AIM & SCOPE
OF THE STUDY
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Meat quality is largely the sum of the characteristics that register favourably or adversely on an individual's senses. When one visualises the food spectrum ranging from good to bad, the extremes are easily differentiated, but this is not true of the middle part of the spectrum. Especially in case of meat, various autolytic, degradative, oxidative and microbial changes as well as enzymatic activities occur resulting in the formation and accumulation of various chemical compounds during post mortem handling. As a result, the overall quality characteristics are bound to be altered. In raw meat, microbial spoilage is the main source of undesirable odours, whereas in chill stored processed meats and also in frozen meat the development of oxidative rancidity is the major problem, which limits the shelf life of such products.

Oxidation of lipids is one of the major causes of deterioration in the quality of meat and meat products during production and storage. Development of oxidative rancidity in meat begins soon after death and continues to increase in intensity until the product becomes unacceptable to consumers. The rapid development of off flavours in such products is a major challenge to meat chemists as the demand for meat items is predicted to steadily increase over the next decade. The rapid onset of rancidity in cooked meats during refrigerated storage is often called 'Warmed over Flavour' (WOF) and is readily detectable after forty eight hours of storage. In particular when foods are made stable against microbiological deterioration, often lipid oxidation instead becomes the main deteriorative reaction during storage. Many a dry and chilled foods exemplify this.

The process of WOF development in meat products is attributed to the auto-oxidation of meat lipids and formation of hydro-peroxides which, via many different pathways, decompose into a large number of volatile compounds. Flavour is an important quality attribute of muscle foods. The flavour of meat is subject to variability due to both intrinsic and extrinsic factors and it affects the overall acceptability of foods. These factors are of
utmost importance because they influence the judgement of the consumer, even before the food is consumed.

Lipid oxidation in muscle foods is generally non-enzymatic and mainly involves either free radicals and/or reactive oxygen species such as singlet oxygen to react with substrates such as unsaturated fatty acids. Oxidation is initiated during cooking and continues during storage. Various factors affect the extent of oxidation, e.g.; availability of oxygen, temperature of cooking, method of cooking, species of meat, packing and storage conditions and presence of various pro and antioxidants. Cations, such as iron and copper, present in meat, are known to act as pro-oxidant catalysts and quenching of such a property is considered to be a key factor for the oxidative stability of meat and meat products. Heme pigments serve as a source of free iron, being readily broken down during the cooking process and catalyse auto-oxidation leading to rancidity in cooked or dehydrated meat more so if the meat has a high degree of unsaturation. There are some reports available about the higher catalytic activity of non-heme iron than heme iron in the lipid oxidation profile of cooked meat. Processing operations which disrupt the oxidative balance of skeletal muscle include: particle size reduction, which mixes oxidation catalysts with lipids and introduces oxygen into previously an aerobic tissue, cooking, which causes disruption of cellular organization in the skeletal muscle tissues, resulting in protein denaturation and loss of antioxidant enzyme activity, the release of protein bound iron and salting, which increase the catalytic activity of iron and reduce antioxidant enzyme activity. These processing operations can markedly increase the lipid oxidation in muscle foods. Therefore, during processing of meat, control of these catalytic systems is very important to minimise lipid oxidation.

The problem of lipid oxidation in meats is very complex and has a negative impact on flavour, colour and nutritional characteristics of fresh, frozen or cooked meat or meat products. Several adverse health effects, due to the presence of reactive oxygen species (ROS), such as super oxide radical (O'2), hydroxyl radical (OH') and peroxyl radical (ROO') during lipid oxidation have been reported. Products of lipid oxidation also interfere with
the absorption of protein or folic acid and it has also been found that they can cause pathological changes in the digestive tract. So in foods, including those made from muscle, there is a need to extend the shelf life of the product until it is consumed. Many of the naturally occurring antioxidants are destroyed during the processing of the raw product. The shelf life of processed meat can be extended by using antioxidants and proper packaging materials.

To avoid or delay the auto oxidation process, antioxidants have been utilised successfully for over fifty years. Synthetic antioxidants, such as butylated hydroxy anisole, butylated hydroxyl toluene, tertiary butyl hydroxyl anisole and propyl gallate are commonly used as preservatives and are thus consumed in appreciable quantities by human beings. However the use of such compounds has been related to health risks resulting in strict regulations of their use in foods. They can have carcinogenic effects in living organisms. Because of the growing concern for the potential health hazard of synthetic antioxidants, there is a renewed interest in the use of naturally occurring substances.

There are few reports available in the literature about the use of ascorbic acid and its derivatives and tocopherols in some meat products. Spices and herbal extracts were also used in food system as natural antioxidants.

Compounds that are formed by non-enzymatic chemical reaction involving condensation of an amino group and reducing group and formation of intermediates that polymerise to form brown pigments are known as Maillard Reaction Products (MRPs). Melanoidins or pre melanoidins resulting from the Maillard reaction have strong antioxidant properties in certain lipid mixtures. The use of MRP had tremendous potential in preventing or retarding oxidation reactions in lipid food systems.

Demand for high quality foods that are less heavily processed, containing lower levels of preservatives and requiring minimal preparation at the user end had been on the increase world over, including India. Extension
of shelf life of perishable foods and maximum retention of desirable qualities in the processed food are the primary aims of all methods of preservation. High moisture content and the various chemical constituents that constitute the foods are important factors that determine the susceptibility of a food for chemical degradation. Meat provides a favourite medium for rapid chemical deterioration.

Meat eating practices and preferences vary considerably from one country to another and from one region to another. Since meat is a valuable and perishable commodity suitable processing and preservation methods have to be selected carefully to suit the needs of the consumer. Hurdle processing and irradiation are the emerging food processing techniques for meat products and could be successfully employed in the development of meat and poultry products. Dehydration techniques like Freeze drying and fluidised bed drying can also be employed, by standardising the additive combination and processing parameters. In all these processing techniques the extension of shelf life and over all stability could be achieved by standardising proper antioxidant combinations to inhibit the lipid oxidation. Important meat species used for domestic consumption are sheep and chicken, whereas for export, frozen buffalo beef and convenience products based on chicken and mutton storable at low temperature are generally required. The demand for meat based convenience food is likely to grow in the near future. In these products, the quality problems mainly pertain to the off-odours arising from oxidative changes initiated during processing. The extent of these quality problems, happening because of the oxidation of lipids is species specific. So the stability of the products prepared from different species will have variation. Hence the effectiveness of antioxidants, i.e., the antioxidant potential of natural antioxidants has to be ascertained / determined before incorporation to get a stable final product.

Most of the published literature on meat spoilage and rancidity development relate to low temperature, aged/conditioned meat mostly pork and beef, handled under hygienic conditions and nitrite cured meats which are more common than uncured meats in the western countries. Information on
the chemical stabilities of meat products prepared from sheep and chicken under different conditions of processing are also scarce. Considerable species variations are also reported with regard to their susceptibility to oxidative rancidity development. All these problems arising from chemical changes induced during processing and storage need to be examined in detail with reference to the prevalent practices of handling and processing of mutton and chicken in our country. The origin of rancidity problems, under the Indian conditions of cooking and preparation of the spicy product need to be understood properly, in view of the increasing demand for convenience foods.

There is paucity of information on the detailed antioxidant activity of various MRPs and its synergistic antioxidative potential with other natural antioxidants with respect to meat and meat products. The effectiveness of using MRPs i.e. early MRPs in inhibiting the WOF and rancidity characteristics in common domestic species like sheep and chicken is not reported earlier and need to be established. Standardising the preparation of MRPs w.r.t concentration and time and also with regard to sugar and amino acid will facilitate the development of shelf stable meat products for civilian and Armed forces. Further research is required to determine the most useful MRPs for preventing WOF in cooked meat during storage. Since a major aspect of WOF is loss of desirable meaty flavour during storage, the production of MRP mixtures that can both potentiate desirable flavour and prevent oxidation during storage is highly desirable. Not much information is available on the role of heme iron and non-heme iron in the presence of natural antioxidants in cooked meat. The extent of release of non-heme iron during cooking and storage in the presence of natural antioxidants will throw more light on the catalytic activity of non-heme iron and the antioxidant potential of natural antioxidants. We need additional studies to find inhibitors capable of slowing down the reactions involved in lipid oxidation. Better understanding of the inhibitors present in muscle or created during cooking is needed. More information on the effect of various cooking methods and processing techniques and the degree of heat treatment on the susceptibility of meat to lipid oxidation and WOF development are also required. Identifying proper MRP combination, which can have equivalent antioxidant potential of
synthetic antioxidants in meat/poultry system will facilitate to substitute, synthetic antioxidants with MRPs to control the lipid oxidation. Dehydration, hurdle processing and irradiation can be successfully employed in the development of meat products. Effectiveness of MRPs synergistically and individually could throw more information on the inhibition of lipid oxidation and its shelf stability characteristics. Flavour/volatile profile in relation to different processing techniques and additives have to be established in meat and meat products. Not much literature is available on the use of MRPs in these processing techniques of meat products.

In view of this lack of information, and keeping the objectives in mind, it was proposed to study the following aspects in meat and meat products.

2.1. Plan of work

1. Studies for standardising the proper combination, preparation and application of MRPs with antioxidant characteristics.

2. Investigation to evaluate the antioxidant potential of various MRPs in model system comprised of methyl linoleate.

3. Antioxidant assay of MRPs in terms of DPPH radical scavenging, β-carotene and reducing power to establish the MRP combination with good antioxidant activity.

4. Studies on the UV-visible spectrum of MRP with good antioxidant potential to evaluate the characteristics of MRP compounds.

5. To establish the antioxidant activity of MRPs, spices and ascorbic acid and its comparative evaluation with synthetic antioxidants (BHA, BHT, TBHQ and PG) in different species of meat (sheep, beef, pork and chicken).

6. Detailed chemical evaluation on the effect of natural antioxidants on the WOF development and lipid oxidation in meat and meat products.

7. Evaluation of the parameters like peroxide value, TBARS, Total carbonyls, FFA, Gas liquid chromatography profile of total fatty acids to understand the lipid oxidation and other stability characteristics during processing and storage.
8. To examine the catalytic activity of non-heme iron and the effect of additives in controlling the catalytic activity and thus lipid oxidation.
9. To establish the correlation and best fit equations between the oxidative rancidity parameters in different species of meat and also in processing.
10. Effective utilisation of MRPs, spices, ascorbic acid and its esters in controlling lipid oxidation in various processing techniques like Freeze drying, Fluidised bed drying, Hurdle processing and Irradiation.
11. Studies on the effect of MRPs on the lipid oxidation during irradiation and storage of chicken products w.r.t irradiation dosage.
13. Total volatile profile of chicken samples prepared by Freeze drying and Irradiation processing.
14. Standardisation of the processing techniques to develop chemically stable, safe meat and meat products for civil and service uses.
15. Effect of irradiation on the DSC characteristics of Fluidised bed dried mutton in terms of Tg, ΔH and crystallinity.

2.2. Scope

This study will be of importance to food industry-

a) To understand the role of various intrinsic and extrinsic factors responsible for lipid oxidation.

b) To devise preventive measures to minimise lipid oxidation during handling, processing and storage.

c) By identifying proper antioxidant combinations shelf stable meat/poultry products can be developed by various processing techniques like dehydration, hurdle processing and irradiation.

d) Prevention of WOF in cooked refrigerated meat.

e) Study will help in identifying and using suitable natural antioxidants in lieu of synthetic one, for developing shelf stable meat products with better sensory attributes.