DEVELOPMENT AND STORAGE QUALITY OF FUNCTIONAL TURKEY MEAT LOAF

Thesis

Submitted to the
DEEMED UNIVERSITY
Indian Veterinary Research Institute
Izatnagar - 243 122 (U.P.), India

Dr. Pooja Farswan
Roll No. 5321

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

Master of Veterinary Science
(Poultry Science)

2015

Dedicated to....

My Beloved Parents

केन्द्रीय पक्षी अनुसंधान संस्थान
इज्जतनगर –243122, (उ.प्र.), भारत

DIVISION OF POST HARVEST TECHNOLOGY
ICAR-CENTRAL AVIAN RESEARCH INSTITUTE
IZATNAGAR - 243 122, U.P., INDIA

Dr. C.K. Beura
M.V.Sc., Ph.D.
Principal Scientist

Dated: 20.06, 2015

Certificate

Certified that the research work embodied in this thesis entitled **"Development and Storage Quality of Functional Turkey Meat Loaf"** submitted by Dr. Pooja Farswan, Roll No. 5321, for the award of Master of Veterinary Science degree in Poultry Science at Indian Veterinary Research Institute, Izatnagar, is the original work carried out by the candidate herself under my supervision and guidance.

It is further certified that Dr. Pooja Farswan, Roll No. 5321, has worked for more than 21 months in this Institute and has put in more than 150 days attendance under me from the date of registration for the degree of Master of Veterinary Science of the Deemed University, as required under the relevant ordinance.

CKBeura

(C.K. BEURA)
Chairman
Advisory Committee

Certificate

We the undersigned members of Advisory Committee of **Dr. Pooja Farswan,** *Roll No. 5321, a candidate for the degree of* **Master of Veterinary Science** *with the major discipline in* **Poultry Science**, *agree that the thesis entitled* "**Development and Storage Quality of Functional Turkey Meat Loaf**" *may be submitted in partial fulfillment of the requirement for the degree.*

We have gone through the contents of the thesis and are fully satisfied with the work carried out by the candidate, which is being presented for the award of **Master of Veterinary Science** *Degree of this Institute.*

It is further certified that the candidate has completed all the prescribed requirements governing the award of **Master of Veterinary Science** *Degree of the Deemed University, Indian Veterinary Research Institute, Izatnagar.*

Signature
Name Dr. Amitav Bhattacharyya
External Examiner
Date: 25/07/2015

(C.K. Beura)
Chairman
Advisory Committee
Date: 20.06.2015

MEMBERS OF STUDENT'S ADVISORY COMMITTEE	
Dr. **A.S. Yadav**, Principal Scientist & Head Division of Post Harvest Technology, ICAR-CARI, Izatnagar	....
Dr. **Ashim K. Biswas**, Senior Scientist Division of Post Harvest Technology, ICAR-CARI, Izatnagar	....
Dr. **B.H.M. Patel**, Senior Scientist Livestock Production and Managment Section, ICAR-IVRI, Izatnagar	....

ACKNOWLEDGEMENTS

As Henry Ford said "Coming together is a beginning, keeping together is progress, and working together is success". So many people were with me for successful completion of this work. It would be incomplete in all ways, without expressing thanks to all those people who helped me a lot during my research days.

First and foremost, I would like to express my enduring gratitude to Chairman of my advisory committee, ***Dr. C.K.Beura****, Principal Scientist, for his guidance, fatherly care, constant encouragement, and willingness to help at any time. At every point of work, he was very instrumental in making it a success overcoming all the hurdles.*

I take this opportunity to thank ***Dr. A.K.Biswas*** *,Senior Scientist who provided me all facilities for research and for his timely advice. Words would not be enough for expressing my thanks to* ***Dr. A.S.Yadav****, Principal scientist for his encouragement and timely help especially in conducting microbiological evaluation.*

Dr. Avishek Biswas*, Senior scientist also provided me support during my research Special mention is needed for the support and care provided throughout these two years by* ***Dr. Praveen Kumar Tyagi,*** *Head, PGE&T and* ***Dr. A. B. Mandal****.*

I am highly obliged and thankful to scientists of this division Dr .Chandrahas ***Dr.Divya, Dr., Dr. Raj Narayan, Dr. D. P. Singh, Dr. V. K. Saxena, Dr. Chandra Deo, Dr.Ram Singh ,Dr. Pramod Kumar Tyagi*** *and* ***Dr. S. Majumdar.***

I would like to say special thanks to all those who participated in sensory evaluation of my product, during its preliminary trials and storage studies. Their valuable suggestions and opinions helped me in improving the product.

I owe particular thanks to my batchmates ***Dr.Ganeshan,Mukesh, Surinder, Mohit, Suryapal,Sudhir, Nirmal and Leikhram Kripyalini, Madhu Mishra, Sakshi Dubey and Bhuwana Priya*** *for the brightest and blissful days in CARI. I also take this opportunity to thank my beloved seniors and juniors for their encouraging words and ever helping nature. I will remember their positive attitude always in my life. Special thanks are owed to* ***Dr. Prasant Khatke , Geeta Pipaliya, Richa Arora*** *and* ***Mohan Shanker.*** *Working environment in my lab was so good and relieving. I owe special thanks to laboratory staff* ***Aryaji, Anilji, Kaushikji ,Bajpayji and Lalit*** *for their technical* *support. I also extend my special thanks to* **Parveen, Moorthi** *and* **Munna.** *Without love, support and care given by my* **mother Pushpa Farswan** *and* ***father BhajanSingh*** *and brother* **Deepak Farswan** *and sister* **Deepti Farswan**

I would not have been able to accomplish this. I would ever remember good days spent with my friends **Dr. Sandeep kumar Talwar, Yamini Verma , Ankita, Pooja Batla And Abhivyakti Pathak .**

I would like to thank the **IVRI Director, Dr. R.K. Singh, CARI Director, Dr. J. M. Kataria, Joint Director (Acad.)**, *and* **Scientific Coordinator, IVRI** *for providing necessary facilities and resource required for this work. I also acknowledge the financial assistance received from* **IVRI** *in the form of ICAR - JRF Scholarship.*

Above all I thank God All mighty for all the blessings and opportunities he has given in my life.

I also thank the rest of all, whom I failed to mention here.

P.Farswan.

Date: **(Pooja Farswan)**

Place: *IVRI, Izatnagar*

ABBREVIATIONS

%	:	Per cent
ABTS	:	2- 2- azinobis- 3ethylbenthiazoline- 6- sulphonic acid
AOAC	:	Association of official chemists
APEDA	:	
ARMD	:	age-related macular degeneration
BAHS	:	Basic Animal Husbandry Statistics
CARI	:	Central Avian Research Institute
CFU	:	Colony forming units
df	:	degree of freedom
DPPH	:	1,1- diphenyl – 2 – picrylhydrazyl
E-BCP	:	β-caryophyllin
FAO	:	Food and agricultural organisation
FDA	:	Food and Drug Administration
FFA	:	Free fatty acids
GDP	:	Gross domestic product
GI	:	Gastro intestinal
HDL	:	High density cholesterol
ICAR	:	Indian council of agricultural research
$K_2S_2O_8$	:	Potassium persulphate
KOH	:	Potassium hydro-oxide
LDL	:	Low density cholesterol
LDPE	:	Low density polyethylene
ND	:	Not detectable
PDA	:	Potato dextrose agar
PET	:	Polyethylene terephthelet
ppm	:	Parts per million
PV	:	Peroxide value
SPC	:	Standard plate count
TBARS	:	2-Thiobarbituric acid reacting substances
TCA	:	Trichloroacetic acid

LIST OF TABLES

LIST OF FIGURES

CONTENTS

Introduction

1 INTRODUCTION

Poultry is a part of our livestock sector that provides protein in terms of meat and eggs. Poultry industry contributes about Rs. 600 billion accounting for about 0.77% of the national GDP and ~10% of the livestock GDP and provides employment to over five million people in the Country. Poultry sector is dubbed as the one having highest employability per unit of investment. The Indian poultry sector with 7.3% growth in poultry population, has witnessed one of the fastest annual growth of about 6% in eggs and 10% in meat production over the last decade amongst all animal based sectors. As per Livestock Census Reports, Ministry of Agriculture, Government of India, there were 73.55 million poultry in the year 1951 rose to 648.83 million in 2007 at 3.96% annual growth rate (BAHS, 2012). Poultry sector growth is being driven by rising incomes and a rapidly expanding middle class, together with the emergence of vertically integrated poultry producers that have reduced consumer prices by lowering production and marketing cost. The international trade in poultry meat and egg accounts for about 12% and 2% of global output of nearly 100 mmt poultry meat and 64 mmt eggs, respectively (ICAR, 2014). Rural poultry contributes 93.51% to total population. Livestock products such as meat, milk and eggs contribute one sixth of the calories and one third of the protein of the per capita food supplies in world. The egg production has increased from 1832 million in 1950-51 to 65,480 million in 2011-12 (BAHS, 2012). Among poultry species, chicken production has already acquired large scale commercial dimensions in India due to its better efficiency than other domesticated poultry species to convert poultry feed into nutritious egg and meat. Chicken (including desi fowl) accounts for about 95.21% of the total poultry population, followed by 4.25% ducks. The remaining 0.54% is comprised of other domesticated poultry species such as quail, turkey, guinea fowl and goose etc. The population of quails and turkeys is growing exponentially in the country owing to their ever increasing popularity, lower susceptibility to common poultry diseases and higher returns (ICAR, 2014).Therefore, diversified poultry farming is the need of the day for Indian poultry industry, especially for rural poultry farming.

Turkeys are native to the United States and Mexico.They are traditionally eaten as the main course of thanksgiving in the United States and Canada, and at Christmas feasts in much of the rest of the world.Commercial Turkey production is big business in Israel, U.S.A., France, Italy, United Kingdom, Canada and Netherlands. From the 16th to 20th centuries, turkeys spread throughout the world as domestic birds. During these 500 years of domestication, many varieties of turkey have been developed. Seven standard varieties are recognized by the American standard of perfection for poultry namely Bronze, White, Holland, Bourbon Red, Narragansett, Black Slate and Beltsville Small White. A dozen more non standard varieties including wild turkeys are also available (Majumdar *et al.*, 2012). Although turkeys were introduced in India several decades ago by the Christian missionaries but the turkey farming as such had very little progress (Kumar, 2007). High cost of production, long generation interval, and less market demand are the major setback for its low popularity.

Turkey farming is a new concept in India.It is gaining popularity day by day among the poultry farmers and it is gaining popularity in Andhra Pradesh, Tamil Nadu, Punjab, Kerala, Haryana, and Uttar Pradesh. Turkeys can be raised under semi intensive system. In southern part of India, Turkeys are reared domestically in small scale units. C.A.R.I. Izatnagar has Turkey Research Unit in its campus to carry out research on various aspects of turkey production under tropical climate .

In India, the demand for meat based convenience foods has increased many times within a short period of time and it is mainly due to the combined effect of rapid industrialization and urbanization. Piernas and Popkin (2010) reported that the frequency of snacking increased by more than 25% between 2003–2006 which, therefore, correlated with an increase in energy intake from 18% to 24% and increase in salty snack consumption almost doubled over the last two decades (Nielsen and Popkin, 2003). Students and working people are the major consumers of these high calorie, high salty unhealthy diet. The change in food habits especially to these types of foods have resulted in increased incidence of cardiovascular diseases, obesity, cancer etc. The development of functional meat products could combat the current diet related health problems.

The country has exported 4,37,673.53 MT of poultry products to the world for the worth of Rs. 565.87 crores during the year 2013-14. Meat based ready to eat functional food products, in particular poultry meat products, has special significance because of its richness in nutrients and its acceptability as a protein rich food. Functional food or otherwise called health foods are nothing but food items enriched with one or more nutrients which can provide some health benefits. The functional ingredients of natural origin are well accepted than the synthetic products. Meat based functional foods are getting popular as it may contain antioxidants, dietary fibers, vitamins, minerals and other bioactive compounds depending upon the type of the product and nature of ingredients added to it (Xiao, 2010).

Many studies have been conducted on poultry meat and red meat by incorporation of nutrient rich ingredients of plant origin to make meat based functional foods, which can provide improved flavour and taste along with supplementation of nutrients which are not available or insufficiently available from whole meat products (Jiménez-Colmenero *et al*., 2001). Many processing techniques have been standardized for several meat products but most of them have limited acceptability and shorter shelf life at ambient temperature.

Among poultry meat, majority of the work have been done on chicken meat but very less literature is available on meat of other species especially turkey meat. Turkeys are reared for meat and they are quite popular in western countries including U.S.A. and U.K (FAO, 2012). Turkey meat is famous for its leanness and delicacy. In India, turkey rearing is gradually getting popularized and is showing encouraging trend in the past decade. The availability of turkey meat products is limited in our country.

Since very limited research work has been carried out on the suitability of cereals and natural preservatives as dietary fiber source, natural extenders/fillers, anti-oxidants and antimicrobials on development of meat products, the present work was therefore planned to find out the effect of incorporation of selected cereals and natural preservatives to develop turkey meat loaf, a ready-to-eat functional product.

The objectives of the proposed study are as follows:

1. **To identify suitable cereal flour(s) for standardization of formulation in development of functional turkey meat loaf.**
2. **To optimize the level and type of some selected natural preservatives in the development of functional turkey meat loaf.**
3. **To study the storage stability of functional turkey meat loaf at refrigeration temperature (4 ± 1 °C) under aerobic packaging condition.**

✍ ✍ ✍

Review of Literature

2 REVIEW OF LITERATURE

2.1 FUNCTIONAL MEAT PRODUCT

The global meat industry faces a lot of challenges and whether as a result of consumer demand or because of the ferocious competition in the industry, research studies into new products are continuous. However, such research studies and the launch of new products are directed at providing healthy alternatives to what has frequently been accused of causing a variety of pathologies (Jiménez-Colmenero,2000). The underlying idea behind functional food is to reduce the prevalence of chronic diseases by curbing the consumption of habitually consumed foods. The formulation of foods according to the beneficial effects that their non-nutritional ingredients may have for the consumer has become an area of great interest for large food companies, including the meat sector (Vasconcellos, 2001). According to Pascal and Collet-Ribbing, (1998) a functional food is "a food which may be considered functional if it contains a component (be it nutrient or not) with a selective effect on one or various functions of the organism, whose positive effects justify that it can be regarded as functional (physiological) or even healthy." A food can be regarded as functional if it is satisfactorily demonstrated to beneficially affect one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either improved health or well-being and/or to a reduction in the risk of disease. A functional food must remain food and it must demonstrate its effects in amounts that can normally be expected to be consumed in the diet: it is not a pill or a capsule, but part of the normal food pattern (Dipplock *et al.,* 1999). The term "Functional Foods" has been first mentioned in Japan in early 1980s to define some food products fortified with special constituents that were beneficial to physiological health for human (Hardy, 2000). Arihara (2006) reported that utilization of functional ingredients like vegetable proteins, fibers, antioxidants, probiotics and prebiotics is one approach to the development of functional meat products. These are used as foods that are used to prevent and treat certain disorders and diseases, in addition to their nutritional value. There are three basic requirements for a food to be regarded as functional (Goldberg, 1994) such as

(i) it is a food (not capsules, tablets, or powder) derived from naturally occurring ingredients.

(ii) it is consumed as a part of daily diet

(iii) it should regulate some specific purposes such as enhancing biological defence mechanisms, preventing and treating some specific diseases and controlling the physical and mental conditions.

Meat and meat products are essential in the diet of both developed and developing countries. Their principal components besides water, proteins and fats are a substantial amount of minerals and vitamins of a high degree of bioavailability. Both meat and its associated products can be modified by adding ingredients considered beneficial for health or by reducing or eliminating components that are considered harmful. In this way, a series of food can be obtained which, without altering their base, considered healthy .

2.2 TURKEY MEAT

Like chicken, turkey meat has high nutritional value as it is a rich source of animal protein containing all essential amino acids required in human diet. Turkey meat is low in fat, calories and cholesterol than chicken and duck meat (Baggio *et al.*,2005). It is a good source of B-complex vitamins and minerals. Turkey meat not only contains essential fatty acids but also has higher content of polyunsaturated fatty acids than chicken and duck meat which is highly desirable for human health. In the lean meat categories, turkey occupies the top place.The turkey meat is excellent source of niacin and phosphorus and plays major role in the development of young children (Majumdar *et al.*, 2012). The muscle fibre of the turkey meat is easily digestible as compared to other poultry meat. It has low sodium content and therefore, safe for the elderly people and those suffering from heart problems.

High quality turkey meat products containing textured vegetable protein can be manufactured without affecting the organoleptic properties and palatability (Nedljkovic *et al.,* 1979). Many products from turkey meat has been developed like canned turkeys, turkey paste, smoked turkeys, turkey rolls, sticks, pickle, blocks, turkey cocktail sausages (Kumar, 2007).

2.2.1 TURKEY MEAT COMPOSITION

The moisture , crude protein , fat and ash composition of turkey meat is about 74-75, 21-23, 1-2 and 1 respectively foe 6 week old turkey , 73-74, 22-24, 1-2 and 1 respectively for 8 week old turkey , 74-75,21-23, 1-3 and 1-1.5 respectively for 10 week old turkey , 73-74, 21-24, 1-3and 1 respectively for 12 week old turkey and 74-75,21-24,1-2.5 and 1% respectively for 14 week old turkey (Majumdar *et al.,* 2005).The meat quality of 40 carcasses of 16-17 week old Orlopp H 606 turkeys stored for 3, 6 or 9 days at 0-2°C indicated that thigh meat had a higher pH than breast meat . Color darkened and shear value decreased during storage . Breast meat contained 1.28 fat and 23.82% protein and corresponding values for thigh meat were 3.54 and 20.62% respectively . No significant differences in moisture and ash contents of the two meat types were observed. The high digestibility and low fat content of poultry meat make it suitable for consumption by convalescents and the elderly . The potential for full utilization of the technological properties of poultry meat in the meat processing industry has been discussed by Kondaiah *et al.* (1992). Grunden *et al.* (1972) reported that the composition of deboned turkey racks ranged as follows: moisture, 63.4% to 73.7%; fat, 12.7% to 22.5%; protein, 11.7% to 12.8%.

2.2.2 PHYSIOCHEMICAL CHARACTERISTICS OF TURKEY MEAT

Meat is the main source of animal protein. Its quality describes many of nutrients, biological and technological indicators.

The most important one – the human body's nutrients and, in particular - a high biological value protein needs (Jukna *et al.,* 2010). Proteins determine the nutritional value of meat, they influence changes in the technological processes and physical - chemical parameters of meat. Meat quality and its nutritional value depend on meat components ratio (Culioli *et al.*, 2003).The protein percentage in turkey meat and broiler meat is 22.19 and 21.43, respectively.

Intramuscular fat increases energy value, improves the taste, but too much body fat inhibits gastric acid secretion and complicates protein digestibility (Jukna *et al.,* 2007). Consumers prefer lean meat with reduced content of fat. However, low intramuscular fat content in worse taste qualities of meat (Valsta *et al.*, 2005; Jukna *et al.,* 2010). Among the ostrich, turkey and broiler meat, the highest amount of intramuscular fat was found in broiler meat ,the lowest value in turkey meat . The difference between the fat in broiler and turkey meat was 0.99 percent. By comparing turkey and ostrich meat in regard to the fat content, the difference of 0.61 percent was established. Intramuscular fat is the most variable part of the meat. Its coefficient of variation is several times higher than other meat characteristics. Fat content influenced meat technological, organoleptic properties and nutritional value of meat (Honikel, 2004). In fat are located fat-soluble vitamins and as well as facilitates the A and vitamin D absorption. They used in active substances including the formation of hormones (Valsta *et al.,* 2005).

Variation of mineral coefficient in ostrich, turkey and broiler meat was very low. The highest ash content was 3.32 ± 0.06 percent in ostrich meat ($p < 0.01$),while in turkey meat the lowest ash content of 0.92 ± 0.12 percent was found ($p < 0.05$), which coincides with the literature (Sale, 1998). Comparing the ostrich and turkey meat ash content, difference was 2.40 percent.

Physical and chemical properties describe meat culinary, technological and nutritional value (Jukna *et al.,* 2007). Meat pH is an important indicator of quality, determinative for longer storage possibility and some technological properties (Wagner, 1999). High pH of meat favours microbiological growth leading to spoilage and production of objectionable flavours. The ultimate pH of the large breast muscle and leg meat of turkey is 5.6-5.8 and 6.1-6.4, respectively. In turkey, meat final pH is reached within 30 minutes after slaughter, irrespective of final pH. A slight brightening of color immediately after slaughter was observed at very low pH. The highest pH 6.6 ± 0.34 ($p < 0.01$) was in turkey meat, compared to turkey and broiler meat.

Water holding capacity (WHC) of meat is an important technological feature, which defines the ability to produce high quality products (Barton – Garde *et al.,* 2001; Jukna *et al.,* 2007). It is defined as the ability of meat to retain its own or added water during application of external forces such as heating, cutting, grinding or pressing. The raw meat has good water holding capacity, it does not emit juice. Among the ostrich, turkey and broiler meat, ostrich meat was characterized by the lowest water holding capacity 61.70 ± 4.33 percent, whereas the highest was in turkey meat 68.80 ± 1.13 percent ($p<0.01$), difference between the ostrich and turkey meat water holding characteristics was 7.1 percent. Water holding capacity of chicken broiler meat was 64.43 ± 3.89 percent. ($p <0.001$), it differed from the turkey meat by 4.37 percent and 2.73 percent from the ostrich meat.WHC was increased by added NaCl. Holding time did not significantly influence water binding capacity .

One of most important technological parameters is cooking loss, which determines the final quantity of the product and organoleptic characteristics. Studies showed that among ostrich ,turkey and broiler meat, the loss was the lowest in turkey meat from 11.02 ± 1.48 percent, the highest loss in ostrich meat 20.35 ± 2.76 percent. Cooking loss of broiler meat was 14.50 ± 2.26 percent and it is only 3.48 percent more than turkey cooking loss and 5.85 percent less than the ostrich meat cooking losses.

2.3 RAW MATERIALS

2.3.1 Ragi

Finger millet or *ragi* is one of the ancient millets in India (2300 BC). Finger millet (*Eleusine coracana*) is popularly known as Ragi in India. *Eleusine coracana* is an annual plant widely grown as a cereal in the arid areas of Africa and Asia (Mohan *et al*., 2005). Ragi is very useful material for the preparation of beverages and health foods, such as infant food and eternal food formulations (Meera,1997). It remains one of the main ingredients of the staple diet in Karnataka. It is used both in native and malted conditions due to its low cost and presence of high amylolytic activity in its malt (M.Nirmala and G.Muralikrishna;2003). Nutritionally, when ragi is used as a whole grain, it is higher in protein and minerals in comparison to all other cereals and millets.

It contains important amino acids *viz*., isoleucine, leucine, methionine and phenyl alanine which are not present in other starchy meals. Isoleucine helps in muscle repair, blood formation, bone formation and improves skin health. Valine is an essential amino acid which facilitates metabolism and repair of body tissues. Another essential amino acid, not found in most cereals, is methionine. It is found in Ragi. Methionine is useful in various body processes, helps in eliminating fat from the body and is main provider of sulphur in body. Sulphur is essential for production of glutathione, which is the body's natural and most important antioxidant (Castelluccio *et al.*, 1995 and Shahidi *et al.*,1992). It has the highest amount of calcium (344mg%) and potassium (408mg%) (S. Shobana and K. Krishnaswamy, 2013). Ragi is the richest source of calcium among plant foods. It is a great source of iron making it beneficial for individuals with low haemoglobin level . Its consumption helps in anemia. Ragi also contains an amino acid, tryptophan which reduces appetite. It has a much higher amount of dietary fiber compared to white rice and other grains. Regular consumption of finger millet is known to reduce the risk of diabetes mellitus, tumors , atherosclerosis (Subba Rao & Muralikrishna, 2002) and gastrointestinal tract disorders and these properties are attributed to its high polyphenol and dietary fiber contents. Ragi contains amino acids lecithin and methionine which help in bringing down cholesterol levels by eliminating excess fat from liver. Finger Millet also contains the amino acid threonine which hinders fat formation in the liver and helps to bring down the cholesterol levels. Ragi is an excellent plant source of natural iron. Sprouted ragi develops vitamin C in the process of sprouting, therefore, the iron in ragi becomes more bio-available when consumed as sprouted ragi flour or ragi malt.

2.3.2 Oat

Oat is considered as a minor grain crop, which contains a high level of nutrients, such as protein, fat, minerals and vitamins (Xin-Zhong Hu *et al.*, 2014). Oats generally can be divided into two categories: hulled oats and naked oats. Due to the beneficial effect of oats and oat products, the hulled oats have been used as breakfast cereals in the form of rolled oats and steel cut groats in western countries for many years (Robert, 1995). In China, oat was used as a traditional Chinese medicine due to its lubricative feature in intestine for hundreds of years (Zhang *et al.*, 2012). Oatmeal and oat bran are significant sources of dietary fiber. One component of the soluble fibre found in oats is beta-glucans, a soluble fiber which has proven effective in lowering blood cholesterol (Wood; 2011 and FDA; 1997). The bad cholesterol i.e. LDL is trapped without lowering good cholesterol (HDL). The crude fat content of oats is 2–12%, and the extracted oat oil has been shown to possess nutritional potential (Tong *et al.*, 2014). Some of the more than 75 different lipids found in oats (Singh *et al.*, 2013) have antioxidant and anti-inflammatory activities (Andersson and Hellstrand, 2012). Tong *et al.* (2014) determined the predominant components of oat oil to be palmitic acid (16:0; 18%), stearic acid (18:0; 1.5%), oleic acid (18:1; 33%), linoleic acid (18:2; 45%) and linolenic acid (18:3; 2%). Of these, linolenic and linoleic acids are omega-3 and omega-6 fatty acids, respectively; both of which are associated with health benefits in humans and other animals (Benjamin and Spener, 2009 and Turchini *et al.*, 2012). In addition, β-glucan has been proposed to contribute to enhanced satiety. Enhanced satiety offers many potential benefits to consumers with weight management goals (Hetherington *et al.*, 2013). Oats and grains are also one of the best sources of compounds called tocotrienols. These are antioxidants which together with tocopherols form vitamin E. The tocotrienols inhibit cholesterol synthesis and have been found to lower blood cholesterol. Oat beta-glucan slows the rise in blood glucose levels following a meal and delays its decline to pre-meal levels (FDA, HHS, 2002). Oats, like other grains and vegetables, contain hundreds of phytochemicals (plant chemicals). Many phytochemicals are thought to reduce a person's risk of getting cancer. Phytoestrogen compounds, called lignans, in oats have been linked to decreased risk of hormone-related diseases such as breast cancer. The insoluble fibers in oats are also thought to reduce carcinogens in the gastrointestinal tract. Oats rich in soluble fibre can reduce hypertension or high blood pressure. Oats have a high fiber content. Fiber is necessary in keeping bowel movements regular (Saara Pentikainen *et al.*, 2014). Oats have a higher concentration of well-balanced protein than other cereals. They contain a good balance of essential fatty acids, which have been linked with longevity and general good health, and also have one of the best amino acid profiles of any grain.

2.3.3 Oregano

Oregano (*Origanum vulgare)* is a common species of *Origanum*, a genus of the mint family (Lamiaceae) It is widely used as a culinary spice due to its flavouring properties originating from its essential oil (Marko Stamenic *et al.*, 2014). The amount of essential oil in Greek oregano is considered to be high, up to 8% (Kokkini &Vokou, 1989) and rich mainly in four components: carvacrol, thymol, p-cymene and c-terpinene. However, numerous studies showed that the amounts of these four components present in the essential oil, as well as the amount of the oil, can significantly vary depending on factors such as geographical location of the crops and/or harvest season (Bonfanti *et al.*, 2012). It is native to warm-temperate western and south-western Eurasia and the Mediterranean region. Sivropoulou *et al.* (1996) investigated antibacterial effect of carvacrol rich Greek oregano essential oil. It was found that the essential oil, carvacrol and thymol had strong antibacterial effect (except on P. aeruginosa), unlike p-cimene and c-terpinene. Adam *et al.* (1998) presented results on antifungal activity of thymol and carvacrol rich Greek oregano essential oil. It was shown that the Greek oregano oil was superior compared to those of mint, lavender and sage against the human pathogens *Malassezia furfur, Trichophyton rubrum,* and *Trichosporon beigelii.* Thymol rich oil of O. vulgare L. ssp. hirtum was also found to have good antioxidant activity which was fairly better than the activity of individual components of the oil (Milos, Mastelic, & Jerkovic, 2000). Zheng and Wang (2001) examined the phenolic compounds content and antioxidant activities of almost thirty culinary and medicinal herbs. It was found that the content of phenolic components was the highest and the antioxidant effect of essential oil was the strongest in the case of Greek oregano. The radical-scavenging activity of these phenolic compounds is optimal for blocking alimentary free radicals, their chain-breaking activity protects against peroxidized foods, and their iron-chelating activity defends the body from the deleterious action of free iron (Cervato *et al.*, 2000). Esen *et al.* (2007) investigated antibacterial and antifungal effect of essential oils. Oregano has shown antimicrobial activity in a number of studies. *Origanum vulgare* essential oils are effective against 41 strains of the food pathogen *Listeria monocytogenes* and it shows this property due to the presence of an essential compound called carvacrol.

The natural preservative is also used to treat respiratory tract disorders, gastrointestinal (GI) disorders, menstrual cramps, and urinary tract disorders (Souza *et al.*, 2007). It is also applied topically to help treat a number of skin conditions, such as acne and dandruff (Kintzios, 2004; Shylaja, 2004). Oregano principally contains: fiber, iron, manganese, vitamin E, iron, calcium, omega fatty acids, manganese, and typtophan. It is also a rich source of Vitamin K - an important vitamin which promotes bone growth, the maintenance of bone density, and the production of blood clotting proteins. An active ingredient called β-caryophyllin (E-BCP) is present in oregano which may possibly be of use against disorders such as osteoporosis and arteriosclerosis.

2.3.4 Parsley

Parsley is a popular culinary and medicinal herb. This wonderful, fragrant rich biennial herb is native to the Mediterranean region belonging in the *Apiaceae* family, in the genus *Petroselinum*. Its botanical name is *Petroselinum crispum*. Parsley (*Petroselinum crispum, Apiaceae*) is a well-known herb used to give fragrance to different food products. It has also been used as a medicinal plant for ailments and complaints of the gastro intestinal tract, as well as the kidney and lower urinary tracts, and for stimulating digestion (Popovic *et al.,* 2007). It is recognized as one of the functional food for its unique antioxidants, and disease preventing properties. Parsley is an important source of phytochemicals such as carotenoids, flavonoids, and vitamin C. Parsley is rich in poly-phenolic flavonoid antioxidants, including *apiin, apigenin, crisoeriol, and luteolin.* β-carotene is a fat soluble plant component that is easily converted by the body into vitamin A whenever required (Brigitte *et al*., 2005). Diets with β-carotene-rich foods are also associated with a reduced risk for the development and progression of conditions like atherosclerosis, diabetes, and colon cancer (Daly *et al*., 2010). β-carotene may also be helpful in reducing the severity of asthma, osteoarthritis, and rheumatoid arthritis. The compound is an important nutrient to form a strong immune system. The flavonoids in parsley have been shown to function as antioxidants that combine with highly reactive oxygen species and help in the prevention of oxygen-based damage to cells (Brigitte *et al*., 2005). Vitamin C is the body's primary water-soluble antioxidant, rendering harmless dangerous free radicals in all water-soluble areas of the body. High levels of free radicals contribute to the development and progression of a wide variety of diseases, including atherosclerosis, colon cancer, diabetes, and asthma. Vitamin C is also a powerful anti-inflammatory agent, which explains its usefulness in conditions such as osteoarthritis and rheumatoid arthritis (Pattison *et al*., 2004). Furthermore, apigenin, a chemical found in great quantities in parsley, has been found to have potent anticancer activity. It works by inhibiting the formation of new blood vessels that feed a tumour (Guan *et al*., 2012). Parsley is one of less calorific herb. 100 g of fresh leaves carry only 36 calories. Additionally, its leaves contain zero cholesterol and fat, but rich in anti-oxidants, vitamins, minerals, and dietary fiber. It contains health benefiting essential volatile oils that include *myristicin, limonene, eugenol, and alpha-thujene.* The essential oil, Eugenol**,** present in this herb has been used in therapeutic application in dentistry as a local anaesthetic and anti-septic agent for teeth and gum diseases. The herb is also a good source of minerals like potassium**,** calcium (Erne *et al*., 1984 and Bruschi *et al*., 1985), manganese, iron, and magnesium. 100 g fresh herb provides 554 mg or 12% of daily-required levels of potassium. Potassium is the chief component of cell and body fluids that helps control heart rate and blood pressure by countering the effects of sodium. Iron is essential for the production of heme, which is an important oxygen-carrying component inside the red blood cells and manganese is used by the body as a co-factor for the antioxidant enzyme, *superoxide dismutase.* The herb is an excellent source of vitamin-K and folates. Zea-xanthin helps prevent age-related macular degeneration (ARMD) in the retina of the eye in the old age population through its anti-oxidant and ultra-violet light filtering functions. Fresh herb leaves are also rich in many essential vitamins such as pantothenic acid (vitamin B-5), riboflavin (vitamin B-2), niacin (vitamin B-3), pyridoxine (vitamin B-6) and thiamin (vitamin B-1). These vitamins play a vital role in carbohydrate, fat and protein metabolism by acting as co-enzymes inside the human body. It is, perhaps, the richest herbal source for vitamin K (Yazicioglu and Tuzlaci,1996) providing 1640 µg or 1366% of recommended daily intake. Vitamin K has been found to have the potential role in bone health by promoting osteotrophic activity in the bones. It has also established role in the treatment of Alzheimer's disease patients by limiting neuronal damage in the brain.

2.3.5 ALPHA (α) TOCOPHEROL ACETATE

Lipid oxidation represents one of the major causes of the progressive deterioration in the quality of meat products, limiting their storage shelf life. The deterioration in organoleptic characteristics, and the associated loss of nutritional value induced by the oxidative process, can be delayed by the addition of antioxidants. Nevertheless, the precise biological mechanisms by which it exerts its beneficial effects are still unclear, and are currently the focus of extensive research efforts (Brigelius-Flohe and Galli, 2010; Golli and Azzi, 2010). The term "vitamin E" actually refers to a group of related fat-soluble molecules that are found in many natural sources and are widely used as functional ingredients in food, pharmaceutical, and cosmetic preparations (Chiu and Yang, 1992 and Rigotti, 2007). The most important biologically active form of vitamin E is α-tocopherol, and therefore this form tends to be used in commercial products. There has been considerable interest in fortifying foods, beverages, and supplements with vitamin E due to its beneficial nutritional qualities (Mc Clements *et al*., 2009 and Yang and Huffman, 2011). However, there are a number of challenges associated with incorporating vitamin E into commercial products due to its chemical instability, poor water-solubility, and variable bioavailability.

The α-tocopherol form of vitamin E is highly unstable to oxidation and may therefore be lost during the processing, storage, and utilisation of commercial products due to its chemical degradation (Gawrysiak-Witulska *et al*., 2009 and Yoon and Choe, 2009). For this reason, a more chemically stable esterified form (α-tocopherol acetate) is typically used in commercial products (rather than the free form) (Lauridsen *et al*; 2001). So α-tocopherol has two functions: it acts as a vitamin (vitamin E) and it acts as an essential antioxidant. Vitamin E cannot be synthesized by the body and must therefore be supplied in the diet or through supplementation. It is only stored in the body for a relatively short time and must be replenished on a regular basis. Unlike the other fat-soluble vitamins, A, D, and K, which are stored in the liver, vitamin E is stored throughout the body in the lipid phase. This fact is of crucial importance in the utilization of α-tocopherol to modify metabolic reactions.

Materials and Methods

3 MATERIALS AND METHODS

3.1 Experimental Design

The experiment was designed to develop functional turkey meat loaf incorporated with fiber rich cereals and natural preservatives having antioxidant and antimicrobial activity. Preliminary trials were conducted to standardize formulation for the development of functional turkey meat loaf, to select a suitable cooking method and cooking time-temperature combination. Experiments were conducted to identify the type and optimum level of cereal flours and natural preservatives. The functional turkey meat loaf, thus developed were stored at 4 ± 1°C in incubator and a detailed quality study during storage was carried out. Thus, the studies were broadly divided into 2 phases; first phase consisting of preliminary trials, second section consisting of 3 experiments (Exp.1, Exp.2 & Exp.3). Each experiment was done in triplicates. In Exp-1, standardization of cereal flour(s) – oat flour and ragi flour in development of functional turkey meat loaf and in Exp.2, optimization of natural preservatives (oregano and parsley) and alpha tocopherol acetate and their levels in development of functional turkey meat loaf were done. In Exp.3, storage stability of functional turkey meat loaf during storage at refrigeration temperature (4 ± 1°C) under aerobic packaging condition was studied. Formulation cost of functional turkey meat loaf thus developed was also worked out.

3.2. Raw Materials

3.2.1 Turkey meat

Meat samples required for the experiments were obtained from turkey slaughtered as per standard procedure in the poultry processing plant of Division of Post Harvest Technology, CARI, Izatnagar, India. After removal of all separable connective tissue, fat and fascia, the deboned turkey meat were cut into chunks of about 3-4 cm and tenderized separately using papain (0.25%) at 4°C for 40 hrs. Tenderized meat then washed and packed separately in low density polyethylene (LDPE) bags and kept at frozen temperature (-18 ± 1 °C) till subsequent use in the experimental trials. Frozen turkey meat was minced by using Hobart Mincer (Model No. 4812) through 6mm grinder plate followed by 4mm grinder plate, packed in LDPE bags and stored frozen at -18 ± 1 °C. Minced frozen meat was partially thawed at 4 ± 1°C for 15 hrs prior to preparation of functional turkey meat loaf.

3.2.2 Cereals

Cereals required for the experiments [oats (*Avena sativa*) and ragi (*Eleusine coracana*)] were purchased from local market in the fresh form, washed, dried, powdered and stored in PET (polyethylene terephthelet) jars.

3.2.3 Herbs

Herbs required for the experiments [oregano (*Origanum vulgare*),parsley (*Petroselinum crispum*)] were purchased from local market in the fresh form, washed and crushed before use and alpha tocopherol acetate is also used .

3.2.4 Spicemix

The spices were procured from local market of Izatnagar, Bareilly, India. After removal of extraneous matters the spices were oven dried at 50 ± 2°C for 30 min. The ingredients were ground mechanically and sieved through a fine mesh screen. The powders so obtained were mixed in suitable proportion to obtain a spice mix for functional poultry meat finger sticks. The spice mix was stored in a PET jar for subsequent use. The formulation of spice mix prepared is given in Table 3.1

3.2.5 Condiment paste preparation

Fresh ginger, garlic and onion were washed, peeled and cut into small pieces. They were blended in the ratio 1:1:3 to a fine paste with a known quantity of chilled water in a blender.

3.2.6 Other ingredients

Refined salt (Tata salt, Tata chemicals Ltd., Mumbai), Refined sunflower oil (Fortune, Adani Wilmar Ltd., Ahmedabad, India), were used. Chemicals/ food additives incorporated in the formulations were of food grade quality and procured from reputed firms i.e., Sodium tripolyphosphate. Packaging materials, Low density polyethylene (LDPE) and food storage pouch for aerobic packaging of functional turkey meat loaf were purchased from reputed manufactures.

Table 3.1 Composition of spice mix

Sl. No.	Name of ingredients	Percentage (w/w)
1	Aniseed (Soanf)	12.4
2	Black pepper (Kalimirch)	18.4
3	Caraway seeds (Ajwain)	10.
4	Capsicum (Mirch powder)	10.4
5	Cardamom dry (Badi elaichi)	5.15
6	Cardamom dry (Chhoti elaichi)	2.00
7	Cinnamon (Dalchini)	5.15
8	Cloves (Laung)	2.00
9	Coriander (Dhania)	12.60
10	Cumin seeds (Zeera)	15.50
11	Mace (Jawitri)	2
12	Nutmeg (Jaifal)	2
	Total	**100.00**

3.3 Preparation of emulsion for Functional Turkey Meat Loaf

All ingredients were added according to Table 3.1. Minced turkey meat and soya protein were mixed in a paddle type mixer (Hobart Food Mixer, Model No. N50G) for 2 min. Ingredients other than flours were added to this meat mix along with 10% water and mixed for

1 min and then added flours for mixing. Finally, a uniform emulsion was prepared and then filled in the previously greased aluminium moulds depending upon the quantity . Flow chart for the preparation of functional turkey meat loaf is given in Fig.1

Table 3.2: Composition of functional turkey meat loaves

Ingredients %	Initial Formulation	Standardised Formulation
Turkey meat	67.95	66.79
Textured soya protein	5	3.5
Egg	5	3.5
Vegetable oil	5.0	5.0
Refined wheat flour	3.0	3.5
Table Salt	1.5	1.8
Cane Sugar	0.25	0.25
Sodium Bi-carbonate	0.25	0.60
Sodium nitrite(ppm)	100	100
TSPP	0.2	0.3
Spice Mix	1.75	1.75
Condiments	3.0	3.0
Ice- Flakes	7	10.0
Total	**100**	**100**

3.4 Cooking method

Based on preliminary trials conducted, hot air oven was adopted for the preparation of functional turkey meat loaf. Aluminium moulds containing raw functional turkey meat loaf were cooked in a hot air oven for about 45- 60 min at 180°C which was found to be adequate for cooking.

3.5 Packaging

After preparation, functional turkey meat loaves were cooled to room temperature. The functional turkey meat loaves were packed aerobically in LDPE.

Fig: 3.1 Flow diagram for the preparation of Functional Turkey Meat Loaf

Turkey meat

↓

Deboning, removal of fascia,connective tissue and fat

↓

Washing and packing in LDPE stored at -18 ± 1 °C for 24 hrs

↓

Mincing using 4mm and 6mm plates in mincer

↓

Mixing turkey meat and soya protein for 1min in paddle type mixer

↓

Addition of salt , sugar, spices, condiments , egg etc

↓

Mixing in paddle type mixer for 1 min

↓

Addition of cereal flours and 7% water

↓

Mixing in paddle type mixer for 2 min

↓

Emulsion manually filling into aluminium moulds

↓

Cooking in hot air oven for 45- 60 minutes

↓

Cooling to room temperature

↓

Sensory evaluation——— quality evaluation——storage at 4 ± 1 °C

↓

Packing in LDPE

3.6 Experimental Details

Preliminary trials were conducted to standardize formulation for the development of functional turkey meat loaves, to select a suitable cooking method and cooking time-temperature combination. This standardized procedure was followed for experimental trials. The best product selected from preliminary trials based on sensory evaluation was taken as control product for further studied conducted.

3.6.1 Experiment – 1

To the selected composition, two flours (oat flour and ragi flour) at different levels were added in eight treatments and the level of minced meat was adjusted accordingly without changing the level of other ingredients. The emulsion was subjected to hot air oven cooking. Physico – chemical, proximate analysis and sensory evaluation were done to select the best product.

Table 3.3 : Composition of treatments Experiment – 1

Ingredients	T1	T2	T3	T4	T5	T6	T7	T8
Turkey meat	63.8	61.8	63.8	61.8	61.8	61.8	62.8	60.8
Oat Flour	3.0	5.0	—	—	3.0	2.0	2.0	3.0
Ragi Flour	—	—	3.0	5.0	2.0	3.0	2.0	3.0
Textured Soya Protein	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Egg	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Vegetable oil	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Refined Wheat Flour	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Table Salt	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Cane sugar	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Sodium bi carbonate	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Sodium Nitrite(ppm)	100	100	100	100	100	100	100	100
TSPP	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Spice Mix	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
Condiments	3	3	3	3	3	3	3	3
Ice flakes	10	10	10	10	10	10	10	10
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

3.6.2 Experiment – 2

The selected best product based on sensory evaluation in experiment No.1 was treatment 8 and composition of treatment 8 has been taken for incorporation of natural preservatives in experiment 2. Two different natural preservatives (oregano and parsley) and α-tocopherol acetate were added at predefined levels and four combinations were made accordingly. Then the emulsion was subjected to hot air oven cooking. Microbiological, antioxident parameters, β-caratone estimation and sensory evaluation were done to select the best product. Based on sensory evaluation, the best product of Experiment - 2 was selected.

Table 3.4 : Composition of treatments Experiment – 2

Ingredients %	T1	T2	T3	T4
Turkey meat	60.3	60.5	60.05	60.05
Oat Flour	3.0	3.0	3.0	3.0
Ragi Flour	3.0	3.0	3.0	3.0
Oregano	—	0.25	0.25	0.25
Parsley	0.5	—	0.5	0.5
Alpha Tocopherol Acetate(ppm)	150	150	—	150
Textured Soya Protein	3.5	3.5	3.5	3.5
Egg	3.5	3.5	3.5	3.5
Vegetable oil	5.0	5.0	5.0	5.0
Refined Wheat Flour	3.5	3.5	3.5	3.5
Table Salt	1.8	1.8	1.8	1.8
Cane sugar	0.25	0.25	0.25	0.25
Sodium bi carbonate	0.6	0.6	0.	0.6
Sodium Nitrite(ppm)	100	100	100	100
TSPP	0.3	0.3	0.3	0.3
Spice Mix	1.75	1.75	1.75	1.75
Condiments	3	3	3	3
Ice flakes	10	10	10	10
Total	**100**	**100**	**100**	**100**

In this experiment ,the determination of antioxidant parameters (ABTS , DPPH) and the β- carotene was done by using the following methodology .

3.6.2.1 ABTS$^+$ (2- 2- azinobis- 3ethylbenthiazoline- 6- sulphonic acid) radical cation activity

The spectrophotometric analysis of ABTS$^+$ radical scavenging activity was determined according to method of ABTS, a stable free radical (Shirwaikar *et al* 2006). This method is based on the ability of antioxidants to quench the long-lived ABTS radical cation, a blue/green chromophore with characteristic absorption at 734 nm, in comparison to that of standard antioxidants. ABTS$^+$ was dissolved in water to a 7 mM concentration. ABTS radical cation (ABTS$^+$) was produced by reacting ABTS$^+$ stock solution with 2.45 mM potassium persulphate ($K_2S_2O_8$) and allowing the mixture to stand in the dark at room temperature for 16 hrs before use. Because ABTS$^+$ and potassium persulphate react stoichiometrically at a ratio of 1:0.5 (mol/mol), this will result incomplete oxidation of ABTS$^+$. Oxidation of ABTS$^+$ commenced immediately, but the absorbance was not maximal and stable until 6 hrs had elapsed. The radical was stable in this form more than two days, when stored in dark at room temperature. Prior to use, the stock solution was diluted with ethanol to an absorbance of 0.70 at t_0 (t=0 min) and equilibrated at 30°C exactly 6 min after initial mixing. About 2 ml of ABTS$^+$ working standard solution was mixed with 0.5ml of extract (prepared as mentioned for DPPH)/standard and absorbancy was measured after 20 min (t_{20}) at 734 nm. The ABTS$^+$ activity was calculated by using formula: ABTS$^+$ activity (% inhibition) = $[(0.7 - At_{20})/ 0.7] \times 100$.

3.6.2.2 1,1- diphenyl – 2 – picrylhydrazyl(DPPH) radical scavenging activity

The ability to scavenge 1,1- diphenyl – 2 – picrylhydrazyl (DPPH) radical by added antioxidants in functional turkey meat loaf was estimated following the method of Keto et al (1988) with slight modifications . DPPH can make stable free radicals in aqueous or ethanol solution , however , fresh DPPH solution was prepared before every measurement . In method, 5g of meat loaf was triturated with 20 ml of ethanol for 2 min. the content was quantitatively transferred into a beaker and filtered through Whatman filter paper No. 42 . Then 1 ml of the filtrate was mixed with 1 ml of 0.1 M Tris-HCl buffer (pH 7.4) and 1 ml of DPPH regent (250µM) in test tubes .The content was gently mixed and then incubated in dark for 20 min.The absorbancy was measured at 517 nm using a UV-VIS Spectrophotometer (Elico SL- 159 India Limited , Mumbai) absorbancy in time t=20 min(t_{20}). Ethanol was used as blank sample.

DPPH free radical scavenging activity was calculated as a decreased of absorbancy from the equation . Scavenging activity (% inhibition) = 100 – At_{20}/ At0)*100 . Gallic acid equivalent(200-600µM/ ml) also calculated for comparing scavenging activity with standard antioxidant.

3.6.2.3 Estimation of β - carotene

Beta-carotene content in meat emulsion was determined by following method (Biswas 2011) .A representative portion of the meat emulsion (1g) was taken and then triturated with 20 ml of acetone using pestle and mortar in the presence of anhydrous sodium sulphate. The sample was quantitatively transferred in a polypropylene centrifuge tube and held at 4±1ÚC for 15 min with occasional shaking. The component so obtained was then centrifuged at 5000 rpm for 10 min in a refrigerated centrifuge. Supernatant was decanted in separate tube and the sample was re-extracted again with 20 ml of acetone. Both the supernatant were combined and then passed through the Whatman filter paper No. 42. The absorbance of the extract was determined at 449 nm wavelength in a UV-VIS spectrophotometer (Elico India Limited, Mumbai). The concentration of β-carotene was determined by external standard method substituting respective absorbance in the linear regression formula (y= 0.108- 0.008 and r^2=0.994; where y=absorbance, x= β-carotene concentration in µg/ml , and r^2=correlation coefficient)

3.6.3 Experiment – 3.

The selected best product based on sensory evaluation in experiment No.2 was treatment 4. The selected product after proper packaging was stored for a period of 15 days in a refrigerator at a temperature 4 ± 1 °C. Proximate analysis of the product was conducted on 0^{th} day and 15^{th} day of storage because it was spoiled on 15^{th} day . Parameters like sensory evaluation, product pH, 2-TBARS value, free fatty acid value, peroxide value, tintometer colour reading and microbiological studies were conducted on 0^{th} day, 5^{th}, 10^{th} and 15^{th} day of storage.

3.6.3.1 Sample preparation

Three replicate samples of 70g emulsion were collected on the day of product preparation, packed in LDPE bags, sealed and stored at -18± 1°C until used for analysis maximum within 2 days. Three replicate samples of functional turkey meat loaves, each sample weighing 50g were stored in LDPE bags for not more than 2days before analysis. Duplicate samples of emulsion and products were selected for microbiological study on the same day of product preparation.

3.6.3.2. 2-Thiobarbituric acid reacting substances (TBARS)

The extraction method described by *Witte et al.,* (1970) was used with suitable modifications for determination of TBARS value in functional turkey meat loaves. 10g of sample was triturated with 25 ml of precooled 20% trichloroacetic acid (TCA) in 2 M orthophosphoric acid solution for 2 min. The content was then transferred quantitatively to a beaker by rinsing with 25 ml of cold distilled water, well mixed and filtered through ashless filter paper (Whatman filter paper No. 1 supplied by s. d. fine chemicals Ltd., Mumbai, India). Then 3 ml of TCA extract (filtrate) was mixed with 3 ml of 2-thiobarbituric acid (TBA) reagent (0.005 M) in test tubes and placed in a dark cabinet for 16 hrs. A blank sample was made by mixing 3 ml of 10% TCA and 3 ml of 0.005 M TBA reagent. Absorbance (O.D.) was measured at fixed wavelength of 532 nm with a scanning range of 531 to 533 nm using spectrophotometer (Thermospectronic, Genesys 100V). TBA value was calculated as mg malonaldehyde per kg of sample by multiplying O.D. value with K factor of 5.2.

3.6.3.3 Free fatty acids (FFAs)

The method as described by Koniecko (1979) was followed for quantification of free fatty acids. For this, 5 g of sample was blended into fine powder using anhydrous sodium sulphate and then mixed with 30 ml of chloroform for 2 min. The slurry was filtered through Whatman filter paper No. 1 into a 100 ml conical flask. About 2 or 3 drops of 0.2 % phenolphthalein indicator solution were added to the chloroform extract, which was then titrated against 0.1N alcoholic potassium hydroxide to get the pink colour end point. The quantity of potassium hydroxide required for titration was recorded and calculated as follows: Free fatty acid (FFA) % = [(0.1 × ml 0.1N alcoholic KOH × 0.282)/ Sample weight (g)] × 100.

3.6.3.4 Peroxide value

The peroxide value was measured as per procedure described by Koniecko (1979) with suitable modifications. Five gram of meat sample was blended with 30 ml chloroform for

2 min in the presence of anhydrous sodium sulphate. The mixture was filtered through Whatman filter paper No.1 and 25 ml aliquot of the filtrate was transferred to 250 ml conical flask to which 30 ml of glacial acetic acid and 2 ml of saturated potassium iodide solution were added and allowed to stand for 2 min with occasional shaking (swirling) after which 100 ml of distilled water and 2 ml of fresh 1 percent starch solution were added. Flask contents were titrated immediately against 0.1N sodium thiosulphate till the end point was reached (non-aqueous layer turned to colourless). The peroxide value (meq/kg of the meat) was calculated as per the following formula; PV (meq/kg sample) = [(0.1 × ml 0.1N sodium thiosulphate)/ Wt. of sample (g)] × 1000.

3.6.3.5 Lovibond Tintometer colour

Colour of the functional turkey Meat loaf were measured using Lovi bond Tintometer (Model F, Greenwich, U.K.). Three different samples of each product wereanalyzed . The sample colour was matched by adjusting red (a) and yellow (b) units and the corresponding colour units were recorded. The hue and chroma values were determined by using the formula, ($\tan^{-1} b/a$) (Little, 1975) and $(a^2 + b^2)^{1/2}$ (Froehlich *et al.*, 1983) respectively, where a = red unit and b = yellow unit.

3.6.3.6 Proximate analysis

Proximate composition of functional turkey meat loaves, both control and treatment, were determined according to the method described by AOAC (1995). Moisture content of the product was determined by the oven drying method at 110°C for 24 hrs. Crude protein content was determined by the Micro - Kjeldahl method. Total fat was determined by the Soxhlet method. Fibertech (FOSS, Fibercup2021) method was used for crude fiber estimation. Total ash was determined by ignition of the sample at 600°C in muffle furnace.

3.6.3.7 pH

pH values of emulsion and products were determined as per AOAC (1995). Homogenates were prepared by blending 10g sample with 50 ml distilled water for 1 min. pH of the homogenates was recorded by digital pH meter (Cyber Scan 2100).

3.6.3.8 Cooking yield

The weight of emulsion before extrusion, weight of emulsion remaining after extrusion and product weight were recorded. Cooking yield was calculated using the formula, cooking yield (%) = weight of product obtained/ weight of emulsion x 100.

3.6.3.9 Microbiological analysis

Standard plate count, total coliforms count, *Staphylococcus* species count, *Salmonella* spp. count and yeast and mould counts (Y&M) in the samples were enumerated as per the methods described by APHA, 2001. Readymade media from Hi-media Laboratories (P) Ltd., Mumbai, were used for enumeration of different microbes. Duplicate plates were prepared and the counts were expressed as log colony forming units (cfu) per gram.

3.6.3.9.1 Preparation of sample

1 g sample from functional turkey meat loaves at different stages of storage were taken aseptically and blended with 9 ml of normal saline solution. Serial ten fold dilutions were made in pre-sterilized tubes containing 0.9 ml of normal saline solution. The sample preparation and plating were carried out under Class II biosafety cabinet. Two samples from each group were processed for microbiological analysis.

3.6.3.9.2 Standard plate count (SPC)

For estimating SPC, the approximate dilutions were selected and 1 ml of the selected dilution was aseptically transferred to standard petridish of 100mm diameter. To each plate about 10-15 ml of melted and cooled (45°C) plate count agar was added and allowed to solidify. The inverted petridishes were incubated at 37°C for 24-48 hrs and colonies were counted under a colony counter having 30-300 colonies. The average count was multiplied by the dilution factor and expressed as log cfu/g of the sample.

3.6.3.9.3 Total coliform count

For estimating total coliforms, MacConkey agar was used. The procedure of plating was stated as above. Red to pink colonies of 0.5mm in diameter were counted and expressed as log cfu/g of sample.

3.6.3.9.4 *Staphylococcus* spp. count

Serial dilutions were made as mentioned previously. About 15 ml of Baired Parker Agar base media (Hi-Media) was poured into the petridish containing 1 ml of diluted sample. Then the petridishes were incubated at 37°C for 24-48 hrs. Viable colonies (Dark centered colonies surrounded by white rings) were counted and expressed in log cfu/g of sample.

3.6.3.9.5 *Salmonella* spp. count

For estimating *Salmonella* spp. count, MacConkey agar was used. The procedure of plating was stated as above. Light pink colonies of 0.5mm in diameter were counted and expressed as log cfu/g of sample.

3.6.3.9.6 Yeast and Mould count

Duplicate 0.1ml volume of inoculums of suitable dilutions was spread over the surface of the pre poured petridish with potato dextrose agar (PDA) media. The plates were incubated at 25°C for 5days. Following incubation plates showing 30-300 colonies were counted and expressed as log cfu/g of sample.

3.6.3.9.7 Psychrotrophic Count

Procedure mentioned for Standard Plate Count was followed but the plates were incubated at a temperature of 5°C for seven days. Colonies were counted and results expressed in a similar way.

3.6.3.10 Sensory evaluation

Sensory attributes of the products was evaluated by a panel consisting of minimum six semi-trained members using 8 point descriptive scale (Keeton, 1983). The panelists were explained about the nature of the experiment prior to analysis. Sensory attributes including appearance and colour, flavour, binding, texture, juiciness, meat flavour intensity, after taste, after taste and overall acceptability were evaluated using 8 point scale, being 8 excellent and 1 extremely poor for all sensory variables.

3.6.3.11 Determination of Formulation cost of functional turkey meat loaves

Formulation cost of functional turkey meat loaves at laboratory scale were calculated by considering various factors influencing the marketability of the product such as raw material cost, processing cost, distributor's margin, gross profit, storage cost etc.

3.7 Statistical analysis

The data obtained from the above experiments were subjected to statistical analysis. Duplicate samples were drawn for each parameter and the experiment was replicated thrice. Means and standard error were calculated following the standard statistical procedures. Data from each experiment were subjected to Analysis of Variance as per the procedures of Snedecor and Cochran, (1980). The effects between treatment, between storage periods and their interactions were determined (Duncan, 1995).

DIVISION OF POST-HARVEST TECHNOLOGY
CARI, IZATNAGAR

PROFORMA FOR SENSORY EVALUATION

Name : Experiment No:

Product : **Functional Turkey Meat Loaf** Date:
Sensory attributes : 8-point scale for descriptive attributes of product

	8	7	6	5	4	3	2	1
Colour & Appearance	Excellent	Very good	Good	Fair	Slightly poor	Moderately poor	Very poor	Extremely poor
Flavour	Extremely desirable	Very desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Moderately undesirable	Very undesirable	Extremely undesirable
Binding	Extremely desirable	Very desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Moderately undesirable	Very undesirable	Extremely undesirable
Texture	Extremely desirable	Very desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Moderately undesirable	Very undesirable	Extremely undesirable
Juiciness	Extremely Juicy	Very Juicy	Moderately Juicy	Slightly Juicy	Slightly Dry	Moderately Dry	Very Dry	Extremely Dry
Meat Flavor intensity	Extremely desirable	Very desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Moderately undesirable	Very undesirable	Extremely undesirable
After Taste	Extremely desirable	Very desirable	Moderately desirable	Slightly desirable	Slightly undesirable	Moderately undesirable	Very undesirable	Extremely undesirable
Overall Acceptability	Extremely acceptable	Very acceptable	Moderately acceptable	Slightly acceptable	Slightly unacceptable	Moderately unacceptable	Very unacceptable	Extremely unacceptable
Sample	**Colour & Appearance**	**Flavour**	**Binding**	**Texture**	**Juiciness**	**Meat Flavor intensity**	**After Taste**	**Overall Acceptability**
1								
2								
3.								
4.								

Remarks: Signature:

Results

4 RESULTS

The present chapter describes the results obtained from different experiments carried out during the present study in accordance with the objectives and following the methods described in the preceding chapter . Each parameter was selected in such a way so as to have effect on the quality attributes of turkey meat loaf , so that the final product may have the good acceptability .

4.1 Preliminary Trials

Several preliminary trials were conducted for developing a suitable formulation for functional turkey meat loaf. Based on the sensory evaluation results of these trials, a basic composition of functional turkey meat loaf was developed without adding any specific functional ingredient. This product was selected as the control for comparing the functional qualities of final product during storage studies. Different levels of many ingredients like salt, refined vegetable oil ,tetra sodium pyrophosphate and water were adopted during the preliminary trials for selecting the best formulation . The levels selected thus made the standardized formulation.

4.2 Identification of Suitable Cereal Flour(s) For Standardization of Formulation in Development of Functional Turkey Meat Loaf

Incorporation of two different flours, oat flour and ragi flour were attempted in this experiment by partially replacing lean meat. In treatments, all other ingredients were used at the same level as in control.

4.2.1 Physico-chemical characteristics

Incorporation of eight different levels of oat flour and ragi flour either alone or in combination resulted in significantly different ($P<0.01$) emulsion pH. The results analyzed are summarized in Table 4. 1 and 4.2. Highest emulsion pH 7.272 was observed when oat flour added at a level of 3% and ragi flour also at 3%. The product pH showed similar trends to that of emulsion pH. Lower pH were observed with product containing less amount of cereal flour. The maximum and minimum values obtained for product pH were 7.356 and 7.131 respectively. Results of emulsion stability revealed that the formulation containing higher flour level was having the highest emulsion stability. The cooking yield was calculated for all combinations and highest cooking yield was showed by the formulation having 5% ragi flour. There was a significant variation in cooking yield among treatments having different flours.

4.2.2 Proximate composition

Proximate composition of functional turkey meat loaf was analyzed following the standard procedures mentioned in Chapter 3. The result of proximate analysis of products is summarized in Table4.3 and 4.4. The parameters selected for study were moisture, protein, fat, crude fiber and total ash. Each experiment was done in triplicates and duplicate samples were taken for analysis from each treatment.

The moisture content differed significantly ($P<0.01$) amongst the treated products. The highest moisture content has been shown by T_8 sample which contained 50.38% moisture having 3% oat flour and 3% ragi flour. The least value was showed by T_3 sample incorporated with 3 % ragi flour. The highest protein value was observed in T_6 sample and lowest by T_1. Fat content did not show any considerable change when different combinations of oat and ragi flours were used.

The highest fat content was observed in T_3 having 3% ragi flour which contained least amount of added flours especially ragi.

Table 4.1: Physico–chemical characteristics of functional turkey meat loaf in Experiment – 1

Treatments	Emulsion pH	Product pH	Cooking yield (%)	Emulsion stability (%)
T_1	7.111^{A}±0.003	7.131^{A}±0.001	83.662^{A}±0.001	90.003^{A}±0.001
T_2	7.213^{C}±0.008	7.223^{C}±0.001	83.676^{C}±.001	90.234^{B}±0.002
T_3	7.114^{A}±0.005	7.214^{B}±0.001	83.675^{BC}±0.001	90.003^{A}±0.001
T_4	7.217^{C} ±0.003	7.321^{G}±0.001	83.683^{C}±0.001	90.246^{C}±0.001
T_5	7.256^{D} ±0.001	7.282^{F}±0.001	83.663^{A}±0.001	91.236^{F}±0.001
T_6	7.251^{D}±0.001	7.263^{E}±0.006	83.665^{AB}±0.001	91.125^{E}±0.001
T_7	7.152^{B} ±0.001	7.255^{D}±0.001	83.661^{A}±0.001	91.112^{D}±0.001
T_8	7.272^{E} ±0.002	7.356^{H}±0.001	83.666^{AB}±0.009	92.252^{G}±0.003
Overall mean± SE	7.198 ± .012	7.255±0.013	83.668±0.001	90.776±.757

T_1 = 3% oat flour , T_2 = 5% oat flour ,T_3 = 3% ragi flour , T_4 = 5% ragi flour , T_5 = 3% oat flour and 2% ragi flour , T_6= 2% oat flour and 3% ragi flour , T_7 = 2%oat flour and 2% ragi flour , T_8 = 3% oat flour and 3% ragi flour .

*Means with different superscript(s) in a column differ significantly (P<0.01).

Table 4.2: Analysis of variance for physico–chemical characteristics of functional turkey meat loaf in Experiment – 1

Parameters	Between treatments MSS	df = 7 F	Within treatments df =16 MSS
Emusion pH	0.012	1351.220^{***}	0.001
Product pH	0.014	971.835^{***}	0.001
Cooking yield	0.001	6.271	0.001
Emulsion Stability	1.883	223717.940^{***}	0.001

*Value indicates level of significance ** P<0.05, *** P<0.01

Table 4.3: Proximate composition (%) of functional turkey meat loaf

Parameters	Moisture	Protein	Fat	Fibre	Total Ash
T_1	49.543^{D}±0.001	24.124^{A}±0.002	13.323^{A}±0.001	3.115^{A}±0.001	6.126^{A}±0.001
T_2	50.122^{E}±0.001	24.236^{B}±0.001	13.214^{A}±0.045	3.119^{A}±0.001	6.252^{C}±0.003
T_3	49.242^{A}±0.001	24.326^{C}±0.001	14.154^{C}±0.028	3.116^{A}±0.003	6.177^{B}±0.021
T_4	50.223^{F}±0.001	24.577^{D}±0.006	13.224^{A}±0.005	3.120^{A}±0.002	6.251^{C}±0.002
T_5	50.323^{G}±0.001	24.149^{S}±0.003	13.520^{B}±0.133	3.255^{C}±0.001	6.323^{D}±0.001
T_6	49.323^{B}±0.001	25.123^{E}±0.001	14.114^{C}±0.063	3.256^{C}±0.002	6.328^{D}±0.004
T_7	49.458^{C}±0.001	24.125^{A}±0.001	13.223^{A}±0.009	3.215^{B}±0.017	6.245^{C}±0.002
T_8	50.377^{G}±0.067	24.157^{A}±0.031	13.238^{A}±0.012	4.156^{D}±0.018	7.138^{E}±0.009
Overall Mean ± SE	49.826±0.093	24.352±00.067	13.501±0.080	3.294±0.069	6.355±0.063

T_1 = 3% oat flour , T_2 = 5% oat flour ,T_3 = 3% ragi flour , T_4 = 5% ragi flour , T_5 = 3% oat flour and 2% ragi flour , T_6= 2% oat flour and 3% ragi flour , T_7 = 2%oat flour and 2% ragi flour , T_8 = 3% oat flour and 3% ragi flour .

*Means with different superscript(s) in a column differ significantly (P<0.05).

Table 4.4: Analysis of variance for proximate composition of functional turkey meat loaf

Parameters	Between treatments MSS	Within treatments df =16 MSS	df = 7 F
Moisture	0.688	0.002	402.809**
Protein	0.360	0.001	896.653
Fat	0.489	0.009	52.359
Fibre	0.376	0.001	1453.137***
Ash	0.314	0.001	1375.852**

*Value indicates level of significance ** P<0.05, *** P<0.01

Table 4.5 : Sensory evaluation of functional turkey meat loaf in Experiment - 1

Parameters	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	Overall Mean ± SE
Color & appearance	$5.80^{BC}\pm0.48$	$5.80^{BC}\pm0.48$	$4.80^{AB}\pm0.20$	$4.60^{A}\pm0.24$	$6.20^{C}\pm0.20$	$6.00^{C}\pm0.31$	$6.00^{C}\pm0.01$	$6.60^{C}\pm0.40$	5.72±0.14
Flavour	$5.40^{AB}\pm0.40$	$5.40^{AB}\pm0.40$	$4.80^{A}\pm0.37$	$4.80^{A}\pm0.37$	$6.00^{AB}\pm0.31$	$6.00^{AB}\pm0.31$	$5.20^{AB}\pm0.20$	$6.20^{C}\pm0.48$	5.47±0.14
Binding	$5.00^{AB}\pm0.54$	$5.20^{AB}\pm0.58$	$4.80^{A}\pm0.48$	$4.80^{A}\pm0.48$	$6.20^{AB}\pm0.58$	$6.00^{AB}\pm0.31$	$5.20^{AB}\pm0.20$	$6.40^{C}\pm0.24$	5.45±0.17
Texture	$5.20^{AB}\pm0.58$	$5.20^{AB}\pm0.58$	$4.20^{A}\pm0.37$	$4.40^{A}\pm0.40$	$6.00^{B}\pm0.01$	$5.80^{BC}\pm0.20$	$5.80^{BC}\pm0.20$	$6.60^{C}\pm0.24$	5.40±0.17
Juiciness	$5.40^{AB}\pm0.60$	$5.20^{AB}\pm0.58$	$5.00^{A}\pm0.31$	$4.80^{A}\pm0.37$	$6.00^{AB}\pm0.01$	$5.80^{AB}\pm0.20$	$5.60^{AB}\pm0.24$	$6.40^{C}\pm0.24$	5.52±0.14
MeatFlavour Intensity	$5.20^{ABC}\pm0.58$	$5.00^{AB}\pm0.54$	$4.40^{AB}\pm0.50$	$4.20^{A}\pm0.37$	$5.40^{ABC}\pm0.40$	$4.60^{BC}\pm0.24$	$5.20^{ABC}\pm0.20$	$6.40^{C}\pm0.24$	5.17±0.16
After Taste	$5.20^{A}\pm0.58$	$5.20^{A}\pm0.58$	$4.60^{A}\pm0.50$	$4.60^{A}\pm0.50$	$5.80^{AB}\pm0.20$	$5.80^{AB}\pm0.20$	$5.60^{AB}\pm0.24$	$6.60^{B}\pm0.24$	5.42±0.16
Overall Acceptability	$5.00^{AB}\pm0.63$	$4.80^{AB}\pm0.58$	$4.20^{A}\pm0.58$	$4.00^{A}\pm0.44$	$5.60^{BC}\pm0.24$	$5.80^{BC}\pm0.20$	$5.60^{BC}\pm0.24$	$6.60^{C}\pm0.24$	5.20±0.19

T_1 = 3% oat flour , T_2 = 5% oat flour, T_3 = 3% ragi flour, T_4 = 5% ragi flour, T_5 = 3% oat flour and 2% ragi flour, T_6= 2% oat flour and 3% ragi flour , T_7 = 2% oat flour and 2% ragi flour, T_8 = 3% oat flour and 3% ragi flour .
Means with different superscript(s) in a row differ significantly ($P<0.05$).

Table 4.6: Analysis of variance for sensory attributes of functional turkey meat loaf in Experiment - 1

Parameters	Between treatments MSS	df = 7 F	Within treatments df =32 MSS
Color	2.339	4.253*	0.550
Flavour	1.482	2.196	0.675
Binding	2.100	2.024	1.038
Texture	3.314	4.735**	0.700
Juiciness	1.425	2.073	0.688
Meat FlavourIntensity	2.368	2.786*	0.850
After Taste	2.254	2.576*	0.875
Overall Acceptability	3.771	4.023**	0.938

Value indicates level of significance : P<0.05 ** P<0.01

While analyzing crude fiber content of functional turkey meat loaf after incorporation of fiber rich whole grain flours, as expected product with 3% oat flour and 3% ragi flour that is T_8 was showing the highest value of 4.16. There was a significant difference ($P<0.01$) among the crude fiber content of various treatments. The total ash content of treated products was analyzed and it was found that T_8 had highest value(7.14). Ash content of all the analyzed products were changed significantly ($P<0.01$).

4.2.3 Sensory evaluation

Eight different sensory attributes were analyzed for functional turkey meat loaf using 8-point descriptive scale where 8 indicates extremely desirable and 1 indicates extremely undesirable. The sensory qualities analyzed were colour and appearance, flavour, binding, texture, juiciness, meat flavour intensity, after taste and overall acceptability. The results pertaining to sensory attributes is presented in table 4.5 and 4.6.

On sensory evaluation, the average scores obtained for colour and appearance of products were ranging from 4.60 to 6.60 with an overall mean 5.72. The treatment T_8 showed the highest ($P<0.05$) value among all treated products. Sensory results were showing a difference in flavour among all the treated products and the highest value was of T_8 with a value of 6.20 followed by T_5. Among all the treated products the best binding was of T_8 having 3% oat flour and 3% ragi flour. Sensory scores analyzed for texture were found to be varying with different compositions. Treatments T_8 followed by T_5 were showing significantly ($P<0.05$) higher scores. The least value was obtained when composition contained 3% ragi flour.

Among all the treatments analyzed, highest score for juiciness was 6.40 observed for $T_{8.}$ A significant change in juiciness was noted in other treatments with an overall mean value of 5.52. T_8 showed the lowest sensory scores for meat flavour intensity. The highest value was shown by T_1 (6.40) and other treatments had values between 4.40 and 5.40. T_8 scored the highest for after taste with the value of 6.60 and with overall mean 5.42. Overall acceptability scores of product T_8 was best and the value was 6.60 with a total mean of 5.20.

Based on the sensory score of eight different treatments analyzed for different sensory attributes, the product having significantly higher ($P<0.05$) values than rest of treatments was selected. In which treatment T_8 was found to be the best.

4.3 Identification of Suitable Natural Preservatives for Standardization of Formulation in development of Functional Turkey Meat Loaf

Based on sensory evaluation, product T_8 from previous experiment 4.2 was found to be most suitable amongst all the treatments and hence this formulation incorporated with two natural preservative and alpha tocopherol acetate at two different levels by partially replacing the lean meat content have been studied in this experiment .

4.3.1 Antioxidant Parameters and β- carotene

Two different levels of oregano, parsley and alpha tocopherol acetate when incorporated into the formulation (selected best from previous Exp. 4.2) then the antioxidant parameters (ABTS and DPPH) and the β- carotene were studied . The results are summarized in table 4.7 and 4.8. The value for $ABTS^+$ activity (% inhibition) for T_3 is 94.856 which was least among the four treatments and the highest activity was for the T_4 treatment having the value of 98.284.Each treatment differed significantly to another treatment.

The mean value of DPPH radical scavenging activity(% inhibition) was highest for the T_4 treatment with a value of 80.333. The trend of increasing % inhibition is same as that of $ABTS^+$ activity from T_3 then T_1 which is lastly followed by T_4.

The β-carotenoid estimation results were different from $ABTS^+$ and DPPH radical scavenging activity . The highest mean value of β- carotenoid was for T_4 followed by T_3, both having parsley and the lowest mean value was for T_2 which was not having parsley responsible for β- carotenoid concentration in the present meat loaf.

4.3.2 Microbiological Results

The results of microbiological study is summarized in table 4.9 and 4.10. It was found that the T_1 is having the highest mean value of 3.022 of SPC which differed significantly from the other treatment while the treatments having equal concentration of oregano do not differed significantly . The lowest SPC count was of T_4 with a mean value of 2.793 and the overall mean is 2.877 for SPC. The coliforms, Staphylococcus spp. Yeast and mould and Salmonella spp. was not found in any treatments of experiment no. 2.

Table 4.7: Antioxidant parameters and β- carotene of functional turkey meat loaves in Experiment – 2

Treatments	ABTS	DPPH	β- Carotene
T_1	$96.573^{B} \pm 0.001$	$55.153^{A} \pm 1.665$	$12.411^{B} \pm 0.011$
T_2	$98.284^{C} \pm 0.001$	$78.791^{B} \pm 1.001$	$0.021^{A} \pm 0.001$
T_3	$94.856^{A} \pm 0.001$	$48.181^{A} \pm 0.008$	$14.061^{C} \pm 0.001$
T_4	$98.284^{D} \pm 0.001$	$80.333^{B} \pm 0.001$	$16.851^{D} \pm 0.001$
Total Mean ± SE	96.999 ± 0.428	65.614±4.789	10.836 ± 1.942

Mean with different superscripts vary columnwise significantly(P<0.05)
T_1= 150 ppm α- Tocopherol acetate and 0.5% parsley powder, T_2 = 150ppm α- Tocopherol acetate and 0.25 % oregano powder; T_3 = 0.25% oregano powder and 0.5 % pasley powder ; T_4 = 150 ppm α- Tocopherol acetate, 0.25% oregano powder and 0.5% parsley powder.

Table 4.8: Analysis of variance for antioxidant parameters and β- carotene of functional turkey meat loaves

Parameters	Between treatments MSS	df = 7 F	Within treatments df =32 MSS
ABTS	8.076	1938192.607**	0.001
DPPH	803.621	10.425**	77.088
β – Carotene	166.026	5355667.742**	0.001

* Value indicate level of significance * $P<0.05$, ** $P<0.01$

Table 4.9: Microbiological analysis of functional turkey meat loaf

Treatments	SPC	*E. coli*	*Staphylococcus* Spp. count	Yeast and mould	*Salmonella* detection
T_1	$3.002^B \pm 0.586$	ND	ND	ND	ND
T_2	$2.819^A \pm 0.041$	ND	ND	ND	ND
T_3	$2.895^A \pm 0.058$	ND	ND	ND	ND
T_4	$2.793^A \pm 0.059$	ND	ND	ND	ND
Overall Mean ± SE	2.877 ± 0.035	—	—	—	—

**Mean with different superscripts vary columnwise significantly(P<0.01)
**T1= 150 ppm α- Tocopherol acetate and 0.5% parsley powder, T2 = 150ppm α- Tocopherol acetate and 0.25 % oregano powder; T3 = 0.25% oregano powder and 0.5 % pasley powder ; T4 = 150 ppm α-Tocopherol acetate, 0.25% oregano powder and 0.5% parsley powder

Table 4.10: Analysis of variance for microbiological parameters of functional turkey meat loaves in Experiment – 2

Parameters	Between treatments MSS F3	df = 8 F	Within treatments df =3 MSS
SPC	0.031	3.407**	0.073
E. Coli	ND	ND	ND
Staphylococcus Spp. count	ND	ND	ND
Yeast and Mould Count	ND	ND	ND
Salmonella Detection	ND	ND	ND

* Value indicate level of significance * P<0.05, ** P<0.01

Table 4.11 : Colour characteristics of functional turkey meat loaves

Treatments	Redness	Yellowness	Hue angle	Chroma
T_1	$1.533^B \pm 0.033$	$3.133^A \pm 0.033$	$63.930^A \pm .248$	$3.487^A \pm 0.044$
T_2	$2.133^C \pm 0.033$	$4.533^C \pm 0.033$	$64.797^A \pm .447$	$5.009^C \pm 0.026$
T_3	$1.366^A \pm 0.033$	$5.333^D \pm 0.033$	$75.623^D \pm .420$	$5.505^D \pm 0.024$
T_4	$1.533^B \pm 0.033$	$4.300^B \pm 0.033$	$70.376^B \pm .393$	$4.565^B \pm 0.011$
Total Mean±SE	1.641 ± 0.089	4.325 ± 0.237	68.681±1.429	4.642±0.224

**Mean with different superscripts vary columnwise significantly($P<0.01$)
T_1= 150 ppm α- Tocopherol acetate and 0.5% parsley powder, T_2 = 150ppm α- Tocopherol acetate and 0.25 % oregano powder; T_3 = 0.25% oregano powder and 0.5 % pasley powder ; T_4 = 150 ppm α- Tocopherol acetate, 0.25% oregano powder and 0.5% parsley powder

Table : 4.12 Anlysis of variance of colour characteristics

Parameters	Between treatments MSS F3	df = 3 F	Within treatments df =8 MSS
Redness	0.341	102.250*	0.003
Yellowness	2.481	992.333**	0.003
Hue Angle	88.720	199.494**	0.445
Chroma	2.219	868.505**	0.003

* Value indicate level of significance * P<0.05, ** P<0.01

Table 4.13: Sensory evaluation of functional turkey meat loaf after in Experiment-2

	T_1	T_2	T_3	T_4	Overall Mean ± SE
Colour And Appearance	$4.60^{A} \pm 0.24$	$6.0^{B} \pm 0.01$	$6.0^{B} \pm 0.54$	$6.6^{B} \pm 0.24$	$5.8^{B} \pm 0.22$
Flavour	$5.4^{A} \pm 0.24$	$5.8^{AB} \pm 0.20$	$5.0^{A} \pm 0.77$	$6.8^{B} \pm 0.20$	5.75 ± 0.25
Binding	$5.0^{A} \pm 0.31$	$5.2^{A} \pm 0.37$	$6.2^{B} \pm 0.20$	$6.6^{B} \pm 0.24$	5.75 ± 0.20
Texture	$5.6^{A} \pm 0.24$	$5.4^{A} \pm 0.24$	$5.8^{AB} \pm 0.20$	$6.6^{B} \pm 0.24$	5.85 ± 0.15
Juiciness	$5.8^{BC} \pm 0.20$	$4.6^{A} \pm 0.50$	$5.2^{AB} \pm 0.20$	$6.4^{C} \pm 0.24$	5.5 ± 0.21
Meat FlavourIntensity	$5.6^{A} \pm 0.24$	$6.8^{A} \pm 0.20$	$5.6^{A} \pm 0.24$	$5.6^{B} \pm 0.24$	5.9 ± 0.16
After Taste	$5.2^{A} \pm 0.20$	$5.2^{A} \pm 0.20$	$5.6^{AB} \pm 0.40$	$6.2^{B} \pm 0.20$	5.5 ± 0.15
Overall Acceptability	$4.6^{A} \pm 0.24$	$5.0^{B} \pm 0.01$	$6.0^{C} \pm 0.01$	$7.0^{D} \pm 0.01$	5.65 ± 0.01

T_1= 150 ppm α- Tocopherol acetate and 0.5% parsley powder, T_2 = 150ppm α- Tocopherol acetate and 0.25 % oregano powder; T_3 = 0.25% oregano powder and 0.5 % pasley powder ; T_4 = 150 ppm α- Tocopherol acetate, 0.25% oregano powder and 0.5% parsley powder

*Means with different superscript(s) in a row differ significantly (P<0.01).

Table 4.14: Analysis of variance for sensory evaluation of functional turkey meat loaf after Experiment - 2

Parameters	Between treatments MSS df3	df = 3 F	Within treatments df =16 MSS
Colour and Appearance	3.60	6.857**	0.525
Flavour	2.983	3.225*	0.925
Binding	2.983	7.020**	0.425
Texture	1.383	5.030*	0.275
Juiciness	3.00	6.00**	0.50
Meat FlavourIntensity	1.80	6.545**	0.275
After Taste	1.117	3.190*	0.350
Overall Acceptability	5.783	77.111**	0.075

* Value indicate level of significance * $P<0.05$, ** $P<0.01$

4.3.3 Colour Characeristics

Redness (*a*-value) show significant change in the treatment groups. The results are analyzed in Table 4.11 and 4.12. The highest *a*-value was observed for T_2 with a mean value of 2.133 and the lowest mean value is of T_3 having mean of 1.366. However, a significant difference was observed between treatment groups.

Yellowness (*b*-value) also showed a significant difference between treatment groups. T_3 showed its highest *b*-value of 5.333, where as treatment T_1 showed the least value of 3.133.

Hue angle of all the treatment groups were calculated. Hue angle value of the treatment groups were significantly ($P<0.001$) different from each other. T_3 showed the maximum average value of 75.623 followed by T_4.

Chroma values of all treatment groups were significantly ($P<0.01$)different from each other. Highest chroma value of was observed for the treatment T_3 (5.50) with a mean value of 4.642. There was significant difference between treatments.

4.3.4 Sensory evaluation

After incorporation of natural preservatives in the functional turkey meat loaf, its eight different sensory attributes were analyzed to assess the acceptability of the product. The summarized results of sensory evaluation are given in Table 4.13 and 4.14. According to the data presented, the highest score for colourand appearance (6.6) was given to product T_4 by the panelists which showed a significant difference from other treatments ($P<0.01$). T_2 and T_3 also showed the same scores (6.0) which contained 0.25% oregano in formulation.

The flavour characteristic of functional turkey meat loaf were found ranging from 5.0 (T_3) to 6.8 (T_4). T_4 showed a value (6.8) significantly higher ($P<0.05$) than other treatments having 150 ppm alpha tocopherol acetate , 0.25% oregano and 0.5% parsley.

According to sensory scores, the textural properties of functional turkey meat loaves T_1, T_2, and T_3 showed a significantly low ($P<0.05$) score when compared with value 6.60 of T_4. Treatment with more accepted binding was found to be with T_4 and T_1 and varied significantly ($P<0.01$) than all other treatments. Juiciness was also noticed higher in T_4 (6.4) when compared with all other treatments. Meat flavour intensity score of T_1, T_2, T_3 and T_4 were 5.6, 6.4, 5.6 and 5.6 respectively.

After taste scores were also observed higher for T_4 (6.20) than all other treatments. Overall acceptability values of these treatments showed that T_4 was superior to other products evaluated in this study with an overall acceptability score of 7.00 T_3 also has recorded a better score on sensory evaluation, but was significantly lower ($P<0.05$) than that of T_4. Product containing alpha tocopherol acetate and parsley were found having the least score.

4.4 Storage quality of functional turkey meat loaf at 4±1^{o}C under aerobic packaging condition

4.4.1 Analysis of storage quality parameters

TBARS, PV, FFA and pH value of all the stored products were determined at 5 days interval from 0th day to 15th day of storage. The results are presented in Table 4.15 and 4.16. Control products showed average TBARS values of 0.263, 0.287, 0.305 and 0.325 over duration of storage period (0^{th} ,5^{th} ,10^{th} ,15^{th} day) .The overall mean value was found to be 0295. The observed corresponding TBARS values of treatments were 0.257, 0.281, 0.302 and 0.319 with a total mean average of 0.290. TBARS values found were increasing with increase in storage in case of both control and treatment during storage. The highest TBARS value of the control and treated product were observed on the 15th day of storage. The observed control values on each day of analysis were significantly higher than that of the product value on the same day of storage.

Peroxide value also showed an increasing trend during storage for both control product and treatment. In case of control product, the observed value remained at 0.001 meq/kg of the product. A significant variation was observed after 10th days of storage. In treated product the peroxide value did not show any significant difference during the initial 10 days of storage. When compared with the treated product, average PV value of control was the same for first initial 05 days of storage. Later, control showed significant increase in value than treatments on same day of storage. Free Fatty acid content of control and treated products were observed increasing according to the increase in storage periods. On the same day of storage, the observed treatment value and the control value were differed significantly ($P<0.01$).

Table 4.15: Quality parameters of functional turkey meat loaf during storage at 4 ± 1°C under aerobic packaging condition

	Day 0	Day 5	Day 10	Day 15	Total Mean±SE
			TBARS (mg malonaldehyde/kg)		
Control	0.263^{Ab} ±0.001	0.287^{Bb} ±0.001	0.305^{Cb} ±0.002	0.325^{Db} ±0.001	0.295 ±0.006
Treatment	0.257^{Aa} ±0.002	0.281^{Ba} ±0.008	0.302^{Ca} ±0.001	0.319^{Da} ±0.004	0.290 ±0.007
			Peroxide Value (meq/kg)		
Control	0.001^{Aa} ± 0.001	0.001^{ABa} ±0.001	0.002^{BCb} ±0.001	0.003^{Cb} ±0.001	0.001 ±0.001
Treatment	0.001^{Aa} ±0.001	0.001^{ABa} ±0.001	0.001^{ABa} ±0.001	0.002^{Ba} ±0.001	0.001 ±0.001
			Free Fatty Acid		
Control	0.866^{Ab} ±0.001	0.882^{Bb} ±0.001	0.902^{Cb} ±0.001	1.012^{Db} ±0.001	0.915 ±0.017
Treatment	0.865^{Aa} ±0.001	0.881^{Ba} ±0.001	0.898^{Ca} ±0.003	1.008^{Da} ±0.003	1.008 ±0.003
			Product pH		
Control	7.341^{Cb} ±0.001	7.201^{BCb} ±0.078	7.141^{Bb} ±0.035	6.992^{Ab} ±0.001	7.169 ±0.041
Treatment	7.348^{B}a ± 0.128	7.276^{ABa} ±0.097	7.206^{ABa} ±0.001	7.054^{Aa} ±0.002	7.221 ±0.047

*Means with different capital letter superscript(s) in a row differ significantly (P<0.01).

*Means with different small letter superscript(s) in a column differ significantly (P<0.01).

Table 4.16: Analysis of variance for quality parameters of functional turkey meat loaf during storage at 4 ± 1°C

Parameters	Treatment df = 1		Storage Days df=3		Treatment *Storage days		Error df=16
	MSS	F	MSS	F	MSS	F	MSS
TBARS	0.004	107.60**	3.958	0.001*	3.667	0.093*	0.002
Peroxide Value	3.750	1.125*	3.042	9.125**	3.750	1.125*	0.003
Free FattyAcid	0.026	2817.154**	9.083	0.001*	7.375	0.812*	0.001
Product pH	0.016	1.310*	0.108	8.9677**	0.001	0.112*	0.012
SPC	0.169	44.502**	3.961	974.739**	0.008	2.046*	0.004
Psychrotrophic Count	0.004	0.308*	0.230	17.283**	0.002	0.167*	0.013

*Value indicate level of significance * P<0.05, ** P<0.01

Table 4.17: Proximate composition (%) of functional turkey meat loaf during storage at 4 ± 1°C

	Day 0	Day 15	Total mean ± SE
		Moisture	
Control	50.377^{Ab} ± 0.067	50.410^{Ba} ± 0.073	50.393 ± 0.045
Traetment	49.485^{Aa}± 0.028	49.977^{Bb} ± 0.077	49.731±0.11
		Protein	
Control	24.157^{Bb} ±0.031	24.132^{Aa} ± 0.002	24.145±0.015
Treatment	24.156^{Ba} ± 0.001	24.133^{Ab} ± 0.012	24.145±0.007
		Fat	
Control	13.283^{Bb}± 0.012	13.089^{Ab} ± 0.044	13.164±0.039
Traetment	13.243^{Ba} ± 0.068	13.147^{Aa} ± 0.034	13.195±0.040
		Crude fiber	
Control	4.156^{Ab}± 0.018	4.156^{Aa} ± 0.018	4.156±0.011
Treatment	4.153^{Aa} ± 0.014	4.160^{Bb} ± 0.002	4.156±0.006
		Ash	
Control	7.128^{Ab} ± 0.071	7.138^{Bb} ± 0.009	7.133±0.032
Treatment	7.118^{Aa} ± 0.029	7.133^{Ba} ± 0.004	7.125±0.013

*Means with different superscripts of capital letters vary rowwise (P<0.05).
*Means with different superscripts of small letters vary columnwise (P<0.01) .

Table 4.18: Analysis of variance for proximate composition (%) of functional turkey meat loaf during storage at 4 ± 1°C

Parameters	Treatment df = 1		Storage Days df=1		Treatment *Storage days		Error df=8
	MSS	F	MSS	F	MSS	F	MSS
Moisture	0.013	0.001**	1.318	104.517**	0.206	16.351*	0.013
Protein	1.318	0.001**	0.002	1.986*	0.333	0.006*	0.001
Fat	0.003	0.509**	0.045	7.591*	0.002	0.352*	0.006
Crude Fibre	0.001	0.001**	4.033	0.059*	0.033	0.059*	0.001
Total Ash	0.001	0.40**	0.001	0.108*	0.875	0.004*	0.005

*Value indicate level of significance * P<0.05, ** P<0.01

Table 4.19: Colour characteristics of functional turkey meat loaf during storage at 4±1°C

	Day 0	Day 5	Day 10	Day 15	Total Mean±SE
			Reddness (a-value)		
Control	1.366^{Bb}	1.300^{Ba}	1.166^{Aa}	1.333^{Bb}	1.291
	±0.033	±0.001	±0.333	±0.333	±.025
Treatment	1.266^{Ba}	1.433^{Ab}	1.301^{Ab}	1.266^{Aa}	1.316
	±0.033	±0.033	±0.001	±0.333	±0.024
			Yellowness (b-value)		
Control	0.533^{Aa}	0.766^{Ba}	1.533^{Da}	1.333^{Ca}	1.041
	±0.333	±0.333	±0.333	±0.333	±0.123
Treatment	3.133^{Cb}	2.766^{Bb}	3.433^{Db}	2.333^{Ab}	2.916
	±0.333	±0.033	±0.333	±0.333	±0.124
			Hue Angle		
Control	22.188^{Aa}	38.548^{Ba}	52.723^{Ca}	44.999^{BCa}	39.615
	±1.885	±6.941	±1.383	±1.224	±3.741
Treatment	59.958^{Ab}	62.606^{Cb}	69.527^{Db}	61.490^{Bb}	62.577
	±5.229	±0.829	±0.182	±0.966	±1.754
			Chroma		
Control	1.467^{Aa}	1.509^{Aa}	1.927^{Ba}	1.886^{Ba}	1.697
	±0.038	±0.016	±0.007	±0.024	±0.064
Treatment	3.379^{Ab}	3.231^{Ab}	3.671^{Bb}	2.655^{Ab}	2.234
	±0.038	±0.101	±0.301	±0.014	±0.114

*Means with different capital letter superscript(s) in a row differ significantly (P<0.01).

*Means with different small letter superscript(s) in a column differ significantly (P<0.05).

Table 4.20: Microbiological quality of functional turkey meat loaf during storage at 4±1°C

	Day 0	Day 5	Day 10	Day 15	Total Mean±SE
			SPC		
Control	2.756^{Ab}	3.34^{Bb}	3.476^{Bb}	4.663^{Cb}	3.561
	±0.069	±0.036	±0.008	±0.001	±0.209
Treatment	2.556^{Aa}	3.203^{Ba}	3.397^{Ca}	4.417^{Da}	3.393
	±0.058	±0.015	±0.009	±0.001	±0.201
			Total Coliform Count		
Control	ND	ND	ND	ND	ND
Treatment	ND	ND	ND	ND	ND
			Staphylococcus *spp.* count		
Control	ND	ND	ND	ND	ND
Treatment	ND	ND	ND	ND	ND
			Salmonella *spp.* Count		
Control	ND	ND	ND	ND	ND
Treatment	ND	ND	ND	ND	ND
			Yeast and mould count		
Control	ND	ND	ND	ND	ND
Treatment	ND	ND	ND	ND	ND
			Psychrotrophic count		
Control	2.228^{Ab}	2.318^{Bb}	2.330^{Cb}	2.709^{Db}	2.396
	±0.057	±0.039	±0.105	±0.075	±0.064
Treatment	2.211^{Aa}	2.317^{Ba}	2.327^{Ca}	2.626^{Da}	2.370
	±0.055	±0.058	±0.062	±0.054	±0.052

*Means with different capital letter superscript(s) in a row differ significantly (P<0.05).

*Means with different small letter superscript(s) in a column differ significantly (P<0.01).

Table 4.21: Sensory attributes of functional turkey meat loaf during storage at 4±1°C

	Day 0	Day 5	Day 10	Day 15	Total Mean±SE
			Color And Appearance		
Control	6.67^{Aa}±0.21	6.73^{Aa}±0.29	6.20^{Ba}±0.04	6.15^{Ba} ±0.04	6.43±0.14
Treatment	7.52^{Ab}±0.06	7.50^{Ab}±0.04	7.50^{Ab}±0.04	7.49^{ABb}± 0.03	7.50±0.04
			Flavour		
Control	6.63^{Aa}±0.10	6.48^{Ba}±0.12	6.49^{Ba}±0.09	6.37^{Ca}±0.11	6.49±0.10
Treatment	7.53^{Ab}±0.05	7.52^{ABb}±0.02	7.50^{Bb}±0.03	7.50^{Bb}±0.02	7.51±0.03
			Binding		
Control	6.76^{Aa}±0.23	6.54^{Aa}±0.59	5.82^{Ba}±0.80	5.72^{Ba}±0.76	6.21±0.59
Treatment	7.52^{Bb}±0.06	7.50^{Bb}±0.04	7.50^{ABb}±0.03	7.48^{BCb}±0.03	7.50±0.04
			Texture		
Control	6.66^{Aa}±0.21	6.73^{Aa}±0.29	6.20^{Ba}±0.04	6.15^{Ba}±0.04	6.43±0.14
Treatment	7.52^{Cb}±0.04	7.50^{Ab}±0.03	7.49^{Ab}±0.03	7.50^{ABb}±0.02	7.50±0.03
			Juiciness		
Control	6.95^{Ca}±0.52	6.88^{BCa}±0.59	6.87^{ABa}±0.79	6.86^{Aa}±0.79	6.89±0.67
Treatment	7.54^{Db}±0.02	7.52^{Cb}±0.24	7.50^{Bb}±0.35	7.41^{Ab}±0.45	7.49±0.26
			Meat Flavour Intensity		
Control	6.83^{Aa}±0.04	6.75^{Aa}±0.45	6.22^{Ba}±0.21	6.19^{Ba}±0.25	6.49±0.23
Treatment	7.57^{Ab}±0.25	7.55^{Ab}±0.05	7.55^{Ab}±0.01	7.54^{Ab}±0.01	7.55±0.08
			After Taste		
Control	6.93^{Ba}±0.02	7.16^{Aa}±0.25	6.63^{Ba}±0.14	7.06^{Ba}±0.12	6.94±0.13
Treatment	7.53^{Ab}±0.15	7.50^{ABb}±0.15	7.40^{Bb}±0.16	7.48^{BCb}±0.18	7.47±0.16
			Overall Acceptability		
Control	6.66^{Aa}±0.21	6.73^{Aa}±0.29	6.20^{Ba}±0.04	6.15^{Ba}±0.04	6.43±0.14
Treatment	7.52^{Ab}±0.04	7.52^{Ab}±0.04	7.50^{ABb}±0.02	7.5^{ABb}±0.02	7.51±0.03

*Means with different capital letter superscript(s) in a row differ significantly (P<0.05).

*Means with different small letter superscript(s) in a column differ significantly (P<0.01).

The pH values observed for control product were lower than the treated product throughout the storage period. There was a significant reduction in pH of control and treated products stored for a period of 15 days. Control showed the highest pH value of 7.341, whereas treated sample showed higher value 7.348 on 0th day of storage. The least values were observed during the 15th day of storage for both control and treatment with 6.992 and 7.054 respectively.

4.4.2 Proximate analysis

The results are analyzed in 4.17 and 4.18. The observed percent moisture content of the products control and treatment were 50.377 and 49.485 respectively on the 0th day analysis. On the 15th day of storage also, the values also showed significant difference ($P<0.05$) between control and treatment product. On 15th day of storage, treatment showed a significant increase in moisture content. The average percent protein value of functional turkey meat loaf decreased throughout the storage period . The protein content of treatment product showed a higher protein value when compared with the control product during the entire period of study. The percent fat values observed for control and treatment product during storage period was reducing significantly in both products.

Higher difference in fat content was noticed in control product than the treatment throughout the storage period. A significant difference observed for percent crude fiber content of treatment than the control during the 15 days storage period. The fiber content of both products remained unaffected irrespective of the storage time. The observed percent total ash content of both control and treatment were significantly varying throughout the study. The average mean of control product was 7.128 and 7.138 on 0^{th} day and 15^{th} day respectively while that of treatment product the mean was 7.118 and 7.133 on 0^{th} and 15^{th} day respectively. Higher ash content was observed in treatment product than the control. On storage, total ash content of both control and treatment were found significantly increasing.

4.4.3 Lovibond tintometer colour

The results are analyzed in Table 4.19. Redness (*a*-value) showed significant change during the storage of control and treated products. For the control product the highest *a*-value was observed on the 0^{th} day of storage. The treated product also change significantly throughout the storage and the highest marginal value was shown on the 5^{th} day. However, a significantdifference between control and treated product observed on 0th and 15th day of storage.

Yellowness (*b*-value) showed a significant difference between the control and treatment product. Control showed its lowest *b*-value on 0th day of storage, where as treatment showed the maximum value on the 10th day. The lowest observed *b* value of treatment was on 15th day of storage.

Hue angle of the control and treated products were calculated. Hue angle value of the treated product was significantly (P<0.01) more than the control. Control showed the maximum average value on the 10th day of storage followed by 15th day whereas, treatment showed the least value on 0th day and significantly different from other days.

Chroma values of control product was significantly (P<0.01) lower than the treated sample throughout the storage period. A significant difference was also observed during the storage of treated products. Highest chroma value of treatment was observed on the 0th dayof storage.

4.4.4 Microbiological quality

Standard plate count (SPC) and Psychrotrophic count of the functional turkey meat loaf and control product were studied from 0th day of storage to 15th day on every 5 days interval. A significant but linear increase in SPC was observed in case of both treatment and control. However, SPC was apparently lower in treated products. The total coliform count, *Staphylococcus* spp. count, *Salmonella* spp. count, yeast and mould count (Y&M) were not found in any of the product at any storage interval. After 15 days of storage, control and treatment products shown to be satisfying the safety limits recommended for meat products, in which treatment showed lower count than the control. The results obtained are summarized in Table 4.20 and Table 4.16.

4.4.5. Sensory evaluation

Eight different sensory attributes were analyzed for functional turkey meat loaf and control. The average scores obtained for colour and appearance of the control product was 6.67, 5.00 , 6.20 and 6.15 on 0, 5, 10 and 15 days respectively. On these same days, treatment showed higher values than the control. Even on 15th day of storage, treated product showed a mean colour and appearance score of 7.49. The average scores obtained for flavour of the control product was 6.63, 6.48, 6.49and 6.37 on 0, 5, 10 and 15 days of storage, respectively. Treatment showed higher values than the control with a mean score of 7.50 on 15th day of storage.

Sensory scores when analyzed for texture and binding, treatment showed significantly higher values than the control on same day of storage. Even on 15th day, treated product showed an average texture score of 7.50 and binding score of 7.48. The mean scores obtained for binding of the control product was 6.76, 6.54, 5.82 and 5.72 on 0, 5, 10 and 15 days of storage respectively. Scores obtained for parameters like meat flavour intensity, after taste, juiciness and overall acceptability also indicated that treatment product was having highest score when compared with the control product. The average scores obtained for meat flavour intensity of the treated product was 7.57, 7.55, 7.55 and 7.54 on 0, 5, 10 and 15 days of storage, after taste of the treated product was 7.53, 7.50, 7.40 and 7.48 on 0, 5, 10 and 15 days of storage and overall acceptability of the treated product was 7.52, 7.52, 7.50 and 7.50 on 0, 5, 10, and 15 days of storage respectively. On these same days, treatment showed significantly higher values ($P<0.05$) than the control. Results obtained for sensory evaluation of the stored products are summarized in Table 4.21.

4.5 Cost of production of Functional turkey meat loaf

Economics of was functional turkey meat loaf calculated considering various factors like cost for dressing of turkey, formulation cost for emulsion, depreciation cost on equipments/machineries, labour cost, electricity cost, cost of packaging, water charges, building (rent) and miscellaneous charges at present.

At present cost of dressed turkey at CARI, Izatnagar is Rs. 100/- per kg, which yield 350 g meat.

Table 4.23: Processing Equipment cost:

Sl. No	Equipments	Unit cost	Approx. cost
1	Meat mincer	1,00,000	1,00,000
2	Meat mixer/Paddle mixture/spice grinder mixture	70,000	70,000
3	Homogenizer	10,000	10,000
4	Table	20,000	60,000
5	Moulds and tray	6,000	6,000
6	Weighing balance	18,000	18,000
7	Heat sealer	5,000	15,000
	Total		**2,79,000**

Table 4.24: Storage equipments (for meat)

Sl. No	Equipments	Unit cost	Approx. cost
1	Deep freezer (345 lit)	50,000	1,00,000
2	Refrigerator (5000 lit)	60,000	1,20,000
3	Three wheeler	7500	15,000
4	Containers , knives etc	__	1,00,000
	Total		**3,35,000**

Equipments depreciation @ 10% per annum	**= Rs.65, 400/-**
Per day basis	=Rs. 218.00/- (300 working days)
Labour cost	
Skilled worker (One)	=Rs. 250/-
Unskilled worker (Three)	=Rs.650/-
Electricity charges (approx 30 KWH per day)	= Rs. 120/-
Cost of packaging (polyethylene pouch)	150×4 =Rs. 600/-
Water charges (2000lit)	=Rs.60 per day
Building (rent)	=Rs. 6000/- per month Rs.200 per day
Miscellaneous	=Rs. 200/- per day
(cleaning agent, knife sharpening etc)	

Table 4.22: Formulation cost

Sl. No.	Ingredients	For 100kg emulsion Rate/ kg	Qty	Cost (Rs.)
1	Deboned turkey meat	285/-	60.05kg	17114.25/-
2	Textured soya protein	250/-	3.5kg	875/-
3	Oat flour	150/-	3.00kg	450/-
4	Ragi flour	80/-	3.00kg	240/-
5	Egg	50/-	3.50kg	175/-
6	Spicemix	300/-	1.70kg	525/-
7	Condiments	50/-	3.0kg	150/-
8	Refined Wheat Flour	35/-	3.50kg	122.50/-
9	Sodium Bi- carbonate	474/-	0.60kg	284.4/-
10	Vegetable oil	110/-	5kg	550/-
11	TSPP	1888/-	0.30kg	566.4/-
12	Sodium Nitrite	688/-	0.10kg	68.8/-
13	Oregano	700/-	0.25kg	175/-
14	Parsley	3200/-	0.5kg	1600/-
15	α – Tocopheral Acetate	35000/-	0.15kg	5250
16	Cane sugar	60/-	0.25kg	15
	Total			**28161.35/-**

(In 1 kg emulsion used for product preparation, 10% will be added water, so actual cost of 100 kg emulsion is Rs. **25345.250/**-)

Total overhead cost (Rs. 218.00 + Rs. 900 +Rs. 1180) =Rs. 2298.00/-

Total processing cost for 100 kg of emulsion = Rs. 25345.250+ Rs.2298/-

=Rs.27643.25

(Cooking yield is 83%, so product obtained with 100 kg emulsion is = 83kg)

Production cost of turkey meat loaf in 250 g packets is Rs. 83.26/-.

Fig. 4.1: Mincing of meat for the emulsion preparation of Functional Turkey Meat Loaf

Fig 4.2: Emulsion filled in aluminium moulds in Experiment No -2

Fig. 4.3: Functional Turkey Meat Loaf

Fig. 4.4: Slices of the Functional Turkey Meat Loaf

Fig. 4.5: Sensory evaluation of Functional Turkey Meat Loaf : Experiment 1.

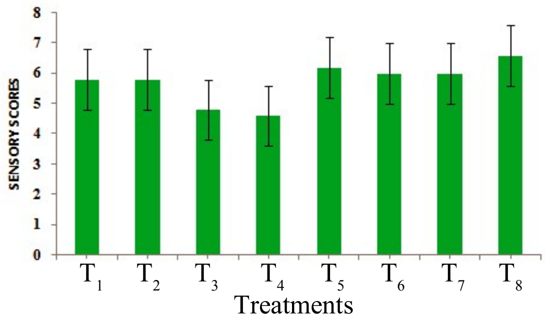

Fig. 4.5.1: Colour and Appearance

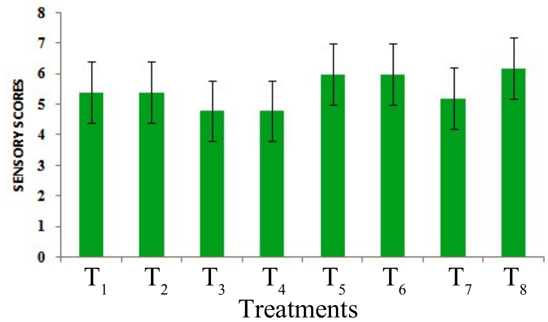

Fig. 4.5.2: Flavour

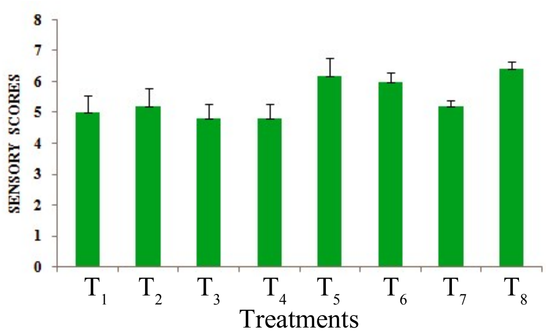

Fig. 4.5.3: Binding

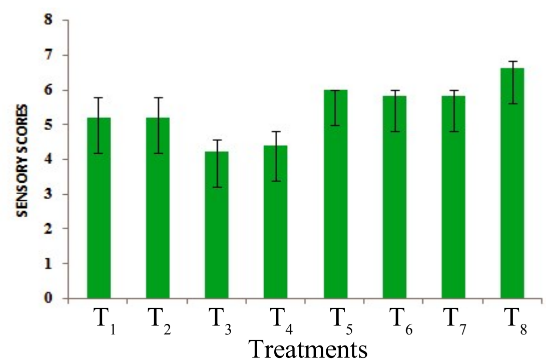

Fig. 4.5.4: Texture

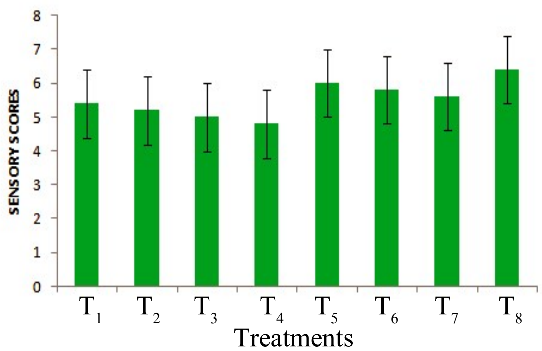

Fig. 4.5.5: Juiciness

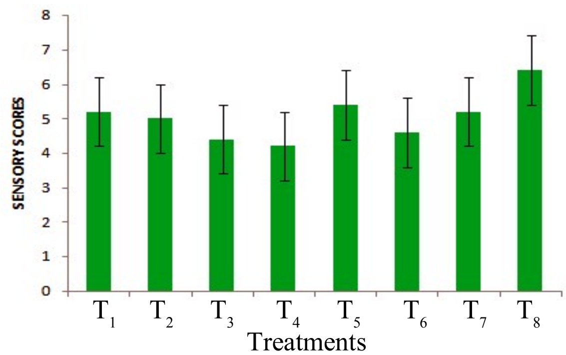

Fig. 4.5.6: Meat Flavour Intensity

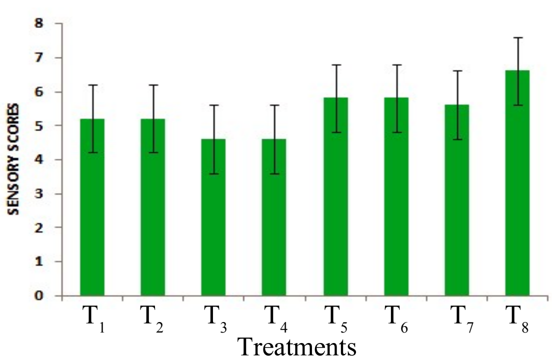

Fig. 4.5.7: After taste

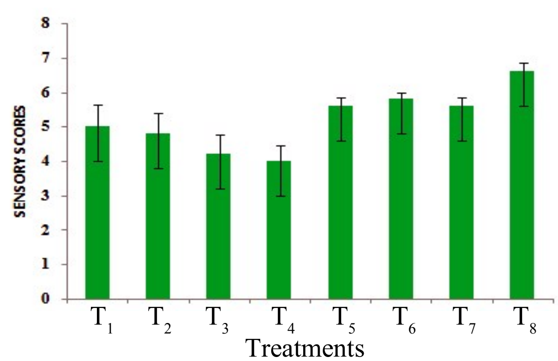

Fig. 4.5.8: Overall acceptability

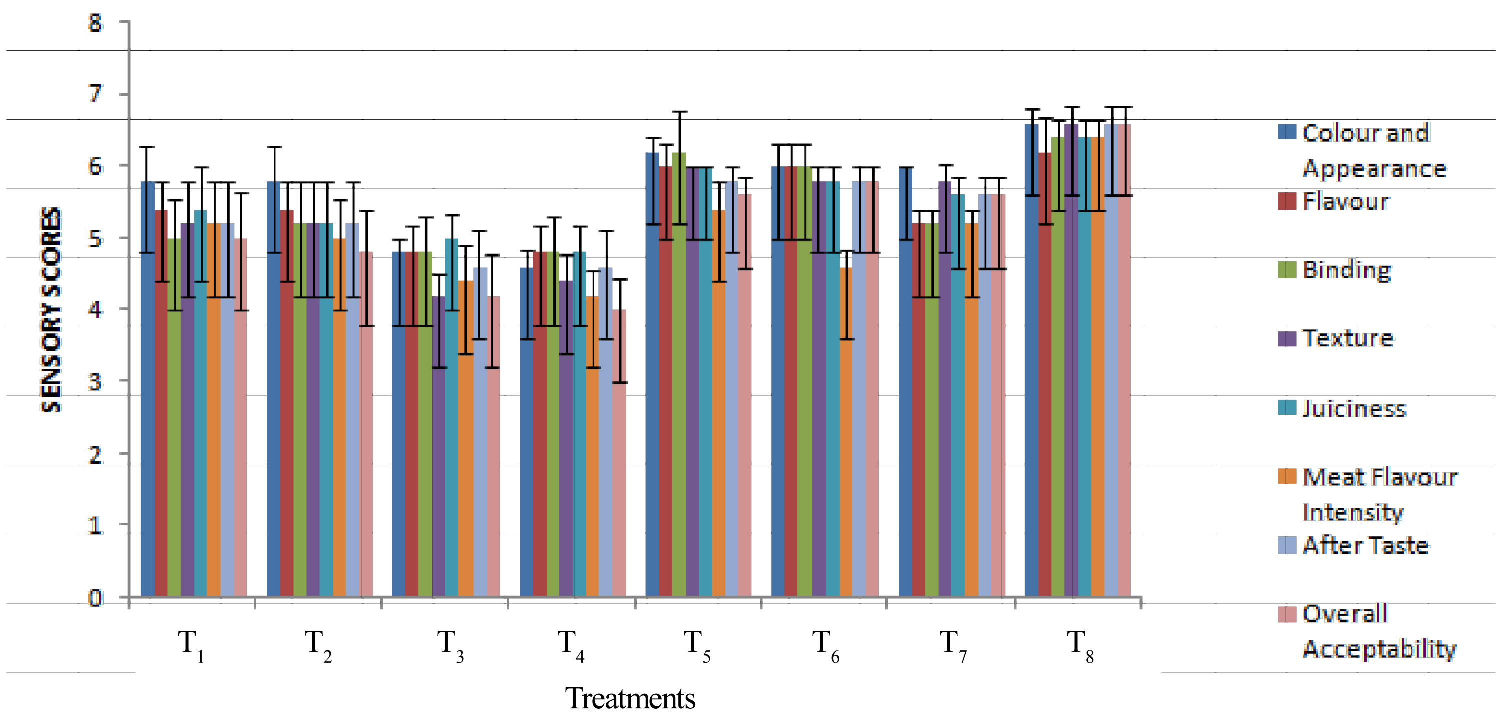

Fig. 4.5.9: Sensory evaluation of Functional Turkey Meat Loaf, Experiment – 1

Fig.4.6: Sensory evaluation of Functional Turkey Meat Loaf: Experiment 2.

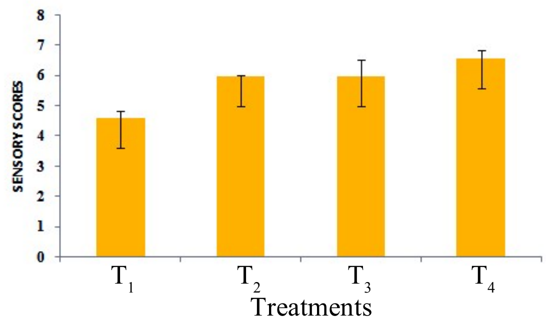

Fig. 4.6.1: Colour and Appearance

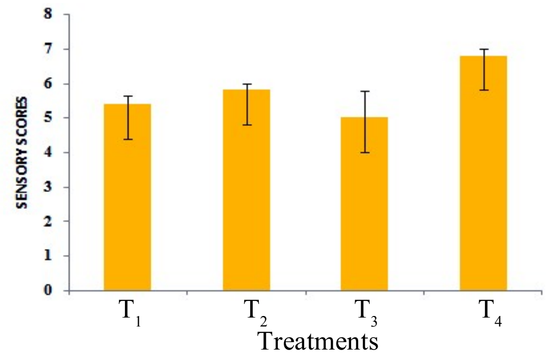

Fig. 4.6.2: Flavour

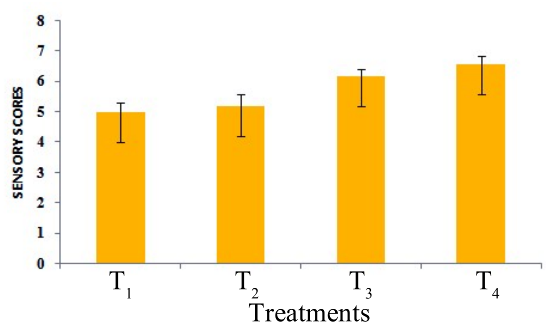

Fig. 4.6.3: Binding

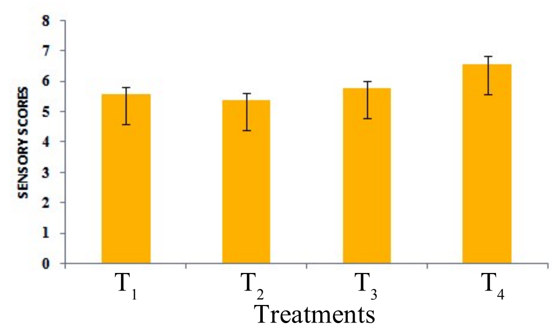

Fig. 4.6.4: Texture

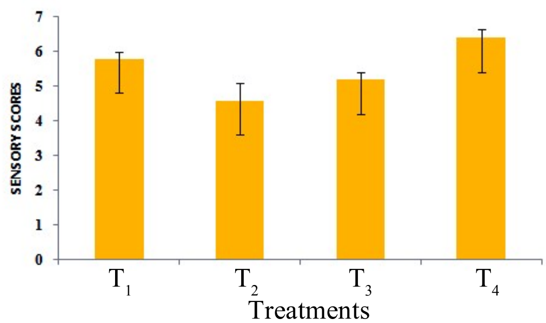

Fig. 4.6.5: Juiciness

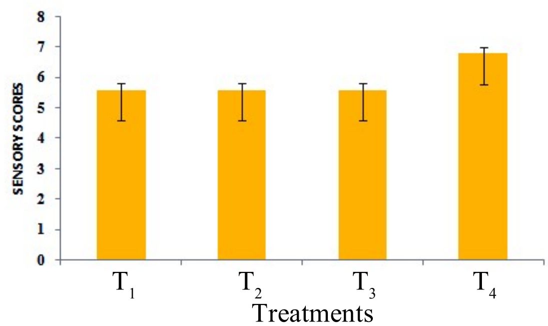

Fig. 4.6.6: Meat Flavour Intensity

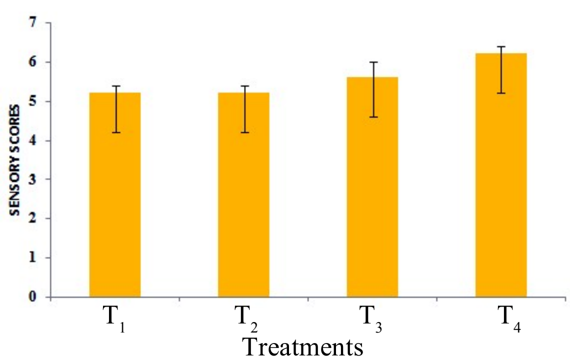

Fig. 4.6.7: After taste

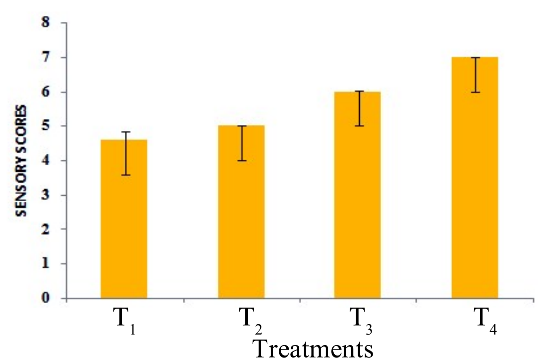

Fig. 4.6.8: Overall acceptability

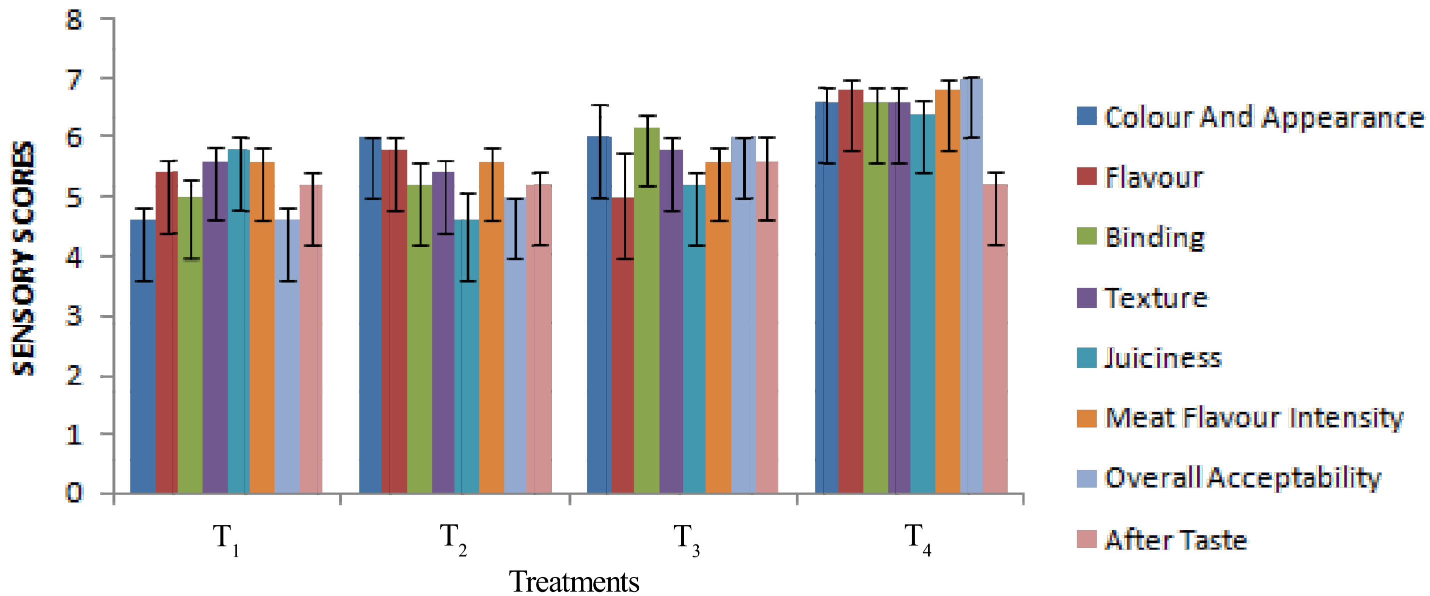

Fig 4.6.9: Sensory evaluation of Functional Turkey Meat Loaf, Experiment - 2

Fig 4.7: Sensory evaluation of Functional Turkey Meat Loaf during storage: Experiment 3.

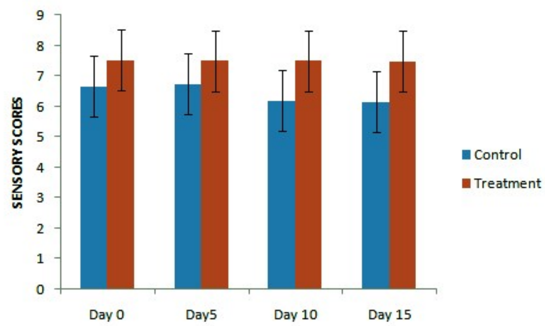

Fig. 4.7.1: Colour and Appearance

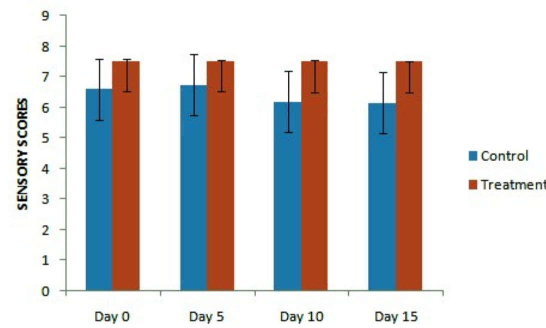

Fig. 4.7.2: Flavour

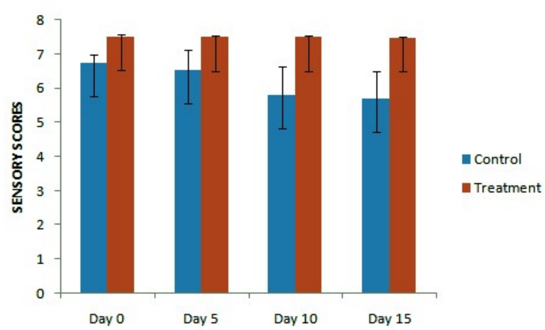

Fig. 4.7.3: Binding

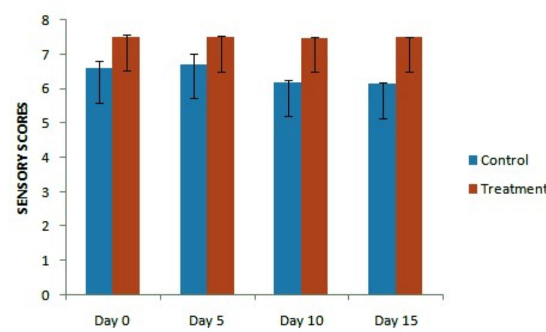

Fig. 4.7.4: Texture

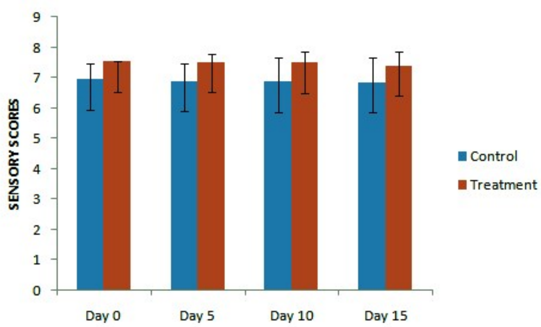

Fig. 4.7.5: Juiciness

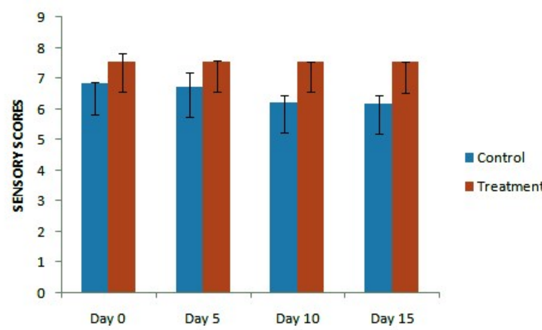

Fig. 4.7.6: Meat Flavour Intensity

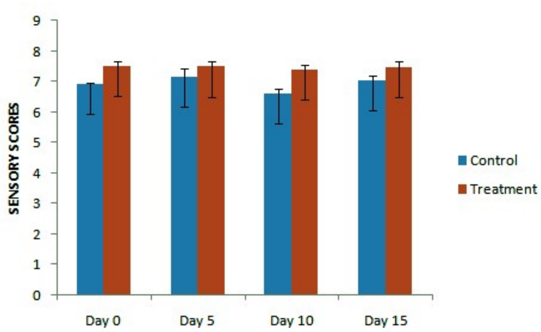

Fig. 4.7.7: After taste

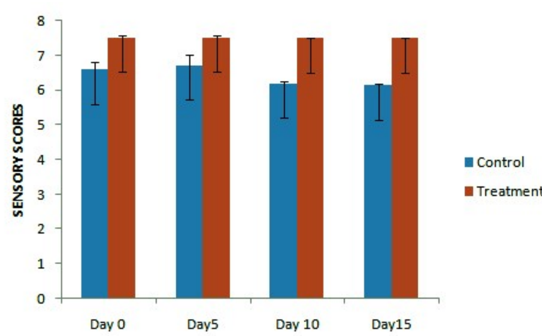

Fig. 4.7.8: Overall acceptability

Discussion

5 DISCUSSION

5.1 Identification of Suitable Cereal Flour(s) For Standardization of Formulation in Development of Functional Turkey Meat Loaf

The results of this study on Turkey Meat Loaf has been presented in preceeding Chapter. The discussion in relation to the findings is placed in this section.

5.1.1 Physio- Chemical Properties

On analysis, all the treatments studied have shown values of emulsion pH ranging from 7.11 to 7.26. Emulsion pH of T_8 (incorporated with 3% oat flour and 3% ragi flour) was found to be the highest value observed. Hemung *et al.* (2013) reported that surface hydrophobicity of sarcoplasmic proteins increases with pH of the emulsion and this will inturn increase the emulsion stability and cooking yield. The cooking yield had a positive correlation with the emulsion stability (Kanimozhi, 2012).The cooking yield was significantly higher probably due to the ability of oat hydro-colloidable fibre (β-glucan) to create a tri-dimensional matrix, holding not only water, but also fat and avoiding losses of fat and water during cooking (Giese,1992, Inglett *et al.,* 1994, Taki, 1991 and Warner and Inglett, 1997). According to a study conducted by Antara *et al.* (2004), presence of fermentable carbohydrates in the product may result in low pH value. Addition of oat flour and ragi flour at different proportion in the emulsion resulted in significant variation of product pH from that of emulsion pH.

5.1.2 Proximate Analysis

Moisture content of the treated products was significantly varying with different levels and composition of flours with a mean value of 49.82%.The percentage of moisture retention increased because of the greater amounts of water added coupled with the water binding ability of β-glucan in oat flour and also due to ragi flour (Pinero *et al.,* 2008). The addition of oat and ragi flour do not affect the protein content in beef patties (Kumar and Sharma, 2004, Mansour and Khalil, 1999, Troutt *et al.,* 1992 and Troy *et al.,*1999).Turkey meat loaf when incorporated with different levels and combination of oat and ragi flour resulted in increased fiber content with an overall mean value 3.29%. Treatment with 3% oat flour and 3% ragi flour was having the highest value of 4.15%. Cofrades *et al.* (2000) reported similar results when fiber rich cereals were used in meat products. With incorporation of fiber rich cereals in functional turkey meat loaf the mean fat value observed was 13.5% and the maximum value (14.15%) observed in T_3 which contain the minimum amount of flour especially ragi flour which describes the fat retension property of cereals. Brewer (2012) also reported the benefits of incorporation of cereal flours for the improvement of physico-chemical, functional and nutritive qualities of meat foods. Relatively high amount of ash content was observed in functional turkey meat loaf, which may be due to incorporation of oat flour. For preparation of flour, whole oats had been used which contain 22-31% ash (Svihus and Gullord, 2002).

5.1.3 Sensory Evaluation

Sensory evaluation conducted based on 8 point descriptive scale have shownthat product having 3% oat flour and 3% ragi flour in formulation was most acceptable.It is found that it is more juicer than other treatments which could be attributed to the increased moisture retention of the product during cooking.These findings agree with those of Desmond *et al.,* (1998 a & b) who found that the oat aided in water retention, produced juicer low fat beef patties. Pszczola (1991) also reported that oat fiber has the ability to retain moisture and prevents meat from drying out when cooked. Meat flavour intensity was found to be decreasing when flour level increased which was also reported by Frempong *et al.,*1996. Berry et al. (1996) and Troutt *et al.* (1992) showed that the decrease of fat level in meat products result in reduction of the flavour intensity.

5.2 Identification of Suitable Natural Preservatives and Alpha (α)-Tocopherol Acetate for Standardization of Formulation in Development of Functional Turkey Meat Loaf.

5.2.1 Antioxidant Parameters and β- carotene

Most natural antioxidant or neo-formed antioxidants upon processing are multifunctional, and in complex heterogeneous foods such as meat and meat products, their activity cannot be evaluated by a single method (Perez-Jiménez &Saura-Calixto, 2005). The ABTS radical determines the single electron-transfer capabilities of these (Re *et al*., 1999) while scavenging of DPPH radical allows evaluation of the hydrogen-donating potency of antioxidative compounds (Brand-Williams *et al.,* 1995).The highest ABTS inhibition activity was shown by the T_4 treatment having oregano and alpha-tocopherol acetate both. The treatment T_4 had higher antioxidant property than T_3 because parsley also has some antioxidant capacity which was initially determined by the β-carotene bleaching assay. But the antioxidant activity was much weaker than that of 0.01 mg/mL of BHT and α-tocopherol acetate (Hui Zhang *et al.,* 2006). All the treatments treated with antioxidant (alpha-tocopherol acetate) showed very good radical-scavenging activities and there was a strong correlation between antioxidant activity and concentrations of active compound present in added preservatives (Khare *et al.,* 2014). The DPPH also shows the same increasing trend like that of ABTS. The β-carotene concentration was found to be highest in T_4 treatment and lowest in T_2 because of the absence of parsley in treatment T_2. The UV–VIS spectrophotometry detection and acetone as the extraction medium was successfully employed for the simple and rapid determination of β-carotene content (Biswas *et al.,* 2011).

5.2.2 Microbiological Properties

The supplementation of oregano, alpha-tocopherol acetate and parsley can be proved to be useful in context of the microbiological intervention. The oregano has anti-microbial active compounds responsible for controlling the growth of bacteria, thus, reducing the SPC. The lowest SPC count was in T_4 treatment and the highest in T_1 *i.e.* not having oregano.The use of chitosan, EDTA, eugenol and peppermint essential oil significantly affected the SPC (Standard plate count) of treated samples of chicken noodles (Khare *et al.,* 2014). There was complete absence of yeast and moulds, *Salmonella* spp., *Staphylococcus* spp. and *E.coli* .

5.2.3 Lovibond Tintometer Colour

The highest redness (a-value) was shown by T_2 treatment which was not having parsley which shows that redness 'a' value is affected by adding parsley and yellowness 'b' value shows the highest value in T_3 which was not having alpha-tocopherol acetate. Both the redness and yellowness differ significantly in each treatment. Hue angle and chroma also differed significantly.

5.2.4 Sensory Evaluation

Incorporation of different natural preservatives in the formulation significantly changed the sensory qualities of functional turkey meat loaf. Alpha-tocopherol acetate, oregano, parsley when incorporated at the level of 150 ppm, 0.25% and 0.5% respectively in T_4 sample, it helped improved colour and appearance of the product (6.6) as well as other sensory qualities like flavour (6.8), texture (6.6), binding (6.6) and overall acceptability (7.00).

5.3 Storage Stability of Functional Turkey Meat Loaf at refrigeration temperature (4 ± 1°C) Under Aerobic Packaging Condition

5.3.1 Physiochemical Properties

A small but statistically significant (P<0.05) reduction in the pH values was recorded by adding oregano in meat product throughout the 15 days of storage of turkey meat loaf probably attributed to the production of lactic acid (Chouliara *et al.,* 2007). The TBARS values for all treatments varied between 0.1 and 0.9 mg malonylaldehyde/kg meat indicating a very low degree of lipid oxidation. These values are in agreement to those of Kim *et al.* (1995) who reported TBARS values of 0.13–0.68 mg MDA/kg meat for turkey and pork after 7 days of storage. The TBARS value of treatment comes in this range. TBARS values of the control product gradually increased from 0.263, 0.283, 0.305 and 0.325 during the 15 days of storage. Incorporation of oregano resulted in reduced TBARS values of treated product with values 0.257, 0.281, 0.302 and 0.319 on corresponding days. Peroxide value of control observed was 0.001,0.001.0.002and 0.003, but the treated product when incorporated with oat and ragi flour, oregano, parsley and α-tocopherol acetate showed the values as 0.001, 0.001, 0.001 and 0.002 on 0th, 5th, 10th and 15th days respectively. Cocconelli (2007) and Incze (2010) also reported changes in pH of meat products during storage period.

5.3.2 Proximate Analysis

A significant increase in moisture content of treated product was noted on15th day while that of control was almost similar throughout the study. Protein, fat, crude fibre and ash also showed some significant changes during storage.

5.3.3 Microbiological Quality

Control and product samples were analyzed for standard plate count (SPC), total coliform count, Salmonella spp. count, Staphylococcus spp. count and yeast and mould count (Y&M). Control and treated products shown an increase in standard plate count during storage, but control products were having consistently higher values than the treated product. In the treated product, highest SPC was observed on 15th day (4.4cfu/g) and for control it was 4.6cfu/g. No growth was observed for total coliform count, *Salmonella* spp.count, *Staphylococcus* spp. count and yeast and mould count (Y&M). The psychrotrophs count also showed the same trend in which control product was having more count than treatment.

5.3.4 Lovibond Tintometer Colour Values

The colour values indicating redness (*a*-value), yellowness (*b*-value), hue angle and chroma value were analyzed on every 5 days interval for a period of 15 days. For the control product, *a*-value was noted to be 1.366, 1.300, 1.166 and 1.133. But the control product showed a significantly lower a-value that of treatments which indicates higher oxidative stability of the treated product (Mohamed *et al.,* 2011). The *b*-value of both control and treated products were consistently varying. Control product showed a maximum *b*-value on 10th day of storage, and treated product also showed its highest value on 10th day of storage. Throughout the study a significantly lower ($P<0.05$) b-value was noted for control product than the treatment. The hue angle was consistently increasing for control product with significant difference whereas the product showed significantly higher values on storage when compared on respective days of storage. The chroma value for treated product was significantly higher than control products.

5.3.5 Sensory Evaluation

Different sensory characteristics of control and treated products were analyzed. Treated product showed significantly higher sensory scores for all attributes than the control. A significant variation was observed for both control and treated product during storage period of 15 days. After completion of 15 days storage, colour and appearance of control and treated product were 6.15 and 7.49 respectively. Same trend was observed inflavour, texture, juiciness, meat flavour intensity, after taste. Overall acceptability in control and product group were 6.15 and 7.5 respectively on the 15th day of storage. As a whole, control was rated fair to good acceptability on 15th day of storage. Treated product was having very good to excellent scores even on the 15th day of storage.

Present study indicates that product incorporated with 3% oat flour and 3% ragi flour with 0.25% oregano, 0.5% parsley and 150 ppm alpha-tocopherolacetate showing very good sensory scores when compared to control product.

✍✍✍

Summary and Conclusions

6 SUMMARY AND CONCLUSIONS

6.1 Exp. 1: Identification of suitable cereal flour(s) for standardization of formulation in development of functional turkey meat loaf

Oat flour and ragi flour at eight different levels were incorporated in the formulation and various quality parameters were analyzed. The pH of emulsions and meat loaf differed significantly ($P<0.01$) with the incorporation of cereal flours. Emulsion stability and cooking yield were highest in T_8 sample. Incorporation of different levels of flour either alone or in combination resulted in significantly different emulsion pH. The product pH showed similar trend to that of emulsion pH. Lower pH was observed with product containing less amount of cereal flour. Results of emulsion stability revealed that the formulation containing higher flour level was having the highest emulsion stability and cooking yield and it was proven in the formulation having 3% oat flour and 3% ragi flour. With regards to proximate composition, significantly higher moisture, crude fiber and total ash contents were found in T_8 sample when compared to other treatments. Protein and fat contents did not differ significantly. Sensory attributes viz. colour and appearance, flavour, texture, binding, juiciness, after taste and overall acceptability were highest for T_8 sample. Hence, based on sensory scores, it has been observed that 3% oat flour +3% ragi flour was suitable for preparation of functional turkey meat loaf.

6.2 Exp. 2: Optimization of the level and type of natural preservatives and alpha tocopherol acetate suitable for development of functional turkey meat loaf

Different combinations of oregano, parsley and alpha tocopherol acetate were incorporated into the formulation which was selected in the first experiment. Highest $ABTS^+$ radical scavenging activity was observed in T_4 sample while analysis. The same trend of increasing the radical scavenging activity was also seen in the DPPH results. The maximum inhibition activity was shown by the T_4 sample followed by T_2 and the minimum inhibition activity was shown by T_3 sample. It was observed that T_4 sample was having the highest β-carotene concentration as compared to all other treatments. Incorporation of oregano (0.25%), parsley (0.25%) and alpha tocopherol acetate (150 ppm) in the product (T_4) markedly improved all sensory attributes of tukey meat loaf.

6.3 Exp. 3: Storage stability of functional turkey meat loaf at refrigeration temperature (4 ±1°C) under aerobic packaging condition

For storability study, functional turkey meat loaf were prepared with selected levels of flours and natural preservatives and that were considered for quality evaluation at refrigeration temperature storage under aerobic packaging condition. Analysis of turkey meat loaf indicated that incorporation of flours and natural preservatives significantly declined TBARS value, peroxide value (PV) and FFA contents as compared to control, whereas pH was found increased. However, values of all these parameters were increased and pH was decreased with the increase in storage days. Even after 15 days of storage TBARS value, peroxide value (PV) and FFA contents were observed much lower than the threshold values/maximum permissible limits. The observed control values on each day of analysis were significantly higher than that of the product value on the same day of storage. A significant difference in proximate values of control and treatment observed throughout the study. But significant changes in moisture and fat content of treatment were recorded. Instrumental colour values differed significantly ($P<0.05$) with the incorporation of natural preservatives and on the subsequent days of storage. Treatment sample showed higher values for all the colour coordinates *i.e.* yellowness (*b*-value), hue angle and chroma values as compared to control except redness (*a*-value). In regards to microbiological quality, treated sample had significantly lower standard plate count (SPC) compared to control. But SPC was increased in both the treated and control samples with the increase of storage days. Total Coliform, *Staphylococcus* spp., Salmonella spp., yeast and mold were absent throughout the storage time. Treated sample showed significantly higher sensory scores for all most all sensory attributes. The sensory scores for all attributes decreased with the increase of storage interval but even after 15 days of storage treated product was rated excellent to good. Overall acceptability scores indicated that panelists had slightly higher liking for the functional turkey meat loaf containing 3% oat flour + 3% ragi flour in combination with 0.25% oregano, 0.5% parsley and 150ppm alpha tocopherol acetate.

Conclusion

☞ For the development of functional turkey meat loaf , formulation containing 3% oat flour and 3% ragi flour was found to be the best.

☞ Incorporation of oregano (0.25%), parsley (0.5%), alpha tocopherol acetate (150 ppm) in the formulation improved antioxidant radical scavenging activity and the β-carotene concentration and also the sensory qualities of the product .

☞ Functional turkey meat loaf developed by incorporation with 3% oat flour ,3% ragi flour, 0.25% oregano, 0.5% parsley, 150 ppm alpha tocopherol acetate can be stored at 4 ± 1^{o}C for 15 days without significantly affecting its physico-chemical, microbiological and sensory quality parameters.

☞ Inclusion of flours in development of functional turkey meat loaf substantially increased crude fibre content which has health benefits whereas oregano has antimicrobial effect on the product and alpha tocopherol acetate has antioxidant property. Parsley added some colour to the product and also is rich in β-carotene.

☞ Functional turkey meat loaf which was developed from turkey meat is ready-to-eat functional meat product with relatively long shelf life when stored at refrigeration temperature.

✍✍✍

Mini Abstract

7 MINI ABSTRACT

Meats have great potential for delivering important nutrients such as fatty acids, minerals, dietary fiber, antioxidants and bioactive peptides into the diet. Turkey meat fits well into it as it contains low calories and high protein as compared to chicken meat. Because of this reason many turkey meat products are now available in market. But very limited research work have been carried out in our country on suitability of cereal flours and natural preservatives on the comminuted meat products. Therefore, the present study was undertaken to develop turkey meat loaf with the incorporation of different levels of cereal flours (oat and ragi) and natural preservatives (oregano and parsley) as powder and also alpha (á)tocopherol acetate . Effect of these non meat ingredients as extenders, antioxidants, antimicrobial and flavouring agent on the quality of turkey meat loaf during refrigeration storage were also studied. A formulation was standardized in which 3% oat and 3% ragi as cereal flours and 0.25% oregano, 0.5% parsley and 150 ppm alpha tocopherol acetate as natural preservatives was selected for storage study. For the preparation of functional turkey meat loaf, emulsion was manually filled in moulds and then cooked in hot air oven for 45-60 minutes. Incorporation of flours increased crude fiber content, whereas oregano helped improved not only the flavour but also the antimicrobial properties of the product, and alpha tocopherol acetate improved the antioxidant activity. The functional product was found to have a chemical composition of 24 % crude protein, 13% total fat, 6% ash and 3% crude fiber. In regard to storage studies, the developed product could well be stored for a period of 15 days at refrigeration temperature (4±1p C) without significantly affecting the physico–chemical, microbiological and sensory qualities. Functional turkey meat loaf developed with addition of oat flour, ragi flour, oregano, parsley and alpha tocopherol acetate could be a new addition among functional poultry products with a shelf life of 15 days.

लघु सारांश

8 लघु सारांश

मीट आहार में फैटी एसिड, खनिज, फाइबर आहार, एंटीऑक्सीडेट और bioactive पेप्टाइडस के रूप में महत्वपूर्ण पोषक तत्वों पहुंचाने के लिए काफी क्ष्ज्ञमता है। टर्की मांस इस श्रेणी में सही तरह से आता है क्योंकि चिकन मांस की तुलना में इसमें कम कैलोरी और प्रोटीन होता है। इसी कारण कई टर्की मांस उत्पाद अब बाजार में उपलब्ध हैं। लेकिन बहुत सीमित अनुसंधान कार्य comminuted मांस उत्पादों पर अनाज आटे और प्राकृतिक संरक्षक की उपयुक्तता पर हमारे देश में कार्य किया गया है। इसलिए वर्तमान अध्ययन अनाज आटे (जई और मंडुवा) और पाउडर के रूप में प्राकृतिक संरक्षक (अजवाई की पत्ती और अजमोद) और α-tocopherol acetate के विभिन्न स्तरों के समावेश के साथ टर्की मांस का loaf विकसित करने के लिए किया गया था। प्रशीतन भंडारण के दौरान टर्की मांस loaf की गुणवत्ता पर extender एंटीऑक्स्टेट, रोगाणुरोधी और स्वादिष्ट बनाने का मसाला एजेन्ट के रूप में इन गैर मांस सामग्री के प्रभाव का भी अध्ययन किया गया। निरूपण जो मानकीकृत किया गया उसमें 3 प्रतिशत जई और 5 प्रतिशत मंडुवा के आटे के साथ 0.25% oregano, 0.5% अजमोद और 150 ppm α-tocopherol acetate (प्राकृतिक संरक्षक की तरह) भंडारण अध्ययन के लिय चुना गया। कार्यात्मक टर्की मांस loaf को बनाने के लिए emulsion को mannualy साचों में भरा गया और उसके बाद 45–60 मिनट के लिए गर्म हवा ओवन में पकाया जाता है। आटे के समावेश से कच्चे फाइबर में वृद्धि हुई जबकि ougono ने स्वाद में सुधार ही नहीं बल्कि उत्पाद रोगाणुरोधी मापदण्ड की मदद की और α-tocopherol acetate ने antioxidant गतिविधि में सुधार किया। यह पाया गया था कि कार्यात्मक उत्पाद 29 प्रतिशत सीपी, 13 प्रतिशत कुल वसा, 6 प्रतिशत राख और 3 प्रतिशत कच्चे फाइवर की एक रासायनिक संरचना है। भण्डारण पढ़ाई के संबंध में विकसित उत्पाद भौतिक रासायनिक, सूक्ष्मजीव विज्ञानी और संवेदी गुणों की प्रभावित किए बिना प्रशीतन तापमान ($4\pm1^{o}C$) में 15 दिनों की अवधि के लिए भंडारित किया जा सकता है। जई, मंडुवा के आटा, oregano और अजमोद और α-tocopherol acetate से विकसित कार्यात्मक टर्की मांस loaf 15 दिनों की शेल्फ लाइफ के साथ कार्यात्मक पोल्ट्री उत्पादों के बीच एक नया योगदान हो सकता है।

References

9 REFERENCES

Adam, K., Sivropoulou, A., Kokkini, S., Lanaras, T. and Arsenakis, M. 1998. Antifungal activities of Origanum vulgare subsp. hirtum, Mentha spicata, Lavandula angustifolia, and Salvia fruticosa essential oils against human pathogenic fungi. J. Agric. Food Chem. **46:** 1739–1745

Andersson, K.E. and Hellstrand, P. 2012. Dietary oats and modulation of atherogenic pathways Mol. Nutr. Food Res. **56 (7):** 1003–1013.

Antara, N. S., Sujava, I. N., Yokto, Asano, A. K. and Tomito. F. 2004. Effects of indigenous starter cultures on the microbial and physicochemical characteristics of Urutan, a Balinese fermented sausage. J. Biosci. Bioeng. **98**: 92–98.

AOAC. 1995. Official Methods of analysis. 16th ed. Association of Official Agricultural Chemists, Washington D. C.

APHA. 2001. Compendium of Method of Microbiological Examination of Foods. 4th ed., American Public Health Association, Inc., Washington, D. C.

Arihara, K. 2006. Strategies for designing novel functional meat products. Meat Sci., **74:** 219-229.

Baggio, S.R., Miguel. A.M.R., Bragagnolo. Neura 2005. Simultaneous determination of cholesterol oxides, cholesterol and fatty acids in processed turkey meat products. Food Chem. **89.3:** 475-484.

Barton-Garde, P.A. and Bejerholm, C. 2001. Eating quality of pork – rhat the lenes have found. Pig Farming, **33:** 56 – 57.

Benjamin, S. and Spener, F. 2009. Conjugated linoleic acids as functional food: an insight into their health benefits Nutr. Metab. **6:** 36.

Berry, B., Joseph, R. and Stanfield, M. 1996. Use of electrical stimulation, hot processing and carrageenan for processing low-fat ground beef. Meat Science, **42(1):** 111–123.

Biswas,A.K., Sahoo, J. and Chatli, M . K. 2011. A simple UV-Vis spectrophotometric method for determination of b-carotene content in raw carrot, sweet potato and supplemented chicken meat nuggets. Food Sci. Tech. **44:** 1809- 1813.

Bonfanti, C., Ianne, R., Mazzaglia, A., Lanza, C. M., Napoli,. E.M. and Ruberto, G. 2012. Emerging cultivation of oregano in Sicily: Sensory evaluation of plants and chemical composition of essential oils. Industrial Crops and Products. **35:** 160–165.

Brand-Williams, W., Cuvelier, M. E. and Berset, C. 1995. Use of a free radical method to evaluate antioxidant activity. Lebensmittel-Wissenschaft und –Technologie, **28:** 25–30.

Brewer, M. S. 2012. Reducing the fat content in ground beef without sacrificing quality: A review. Meat Sci. **91:** 385-395.

Brigelius-Flohe, R. and Galli, F. 2010. Vitamin E: A vitamin still awaiting the detection of its biological function. Mol. Nutr. Food Res. **54(5):** 583–587.

Brigitte, A.G., Paul, E. M. and Jeffrey, B.B. 2005. Flavonols, flavones, flavanones, and human health: Epidemiological evidence. J. Med. Food. **8:** 281–290.

Bruschi, G., Bruschi, M.E., Carappo, M., Orlandini, G., Spaggiari, M. and Cavatorta, A. 1985. Cytoplasmic free [Ca_{2+}] is increased in the platelets of spontaneously hypertensive rats and essential hypertensive patients. Clinical Science. **68:** 179–184.

Castelluccio, C., Paganga, G., Melikian, N., Bolwell, G.P., Pridham, J., Sampson, J. and Rice-Evans, C. 1995. Antioxidant potential of intermediates in phenylpropanoid metabolism in higher plants. FEBS Lett. **368(1):** 188–192.

Cervato, G., Carabelli, M., Gervasio, S., Cittera, A., Cazzola, R. and Cestaro, B. 2000. Antioxidant properties of oregano (Origanum vulgare) leaf extracts. J. Food Biochemistry. **24:** 453–465.

Chiu, Y. and Yang, W. 1992. Preparation of vitamin E microemulsion possessing high resistance to oxidation in air. Colloids and Surfaces, **63(3–4):** 311–322.

Chouliara, E., Karatapanis, A., Savvaidis, I.N. and Kontominas, M.G. 2007. Combined effect of oregano essential oil and modified atmosphere packaging on shelf-life extension of fresh chicken breast meat, stored at 4 1$_o$C. Food Microbiology. 607-617.

Cocconelli, P. S. 2007. Starter cultures: Bacteria. In F. Toldra (Ed.). Handbook of fermented meat and poultry. Oxford: Blackwell Publishing Ltd. 137–145.

Cofrades, S., Hughes, E. and Troy, D. J. 2000. Effects of oat fiber and carrageenan on the texture of frankfurters formulated with low and high fat. Eur. Food Res. Technol. **211**: 19–26.

Culioli, J., Berri, C., Mourot, J. 2003. Muscle foods: consumption, composition and quality. Sci. Aliments. **23:** 13 – 34

Daly, T., Jiwan, M. A., O'Brien, N.M. and Aherne, S.A. 2010. Carotenoid content of commonly consumed herbs and assessment of their bioaccessibility using an *in vitro* digestion model. Plant Foods for Human Nutrition. **65:** 164–169.

Department of Animal Husbandry 2012. Basic Animal Husbandry Statistics.3.

Desmond, E., Troy, D. and Buckley, D. 1998a. The effects of tapioca starch, oat fibre and whey protein on the physical and sensory properties of low-fat beef burgers. Lebensmittel Wissenschaft and Technologies, **31(7&8):** 653–657.

Desmond, E., Troy, D. and Buckley, D. 1998b. Comparative studies of nonmeat adjuncts used in the manufacture of low-fat beef burgers. Journal of Muscle Foods, **9(3):** 221–241.

Dipplock, A.T., Agget, P.J., Ashwell, M., Bornet, F., Fern, E.B. and Robertfroid, M.B. 1999. Scientific concepts of functional foods in Europe: consensus document. Br J Nutr **81(1):**S1–S27.

Ducan, C. L. and Foster, E. M. 1995. Effect of sodium nitrite, sodium chloride on germination and outgrowth of anaerobic spores. J. Appl. Microbiol. **16**: 406-408

Erne, P., Bolli, P., Burgisser, E. and Buhler, F.R. 1984. Correlation of platelet calcium with blood pressure. Effect of antihypertensive therapy. J. Medicine. **310**: 1084–1088.

Esen, G., Azaz, A. D., Kurkcuoglu, M., Can Baser, K. H. and Tinmaz, A. 2007. Essential oil and antimicrobial activity of wild and cultivated Origanum vulgare L. ssp.hirtum from the Marmara region, Turkey. Flavour and Fragrance Journal. 22: 371–376.

FAO 2012. Food and Agricultural Organization . www.fao.org

FDA . 1997. Food Labeling: Health Claim; Oats and Coronary Heart Disease; Final Rule. http://www.fda.gov

Frempong, I. E. A., Annan-Prah, A. and Wiredu, R. 1996. Cassava as a Non- Conventional Filler in Comminuted Meat Products. Meat Sci. **44**: 193-202.

Froehlich, D. A., Gullet, E. A., Usborne, W. R. 1983. Effect of nitrite and salt on the colour, favour and overall acceptability of ham. J. Food Sci. **48**: 152-154.

Gawrysiak-Witulska, M., Siger. A. and Nogala-Kalucka, M. 2009. Degradation of tocopherols during near-ambient rapeseed drying. J. Food Lipids. **16(4):** 524–539

Giese, J. 1992. Developing low-fat meat products. Food Technology, **46:** 100–108

Goldberg, I .1994 . Functional foods. Designer foods, pharmafoods, nutraceuticals, Chapman and Hall, London ,Goldberg (Ed.), 3–16.

Golli, F. and Azzi, A. 2010. Present trends in vitamin E research. Biofactors, **36(1):** 33–42.

Grunden, L. P., MacNeil, J. H. and Dimick, P. S. 1972. Poultry product quality: chemical and physical characteristics of mechanically deboned poultry meat. J. Food Sci. **37:** 247-249.

Guan, H., Gao, L., Zhu, L., Yan, L., Fu, M. and Chen, C. 2012. Apigenin attenuates neointima formation via suppression of vascular smooth muscle cell phenotypic transformation. J. of Cellular Biochemistry. **113:** 198–207.

Hardy, G. 2000. Nutraceuticals and functional foods: Introduction and meaning. Nutrition, **16:** 688-697.

Hemung, B. O., Benjakul, S. and Yongsawatdigul, J. 2013. pH-dependent characteristics of gel-like emulsion stabilized by threadfin bream sarcoplasmic proteins. Food Hydrocolloids. **30**: 315-322.

Hetherington, M.M., Cunningham, K., Dye, L., Gibson, E.L., Gregersen, N.T., Halford, J.C. and Van Trijp, H.C. 2013. Potential benefits of satiety to the consumer: Scientific considerations. Nutr. Res. Rev. **26(1):** 22-38.

Honikel, O.K. 2004. Aktualles aus der internationalen Fleischforschung. Fleischwirtschaft. **5:** S. 18.

Hu. Xin-Zhong , Zheng. Jian-Mei Li .Xiao-ping , Xu. Chao and Zhao.Qiong. 2014. Chemical composition and sensory characteristics of oat flakes: A comparative study of naked oat flakes from China and hulled oat flakes from western countries. J. Cereal Sci. **60(2):** 297-301

ICAR 2014. Indian Council Of Agricultural Research;www.icar.org/cari

Incze, K. 2007. European Products. In the Handbook of Fermented Meat and Poultry, edited by F. Toldra, Ames, Iowa; Blackwell Publishing.

Inglett, G., Warner, K. and Newman, R. 1994. Sensory and nutritional evaluations of oatrim. Cereal Foods World, **39(10):** 755–759

Jiménez-Colmenero F. 2000. Relevant factors in strategies for fat reduction in meat products. Trends Food Sci. Technol. **11:** 56–66.

Jiménez-Colmenero. F., Carballo, J. and Cofrades, S. 2001. Healthier meat and meat products: their role as functional foods.Meat Sci. **59(1):** 5-13

Jukna, C., Jukna, V., Peciulaitiene, N. and Kerziene, S. 2010. Influence of English Large White breed on fattening and meat characteristics and meat quality of Lithuanian White pigs. Vet. Med. Zoot., **51(73):** 17-22.

Jukna, V., Jukna, C. and Peciulaitiene, N. 2007. Genetic factors influence on pork quality. Vet. Med. Zoot., **40(62):** 35-38.

Kanimozhi, R.K. 2012. Studies on incorporation of selected vegetables and herbs on the quality of chicken nuggets. Thesis, PhD. Deemed University, Indian Veterinary Research Institute, Izatnagar, India.

Kim, B. K. 1993. Physical and functional properties of several extrusion texturized oilseed protein products containing beef muscle. J. Korean Soc. Food Sci. Nutr. **22**: 328.

Kintzios, S.E., 2004. Oregano. In: Peter, K.V. (Ed.), Handbook of Herbs and Spices. CRCPress, Boca Raton, Florida. 215–226.

Kokkini, S. and Vokou, D. 1989. Carvacrol-rich plants in Greece. Flavour. Fragrance J. **4:** 1–7.

Kondaiah, N. and Panda, B. 1992. Processing and utilization of spent hens. World Poult. Sci. **48:** 255–265.

Koniecko, E.S. 1979. Handbook of Meat Chemistry. Avery Publishing Group, Inc., Wayne, New Jersey, 53-55.

Kumar, K.A., Biswas, A.K. and Sahoo, J. 2014. Comparison study of chitosan, EDTA, eugenol and peppermint oil for antioxidant and antimicrobial potentials in chicken noodles and their effect on colour and oxidative stability at ambient temperature Storage. LWT **55:** 286-293.

Kumar, S. 2007. Studies on processing of restructured turkey meat blocks. Thesis, MVSc submitted to Deemed University, IVRI, Izatnagar, India.

Kumar, M. and Sharma, B.D. 2004. The storage stability and textural, physico-chemical and sensory quality of low-fat ground pork patties with Carrageenan as fat replacer. Int. J. Food Sci. Technol. **39.1:** 31–42.

Lauridsen, C., Hedemann, M. S. and Jensen, S. K. 2001. Hydrolysis of tocopheryl and retinyl esters by porcine carboxyl ester hydrolase is affected by their carboxylate moiety and bile acids. J. Nutr. Biochem., **12(4):** 219–224.

Little, A. C. 1975. Off on a tangent. J. Food Sci. **40**: 410–412.

Majumdar, S., Bhanja, S.K. and Rajnarayn . 2012. Hyderabad. 5-7 December 2012. Present scenario and future prospects of turkey and quail as diversified poultry. 167.

Majumdar. S., Bhanja. S.K., Singh. R.P. and Agarwal. S.K. 2005. Effect of age on the carcass Traits and Meat Quality of Turkey Poults. J. Appl. Anim. Res. **27:** 85-88

Mansour, E. and Khalil, A. 1999. Characteristics of low-fat beefburgers as influenced by various types of wheat fibres. J. Sci. Food Agric., **79:** 493–498.

McClements, D. J., Decker, E. A., Park, Y. and Weiss, J. 2009. Structural design principles for delivery of bioactive components in nutraceuticals and functional foods. Crit. Rev. Food Sci. Nutr., **49(6):** 577–606.

Meera, C.1997. Development of eteral foods based on malted cereals . Thesis. Phd. University of Mysore. Mysore.

Milos, M., Mastelic, J. and Jerkovic, I. 2000. Chemical composition and antioxidant effect of glycosidically bound volatile compounds from oregano (*Origanum vulgare L.* ssp. *hirtum*). Food Chem. **71:** 79–83.

Mohamed, H.M.H., Mansour, H.A. and Farag, M.D.E. and Din, H. 2011.The use of natural herbal extracts for improving the lipid stability and sensory characteristics of irradiated ground beef. Meat Sci., **87(1):** 33-39.

Mohan, B.H., Gopal, A., Malleshi, N.G. and Tharanathan, R.N.2005. Characteristics of native and enzymatically hydrolyzed ragi (*Eleusine coracana*) and rice (*Oryza sativa*) starches. Carbohydrate Polymers. **59:** 43-50.

Nedljkovic, L., Curilovic. V. and Ikic, N. 1979. Manufacture of turkey meat products using textured vegetable proteins. Technologija Mesa, **20(10):** 295-298.

Nielsen, S.J. and Popkin, B.M. 2003. Patterns and trends in food portion sizes, 1977-1998. J. Am. Med. Assoc. **289(4):** 450-453.

Nirmala, M. and Muralikrishna, G. 2003. Properties of three purified a-amylases from malted finger millet (*Ragi, Eleusine coracana*, Indaf-15). Carbohydrate Polymers. **54:** 43-50.

Pascal, G. and Collet-Ribbing, C. 1998. Las perspectives europeas sobre los alimentos funcionales. Institute for Prospective Technolgical Studies: Sevilla, Spain. IPTS Report **24:** 1–7.

Pattison, D. J., Silman, A. J., Goodson, N. J., Lunt, M., Bunn, D. and Luben, R. 2004. Vitamin C and the risk of developing inflammatory polyarthritis: Prospective nested case–control study. Annals of the Rheumatic Diseases. **63:** 843–847.

Pentikainen, S., Karhunen, L., Flander, L., Katina, K., Alexandra, A., Pierre, V.S. and Poutanen, K. 2014. Enrichment of biscuits and juice with oat β-glucan enhances postprandial satiety. Appetite.**75:** 150-156.

Perez-Jiménez, J. and Saura-Calixto, F. 2005. Literature data may underestimate the actual antioxidant capacity of cereals. J. Agric. Food Chem., **53:** 5036–5040.

Piernas, C. and Popkin, B.M. 2010. Snacking increased among US adults between 1977 and 2006. J. Nutr., **140(2):** 325-332.

Pinero, M., Ferrer, M., Arenas, L., Huerta-Leidenz, N., Parra, K. and Araujo, S. 2005. Sensorial and chemical attributes of a light meat product formulated with oat's soluble fiber. Revista Científica, FCV-LUZ, **3:** 279–285.

Popovic, M., Kaurinovic, B., Jakovljevic, V., Mimica-Dukic, N. and Bursac, M. 2007. Effect of parsley (Petroselinum crispum (Mill.) Nym. ex A.W. Hill, Apiaceae) extracts on some biochemical parameters of oxidative stress in mice treated with CCl4. Phytotherapy Res., **21:** 717–723.

Pszczola, D. 1991. Oat-bran based ingredient blend replaces fat in ground beef and pork sausage. Food Technol., **45:** 60.

Re, R., Pellegrini, N., Proteggente, A., Pannala, A., Yang, M. and Rice-Evans, C. 1999. Antioxidant activity applying an improved ABTS radical cation decolorization assay. Free Rad. Biol. Med., **26:** 1231–1237.

Rigotti, A. 2007. Absorption, transport, and tissue delivery of vitamin E. Mol. Asp. Med., **28(5–6):** 423–436.

Robert, W.W. 1995. The oat crop: production and utilization. Chapman & Hall, London .

Sales, J. 1998. Fatty acid Composition and cholesterol content o different ostrich muscles. Meat Sci. **49(4):** 489 – 492.

Shahidi, F., Janitha, P.K. and Wanasundara, P.D. 1992. Phenolic antioxidants Food Sci. Nutr. **32:** 67–103.

Shobana, S., Krishnaswamy, K., Sudha, V., Malleshi, N.G., Anjana, R.M., Palaniappan, L. and Mohan, V. 2013. Chapter One – Finger Millet (*Ragi*, *Eleusine coracana* L.): A Review of Its Nutritional Properties, Processing, and Plausible Health Benefits. Adv. Food Nutr. Res. **69:** 1-39.

Shylaja, M.R. 2004. The functional role of herbal spices. In: Peter, K.V. (Ed.), Hand-book of Herbs and Spices. CRC Press, Boca Raton, Florida. 11–21.

Sivropoulou, A., Papanikolaou, E., Nikolaou, C., Kokkini, S., Lanaras, T. and Arsenakis, M. 1996. Antimicrobial and cytotoxic activities of Origanum essential oils. J. Agric. Food Chem. **44:** 1202–1205.

Snedecor, G.W. and Cochran, W.G. 1994. Statistical methods. 8th edition. Iowa State University Press.

Souza, E.L., Stamford, T.L.M., Lima, E.O. and Trajano, V.N. 2007. Effectiveness of Origanumvulgare L. essential oil to inhibit the growth of food spoiling yeasts. Food Control **18:** 409–413.

Staenic. M., Vulic, J., Djilas, S., Misic, D., Tadic, V., Petrovic, S. and Zizovic I. 2014.Free-radical scavenging activity and antibacterial impact of Greek oregano isolates obtained by SFE. Food Chem.**165:** 307-315.

Subba Rao. M.V.S.S.T. and Muralikrishna, G. 2002. Evaluation of the antioxidant properties of free and bound phenolic acids from native and malted finger millet (Ragi, *Eleusine coracana*, Indaf-15). J. Agric. Food Chem. **50:** 889–892.

Svihus, B. and Gullord, M. 2002. Effect of chemical content and physical characteristics on nutritive value of wheat, barley and oats for poulty. Anim. Feed Sci. Tech. **102**: 71- 92.

Taki, G. 1991. Functional ingredient blend produces low-fat meat products to meet consumer expectations. Food Technol., **45:** 70–74

Tong, L.T., Zhong, K., Liu, L., Guo, L., Cao, L. and Zhou, S. 2014.Oat oil lowers the plasma and liver cholesterol concentrations by promoting the excretion of faecal lipids in hypercholesterolemic rats. Food Chem. **142:** 129–134.

Troutt, E., Hunt, M., Johnson, D., Claus, J., Kastener, C., Kropf, D. and Stroda, S. 1992. Characteristics of low-fat ground beef containing texture-modifying ingredients. J. Food Sci., **57(1):** 19–23.

Troy, D., Desmond, E. and Buckley, D. 1999. Eating quality of low-fat beef burgers containing fat-replacing functional blends. J. Sci. Food Agric., **79:** 507–516.

Turchini, G.M., Nichols, P.D., Barrow, C. and Sinclair, A.J. 2012. Jumping on the omega-3 bandwagon: distinguishing the role of long-chain and short-chain omega-3 fatty acids. Food Sci. Nutr. **52(9):** 795–803.

Valsta, L.M., Tapanainen, H. and Mannisto, S. 2005. Meat fats in nutrition. A rewiew. Meat Sci. **70:** 525-530.

Vasconcellos, J.A. 2001. Alimentos funcionales. Conceptos y beneficios para la salud. World Food Sci. **1(6):** 1–19.

Wagner, H. 1999. Aromabildende Stoffe in Fleisch. Institut fur Chemie und Physik, Bundesanstalt tir Fleischforschung, 111.

Warner, K. and Inglett, G. 1997. Flavor and texture characteristics of foods containing Z-trim corn and oat fibers as fat and flour replace. Cereal Food World, **42(10):** 821–825.

Witte, V.C., Krause, G.F. and Bailey, M.E. 1970. A new extraction method for determining 2-thiobarbituric acid values of pork and beef during storage. J. Food Sci., 35: 582-585.

Wood, P.J. 2011. Oat β-glucan: properties and function. Oats: Chemistry and Technology . American Association of Cereal Chemistr. 219–254.

Yang, Z. Y. and Huffman, S. L. 2011. Review of fortified food and beverage products for pregnant and lactating women and their impact on nutritional status. Maternal and Child Nutr. **7:** 19–43.

Yazicioglu, A. and Tuzlaci, E. 1996. Folkmedicinal plants of Trabzon (Turkey). Fitoterapia .**67:** 307–318.

Yoon, Y. and Choe, E. 2009. Lipid oxidation and stability of tocopherols and phospholipids in soy-added fried products during storage in the dark. Food Sci. Biotechnol. **18(2):** 356–361.

Zhang, P.P., Hu. X.Z., Zhen, H.M., Xu. C. and Fan, M.T. 2012. Oat β-glucan increased ATPases activity and energy charge in small intestine of rats J. Agric. Food Chem. **60:** 9822–9827.

Zhang,W., Xiao, S., Samaraweera, H.J., Lee, E.U. and Ahn, D. 2010. Improving functional value of meat products. Meat Sci. **86(1):** 15-31

Zhang, H., Chen, F., Wang, X., Yao-Hui and Yuan 2006. Evaluation of antioxidant activity of parsley (Petroselinum crispum) essential oil and identification of its antioxidant constituents.Food Res. Int. **39:** 833- 839.

Zheng, W. and Wang, S. Y. 2001. Antioxidant activity and phenolic compounds in selected herbs. J. Agric. Food Chem. **49:** 5165–5170.

VITAE

Name	:	**Dr. Pooja Farswan**
Date	:	16th January 1990
Father's Name	:	Bhajan Singh
Mother's Name	:	Pushpa Farswan
Permanent Address	:	Pocket A-3, Flat No.—62, Sector- 8, Rohini, Delhi— 110085
Phone No.	:	9410514356
E-mail	:	poojafarswan1990@gmail.com

Educational qualification

Degree	Board/University	Year	OGPA
B.V.Sc. & A.H.	G.B. Pant University of Agriculture and Technology	2013	7.132/10
MVSc (PSC)	Deemed University Indian Veterinary Research Institute Izatnagar	2015	8.00/10

Members of Societies

☞ Member of Uttarakhand State Veterinary Council

Fellowship

☞ ICAR- JRF Scholarship