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Original article

Gamma irradiation effects on microbial decontamination of ostrich meat

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A B S T R A C T

In this work effects of gamma irradiation and storage time on microbial decontamination of fresh camel meat stored at 4˚C were evaluated. Microbial analysis indicated that irradiation had a significant effect on the reduction of microbial loads. Among the analyzed bacteria, coliforms were most sensitive to gamma radiation. Considering the sensory analyses and Total bacterial counts analyses as a whole, air-packed samples irradiated at 1.0 kGy were acceptable under refrigerated storage for 9 days, compared to 5 and 7 days for irradiated at 3.0 kGy and non irradiated air-packaged samples, respectively.

1. Introduction

Microorganisms control in meat products is the major concern in the preparation of high quality foods (Jo et al. 2004). The hygienic state of animals prior, during and after slaughter can be critical to the finished product quality (Satin 2002). 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). In 1997, the FDA approved the irradiation of meat products (fresh and frozen beef, lamb and pork) for controlling disease causing microorganisms such as *Escherichia Coli, Salmonella, Listeria* and other food borne pathogens (Bartlett et al. 2000). Irradiation of food up to an overall dose of 10 kGy is accepted in several countries for commercial food processing (Lacroix and Quattara, 2000). Gamma irradiation has been employed for decontamination of animal foods (Chwla et al. 2003; Fu et al. 2000; Kamat et al. 2000; Mahrour et al. 2003; Yang et al. 1993) and then to prolong the storage period of irradiated food. The relatively high pH of ostrich meat creates an ideal environment for rapid microbial spoilage in some packaging conditions (Alonso-Calleja et al. 2004; Doherty et al. 1996; Sales and Mellet, 1996). Ostrich meat also contains high amounts of polyunsaturated fatty acids as compared to beef and chicken making it more susceptible to oxidation (Horbanczuk and sales, 1998; Sales and Oliver-Lyons, 1996). 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 microbial 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 microbial and sensory qualities of ostrich meat during refrigerated storage.

2. Materials and methods

2.1. Sample preparation and packaging

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). Muscle samples were cut cylindrically (5 cm diameter and 10 cm length). Any visible fat was removed from the muscle tissues. Measurements of microbial and sensory quality were conducted on meat samples. 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-62lm)). The samples were packed and sealed aseptically in polyethylene pouches and divided into two groups, one group of ostrich meat was kept as control (non irradiation) and another group was irradiated. The packs remained in storage at 4°C for the entire duration of the experiment. Samples were analyzed at 0, 7, 14, 21 days post-slaughter.

2.2. Irradiation

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 ^{60}Co source at a dose rate of 1.576 kGy/h. The dose rate was established using alanine transfer dosimeter to make sure that the dose reached the target dose.

2.3. Microbial analyses

A sample (25 g) was drawn aseptically and transferred to 225 ml of sterile 0.1% peptone water solution. The sample was homogenized in a stomacher Lab Blender 500 for 1min at room temperature. For microbial enumeration, 0.1 ml samples of serial dilution of meat homogenates were spread on the surface of dry media: Total plate count was performed on plate count agar (Merck, Germany). The samples were incubated at 25^{oC} for 72 h; lactic acid bacteria on MRS (Merck), overlaid with the same medium and incubated at 25^{oC} for 96 h under anaerobic conditions; Pseudomonas spp. on cetrimide–fucidin–cephaloridine (CFC) agar (Oxoid, UK) incubated at 25^{oC} for 48 h; Yeasts and molds were enumerated using acidified potato dextrose agar (Merck, Germany) after incubating at 30 ± 2^{oC} for 3 days. Enterobacteriaceae on Violet Red Bile Dextrose Agar (Merck, Germany) incubated at 37^{oC} for 24 h. The data (growth counts) were transformed to log10 values. The coliform colony count was determined on Violet Red Bile Agar (VRBA) (Oxoid, CM485, UK) at 37 1C for 48h. The count of Staphylococcus aureus was accomplished in selective medium BPA (Baird-Parker-Agar) and BHI, incubated at 35°C for 48 hours (Vanderzant and Splittstroesser 1992).

2.4. Sensory evaluation

A sensory test, using a consumer type panel, comprised of 5 staff members from different departments, was employed to detect sensory differences samples within 6 months after storage in freezing condition. Each untrained panelist received four coded samples. Each member independently evaluated the turkey meat for taste, odor, color and flavor on a 5-point hedonic scale (1: extremely poor, 2: poor, 3: acceptable, 4: good and 5: excellent) (Lavrova and Krilova 1975). 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 microbial 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. Microbial analyses

The changes in counts of aerobic mesophilic bacteria, coliform, Staphylococcus aureus, Pseudomonas, Enterobacteriaceae and lactic acid bacteria (LAB) for the ostrich meat samples during storage at 4 °C are depicted in Fig. 1. The effects of gamma irradiation of ostrich meat were restricted in the counts of microbial flora with the concomitant benefit of prolonging refrigerated shelf-life on the samples. During storage, these microorganisms significantly increased samples, while the rate of increase was lower in irradiated packaged samples. Initial microbial counts at day 0 were 5.23 log CFU/g for total aerobic plate counts, 4.5 log CFU/g for Staphylococcus aureus, 3.8 log CFU/g for lactic acid bacteria, 3.12 log CFU/g for Pseudomonas, 2.4 log CFU/g for Enterobacteriaceae and 2.2 for Coliforms. The initial load of aerobic bacteria in Air-packaged meat samples was 5.23 log CFU/g and reached to 8.47 log CFU/g after 21 days of storage. Microbial loads showed differences ($P<0.05$) during storage and between radiation doses. The aerobic bacterial population inhibited by irradiation. The high microbial load found in ostrich meat in relation to other red meats has been attributed to the high pH of this meat which creates an ideal environment for rapid microbial spoilage in some packaging conditions (Alonso-Calleja et al. 2004; Fernandez-Lopez et al. 2008; Sales and Mellet 1996; Seydim et al. 2006). According to Capita et al (2006) storage temperature and time both affect the microbial count of meat. In the cited study, time of storage influenced all the microbial groups of ostrich meat. These results agree with previous observations on the other kinds of meat (Jouki and Khazaei, 2011; Jouki et al., 2012). Total aerobic counts after irradiation decreased as irradiation dose increased up to 3 kGy (figure 1). Irradiation at 1 and 3 kGy resulted in up to a 2 and 3 log reduction in total microbial counts, resulting in a final count of about 3-log at the day 0. The total aerobic bacteria count increased during storage, but it was lower in samples irradiated at higher doses (figure 1). The total count on day 21 in all meat samples irradiated at 3 kGy was lower than the count in non-irradiated samples on day 0, while the count on day7 in samples irradiated at 1 kGy were similar to the count in non-irradiated samples on day. Thayer et al. (1995) found that the total bacterial count of chicken wings was reduced by about 2 log cycles with irradiation at 1.4 kGy. we reported a rapid growth of viable bacteria in air-packed samples, reaching a population of 7 log CFU/g after four to five days of storage at 4° C; the use of gamma irradiation extended the time required for the total count of bacteria to reach 7 log CFU/g to three or four days of storage. In this work, shelf-life extension was mostly due to the irradiation-induced prolongation of the lag phase, found to be higher for the samples treated with 3.0 kGy. Irradiated samples had lower ($P<0.05$) counts than non irradiated sample. *Staphylococcus aureus* population showed a general increase during storage time in all packages ($P<0.05$) and remained about 7.5 CFU/g in the meat samples packaged under air, while Samples irradiated at 1 and 3 kGy showed *Staphylococcus aureus* population between 5.5 and 3.5 CFU/g at the end of storage time (21 days). Of the phychrotrophic bacteria, pseudomonas spp. are gram negative bacteria dominated at refrigeration temperatures and considered as one of the main spoilage microorganisms in meat and poultry (jay 2000). Pseudomonas began to increase in all groups and reaching 8.1 log CFU/g and 7.3 log CFU/g respectively in air-packages at the end of storage (day 21). Irradiation dose of 1 kGy reduced the counts of Enterobacteriaceae by 1 log units, but for 3 kGy no growth of Enterobacteriaceae were observed (Figure 1). Chouliara et al. (2008) reported that using an irradiation dose of 2 kGy resulted in a reduction of Enterobacteriaceae by approximately 2 log CFU/g in aerobically packaged chicken breast stored at 4°C, while a dose of 4 kGy eliminated the mentioned microorganisms during 25days of storage. Among the microbial flora in ostrich meat, LAB were the most resistant of them to irradiation process. Irradiation doses of 1 and 3 kGy produced immediate LAB reduction of 1and 1.9 log units, respectively. Lacroix et al. (2004) reported that LAB and Brochothrix thermosphacta are more resistant to irradiation treatment than

Enterobacteriaceae and Pseudomonas. The initial counts of Pseudomonas demonstrated a considerable number (3.12 log CFU/g) of these organisms in non-irradiated ostrich meat samples. Irradiation dose of 1 kGy reduced the initial counts of Pseudomonas by 2 log units, while at doses of 3 kGy these organisms were below the detection level during refrigerated storage (Figure 3). The number of A*erobic bacteria, Coliform and St aureus* decrease with increase of irradiation, therefore irradiation significantly (P<0.05) reduced them (figure 1). The 3 kGy dose reduced the counts of *St aureus* by more than 2 log units in ostrich meat. The results of this research concerned the reduction of Staphylococcus aureus population in irradiated ostrich meat are similar to those found by some authors. Nouchpramool et al. (1985) observed that the dose of radiation of 3.0 kGy was able to eliminate Staphylococcus aureus in frozen shrimp. The dose of 2.5 kGy was able to eliminate Staphylococcus aureus in smoked fish (Research, 1978). Thayer et al. (1997) concluded that Staphylococcus aureus can be eliminated or greatly reduced in number in bison, alligator and caiman meats by doses of gamma radiation between 1.5 and 3.0 kGy and storage at 5°C. According to Thayer (1995) low doses of ionizing radiation (<3.0 kGy) may eliminate or significantly decrease the population of the most common enteric pathogens such as Campylobacter jejuni, Escherichia coli, Staphylococcus aureus, Salmonella spp., Listeria monocytogenes and Aeromonas hydrophila. Ionizing radiation can be an effective step in a program to kill enteric pathogens associated with meat and poultry products. **T**he total coliform group did not show detectable growth in the samples irradiated at 3.0 kGy (Figure 1). According to the data that group was eliminated from the ostrich meat irradiated to 3.0 kGy, and had difficulty to start growth after irradiation with 1.0 kGy. Abu-Tarboush et al. (1997) also found that irradiation with 2.5 kGy and storage at 4°C for 21 days was sufficient to eliminate total coliforms in chicken meat. In another experiment, gamma irradiation of chicken with 1 and 1.8 kGy was sufficient to eliminate total coliforms (Lewis et al. 2002).The results of this study indicate that irradiation doses of 1.0 and 3 kGy were effective in eliminating bacteria in ostrich meat. Gamma irradiation treatment at 1.0 and 3 kGy reduced coliforms, Enterobacteriaceae, aerobic bacteria and psychrotrophs when compared to controls receiving no irradiation treatment (figure 1). Although coliforms, Enterobacteriaceae, and psychrotrophs were eliminated using 3 kGy of irradiation, aerobic bacteria populations were greatly reduced but not completely eliminated. Counts of 7 log CFU/g is the approximate point at which meat would be unacceptable (Dainty and Mackey 1992). Therefore, the shelf life of irradiated ostrich meat stored under aerobic conditions would be 7 days, while irradiated ostrich meat would be 9 days.

3.2. Sensory quality

The ostrich meat was also evaluated for changes in surface color, texture, and odor by semi-trained panelists. 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, 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 air-packaged samples and irradiated at 3 kGy. Data from sensory analysis confirmed those from microbiological tests. Panelists rejected air packaged samples after 7 days storage at 4°C, where samples reached or exceeded the spoilage onset (10^7 CFU/g). At day 14, nonirradiated 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 packaged 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 irradiated had significant impacts on panel acceptability. In our present study, irradiation at dose 1 kGy extended the shelf life of air-packaged Ostrich meat about 9 days as 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 microbial analyses and organoleptic evaluation, it was found that irradiation dose of 1 kGy could extend the shelf life of ostrich meat for 9 days.

4. Conclusion

Gamma irradiation at 1.0 kGy reduced the microbial populations. Microbial loads showed differences (P<0.05) during storage and between radiation doses. The aerobic bacterial population inhibited by irradiation. Gamma irradiation treatment at 1.0 and 3 kGy reduced coliforms, Enterobacteriaceae, aerobic bacteria and psychrotrophs when compared to controls receiving no irradiation treatment. Among the analyzed bacteria, coliforms were most sensitive to gamma radiation. Data from sensory analysis confirmed those from microbiological tests. Considering the sensory analyses, Total bacterial counts as a whole, air-packed samples irradiated at 1.0 kGy were acceptable for 9 days under refrigerated storage.

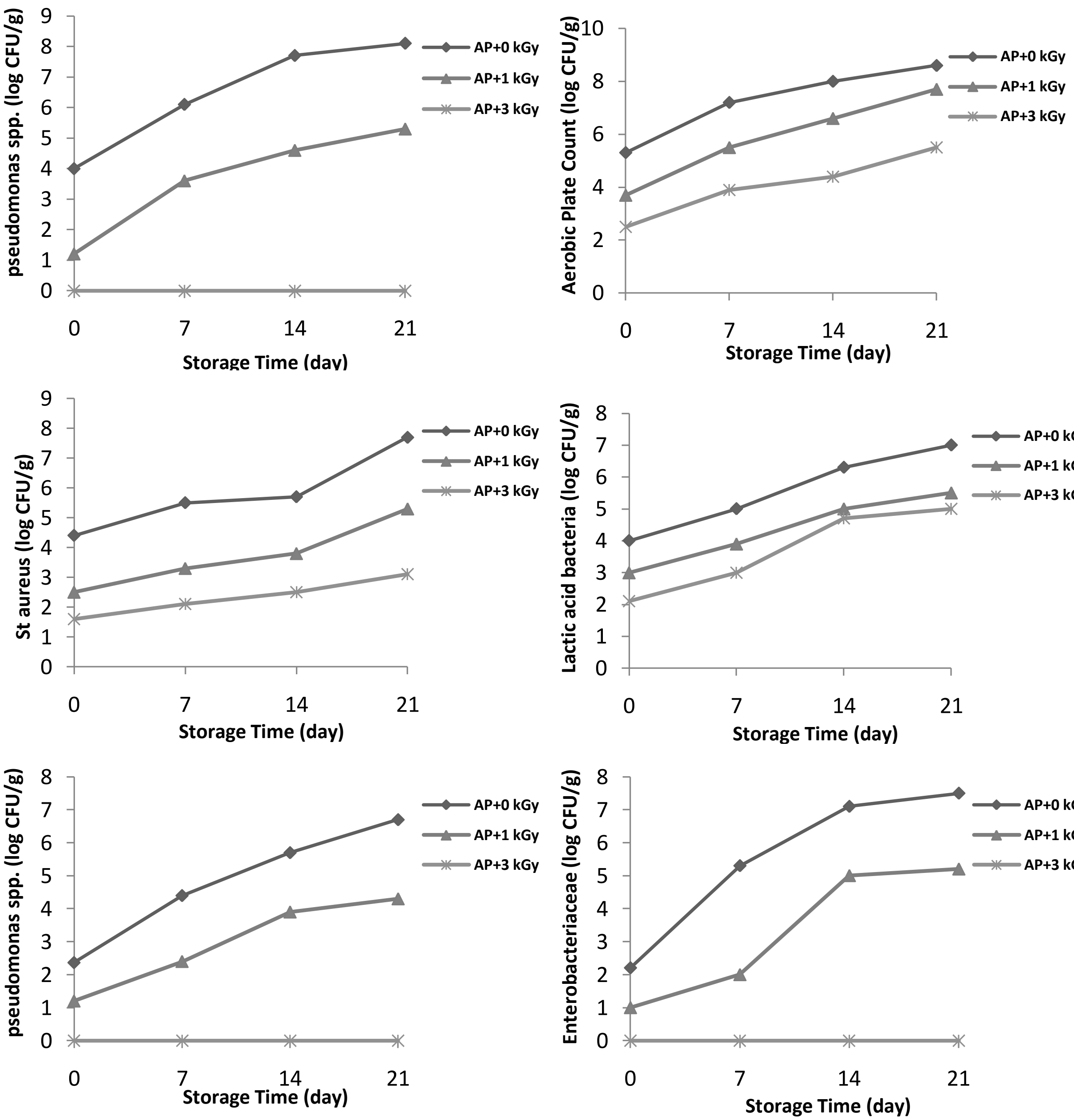

Fig. 1. Microbial changes of irradiated and nonirradiated ostrich meat during refrigerated storage. AP: air-packaged.

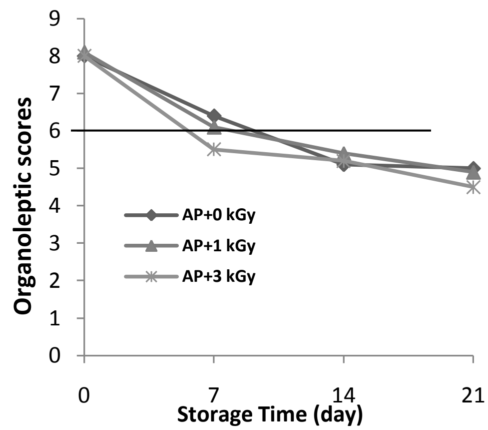

Fig. 2. Organoleptic scores of irradiated ostrich meat during refrigerated storage. AP= Air packaging

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References

Abu-Tarboush, H.M., Al-Kahtani, H.A., Atia M, Abou-Arab, A.A., Bajaber, A.S., El-Mojaddidi, M.A., 1997. Sensory and microbial quality of chicken as affected by irradiation and post irradiation storage at 4 ˚C. J. Food Prot. 60, 761–770.

Alonso-Calleja, C., Martinez-Fernandez, B., Prieto, M., Capita, R., 2004. Microbiological quality of vacuum-packed retail ostrich meat in Spain. Food Mic. 21, 241−24.

Bartlett, J.G., Bruhn, C., Murano, E., Olson, D., 2000. The irradiation of beef products. http://www.beef.org/documents/ ACF 9A4.pd

Chwla, S.P., Kim, D.H., Jo, C., Lee, J.W., Song, H.P., Byun, M.W., 2003. Effect of gamma irradiation on the survival of pathogens in Kwamegi, a traditional Korean semidried seafood. J. Food Prot. 66(11), 2093–2096.

Capita, R., Diaz-Rodriguez, N., Prieto, M., Alonso-Calleja, C., 2006. Effects of temperature, oxygen exclusion, and storage on the microbial loads and pH of packed ostrich steaks. Meat Sci. 73, 498-502.

Chouliara, I., Savvaidis, I.N., Panagiotakis, N., Kontominas, M.G., 2004. Preservation of salted, vacuum-packaged, refrigerated sea bream (Sparus aurata) fillets by irradiation: microbiological, chemical and sensory attributes. Food Mic. 21, 351–359.

Dainty, R.H., Mackey, B.M., 1992. The relationship between the phenotypic properties of bacteria from chill-stored meat and spoilage processes. The Journal of Applied Bacteriology, 73, 103−114.

Doherty, M.A., Sheridan, J.J., Allen, P., McDowell, D.A., Balir, I.S., 1996. Physical characteristics of lamb primal packaged under vacuum or modified atmospheres. Meat Sci. 42, 315–324.

Fu, J., Shen, W., Bao, J., Chen, Q., 2000. The decontamination effects of gamma irradiation on the edible gelatin. Radiat Phys Chem. 57(3-6), 345–348.

Fernandez-Lopez, J., Sayas-Barbera, E., Munoz, T., Sendra, E., Navarro, C., Perez-Alvarez, J.A., 2008. Effect of packaging conditions on shelf-life of ostrich steaks. Meat Sci. 78, 143−152.

Gants, R., 1998. Irradiation: weighing the risks and benefits. Meat Poult. 5(1), 34–42

Girolami, A., Marsico, I., D'Andrea, G., Braghieri, A., Napolitano, F., Cifuni, G.F., 2003. Fatty acid profile, cholesterol content and tenderness of ostrich meat as influenced by age at slaughter and muscle type. Meat Sci. 64(7), 309–315.

Horbanczuk, J.O., Sales, J., 1998. Lipid and cholesterol content and fatty acid composition of meat obtained from ostriches reared on a commercial farm. Anim. Sci. Paper. Report. 16, 51-55

Jay, J.M., 2000. Modern food Microbiology.6th Ed. Aspen publishers, Inc., Gaithersburg.

Jo, C., Lee, N.Y., Kang, H.J., Shin, D.H., Byun, M.W., 2004. Inactivation of food-borne pathogens in marinated beef rib by ionizing radiation. Food Mic. 21(5), 543–8.

Jouki, M., Khazaei, N., 2011. Effects of Storage Time on Some Characteristics of Packed Camel Meat in Low Temperature. Int J Anim Vet Adv 3(6), 460-464.

Jouki, M., Tabatabaei, F., Khazaei, N., Motamedi Sedeh, F., 2012. Effects of Storage Time on Quality Characteristics of Frozen Turkey Meat. Int J Anim Vet Adv., 4(1), 63-67.

Kamat, A., Warke, R., Kamat, M., Thomas, P., 2000. Low-dose irradiation as a measure to improve microbial quality of icecream. Int J Food Mic. 62(1-2), 27–35.

Lacroix, M., Quattara, B., 2000. Combined industrial processes with irradiation to assure innocuity and preservation of food products-a review. Food Res Int. 33(9), 719–724.

Lacroix, M., Chiasson, F., Borsa, J., Ouattara, B. 2004. Radiosensitization of Escherichia coli and Salmonella typhi in presence of active compounds. Radiat Phys Chem. 71, 65–68.

Lavrova, L.P., Krilova, V.X., 1975. Luncheon meat technology. Food's Industry, Moscow, 325–326 (in Russian).

Lewis, S.J., Velasquez, A., Cuppet, S.L., Mckef, S.R., 2002. Effect of electron beam irradiation on poultry meat safety and quality. Poult. Sci. 81, 896–903.

Mahrour, A., Caillet, S., Nketsa-Tabiri, J., Lacroix, M., 2003. Microbial and sensory quality of marinated and irradiated chicken. J Food Prot. 66(11), 2156–2159.

Miyauchi, D.T., Eklund, M.W., Spinelli, J., Stall, N.V., 1964. Irradiation preservation of pacific coast shellfish, storage life of icing crabmeats at 33°F and 42°F. Food Technol. 18, 677-681.

Nouchpramool, K., Pungsilpa, S., Adulyatham, P., 1985. Improvement of bacteriological quality of frozen shrimp by gamma radiation. Office of Atomic Energy for Peace, v.9, p.23

Paleari, M.A., Camisasca, S., Beretta, G., Renon, P., Corsico, P., Bertolo, G., et al., 1998. Ostrich meat: Physico-chemical characteristics and comparison with turkey and bovine meat. Meat Sci. 48, 205–210.

Research coordination meeting wholesomeness of food irradiation processing. 1978. Food Irradiation Information, v.9, p.128-133.

Sales, J., 1996. Histological, biophysical, physical and chemical characteristics of different ostrich muscles. J Sci Food Agric. 70(1), 109.

Sales, J., Horbanczuk, J.O., 1999. Cold-shortening in different ostrich muscles. Czech J Anim Sci. 44, 273-275.

Sales, J., Hayes, J.P., 1996. Proximate, amino acid and mineral composition of ostrich meat. Food Chem. 56, 167–170.

Sales, J., Mellett, F.D., 1996. Post-mortem pH decline in different ostrich muscles. Meat Sci. 42, 235-238.

SAS/STAT. 1988. User's guide, release 6.03 edn. Cary, SAS Institute Inc, NC.

Sales, J., Oliver-Lyons, B., 1996. Ostrich meat: a review. Food Aust. 48(11), 504–511.

Satin, M., 2002. Use of irradiation for microbial decontamination of meat: situation and perspectives. Meat Sci. 62(3), 277–83.

Seydim, A.C., Acton, J.C., Hall, M.A., Dawson, P.L., 2006. Effects of packaging atmospheres on shelf-life quality of ground ostrich meat. Meat Sci. 73, 503−510.

Thayer, D.W., 1995. Use of irradiation to kill enteric pathogens on meat and poultry. J Food Safety. 15(2), 181-192.

Thayer, D.W., Boyd, G., Fox, J.B.J.R., Lakritz, L., 1997. Elimination by gamma irradiation of Salmonella spp. and strains of Staphylococcus aureus inoculated in bison, ostrich, alligator, and caiman meat. J Food Prot. 60(7), 756-760.

Thayer, D.W., Boyd, G., Huhtanen, C.N., 1995. Effect of ionizing radiation and anaerobic refrigerated storage on indigenous microlflora, Salmonella, and Clostridium botulinum types A and B in vacuum-canned, mechanically deboned chicken meat. J Food Prot. 58(7), 752–757.

Vanderzant, C., Splittstroesser, D.F., 1992. Compendium of methods for the microbiological examination of foods. 3.ed. Washington: American Public Health Association, 1219 p.

Yang, S.F., Perng, F.S., Liou, S.E., Wu, J.J., 1993. Effects of gamma irradiation on chromophores and volatile components of grass shrimp muscle. Radiat. Phys. Chem. 42(1-3): 319–322.