Reduction of microbial contamination of spices by irradiation

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The microbial contamination of spices, spice-mixtures and starch-containing ingredients is in general considerable /10^5-10^8 g^{-1}/, and this causes many problems in several branches of the food industry. The heat resistant bacterial and mould spores are responsible for the considerable part of microbial contamination. These facts account for the world-wide endeavour to sterilize the ingredients.

Recently, two ways are most frequently used to solve the problem: preparation and use of spice-extracts and cell count reduction by fumigation with ethylene oxide or propylene oxide. The disadvantage of the spice extract is its homogeneous distribution in the product thereby resulting in a different flavour effect, than in the case of spices. Due to the homogeneous distribution of ground spices, so-called "hot spots" are formed and as a consequence, the hedonic value of the product will considerably be increased /1/.

The use of ethylene oxide or propylene oxide gives rise to several problems, too. Decontamination of such kind is a time-consuming process and not so effective towards bacterial spores as required. Non-desirable changes in the flavour and colour of some spices may occur /pimento, mustard, etc./. Ethylene oxide and its compounds formed with some food components, inorganic chlorides, resp.,involve problems with chemical residues. Ethylene oxide and epichlorhydrin result in mutagenic effect, while propylene oxide has cancerogenic effect.

The use of ionizing radiation in reduction of microbial contamination of the different appears to be a very promising method. As irradiation is a physical procedure, problems with chemical residues are excluded. In the course of experiments it was found that the microbe count of spices has been reduced in the function of the radiation dose. Depending on the initial cell count, the use of 8-20 kGy is needed to achieve the commercial sterility /viable cell count less than 10 per gram/. Considering the energy and penetrating power of ionizing radiation, gamma radiation /e.g. ^{60}Co radioactive isotope/ appears to be the most suitable tool to treat spices in bigger packaging units.

The use of ionizing radiation to reduce the microbe count in paprika was first reported by Hungarian authors /2/ in 1961. Early research included determination of the effective dose and possible changes in pigment content. In the past 20 years, investigations were extended to eight spices and some spice-mixtures and other ingredients. The tests had been manifold and report on the results have been published in more than 50 works.

MATERIALS AND METHODS

Ground paprika, black pepper, spice mixture and onion powder were used in the experiments. To exclude re-contamination, the test materials were sealed in polyethylene foils. Samples were treated with different doses in the dose range from 5 to 10 kGy. Irradiation was carried out in an RH-gamma-30 /^{60}Co/ laboratory source. When the cell count reducing effect of ethylene oxide was compared with that of irradiation, the treatment with ethylene oxide was carried out in a plant equipment. /12.5 m³ capacity at an ethylene oxide concentration of 600 $g.m^{-3}$, the treatment lasted for 6^h at 25°C/. Irradiation was carried out in a ^{60}Co panoramic radiation source of 2.1 PBq activity.

The mesophilic aerobic cell count, mesophilic and thermophilic aerob spore count, Enterobacteriaceae- and mould counts were determined by the most probable number /MNP/ method in three parallels and 3 repetitions.

RESULTS

Results of experiments carried out with ground paprika and black pepper are summarized in Figs.1 and 2. From the reduction of the different groups of microbes is can be seen that ionising radiation results in a satisfactory reduction of microbe count by the use of doses from 3 to 10 kGy. There is no correlation between the mould count and the total cell count.

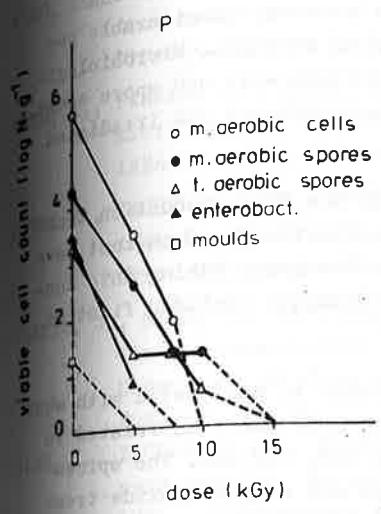

Fig.1. Viable cell count of ground paprika as a function of irradiation dose

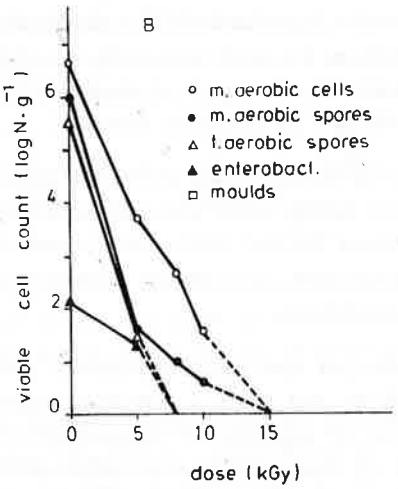

Fig.2. Viable cell count of black pepper as a function of irradiation dose

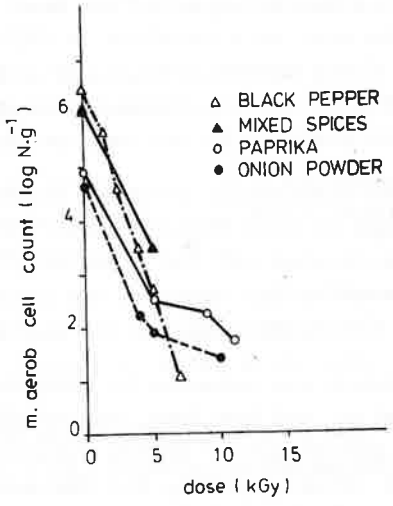

Fig.3. Mesophylic aerobe cell count of spices as a function of irradiation dose

The development of mesophilic aerobic microbe count of different spices in the function of the radiation dose are to be seen in Fig.3. Irradiation with 5 kGy ensures the appropriate reduction of cell count by 2-3 orders of magnitude. The effect of ethylene oxide treatment and irradiation on ground paprika can be seen in Fig.4.

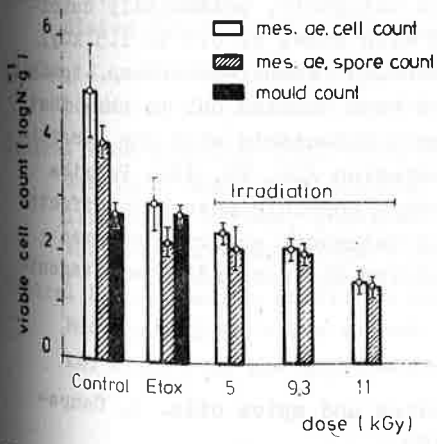

Fig.4. Microbiological quality of ground paprika as a function of ethylene oxide treatment /Etox/ and of radiation dose.

The investigations showd that radiation treatment of paprika and onion powder /in a packing excluding re -contamination/ with a 5 kGy dose was as efficient as ethylene oxide treatment /3,4/ resulting in a microbe count reduction of 2 to 3 orders of magnitude both, but more efficient in the case of moulds. Higher doses are more effective, however, such a microbiological purity is seldom required is practice. In addition to the microbiological effect, these doses at the same time solve the disinfestation.

On the basis of the microbiological tests and experiences in practical application of irradiated spices and ingredients, the decontaminating effect of radiation doses of 5 kGy can be considered satisfactory.

Microbiological research proved that irradiation not only reduces the microbe count but also increases the sensitivity of spores to sodium chloride and heat /6, 7, 8/. Thus in the application of spices and ingredients, even heat treatments at lower temperatures increase the safety of storage. It was found that stable products /storage time: 2 years/ were obtained in the production of canned minced meat with the use of spices

and mixed ingredients irradiated with a 5 kGy dose even in case of F_0=3-3.4. In this way savings in time and energy can be achieved /9/. Similar results were obtained also for canned pork liver cream /10/. The microbe count reduction in spices is especially important in case of meat products /sausage, hamburger etc./. High microbial contamination of mixed ingredients may unfavourably effect the storability of raw meat products at refrigerator temperatures: it is, therefore, reasonable to use irradiated spices also for such products /11/. Considering that the thermostability of spores reduces after irradiation and that spores can be expected the heat treatment used in the production process, considerable results have been obtained in fullscale experiments for the different sausages. Microbiological tests showed a threefold reduction in both mesophilic aerob viable cell and spore count. No difference was found in the taste of sausages produced with unirradiated and irradiated spice-mixtures by the test panel in the triangular tests.

It is a generally accepted custom to subject any new food and any new food production technology to food hygiene tests before being sold and introduced, respectively. Such test have been carried out for irradiated foods in the different countries for long. Taking into consideration the national and international interests, research in Hungary included first of all irradiated paprika and spice-mixtures.

Research was extended to both technical and methodological problems. It was tested with what results, and how long, can animals be fed with a modified food 33 % of which as related to the percentage of solids consisting of paprika or spice-mixtures /12, 13/ etc. The spices were irradiated but, for the sake of comparison,also unirradiated and ethylene oxide treated or heat-treated spices were used. In the tests, radiation doses in the range of 5 to 45 kGy were used. In the experiments, the rate of growth, body and organ weight, food consumption, hematology data, results of clinical hemato-chemical tests, enzyme activity in blood sera, results of urine, lives, liver function tests etc.were studied. The majority of test results relate to samples treated with radiation doses of 5 and 15 kGy. Multigeneration animal tests brought very good results. There was no significant difference between the results obtained for animals fed with irradiated or unirradiated samples. Irradiated samples caused neither harmful nor pathologic alteration in the animal organism. Carcinogenesis or teratogenesis were not observed. To detect mutagenic, potentially carcinogen materials in spices, paprika, dried onions irradiated with doses of 0.5 to 1.5 kGy, Host-mediated assay, Ames-test, prophage induction and Salmonella /mammal-microsome tests with urine and blood of rats fed with irradiated spices have been carried out to show that no materials of harmful effects to DNA are produced in amounts detectable with the sensitivity of the test methods used in spices as a result of irradiation /14, 15, 16/. Paprika was irradiated with doses in the range of 0 to 60 kGy to detect possible mutagenic effects by means of the Drosophila mosaic-test. It was found that no mutagenic activity occured after irradiation with 5 kGy doses. Wing and germ-line mosaicism did not indicate mutagenicity even in case of higher doses /45 to 60 kGy/ /17/.

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