



Original article

Effects of gamma irradiation and storage time on ostrich meat tenderness

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ABSTRACT

In this study effects of gamma irradiation and storage time on the Appearance and Texture changes of fresh ostrich meat stored at 4°C were evaluated. Ostrich meat irradiated at 0.0, 1.0 and 3.0 kGy. Analysis of variance showed that aging of meat affected SF in all treatments. There were significant differences among radiation doses at any of the times. Sensory panel results were in general agreement with the mechanical changes, suggesting that the gamma irradiation at 1.0 kGy had a significant impact on the quality of refrigerated ostrich meat. Air-packaged samples irradiated at 1.0 kGy were acceptable under refrigerated storage for 9 days, compared to 7 and 5 days for non irradiated and samples irradiated at 3.0 kGy, respectively.

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1. Introduction

Irradiation is known to be the best method for the control of potentially pathogenic microorganisms in meat without affecting its physical state (Gants, 1998). Food irradiation is generally defined as the process in which foods are exposed to certain forms of ionizing energy from radioactive sources mainly gamma rays. Cobalt-60 is a highly penetrating source of ionizing radiation used in food either fresh or after processing and packaging. Irradiated foods are not radioactive (Satin, 2002). The consumption of beef in Iran at that time declined and consumers started to look for alternative kinds of red meat from not traditional species like ostrich. Several studies have been published on physical properties, chemical composition, sensory properties and nutritive values of ostrich meat (Girolami *et al.*, 2003; Paleari *et al.*, 1998; Sales, 1996; Sales and Hayes, 1996; Sales and Horbanczuk, 1998) whereas no data have been published on tenderness changes and sensory quality of fresh Ostrich meat by

gamma irradiation during storage time. The objective of this study was to investigate the effects of gamma irradiation and storage time on tenderness and sensory qualities of ostrich meat during refrigerated storage.

2. Materials and methods

2.1. Sample preparation

Ostrich meat samples from Six ostriches (*Struthio camelus* var. *domesticus*) were obtained at a slaughter house (Qazvin, Iran) 1 h after slaughtering and used separately as replications for preparation of samples (three separate replicates). The samples were wrapped in clean sterile polyethylene bags and transported in a clean cool box containing ice cubes to the laboratory of the Department of Food Science and Technology. Muscle samples were cut cylindrically (5 cm diameter and 10 cm length). Any visible fat was removed from the muscle tissues.

2.2. Packaging and irradiation

A Packaging machine model A200, (Henkelman, Netherlands) was used for packing. Meat samples were randomly assigned to packages (sterile polyester polyethylene (PET/Poly) pouches (thickness-62µm)). One group of ostrich meat was kept as control (non irradiated) and the second groups were irradiated. Packaged ostrich meat samples were gamma irradiated at the Atomic Energy Organization of Iran (AEOI, Tehran, Iran) inside a package irradiator (Gamma Cell 220, Nordion Intl. Inc., Ontario, Canada) with a ⁶⁰Co source at a dose rate of 1.576 kGy/h. The packs remained in storage at 4°C for the entire duration of the experiment.

2.3. Texture assessment

Tensile strength was calculated from the maximum load during a tension test carried to rupture the specimen (Honikel, 1998) by using an Instron Model Testometric (M350-10CT, Rochdale, England). Muscles were cut perpendicular to the muscle fiber orientation to produce 2cm thick slices. Slices were hooked to the testing machine and the resistance to tearing (tensile stress) was determined at tensile velocity of 60 mm/min.

2.4. Sensory evaluation

In this study, a 5-member trained sensory attribute panel evaluated raw samples of ostrich meat. The panelists consisted of staff members in the Dept. of Meat Science, University of Tehran. Panelists were given an orientation for 30 min about appearance (color), odor, texture and overall quality of fresh ostrich meat. Samples were introduced to panelists in covered petri-dishes coded with 3-digit random numbers. Acceptability of raw meat was evaluated using a 9-point hedonic scale, where 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, and 1 = dislike extremely (Peryam and Pilgrim, 1957). Scores from 6 to 9 were considered acceptable (Paul *et al.*, 1990). Evaluation was performed under cool white fluorescent light in the sensory laboratory. The same meat samples were evaluated over storage times. The shelf life limit was defined as the point when 50% of the panelists rejected the sample.

2.5. Statistical analysis

Data from shear force and sensory analysis were subjected to an analysis of irradiation doses (0, 1.0 and 3.0 kGy), and storage time (1, 7, 14, and 21 days) by simple and interaction effects using two-way ANOVA. Comparison of means were based on Post Hoc multiple test (Tukey). Data were analyzed using the SAS (1988) statistical package.

3. Results and discussion

3.1. Textural analysis

The palatability of meat is determined by the combination of tenderness, juiciness and meat flavor (Koochmaraie *et al.*, 2002). Of these, tenderness is the most important for consumers. Risvik (1994) has described tenderness as one of the main meat quality attributes important for its acceptability and purchasing intention of consumers. An objective measure of tenderness is the force required to shear a standardized piece of meat with low shear values being desirable. The tensile strength test is best suited for structural investigations rather than to

predict sensory evaluation of tenderness. It is a useful test in conjunction with other methods. The test can be carried out on raw or cooked meat. Results will be affected by sample size and strain rate, but this latter effect is small. Shear force values at different postmortem times are presented in figure 1. Analysis of variance showed that aging of meat affected SF in all treatments, as has been found in other studies where post mortem aging increased meat tenderness (Pinkas *et al.*, 1978; Jeremiah *et al.* 1997; Jouki and Khazaei, 2011; Jouki *et al.*, 2012). Of the total reduction in shear force that occurred after 21 days of aging 50% occurred during the first 7 days of aging. Other researchers also reported that the greater improvement in shear force occurred during the 1st week (Campo *et al.*, 2000; Monson *et al.*, 2005; Jouki and Khazaei, 2012). Significant differences existed among the different doses of radiation in the shear force values of ostrich meat. Warner-Bratzler tests suggest air-packaged non irradiated samples stored at 4°C tend to have lower shear forces than those irradiated (Figure 1). Air packaging for ostrich meat were found to negatively influence shear force as well as the sensory attributes tenderness and meat aroma. Shear force values of irradiated ostrich meat were significantly ($P < 0.01$) higher than nonirradiated. Mean value of shear force of irradiated ostrich meat during 21 days refrigerated storage was significantly ($P < 0.01$) higher than those of the nonirradiated samples. The results of this study clearly indicate that irradiation affects the texture quality of ostrich meat. However, these contradictory findings may reveal the complexity in understanding of textural characteristics of irradiated poultry meat.

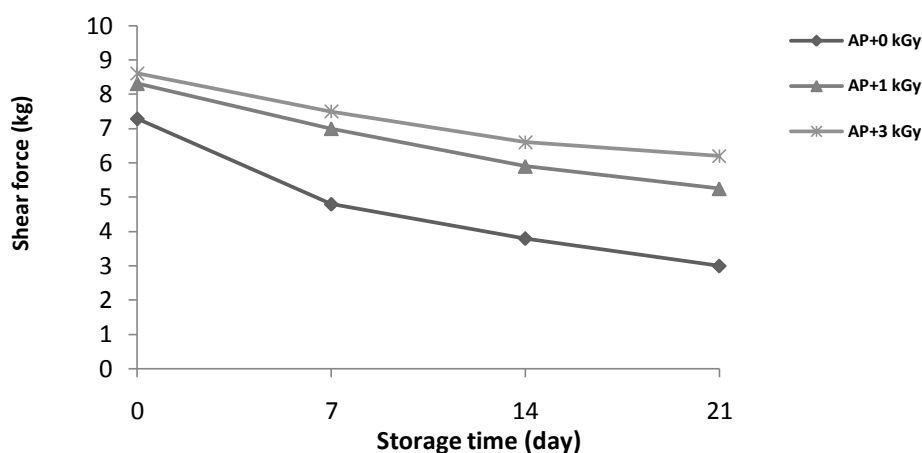


Fig. 1. Shear force changes of packaged ostrich meat affected by irradiation dose during the storage time at 4°C.

3.2. Sensory quality

The sensory attributes of irradiated ostrich meat during storage at 4°C are shown in figure 2. By the 7 days of the storage time, irradiated packaged samples were acceptable (scores >6). The surface of the samples, especially those irradiated packaged, was not severely discolored and remained acceptable even after 7 days storage. Storage time effect within treatment indicated that surface discoloration increased ($P < 0.05$) especially at day 21 in irradiated air-packaged samples. At day 14, air packaged ostrich meat samples received lower scores than other samples (about color and texture), significant differences ($P < 0.05$) were found between them at day 14 and during storage time. By the end of the storage time irradiated samples had acceptable texture. The acceptable samples were described as having good appearance or natural odor without any sign of rancidity. The ostrich meat packaged in air quickly lost its qualities (especially odor and texture) during 7 days of storage period. The acceptability results from figure 2 indicated that storage time and radiation doses had significant impacts on panel acceptability. In our present study, irradiation at dose 1 kGy extended the shelf life of packaged Ostrich meat about 9 days a compared to the air-packaged samples (7 days) stored at refrigeration temperature. Miyauchi *et al.* (1964) stated that the average sensory score of 6 might be acceptable. On the basis of organoleptic evaluation, it was found that irradiation dose of 1 kGy could extend the shelf life of ostrich meat for 9 days.

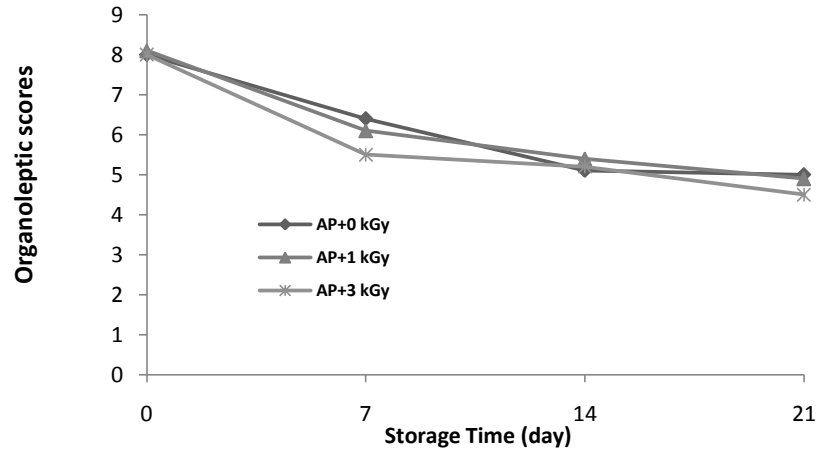


Fig. 2. Organoleptic scores of irradiated ostrich meat during refrigerated storage. AP= Air packaging.

4. Conclusion

Tenderness increased with aging time. In this study we have observed the evolution of the shear force and sensory quality when preserved in samples treated by gamma irradiation at 1.0 kGy. In general, there were significant differences among irradiated and nonirradiated samples for Shear force values. In summary, gamma irradiation at 1.0 kGy accompanied by refrigeration storage enhanced product shelf life for 9 days without undesirable and detrimental effects on its sensory acceptability.

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