Radiosensitivity of some microorganisms on meat

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The demand for ready-to-serve foods is steadily increasing in public and family catering alike. Minced meat is one of the popular products. The production and storage of this food involves considerable problems both for manufacturers and for consumers. The quality of the raw-material, its production technological and production hygienic conditions greatly influence the microbiological quality of the product. Unsatisfactory microbiological quality leads to a short storage time and presents hygienic risks for the consumer. Possible marketing time at 4-6°C is not longer than one or two days in most countries.

Although the microbiological quality of the raw material can be improved by chemical treatment /8.,10./, the result is not satisfactory. The effect of ionizing radiation /cell killing and growth inhibition/ on the microbes is well known /5./. As a physical procedure, no problem arises from chemical residues. From the point of view of energy consumption, the technology is very economical /2./.

Irradiation as a food preservation method has already been accepted in many countries. The wholesomeness tests with irradiated food have brought favourable results /13./.

The purpose of our investigations was to determine the extent to which an irradiation dose of 2 kGy, effective from the point view of shelf-life decreases the number of microorganisms that are to be found on meat and are objectionable from food hygienic considerations. We wanted to establish the radioresistance of these microorganisms in the product.

MATERIALS AND METHODS

The strains applied in our tests were selected from the collection according to frequency of occurence, pathogenity, food spoiling effect, virulence, viability, resp.: *E.coli* 9596, *Salmonella panama*, *Salmonella derby*, *Streptococcus faecalis* 8087, *Staphylococcus aureus* 62, *Clostridium sporogenes* 3679 PA. We propagated the bacteria in nutrient broth, then produced a suspension of 10^7-10^8 ml^{-1} cell density in buffered /pH = 7.0/ pepton solution. The radiosensitivity, i.e. the D_{10} value of the microorganisms we established from the survival curve.

The radioresistance of the bacteria was tested in minced meat products made of pork, spices /1 %/, treated with 5 kGy /to decrease the cell count/ and other non-treated materials were mixed in the samples. To the natural microflora of the meat we added a suspension of the mixture of other bacteria with the exception of *C.sporogenes*. The samples infected with *C.sporogenes*, no other microbes were added. The meat balls that weighed approx. 40 g each were packed in polythene foil by pairs, irradiated and then stored at 0°C. We defined the number of mesophilic aerobic and psychrotolerant microbes, *E.coli*, *S.aureus*, *Str.faecalis*, *C.sporogenes* and *Salmonella* as a function of irradiation dose and storage time. The storage temperature was 4°C.

The bacterial suspensions and the samples were placed in an RH-gamma-30 laboratory radiation source /^{60}Co, nominal activity 5.6 TBq, dose rate 5 kGy.h^{-1}/. The microbial suspensions were irradiated in the dose range of 0.25-16 kGy, the minced meat product with 1 and 2 kGy. Troughout irradiation the temperature was kept at 24-25°C.

The viable cell count was defined in the appropriate culture media by the MPN method. From positive test-tubes we made control tests in order to identify the microbes. To determine the microbial count, we took two samples and had three parallel inoculations. The series of experiments were repeated three times. The diagrams show the average microbial count and the standard deviation.

In the storage experiment, we determined the pH and also the redoxpotential values of the product.

RESULTS

The radiosensitivity of microorganisms is characterised by the D_{10} value. We determined the survival of bacterium strains as a function of radiation dose. In the test suspension, the microbial count was rather high /10^7-10^8 ml^{-1}/, while in practice there is no such high loading of these bacteria. The D_{10} value was computed from the survival curve /Table 1./.

Given the D_{10} value, we could estimate the radiation dose needed to reduce the microbial load from a definite value to a predetermined low count. The D_{10} values were in conformity with other authors' relevant data /1.,3.,5.,6.,7.,8.,9./. It could be stated that, with the exception of C.sporogenes, 2 kGy caused a decrease by six orders of magnitude in Str.faecalis, and a still greater fall in the other microbes of the culture liquid.

In minced meat products, artificially infected with microbes, the 2 kGy treatment resulted in a decrease in the mesophilic microbial count of approx. three orders of magnitude, and reached the original spoilage level only after 12 days. Untreated samples surpassed that value already after 3-5 days. The psychrotolerant microbes were more sensitive to irradiation, but storage temperature helped their growth. However, the cell count decreasing effect of irradiation was definite.

E.coli was also very sensitive in the meat product /a decrease of three orders of magnitude occured/, no growth was experienced during the 12 days of storage.

The two Salmonella strains were equally sensitive, the decrease here was of four orders of magnitude, and their number did not change in the test period /Figure 1./.

The number of S.aureus decreased by four orders of magnitude, no living microbe could be found after eight days following the 2 kGy treatment. In this case the after-effect of irradiation was strikingly good. The Str.faecalis was relatively more resistant to irradiation /a decrease by 1-1.5 orders of magnitude occured /Figure 2./.

C.sporogenes was very resistant. The viable count of two last microorganisms did not change during storage subsequent to irradiation /Figure 3./.

Table 1.

MICROORGANISM	D_{10} (kGy)
E. coli 9596	0.11
S. derby	0.13
Staph. aureus 62	0.14
S. panama	0.32
Str. faecalis 8087	0.33
C. sporogenes 3679PA	2.90

Kovács-Kovács-Domján-Kiss (1.)

Table 1.

D_{10} value of microorganisms in nutrient medium.

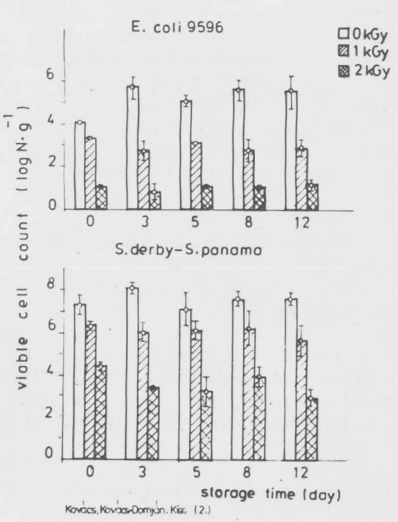

Figure 1.

Viable cell count of the minced meat product infected with E.coli 9596, Salmonella derby and Salmonella panama resp. as a function of irradiation dose and storage time at 4°C.

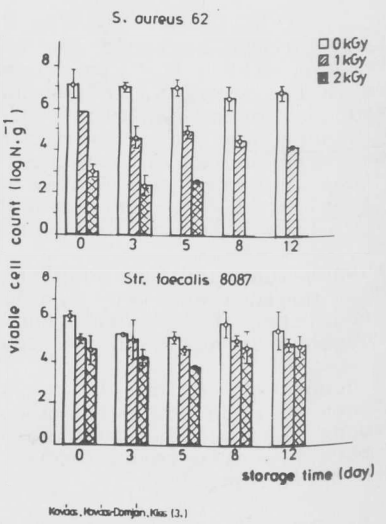

Figure 2.

Viable cell count of the minced meat product infected with Staphylococcus aureus 62, Streptococcus faecalis 8087 resp. as a function of irradiation dose and storage time at 4°C.

he redox potential of the irradiated samples
howed a slight decrease in the test period/12
ays/, but was still much smaller /ΔR_H = 10-30/
han that of the untreated sample /ΔR_H = 50-70/.
he pH values decreased to the same proportion.
ue to the presence of oxymioglobin, the colour
f the treated samples remained for a relatively
ong time lighter than that of the untreated
nes i.e. it was more resistant to oxidation.

ummarizing the results, it can be stated that,
rom the point of view of storability, the
ptimum dose of 2 kGy eliminates the pathogenic
embers of the Enterobacteriaceae family and
e toxin-producing S.aureus. But in spite of
elative resistance of S.panama 2 kGy are suffi-
ent. In practice, the radioresistant populati-
ns do not develope /4.,5./. In order to detect
lls damaged by irradiation, the applied method
s to be modified /9./. The great resistance
f Str.faecalis makes it necessary to strictly
ontrol the hygiene of the processes. A stagna-
ion in cell count during storage indicates
hat the growth is strongly inhibited by irra-
iation. Investigations revealed that the
icrobiological quality of the meat /e.g. high
ontamination and, thus the qualitative composi-
ion of the microflora also influence the
ffectiveness of the treatment.

rradiation increases storage life, but it cannot
eplace strict hygienic prescriptions. Irradia-
ion decreases the number of microbes, improves
icrobiological quality and lengthens storage
ife of minced meat products, but "good manu-
acture practice" is still an absolute require-
ent.

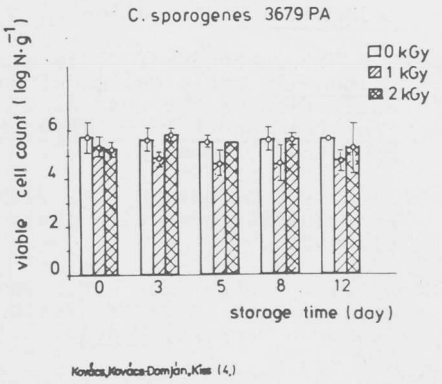

Figure 3.

Viable cell count of the minced meat product infected with C.sporogenes 3679 PA resp. as a function of irradiation dose and storage time at 4°C.

t the session of the Joint WHO/FAO/IAEA Committe on the Wholesomeness of Irradiated ood, held at Geneve in October 1980 experts proposed that foods should be allowed a reatment by an average dose of 10 kGy. That treatment is five times higher than the one suggested by us, therefore no health objections can be raised against the practical pplication of the process.

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