# A COMPARATIVE STUDY ON ANTIMICROBIAL AND ANTIOXIDANT PROPERTIES OF SOME MEAT ADDITIVES


**A**
**Thesis**
**Submitted to**
**West Bengal University of Animal and Fishery Sciences**
**In partial fulfillment of the requirements for the Degree of**

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

By
**VINOD KUMAR**
*B. V. Sc. & A. H.*

**Department of Livestock Products Technology**
**Faculty of Veterinary and Animal Science**
**West Bengal University of Animal and Fishery Sciences**
**Kolkata – 700037**
**2011**

# Dedicated To –

My Family

&

Well wishers

# DEPARTMENT OF LIVESTOCK PRODUCTS TECHNOLOGY

## WEST BENGAL UNIVERSITY OF ANIMAL AND FISHERY SCIENCES

**From:**
*Prof.(Dr.) S.Biswas*
**M.V.Sc, Ph.D.**

37, Kshudiram Bose Sarani,
Belgachia, Kolkata –37.

Ref. No. .....

Date .....

# Certificate

*This is to certify that the work embodied in this thesis entitled "A comparative Study on antimicrobial and antioxidant properties of some meat additives "submitted by vinod kumar in partial fulfillment for the degree of Master of Veterinary Science in Livestock Products Technology of West Bengal University of Animal and Fishery Science, Kolkata, is the original carried out by the candidate himself under my guidance. The results of the investigation reported in the thesis have not so far been submitted for any other Degree or Diploma. The assistance and help received during the course of investigation have been duly acknowledged.*

**Dated** 26.9.11
**The.....**

**Kolkata-37**

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*Certified that the thesis entitled "A COMPARATIVE STUDY ON ANTIMICROBIAL AND ANTIOXIDANT PROPERTIES OF SOME MEAT ADDITIVES".*

*Submitted by* **Vinod Kumar** *in partial fulfillment for the degree of* **Master of Veterinary Science** *in Livestock Products Technology of West Bengal University of Animal and Fishery Science, Kolkata embodies the original work done by the candidate. The candidate has carried out his work sincerely and methodically.*

*We have carefully gone through the content of the thesis and are fully satisfied with the work which is being presented by him. It is therefore approved on* 18-10-2011 *for the award of degree of Master of Veterinary Science of this University.*

.....
Signature of the External Examiner

Name: UMA GHOSH

.....
18/10/11

**(Prof. S. Biswas)**

Chairman

Advisory Committee

## MEMBERS OF THE ADVISORY COMMITTEE

1. **Prof. A.Sahoo** ..... 18/10/11
   Deptt. of Animal Genetics & Breeding

2. **Prof. B. Ray** .....
   Deptt. of Animal Nutrition 18/10/2011

3. **Dr. S. Batabyal** .....
   Deptt. of Vety. Biochemistry 18/10/2011

4. **Dr. D. Bhattacharyya**
   Deptt. of Livestock products Technology ..... 18/10/11

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*Place: Kolkata.*

Vinod Kumar

***(Vinod Kumar)***

# CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

| | |
|---|---|
| mM | : milliMole |
| Mg | : milligram |
| Min. | : Minute |
| ml | : milliliter |
| mm | : millimeter |
| mM | : Millimole |
| N | : Normal |
| NaOH | : Sodium hydroxide |
| nm | : nanometer |
| No. | : Number |
| OD | :Optical Density |
| P value | : Probability value |
| pH | : Negative logarithm of hydrogen ion |
| ppm | : parts per million |
| rpm | : revolution per minute |
| SE | : Standard Error of Mean |
| SPC | : Standard Plate Count |
| Staph. | : Staphylococcus |
| STPP | : Sodium tripolyphosphate |
| Std. | : Standard |
| TBARS | : Thio Barbituric Acid reacting Substances |
| TV | : Tyrosine Value |
| TCA | : Trichloro Acetic Acid |
| TPC | : Total Plate Count |
| TPSC | : Total Psychrophilic Count |
| TSP | : Texture Soy Protein |
| viz. | : Namely |
| VP | : Vacuum Packaging |
| w/v | : weight / volume |
| WHC | : Water Holding Capacity |
| Wt. | : Weight |
| YMC | : Yeast and Mould Count |

| | |
|---|---|
| % | : percentage |
| & | : and |
| @ | : at the rate of |
| < | : Less than |
| > | : Greater than |
| ≤ | : Less than equal to |
| $a_w$ | : Water activity |
| ANOVA | : Analysis of Variance |
| µ | : micron |
| µg | : microgram |
| µl | : microlitre |
| $^0C$ | : Degree Centigrade |
| Approx. | : Approximately |
| B.P | :Boiling Point |
| Cfu | : colony forming unit |
| cm. | : centimeter |
| Conc. | : Concentration |
| CP | : Crude Protein |
| D/d | : Day |
| e. g. | : As per example |
| ES | : Emulsion Stability |
| EE | : Ether Extracts |
| *et. al.* | : Co- workers |
| ERV | : Extract Release Volume |
| Fig. | : Figure |
| GDP | : Gross Domestic Product |
| g/gm | : gram |
| H/hrs. | : hours |
| $H_2SO_4$ | : Sulphuric acid |
| ICRA | : International credit rating agency |
| IU | : International Unit |
| i.e. | : That is |
| Kg | : kilogram |
| L | : liter |
| LDL | :Low Density protein |
| LDPE | : Low Density polyethylene |
| Lbs | : Pound |
| Ltd. | : Limited |
| M | : Molar |
| MDFP | :Mechanically deboned fowl meal |
| MDPM | : Mechanically deboned poultry meal |

# CHAPTER-I

# INTRODUCTION

# *Chapter-I*

## *Introduction*

The Indian poultry industry is growing. As the country progresses and people become prosperous, they change their food habits and eat more eggs and meat. This phenomenon is seen throughout the world. India is a country of contrasts. There are various religious beliefs and many people are against eating eggs and meat. There are certain religions, which prohibit particular meats. Beef is taboo for Hindus as pork is for Muslims. In Himalayan states, fish is prohibited but buffalo meat is accepted. In spite of these contrasts, consumption of eggs and meat is on the increase.

The growth trend is likely to continue for the present decade, as demand has been growing steadily on the back of favourable socio-economic factors like healthy GDP growth, rising purchasing power, changing food habits and increasing urbanization, the statement said.

ICRA's assessment based on industry feedback indicates that domestic broiler meat demand is expected to grow at around 15-18%, while that of eggs is tipped to rise at 5-7% over the medium-to-long term, an International Credit Rating Agency (ICRA) statement said.

The Indian poultry sector has been growing at around 8-10% annually over the last decade and at more than 15% in the last three years, it added.At present India ranks 21st in the world with regard to world poultry meat. In 1995 poultry meat reached 0.5 million metric tonnes & it increased to 0.87 million metric tonnes in 2000. The growth rate is 11% per annum.

Meat and its products have experienced increasing popularity and become widely spread all over the world. The appearance of food is one of the major determinants of its appeal to consumers and consequently, sales of the product. However, during storage, quality attributes of the products deteriorate due to lipid oxidation and bacterial

growth which are the main factors that determine food quality loss and shelf life reduction. Lipid oxidation leads to the degradation of lipids and proteins which, in turn, contribute to the reduction in nutritional quality as well as deterioration in flavor, color and texture of displayed meat products (Aguirrezábal *et al.*, 2000), while bacterial contamination can precipitate major public health hazard and economic loss in terms of food poisoning and meat spoilage (Fernandez –Lopez *et al.*, 2005).

# CHICKEN PATTIES

Due to rapid urbanisation, there is a growing demand for novel ready to eat meat products. At present, there is difficulty in marketing heavy spent broiler to be sold as dressed chicken for consumption. For efficient and economic utilization of spent broilers, a process know-how for valued added novel Chicken Patties has been developed. This technology will help the farmers to market their spent broilers economically with increased returns. The chicken patties can be presented as sandwiches, salads and also consumed after frying.

# MORINGA LEAF

## Binomial name (*Moringa oleifera)*

*Moringa oleifera* is the most widely cultivated species of a monogeneric family, the Moringaceae, that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. This rapidly-growing tree (also known as the horseradish tree, drumstick tree, benzolive tree, kelor, marango, mlonge, moonga, mulangay, nébéday, saijhan, sajna or Ben oil tree), was utilized by the ancient Romans, Greeks and Egyptians. Leaflets can be stripped from the feathery, fern-like leaves and used in any spinach recipe. They are exceptionally nutritious and antioxidant.so its use as Very young plants can also be used as a tender vegetable. In many cultures, the diet consists mainly of a starchy dish or porridge made from corn meal, cassava, millet or the like. Side dishes or "sauces" served with the starchy main dish are therefore very important nutritionally, as they are often the only source of extra protein, vitamins and minerals.

**Constituents:** deic, palmitic and stearic acid, saponins, glycoside, gum, protein

**Vitamins:** A (8855 IU per 100g), B1, B2, B3, C

**Minerals:** calcium, iron, phosphorus, magnesium

**Actions:** tonic, digestive, vermifuge, diuretic, aphrodisiac, anti-inflammatory, antioxidant & antimicrobial.

## GARLIC (*Allium sativum*):

A member of the lily or *Allium* family, which also includes onions and leeks, garlic is rich in a variety of powerful sulfur-containing compounds including *thiosulfates* (of which the best known compound is *allicin*), *sulfoxides* (among which the best known compound is *alliin*), and *dithiins* (in which the most researched compound is ajoene). While these compounds are responsible for garlic's characteristically pungent odour, they are also the source of many of its health-promoting effects. Allicin is the key component from Garlic. **Allicin** has been referred to as "Mother Nature's defender," "The Heart of Garlic," which happens to be the name of a recent book by **Peter Josling.** Pharmacological activities of allicin in many areas, including: anticoagulation, antihypertensive, antimicrobial, antibiotic, antiphrastic, antimitotic, antiviral, antitumor, antioxidant, antiaging,antiplatelet, detoxifies heavy metals, fibrinolysis, Humoral immunity(refers to antibody production, and all the accessory processes that accompany it), hypolipidaemic (lipid-lowering),and immune enhancer and modulator.

## VITAMIN E (Tocopherol):

Vitamin E is a generic term used for all tocopherols and tocotrienols, as all exert the same biological action. The efficacy with which they do so is very low in the case of the tocotrienols,whereas tocopherols, and in particular a-tocopherol, are much more active and potent and account for almost all the vitamin E activity of living tissues. The antioxidant effects of vitamin E have been reported in many poultry studies **(Bollengier-Lee *et al.*, 1998; 1999; Chen *et al.*, 1998)**

According to **wrick (1995)**, the expectation of the consumer for meat is that, it should be healthy, rich in protein low in fat, tender and have a typical flavour .currently dietary recommendations favour the consumption of less saturated fat (Brisson,1986;haq et al.,1995)

Chicken meats and products are generally a very popular food commodity around the world, and its consumption has increased over the last decades in many counties (Chouliara et al., 2007).some of the reasons for their popularity are the relatively low cost of production ,low fat content, and high nutritional value of chicken breast meat. Chicken contains relatively high concentration of polyunsaturated fatty acids. However high degree of polyunsaturated accelerates oxidation process, leading to detoriation in meat flavours, colour, and taste.(Sayago-Ayerdi *et al.*,2009).

Lipid oxidation is a major cause of quality deterioration in meat & meat products and give rise to rancidity and the formation of undesirable odours & flavours, which affect the functional, sensory, and nutritive values of meat products.(Gray *et al.*,1996).

Antioxidants play an important role in the chicken meat industry as inhibitors of oxidative rancidity and improve of shelf life. Synthetic antioxidants such as BHT (butryl-hydroxytoluene), TBHQ (tert-butylhydroquinones) is limited used due to their potential carcinogenic effects (Choe *et al.*,2010).thus ,in the processing of chicken meat products, there is increasing need for a natural way to minimise oxidative rancidity and extend shelf life.(Naveena et *al.*,2008).

Now –a-day chicken meat & its products (chicken patties) have become great demand. To fulfil the demand of consumer shelf life of products (chicken patties) have a big problem, because products store a long period. Chicken patties can detoriate during storage due to lipid oxidation & microbial growth, reducing nutritional quality & affecting flavour. Therefore keeping the facts in view, the present study was designed with the following objectives.

1. To study the antioxidant effects of garlic, moringa leaf and vitamin e included in chicken patties.

2. To study the antimicrobial effects of garlic, moringa leaf and vitamin e included in chicken patties.

3. To compare the antioxidant & antimicrobial action of garlic, moringa leaf and vitamin e included in chicken patties.

4. To study the effect of garlic, moringa leaf and vitamin e on phisico-chemical, proximate composition microbiological & sensory quality of chicken patties.

5. To study the storage stability of chicken patties during domestic refrigeration storage.

# CHAPTER-II

# REVIEW OF LITERATURE

# *Chapter-II*

## *Review of literature*

## 2.1 Chicken patties:

The quality of patties containing mechanically deboned poultry meat(MDPM), and deboned fowl meat(MDFP) and two levels of structured protein fibre (8% and 16%) was evaluated by **Lyon *et. al.*, (1978a)**. Patties with 0 and 8% SPF ranked highest for overall impression.

**Lyon *et al.*(1978a)** suggested that interchangeable ratios of 40 :60/60:40 MDPM and MDFM can be incorporated with SPF to yield good quality chicken patties were developed with indigenous flavour profiles by Padda *et al.* (1987) concluded that acceptable patties can be made from blends of pork and turkey containing relative high levels of turkey.

**Lyon *et. al.* (1978b)** also evaluated the effects of level structured protein fibre on quality of mechanically deboned chicken meat patties.

**Lyon *et al.* (1982)** reported that giblet incorporated 10% into the patties significantly affected textures, patties with thigh meat alone.

Processed meat products containing mechanically deboned upto (30-35) % of the total meat component gave satisfactory colour, texture and palatability quality (**Kim et al., 1981**).

**Ande *et al.* (1984)** investigated the edible yield and characteristics of patties manufactured from two types of chicken carcasses. Texture profile analysis of patties made from mixed and flake-cut MDPM was reported by Lyon et al. (1980). Objectively, flake cut patties were more springy than mixed patties when SPF level was equal (15%). Flake cut patties either of the flaked or mixed patties with 15% SPF. The eating quality of ground chicken-soy patties was reported by **Molonon et al. (1976)**. **Cunningham (1977)** studied the composition sensory properties and frozen stability of chicken & chicken-soy patties.

**Hollender *et. al.* (1987)** studies the effect of fragmentation method and formulation on the quality of meat patties made from restructured spent layer meat. They found that acceptability scores for both flavour & texture were highest for breast meat patties and lowest for leg meat patties.

Partial replacement of chicken meat with giblets in the preparation of patties was also reported by **Thind *et al.* (1988).**

**Anjaneyulu *et al.* (1990)** reported that appearance, flavour and overall acceptability of chicken patties were significantly better than patties of combinations of meat (spent hens meat + old sheep meat) which are markedly better than mutton patties.

**O'Sullivan *et al.* (2004)** reported that antioxidants were added (concentration range 0-4%) to fresh, minced chicken meat. Antioxidant potential was assessed through TBARS and colour measurements. Optimum test ingredient concentrations determined were; aloe Vera (AV) (1.0%), fenugreek (Fen) (0.01%), ginseng (Gin) (0.05%), mustard (Mtd) (0.25%), rosemary (RM) (0.1%), sage (S) (0.1%), soya protein (SP) (0.01%), tea catechins (TC) (0.01%) and whey protein concentrate (WPC) (2%). The optimum concentration of each test ingredient was incorporated into fresh, previously frozen and cooked chicken patties. Control meat (low vitamin E) was divided into 11 groups. Overall, TC, RM and S had the best antioxidant potential in fresh, previously frozen and cooked chicken patties.

**Rosli *et al.* (2011)** reported the optical and textural properties of chicken patty formulated with different level of grey oyster mushroom (*Pleurotus sajor-caju*) at 0, 25 or 50% to replace chicken meat. As result, the addition of oyster mushroom chicken patties has decreased the lightness, yellowness, hardness and chewiness while no changes were noted in the redness of the patties.

## 2.2 Vitamin E

Meat products-typically high in fat and, therefore, susceptible to oxidative rancidity--must be processed and handled carefully to avoid spoilage. Product losses due to undesirable changes in flavour, aroma and colour can be costly. Adding mixed tocopherols to meats and meat products helps stabilize these products against oxidative rancidity. Tocopherols,

which have been considered GRAS (generally recognized as safe) by the Food and Drug Administration for decades, now have final USDA approval for use in meats and meat products. Meat processors can use Covi-ox natural mixed tocopherols from Henkel's Fine Chemicals Division (LaGrange, Ill.) as an alternative to synthetic antioxidants such as BHA and BHT. Tocopherol-based preservatives enable marketers to position products as "all natural" with "no artificial preservatives." They can appear on an ingredient statement as "vitamin E added for freshness," or "natural mixed tocopherols, a source of vitamin E, added to protect flavour."

**Ruiz *et al.* (2001)** supplemented meat sample with vitamin E showed lower rancidity levels, although the differences were only significant when compared to a beta-carotene diet, whereas the control treatment showed intermediate scores.

The addition of alpha-tocopherol + gallate or alpha-tocopherol + sesamol was effective in reducing off-odour volatiles, but had no effect on the redness of irradiated turkey patties Vitamin E (VE) is one of the most important lipid-soluble primary defense antioxidants (**Nam and Ahn 2002b, 2003; Lee and Ahn 2003c**)

**Rezk *et al.* (2004)** Stated that Vitamin E (VE) is a generic term used for several naturally occurring tocopherols and tocotrienols.The VE molecule can be divided into two parts, ahydroxyl-bearing aromatic system (one phenolic and one heterocyclic ring, called the chroman head) that is responsible for its antioxidant properties, and either a saturated (tocopherols) or polyunsaturated (tocotrienols) hydrocarbon tail for the orientation of VE in the lipid membrane.

**Gaytan and Narciso. (2008)** reported supranutritional supplementation levels of vitamin E are more effective at inhibiting the lipid oxidation development in chicken meat than some current levels used by the poultry industry. Neither dietary fat nor vitamin E level seems to affect the development of pale, soft, and exudative meat condition in chicken meat.

## 2.2.1 Antioxidant property of vitamin E

**Hsieh and Kinsella (1989); Chen and Ahn(1998)** Antioxidants such as free radical terminators or metal chelating agents are commonly used in meat to reduce lipid oxidation and improve sensory quality of cooked meat.

**Mallet *et al.* (1994)** reported the plant kingdom offers a range of natural phenolic compounds, among which "-tocopherol (vitamin E) is best known as one of the most efficient naturally occurring lip soluble antioxidants.

**Schaefer et al. (1995)** said that Tocopherols (or "Vitamin E") especially important in slowdown post-*mortem* oxidative changes due to their antioxidant properties.

**Stahl and Sies. (1996)** reported that several lines of evidence indicate that alpha-tocopherol is the most effective phenolic antioxidant for reducing lipid peroxidation in tissues. Especially membranes and low-density lipoproteins are protected.

**Russell *et al.* (2003)** reported Tocopherol has demonstrated strong antioxidant activity in a wide range of meats when elevated levels of "-tocopheryl acetate were supplemented in the diet of poultry; chicken (**O'Neill *et al.*, 1999**) turkey (**Higgins *et al.*, 1998**) and duck.

Vitamin E is known for its antioxidant properties that can protect sensitive compounds from oxidative degradation, however, at elevated concentrations vitamin E acts as a pro-oxidant that accelerates the oxidative degradation process. This is understood in terms of the mechanism of radical formation that is responsible for the bioactivity of vitamin E. **(Ouchi *et al.* 2009 and Chapman *et al.* 2009.)**

## 2.2.2 Antimicrobial and therapeutic property of vitamin E:

Vitamin E is thought to play a role in preventing atherosclerosis and Research studies suggest that vitamin E has numerous health benefits. cardiovascular diseases (heart disease and stroke) due to its effects on a number of steps in the development of atherosclerosis e.g. inhibition of LDL(low density lipoprotein) oxidation, inhibition of smooth muscle cell proliferation, inhibition of platelet adhesion, aggregation and platelet release reaction.

Recent studies suggested that vitamin E enhances immunity in the elderly, and that supplementation with vitamin E lowers the risk of contracting an upper respiratory tract infection, particularly the common cold.

Vitamin E in combination with vitamin C may protect the body from oxidative stress caused by extreme sports (e.g. ultra marathon running).

## 2.3 Drumstik *(Moringa oleifera)*

**Oliveira *et al.* (1999)** reported *M.oliefera* is considered one of the world's most useful tree, as almost every part of the tree can be used for food, or has some other beneficial property. Furthermore extracts from all parts of the plant show pharmalogical properties recognised by popular used and correlated by the scientific community.

*Moringa oleifera*, or the horseradish tree, is a pan-tropical species that is known by such regional names as benzolive, drumstick tree, kelor, marango, mlonge, mulangay, nébéday, saijhan, and sajnaAll parts of the Moringa tree are edible and have long been consumed by humans. . Moringa seed oil (yield 30-40% by weight), also known as Ben oil, is a sweet non-sticking, non-drying oil that resists rancidity. It has been used in salads, for fine machine lubrication, and in the manu-facture of perfume and hair care products. In the West, one of the best known uses for Moringa is the use of powdered seeds to flocculate contaminants and purify drinking water, but the seeds are also eaten green, roasted, powdered and steeped for tea or used in curries. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Ca, Fe, Vitamin C, and carotenoids suitable for utilization in many of the so-called "developing" regions of the world where undernourishment is a major concern. Moringa trees have been used to combat malnutrition, especially among infants and nursing mothers. Moringa leaves contain more Vitamin A than carrots, more calcium than milk, more iron than spinach, more Vitamin C than oranges, and more potassium than bananas," and that the protein quality of Moringa leaves rivals that of milk and eggs.(**Jed W. Fahey.,2005).**

**Ram. (1994)** said that it is an exceptionally nutritious vegetable tree with a variety of potential uses.

The leaves can be eaten fresh cooked or stored as dried powder for several months. The pods, when young can be cooked; eaten like beans **(NRC;2006). HSU. (2006)** reported that, its oil and micronutrients have been reported to contain antitumor, antileptic, antididuretic, anti-inflammatory and venomous bite characters.

The *leaves are 38% protein with all essential amino acids*, which will be of interest to vegetarians, or people who wish to cut back on meat and dairy products, or regions where protein is lacking. Two tablespoons of the high protein powder was given in the daily diet, to help overcome malnutrition. Amino acids in green leafy vegetables vary considerably, and many that are staples, are low in the sulphur bearing amino acids methionine and cysteine, whereas in the drumstick tree it is an extremely rich source in comparison to other greens and vegetables. The drumstick tree is listed as the highest protein ratio of any plant on earth. The calcium content is very high at 297mg per 100g of leaves.

**Mahmood *et al.* (2010)** reported that *Moringa* provides a rich and rare combination of nutrients, amino acids, antioxidants, antiaging and anti-inflammatory properties used for nutrition and healing. *Moringa* is sometimes called "Mother's Best Friend" and "Miracle Tree." Since 1998, the World Health Organization has promoted Maringa as an alternative to imported food supplies to treat malnutrition. It contains {seven times the vitamin C of oranges}; {four times the vitamin A of carrots}, {four times the calcium of milk}, {three times the potassium of banana} and {two times the protein of yogurt}.But the micro-nutrient content is even more in dried leaves; {ten times the vitamin A of carrots}, {17 times the calcium of milk}, {15 times the potassium of bananas}, {25 times the iron of spinach} and {nine times the protein of yogurt}. Moringa is an alternative to imported food supplies to treat malnutrition in poor countries. Moringa trees have been used to combat malnutrition, especially among infants and nursing mothers. Leaves can be eaten fresh, cooked, or stored as dried powder for many months without refrigeration, and reportedly without loss of nutritional value. Moringa is especially promising as a food source in the tropics because the tree is in full leaf at the end of the dry season when other foods are typically scarce.

## 2.3.1 Antioxidant property of moringa leaf:

The antioxidant activities of bioflavonoids complement, extend, and sometimes synergize the antioxidant activities of vitamin C, vitamin E, and carotenoids, making them an important nutritional component in the body's defences against free radical damage as reported by **Ho, (1994).**

Moringa contains specific plant pigments with demonstrated potent antioxidant properties such as the carotenoids - lutein, alpha-carotene and beta-carotene, xanthins, and chlorophyll; other phytochemicals with known powerful antioxidant ability – kaempferol, quercetin, rutin and caffeoylquinic acids; powerful antioxidant vitamins -C, E, and A (**Siddhuraju and Becker, 2003; Aslam *et al.*, 2005**)

**Sreelatha and Padma. (2009)** reported Moringa oleifera leaf extracts were tested in two stages of maturity using standard in vitro models. The successive aqueous extract of Moringa oleifera exhibited strong scavenging effect on 2, 2-diphenyl-2-picryl hydrazyl (DPPH) free radical, superoxide, nitric oxide radical and inhibition of lipid per oxidation. The extracts of Moringa oleifera both mature and tender leaves have potent antioxidant activity against free radicals, prevent oxidative damage to major biomolecules and afford significant protection against oxidative damage.

**Mahmood *et al.* (2010)** analysed that Antioxidants play an important role in inhibiting and scavenging free radicals, thus providing protection to human against infections and degenerative diseases. He suggested that the extracts of *Moringa oleifera* both mature and tender leaves have potent antioxidant activity against free radicals, prevent oxidative damage to major biomolecules and afford significant protection against oxidative damage.

## 2.3.2 Antimicrobial property of moringa leaf

**Price (1985)** reported that Pterygospermin and/or related compounds (isothiocyanates) found in various parts of the moringa plant, have been shown to have antibiotic and fungicidal properties. Though other moringa plant parts are effective against infections, much of the formal research to date has focused on extracts from the seed. "Herbal applications are commonly used to treat skin infections in developing

countries, although few investigations are conducted to validate scientifically their popular use. A study showed that mice infected with *S. aureus* recovered as quickly with a specially prepared aqueous extract of moringa seed as with the antibiotic neomycin.

**Oliveira *et al.* (1999)** reported Furthermore extracts from all parts of the plant show pharmacological properties, recognized by popular use and corroborated by the scientific community.

**Fahey (2005)** Stated antibiotic activity against *Helicobacter pylori*.Moringa species have long been recognized by folk medicine practitioners as having value in tumour therapy.

**Mahmood *et al.*(2010)** Investigated variety of detoxication and antioxidant enzymes and biomarkers as a result of treatment with Moringa or with phytochemicals isolated from Moringa have shown, antiulcer, effect on immune response, spasmolytic activities, hypocholesterolemic effects , antibacterial activity. Sympatholytic activity and antiviral activity against herpes simplex virus type-1.

**Bukar *et al.* (2011)** Described *Moringa olifera* chloroform and ethanol extracts possess as sanitizers/preservatives. This is due to the fact that they were found to possess antimicrobial activities against some food borne microorganisms often implicated in the spoilage of foods and food – borne illnesses.

## 2.4 Garlic:

Garlic is widely used in many forms of cooking for its strong flavor, which is considered to enhance many other flavors. Depending on the form of cooking and the desired result, the flavor is either mellow or intense. It is often paired with onion, tomato and ginger. Garlic has been used since antiquity for both medicinal as well as culinary purpose. It is a broad spectrum antibiotic killing a very wide variety of microorganism therefore it is called as dietary antibiotic (**www. Medherb. Com**).

Garlic has long been used in many cultures for infections, worms and as an antibiotic and antiseptic. Louis Pasteur discovered its bactericidal capacity. It was used in this capacity. It was used in this capacity so well by the Russian army therefore it was called "Russian Penicillin". It lowers blood cholesterol and blood pressure, and is used for bronchial and pulmonary infections. It is toxic to some cancer cells, has antifungal

activity against Candida, and is used as a worm remedy, as a detoxifying agent and to prevent and treat flu. In summary, garlic reportedly has many medicinal properties, including antiseptic, and in warding off colds and flu.

It also contains alliin. Ajoene, enzymes, vitamin B minerals, and flavonoids. A large number of sulfur compounds contribute to the smell and taste of garlic. Diallyl disulfide (DAS) is responsible for its odor. Allicin has been found to be the compound most responsible for the spiciness of raw garlic. This chemical opens thermo transient receptor potential channels that are responsible for the burning sense of heat in foods containing garlic.

It is said that therapeutic uses include antimicrobial, diaphoretic, diuretic, expectorant, antiflatulent and cholesterol lowering properties. Garlic, which is available in three different forms (fresh dehydrated, and extracted), is one of the most common spice which is frequently used in Chinese style sausage.

There are a lot of reports concerning the antibacterial and antioxidant effects of garlic on meat products (**Jurdi-Haldeman et al. 1987; kourounakis and Rekka, 1991; Lin et al., El-Rahman, 1987; Ismaiel and pierson, 1990**).

**Solly (2000)** analyzed the composition of the garlic bulbs and leaves and reported that moisture, organic matter and inorganic matter to be 84.09% and 87.14% and 13.38% and 11.27% and 1.53% and 1.59% respectively.

## 2.4.1 Antioxidant property of garlic:

**Bors and Saran (1987)** widely studied the antioxidant activity of garlic.

**Yang *et al.* (1993)** revealed that garlic bulb and onion, two members of allium family are known to have potent antioxidant activity.

**Imai *et al.* (1994)** investigated the antioxidant properties of 3 garlic clove preparations and their organosulphur compounds using the chemiluminescence and 1, 1-diphenyl-2 picrylhydrazyl (DPPH) assays. Aged garlic extract inhibited the emission of low level chemiluminescence and the early formation of thiobarbituric acid reactive substance in isolated rat liver microsomes, whereas the water extracts of raw and heat

treated garlic increased the emission of low level chemiluminescence. S- Allycysteine and S- allylmerccaptocysteine, the major organosulpur compounds in aged garlic extract, showed radical scavenging activity in both the chemiluminescence and the DPPH assays.

**Prasad *et al.* (1996)** indicated that allicin, a scavenger of peroxide radicals, which is responsible for antioxidant activity of garlic bulb.

**El-zeini and Atta (1997)** examined the antioxidant effect of crude garlic extract (2.5, 5, 10, or 20 %) in fresh lean beef muscle samples obtained from an abattoir in Cairo, Egypt. It significantly decreased the values of thiobarbituric acid, peroxide and kreis optical density in meat kept in the refrigerator for 1, 3 and 5 days, showing that the garlic extract had an antioxidative effect.

**Sallam *et al.* (2004)** tested fresh garlic for its antioxidant effects in raw chicken sausages stored at 30 'c. Initially mean peroxide value and TBA values were 6.32 and 0.140 respectively. After chicken sausages were stored for 3 weeks, samples containing fresh garlic 50g/kg had TBA value of 0.151 and peroxide value of 8.64. In comparison with control, garlic significantly ($p<0.05$) delayed lipid oxidation.

**Czapska *et al.* (2006)** conducted an experiment to evaluate the antioxidative property of commercial water extracts prepared from horseradish, mustard , garlic and thyme. In order to estimate the antioxidative property of investigated extracts, the reducing power of iron was determined as well as the scavenging effect of radical DPPH and total antioxidative power using the FRAP method. They indicated that the investigated extracts possess different antioxidative properties.

## 2.4.2 Antimicrobial effect of Garlic:

According to the British Journal of Biomedical Science, allicin is considered to be the most potent antibacterial agent in crushed garlic extracts. Garlic has been used since the days of the Egyptians to treat wounds, infections, tumors, and intestinal parasites. Allicin may reduce atherosclerosis and fat deposition, normalize the lipoprotein balance, decrease blood pressure, have anti-thrombotic and anti-inflammatory activities, and function as an antioxidant. Garlic has been widely reported to protect against cardiovascular disease by reducing serum cholesterol concentrations and blood pressure and by inhibiting platelet aggregation. Garlic detoxifies chemical carcinogens and

prevents carcinogenesis and can also directly inhibit the growth of cancer cells. Allicin, the heart of garlic, stimulates immunity, including macrophage activity, natural killer and killer cells, and LA K cells, and to increase the production of IL-2, TNF, and interferon-gamma.

**Cavallito and Balley (1944)** demonstrated that the principle antimicrobial component of garlic is allicin which is allyl 2-propenethiosulphate and absent in intact garlic but generated from its precursor alliin through enzymatic hydrolysis.

**Al-Delaimy et al. (1971)** mentioned to prolong the shelf- life of fresh camel meat by the use of fresh garlic as an antimicrobial and preservative agent. The storage temperatures (room temp erature 20 -22°C and 12°C and refrigerator 2-3°C) were used in this investigation. Irrespestive of storage temperature, treatments wit 5,10 and 15% (by wt.) of fresh garlic segments' , ground with fresh lean camel meat , were found to increase the period of shelf-life, two,three- and more than fourfold, respectively, compared with the corresponding control samples .After 4 days storages at room temperature, 12 days incubation and 28 days refrigeration, it was found that treatments with 15 and 25% garlic resulted in complete inhibition of microbial growth with no sign of any organoleptic spoilage of the meat.

**Gandhi and Ghodekar (1988)** assayed Dahi ,yoghurt ,acidophilus milk and garlic extracts for antimicrobial activity against Micrococuus flavus, Enterococcus faecalis, Bacillus cereus and Salmonella veltevreders.All the four organisms were inhibited by garlic extract.The anti-microbial activity of the cultured milks was marginally improved by addition of garlic extract.

**Beuchat and Golden (1989)** specifically indicated that allicin is an inhibitor of –SH group enzyme that specifically inhibit acetyl co-A sythetase in fatty acid synthesis.

**Russel (1991)** observed that gram –negative bacteria had been reported to be more resistant than gram-positive to antimicrobial effect of essentials oils derived from spice plants because of their cell wall lipopolysaccharide.

**Nath (1992)** found that fat & protein content of chicken patties differed significantly due to cooking method but not the moisture content.

**Chanegriha et al. (1994)** revealed that cell wall lipopolysacaride may prevent the essentials oils active compound to reach the cytoplasmic membrane of Gram-negative bacteria.

**Nakatani (1994) and Deans and Ritchie (1987)** reported the gram positive bacteria were more sensitive to "essentials oils" from spice plants than gram-negative bacteria.

**Delaquis and Mazza (1995)** described antimicrobial properties of isothiocyanates derived from onion and garlic. They also proposed that the formation of reactive thicyanate radical could mediate the anti-microbial property.

**Ahsan and Islam (1996)** experimented the aqueous extract of Allium sativum, obtained from a commercial source in Bangladesh, and its active constituent allicin against 20 pathogenic strains of Gram positive and Gram negative bacteria. Both the extract and allicin showed significant activity against all bacteria tested except Pseudomonas, while 10 micrograms ampicillin and 25 microgram kanamycin were ineffective against many of bacteria .Allicin was the most potent.

**EL-Zeini and Atta (1997)** examined the antimicrobial effect of crude garlic extract (2.5, 5, 10 or 20%) on Escherichia coli and Staphylococcus aureus in fresh lean beef muscle samples obtained from an abattoir in Cairo, Egypt. The garlic extract reduced the number of bacteria attached to muscle samples in a dose-dependent fashion.

**Yin and Cheng (1998)** examined the inhibitory effects of water soluble extracts of garlic bulbs,green garlic, green onions (Allium fistulosum var. caespitosum), hot peppers, ginger, Chinese parsley (Coriandrum sativum), and basil (ocimum basilicum) on the growth of A. niger and A. flavus. Garlic bulbs, green garlic and green onions showed an inhibitory effect against these two fungi.

**Ankri and Mirelman (1999)** briefly reviewed the antimicrobial, antifungal, antiparsitic (against human intestinal parasites) and antiviral activities, and mechanism of action of allicin.

**Kirubaharan *et al.* (1999)** tested the possible antibacterial effect of garlic (Allium sativum) by adding various concentrations of the supernatant of a centrifugal preparation of crushed, unpeepled garlic cloves to cultures of a local strin of Escherchia

coli isolated from milk.When added the 4% level there was no detectable bacterial growth while at the 1 and 2% levels growth was variable.The inhibitory effect of the garlic extract was also demonstrated by the inhibiton of bacterial growth in culture plates in which filter discs impregnated with the extract were placed.

**Mehrabian and Larry (2003)** revealed the minimum inhibitory concentration of garlic extract against enteric bacteria. It inhibited the growth of pathogenic bacteria which were resistant to commonly used antibiotic.

**Sallam *et al.* (2004)** tested fresh garlic, garlic powder and garlic oil for their antimicrobial effect in raw chicken sausage stored at 3°C. Samples initially had an aerobic plate count (APC) of 4.41 log10 cfu/g. APC was significantly reduced by garlic powder (9g/kg) or fresh garlic (30g/kg), which led to increase in shelf life of 21 days. Compared with the control, neither BHA nor garlic oil showed a significant difference in APC.

**Oliveira *et al.* (2005)** investigated the antibacterial effect of garlic extract (5, 10 and 15%) on poultry carcasses obtained from a slaughterhouse, stored under refrigeration, and evaluated at selected time intervals. The effect of garlic extracts on the microbial contaminants of the poultry carcass surface-Salmonella, strict and facultative aerobic, mesophilic, and total and faecal coliforms-was evaluated. The garlic extract exhibited a concentration dependent reduction of microbial contamination. Garlic extracts concentrations of 10 and 15% were the most effective.The bacteriostatic action of garlic extract against mesophilic microbiota can be observed until the third storage day.The count of total and faecal coliforms remained low during the storage period.

**Ravishankar and Gupta (2005)** studied the microbial activity of garlic, ginger and turmeric against E. coli in ground beef. They found that fresh garlic and commercial ginger paste showed the strongest antimicrobial activity with complete inactivation of E. coli 0157:H7 at 3 days at 4°C and 8°C.

Garlic (*Allium sativum*) has been cultivated for use as a spice by many different cultures. Garlic has been used since ancient times as a broad-spectrum antimicrobial. Sulfur content in the garlic is regarded as being the active principle. Garlic contains allin [(+)-S-allyl-L-cysteine sulphoxide] and (+)-S-methyl-L-cysteine

sulphoxide, gamma-L-glutamyl peptide, S-allyl-cysteine. Allin in presence of the enzyme alliinase get converted to allin. (**Mohair. 2005**)

**Czapska *et al.* (2006)** conducted an experiment to evaluate antibacterial property of commercial water extracts prepared from horseradish, mustard, garlic and thyme. Microbial analysis concerned with the estimation and comparison of antibacterial activity of the investigated extracts in relation to the Staphylococcus aureus strain, including the effect of various concentrations of each extracts, temperature and incubation times was performed. They indicated that the investigated extracts posses different antimicrobial properties. A higher biological activity in relation to the test strain Staphylococcus aureus we observed in horseradish and garlic extracts.

## 2.5 Proximate composition:

**Panda (1968)** demonstrated that chicken sausage containing 50% chicken meat contained moisture 62-65%, protein 15-17%, fat 15-17%, and carbohydrate 3-4%.

**Majhi and Panda (1973)** standardized the condition for preparation of chicken sausages. They evaluated the proximate composition of fresh and moist heated sausages as 65.45 and 67.58% moisture, 10.67 and 12.42 % protein, 10.67 and 10.49 % ether extract, 2.97 and 2.66% total ash and 10.23 and 6.83 nitrogen free extracts respectively.

**Kondaiah and Panda (1987)** stated that cooked products recorded significantly higher crude protein than raw products due to moisture diminution on heat treatment in case of sausage preparation.

**Hoelscher *et al.* (1987)** reported that the protein in broiled beef patties did not differ significantly from raw patties at 0-5% initial fat.

Proximate composition is also reported by **Malik (1988)** in rabbit patties and **Anjeneyulu (1988)** in buffalo patties.

**Salahuddin *et al.* (1989) and Lingaiah and Reddy (2001)** stated that cooking causes diminution of moisture content in sausage there by percentage of fat is enhanced in cooked products.

**Vidarthi *et al.* (1989)** studied the effect of different levels of texturised soy protein on physio-chemical & organoleptic properties of meat patties and stated the cooked products recorded significantly higher crude protein and fat than raw products.

**Malik et al. (1990)** carried out and investigation to study the effect of 0,5,10 and 15% level of hydrogenated vegetable fat on sensory quality of patties. The overall sensory scores of broiled patties added with 5 % HVF and control (0%). The overall acceptability to scores of patties with 20% HVF were judged between moderately acceptable to very acceptable and with 15 % HVF were between slightly acceptable to moderately acceptable

**Young *et al.* (1991)** formulated mixture of ground chicken thigh meat with fat (5, 10, 15 and 20%). Proximate composition was compared for patties prepared from the mixtures. As fat content increased moisture: protein ratio increased.

**Anjaneyulu and Sharma (1991)** while the studying on refrigerated storage of cooked patties observed that phosphate blend stabilized the flavour of precooked patties for 18 days and for about a week in case of raw emulsion by inhibiting oxidative rancidity as indicated by lower TBA values but did not inhibit growth of bacteria

**Sutton *et al.* (1995) and Sylvia *et al.* (1994)** demonstrated that sausages often have fat contents between 8.94 and 19.33%, protein contents between 9 and 17%, moisture contents between 52.54% and 68.80%, and salt contents of 1.60 to 2.68%.

**Agnihotri and pal (1996)** found significantly higher yield and lower cooking loss in the sausages prepared using 0.5% trisodium polyphosphate, due to higher $p^H$ contributing in more moisture retention in the cooked sausages but protein, fat contents were not affected.

**Rao *et al.* (1999b)** found that moisture and protein contents of sausages with whey protein concentrate (WPC) were higher than those of the control when examining the quality of smoked chicken sausages formulated with broiler spent hen meat and edible by-products in natural proportion and different levels of whey protein concentrate (WPC).

**Lingiah and Reddy (2000)** studied the effect of inclusion of skin and giblets in chicken meat patties at different levels on product quality and found that addition of skin and / or resulted increased fat content and presence of skin alone reduced protein

content of chicken patties and significantly higher (P<0.01) percentage of moisture and significantly lower (P<0.01) percentage of protein and fat in their uncooked formulation of sausages with 18% and 21 % of skin incorporation along with chicken meat in coparison to sausages made from chicken meat alone.

**Manish Kumar *et al.* (2000)** reported that the whey protein concentrate (WPC) when added to formulation of spent hen meat patties at different levels, $P^H$ of raw meat increased with the augmentation levels of WPC.

**Warris (2002)** stated that cooking causes coagulation of most of the myofibrillar and sarcoplasmic protein and much of the water originally in the muscle is lost on heat treatment resulting into reduced moisture percentage in cooked product.

**Rawat (2007)** reported that garlic treated chicken sausage showed higher moisture and total ash content but lower crude protein and ether extracts content in comparison to the coriander and curry leaves treated sausages as well as control during her study on the antioxidative antimicrobial effects of coriander, garlic and curry leaves on fresh chevon sausages.

## 2.6 Physio-chemical property:

### 2.6.1 pH

**Rao and Kowale (1988)** observed that different muscles and cooking methods had a significantly, however, storage either refrigerated or frozen did not alter the pH and the free fatty acid concentration increased significantly on cooking and storage.

**Pandey et al. (1989)** while working on the formulation and quality valuation of ready to use meat patties reported that cooking of the products tended to increase the $P^H$ values significantly.

**Lin and Chaung (1999)** indicated that pH values were fairly stable during storage of low-fat Chinese style sausages at 4°C for 12 weeks.

**Papadima and Bloukas (1999)** observed that pH of traditional Greek sausages decreased continuously with the advancement of storage period.

**Rao et al. (1999)** found higher pH of experimental samples on first day while prepairing sausages extended with skim milk powder and sodium caseinate. In the experimentation the $p^H$ of sausages in the control groups were within the range of 6.30 to 6.36 with the mean value of 6.33 in different period of storage.

**Singh and Verma (2000)** incorporated observed that the $P^H$ values of raw emulsion & that of cooked patties were not affected significantly by the levels of extenders.

**Lingiah and Reddy (2001)** observed an increment in pH values in cooked products than that of raw products. They also obtained higher pH values in the products containing chicken meat and skin in different proportion than that of the pH values of the product from chicken meat alone.

**Sachdev *et al.* (2002)** found that there was significant increase in pH due to prolonged storage of cooked chicken at room temperature for one week and 4 weeks at freezing temperature.

**Sallam *et al.*(2004)** tested fresh garlic, garlic powder and garlic oil for their antimicrobial effect in raw chicken sausage stored at 3°C.In all sausages formulations storage had a significant($P<0.05$) effect on pH values, which tended to increase with storage time. However, after 21 days of storage no significant difference was detected between pH of fresh garlic-formulated sausage and any of the other sausage formulations, which were ranged from 6.85 to 6.90.

**Rawat (2007)** reported an increasing trend in pH of chevon sausages treated with garlic, coriander, and curry leaves separately during refrigeration storage and he also found highest pH values in garlic treated sausage.

## 2.6.2 Thiobarbituric acid values:

**Watts (1962)** reported that the threshold value of TBA is 1-2 mg/kg for rancidity in meat.

**Jacobson and Koehler (1970)** stated the pronounced flavor changes and increased TBA values were observed in refrigerated samples at 4°C.The TBA values

correlated significantly with flavor changes indicating that oxidatives changes occurred as flavour deterioration during refrigerated storage.

**Yamauchi (1973)** indicated that the oxidative rancidity occurred more rapidly in cooked meat than in raw meat due to denaturation of proteins in cooked meat.

**Wilson *et al.* (1976)** stated that the TBA value in used as an indicator of food quality and is highly correlated with rancidity and warmed over flavour in muscles foods.

**Greene and Cumuze (1982)** demonstrated that TBA range of 0.6 to 2.0 was considered to be a minimum detectable level for oxidized flavour in ground beef by experienced sensory panelist.

**Jo *et al.* (1999)** observed that TBA values increased in pork sausages with the increase in fat content.

**Udayasha *et al.* (1999) and Nayak and Tanwar (2005)** reorted that with the advancement of storage period there was increase in the TBA values of treatments, this might be due to the increase lipid oxidation and production of volatile metabolites in the presence of oxygen during storage and aerobic packaging.

## 2.6.3 Cooking loss:

**Hornsttein and Crowe (1963)** concluded that during cooking in water, the soluble part of the flavour and aroma was lost while in dry cooking the main loss was moisture due to evaporation.

**Majhi and Panda (1973)** concluded that the total cooking loss in case of moist heated and dry heated chicken sausages were 28.25% and 34.64% respectively.

**Jose *et al.* (1996)** stated that cooking loss was significantly lower in high-fat bologna sausages.

**Rawat (2007)** observed higher cooking yield in garlic treated chevon sausage in comparison to coriander and curry leaves treated sausages.

## 2.6.4 Emulsion stability:

**Aluko and Mine (1997)** reported that reduced level of non-protein materials in the coriander protein concentrate enhanced emulsion forming properties and contributed to formation of oil droplets with smaller sizes.

**Aluko and Mine (1998)** revealed that the poor emulsion foaming ability of coriander seed powder resulted in the presence of large size oil droplets, which are probably as a result of flocculation of smaller-sized oil droplets.

**Rao *et al.* (1999)** found improved emulsion stability of sausage batters, extended with skimmed milk powder and sodium caseinate.

**Rao and Reddy (2000)** observed and inverse relationship between emulsion stability and percentages of the ether extract while studying yhe influence of binders and refrigerated storage on the quqlity of chicken meat products.

**Singh and Verma (2000)** incorporated 0,10,15 and 20% textured soy (TS) in chicken patties and observed that the emulsion from 20% TS had significantly higher moisture and lower ether extracts content s than other treatments and increment in fat percentage on cooking than that of in raw. The crude proteins contents of emulsion ranged from 19.6 to 21 % and that of cooked patties from 26.16 to 27.92 %.

**Ye and Singh (2000)** reported that coriander protein concentrate could be useful ingredient in the formulation of acidic food emulsions such as mayonnaise, salad creams and other food emulsions.

## 2.7 Microbiological study:

Bureau of Indian standards (1969) specified that maximum level of aerobic plate count in uncooked and cooked chicken sausage should be $1\times10^6$/g and 1000/g respectively (Meat and Meat products-chicken sausage specification, IS 5402:1969).

**Patterson (1970)** concluded that spoilage changes become evident when the total numbers of bacteria/g meat reach $10^8$-$10^9$.

**Pierson *et al.* (1970)** observed that when meat is stored under aerobic conditions at 3°C for 15 days, no spoilage changes were seen.

**Froning *et al.* (1971)** reported that microbials load in turkey frankfurters showed some increase in total counts during refrigeration storage.

**Tendon (1974)** reported a bacterial count of 7.8 $\times 10^7$/gm. in chicken sausages stored at 5°C for 7 days.

**Cunningham and Bowers (1977)** reported that the chicken patties had initial total count of $10^4$/gm. prior to refrigeration storage but after 10 days the total count was $7\times10^6$/gm.

**Panda (1983)** reported total plate count of $2.1\times10^4$, $3.3\times10^7$ and $6.9\times10^7$ respectively on 0 day and $7^{th}$ day and $14^{th}$ day of storage in samples of chicken slices.

**Salahuddin *et al.* (1989)** observed that storage had a signigicant effect on microbial counts tended to decrease on $5^{th}$ and $10^{th}$ days and the counts on $15^{th}$ day did not differ from those on $10^{th}$ day.

**Anand *et al.* (1990)** carried out microbiological analysis on chicken sausages and observed the presence of enterotoxigenic microbes, particularly Staphylococcus with average count of $\log_{10}$ 3.77 per gram of sauasage.

**Anand et al. (1991)** studied the deep fat frying of patties resulted in destruction of patties resulted of destruction of pathogenic microflora with more than one log / gm. reduction in aerobic plates counts.

**Anand *et al.* (1992)** observed marked increase in yeast and mold counts in chicken tandoori at refrigeration storage.

**Anil *et al.* (1995)** examined the keeping quality of poultry sausage in terms of its chemical, microbiological and organoleptic quality.The samples are analysed after 1, 3 and 7 days during ageing and after 14, 21 and 30 days during storage.The number of total microorganisms and Lactobacillus spp. Increased during ageing and storage while coliform bacteria and yeast-moulds decreased.After $7^{th}$ day no coliform bacteria was detected.

**Reddy and Vijaylakshmi (1988)** studied quality of chicken sausages incorporating chicken skin, gizzard ,heart and yolk during frozen storage at 18°C for 0, 15,30,45&60 days and found that mesophilic counts were reduced.

**Sharma (1999)** reported that fungi got upper hand over bacteria in meat and meat products.

## 6.8 Sensory evaluation:

**Weirbicki and Deathrage (1958)** observed that the consumer quality of the meat and meat product such as tenderness, texture and shrinkage on cooking depends upon the degree of dehydration of muscle protein.

**Jacobson and Koehler (1970)** stated that pronounced flavour changes were observed in refrigerated samples at 4°C.

**Lin *et al.* (1979)** reported that the palatability of pork sausage was acceptable throughout 8 weeks of frozen storage and upto 21 days storage at 2°C.After 4 weeks of 2°C storage, bacterial growth in prerigor sausage caused off odours in the meat, all sausages were rated undesirable.

**Panda (1980)** worked on use of various binders on acceptability of chicken sausage and sensory tastes showed no significant variation in the appearance tenderness of the products irrespective of types of binders. However , certain binders were found to give the best flavour and general acceptability of the product.

**McCormick et al. (1981)** observed better flavour and juciness in pan frying of beef patties than broiling.

**Berry and Leddy (1984)** studied six cooking methods. They reported that flavour scores of beef patties were better in case of frying however frying caused decrease in scores of tenderness in comparison to other metods Microwave cooking was found less satisfactory

**Breukink and Casey (1989)** reported that goat meat sausages were tenderness, less juicy and had lesser desirable aroma than beef sausages. The sensory

panel's results revealed that goat meat smoked products were higher in sensory quality than that of the corresponding beef products.

**Sahoo and Berwal (1993)** studied the effect of incorporation of different level (15, 20 and 25%) turkey fat and skin (TFS) on organoleptic quqlity of cooked turkey sausages was evaluated. TFS levels marginally affected organoleptic scores. However, inclusion of 25% TFS scored lowest in general.

**Sushil Kumar et *al.* (1997)** copared the quality of sausages from chicken and rabbit meat wher they found that organoleptic scores indicated differences for appearance, colour, aroma, texture and juiciness.

**Reddy and Vijaylakshmi (1988)** studied effects incorporation of chicken skin, gizzard, heart and yolk and that of raw or cooked meat quality of chicken sausages during frozen storage at -18°C for 0,15,30,45 and 60 days and found that frozen storage of sausages prepared with raw meat obtained significantly higher scores for appearance, flavour, juciness, firmness and overall acceptability and frozen storage of sausages for 60 days significantly reduced the sensory scores.

**Singh and Verma (2000)** showed that sensory evaluation of chicken patty with or without textured soy (TS) at the level of 10% were quality acceptable, however , the overall acceptability scores declined significantly with a further increase in the level of soy due to reduced juciness and mild to moderate soy flavour.

**Lingaiah and Reddy (2001)** reported that sausages prepared frim chicken meat along with skin giblet were significantly less tender than that prepared from chicken meat alone.

**Pszczcola (2001)** described that cinnamic aldehyde is chiefly responsible for imparting characteristic flavour and odour.

**Sallam *et al.* (2004)** reported that sausage formulations containing fresh garlic had a significantly stronger flavour than the other samples.

# CHAPTER-III

# MATERIALS AND METHODS

# *Chapter-III*

## *Materials and methods*

### 3.1 **Chicken meat source:**

Broiler birds (vencobb) of around 6-7 weeks age brought from local market. The birds were kept fasted for 24 hours with only adlibitum potable water. After 24 hours, the birds were weighed and slaughtered by "modified kosher" method.

### Dressing and Deboning Procedures:

Dressing: - After slaughtering scalding was done for 90 seconds in water at 55°c in case of broiler birds. Defeathering was carried out by defeathering machine. Evisceration was done by opening abdomen and removing viscera including liver, gizzard and heart. The eviscerated carcasses were washed in running tap water thoroughly.

Deboning: - After dressing, chilling was done overnight at (4±1°C) and then the carcasses were deboned manually. The fascia, tendon and ligaments were removed from the meat. The meat obtained from less valued part of broiler (neck, wings, back, skin and organ meat like heart and gizzard)

### 3.2 Sources of Other Materials:

Sources of fat: - From the carcasses, chicken fat along with skin, heart and gizzard were collected during dressing and deboning of carcasses and kept at freezing temperature (4±1°C) till use.

### Non Meat Fillers/ Binders:

Corn flour and whole egg liquid were used. The whole egg liquid was mixed thoroughly before adding to other ingredients.

### Spice mix

A prestandardized spices mix (Table-1) prepared in the laboratory from wholesome and clean ingredients were used throughout the experiment. The ingredients used (Majhi and Panda, 1973) were dried at 70°C for 15 minutes in hot air oven prior to use and grounded by grinder.

Table-1 Composition of spices mixtures

| Ingredients | Percentage |
|---|---|
| Anise (*Pimpinellaanisum*) | 10.00 |
| Black pepper (*Pipernigrum*) | 10.00 |
| Caraway (*Carumcarvi*) | 10.00 |
| Cardamom small (*Elettariacardamomum*) | 5.00 |
| Cloves (*Syzygiumaromaticum*) | 2.50 |
| Cinnamon (*Cinnamomumverum*) | 5.00 |
| Red chilly (*Capsicumfrutescens*) | 10.00 |
| Coriander (*Coriandrumsafivum*) | 10.00 |
| Cumin (*Cumincyminum*) | 20.00 |
| Turmeric (*Curcumalonga*) | 10.00 |
| Capsicum (*Capsicumanum*) | 5.00 |
| Jayetri | 2.50 |

**Green Condiments**

Peeled onion and dry ginger (4:3) were used in the form of a paste after grinding in a blender (mixer).

**Common salt**

Common salt (brand-Tata) was obtained from local market.

**Chemicals**

All the chemicals and media used in the study were of analytical grade and were purchased from standard supplier.

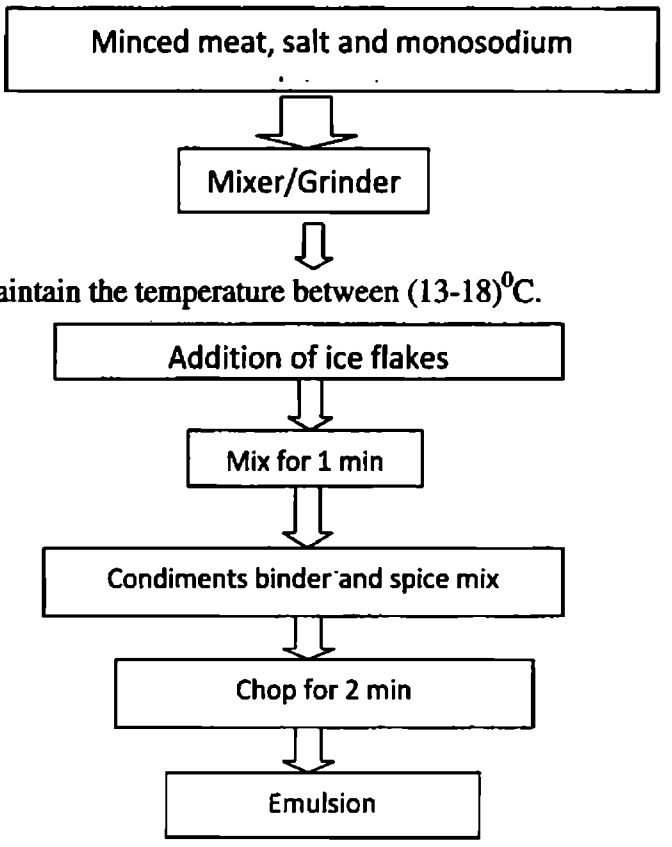
**Packaging Materials:**

Low density polyethylene (LDPE-300G) of food grade was procured from a standard commercial farm and used as packaging material for storage studies.

### 3.3 Emulsion Preparation:

Meat emulsion of 1 kg for each treatment was prepared. Deboned meat was put in room temperature for about 1 hour before mincing. The mincer and chopper were sterilized with warm water (82°C) for 2 minutes prior to use. The meat was coarse minced and fine minced twice by the Hobart meat mincer. Coarse mincing was done by plate with opening size 10 mm and fine mincing by plate with opening size 4 mm.

**Flow chart for emulsion preparation**




From this emulsion, a certain quantity of sample was taken for analysis of pH and emulsion stab.

### 3.4. Preparation of meat patties:

for preparation of meat patties from less valued part of chicken carcass, four different antioxidant different levels were mixed which was best treatment by the researcher. Other ingredients were added as per the formulation (table-2).

Tabie-2 General formula of meat patties Recipe

| Ingredients | T-1 | T-2 | T-3 | T-4 |
|---|---|---|---|---|
| Lean meat (%) | 55.00 | 60.50 | 59.00 | 60.00 |
| Chicken fat including Skin (%) | 5.00 | 3.00 | 3.00 | 5.00 |
| Whole egg (%) | 20.00 | 15.00 | 15.00 | 15.00 |
| Condiments (%) | 4.00 | 4.00 | 4.00 | 4.00 |
| Spice mix (%) | 3.34 | 3.34 | 3.34 | 3.34 |
| Corn flour (%) | 10.00 | 10.00 | 10.00 | 10.00 |
| Table salt (%) | 1.50 | 1.50 | 1.50 | 1.50 |
| Sugar (%) | 1.00 | 1.00 | 1.00 | 1.00 |

| | | | | |
|---|---|---|---|---|
| Monosodiumglutmate (%) | 0.03 | 0.03 | 0.03 | 0.03 |
| Baking powder (%) | 0.13 | 0.13 | 0.13 | 0.13 |
| Moringa leaf (%) | | 1.50 | | |
| Garlic (%) | | | 3.00 | |
| Tocoferrol/Kg | | | | 200IU |

### 3.5 Cooking of Meat Patties

Oven cooking method was used for cooking of meat patties. Cooking was done at 180°C for 25 minutes. Turning off the products was done after first 15 minutes. However, care is taken to maintain the internal temperature within 75°C±1°C. The internal temperature of the products was measured by probe thermometer.

### Effect of Cooking Methods on physical properties of the products

Two parameters dimensional changes and cooking yields were taken into consideration.

### Effect of Cooking Methods on Proximate Composition of the products

Proximate composition (moisture%, protein%, ether extract% and ash %) of cooked products were analysed according to AOAC (1990).

### Effect of Cooking Methods on the Sensory Attributes of the products

The parameters were appearance, flavour, tenderness and overall acceptability evaluated by semi-trained taste panel.

### Effect of Cooking Methods on Storage life of the products:

Refrigerated storage study was conducted at 4±1°C upto the period of 21 days. Observation were recorded for PH, TBA, TPC and sensory properties on 0, 3rd, 7th, 14th &21st day.

**Figure:1.** A.(upper left) raw chicken patties treated with moringa leave extracts. B. (upper right) raw chicken patties treated with vitamin E. C.(lower left) raw chicken patties treated with garlic. D.(lower right) raw chicken patties without any treatment.

**Figure: 2.** A (upper left) raw chicken patties treated with moringa leave extracts. B. (upper right) raw chicken patties treated with vitamin E. C. (lower left) raw chicken patties treated with garlic. D. (lower right) raw chicken patties without any treatment.

**Figure: 3.** chicken patties in Dessicator

**Figure: 4.** Patties covered with packaging material (LDPE)

## 3.6 METHODS OF ANALYSIS

### 3.6.1 pH:

The PH of emulsion and cooked products were determined by the methods of Trout (1992). Homogenates were prepared by blending 10 gram of samples with 50 ml distilled water by using pestle – mortar. The pH of suspensions was taken with digital P meter (Systronics, Model 335).

### 3.6.2. Emulsion Stability Test:

This method was based on the emulsion stability test (Baliga and Madaiah, 1971) with minor modifications (Kondaiah, 1986). About 20 gram of the emulsion was weighed and placed in a polyethylene bag and heated at 80°C for 30 minutes in water bath. The cooked out was drained out and cooked mass was cooled and weighed todetermine the weight loss and expressed as percentage.

### 3.6.3. Cooking Loss:

Weight of raw and cooked products was recorded individually. The per cent cooking loss for each product was calculated as follows.

$$\text{Percent cooking loss} = \frac{\text{Weight of raw product - Weight of cooked product}}{\text{Weight of raw product}} \times 100$$

### 3.6.4 PROXIMATE COMPOSITION

The moisture, protein, ether extract and ash contents of the cooked patties were determined as per AOAC (1990).

### 3.6.4.1 Determination of Moisture:

About 10 grams of minced sample was taken in a porceline crucible and dried in a hot air oven for 24 hours at 100±5°C. The crucible was cooled in a desiccator and again weighed. This was repeated till constant weight was obtained. Loss in weight was reported as moisture content.

### 3.6.4.2 Determination of total protein (Micro-Kjeldahl Distillation Method):

Two grams minced meat were weighed & transferred to a kjeldhal flask. 20 ml of concentrated sulphuric acid & 5 Gms digestion mixture (95 parts Sodium Sulphate & 5 parts Cupper Sulphate) were added to it & digested on a disetion heater until solution turned to clear green or colourless. The digestion samples were made to 250 ml volume by adding water in a volumetric flask. 10 ml of the aliquots were taken into a micro Kjeldhal distillation unit & 20 ml of 40% Sodium Hydroxide solution were added to it. 10 ml of Tashiro's indicator was taken in a 100 ml conical flask &the silver tube dipped in the conical flask and the samples were heated by passing stem into it until 30 ml of the distillate was collected in the conical flask. Then it was titrated with standard by N/70 Sulphuric acid to a light pink end point.

$$\text{Calculation: \% of total protein} = \frac{\text{Amount of N/70 Sulphuric acid consumed} \times 0.0002 \times 250 \times 6.25 \times 100}{\text{Wt. of sample} \times \text{volume of aliquot taken}} \times 100$$

### 3.6.4.3. Determination of Ether Extract

Three grams of died and grinded sample were taken in thimble & extracted for 8 hrs. With petroleum ether (B.P range 60-80°C) in Soxhlet extractor. Oil flask was died in the over at 80°C for 30 minutes cooled in a desiccator & weigh

$$\text{Calculation: \% of Ether Extract} = \frac{\text{(Wt. of + Ether Extract) - (Wt. of empty oil flask)}}{\text{Wt. of sample}} \times 100$$

### 3.6.4.4 Total Ash

10 grams of ground meat product was weighed in a silica crucible and heated at 100°C until water was expelled and the sample was charred. The crucible was then placed in a muffle furnace at 600°C for one hour until white ash was obtained. The crucible was cooled in a desiccator and weighed. This process was continued till constant weighed was obtained.

$$\text{Calculation: \% of total ash} = \frac{\text{(Wt. of crucible with ash – wt. of empty crucible)}}{\text{Wt. of sample}} \times 100$$

### 3.6.5 Thiobarbituric acid (TBA):

Thiobarbituric acid TBA value of the products during storage was determine using the methods of **Tarlagis et al. (1960)**.10gms of products was blended with 50 ml of distilled water in awaring blender for 2 minutes. The mixture was quantitatively transferred to a 500 ml kjeldahl flask. Another 45 ml of distilled water was used to wash the blended thoroughly and transferred to a flask and 5ml liquid.6N Hydrochloric acid was added. Few drops of liquid paraffin were added to present frothing along with few glass beads to prevent bumping during heating. The flask was collected into a graduated cylinder. The distillate was thoroughly mixed and 5ml TBA reagent (0.02M2-thiobarbituric acid in 95% glacial acetic acid was slightly warm in a boiling water bath to bring into solution) was added and mixed. The contents were mixed well and immersed in boiling water bath for 35 minutes. A blank consisting of 5ml distilled water and 5ml TBA reagent was similarly carried through under tape water and OD was read in spectrophotometer at 538 nm. The OD was multiplied by a factor of 7.8 and TBA value was expressed as mg of malonaldehyde per 1000 gm. of sample.

### 3.6.6 Microbiological Examination:

Total aerobic bacterial count in the sample was determined by the methods described by APHA (1984). Readymade media (Hi- Media) were used for the analysis.

#### 3.6.6.1 Sample preparation:

One gm of sample was aseptically weighed & transferred to a sterile mortar containing 9 ml 0.1% sterile peptone water. The sample was homogenized for 2 min. using a sterile pestle & mortar to make $10^{-1}$ dilution. 0.1% peptone water was used as diluents for making further dilutions. One ml of 0.1% peptone water to obtain a $10^{-2}$ and so on upto $10^{-8}$. Preparation of samples & serial dilutions were done near the flame in a horizontal laminar flow apparatus observing all possible aseptic conditions.

#### 3.6.6.2. Total plate count:

23.5 gm. of plate count agar (Hi-Media laboratories Pvt. Ltd.) was suspended in 1000ml of distilled water & boiled to dissolve the medium completely. Sterilized by autoclaving at 15 lbs. pressure (121°C) for 15 minutes. Final pH of the medium was 7.0± 0.2 at 25°C. About 20 ml of sterilized media at 45°C was poured to

each sterile in duplicate after dropping of 1 ml inoculums of suitable dilutions. The plates were incubated at 37°C for 72 hrs. Plate showing 25 to250 colonies were counted using an electronic colony counter. The number of colonies were multiplied by the reciprocal of the respective dilutions & expressed as log cfu/gm.

### 3.7 Sensory evaluation:

Each patty was cut into eight pieces & ball into four pieces &was pan fried for 2.5 minutes. Sensory evaluation of fresh & stored samples was done by a semi trained taste panel consisting of not less than 8 to 10 numbers. During the sensory evaluation water was kept to rinse their mouth. Panelists were detailed about the products. They were given a score card used for taste panel evaluation & asked to mention their preference, as per the scores given against the descriptive terms of different characteristics to be evaluated.

### 3.8 Storage Study:

Refrigerated (4±1°C) storage studies of meat patties & meat balls prepared by using different percentage of meat were conducted upto a period of 21 days. The cooked products were cooled at room temperature (25°C) and packed in a polyethylene bags (HDPE-300G), Sealed properly and kept in the refrigerator at 4±1°C. The labelled samples were taken out from the refrigerator on 0, 3$^{rd}$, 7$^{th}$, 14th&21th day of storage and various parameters were studied.

### 3.8.1Analysis of the stored sample:

Before analysis the stored samples were kept in a room temperature for 30 minutes. But for bacterial study immediately the samples were taken aseptically to microbiological laboratory.

### 3.9 Statistical Methodology:

In the present investigation the data obtained from the number of samples for each parameter under each trial were statistically analyzed and interpreted following the methodology as outlined by Snedecor and Cochran (1967).

# CHAPTER-IV

# RESULTS AND DISCUSSION

The present investigation was envisaged to evaluate the antioxidant and antimicrobial activities of test ingredients; Garlic, vitamin E and moringa leaves in the preparation of chicken patties in order to enhance the shelf life without affecting the quality as well as sensory attributes of the product.

On the basis of previous study, level of garlic is 3% (Rawat 2007), level of moringa leaf is 1.5% (Hajra *et al* 2011) and level of vitamin E is 200 IU/kg (Choi et al. 2010) of chicken patties was the best chosen concentration levels of each treatment was selected for further study. The selected products were packed in LDPE bags and stored at refrigerated temperature (4±1°C) and subjected to studies of various parameters on antioxidant (TBA) activity, physico-chemical, microbiological and sensory attributes on $0^{th}$, $3^{rd}$ , $7^{th}$ , $15^{th}$ and $21^{st}$ day.

# 4.1 PROXIMATE COMPOSITION

## 4.1.1 Moisture

The Mean ± SE with test of significance of moisture content for chicken patties with different treatments (garlic, moringa leaf, vitamin E) and control were presented in table 4.1.

As indicated in Table 4.1 the moisture content of chicken patties of different treatments differ significantly (P<0.01).The moisture percentage of garlic treated patties was found to be highest and the moisture percentage of vitamin E treated patties was found to be lowest among all the groups. Also there was also significant difference between moisture content of **vitamin E** and **control** but moisture content of **garlic** was significantly (P<0.01) higher than the **vitamin E** and **control .**

The result of the experiment is in agreement with the findings of Rawat (2007) who also reported higher moisture content in garlic treated chicken patties as compared to coriander or curry leaves treated sausages.

The mean ± se value of moisture content in chicken patties did not show significant (p>0.05) difference on $0^{th}$, 3rd, 7th, 14th, 21st day at refrigeration temperature.

**Table No: 1.** ***Effect of different treatments on the moisture content (%) of chicken patties (mean±SE):***

| Storage periods / Treatment groups | 0th day | 3rd day | 7th day | 14th day | 21st day | P value |
|---|---|---|---|---|---|---|
| Garlic | 60.140±0.027[a] | 60.44±0.014[a] | 60.022±0.007[a] | 59.973±0.017[a] | 59.491±0.008[a] | P>0.05 |
| Moringa leaf | 60.918± 0.016[b] | 60.240± 0.017[b] | 59.996± 0.017[b] | 59.525± 0.003[b] | 59.322± 0.001[b] | P>0.05 |
| Vitamin E | 57.715± 0.008[d] | 57.552± 0.004[d] | 57.120± 0.001[d] | 57.035± 0.012[d] | 57.012± 0.000[d] | P>0.05 |
| Control | 59.767± 0.154[c] | 59.612± 0.125[c] | 59.233± 0.046[c] | 58.785± 0.157[c] | 58.346± 0.069[c] | P>0.05 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | P<0.01 | N=6 |

***Table No: 2.Effect of different treatments on the protein content (%) of chicken patties (mean±SE):***

| Storage periods / Treatment groups | 0th day | 3rd day | 7th day | 14th day | 21st day | P value |
|---|---|---|---|---|---|---|
| Garlic | 18.146 ± 0.009[b] | 18.790±0.034[b] | 18.767± 0.085[b] | 18.469±0.0770[b] | 17.683 ± 0.162[b] | P>0.05 |
| Moringa leaf | 19.523± 0.009[a] | 19.741±0.008[a] | 19.892± 0.040a | 19.582± 0.066[a] | 19.258± 0.043[a] | P>0.05 |
| Vitamin E | 17782± 0.032[d] | 17.867±0.025[d] | 17.828± 0.077[d] | 17.837± 0.011[d] | 17.748± 0.011[d] | P>0.05 |
| Control | 18.084± 0.036[c] | 18.255±0.062[c] | 18.429± 0.021[c] | 17.786± 0.203[c] | 17.741±0.0417[c] | P>0.05 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | P<0.01 | N=6 |

**P<0.01= Significance at 1%level, P<0.05= Significance at 5%level, P>0.005=Non significance.**

**Superscripts a, b, c, d differed significantly (column wise)** **Superscripts p, q, r, s, t differed significantly (row wise)**

The value of moisture content of the meat did not follow any trend in relation to treatment. The insignificant reduction of moisture content in chicken patties stored at refrigeration temperature might due to evaporation of moisture from chicken patties.

There was no significant effect of storage period on the moisture content of chicken patties stored at refrigeration temperature. This finding is in accordance with Bawa *et al.* (1988), Pangas *et al* (1998)., Biswas *et al.* (2006). and Onibi *et al.* (2009).

## 4.1.2 Protein:

The Mean ± SE with test of significance of protein content for chicken patties with different treatments (garlic, moringa leaf, vitamin E) and control were presented in Table 4.2.

The effect of addition of different treatments on protein content of chicken patties were found to be highly significant ($P<0.01$) and the protein content of the moringa leaves treated patties sample was significantly ($P<0.01$) higher than the other treatment groups throughout the storage period. Total protein content of moringa leaves treated patties was comparatively higher than other the other two treated patties.it was might be due to higher crude protein content of moringa leaves than the other two.

The total protein per cent did not show any significant ($p>0.05$) difference on $0^{th}$, 3rd, 7th, 14th, 21st day at refrigeration temperature. Similar results had been observed by Bawa et al (1988) and Biswas et al (2006).Biswas (2002) reported that the insignificant decrease in protein content at refrigeration storage may be due to depletion of protein by certain type of bacteria, which produce alkalinizing substances.

## 4.1.3 Ether Extracts:

There was significant ($P<0.01$) difference in fat percentage of different treatment as well as control. The Mean±SE with test of significance of Ether extract content for chicken patties with different treatments (garlic, vitamin E, moringa leaf) and control were presented in table 4.3.Table **Tables 4.3** clearly indicate that the fat content was highest in **garlic** treatment. The result is substantiated with result from work of Rawat (2007)

Biswas et al (2006) also reported that there was no significance effect storage periods on the ether extract in duck patties.

**Table No: 3.** ***Effect of different treatments on the Ether extract content (%) of chicken patties (mean±SE)*:**

| Storage periods / Treatment groups | $0^{th}$ day | $3^{rd}$ day | $7^{th}$ day | $14^{th}$ day | $21^{st}$ day | P value |
|---|---|---|---|---|---|---|
| Garlic | $19.905\pm0.036^{a}$ | $19.754\pm0.127^{a}$ | $19.328\pm0.011^{a}$ | $18.934\pm 0.005^{a}$ | 18.407±0.012a | P>0.05 |
| Moringa leaf | $18.538\pm0.013^{b}$ | $18.354\pm0.008^{b}$ | $18.104\pm0.004^{b}$ | $17.913\pm0.020^{b}$ | $17.538\pm0.011^{b}$ | P>0.05 |
| Vitamin E | $17.786\pm 0.009^{b}$ | $17.524\pm0.006^{c}$ | $17.119\pm0.016^{c}$ | $16.922\pm0.003^{c}$ | $16.515 \pm 0.003^{c}$ | P>0.05 |
| Control | $17.786\pm 0.009^{d}$ | $16.533\pm0.004^{d}$ | $16.321\pm0.003^{d}$ | $15.904\pm0.001^{d}$ | $15.511\pm0.002^{d}$ | P>0.05 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | P<0.01 | N=6 |

***Table No: 4. Effect of different treatments on the Total ash content (%) of chicken patties (mean±SE):***

| Storage periods / Treatment groups | $0^{th}$ day | $3^{rd}$ day | $7^{th}$ day | $14^{th}$ day | $21^{st}$ day | P value |
|---|---|---|---|---|---|---|
| Garlic | $5.323\pm0.002^{a}$ | $5.224\pm 0.004^{a}$ | $5.987\pm0.002^{a}$ | $6.190\pm 0.001^{a}$ | $6.288\pm 0.002^{a}$ | P>0.05 |
| Moringa leaf | $4.524\pm 0.004^{c}$ | $3.724\pm 0.003^{c}$ | $4.013\pm0.004^{c}$ | $4.179\pm 0.010^{c}$ | $4.313\pm 0.004^{c}$ | P>0.05 |
| Vitamin E | $3.448\pm 0.004^{d}$ | $3.175\pm 0.003^{d}$ | $3.745\pm0.003^{d}$ | $3.982\pm 0.004^{d}$ | $4.026\pm 0.003^{d}$ | P>0.05 |
| Control | $3.036\pm 0.016^{b}$ | $4.824\pm 0.003^{b}$ | $5.043\pm0.002^{b}$ | $5.182\pm 0.003^{b}$ | $5.321\pm 0.004^{b}$ | P>0.05 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | P<0.01 | N=6 |

**P<0.01= Significance at 1%level, P<0.05=Significance at 5%level, P>0.005=Non significance.**

**Superscripts a, b, c, d differed significantly (column wise)** **Superscripts p, q, r, s, t differed significantly (row wise)**

## 4.1.4 Total Ash:

The Mean ± SE with test of significance of total ash content for chicken patties with different treatments (garlic, moringa leaf, and vitamin E) and control were persented in Table 4.4

Ash per cent value of garlic was found highest in among all treated group and differ significantly ($p<0.01$).and no significance ($p>0.05$) difference between same group during storage .Similar result obtained by Rawat (2007).

## 4.2 PHYSICO- CHEMICAL PROPERTIES:

## 4.2.1 $P^H$:

Highly significant ($P<0.01$) effect of treatments were observed on pH value of chicken patties. The pH value of **garlic** treatment was found to be significantly higher among all the treatments.

The Mean ± SE with test of significance of $p^H$ content for chicken patties with different treatments (garlic, moringa leaf, vitamin E) and control were presented in Table 4.5.The $p^H$ value of garlic treatment was found to be significantly higher among all the treatments in the first 7 days of storage. Similar result has been observed by Rawat (2007) observed higher $p^H$ value in garlic treated chevon sausage over coriander, curry leaves and control throughout the storage period.

During storage, pH value of frozen raw chicken patties decreased until 2 months after storage, and then it began to increase (Table 1). Such an increase in pH is due to the accumulation of metabolites caused by bacterial action in meat and deamination of proteins Jay (1996). McCarthy *et al.* (2001) and Biswas *et al.* (2004) reported similar findings in pork patties containing BHA/BHT antioxidants during refrigeration and freeze storage.

During storage, the pH values of raw chicken patties initially decreased and then significantly ($P < 0.01$) increased with a few exceptions at the end of storage. The initial decrease might be attributed to the acid treatment, whereas the final increase in pH may be attributed to the microbial metabolites (Goddard *et al.* 1996). As stated by Gill

**Table No: 5.** ***Effect of different treatments on the*** **P$^{H}$** ***of chicken patties (mean±SE)*****:**

| Storage periods / Treatment groups | 0$^{th}$ day | 3$^{rd}$ day | 7$^{th}$ day | 14$^{th}$ day | 21$^{st}$ day | P value |
|---|---|---|---|---|---|---|
| Garlic | 5.977 ± 0.029$^{ar}$ | 6.097 ± 0.002$^{aq}$ | 6.173 ± 0.015$^{ap}$ | 5.882 ± 0.019$^{bs}$ | 5.714± 0.003$^{ct}$ | P<0.01 |
| Moringa leaf | 5.748 ± 0.011$^{cs}$ | 5.948± 0.009$^{cq}$ | 6.060 ± 0.021$^{dp}$ | 5.848± 0.018$^{cr}$ | 5.757 ± 0.019$^{bs}$ | P<0.01 |
| Vitamin E | 5.789 ± 0.013$^{cs}$ | 5.903 ± 0.022$^{cq}$ | 6.127 ± 0.019$^{bp}$ | 5.858 ± 0.017$^{cr}$ | 5.721 ± 0.011$^{cs}$ | P<0.01 |
| Control | 5.892± 0.007$^{bs}$ | 6.031± 0.016$^{aq}$ | 6.194 ± 0.002$^{ap}$ | 5.907 ± 0.004$^{ar}$ | 5.821 ±0.005$^{as}$ | P<0.01 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | P<0.01 | N=6 |

***Table No .6. Effect of different treatments on the Emulsion stability and cooking loss of chicken patties (mean±SE):***

| Treatment groups / Parameters | Garlic | Moringa leaf | Vitamin E | Control | P value |
|---|---|---|---|---|---|
| Emulsion stability | 95.485±0.107$^{p}$ | 94.477±0.081$^{q}$ | 92.377± 0.090$^{s}$ | 93.562± 0.115$^{r}$ | P<0.01 |
| cooking loss | 14.202± 0.093$^{s}$ | 15.342± 0.040$^{r}$ | 16.342± 0.088$^{q}$ | 17.352± 0.107$^{p}$ | P<0.01 |

**P<0.01= Significance at 1%level, P<0.05= Significance at 5%level, P>0.005=Non significance.**

**Superscripts a, b, c, d differed significantly (column wise) Superscripts p, q, r, s, t differed significantly (row wise)**

(1983), bacteria on exhaustion of stored glucose utilise amino acids released during protein breakdown and, as a product of amino acid degradation, ammonia accumulates and pH rises.

Sallam et al. (2004) similarly found higher pH values in various types of garlic-treated chicken sausages compared with controls. The pH value of meat was increased with garlic supplementation in diets for finishing pigs (Holden et al., 1998). However, the muscle pH value ranged from 5.74 (in diet samples) to 5.94 (in control sample), and all pH values were within the range expected for normal chicken.

A significantly ($p<0.01$) increasing trend in $p^H$ with the advancement of storage period was observed during the 7days of storage and thereafter the $p^H$ decrease gradually. This observation has also been collaborated with the findings of Biswas et al. (2006).

Ozer et al (2010) also reported $p^H$ value of chicken patties change during freeze storage for a long period after adding of antioxidant. it was suggested that *L*-ascorbic acid and $\alpha$ -tocopherol can be added into chicken patty of the storage quality.

Hamid et al.(2009) $p^H$ value of the reference batch as well as treated samples gradually decreased samples gradually decreased .$p^H$ values of treated and untreated and untreated minced meat decreased as the storage period increased.( Hamid et al.2009) .Bali(1976) reported that rise of $p^H$ of meat on different days may be due to autolysis and bacterial growth indicating signs of decomposition.

## 4.2.2 Emulsion Stability:

The Mean ± SE value of emulsion stability for chicken patties with different treatments (garlic,moringa leaves, vitamin E and control were presented in table 4.6

A significant ($P<0.01$) effect was observed due to treatments on emulsion stability of chicken patties. Emulsion stability of **Garlic** treated chicken patties was significantly ($P<0.01$) higher than the other treatments. The emulsion stability of **Garlic** treatment was observed as 95.485±0.107 which was found to be highest among all the treatments. The emulsion stability of **moringa treated** was observed as 94.477±0.081% and of **Control** and **vitamin E** was 92.377±0.090 and 93.562±0.115 which were found to be lowest among all the treatments. Similar findings observed by Rawat (2007) who

reported higher emulsion stability of garlic treated chevon sausages in comparison to coriander and curry leaves.

### 4.2.3 Cooking Loss:

The Mean ± SE with test of significance of total ash content for chicken patties with different treatments (garlic, moringa leaf, and vitamin E) and control were presented in Table 4.6

A highly significant effect (P<0.01) of different test ingredients was observed on cooking loss. The cooking loss of garlic treated chicken patties was highest among treatment. The value of cooking loss of garlic treatment, moringa leaves treatment, vitamin E and control were 14.202±0.093, 15.342±0.040, 16.342±0.107 respectively. Result was collaborated with Rawat (2007) and Bali et al.(2011) they found cooking loss of garlic treated chicken sausages in comparisons to coriander treated sausages.

Concerning cooking loss, there were significant(p<0.05) decrease in the mean cooking loss of samples supplemented with vitamin E mixed with water compared with those dietary supplemented with onion & garlic and control. Ali et al (2010) and Kim *et al.* (2009).

## 4.3 EVALUATION OF ANTIOXIDANT EFFECTS OF DIFFERENT TREATMENTS ON CHICKEN PATTIES:

### 4.3.1 Tba Value:

A highly significant (P<0.01) effect of treatment as well as storage period on TBA values of chicken patties observed throughout the storage period.TBA value of the different treatment was different during storage period that is presented in table 4.7

TBA value initial stage was not varied more, but during storage the TBA value incease.change in TBA value initially slow but it was increase rapidly after 14 days of storage. In table clear that control has highest value of TBA then among treatment group.Moringa leaves treated chicken patties sample was the lowest TBA value than other. It might be due to antioxidant property of moringa leaves.TBA value of control was after end of 21$^{st}$ day was 1.278±0.041.Over all moringa leaves treated and vitamin E treated patties sample are lower TBA value was 0.234± 0.007 and 0.278± 0.007 respectively on 21$^{st}$ day. Findings was also observed by biswas et al (2011) 1.5% treated

meat showed a significantly (P<0.05) lowest TBA value. This may be due to inhibition of lipid peroxidation by the crude extract treated samples. The *Moringa* leaf extract contains polyphenols that have antioxidant effects. Polyphenols, but not vitamin E, are known to produce strong antioxidant effect in vitro. They act as chain-breaking peroxyl-radical scavengers which lead to the inhibition of lipid peroxidation and also give protection to LDL from oxidation (O'Byrne, *et al,* 2002).

Kim et al (2009) reported dietary supplementation with garlic husk resulted in significantly lower TBARS value in chicken thigh muscle compared with muscle from birds fed non supplemented diets ($P < 0.05$) . Yin and Cheng (1998) reported that garlic had a stronger inhibitory effect on lipid oxidation in their liposome model. Organosulfur compounds in garlic have been reported to have in vivo antioxidant effects against associated oxidations (Borek, 2001). Therefore, garlic in the diets of broilers is the preparation with greater antioxidant activity and protected lipid oxidation.

Biswas et al (2011) suggested the TBA values increased slightly with increase in refrigerated storage period; however, there was a significant ($P < 0.01$) increase in TBA values of duck patties only after 7 days of refrigeration storage, which was similar to the findings of Witte et al. (1970).

TBARS values were significantly ($p < 0.01$) lower in vacuum-packed samples than in aerobic-packed samples .This is because of the high oxygen levels in the aerobic package. The lowest TBARS value was observed in vacuum groups that contained humate. The storage time also had an effect on these values, and the highest TBARS occurred at the end of the storage period. (Aksu et al., 2005)

Yamauchi (1973) indicated the oxidative rancidity occurred more rapidly in cooked meat product than in raw meat due to denaturation of protein in cooked meat.

Antioxidant activity of garlic had been strongly supported Sallem et al.(2004) who tested fresh garlic for its antioxidant effect in raw chicken sausages stored at 30°c.After 3weeks of storage, the sausage containing fresh garlic significantly ($p<0.05$) delayed the lipid oxidation in comparison with control .

**Table No: 7.** ***Effect of different treatments on TBA value of chicken patties (mean±SE)*:**

| Storage periods / Treatment groups | 0th day | 3rd day | 7th day | 14th day | 21st day | P value |
|---|---|---|---|---|---|---|
| Garlic | $0.183\pm0.004^{bs}$ | $0.223\pm0.003^{br}$ | $0.256\pm0.001^{bq}$ | $0.286\pm0.001^{bq}$ | $0.318\pm 0.006^{bp}$ | P<0.01 |
| Moringa leaf | $0.109\pm0.004^{ct}$ | $0.121\pm0.000^{cs}$ | $0.142\pm0.000^{cr}$ | $0.164\pm0.000^{cq}$ | $0.234\pm 0.007^{cp}$ | P<0.01 |
| Vitamin E | $0.121\pm0.003^{ct}$ | $0.181\pm0.004^{cs}$ | $0.204\pm0.001^{br}$ | $0.282\pm0.004^{bq}$ | $0.278\pm 0.007^{cp}$ | P<0.01 |
| Control | $0.322\pm0.006^{at}$ | $0.537\pm0.008^{as}$ | $0.712\pm0.003^{ar}$ | $0.969\pm0.007^{aq}$ | $1.278\pm 0.041^{pa}$ | P<0.01 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | P<0.01 | N=6 |

**Table No: 8.** ***Effect of different treatments on the Total plate count (log cfu/g) of chicken patties (mean±SE)*:**

| Storage periods / Treatment groups | 0th day | 3rd day | 7th day | 14th day | 21st day | P value |
|---|---|---|---|---|---|---|
| Garlic | $2.256\pm0.003^{ct}$ | $2.450\pm0.006^{cs}$ | $2.840\pm0.025^{dr}$ | $3.431\pm 0.023^{dq}$ | $4.439\pm 0.016^{dp}$ | P>0.05 |
| Moringa leaf | $2.736\pm0.015^{bt}$ | $2.927\pm0.008^{bs}$ | $3.296\pm0.027^{cr}$ | $4.079\pm 0.032^{cq}$ | $4.817\pm 0.034^{cp}$ | P>0.05 |
| Vitamin E | $2.791\pm0.038^{bt}$ | $2.956\pm0.016^{bs}$ | $3.523\pm0.040^{br}$ | $4.267\pm 0.059^{bq}$ | $4.901\pm 0.027^{bp}$ | P>0.05 |
| Control | $2.866\pm0.035^{at}$ | $3.311\pm0.044^{as}$ | $3.942\pm0.014^{ar}$ | $4.631\pm 0.013^{aq}$ | $5.437\pm 0.047^{ap}$ | P>0.05 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | P<0.01 | N=6 |

**P<0.01= Significance at 1%level, P<0.05= Significance at 5%level, P>0.005=Non significance**

**Superscripts a, b, c, d differed significantly (column wise) Superscripts p, q, r, s, t differed significantly (row wise)**

# 4.4. MICROBIAL ANALYSIS:

## 4.4.1 Total Plate Count (TPC):

The data presented in **Table 4.8** showed a no significant effect of treatment and storage period on total plate count values of chicken patties. The total plate count values of all treatment ranged 2.256± 0.003to 2.866± 0.035 log cfu/g on $0^{th}$ day of storage which increased significantly to 5.437± 0.047 log cfu/g in **control** and 4.439± 0.016 and 4.817±0.034 log cfu/g in **Garlic** and **moringa leaves** respectively on $21^{st}$ day of observation .Among all the four treatments the total plate count values of **Garlic** was found to be lowest. A significantly increasing trend was also observed in TPC with the advancement of storage period. Result was collaborated with result of **Bharti et al.,** (2011) A highly significant ($P<0.01$) increasing trend was also observed in TPC with the advancement of storage period. The overall mean value for test group was 3.368±0.001 log cfu/g on 0th day and increased to 5.027±0.005 log cfu/g on 14th day of observation. The products under treatment maintained lower TPC values than the control throughout the storage period and were within the limit as proposed by (**Froning et al., 1971**) for cooked meat products that is, 5.33 x 103 cfu/g for total plate count.

Allicin, one of the active principles of freshly crushed garlic homogenates, has a variety of antimicrobial activities. Allicin in its pure form was found to exhibit antibacterial activity against a wide range of Gram-negative and Gram-positive bacteria, including multidrug-resistant enterotoxicogenic strains. The main antimicrobial effect of allicin is due to its chemical reaction with thiol groups of various enzymes, e.g. alcohol dehydrogenase, thioredoxin reductase, and RNA polymerase, which can affect essential metabolism of cysteine proteinase activity involved in the virulence of E. histolytica. **(Ankr et al).**

Also garlic oil provides antimicrobial benefits (Sallam *et al.*, 2004), where garlic oil is rich in organosulfur compounds and their precursors (allicin, dially sulfide & diallyl trisulfides) (Ankri and Mirelman, 1999) inhibiting the growth of a lot of pathogens as APC, *E. coli* & *S. aureus* by reacting with their cystine, inactivating the thio-containing enzymes or affecting the metabolism of lipids (Song *et al.*, 2004) and subsequently, extending the shelf life of the product, so the garlic extracts are potentially useful in preserving meat products (Pranoto *et al.*, 2005).

Reddy *et al.* (1990) indicated this is the excess availability of substrate at $p^H$ 5.07 to the micro flora due to breakdown of meat protein in chillar storage. Microbial load also increased by overcoming in initial shock due to chilling with progress in storage (Das *et al.*1988).

# 4.5 SENSORY EVALUATION

## 4.5.1 Appearance and Colour:

Mean ± SE value of appearance and color for chicken patties stored at refrigeration temperature for different storage periods were tabulated in Table 4.9

The effect of treatments and storage period on appearance/ colour of chicken patties were found to be non-significant. The overall mean value for appearance/colour score of treatments showed non-significant variation and for **garlic** it was found to be highest as compared to other three treatments. A declining trend for appearance/color score was observed with the advancement of storage period. Control was the lowest color value than other three .It is might be due to antioxidant and antimicrobial property of garlic, moringa leaves, vitamin E.

Biswas et al, (2011) reported A significant declining trend for appearance/color score was observed with the advancement of storage period. The overall mean for appearance/colour score was found to be 6.240±0.023 for Con group at 14th day and for treatment it was 6.616±0.050. Jacobson and Koehler, 1970 reported that all the sensory quality values decreased significantly with the advancement of storage period.

Ali et al. (2010) suggested chicken meat as affected by different growth enhancers like garlic, vitamin E during refrigerated and frozen storage. The rate of discoloration in fresh meat is related to the rate of pigment oxidation, oxygen consumption and to the effectiveness of the met myoglobin reducing system. In fact, discoloration and lipid oxidation are known to be related (O'Keefe and Hood, 1982; Ledward, 1991 and Greene *et al.*, 1971).

The effect of endogenous vitamin E on colour quality is more evident in species having higher levels of myoglobin and positive relationship between dietary vitamin E and improved colour stability has been clearly demonstrated in beef (Chan et al., 1996) and lamb (Guidera et al., 1997).

**Table No: 9.** ***Effect of different treatments on the colour of chicken patties (mean±SE)*:**

| Storage periods / Treatment groups | $0^{th}$ day | $3^{rd}$ day | $7^{th}$ day | $14^{th}$ day | $21^{st}$ day | P value |
|---|---|---|---|---|---|---|
| Garlic | $7.855\pm0.012^{p}$ | $7.537\pm0.013^{q}$ | $7.023\pm0.031^{r}$ | $6.586\pm0.021^{s}$ | $5.811\pm 0.011^{t}$ | P<0.01 |
| Moringa leaf | $7.815\pm 0.023^{p}$ | $7.474\pm0.033^{q}$ | $6.943\pm0.012^{r}$ | $6.418\pm0.004^{s}$ | $5.828\pm 0.005^{t}$ | P<0.01 |
| Vitamin E | $7.817\pm 0.002^{p}$ | $7.521\pm0.007^{q}$ | $6.827\pm0.004^{r}$ | $6.432\pm0.012^{s}$ | $5.822\pm 0.006^{t}$ | P<0.01 |
| Control | $7.794\pm 0.001^{p}$ | $7.290\pm0.002^{q}$ | $6.788\pm0.002^{r}$ | $6.368\pm0.010^{s}$ | $5.716\pm 0.001^{t}$ | P<0.01 |
| P value | p>0.05 | p>0.05 | p>0.05 | p>0.05 | p>0.05 | N=6 |

**Table No: 10.** ***Effect of different treatments on the Flavour of chicken patties (mean±SE)*:**

| Storage periods / Treatment groups | $0^{th}$ day | $3^{rd}$ day | $7^{th}$ day | $14^{th}$ day | $21^{st}$ day | P value |
|---|---|---|---|---|---|---|
| Garlic | $7.822\pm0.002^{p}$ | $7.549\pm0.006^{q}$ | $6.839\pm0.016^{r}$ | $6.327\pm0.005^{s}$ | NA | P<0.01 |
| Moringa leaf | $7.752\pm0.006^{p}$ | $7.416\pm 0.003^{q}$ | $6.725\pm0.003^{r}$ | $6.3637\pm0.019^{s}$ | NA | P<0.01 |
| Vitamin E | $7.718\pm0.003^{p}$ | $7.431\pm 0.002^{q}$ | $6.728\pm 0.002^{r}$ | $6.314\pm 0.002^{s}$ | NA | P<0.01 |
| Control | $7.730\pm 0.008^{p}$ | $7.323\pm 0.002^{q}$ | $6.645\pm 0.008^{r}$ | $6.247\pm 0.000^{s}$ | NA | P<0.01 |
| P value | p>0.05 | p>0.05 | p>0.05 | p>0.05 | p>0.05 | N=6 |

**P<0.01= Significance at 1%level, P<0.05= Significance at 5%level, P>0.005=Non significance. NA= Not accepted**
**Superscripts a, b, c, d significantly (column wise) Superscripts p, q, r, s, t differed significantly (row wise)**

## 4.5.2 Flavour:

Non-significant effect of treatments, and storage period was observed on flavour scores of the chicken patties.

The value for flavour was found to be highest for the garlic with a score of7.822±0.002and for moringa, vitamin E and Control was 7.752± 0.006, 7.718± 0.003 and 7.730± 0.008 respectively (table no-10). A non-significant declining trend for flavour score was observed in all test groups with the advancement of storage period. At 21$^{st}$ day of storage the flavour of all treatment group were unacceptable. Control group was highly changing their colour; it might be due to absence of antimicrobial and antioxidant component in control group.

Bharti et al. (2011) observed a declining trend for flavour score was observed in both groups with the advancement of storage period. The overall mean value for VT45 group was found to be 6.394±0.063 on 0th day and a drastic decrease in flavour score was observed on 14th day of observation.Nath (1992) also stated that pronounced flavour changes were observed in refrigerated samples at 4°C. The TBA values correlated significantly with flavour changes indicating that oxidative changes occurred as flavour deterioration during refrigerated storage.

The lower flavour score might be related to increased malonaldehyde formation due to oxidation of fat, which has detrimental effect on the flavour and firmness of the product (Miller et al., 1980). They also observed a significant decrease on 3rd and 6th day's refrigeration storage and found no significant difference between 3rd and 6th day of refrigeration storage. Deterioration of flavour during storage might be due to microbial growth and oxidative rancidity (Suresh et al., 2003).

## 4.5.3 Juiciness:

The effect of treatments and storage period on juiciness of chicken patties was found to be highly significant ($P<0.01$) as per the data presented in the table-11

Juiciness of the garlic treated group was highest in among all treated group. Score value of garlic was 7.739 ±0.003 on first day and other group moringa leaves treated, vitamin E and control were 7.517± 0.002,7.547± 0.014,7.655± 0.006

**Table No: 11.** ***Effect of different treatments on The Juiciness of chicken patties (mean±SE)*:**

| Storage periods / Treatment groups | $0^{th}$ day | $3^{rd}$ day | $7^{th}$ day | $14^{th}$ day | $21^{st}$ day | P value |
|---|---|---|---|---|---|---|
| Garlic | $7.739 \pm 0.003^{ap}$ | $7.236 \pm 0.007^{aq}$ | $6.722 \pm 0.002^{ar}$ | $6.231 \pm 0.010^{as}$ | NA | P<0.01 |
| Moringa leaf | $7.517 \pm 0.002^{cp}$ | $7.123 \pm 0.001^{bq}$ | $6.547 \pm 0.069^{br}$ | $6.118 \pm 0.002^{bs}$ | NA | P<0.01 |
| Vitamin E | $7.547 \pm 0.014^{cp}$ | $7.117 \pm 0.006^{bq}$ | $6.621 \pm 0.004^{br}$ | $6.117 \pm 0.014^{bs}$ | NA | P<0.01 |
| Control | $7.655 \pm 0.006^{bp}$ | $7.009 \pm 0.004^{cq}$ | $6.422 \pm 0.004^{cr}$ | $6.009 \pm 0.004^{cs}$ | NA | P<0.01 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | | N=6 |

**Table No: 12.*Effect of different treatments on the Texture of chicken patties (mean±SE)*:**

| Storage periods / Treatment groups | $0^{th}$ day | $3^{rd}$ day | $7^{th}$ day | $14^{th}$ day | $21^{st}$ day | P value |
|---|---|---|---|---|---|---|
| Garlic | $7.766 \pm 0.006^{ap}$ | $7.208 \pm 0.002^{aq}$ | $6.818 \pm 0.003^{ar}$ | $6.134 \pm 0.004^{as}$ | NA | P<0.01 |
| Moringa leaf | $7.421 \pm 0.002^{bp}$ | $7.019 \pm 0.006^{bq}$ | $6.721 \pm 0.002^{br}$ | $6.080 \pm 0.005^{bs}$ | NA | P<0.01 |
| Vitamin E | $7.302 \pm 0.020^{cp}$ | $7.014 \pm 0.002^{bq}$ | $6.721 \pm 0.007^{br}$ | $6.030 \pm 0.004^{bs}$ | NA | P<0.01 |
| Control | $7.135 \pm 0.012^{dp}$ | $6.828 \pm 0.005^{cq}$ | $6.337 \pm 0.011^{cr}$ | $5.822 \pm 0.002^{cs}$ | NA | P<0.01 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | | N=6 |

**P<0.01= Significance at 1%level, P<0.05= Significance at 5%level, P>0.005=Non significance. NA= Not accepted**
**Superscripts a, b, c, d differed significantly (column wise) Superscripts p, q, r, s, t differed significantly (row wise)**

respectively.21st day they were not acceptable.it was might be due to less water holding capacity. This result collaborated with result of Bali et al., (2011)

Vitamin E was shown to be beneficial for sensory scores (freshness, tenderness and juiciness) of refrigerated pork chops (Dirinck et al., 1996). The lower flavour scores in sausages containing cooked meat was probably due to the loss of volatile compounds like carbonyls during cooking and the reduced juiciness scores might be due to the denaturation of proteins and their inability to hold fat as well as (Lawrie 1998)

## 4.5.4 Texture:

Addition of different treatments showed a significant variation on chicken patties. The data presented in the Table -12 revealed that the effect of treatments and storage period on texture of chicken patties was found to be significant (P<0.01).

The values of Control were found to be less than the other treatment. A declining trend of texture score (P<0.01) was observed with the advancement of storage time and it was 7.135± 0.012 on 0th day and 5.822± 0.002on 14th day of observation .The texture of garlic group was found to be highest among other group. This was collaborated to result of bali et al. (2011)

Bharti et al (2011) found that a significant decreasing trend in the mean value for texture during storage period was observed which 7.019±0.011 were on 0th day and 6.092±0.011 on 14th day of observation.

## 4.5.5 Overall Acceptability:

Overall acceptability scores of chicken patties presented in the Table-13 revealed that there was highly significant (P<0.01) variation in the mean values of overall acceptability due to treatments and storage period.

A significant (P<0.01) declining trend was observed in the score of overall acceptability of chicken due to different treatments. The overall mean value of acceptability score was superior for Garlic than other treatment. The mean scores for

**Table No: 13.** ***Effect of different treatments on the Overall acceptability of chicken patties (mean±SE)*:**

| Storage periods / Treatment groups | 0th day | 3rd day | 7th day | 14th day | 21st day | P value |
|---|---|---|---|---|---|---|
| Garlic | $7.761\pm0.007^{ap}$ | $7.312\pm0.002^{aq}$ | $6.751\pm0.014^{ar}$ | $6.258\pm 0.010^{bs}$ | NA | P<0.01 |
| Moringa leaf | $7.632\pm0.004^{bp}$ | $7.158\pm0.015^{cq}$ | $6.316\pm0.002^{cr}$ | $6.028\pm0.012^{cs}$ | NA | P<0.01 |
| Vitamin E | $7.636\pm0.004^{pb}$ | $7.090\pm0.003^{dq}$ | $6.334\pm0.004^{cr}$ | $6.015\pm0.001^{cs}$ | NA | P<0.01 |
| Control | $7.322\pm0.004^{cp}$ | $6.722\pm0.002^{bq}$ | $6.377\pm0.014^{br}$ | $5.954\pm 0.014^{as}$ | NA | P<0.01 |
| P value | P<0.01 | P<0.01 | P<0.01 | P<0.01 | | N=6 |

**P<0.01= Significance at 1%level, P<0.05= Significance at 5%level, P>0.005=Non significance. NA= Not accepted**
**Superscripts a, b, c, d differed significantly (column wise) Superscripts p, q, r, s, t differed significantly (row wise)**

overall acceptability of control found to be least significant i.e. 5.954± 0.014 on 14$^{th}$ day of storage.

Bharti et al., (2011) also reported on 0th day of observation the overall mean value for juiciness in Con was 5.996±0.038 and 7.229±0.019 for VT45 group and on 14th day of observation it was reduced to 5.481±0.038 and 6.493±0.020 respectively The overall acceptability, decreased during storage. These findings are in agreement with those of Mandal (1993.)

Biswas (2002) reported that the decrease in overall acceptability scores of pork patties might be due to decrease in the value of other sensory characteristic. The result was in congruent with Reddy and Rao (1997) who stated that duck patties could be acceptable up to 6 days under refrigeration storage.

# CHAPTER- V

# SUMMARY AND CONCLUSION

# Chapter- V

# Summary and Conclusion

The present investigation was envisaged to study the antioxidative and antimicrobial effects of garlic, moringa leaf and vitamin E in the preparation of chicken patties in different concentrations. It was an attempt to increase the shelf life without affecting the quality as well as sensory attributes of the product which was of paramount importance.

Chicken patties were prepared by using garlic, moringa leaf and vitamin E at different concentrations levels. On the basis of sensory evaluation viz. appearance, color, flavour, juiciness, texture and overall acceptability the best product from three levels of each treatment were selected. The selected products were packed in LDPE bags and stored at refrigerated temperature (4±1°C) and subjected to comparative studies on physico-chemical, microbiological and sensory attributes on 0th, 3rd, 7th, 14th and 21st day. The salient findings of present study are as follows:

**Evaluation of antioxidant effects of different treatments on storage stability of Chicken patties showed following trends:**

The TBA values of all test groups were almost similar in fresh product but on storage it showed a significant increasing trend with advancement of storage period. The patties containing moringa leaf as a treatment showed a significantly lower TBA value than other treatment and control throughout the observation period. Thus moringa leaves extract was found to have better antioxidant activity as compared to others. The following trend was observed for antioxidant activity of different treatment: **moringa leaf>vitamin E > Garlic>Control.**

**Evaluation of antimicrobial effects of different treatments on storage stability of chicken patties showed following trends:**

Total plate count in all groups increased significantly with advancement of storage period. Patties containing garlic as a treatment showed significantly lower values throughout the storage period as compared to vitamin E, Moringa leaves and control.

Thus garlic, vitamin E and moringa leaf were found to have good antimicrobial property with a lower microbial count. **Garlic> moringa leaf>vitamin E > Control.**

**Physico-chemical analysis showed following trends:**

The pH value of **garlic** treatment was found to be significantly higher among all the treatments. Emulsion stability of **Garlic** treated chicken patties was significantly higher than the other treatments. The cooking loss of garlic treated chicken patties was highest among treatment. The value of cooking loss of garlic treatment, moringa leaves treatment, vitamin E and control were 14.202±0.093, 15.342±0.040, 16.342±0.107 respectively.

**Proximate analysis of chicken patties:**

Moisture content was found to be higher in garlic treated chicken patties moisture content trend was observed as **Garlic>moringa leaf>control>vitamin E.**

The protein content of the chicken patties containing moringa leaf was significantly higher than other group.

Significant difference was observed in fat content of all the treatments and control in chicken patties. Fat content was found to be highest in garlic treated patties followed by moringa leaf and vitamin E.

Ash content was found to be highest in garlic treatment and lowest in vitamin E followed by control.

There was a significant effect of test ingredients on pH values of chicken patties and significantly increasing trend were also observed throughout the observation period in pH values **control>moringa leaf>vitamin E>garlic.**

**Sensory evaluation showed the following trends:**

Sensory scores viz. appearance/color, flavor, texture, juiciness and overall acceptability of chicken patties were significantly different between treatments and with control. There was a significantly higher score for appearance/color, juiciness and overall acceptability for patties containing vitamin E, garlic and moringa leaves as treatments. Among all the sensory parameters texture shows the least significant scores becoz it did not showed better texture and chewiness.

The scores for all the sensory parameters showed a decreasing trend with advancement of storage period and as compared to control, patties with treatments maintained a higher score for all sensory parameters throughout the storage period.

The overall acceptability of chicken patties showed following trend: **Garlic>moringa leaf>vitamin E>Control.**

So that it can be concluded from the investigation performed , that in the preparation of chicken patties, garlic, vitamin E and moriga leaves can be used at 3%, 200mg and 1.5% level respectively without affecting the physico-chemical and sensory attributes of the product and can be stored at refrigeration temperature for 14 days in LDPE bags with good overall acceptability.

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# APPENDIX

## TASTE PANEL SCORE FOR SENSORY EVALUATION

Recipe: Name of judge:

Date/session Designation:

- Please taste the samples in the order presented from left to right.
- Check the box that best describes your overall opinion of each sample.

9-points hedonic scale for overall rating:

| | |
|---|---|
| 9 | Like extremely |
| 8 | Like very much |
| 7 | Like moderately |
| 6 | Like slightly |
| 5 | Neither like nor dislike |
| 4 | Dislike slightly |
| 3 | Dislike moderately |
| 2 | Dislike very much |
| 1 | Dislike extremely |

Now please give your scores below for each sample:

| ATTRIBUTES | SAMPLE1 | SAMPLE2 | SAMPLE3 | SAMPLE4 |
|---|---|---|---|---|
| Colour | | | | |
| Appearance | | | | |
| Odour | | | | |
| Juiciness | | | | |
| Texture | | | | |
| Tenderness | | | | |
| Flavour | | | | |
| Overall acceptance | | | | |

Remarks, if any;

*Signature*