EFFECT OF PRESERVATION BY IRRADIATION ON ANIMAL AND PLANT PROTEINS

BY

NARIMAN MAHMOUD MOHAMED
SHAMS EL DIN

B. Sc. Agric. "Food Science"

Ain Shams University (1972)

Dissertation

Submitted in Partial Fulfilment of the
Requirements for the Degree of
MASTER OF SCIENCE
IN
FOOD TECHNOLOGY

Department of Food Science
Faculty of Agriculture
Ain Shams University
1978

ACKNOWLEDGEMENT

The author would like to express her thanks to Prof. Dr. A.G.El- Warraki Professor of the Food Science Department, Faculty of Agriculture, Ain Shams University and to Prof. Dr. H.M.Roushdy, Director of the National Center for Radiation Research and Technology and to Dr. M.A.El- [illegible]kary Lecturer of the Food Science Department, Faculty of Agriculture, Ain Shams University for their supervision and help in presenting this thesis, valuable suggestions stimulative discussion, and constructive cirticism .

Special thanks are extended to Dr. M.S.El-Dachlouty Head of the Meat and Fish Technology Research Unit, Agric. Research Center for his helps in presenting this thesis.

The author would like to thank all the staff members of the Meat and Fish Technology Research Unit, Agric. Research Center .

بسم الله الرحمن الرحيم

APPROVAL SHEET

Name : Neriman Mahmoud Mohamed Shams El Din

Title: Effect of preservation by irradiation on animal

and plant proteins.

This Thesis has been

approved by:

Committee in charge

Date : 5/ 6/ 1970

CONTENTS

I N T R O D U C T I O N

INTRODUCTION

Fresh meat is highly perishable, specially with lack of low temperature storage facilities in most meat shops. Under these conditions the meat has a life of utmost only a very few days. During cold storage, the shelf life of meat and meat products is also limited due to relatively rapid bacterial decomposition and deep autolysis. Practical preservation methods utilizing the bactericidal properties of ionising radiation are now developed for a number of food stuffs of animal origin. Radurization processes; radiation pasteurisation; prolong the shelf - life of meat at chill temperatures, using doses in the range of 0.15 to 0.5 M.rad. Such treatment did not alter the original properties of meat as with some other preservation methods, such as canning or dehydration (Rhodes, 1959).

Preservation of foods by ionizing radiation, however, is more less accompanied by chemical changes and characteristic flavour changes which depend upon the dose of irradiation. This "irradiation flavour" is marked at high doses of irradiation. At low doses, however, "irradiation flavour" may be detectable. The threshold dose was reported to be 100 K.rad (Hannan and Thórney, 1957) or 250 k.rad (Urbain 1972) for beef. Irradiation of meat at freezing temperatures was claimed to decrease the odour intensity (Kosaric et al., 1973 and Merritt et al., 1975). From the consumer point of view flavour evaluation of irradiated foods is one of the most important criteria, on which the acceptability of the irradiated foods is mainly based. Hence irradiation of frozen meat should be paid more attention.

The problem of the preservation of fresh meats does not ential simply the control of microbial spoilage. Other pathways of quality loss also must be controlled in order that the meat will be acceptable to the consumer, being at the same time suitable for processing. The formation of an exudate, weepage, a liquid which is separated from meat on irradiation makes it unsightly. Even below the threshold, being 250 k.rad for beef; the weepage of fluids from meat could not be controlled (Urbain 1972). On the other hand, radiation pasteurization may be carried out at 500 k.rad, which increases the drip loss. Radiation pasteurization of animal tissues resulted in the development of toughness (Power et al., 1967, and Hassan, 1976).

Phosphate compounds were found to improve the protein solubility, water holding capacity, tenderness of meat. Such compounds also control to some extent the lipid oxidation, bacterial growth, and discolouration of meat and meat products during cold storage, frozen storage, and sausage production. (Alekceyev et al., 1958 Schi[illegible] and Senger, 1964). Phosphate treatment, is of great importance during irradiation of meat in frozen state, specially that freezing and frozen storage are known to affect the water holding capacity, protein solubility, tenderness, and protein hydration (Sokolov, 1965, Awad, 1968, and Mohamed 1974). Moreover irradiation promotes lipid oxidation. On the other hand only few studies were carried out on the effect of phosphates during irradiation of meat and meat products (Kastornykh, Khemutov, 1970, and Palmin et al., 1974). The effect of phosphates during radiation pasteurization of fresh frozen meat, using low doses of 500 k.rad was not carried out, although tripolyphosphates gave good results during radiation sterilisation (4.7 - 7.1 M.rad) of meat at -30°C .

Gamma irradiation leads a rapid discolouration of meat. Irradiation of meat under vacuum or in nitrogen atmosphere, specially the cooked meat resulted in the formation of undesirable strange bright colour. In the presence of oxygen, however, irradiation caused a brown discolouration due to the formation of metmyoglobin. Discolouration of meat was found even at low doses. In the practical range of irradiation (0.05 to 3 mega rep.) the oxidative changes of pigments occurred (Huber, 1953, Groninger et al., 1956, and Sokolov, 1965). Phosphate compounds were able to control discolouration of irradiated meat during coldstorage at 4.4°C (Urbain and Giddings 1972).

Recently in Egypt the ground buffalo meat with soya protein are produced in commercial scale (Personal communication 1977). It was reported that low fat soya such as that which was used in sausage during world war II has a protein content equal to three times its weight of lean meat. (Pearson 1970). Hence soya flour may participate in solving the problem of providing adequate protein to reduce the increasing shortage of meat protein in Egypt and other developing countries. The use of soya flour aids to reduce the cost of meat and meat products, specially under the local conditions of meat shortage and its high price. The cost of meat products with soya[illegible] could be reduced markedly if the meat was taken from camel animals. Camel meat is less expensive than other meats such as beef or mutton's and could be considered as one of the important sources of animal protein. Such meat is considered as one of the toughest types of meat in Egypt. Phosphates agin was claimed to affect the structure of cattle meat, causing appreciable increase of its tenderness and water holding capacity (Alekcayev et al., 1958).

Many studies were carried out on the irradiation of soya beans, as affecting the proteins, amino acids, and lipids (Soiko et al., 1965, Metlitski 1967, Lee, 1969, and Kane et al., 1975). As far as the authors knowledge, there are no available data concerning the irradiation of meat to which soyoprotein has been added, probably due to lack of investigation on this point.

The main object of this investigation is to study the effect of freezing before irradiation with 200 and 500 k rad on the properties of camel meat steaks during storage at 4°C. Pyrophosphate treatment as a mean for improving the quality of frozen and irradiated meat steaks was also studied. The effect of soya flour on the properties of frozen and irradiated ground camel meat, as well as the merit of pyrophosphate addition to such mixtures was also experimented. Cold-storage at $4^{o}C$ was applied to all treatment to determine the shelflife, and the changes of physical, chemical, microbiological changes occurring in meat steaks, ground meat, and ground meat with soya flour.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

1- Chemical and physical changes induced by ionizing radiation

A- Proteins

Ionizing radiation may cause different changes in proteins - Such changes may be classified to the following points:

1) Solubility

Mc Nulty and Hutchinson (1954) reported that dry irradiation of crystalline bovine serum albumin (BSA) decreased its solubility in water - Moreover irradiation of this protein led to a loss in the ability to combine with antibody.

Alexander et al., (1960) found on irradiation of bovine serum albumin with 2-Mev electrons, that protein becomes insoluble in water but remains soluble in salt solutions. With high doses, the protein becomes insoluble in salt solutions - The loss of water solubility is associated with an increase in the average molecular weight. The author suggested that three stages of radiation damage may occur. One event (primary ionization) changes the shape as shown by revelation of 25% of the disulphide bonds. The solubility and molecular weight are not affected. Two events per molecule (i.e. Threshold relation ship with dose) change solubility and give small aggregates. Further irradiation causes extensive aggregation by intermolecular hydrogen bonds.

Kumta and Tappel (1961) reported that irradiation caused both the formation of insoluble protein aggregates and protein fragmentation. However studies carried out on the amino acids in the trichloroacetic acid (T.C.A.) precipitable protein indicated that denaturation or polymerization was not the only cause of formation of insoluble protein aggregates, and that hydrolysis induced by radiation was not the mechanism of fragmentation.

Pavlovski and Palmin (1963) reported that the meat proteins are very stable during irradiation. Myosin, the major protein of muscle retained marked solubility after ionising radiation. The contractability of myosin fibers as well as the ATP-ase activity survived irradiation.

Usumov and Nestrov (1972) found during irradiation of the Longissimus dorsi muscle of 2-year old cattle with 1 and 2.5 M.rads, that the solubility of salt proteins decreased linearly with dose.