</sup>	7.22±0.02 <sup>c</sup>	7.26±0.02 <sup>d</sup>	7.11±0.01 <sup>a</sup>
<b>Flavour</b>	7.11±0.02 <sup>b</sup>	7.16±0.03 <sup>c</sup>	7.22±0.01 <sup>d</sup>	7.06±0.02 <sup>a</sup>
<b>Texture</b>	7.21±0.02 <sup>c</sup>	7.16±0.02 <sup>b</sup>	7.16±0.03 <sup>b</sup>	7.06±0.04 <sup>a</sup>
<b>Juiciness</b>	7.21±0.04 <sup>c</sup>	7.16±0.04 <sup>b</sup>	7.11±0.06 <sup>b</sup>	7.01±0.03 <sup>a</sup>
<b>Overall Acceptability</b>	7.21±0.02 <sup>c</sup>	7.11±0.05 <sup>b</sup>	7.16±0.05 <sup>b</sup>	7.01±0.04 <sup>a</sup>

n = 6, <sup>#</sup>n=21 \*Mean ± SE. with different superscripts row wise (small alphabets) differ significantly ( $p<0.05$ ) **CON** = Chicken nuggets without radish powder (RP), **RP-4** = nuggets with 4.0 % RP, **RP-8** = nuggets with 8.0 % RP and **RP-12** = nuggets with 12.0 % RP.

Cooking yield showed significantly ( $P<0.05$ ) increasing trend with higher amount of radish powder. Similar findings were reported by Mendiratta *et al.*, (2013). They found higher cooking yield for radish incorporated mutton nuggets than control group. This might be due to enhanced moisture retention while cooking by radish fiber. Similar findings were observed for the moisture retention and fat retention of chicken nuggets prepared by incorporating radish powder. Significant ( $P<0.05$ ) increase in moisture retention and fat retention is observed with increase in radish powder incorporation. Verma *et al.*, (2016) reported that when chicken meat balls prepared by adding green cabbage the moisture retention of meat balls also increased. Ergezer *et al.*, (2014) observed increased fat

retention in beef meat balls when incorporated with 20% potato puree.

It was observed from the table that radish incorporated chicken nuggets showed significant ( $P < 0.05$ ) difference in all the sensory parameters like appearance, flavor, texture, juiciness and overall acceptability. A significant ( $P < 0.05$ ) increase in appearance and flavour score is observed for 4% and 8% radish incorporated chicken nuggets as compared to control but for 12% radish incorporated chicken nugget lowest score for appearance and flavour is observed. A significantly ( $P < 0.05$ ) decreasing score for texture is observed with increased level of radish powder as compared to control but the difference was non-significant for 4% and 8% radish incorporated chicken nuggets.

Based on data of proximate composition, physico-chemical and sensory attributes 8% radish incorporated chicken nugget is selected for further study.

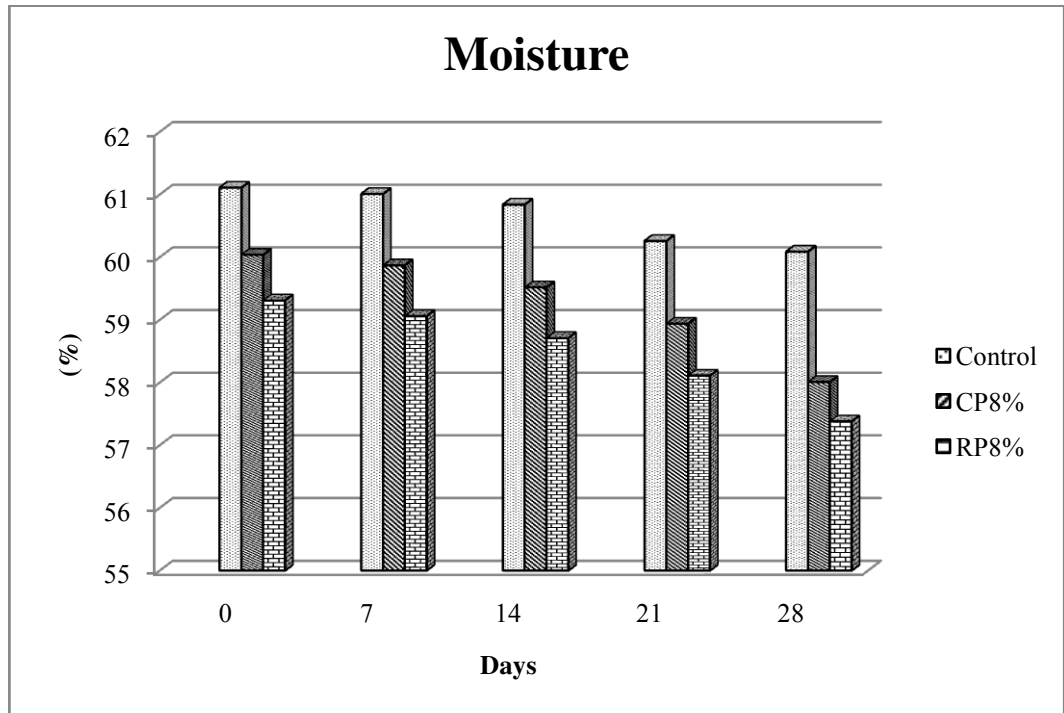
### **4.3 Shelf life of chicken nuggets at refrigeration temperature**

The objective of this experiment was to assess the shelf life of chicken nugget during storage. Chicken nuggets were prepared by using selected level of carrot and radish powder, aseptically packed in HDPE, and stored at refrigeration temperature ( $4 \pm 1^{\circ} \text{C}$ ). The assessment was carry out by observing changes in sensory, physico-chemical and microbiological quality at regular interval of 07 days. Three nuggets samples as viz. C= Control, T-1 = Chicken nuggets with 8.0 % carrot powder, T-2= Chicken nuggets with 8.0 % radish powder. Regularly, the samples were drawn at an interval of 7 days on 1, 7, 14, 21 and 28 days.

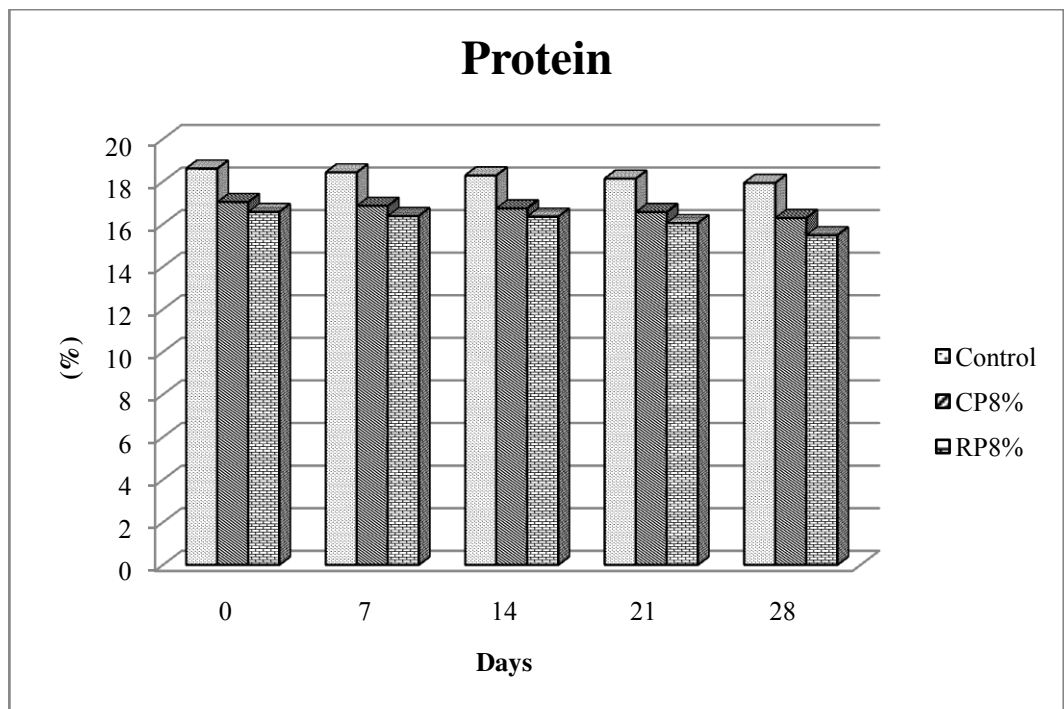
#### **4.3.1 Proximate composition of chicken nuggets during refrigerated storage**

The observations on storage related changes in proximate composition of chicken nuggets incorporated with 8% carrot and radish powder is shown in Table 4.9.

A significant ( $P < 0.05$ ) decrease in moisture content of chicken nuggets was observed during the storage period of 28 days. The finding was in accordance with Patil *et al.*, (2004). Loss of moisture during refrigerated storage could be a possible reason for decreased moisture content. Carrot and radish incorporated



**Fig 4.41** Moisture of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)



**Fig 4.42** Protein of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)

chicken nuggets showed significantly higher moisture content than the control nuggets. Similar findings were reported by Sekhon and Bawa (1990). They reported that when meat products were prepared by adding vegetables the moisture content of the meat product increased. Among the treatments 8% carrot powder incorporated chicken nuggets showed significantly higher moisture content than control and 8% radish incorporated chicken nuggets.

**Table 4.9: Effect of carrot powder (8%) and radish powder (8 %) on proximate composition of chicken nuggets during refrigerated storage (4±1°C) (Mean±S.E.)\***

Treat/Days	Day 1	Day 7	Day 14	Day 21	Day 28
<b>Moisture (%)</b>					
<b>C</b>	61.11±0.03 <sup>CE</sup>	61.01±0.05 <sup>CD</sup>	60.84±0.04 <sup>CC</sup>	60.26±0.07 <sup>CB</sup>	60.09±0.06 <sup>CA</sup>
<b>T-1</b>	60.04±0.03 <sup>BE</sup>	59.87±0.04 <sup>BD</sup>	59.52±0.10 <sup>BC</sup>	58.94±0.05 <sup>BB</sup>	58.01±0.09 <sup>BA</sup>
<b>T-2</b>	59.31±0.08 <sup>AE</sup>	59.06±0.04 <sup>AD</sup>	58.71±0.05 <sup>AC</sup>	58.11±0.06 <sup>AB</sup>	57.38±0.05 <sup>AA</sup>
<b>Protein (%)</b>					
<b>C</b>	18.61±0.83 <sup>b</sup>	18.43±0.86 <sup>b</sup>	18.29±0.88 <sup>b</sup>	18.14±0.90 <sup>b</sup>	17.94±0.85 <sup>b</sup>
<b>T-1</b>	17.04±0.59 <sup>aB</sup>	16.86±0.57 <sup>aAB</sup>	16.74±0.52 <sup>aAB</sup>	16.57±0.55 <sup>aAB</sup>	16.29±0.58 <sup>aA</sup>
<b>T-2</b>	16.57±0.58 <sup>aB</sup>	16.38±0.58 <sup>aB</sup>	16.35±0.55 <sup>aB</sup>	16.05±0.57 <sup>aAB</sup>	15.48±0.53 <sup>aA</sup>
<b>Fat (%)</b>					
<b>C</b>	10.85±0.18 <sup>bB</sup>	10.79±0.13 <sup>bB</sup>	10.74±0.17 <sup>bAB</sup>	10.68±0.15 <sup>bA</sup>	10.58±0.16 <sup>bA</sup>
<b>T-1</b>	9.57±0.20 <sup>aB</sup>	9.48±0.18 <sup>aB</sup>	9.39±0.14 <sup>aAB</sup>	9.32±0.17 <sup>aAB</sup>	9.22±0.16 <sup>aA</sup>
<b>T-2</b>	9.43±0.15 <sup>aC</sup>	9.38±0.15 <sup>aBC</sup>	9.33±0.12 <sup>aBC</sup>	9.28±0.14 <sup>aB</sup>	9.13±0.10 <sup>aA</sup>
<b>Ash (%)</b>					
<b>C</b>	1.87±0.06 <sup>aC</sup>	1.82±0.07 <sup>aC</sup>	1.66±0.06 <sup>aB</sup>	1.44±0.09 <sup>aA</sup>	1.42±0.08 <sup>aA</sup>
<b>T-1</b>	2.68±0.07 <sup>cC</sup>	2.65±0.05 <sup>cC</sup>	2.50±0.07 <sup>cB</sup>	2.35±0.08 <sup>cA</sup>	2.33±0.09 <sup>cA</sup>
<b>T-2</b>	2.46±0.05 <sup>bC</sup>	2.42±0.06 <sup>bC</sup>	2.31±0.08 <sup>bB</sup>	2.08±0.11 <sup>bA</sup>	2.06±0.13 <sup>bA</sup>
<b>Moisture: Protein ratio</b>					
<b>C</b>	3.29±0.08 <sup>a</sup>	3.31±0.07 <sup>a</sup>	3.33±0.08 <sup>a</sup>	3.34±0.06 <sup>a</sup>	3.35±0.09 <sup>a</sup>
<b>T-1</b>	3.52±0.08 <sup>b</sup>	3.55±0.07 <sup>b</sup>	3.56±0.06 <sup>b</sup>	3.57±0.09 <sup>b</sup>	3.58±0.14 <sup>b</sup>
<b>T-2</b>	3.58±0.17 <sup>b</sup>	3.60±0.16 <sup>b</sup>	3.59±0.15 <sup>b</sup>	3.62±0.18 <sup>b</sup>	3.71±0.17 <sup>b</sup>

n=6, \*Mean ± SE. with different superscripts row wise (Capital alphabets) and column wise (small alphabets) differ significantly ( $p<0.05$ ). **C**= Control, **T-1** = Chicken nuggets with 8.0 % carrot powder (CP-8), **T-2**= Chicken nuggets with 8.0 % radish powder (RP-8)

A non-significant ( $P>0.05$ ) decrease in protein percentage of control chicken nuggets is observed during the storage period of 28 days. This might due to decomposition of protein during storage period. While among the treatments a significant decrease in protein content is observed in carrot and radish

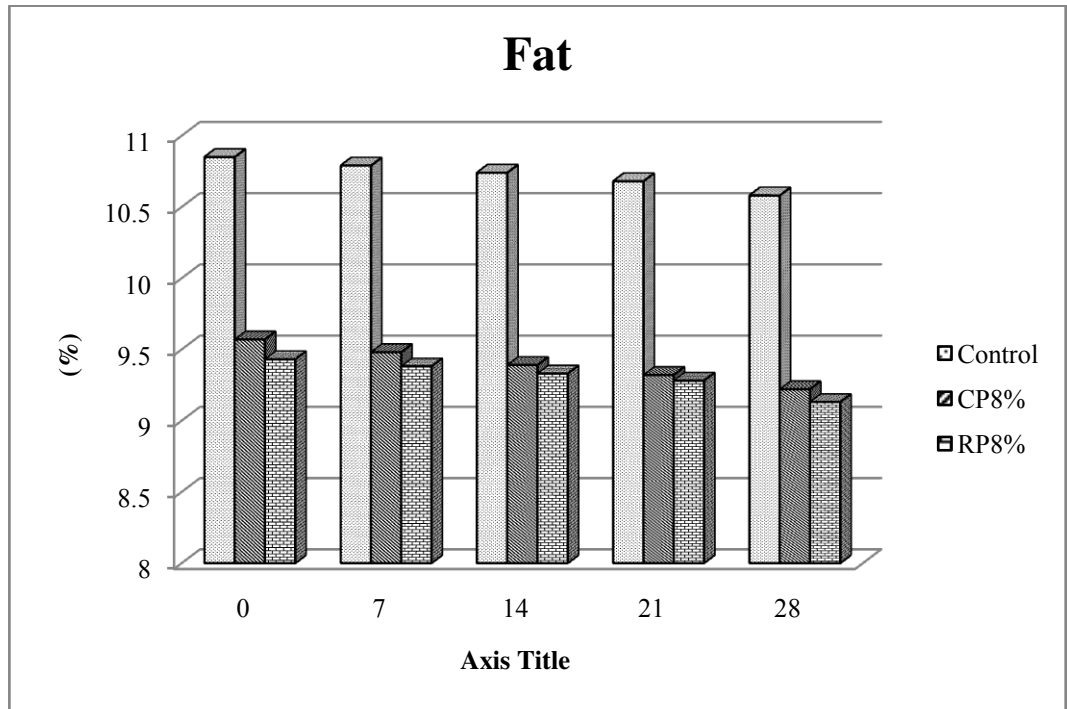
incorporated chicken nuggets when compared to control. Biswas et al., (2011), reported similar finding. They reported that when raw carrot was added in chicken nuggets at different levels the protein content of carrot added chicken nuggets was lower than the control. A non-significant difference was observed between carrot and radish incorporated chicken nuggets.

The fat percentage decreased progressively during the storage period of 28 days. A significant ( $P < 0.05$ ) difference is found in fat percentage of vegetable incorporated chicken nuggets and control. The ash content of the chicken nuggets decreased gradually with storage period of 28 days. A significant ( $P < 0.05$ ) difference in ash content are observed between control and vegetable incorporated chicken nuggets. Control chicken nuggets had highest ash percentage followed by carrot incorporated chicken nuggets. A non-significant ( $P > 0.05$ ) increase in moisture: protein ratio are observed during the storage period of 28 days irrespective of treatment. A significant ( $P < 0.05$ ) difference in moisture: protein ratio was observed within the treatment group. Highest moisture: protein ratio was observed in 8% radish incorporated chicken nuggets.

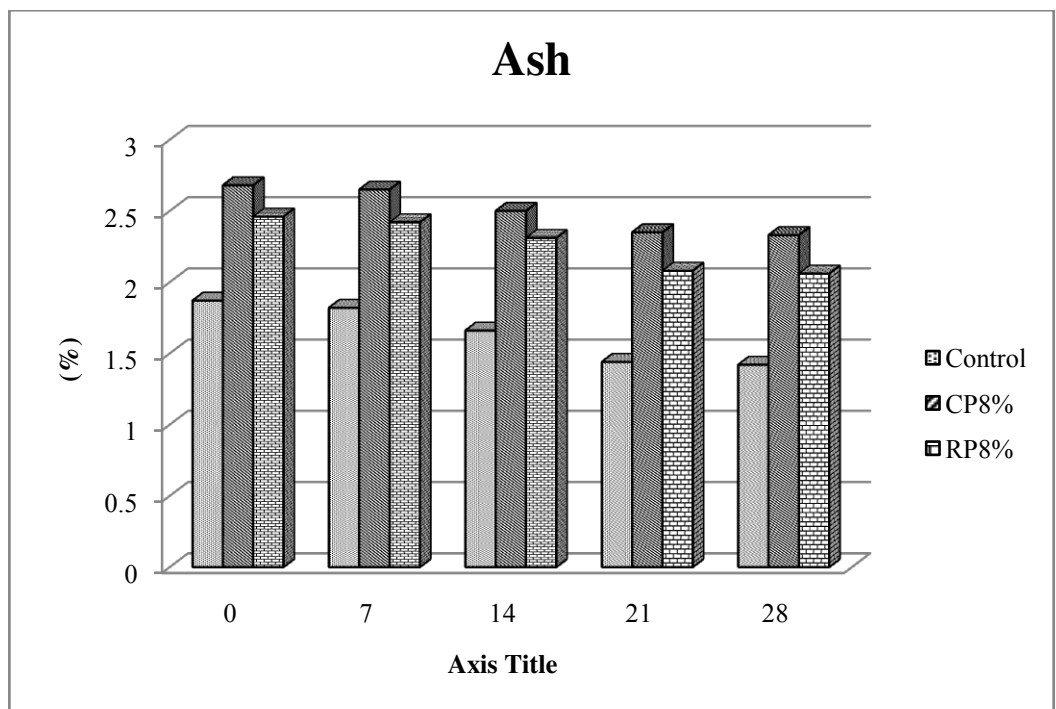
#### **4.3.2 Physico-chemical changes in chicken nuggets during refrigerated storage**

The effect of carrot (8%) and radish powder (8%) on physico-chemical properties of chicken nuggets during refrigerated storage ( $4 \pm 1^\circ\text{C}$ ) shown in Table 4.10.

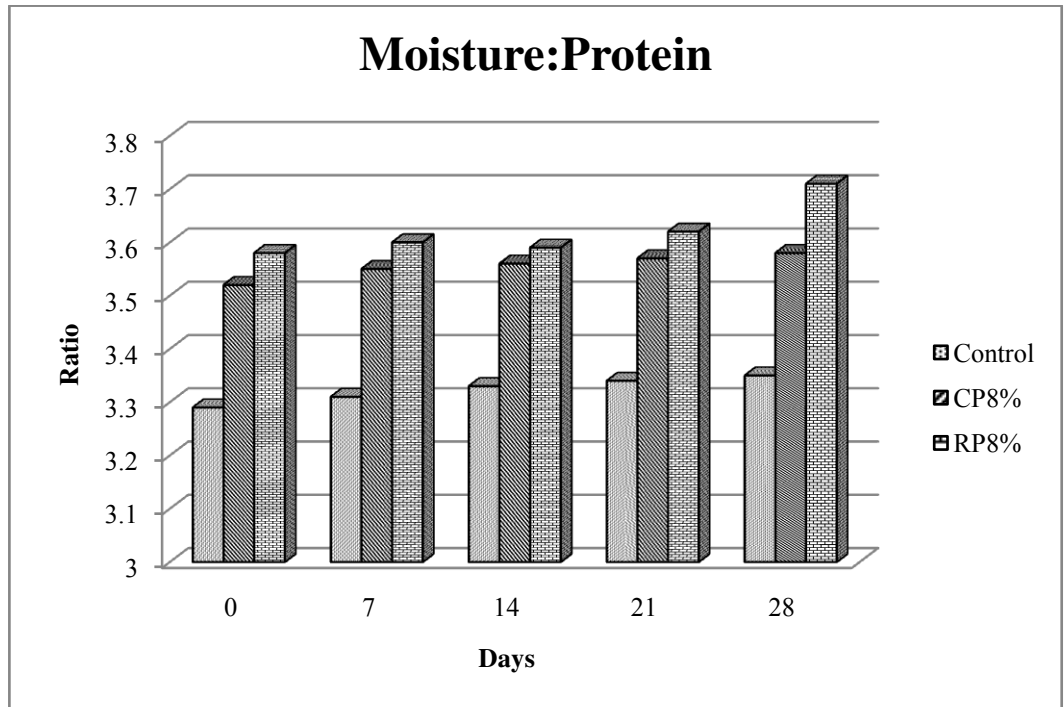
It is observed from the table that the pH values of chicken nuggets increased significantly ( $P < 0.05$ ) with storage period. Increase in pH was however non-significant up to 14<sup>th</sup> day of storage for 8% carrot incorporated chicken nuggets and for 8% radish incorporated chicken nugget the difference was non-significant up to 7<sup>th</sup> day of storage period. Lactic acid degradation and formation of protein metabolites could be a reason for increased pH during storage time. Similar findings were observed by Patil *et al.*, (2004). A significant difference in pH of the product was recorded within the treatments. Highest pH was observed in radish incorporated chicken nuggets followed by carrot incorporated chicken



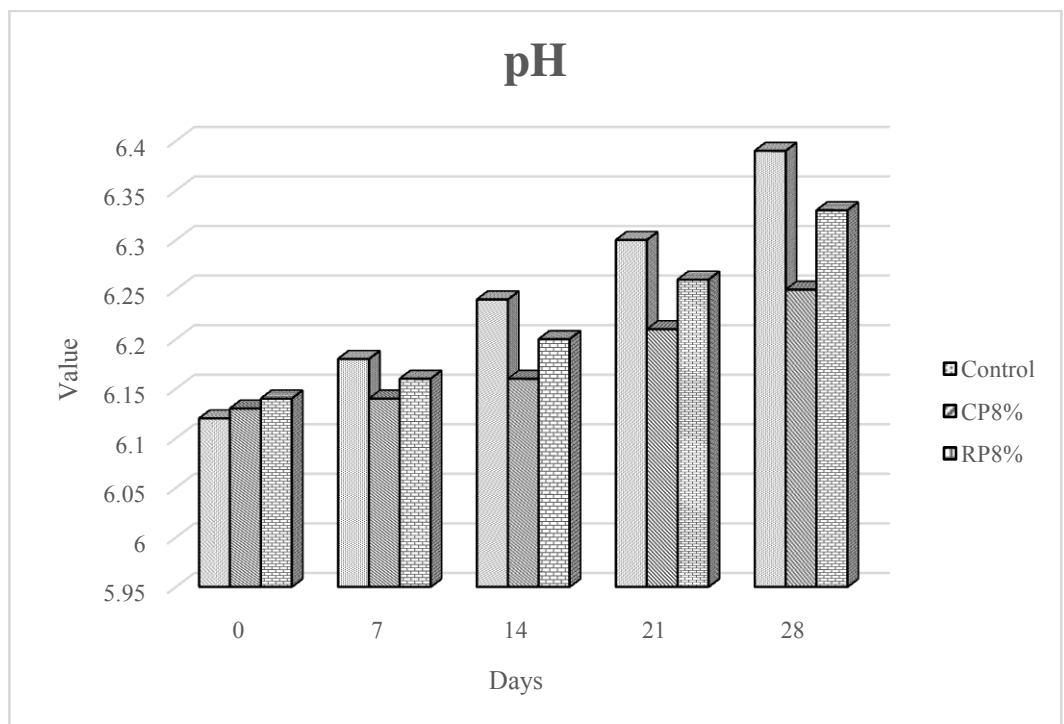
**Fig 4.43 Fat % of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



**Fig 4.44 Ash % of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



**Fig 4.45 Moisture:protein of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



**Fig 4.46 pH of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**

nuggets.

**Table 4.10: Effect of carrot powder (8%) and radish powder (8 %) on physico-chemical properties of chicken nuggets during refrigerated storage (4±1°C) (Mean±S.E.)\***

Treat/ Days	Day 1	Day 7	Day 14	Day 21	Day 28
<b>pH</b>					
<b>C</b>	6.12±0.03 <sup>A</sup>	6.18±0.02 <sup>bB</sup>	6.24±0.01 <sup>cC</sup>	6.30±0.02 <sup>dD</sup>	6.39±0.05 <sup>eE</sup>
<b>T-1</b>	6.13±0.04 <sup>A</sup>	6.14±0.03 <sup>aA</sup>	6.16±0.02 <sup>aA</sup>	6.21±0.02 <sup>aB</sup>	6.25±0.02 <sup>aC</sup>
<b>T-2</b>	6.14±0.04 <sup>A</sup>	6.16±0.03 <sup>abA</sup>	6.20±0.02 <sup>bB</sup>	6.26±0.02 <sup>bC</sup>	6.33±0.02 <sup>bD</sup>
<b>Thiobarbituric acid (mg malonaldehyde/Kg)</b>					
<b>C</b>	0.31±0.05 <sup>A</sup>	0.34±0.07 <sup>aA</sup>	0.56±0.08 <sup>aB</sup>	0.73±0.07 <sup>aC</sup>	0.92±0.09 <sup>bD</sup>
<b>T-1</b>	0.27±0.05 <sup>A</sup>	0.28±0.04 <sup>aA</sup>	0.31±0.04 <sup>aA</sup>	0.46±0.06 <sup>aB</sup>	0.57±0.05 <sup>aC</sup>
<b>T-2</b>	0.28±0.04 <sup>A</sup>	0.30±0.06 <sup>aAB</sup>	0.34±0.06 <sup>aB</sup>	0.51±0.05 <sup>aC</sup>	0.62±0.06 <sup>abD</sup>
<b>Tyrosine value (mg/kg)</b>					
<b>C</b>	0.37±0.03 <sup>A</sup>	0.39±0.01 <sup>bA</sup>	0.43±0.03 <sup>bB</sup>	0.48±0.04 <sup>bC</sup>	0.55±0.05 <sup>bD</sup>
<b>T-1</b>	0.36±0.01 <sup>A</sup>	0.36±0.01 <sup>aA</sup>	0.36±0.02 <sup>aA</sup>	0.40±0.01 <sup>aB</sup>	0.42±0.01 <sup>aB</sup>
<b>T-2</b>	0.36±0.02 <sup>A</sup>	0.36±0.02 <sup>aA</sup>	0.37±0.01 <sup>aA</sup>	0.41±0.02 <sup>aB</sup>	0.43±0.02 <sup>aB</sup>
<b>Titratable acidity (%)</b>					
<b>C</b>	1.95±0.05 <sup>B</sup>	1.94±0.05 <sup>B</sup>	1.92±0.06 <sup>AB</sup>	1.90±0.06 <sup>AB</sup>	1.88±0.05 <sup>A</sup>
<b>T-1</b>	1.99±0.06	1.98±0.07	1.96±0.08	1.94±0.07	1.92±0.08
<b>T-2</b>	1.98±0.07	1.97±0.08	1.95±0.09	1.93±0.08	1.91±0.09
<b>Peroxide Value (meq/Kg)</b>					
<b>C</b>	4.57±0.06 <sup>bA</sup>	4.69±0.05 <sup>bB</sup>	4.85±0.10 <sup>bC</sup>	5.79±0.18 <sup>bD</sup>	6.66±0.15 <sup>bE</sup>
<b>T-1</b>	4.24±0.17 <sup>aA</sup>	4.32±0.14 <sup>aAB</sup>	4.43±0.15 <sup>aB</sup>	4.83±0.13 <sup>aC</sup>	5.53±0.02 <sup>aD</sup>
<b>T-2</b>	4.28±0.17 <sup>aA</sup>	4.36±0.07 <sup>aA</sup>	4.49±0.10 <sup>aB</sup>	4.94±0.12 <sup>aC</sup>	5.70±0.12 <sup>aD</sup>

n=6, \*Mean ± SE. with different superscripts row wise (Capital alphabets) and column wise (small alphabets) differ significantly ( $p<0.05$ ). **C**= Control, **T-1** = Chicken nuggets with 8.0 % carrot powder **T-2**= Chicken nuggets with 8.0 % radish powder

Thiobarbituric acid value of chicken nuggets increased during the storage period of 28 days. However the difference was non-significant ( $P>0.05$ ) up to day 7 for control and up to day 14 for carrot incorporated chicken nuggets. Kaczmarek *et al.*, (2015) observed increased TBARS value of pork sausage during storage. A non-significant ( $P>0.05$ ) difference in Thiobarbituric acid values was observed for the products within treatments. The thiobarbituric acid values of carrot and radish incorporated chicken nuggets were lower than the control chicken nuggets. Similar results were observed by Chatepa *et al.*, (2021). From the study they shown that TBARS values of chevon and pork mixed with 10% aqueous ginger,

garlic and onion extract were lower than the control sample. The highest value for thiobarbituric acid was observed in control chicken nuggets followed by 8% radish incorporated chicken nuggets.

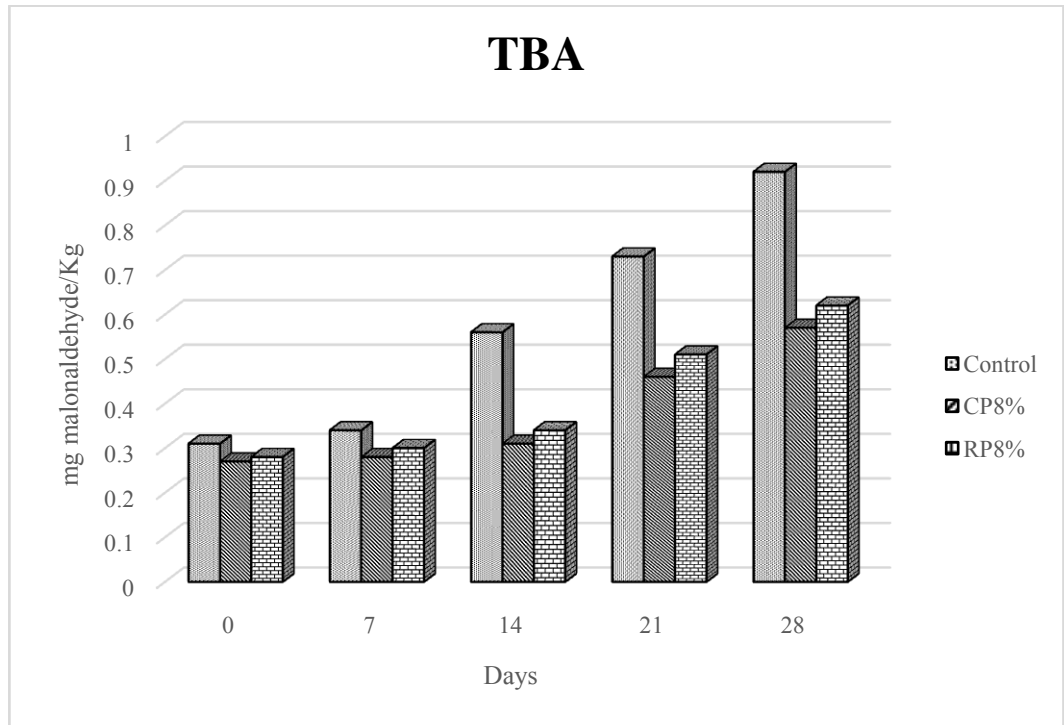
The tyrosine value increased with increase in storage period. The finding was comparable with Devadason et al., (2012). They observed increased tyrosine value of buffalo meat sausage with increase in storage. However for control chicken nuggets the difference was not significant up to 7<sup>th</sup> day of storage and for carrot & radish incorporated chicken nuggets the non-significant increase in tyrosine value was observed up to day 14<sup>th</sup> of storage. The control chicken nuggets showed significantly higher tyrosine value than carrot & radish incorporated chicken nuggets while non-significant difference was observed between vegetable incorporated chicken nuggets.

It was evident from the table that the titratable acidity decreased during the storage period of 28 days. The difference was not significant ( $P < 0.05$ ) for carrot and radish incorporated chicken nuggets during the storage period of 28 days. The highest titratable acidity value is shown by 8% carrot incorporated chicken nuggets irrespective of storage period.

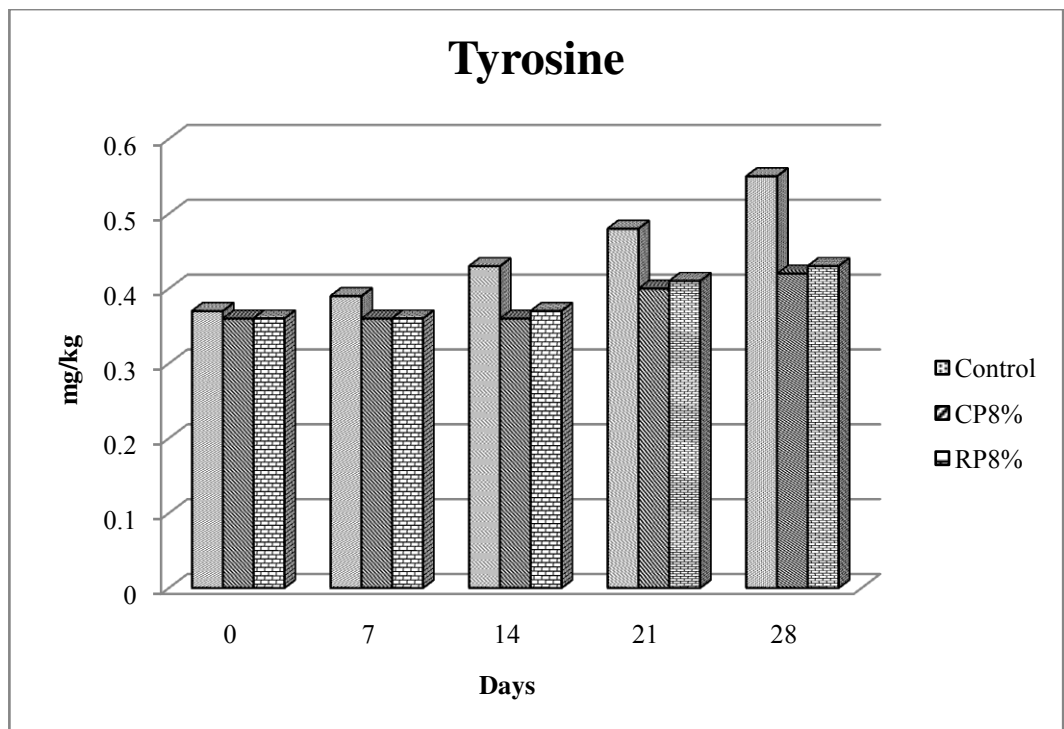
#### **4.3.3 Sensory quality of chicken nuggets during refrigerated storage**

The data with respect to sensory properties of chicken nuggets incorporated with carrot and radish powder during refrigerated storage is shown in Table 4.11.

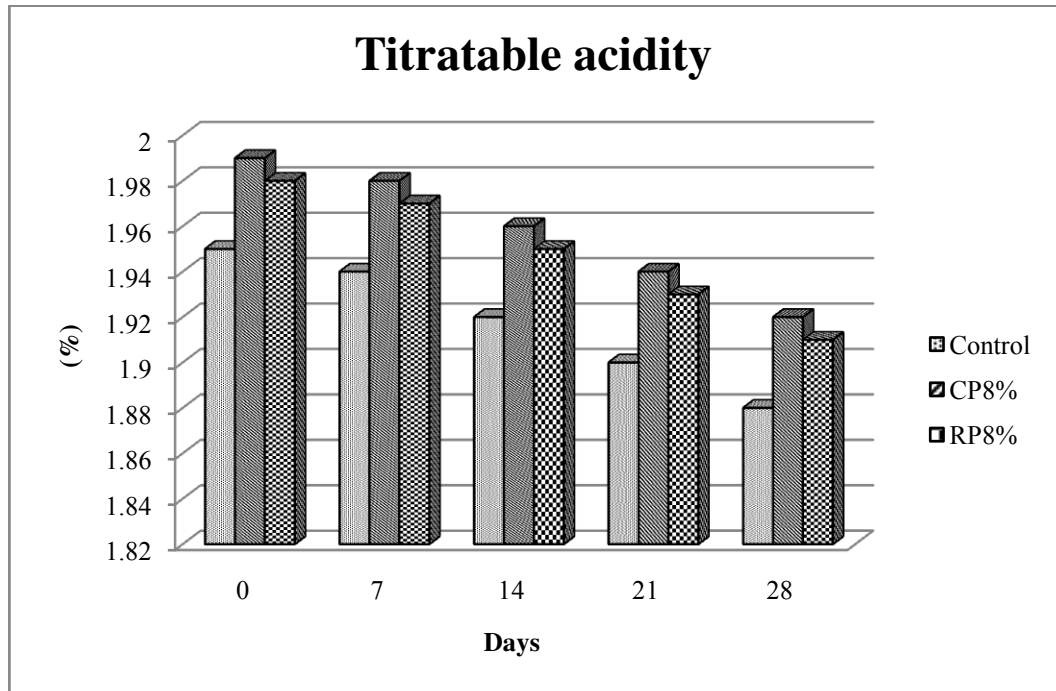
It was observed from the table that the colour and appearance of chicken nuggets decreased significantly during storage period of 28 days irrespective of treatment. The sensory evaluation of control chicken nugget was not performed on day 28. The lowest score for color and appearance was observed on 28<sup>th</sup> day of storage however they were of acceptable quality. Colour and appearance score for carrot and radish incorporated chicken nugget was higher than the control group. The flavor of chicken nuggets declined gradually with the progress of storage period. Loss of fat during storage period might be a reason for declined flavor of chicken nuggets during storage period. The flavor score of control and that of



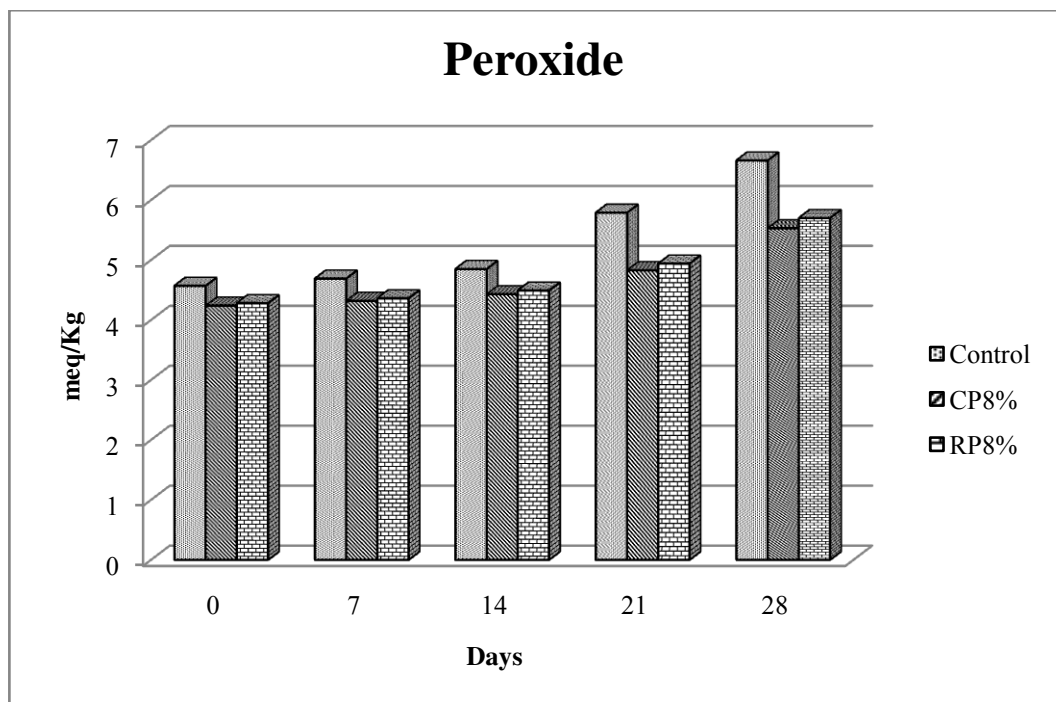
**Fig 4.47 Thiobarbituric acid values of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



**Fig 4.48 Tyrosine value of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



**Fig 4.49** Titratable acidity of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)



**Fig 4.50** Peroxide value of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)

carrot and radish incorporated chicken nuggets did not differ significantly but the carrot incorporated chicken nuggets scored higher for flavor than control and radish incorporated chicken nuggets. The score for texture also declined progressively during storage period of 28 days. The carrot and radish incorporated chicken nuggets scored better for the textural properties than carrot and radish. Similar findings are observed for juiciness and overall acceptability. While among the treatment groups the carrot incorporated chicken nuggets showed higher score for juiciness and overall acceptability irrespective of storage period.

**Table 4.11: Effect of carrot powder (8%) and radish powder (8 %) on sensory properties of chicken nuggets during refrigerated storage (4±1°C) (Mean±S.E.)\***

Treat/ Days	Day 1	Day 7	Day 14	Day 21	Day 28
<b>Colour and Appearance</b>					
<b>C</b>	7.52 ± 0.08 <sup>D</sup>	7.19 ± 0.18 <sup>Ca</sup>	6.00 ± 0.15 <sup>Ba</sup>	5.24 ± 0.18 <sup>Aa</sup>	<b>NP</b>
<b>T-1</b>	7.52 ± 0.08 <sup>C</sup>	7.52 ± 0.09 <sup>Cb</sup>	7.47 ± 0.09 <sup>Cb</sup>	7.14 ± 0.18 <sup>Bc</sup>	6.62 ± 0.28 <sup>Ab</sup>
<b>T-2</b>	7.57 ± 0.13 <sup>E</sup>	7.52 ± 0.06 <sup>Db</sup>	7.37 ± 0.05 <sup>Cb</sup>	6.90 ± 0.08 <sup>Bb</sup>	6.24 ± 0.23 <sup>Aa</sup>
<b>Flavour</b>					
<b>C</b>	7.52 ± 0.10 <sup>D</sup>	7.21 ± 0.18 <sup>Ca</sup>	6.95 ± 0.15 <sup>Ba</sup>	5.09 ± 0.20 <sup>Aa</sup>	<b>NP</b>
<b>T-1</b>	7.57 ± 0.08 <sup>D</sup>	7.47 ± 0.08 <sup>DCb</sup>	7.37 ± 0.14 <sup>Cb</sup>	7.09 ± 0.10 <sup>Bc</sup>	6.47 ± 0.19 <sup>Ab</sup>
<b>T-2</b>	7.57 ± 0.13 <sup>E</sup>	7.47 ± 0.05 <sup>Db</sup>	7.32 ± 0.07 <sup>Cb</sup>	6.82 ± 0.13 <sup>Bb</sup>	6.14 ± 0.21 <sup>Aa</sup>
<b>Texture</b>					
<b>C</b>	7.57 ± 0.09 <sup>D</sup>	7.32 ± 0.18 <sup>Ca</sup>	6.14 ± 0.15 <sup>Ba</sup>	5.00 ± 0.16 <sup>Aa</sup>	<b>NP</b>
<b>T-1</b>	7.62 ± 0.10 <sup>D</sup>	7.57 ± 0.12 <sup>DCb</sup>	7.52 ± 0.09 <sup>Cb</sup>	7.24 ± 0.11 <sup>Bc</sup>	6.67 ± 0.19 <sup>Ab</sup>
<b>T-2</b>	7.62 ± 0.11 <sup>D</sup>	7.57 ± 0.10 <sup>DCb</sup>	7.47 ± 0.10 <sup>Cb</sup>	6.95 ± 0.13 <sup>Bb</sup>	6.32 ± 0.14 <sup>Aa</sup>
<b>Juiciness</b>					
<b>C</b>	7.05 ± 0.06 <sup>Da</sup>	6.72 ± 0.20 <sup>Ca</sup>	6.00 ± 0.17 <sup>Ba</sup>	5.00 ± 0.20 <sup>Aa</sup>	<b>NP</b>
<b>T-1</b>	7.14 ± 0.11 <sup>Db</sup>	7.10 ± 0.16 <sup>DCb</sup>	7.00 ± 0.12 <sup>Cb</sup>	6.82 ± 0.13 <sup>Bb</sup>	6.47 ± 0.09 <sup>Ab</sup>
<b>T-2</b>	7.14 ± 0.10 <sup>Db</sup>	7.05 ± 0.11 <sup>DCb</sup>	6.95 ± 0.11 <sup>Cb</sup>	6.72 ± 0.12 <sup>Bb</sup>	6.32 ± 0.13 <sup>Aa</sup>
<b>Overall Acceptability</b>					
<b>C</b>	7.42 ± 0.10 <sup>D</sup>	7.05 ± 0.19 <sup>Ca</sup>	6.57 ± 0.14 <sup>Ba</sup>	6.00 ± 0.17 <sup>Aa</sup>	<b>NP</b>
<b>T-1</b>	7.52 ± 0.08 <sup>C</sup>	7.52 ± 0.10 <sup>Cb</sup>	7.42 ± 0.15 <sup>Cc</sup>	7.24 ± 0.16 <sup>Bc</sup>	6.67 ± 0.19 <sup>Ab</sup>
<b>T-2</b>	7.47 ± 0.06 <sup>D</sup>	7.42 ± 0.10 <sup>Db</sup>	7.27 ± 0.13 <sup>Cb</sup>	6.95 ± 0.13 <sup>Bb</sup>	6.37 ± 0.13 <sup>Aa</sup>

n=21, \*Mean ± SE. with different superscripts row wise (Capital alphabets) and column wise (small alphabets) differ significantly ( $p < 0.05$ ). **NP:** Not performed **C=** Control, **T-1** = Chicken nuggets with 8.0 % carrot powder **T-2=** Chicken nuggets with 8.0 % radish powder

#### 4.3.4 Microbiological quality of chicken nuggets during refrigerated storage

The data regarding microbiological qualities of chicken nuggets incorporated with carrot and radish powder during refrigerated storage is shown in Table 4.12.

**Table 4.12: Effect of carrot powder (8%) and radish powder (8 %) on microbiological quality of chicken nuggets during refrigerated storage (4±1°C) (Mean±S.E.)\***

Treat/ Days	Day 1	Day 7	Day 14	Day 21	Day 28
<b>Total Plate count (log<sub>10</sub>cfu/g)</b>					
<b>C</b>	2.35±0.03 <sup>Ab</sup>	3.32±0.12 <sup>Bb</sup>	4.09±0.02 <sup>Cb</sup>	4.69±0.03 <sup>Dc</sup>	6.02±0.02 <sup>Ec</sup>
<b>T-1</b>	1.75±0.14 <sup>Aa</sup>	1.87±0.15 <sup>Aa</sup>	2.23±0.10 <sup>Ba</sup>	2.88±0.08 <sup>Ca</sup>	3.62±0.15 <sup>Da</sup>
<b>T-2</b>	1.81±0.17 <sup>Aa</sup>	1.97±0.18 <sup>Aa</sup>	2.34±0.11 <sup>Ba</sup>	3.03±0.04 <sup>Cb</sup>	3.81±0.06 <sup>Db</sup>
<b>Psychrophilic count (log<sub>10</sub>cfu/g)</b>					
<b>C</b>	ND	ND	ND	2.28±0.15 <sup>A</sup>	3.47±0.13 <sup>Bb</sup>
<b>T-1</b>	ND	ND	ND	ND	2.05±0.20 <sup>Aa</sup>
<b>T-2</b>	ND	ND	ND	ND	2.19±0.15 <sup>Aa</sup>
<b>Coliform Count (log<sub>10</sub>cfu/g)</b>					
<b>C</b>	ND	ND	ND	ND	1.07 ± 0.02
<b>T-1</b>	ND	ND	ND	ND	ND
<b>T-2</b>	ND	ND	ND	ND	ND
<b>Yeast and Mould Count (log<sub>10</sub>cfu/g)</b>					
<b>C</b>	ND	ND	ND	1.46±0.06 <sup>Ab</sup>	2.43±0.03 <sup>Bb</sup>
<b>T-1</b>	ND	ND	ND	1.08±0.13 <sup>Aa</sup>	1.77±0.16 <sup>Ba</sup>
<b>T-2</b>	ND	ND	ND	1.17±0.10 <sup>Aa</sup>	1.84±0.15 <sup>Ba</sup>

\*Mean ± SE. with different superscripts row wise (Capital alphabets) and column wise (small alphabets) differ significantly ( $p < 0.05$ ). C= Control, T-1 = Chicken nuggets with 8.0 % carrot powder, T-2= Chicken nuggets with 8.0 % radish powder

It was observed from the Table that total plat count of chicken nuggets increased during the refrigerated storage period of 28 days. A significant increase in total plate count was observed for chicken nuggets of control group during the storage period while for the carrot and radish incorporated nuggets the difference was non-significant up to 14<sup>th</sup> day of storage. Kumar et al., (2018), observed similar findings. They reported that when storage study of chicken meat balls incorporated with different levels of green cabbage was carried out it was observed that the total plate count of both the control and cabbage incorporated meat balls increased during the storage period of 9 days. While within the

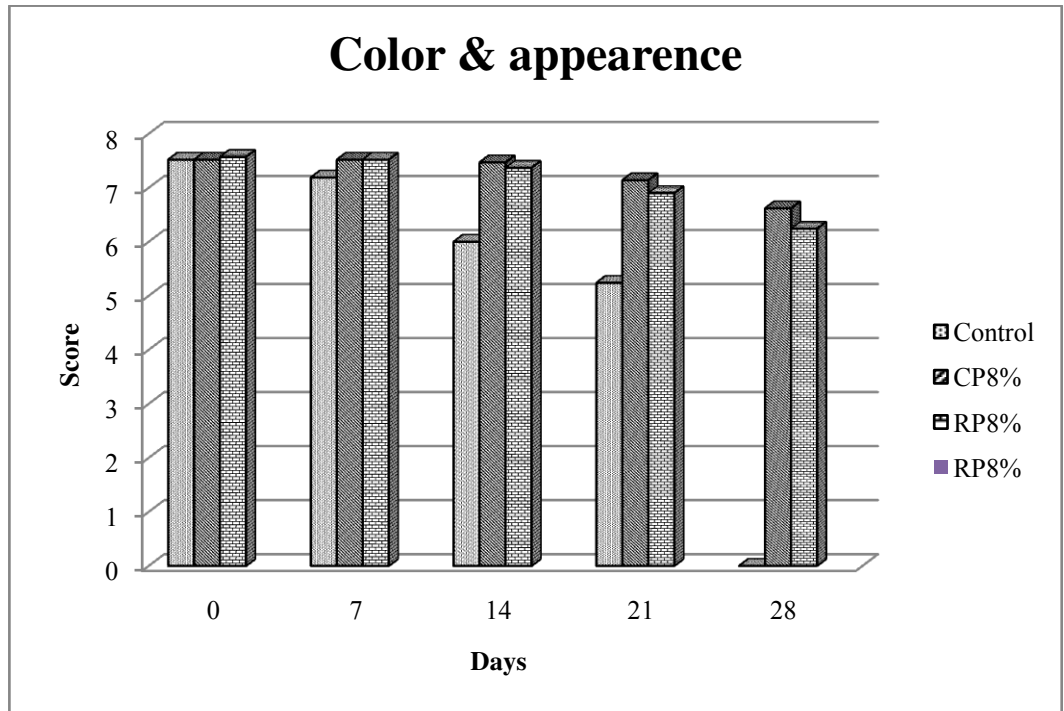
treatment groups control had higher plat count number and lowest plat count is observed in 8% carrot incorporated chicken nuggets.

The psychrophilic count for control chicken nuggets was not observed up to 14<sup>th</sup> day of storage while from day 21 significantly increasing count was observed during storage period of 28 days. For carrot and radish incorporated chicken nuggets the psychrophilic count was observed on 28<sup>th</sup> day of storage period. Within the treatments the control group had highest psychrophilic count than carrot and radish incorporated chicken nuggets. The lower psychrophilic count in carrot and radish incorporated chicken nuggets as compared to control may be due to presence of some antimicrobial agents in carrot and radish. Shinde (2006) found that pork patties containing radish exhibited some antimicrobial activities.

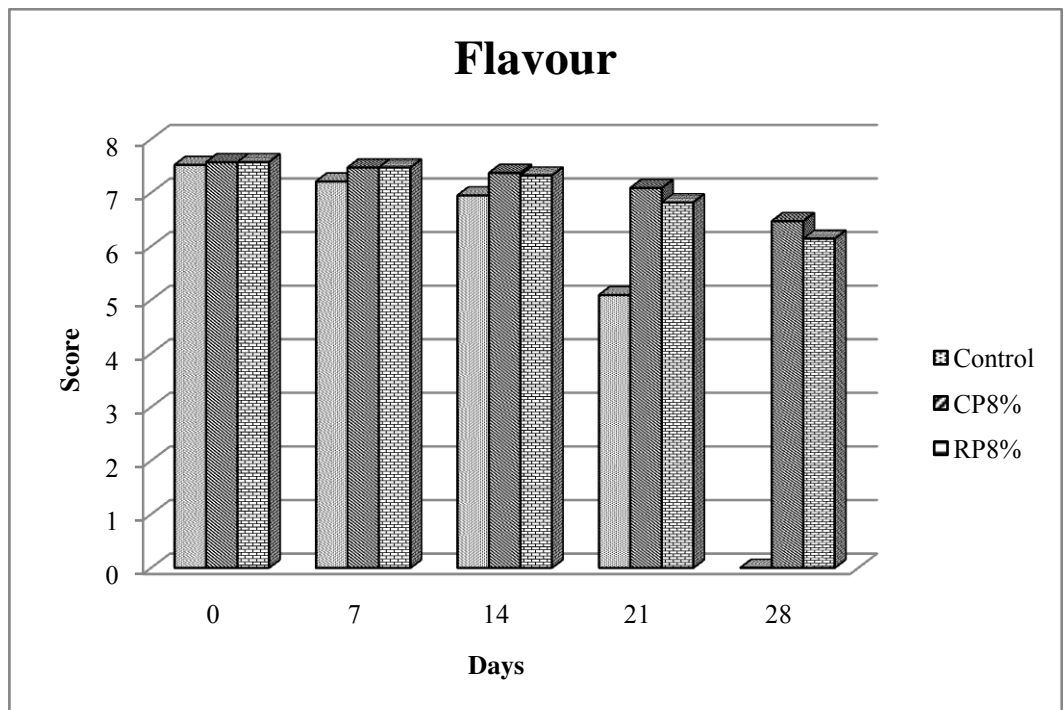
In control chicken nuggets coliform count is detected on 28<sup>th</sup> day of storage period while no coliform count was detected in carrot and radish incorporated chicken nuggets during the whole storage period of 28 days. Similar findings were observed by Goswami *et al.*, (2019) they reported no coliform count during the whole storage period of chicken meat nuggets incorporated with gooseberry pulp powder and gooseberry seed coat powder at refrigeration temperature (4±1°C).

Yeast and mould count was not observed in both control and vegetable incorporated chicken nuggets up to 14<sup>th</sup> day of storage. But from 21<sup>st</sup> day significantly increasing yeast and mould count is recorded. Control group had highest yeast and mould count than the carrot and radish incorporated chicken nuggets. Antimicrobial activity of carrot and radish might be a reason for lower yeast and mould count as compared to control. Anibijuwon *et al.*, (2017) reported that seeds of carrot exhibit antibacterial and antifungal activities.

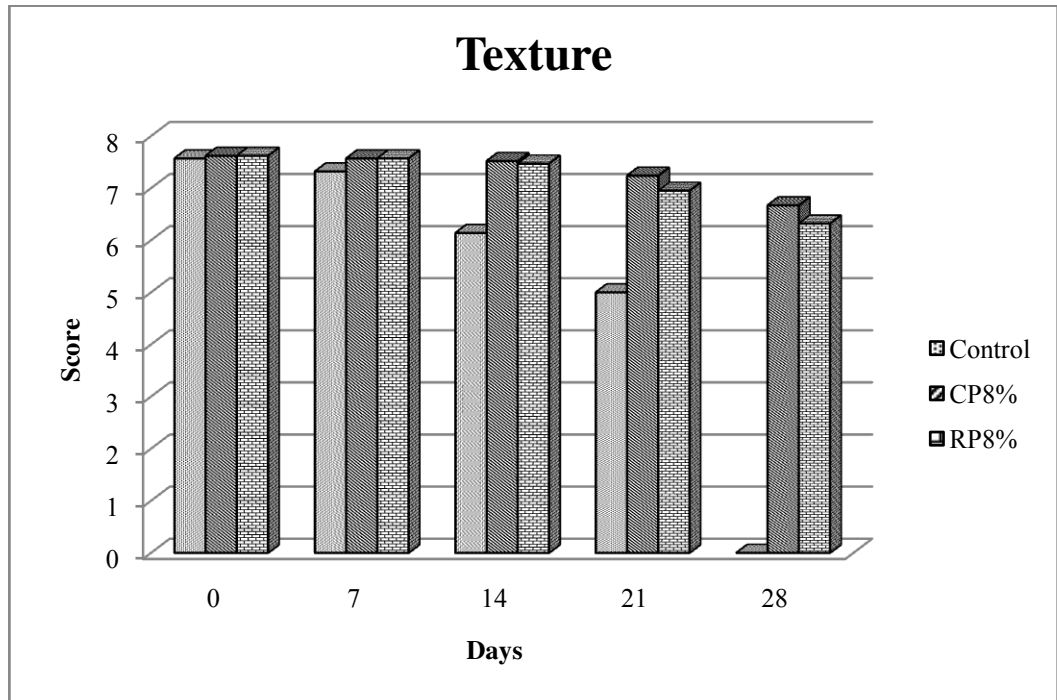
Thus on the basis of findings observed in the storage study it was concluded that chicken nuggets incorporated with 8% carrot powder and 8% radish powder were acceptable up to 28<sup>th</sup> day of refrigerated storage.



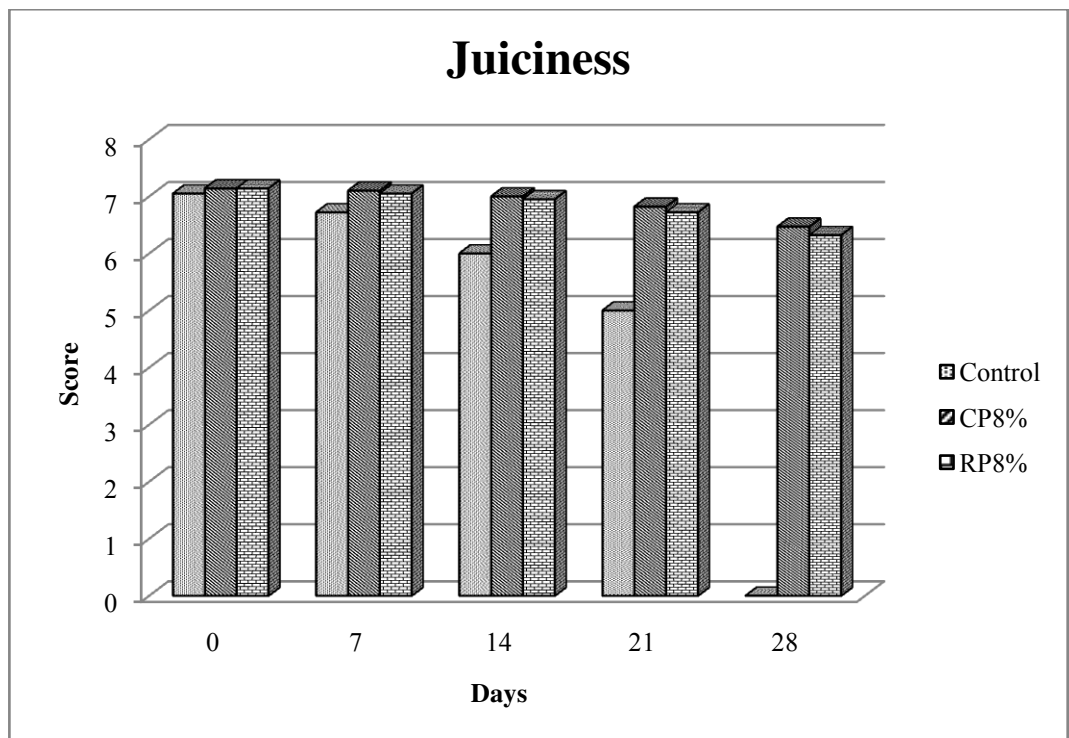
**Fig 4.51** Colour and appearance score of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)



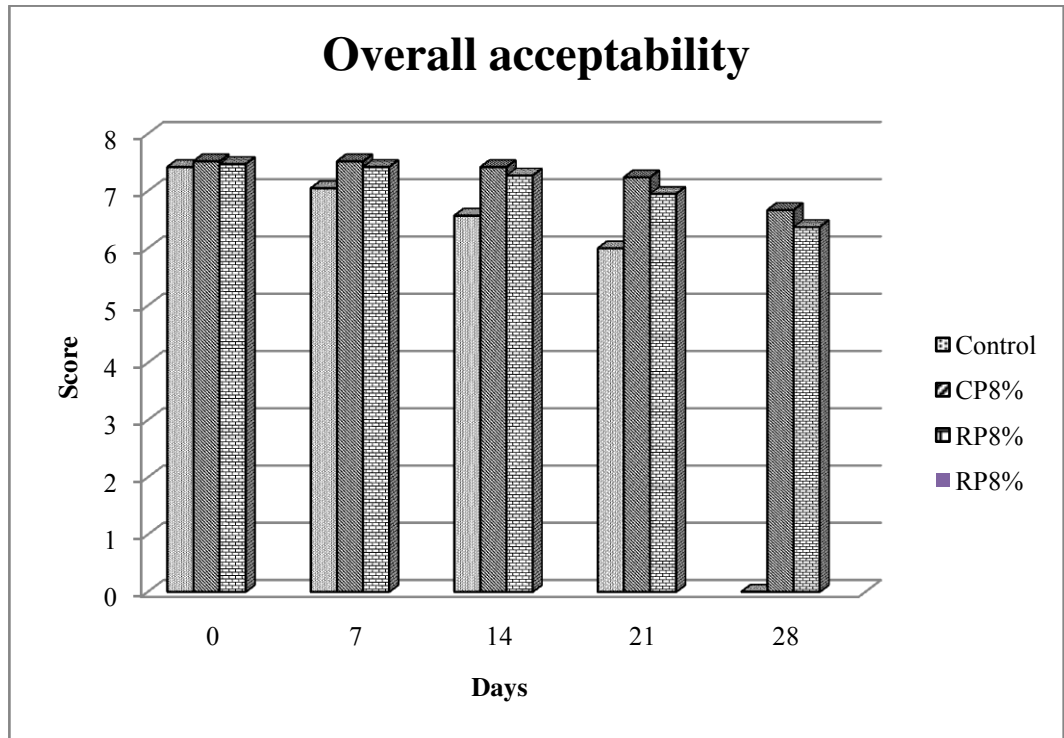
**Fig 4.52** Flavour score of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)



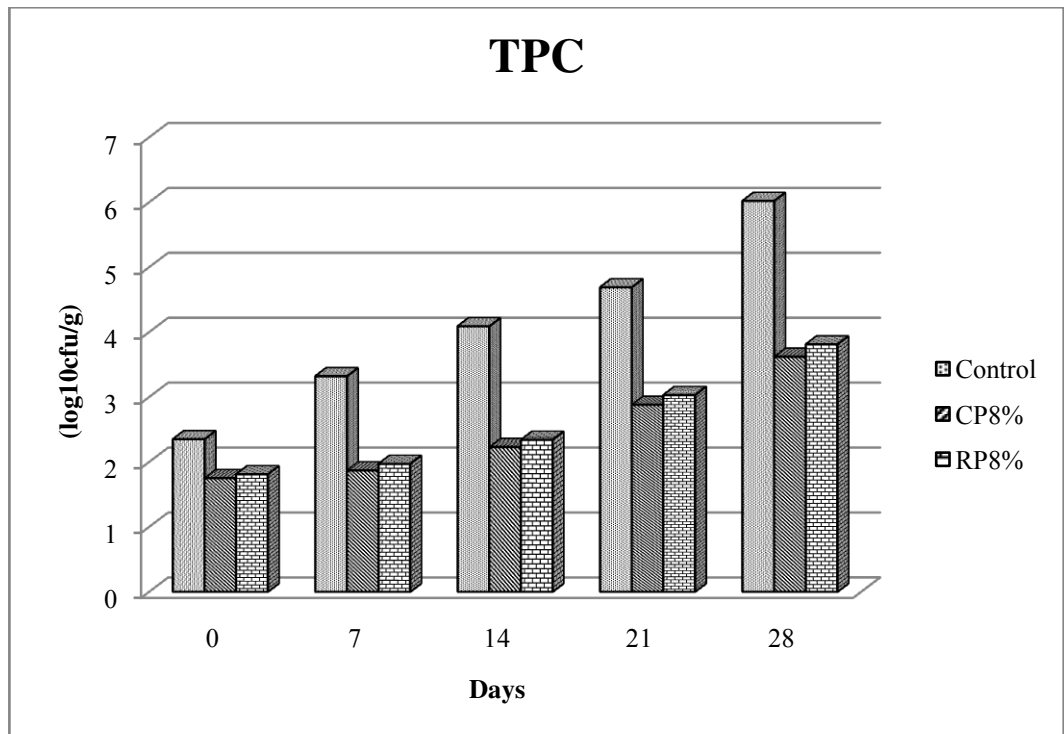
**Fig 4.53 Texture score of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



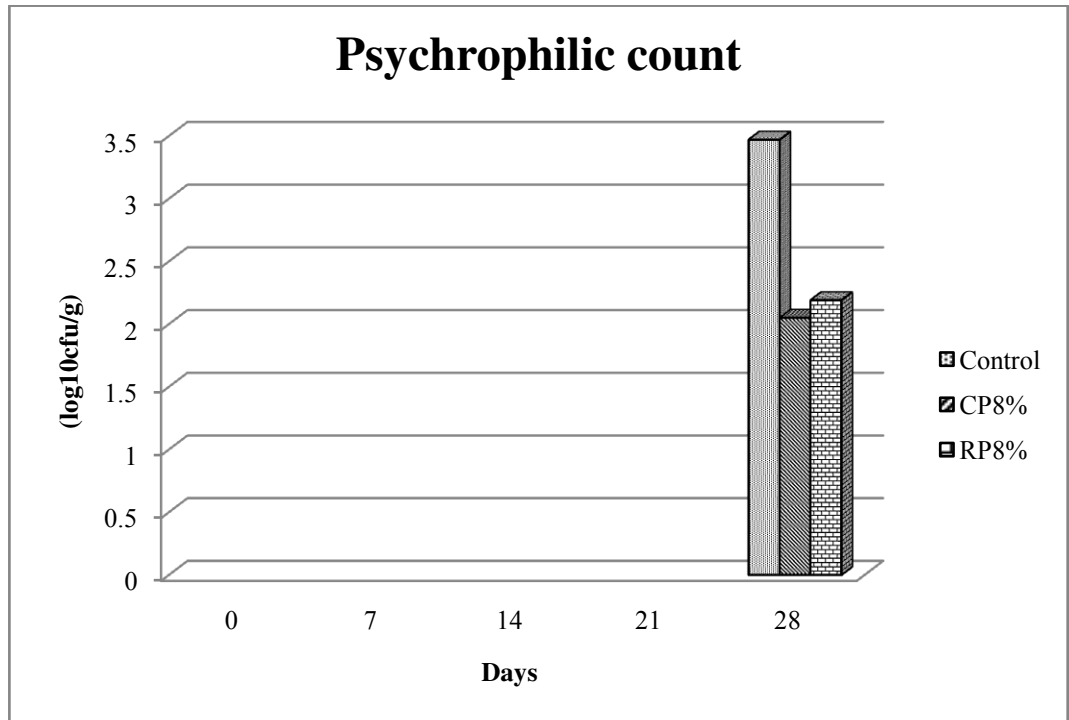
**Fig 4.54 Juiciness score of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



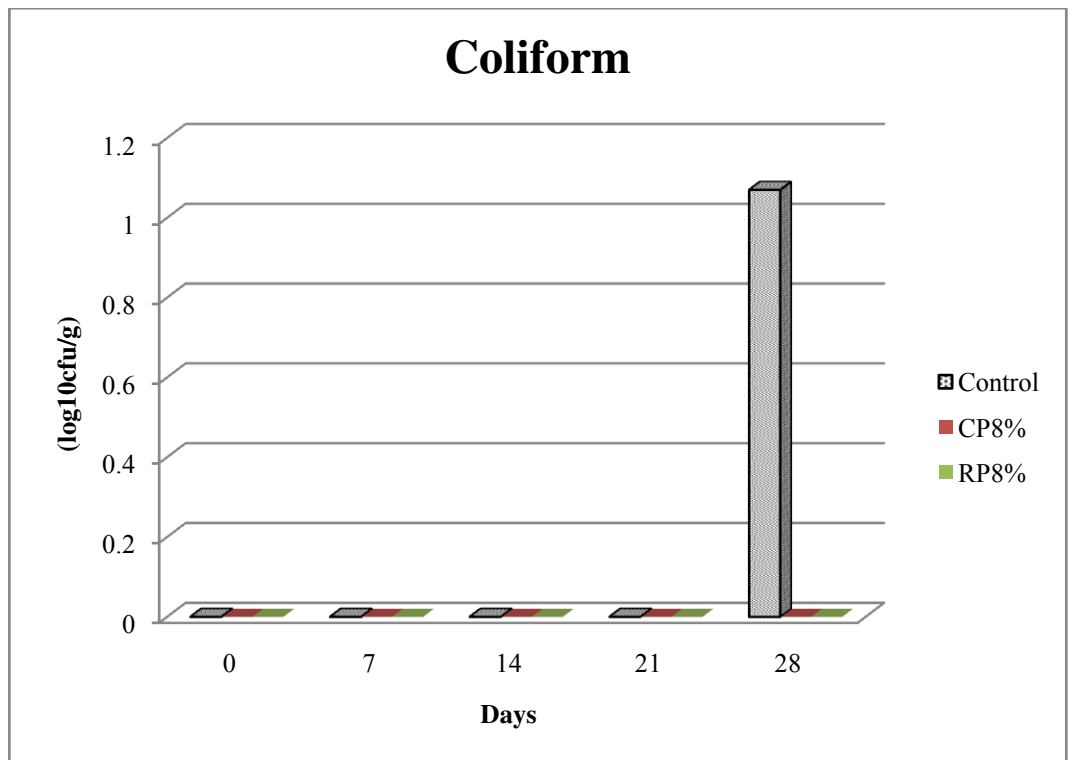
**Fig 4.55 Overall acceptability of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



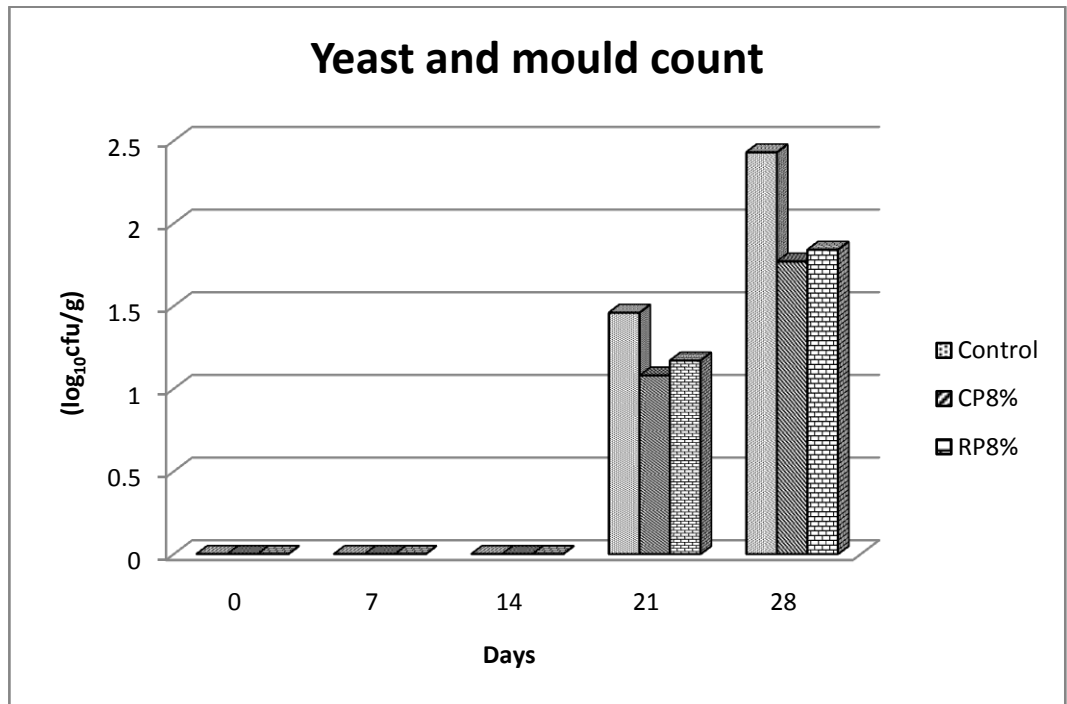
**Fig 4.56 Total plate count of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



**Fig 4.57 Psychrophilic count of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



**Fig 4.58 Coliform count of chicken nuggets added with 8% carrot and 8% radish powder at (4±1°C)**



**Fig 4.59** Yeast and mould of chicken nuggets added with 8% carrot and 8% radish powder ( $4\pm 1^{\circ}\text{C}$ )

#### 4.4 Cost structure of chicken nuggets

The experiment was carried out to assess the cost of the developed chicken nuggets prepared by using selected levels of carrot and radish powder. The cost of production of one kg nuggets emulsion of control and experimental products presented in Table 4.13.

**Table 4.13 Cost structure of chicken sausage**

Particulars	%	Qty in 1 kg	Rate (Rs)	Control (Rs)	T-1 (Rs)	T-2 (Rs)
Deboned meat*	67.00	670	300/Kg	201.00	177	177
Carrot Powder (8%) in T-1	8 (T-1)	80 (T-1)	950/Kg	---	76	---
Radish Powder (8%) in T-2	8 (T-2)	80 (T-2)	650/Kg	---	---	52
Condiments	4.00	40	200/Kg	8.00	8.00	8.00
Spice mix	2.50	25	1000/Kg	25.00	25.00	25.00
Salt	1.50	15	20/Kg	0.30	0.30	0.30
Sodium tetra pyrophosphate (STPP)	0.20	2	1292/Kg	2.58	2.58	2.58
Refined oil	8.00	80	200/Kg	16.00	16.00	16.00
Refined Wheat Flour Maida	4.00	40	60/Kg	2.40	2.40	2.40
Sugar	0.30	3	60/Kg	0.18	0.18	0.18
Eggs	4.50	45 (2 eggs)	6/egg	12.00	12.00	12.00
Cost of packaging material 05 HDPE pouch for 01 Kg (200 gm/ Pack)			0.4/pack	2.00	2.00	2.00
Fuel & labour charges (Rs)			10/Kg	10.00	10.00	10.00
<b>Cost of 1 kg emulsion (Rs)</b>				279.38	331.46	317.46
<b>Product yield (gm)</b>				898.80	921.50	918.80
<b>** Product cost/Kg (Rs)</b>				413.45	423.89	422.65
<b>Net profit/Kg (Rs)</b>				134.07	92.43	105.19

T-1 = Chicken nuggets with 8.0 % carrot powder

T-2= Chicken nuggets with 8.0 % radish powder

\*Deboned meat @ Rs. 300 /kg

\*\*Market price of 1 Kg chicken nuggets: Rs. 460 /-

Cost of various materials and ingredients were calculated considering prevalent market rates in rupees. The cost for 1 kg chicken emulsion were Rs. 279.38 for control, Rs. 331.46 for T-1 and Rs. 317.46 for T-2. Control chicken emulsion recoded lowest cost than emulsion added with carrot (8%) and radish (8%) powder. The highest emulsion cost was recorded for carrot powder added emulsion (T-1) it might be due to the higher rate of carrot powder (Rs. 950/Kg). Further, considering the chicken nuggets yield, the cost of one kg chicken nuggets

was comparatively higher (Rs. 423.89/Kg) in T-1 followed by T-2 (Rs. 422.65/Kg) and control (Rs. 413.45/Kg). However, the net profit was observed to be highest in control chicken nuggets (Rs. 134.07/Kg) followed by T-2 (Rs. 105.19/Kg) and T-1 (Rs. 92.43/Kg). This might be due to higher cost of carrot and radish powder.



# **Summary and Conclusions**

## **CHAPTER - V**

### **SUMMARY AND CONCLUSION**

Meat being a complete food packed with most of the essential nutrients, consumed by most of the peoples all over the world. Various processed meat products produced by fermentation, dehydration, curing are demanded by consumers due to abundance of nutrients and taste of these products. But over the years consumers all over the world are becoming more aware about what they eat because of the increased knowledge about the link between food and health and mostly prefer high fiber low cholesterol diet. Consumers are demanding meat products with natural additives due to adverse health effects of synthetic additives. Though meat is a good source of all the essential nutrients like proteins, vitamins, minerals the fact that saturated fat, cholesterol in high amount and absence of some major nutrients like dietary fiber in meat the persistent positive attitude of consumers towards meat and meat products is getting affected day by day. Consumers are final step in the production chain and it is very crucial to know what they want so to respond to consumers concerns and expectations and to improve the nutritional quality of meat products, different meat processing method and value addition of meat products is taken into consideration by researchers. Incorporating non meat ingredients in meat to enhance its nutritional as well as sensory attributes is one of the ways being used by researchers and experts in meat sector. The non meat ingredient not only improve the nutritional aspects of meat but also enhance the taste, increases consumers demand, the non meat ingredients like vegetables help to hold the moisture, gives color, aroma to the product and most importantly it can reduce the cost of formulation and also increase the shelf life of meat products. Use of vegetables like carrot and radish in meat product which are a good source of fibers and acts as a natural antioxidant can be a good option to fulfill the consumers demand and it will also increase the shelf life of meat products by preventing or delaying lipid oxidation besides reducing the cost of formulation. Thus the present study was organized to evaluate the effect of carrot and radish powder on physico- chemical, sensory and

proximate attributes of chicken nuggets and also to evaluate its shelf life when stored at refrigeration temperature ( $4\pm 1^{\circ}\text{C}$ ) for a period of 28 days.

Chicken emulsion was prepared by adding non meat ingredients like flour, spices, whole egg, condiments along with different levels of carrot and radish powder (4, 8, and 12%) and was subjected to physico-chemical, proximate and sensory evaluation after 3 days of interval up to 9 days. Chicken nuggets are then prepared from that emulsion and cooked at temperature of  $70^{\circ}\text{C}$  for 30 minutes and after performing the physico- chemical, proximate and sensory analysis the desired level of carrot and radish powder to be added in chicken nuggets was decided. Then shelf life study of chicken nuggets made by incorporating selected level of carrot and radish is performed at 7 days interval up to 28 days.

### **5.1 Effect of incorporation of carrot powder on chicken emulsion**

Carrot powder of 4, 8 and 12% level was mixed in chicken emulsion and the emulsion was subjected for proximate, physico- chemical and sensory evaluation and compared with control. The moisture percentage of chicken emulsion increased from 4% to 12% carrot powder. A significant decrease in protein and fat percentage was observed with increase in carrot powder. Ash percentage of chicken emulsion increased with increase in carrot powder level. The difference in ash content was significant when compared to control. The moisture: protein ratio increased progressively from 4% to 12% carrot powder level. While the energy content of chicken emulsion decreased as the level of carrot powder was enhanced. Increase in pH was observed due to addition of carrot powder. The emulsion stability and water holding capacity increased with carrot powder level. The optimum score for sensory attributes like appearance, odour and overall quality of chicken emulsion was noticed in 8% carrot powder added emulsion which was comparable with control.

### **5.2 Effect of incorporation of radish powder on chicken emulsion**

Chicken emulsion added with 4, 8 and 12% radish powder was subjected to proximate, physico-chemical and sensory evaluation. A significant decrease in moisture percentage is observed with increase in radish powder level. The protein

and fat percentage of chicken emulsion decreased with enhanced level of radish powder incorporated in emulsion. The ash percentage and energy content of chicken emulsion increased progressively with increase in radish powder. The pH value of chicken emulsion increased from 4% to 12% level of radish powder. The emulsion stability and water holding capacity also enhanced with increase in radish powder level incorporated in chicken emulsion increased. The optimum sensory score for parameters like appearance, odour and overall quality of chicken emulsion was recorded in 8% radish incorporated chicken emulsion which was comparable with control.

### **5.3 Effect of incorporation of carrot powder on chicken nuggets**

With increase in carrot powder incorporation in chicken in nuggets it is observed that the moisture and ash content of chicken nuggets increased while the protein and fat percentage decreased as the level of radish powder incorporated increased from 4% to 12%. The moisture: protein ratio increase significantly and the energy value decreased with increase in carrot powder added in nuggets. A non significant increase in pH is observed with increase of carrot powder incorporated increased from 4% to 12% level. The cooking yield, moisture retention and fat retention also increased significantly. The sensory score for parameters like appearance, flavor, texture, juiciness and overall acceptability of chicken nuggets decreased as carrot powder incorporated increased. However a non significant difference is observed between 4% and 8% carrot powder incorporated chicken nuggets. Based on these observations from proximate, physico-chemical and sensory parameters the 8% carrot powder level was selected to add in chicken nugget and performed further shelf life study.

### **5.4 Effect of incorporation of radish powder on chicken nuggets**

The moisture, protein, fat and ash percentage of chicken nuggets decreased significantly as the level of radish powder incorporated increased from 4% to 12% level. The moisture: protein ratio and energy content increased progressively with increased radish powder level in chicken nuggets. The pH value showed non significant increase with increase in radish powder level. The cooking yield,

moisture retention and fat retention values increased significantly from 4% to 12% radish incorporation in chicken nuggets. The sensory score for parameters like appearance, flavor, texture, juiciness and overall acceptability of chicken nuggets decreased as carrot powder incorporated increased. However a non significant difference for texture, juiciness and overall acceptability is observed between 4% and 8% carrot powder incorporated chicken nuggets. Thus on the basis of the observations from proximate, physico-chemical and sensory analysis the 8% radish powder level is selected for incorporation in chicken nuggets and the further study for shelf life was performed.

### **5.5 Shelf life of chicken nuggets during refrigerated storage.**

The shelf life study of chicken nuggets incorporated with 8% carrot powder and 8% radish powder was performed at refrigeration temperature ( $4\pm 1^{\circ}\text{C}$ ) during the storage period of 28 days at 7 days interval. During the storage study it was observed that the moisture percentage of chicken nuggets decreased significantly. The protein, fat and ash percentage also declined as the storage period progressed. A non significant increase in moisture: protein ratio is observed with advancement of storage period. pH value increased with storage. The thiobarbituric acid and tyrosine value increased with progress of storage period however the thiobarbituric acid value on 28<sup>th</sup> day of storage was within the spoilage limit. It is observed from the shelf life study that the titratable acidity decreased while the peroxide value increased with storage period. The sensory properties of chicken nuggets like colour, appearance, flavor, texture, juiciness and overall quality decreased progressively with storage period. But the quality of control chicken nuggets and also carrot and radish incorporated chicken nuggets was better up to 28<sup>th</sup> day of storage period. The total plate count increased significantly during storage period but it was within the spoilage limit. The psychrophilic count is not detected in control chicken nugget up to day 14 while in carrot and radish incorporated chicken nugget the psychrophilic count was not found up to day 21<sup>st</sup> of storage period. The coliform count was only detected in control chicken nugget on day 28 of storage period. The yeast and mould count is

observed in both control and vegetable incorporated nuggets from 21<sup>st</sup> day of storage which increased significantly up to day 28<sup>th</sup>.

### **5.6 Cost structure of chicken nuggets**

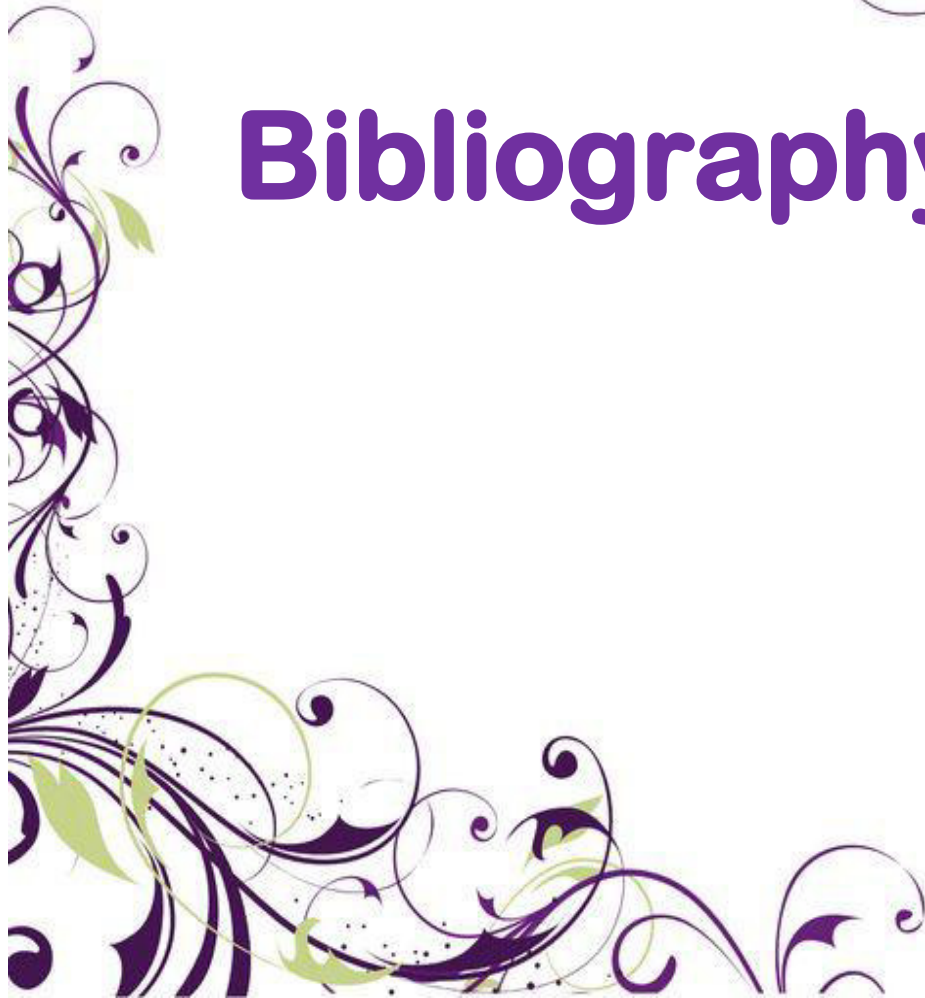
The experiment was carry out to assess the cost of the developed chicken nuggets prepared by using selected levels of carrot and radish powder. Control chicken emulsion recoded lowest cost than emulsion added with carrot (8%) and radish (8%) powder. the net profit was observed to be highest in control chicken nuggets (Rs. 134.07/Kg) followed by T-2 (Rs. 105.19/Kg) and T-1 (Rs. 92.43/Kg). This might be due to higher cost of carrot and radish powder.

### **CONCLUSIONS**

- Chicken emulsion quality can be optimized by incorporation of 8% carrot and 8% radish powder by substituting equivalent amount of meat.
- Addition of 8% carrot and radish powder separately were found most appropriate and comparable to control for development of chicken nuggets.
- The chicken nuggets added with 8 % carrot powder and 8 % radish powder could be stored at refrigeration temperature ( $4\pm 1^{\circ}\text{C}$ ) for 28 days under HDPE packaging without any marked loss in qualities.
- The cost of production for chicken nuggets added with 8 % carrot powder and 8 % radish powder was higher than control nuggets.



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# Appendix

**APPENDIX – I**

**DEPARTMENT OF LIVESTOCK PRODUCTS TECHNOLOGY**  
**College of Veterinary and Animal Sciences, Parbhani**  
Proforma for Organoleptic Evaluation of Meat Emulsion

**Name of Evaluator :**  
**Name of Product :**  
**Scoring Guide :**

**Date:**

<b>Sensory attributes</b>	<b>5-point scale for descriptive attributes of product</b>				
	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>
Appearance	Purplish red	Dark reddish pink	Moderately pink	Light reddish pink	Greyish pink
Odour	Very pleasant	Pleasant	Moderately Pleasant	Moderately unpleasant	Very unpleasant
Overall palatability	Extremely desirable	Desirable	Moderately Desirable	Moderately undesirable	Extremely undesirable

<b>Sample</b>	<b>Color&amp;Appearance</b>	<b>Odour</b>	<b>Overall palatability</b>
1.			
2.			
3.			
4.			

**Remarks**

**Signature**

**APPENDIX – I**  
**A DEPARTMENT OF LIVESTOCK PRODUCTS TECHNOLOGY**  
**College of Veterinary and Animal Sciences, Parbhani**  
Proforma for Organoleptic Evaluation of Meat Products

**Name of Evaluator :**  
**Name of Product :**  
**Scoring Guide :**

**Date:**

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	Color&Appearance	Flavour	Juiciness	Texture	Overall acceptability
1.					
2.					
3.					
4.					

**Remarks**

**Signature**



**Vitae**

## **VITAE**

The author Miss Deshpande Sayali Prashant was born on 21<sup>st</sup> September 1995, at her native place Parbhani, Tal. District. Parbhani (Maharashtra State).

She passed the S.S.C examination in 2011 from Bal Vidya Mandir High School and Junior College, Parbhani and H.S.C. board exam in 2013 from Bal Vidya Mandir High School and Junior College, Parbhani.

Being interested in animal welfare, she joined College of Veterinary and Animal Sciences, Parbhani and completed the B.V.Sc. & A.H. degree in 2019. Further she 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 2019. She has actively completed 21days In-plant training programme at Venkey's India Limited (Food Division), Kamshet pune - 4411030

The author has completed the necessary credit courses for post graduate studies and submitted this thesis in the year 2022. She actively participated in National Service Scheme (NSS) unit during graduation studies.



# **Thesis Abstract**

**APPENDIX-G**  
**THESIS ABSTRACT**

- a) Title of the thesis : **“DEVELOPMENT AND STORAGE STABILITY OF CHICKEN NUGGETS INCORPORATED WITH CARROT (*Daucus Carota subsp. Sativus*) AND RADISH (*Raphanus Raphanistrum*) POWDER”**
- b) Full name of student : **Deshpande Sayali Prashant**
- c) Name and address of Major Advisor : **(Dr. S. N. Rindhe)**  
Advisor/Guide  
Assistant Professor  
Livestock Products Technology
- d) Degree to be awarded : M. V. Sc.
- e) Year of award of degree : 2022
- f) Major subject : **Livestock Products Technology**
- g) Total number of pages in the thesis : 65
- h) Number of words in the abstract : 454
- i) Signature of Student :
- j) Signature, Name and address of forwarding authority (HOD/SH) :

**Dr. A. M. Chappalwar**  
Incharge Professor  
Dept. of Livestock product Technology.

## ABSTRACT

The present experiment was carried out to develop and assess the storage stability of chicken nuggets incorporated with carrot and radish powder. Chicken emulsion was prepared with incorporation of various ingredients viz., spices, condiments, whole egg, flour. Emulsion with three levels of carrot powder (4, 8, and 12%) and radish powder (4, 8, and 12%) were prepared and compared with control (without carrot and radish) for proximate, sensory and physico-chemical attributes at regular interval of three days. Protein and fat content of chicken emulsion decreased, However sensory properties increased with enhancement of carrot and radish powder level. During refrigerated storage, moisture, protein, fat, ash, energy, emulsion stability, water holding capacity and moisture: protein ratio of chicken emulsion decreased significantly ( $P < 0.05$ ) during the storage period. The sensory attributes of chicken emulsion like appearance, flavor and overall quality decreased during storage while 8% carrot and 8% radish incorporated chicken emulsion showed optimum score for all the sensory attributes than control. Chicken nuggets prepared with carrot powder (4, 8 and 12%) and radish powder (4, 8 and 12%) was also evaluated for its proximate, physico-chemical and sensory attributes. It was observed that protein, fat and energy content of chicken nuggets decreased with increase in carrot and radish powder incorporation while ash and moisture: protein ratio increased. Physico-chemical attributes like pH, cooking yield, moisture retention and fat retention increased with increase in amount of carrot and radish powder. All the sensory attributes like appearance, flavor, texture, juiciness and overall acceptability decreased gradually with increase in carrot and radish powder incorporation. Within treatment, 8% carrot and 8% radish incorporated chicken nuggets showed better quality which is comparable to control

During refrigerated storage of chicken nuggets, moisture, protein and fat decreased significantly ( $P < 0.05$ ) while the ash and moisture: protein ratio increased significantly ( $P < 0.05$ ). It was observed that chicken nuggets prepared with incorporation of carrot powder and radish powder showed lower values for thiobarbituric acid, tyrosine and peroxide than control chicken nuggets. The

sensory properties decreased gradually with progression of storage period but all the sensory attributes of carrot and radish incorporated chicken nuggets were higher than control chicken nuggets during entire storage. Similarly chicken nuggets with 8% carrot and 8% radish powder had lower total plate count than control. Psychrophilic count was not observed in treated chicken nuggets up to day 21 of storage. Coliform count was not observed in carrot and radish incorporated chicken nuggets throughout the storage period while yeast and mould count was not detected up to 14 day of storage. Control chicken nuggets recorded lowest cost of production than nuggets added with carrot (8%) and radish (8%) powder.

On the basis of above observations it was concluded that 8% carrot and 8% radish powder incorporated chicken nuggets packed in HDPE packs were acceptable up to 28 day of refrigerated storage.

## प्रबंधाचा सारांश

- १) प्रबंधाचे नाव : गाजर व मुळ्याची भुकटी टाकून चिकन् निगेटची निर्मिती, गुणवत्ता व टिकवणं क्षमता निरीक्षण.
- २) विद्यार्थाचे पूर्ण नाव : देशपांडे सायली प्रशांत
- ३) मार्गदर्शक : डॉ. सं. ना. रींढे  
सहाय्यक प्राध्यापक,  
पशुजन्य पदार्थ प्रक्रिया तंत्रज्ञान विभाग,  
पशुवैद्यक व पशुविज्ञान महाविद्यालय,  
परभणी.
- ४) पदवी : एम.व्ही.एस.सी.
- ५) पदवी प्रदान करण्याचे वर्ष : २०२२
- ६) मुख्य विषय : पशुजन्य पदार्थ प्रक्रिया तंत्रज्ञान विभाग
- ७) प्रबंधाची एकूण पाने : ६५
- ८) सारांशाचे एकूण शब्द : ४४४
- ९) विद्यार्थ्याची स्वाक्षरी :
- १०) अग्रेषण अधिकाऱ्याची :  
सही, नाव व पत्ता  
(विभागप्रमुख)

डॉ. अ. मा. चप्पलवार

प्राध्यापक व विभागप्रमुख,  
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परभणी.

## सारांश

कोंबडीच्या मांसांमध्ये गाजर व मुळयाची भुकटी टाकून चिकन नगेट्सची निर्मिती व सुरक्षितता तपासणे या हेतुने वरील प्रयोग करण्यात आला आहे. विविध मसाले, अंडे व मैदा टाकून चिकन एकजीव मिश्रण तयार करण्यात आले. तयार करण्यात आलेल्या चिकनच्या एकजीव मिश्रणात गाजराची भुकटी (4,8 आणि 12%) व मुळयाची भुकटी (4,8 आणि 12%) या प्रमाणात टाकून भौतिक, रासायनिक गुणधर्मांसाठी परिक्षण करण्यात आले व त्याची तुलना गाजर व मुळयाची भुकटी न टाकता तयार करण्यात आलेल्या चिकनच्या एकजीव मिश्रणासोबत दर तीन दिवयाच्या अंतराने करण्यात आली.

निरीक्षणात असे आढळून आले की, चिकनच्या एकजीव मिश्रणात गाजर व मुळयाच्या भुकटीचे प्रमाण वाढविले असता प्रथीने व स्निग्धांश टक्केवारी मध्ये घट झाली परंतु चवेच्या सर्व गुणधर्मांमध्ये वाढ आढळून आली. चिकनच्या एकजीव मिश्रणाच्या शीतवातावरणात केलेल्या साठवणुकी दरम्यान आद्रतेत तसेच प्रथीने, स्निग्धांश, टक्केवारी, राखेचे प्रमाण, उर्जा, चिकनच्या एकजीव मिश्रणाची स्थिरता, पाणी ग्रहण क्षमता आणि आद्रता यात लक्षणीय घट झाली. चिकनच्या एकजीव मिश्रणाच्या चविष्टपणाच्या गुणधर्मांमध्ये जसे की, स्वाध, गंध आणि एकंदर स्वीकार्यता यामध्ये साठवणूक कालावधी दरम्यान घट नोंदवण्यात आली तर 8% गाजर भुकटी व 8% मुळा भुकटी टाकून तयार करण्यात आलेले चिकनचे एकजीव मिश्रण चवी संबंधीत सर्व गुणधर्मांमध्ये गाजर व मुळा भुकटी न टाकलेल्या एकजीव मिश्रणापेक्षा सरस आढळून आले.

गाजर व मुळा भुकटी (4,8 आणि 12%) टाकून तयार करण्यात आलेल्या चिकन नगेट्चे भौतिक, रासायनिक व चवी संबंधीत गुणधर्मांसाठी परीक्षण करण्यात आले. तपासणीत असे आढळून आले की, नगेट्समध्ये जसे गाजर व मुळा भुकटीचे प्रमाण वाढवले तसे स्निग्धांश टक्केवारी व उर्जेच्या प्रमाणात घट झाली तर राख व आद्रता आणि प्रथीने यांच्या गुणोत्तर प्रमाणात वाढ झाली. त्याच प्रमाणे भौतिक व रासायनिक गुणधर्म जसे की, सामू, शिजवलेल्या पदार्थांचे उत्पादन आद्रता ग्रहण क्षमता, स्निग्धांश ग्रहण क्षमता यामध्ये वाढ नोंदविण्यात आली. तर चवी संबंधीत गुणधर्मांमध्ये घट नोंदविण्यात आली. तयार करण्यात आलेल्या चिकन नगेट्स मधून 8% गाजर भुकटी व 8% मुळयाची भुकटी टाकून तयार करण्यात आलेले नगेट्स हे चांगल्या दर्जाचे होते व गाजर व मुळा भुकटी न टाकलेल्या नगेट्सशी तुलनात्मकदृष्ट्या सारखे होते. गाजर व मुळयाची भुकटी टाकून तयार करण्यात आलेल्या नगेट्समध्ये टी. बी. ए., टायरोसीन व परॉक्साईड चे प्रमाण नियंत्रित नगेट्सच्या तुलनेत कमी आढळून आले.

चवीच्या सर्व गुणधर्मांमध्ये साठवणूक कालावधी दरम्यान घट झालेली आढळून आली. तयार केलेले नगेट्स हे चवीच्या गुणधर्मांमध्ये गाजर व मुळा भुकटी न टाकलेल्या नगेट्स पेक्षा सरस आढळून आले तसेच सुक्ष्मजिवांचे प्रमाण देखील कमी आढळून आले. तसेच साठवणूकीच्या 21 व्या दिवसापर्यंत निम्नतापरागी जिवाणू आढळले नाही तर कोलीफॉर्म जिवाणू संपूर्ण साठवणूक कालावधी दरम्यान आढळले नाही. बुरशीजन्य जिवाणू चौदाव्या दिवसापर्यंत आढळून आले नाही. गाजर व मुळा भुकटी न टाकता तयार करण्यात आलेल्या चिकन

नगेट्सचे निर्मिती मुल्य हे गाजर व मुळा भुकटी टाकून तयार करण्यात आलेल्या नगेट्स पेक्षा कमी आढळून आली.

वरील निरीक्षणावरून असा निष्कर्ष निघतो की, 8% गाजर भुकटी व 8% मुळा भुकटी टाकून तयार करण्यात आलेले चिकन नगेट्स जास्त घनता असलेल्या पॉलीथीन पिशवीमध्ये (HDPE) शीतवातावरणात 28 दिवसांच्या कालावधी पर्यंत सुरक्षीत व खाण्यायोग्य राहतात.