Keeping the quality of ready-to-eat meals by gammairradia tion

Mohammad Hasan Mohammad Abd El-Daiem

This investigation aims to study the possibility of using gamma irradiation for keeping the quality of some ready to eat meals during cold storage (4±1°C). Ready-to-eat meals (included cooked meat balls, mashed potato, baked deboned chicken breast meat with potato slices, baked fish and cooked rice) were prepared and subjected to gamma irradiation at doses of 1.5, 3 and 4.5 kGy followed by storage at 4±1°C, then the effects of irradiation and cold storage on the microbiological aspects, chemical properties and organoleptic properties were studied. The effects on the microbiological aspects of samples were studied through the determination of total bacterial count, total psychrophilic bacteria, total molds and yeasts, total enterobacteriaceae, Staphylococcus aureus, Streptococcus faecalis, Bacillus cereus, the detection of Salmonella and the presence of Vibrio spp (for baked fish). Furthermore, samples of meals were chemically analyzed for their chemical composition, the pH-value, in addition to the determination of the thiobarbituric acid (TBA), total volatile basic nitrogen (TVBN) for meat balls, baked chicken meat and baked fish and trimethylamine (TMA) for baked fish. In addition, attention was focused on the changes occurred in the organoleptic properties of samples by the evaluation of sensory scores for appearance and odor of samples post treatments and during storage as well as for the taste of samples post irradiation treatments only. The rejection of samples during storage was based on one or more of the signs included the visual observation of microbial growth onthe surface of samples, the deterioration of the odor, and if the total bacterial count exceeded 1x107 cfu/g.The results can be summarized as follows: 1-Microbiological aspects:1.1 Non irradiated samples of the prepared meals had an initial total bacterial count of 7.2x105, 4.6x106, 2.5x105, 3.2x106 and 6.5x105 cfu/g for cooked meat balls, mashed potatoes, baked chicken meat with potatoes slices, baked fish and cooked rice, respectively. Irradiation of the prepared meals at doses of 1.5, 3 and 4.5 kGy decreased the initial total bacterial count by 93.3, 99.7 and 99.98 %; 93.04, 99.39 and 99.96 %; 88.8, 96.7 and 99.51 %; 80, 99.44 and99.77 % and 97.08, 99.41 and 99.96 % in the prepared meals, respectively. During storage at 4±1°C, the total bacterial count gradually increased in all samples, but the rate of increase was higher in non-irradiated samples than in irradiated ones.2 Samples of the non-irradiated prepared meals had an initial count for total psychrophilic bacteria of 6.9x105, 5.8x105, 2.9x104, 4.7x103 and 1.5x104 cfu/g in the above mentioned meals, respectively. Irradiation of the prepared meals at doses of 1.5, 3 and 4.5 kGy reduced the count of total psychrophilic bacteria by 86.96, 99.92 and 99.99 %; 94.83, 97.93 and 99.87 %; 80.34, 98.07 and 99.86 % in cooked meat balls, mashed potatoes and baked chicken meat with potatoes, respectively. Irradiation at doses of 1.5, 3 and 4.5 kGy reduced the initial total psychrophilic bacteria by 84.47 and 98.94 % in baked fish and by 86and 94.47 % in cooked rice, respectively, whileirradiation of these meals at dose of 4.5 kGy decreased the counts to below the detection levels. During cold storage of the prepared meals, the total psychrophilic bacteria showed another gradual increase in all irradiated samples as well as non-irradiated ones but the rate of increase was lower in the irradiated samples than in the controls.1.3 The initial count for total yeasts and molds reached 2.6x104, 3.6x104, 1.8x104, 1.5x104 and 2.7x104 cfu/g in non-irradiated cooked meat balls, mashed potatoes, baked chicken meat with potatoes, baked fish and cooked rice, respectively. Irradiation of the prepared meals at doses of 1.5, 3 and 4.5 kGy decreased these initial counts by

89.23, 96.54 and 99.46 %; 84.44, 97.58 and 99.89 %; 88.33, 98.22 and 99.67 %; 84, 95.67 and 99.87 % and 95.18, 97.11 and 99.81 %, respectively. Cold storage of samples at 4±1°C induced gradual increase in the total yeasts and molds for non-irradiated and irradiated meals but at higher rate of increase for the control samples.1.4 Non-irradiated samples of the above mentioned prepared meals had an initial count for enterobacteriaceae reaching 8x102, 1.8103, 4.2x103, 6.4x103 and 4.3x103 cfu/g, respectively. Treatment of the prepared meals at dose of 1.5, kGy reduced their initial counts for enterobacteriaceae by 88.06, 90.56, 94.05, 98.91, and 98.37 %, respectively, however, the counts of enterobacteriaceae showed another gradual increase during cold storage of non-irradiated samples and those irradiated at 1.5 kGy but at low rate of increase in the irradiated samples. Regarding samples of the prepared meals that irradiated at doses of 3 and 4.5 kGy, no viable counts were observed for enterobacteriaceae neither post irradiation treatments nor during storage of samples.1.5 The initial count for Staphylococcus aureus in the prepared meals under investigation (with the same above mentioned sequence) reached 6.8x102, 8.6x102, 1.4x102, 6.3x102 and 4.7x102 cfu/g, respectively. Irradiation of these meals at dose of 1.5 kGy decreased their initial Staphylococcus aureus count by 92.65, 97.91, 89.29, 85.71 and 93.62 %, respectively, but the counts of Staphylococcus aureus gradually increased in non-irradiated samples and those irradiated at dose of 1.5 kGy during cold storage of the prepared meals and the rate of increase was higher in the controls. Meanwhile, Staphylococcus aureus was not detected in samples irradiated at doses of 3 and 4.5 kGy neither post irradiation treatments nor during cold storage of samples.1.6 Non-irradiated samples of cooked meat balls and mashed potatoes had an initial count of 6.7x102 and 3.7x104 cfu/g for Streptococcus faecalis, respectively. Irradiation of these meals at dose of 1.5 kGy reduced their initial count of Streptococcus faecalis by 88.06 and 97.57 %, respectively, while irradiation of these meals at dose of 3 kGy reduced their initial counts to below the detection level in the former meal and by 99.86 % in the other meal.However, further increase in the counts of Streptococcus faecalis were observed during storage of these meals. Regarding samples of non-irradiated baked deboned chicken meat with potatoes, baked fish and cooked rice, the initial Streptococcus faecalis count was 9x102, 8x102 and 3.5x104 cfu/g, respectively. Irradiation of these meals at dose of 1.5 kGy reduced their initial count for Streptococcus faecalis by 95.56, 93.75 and 95.14 %, respectively, but the count in control samples and those irradiated at 1.5 kGy showed another gradual increase during storage at 4±1°C. Meanwhile, Streptococcus faecalis was not detected in these meals after irradiation at doses of 3 and 4.5 kGy neither post treatments nor during storage. In all meals under investigation, the observed increase in the count of Streptococcus faecalis during storage was at higher rate in control samples than in the irradiated ones.1.7 The initial count of Bacillus cereus in non-irradiated samples of the prepared meals was 6.9x102, 6.7x103, 6x102, 7.5x102 and 1.4x103 cfu/g, respectively. Treatment of the prepared meals under investigation at dose of 1.5 kGy decreased their initial Bacillus cereus count by 89.86, 97.91, 89.29, 92 and 97.86 %, respectively, however the counts of Bacillus cereus were gradually increased during storage of non-irradiated samples and those irradiated at 1.5 kGy but at high rate of increase for the controls. Samples of meals that irradiated at doses of 3 and 4.5 kGy showed no viable counts for Bacillus cereusneither post irradiation treatments nor during storage of samples at 4±1°C.1.8 Salmonella was not detected in all irradiated and non-irradiated samples of the prepared meals.1.9 Samples of irradiated and non-irradiated baked fish showed no viable counts for Vibrio spp . 2- Chemical properties:2.1 The chemical analysis for samples of non-irradiated cooked meat balls, mashed potatoes, baked chicken meat with potatoes, baked fish and cooked rice showed that their moisture contents were 50.25, 73.86, 68.93, 70.34 and 60.43 %; respectively, while the percentages of total lipids, crude protein, ash contents and total carbohydrates (referred to dry matter) amounted to20.75, 65.62, 7.4 and 6.23 %; 30.58,<9.42,6.32 and 53.68 %;11.84, 80.53, 5.24 and 2.39 %;9.87,85.6, 4.41and 0.12% and 9.97, 4.57, 2.19and22.27 %,respectively.2.2 Gamma irradiation at the different applied doses had no remarkable effects on the chemical composition of all ready-to-eat meals under investigation.2.3 Gamma irradiation treatments had no real effects on the pH-value of all prepared meals under investigation. During cold storage at 4±1°C, the pH-value gradually decreased in non-irradiated samples of cooked meat balls and those irradiated at dose of 1.5 kGy, while the pH-value of cooked meat balls irradiated at doses of 3 and 4.5kGy showed no real changes. Meanwhile, cold storage of mashed potatoes, baked chicken meat with potatoes, baked fish and cooked rice gradually decreased their pH-value for non-irradiated and all irradiated samples,2.4 Irradiation treatments increased the thiobarbituric acid value (as optical density at 538 nm) for samples of cooked meat balls, baked chicken meat and baked fish, meanwhile cold storage (4±1°C) gradually increased the thiobarbituric acid for irradiated and non-irradiated samples.2.5 Gamma irradiation at the different applied doses caused no real changes in the total volatile basic nitrogen (TVBN) for cooked meat balls, baked chicken meat and baked fish, however, an increase in the contents of TVBN was observed for both irradiated and non-irradiated samples during cold storage at 4±1°C.2.6 The application of gamma irradiation at the different doses used did not affect the contents of trimethylamine (TMA) in baked fish samples, while cold storage at 4±1°C led to further gradual increase in TMA content for both irradiated and non-irradiated baked fish samples. 3. Organoleptic properties:3.1 The results of sensory evaluation showed that gamma irradiation at the different applied doses as well as cold storage had no detectable effects on the appearance of the prepared ready-to-eat meals. All irradiated samples showed a high sensory scores for their appearancesimilar to non-irradiated samples including samples that rejected due to any of signs of rejection.3.2 Subjecting samples of all prepared meals to gamma irradiation had no adverse effects on the odor of samples as irradiated and non-irradiated samples showed similar scores for odor acceptability. During cold storage at 4±1°C, the results of sensory evaluation for the odor were as follows:3.2.1 Non-irradiated cooked meat balls as well those irradiated at doses of 1.5 and 3 kGy showed a similar high scores for their odor including samples that had a total bacterial count higher than 1x107 cfu/g and rejected, while a lower scores for odor were began to be recorded on day 30 of storage for cooked meat balls irradiated at 4.5 kGy dose due to the detection of the odor of oxidation, but samples were still acceptable included those rejected on day 57 of storage due to increasing their total bacterial count to more than 1 x107 cfu/g.3.2.2 Non-irradiated samples of mashed potatoes as well as those irradiated at 1.5, 3 and 4.5 kGy showed a similar high scores for their odor until the rejection of samples due to the detection of the sour off-odor on day 6, 9, 12 and 15 of cold storage, respectively.3.2.3 Samples of non-irradiated baked chicken meat with potatoes as well as those irradiated at doses of 1.5, 3 and 4.5 kGy had a similar high scores for their odor until the detection of the sour off-odor and therejection of these samples on day 12, 18, 21 and 36 of cold storage, respectively.3.2.4 Samples of non-irradiated baked fish showed a high scores for odor including those rejected on day 6 of storage due to their high total bacterial count (>1x107 cfu/g), while samples irradiated at doses of 1.5, 3 and 4.5 kGy showed a similar high scores, compared to the control samples, till the rejection of samples due to the detection of the sour off-odor on day 15, 21 and 30 of cold storage, respectively.3.2.5 Samples of non-irradiated cooked rice as well as those irradiated at doses of 1.5, 3 and 4.5 kGy showed a similar high scores of acceptability for odor till the detection of the sour off-odor and rejection of samples on day 9, 12, 15, and 18 of cold storage, respectively.3.3. Irradiation of the prepared meals at the different applied doses had no adverse effects on the taste of samples as all irradiated meals showed a high scores for their taste compared to the non-irradiated samples.4. As a conclusion, treatment of the prepared meals at doses of 1.5, 3 and 4.5 kGy could extend the refrigerated shelf-life for those meals as the shelf-life was extended for cooked meat balls, mashed potatoes, baked chicken meat with potatoes, baked fish and cooked rice from 6, 3, 9, 3 and 6 days in control samples to 15, 6, 15, 12 and 9 days; 30, 9, 18, 18 and 12 days and 54, 12, 33, 27 and 15 days in irradiated samples, respectively, with improving the microbial safety of samples (regardless of the reason for the rejection of samples).