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Modeling of Various Compositional Changes Occurring in the Sliced Chicken Treated with Gamma Irradiation

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ABSTRACT: Consumers demand for quality of food has triggered the need for the development of a number of non-thermal approaches to food processing, of which Irradiation technology has proven to be very valuable. This review and research aims to develop the models for various constituents of sliced chicken undergoing Irradiation treatment for increasing the self-life. The models developed are as a function of irradiation dose (0-6)kGy, by plotting the graph and finding the trend equation with there R^2 on M S Excel.

KEYWORDS: Irradiation, Radiation, Modeling, Cobalt-60, Radiolysis, M S Excel.

1 INTRODUCTION

The term "radiation chemistry" refers to the chemical reactions that occur as a result of the absorption of ionizing radiation. In the context of food irradiation, the reactants are the chemical constituents of the food and initial radiolysis products that may undergo further chemical reactions. The chemistry involved in the irradiation of foods has been the subject of numerous studies over the years and scientists have compiled a large body of data regarding the effects of ionizing radiation on different foods under various conditions of irradiation. The basic principles are well understood and provide the basis for extrapolation and generalization from data obtained in specific foods irradiated under specific conditions to draw conclusions regarding foods of a similar type irradiated under different, yet related, conditions. The types and amounts of products generated by radiation induced chemical reactions ["radiolysis products") depend on both the chemical constituents of the food and on the specific conditions of irradiation.

The principles of radiation chemistry also govern the extent of change, if any, in both the nutrient levels and the microbial loads of irradiated foods.

Factors Affecting the Radiation Chemistry of Foods- Apart from the chemical composition of the food itself, the specific conditions of irradiation that are most important in considering the radiation chemistry of a given food include the radiation dose, the physical state of the food (e.g., solid or frozen versus liquid or non-frozen state, dried versus hydrated state), and the ambient atmosphere (e.g., air, reduced oxygen, and vacuum). The temperature at which irradiation is conducted can also be a factor, with more radiation-induced changes occuring with increasing temperature. Temperature is less important, however, than the physical state of the food. The amounts of radiolysis products generated in a particular food are directly proportional to the radiation dose. Therefore, one can extrapolate from data obtained at high radiation doses to draw conclusions regarding the effects at lower doses.

The radiation chemistry of food is strongly influenced by the physical state of the food. If all other conditions, including dose and ambient atmosphere, are the same, the extent of chemical change that occurs in a particular food in the frozen state is less than the change that occurs in the non-frozen state. This is because of the reduced mobility, in the frozen state, of the initial radiolysis products, which will tend to recombine rather than diffuse and react with other food components.

Likewise, and for similar reasons, if all other conditions are the same, the extent of chemical change that occurs in the dehydrated state is less than the change that occurs in the fully hydrated state.

The formation of radiolysis products in a given food also is affected by the ambient atmosphere. Irradiation in an atmosphere of high oxygen content generally produces both a greater variety, and greater amounts, of radiolysis products in the food than would be produced in an atmosphere of lower oxygen content. This is because irradiation initiates certain oxidation reactions that occur with greater frequency in foods with high fat content.

With few exceptions, the radiolysis products generated in a particular food are the same or very similar to the products formed in other types of food processing or under common storage conditions. These radiolysis products are also typically formed in very small amounts**.** Radiation-induced chemical changes, if sufficiently large, however, may cause changes in the organoleptic properties of the food. Because food processors want to avoid undesirable effects on taste, odor, color, or texture, there is an incentive to minimize the extent of these chemical changes in food. Thus, the doses used to achieve a given technical effect (e.g., inhibition of sprouting, reduction in microorganisms) must be selected carefully to both achieve the intended effect and minimize undesirable chemical changes.

Typically, the dose or dose range selected will be the lowest dose practical in achieving the desired effect. Irradiation also is often conducted under reduced oxygen levels or on food held at low temperature or in the frozen state.

In general, during inactivation of microorganisms on surfaces, the rate of inactivation is inversely proportional to the initial cell concentration (Shintani, 2000). Food irra-diation is being considered an important tool, in ensuring safety and extending shelf-life of fresh meat and poultry (Yoon, 2003). Thus irradiation can eliminate food-borne pathogenic microorganisms in meat. Furthermore, the use of gamma irradiation as a safety techno-logical treatment in food preservation has now become legally accepted in many countries of the world (Abdel-Daium, 2007).

Misconceptions about Irradiated Food

There are misconceptions in the minds of consumers regarding irradiated food. However, scientific research has proved that consumption of irradiated food is absolutely harmless. The safety of food processed by radiation has been examined carefully, both at the national and international levels. On the basis of extensive studies with laboratory animals carried out in different countries including India, FAO/IAEA/WHO Joint Expert Committee has recommended that the food items irradiated up to an average dose of 10 kilo Gray be accepted as safe from the health angle and do not present any toxicological hazards. In fact, the doses of irradiation required for the treatment of commodities are far below this stipulated limit. The committee has further recognized radiation as a physical process like thermal processing and not as a food additive.

The irradiation process involves passing of food through a radiation field allowing the food to absorb desired radiation energy. The food itself never comes in contact with the radioactive material. Gamma rays, X-rays, and electrons prescribed for radiation processing of food do not induce any radioactivity in foods. In comparison to other food processing and preservation methods the nutritional value is least affected by irradiation. Extensive scientific studies have shown that irradiation has very little effect on the main nutrients such as proteins, carbohydrates, fats, and minerals. Vitamins show varied sensitivity to food processing methods including irradiation. For example, vitamin C and B1 (thiamine) are equally sensitive to irradiation as well as to heat processing. Vitamin A, E, C, K, and B1 in foods are relatively sensitive to radiation, while riboflavin, niacin, and vitamin D are much more stable. The change induced by irradiation on nutrients depends on a number of factors such as the dose of radiation, type of food, and packaging conditions. Very little change in vitamin content is observed in food exposed to doses up to 1 kGy. The Joint Expert Committee of the Food and Agriculture Organization (FAO), World Health Organization (WHO), and International Atomic Energy Agency (IAEA), in 1980 concluded that irradiation does not induce special nutritional problems in food. The committee also rejected the possibility of development of chromosomal abnormalities by the consumption of irradiated food.

Mathematical modeling is an effective way of representing a particular process. It can help us to understand and explore the relationship between the process parameters. Mathematical modeling can help to understand and quantitative behavior of a system. Mathematical models are useful representation of the complete system which is based on visualizations. Mathematical modeling is an important method of translating problems from real life systems to conformable and manageable mathematical expressions whose analytical consideration determines an insight and orientation for solving a problem and provides us with a technique for better development of the system.

The objective of the study is to model the changes in various compositions of irradiated chicken meat in respect to the radiation dose given.

2 MATERIALS AND METHODS

[26]Sliced chicken were purchased from local market (Benha, Qaliobia governorate, Egypt). All samples were transported to the laboratory food irradiation unit, Nuclear Research Center in ice-box (0°C) and surveyed for microbiological counts for counts of total bacteria, psychrophilic bacteria, spore forming bacteria, total molds and yeasts. Then, sliced chicken samples were packed in tightly sealed polyethylene pouches and divided into seven groups and stored in freezing till irradiation treatments.

Gamma irradiation treatments[26]

Four bags from each of sliced chicken were gamma irradiated at 0, 2, 4, and 6 kGy doses using cobalt-60 gamma chamber (1.367 kGy/h) in Cyclotron Project, Nuclear Research Center Atomic Energy Authority, Inshas, Cairo, Egypt. After irradiation, all samples were stored at 4±1°C.

Microbial analysis[26]

Colony forming units for total bacterial count were counted by plating on plate count agar medium and incubated at 30°C for three to five days (APHA, 1992). Total molds and yeasts were counted on oxytetracycline glucose yeast extract agar medium according to Oxoid, (1998). psychrophilic and spore forming bacteria count according to (FDA, 2002).

Statistical analysis[26]

The statistical evaluation of the mean data was compared using one-way analysis of variance (ANOVA) according to Zar (1984). The chosen level of significance was P≤ 0.05.

3 RESULT AND DISCUSSION

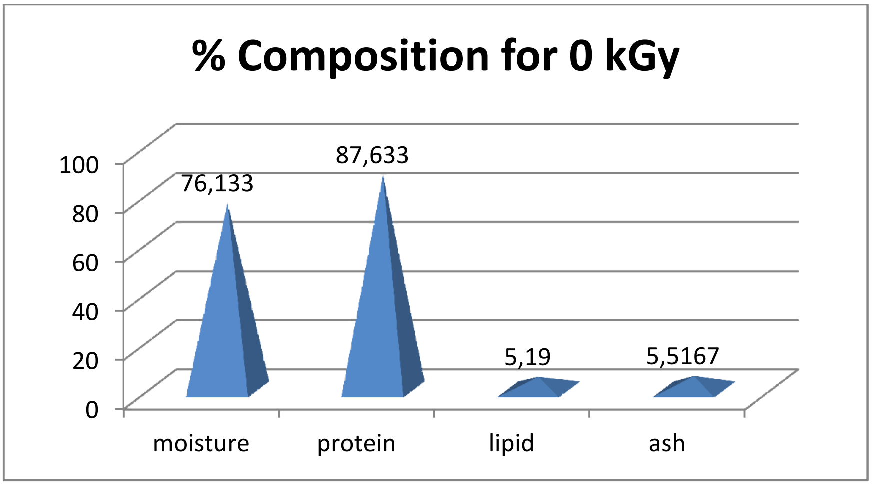

Fig 1. % composition of sliced un treated chicken

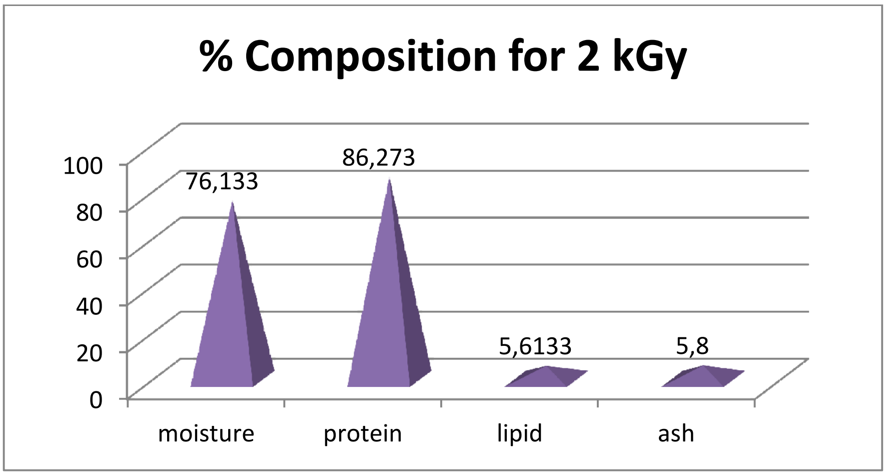

Fig 2. % composition of sliced irradiated chicken for 2 kGy

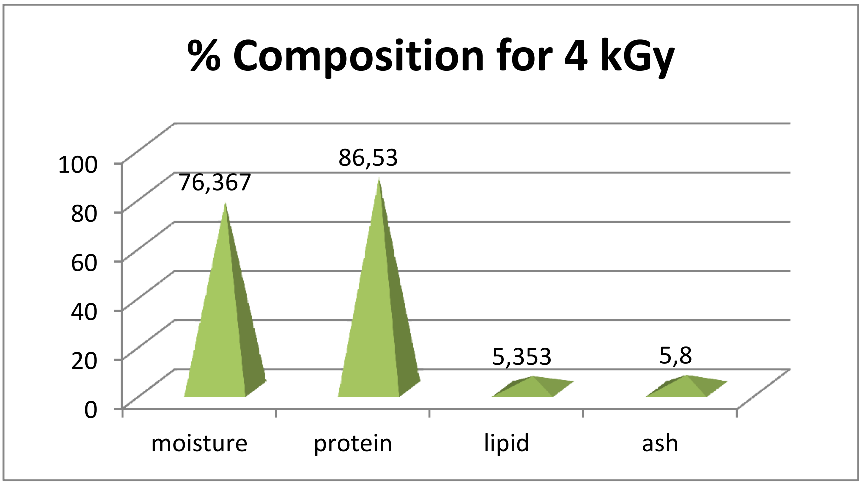

Fig 3. % composition of sliced irradiated chicken for 4 kGy

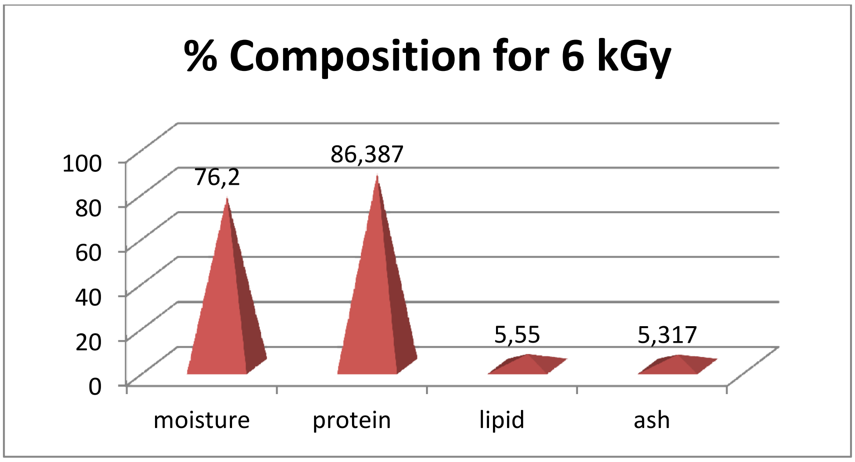

Fig 4. % composition of sliced irradiated chicken for 6 kGy

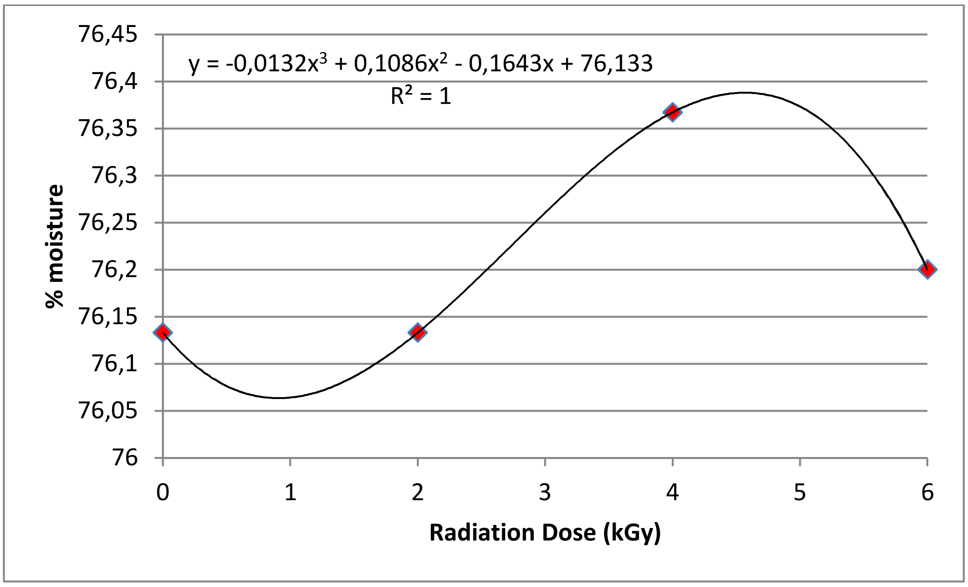

Fig 5. Modeled Graph for % moisture content Vs Irradiation dose

From above graph we can say that % moisture content decreases from 0-1 kGy then rises from 1-4.5 kGy then again decreases till 6 kGy.

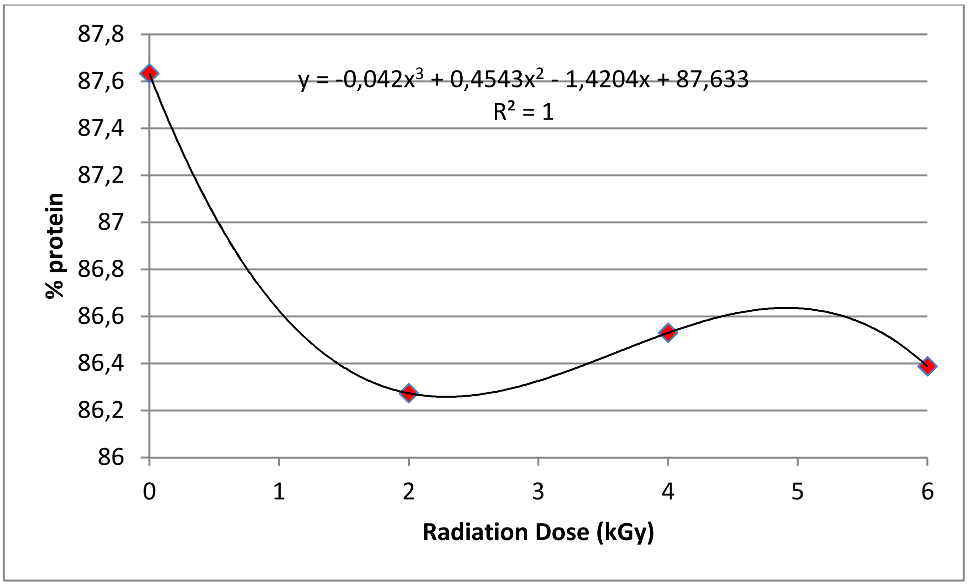

Fig 6. Modeled Graph for % Protein Vs Irradiation dose

From the above graph we can say that first there is decrease in % protein content from 0-2 kGy and then rises from 2- 5 kGy then again decrease from 5-6 kGy.

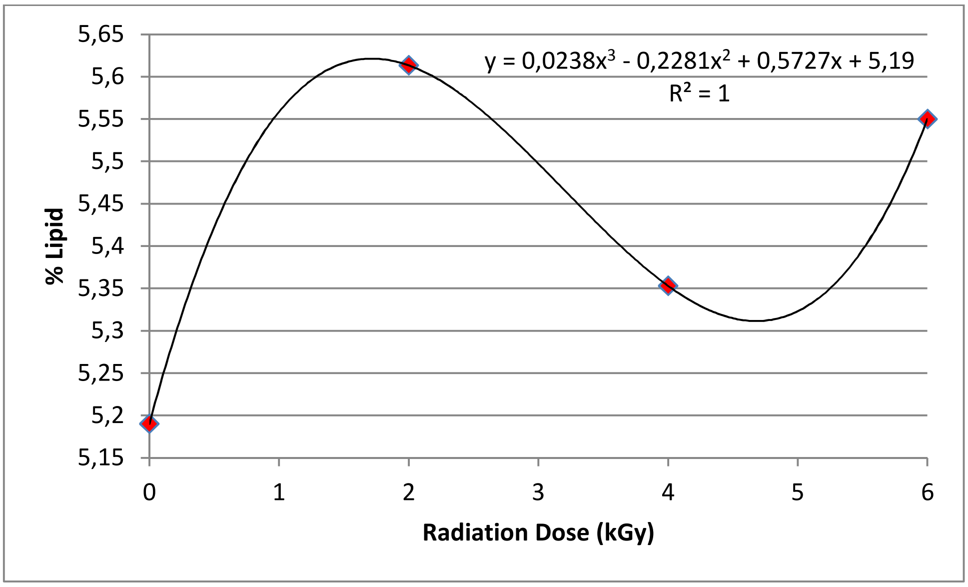

Fig 7. Modeled Graph for % Lipid content Vs Irradiation dose

From the graph above we can make out that there is increase in % lipid content for 0-2 kGy dose of Gamma-irradiation, then it decreases from 2-4.8 kGy and then again abrupt rise till 6 kGy.

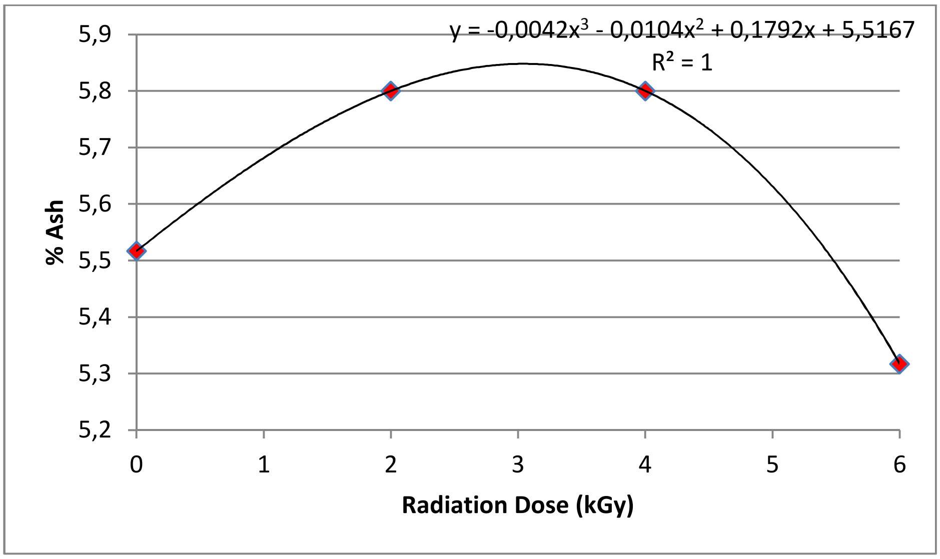

Fig 8. Modeled Graph for % Ash content Vs Irradiation dose

From the above graph it can be concluded that there is rise in % Ash from 0 kGy till 3 kGy then it decreases till 6 kGy.

4 CONCLUSION

The effect of various gamma irradiation doses on the chemical composition of sliced chicken was studied and the data and From above graphs, it could be noticed that the moisture, total protein, lipid and ash contents were tends to change with the irradiation treatment of sliced chicken respectively. From the above graphs and model prepared one can make out the changes in compositions of sliced chicken with the irradiation dose (0-6) kGy of the same.

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