SPICED Symposium Spices and Herbs
A Risk-Free Taste Experience?
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Decontamination of Spice Paprika

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Microbial investigations

Spice paprika

There are no microbiological standards for dried spices and herbs in EC legislation.

The European Spice Association (ESA) specifies that Salmonella should be absent in 25 g of spice, *Escherichia coli* to be present at less than 10^2 cfu/g, and other bacteria requirements to be agreed between buyer and seller.

Hungarian legislation requires the determination of counts of mesophilic aerobic total microbes, yeasts, moulds, Salmonella, coliforms and *Escherichia coli* from spice paprika.

Microbes determined in our study: **mesophilic aerobic total count, yeast, mould, Salmonella, *Enterobacteriaceae*, *Escherichia coli***, and **coliforms.**

Decontamination methods

- **Gas treatment**	fumigation with ethylene oxide, in specially designed vacuum chambers, 1-4 orders of magnitude reduction, toxicological considerations
- **UV irradiation**	limited effect continuous agitation
- **Ionising radiation**	gamma rays (^{60}CO or ^{137}Cs) (X-rays, acccelerated electrons), no temperature rise, through packaging, 3-10 kGy 1-4 orders of magnitude reduction
- **Microwave treatment**	needs water, uneven
- **Steam treatment**	effective in microbial reduction, colour loss
- **Cooking extrusion**	UK patent, 4 orders of magnitude reduction
- **Radio-frequency treatment**	in experimental state

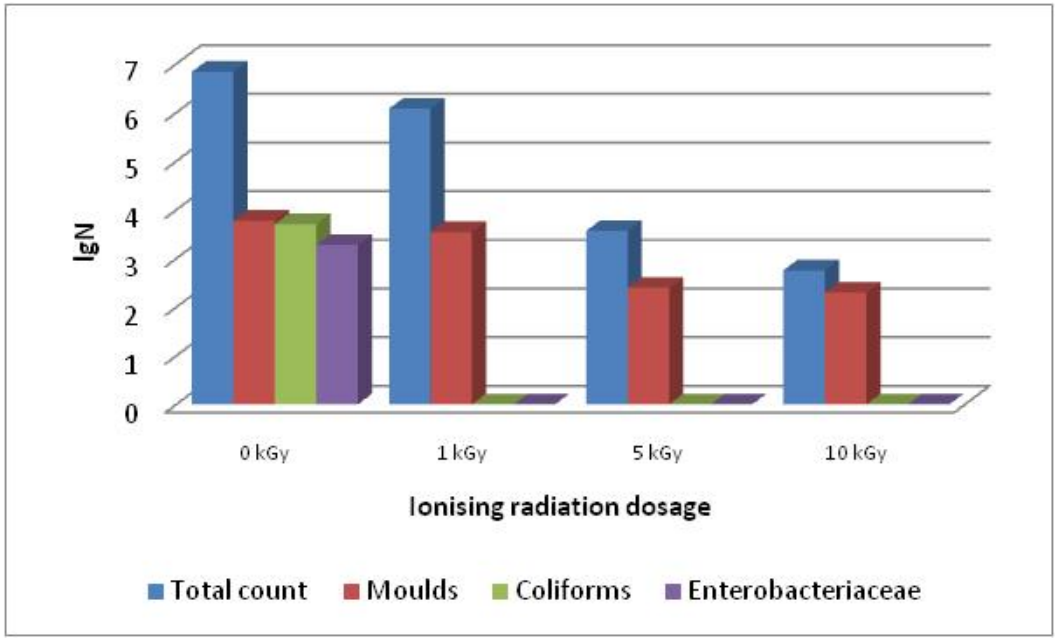
Irradiation of spice paprika powder

Ionizing radiation of spices is authorized in the EU for microbial decontamination of spices up to the dose of 10 kGy.

According to the literature, irradiation with 5 kGy ensures the appropriate reduction of cell count by 2-3 orders of magnitude.

Spice paprika powder was received from BFR. *Escherichia coli*, Salmonella, and yeasts could not be detected in the sample.

The untreated spice paprika powder was irradiated with ionising radiation (^{60}Co) with 1, 5, and 10 kGy in the Institute of Isotopes Co., Ltd, Budapest, Hungary.

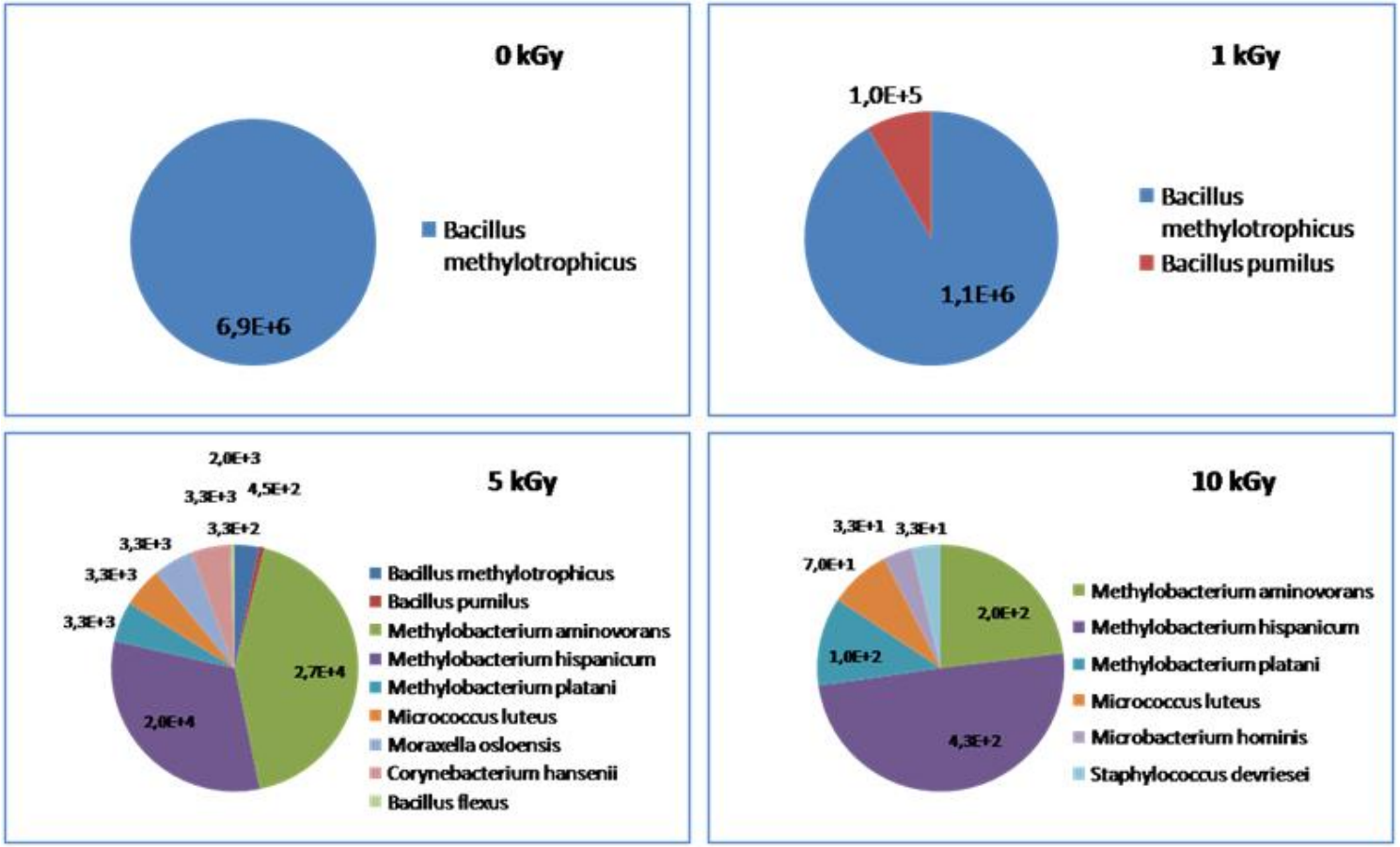


At 1 kGy dosage coliforms and *Enterobacteriaceae* have disappeared from the sample.

At 5 kGy, total count has been reduced by 4 orders of magnitude, mould count has been reduced by more than one order of magnitude.

Effect of irradiation on the dominant microflora of spice paprika powder

Following irradiation treatment the initially dominant microflora of Bacilli of the spice paprika (*B. methylotrophicus, B. pumilus*) **gradually disappears**, and **species less sensitive to irradiation** (*Methylobacterium* spp., *Micrococcus* spp. and *Microbacterium* spp.) **come into view**. This way we have also isolated **bacteria of human origin** from the spice paprika powder examined (*Staphylococcus* spp., *Corynebacterium hansenii*).



Radiation resistance of *Methylobacterium/Staphylococcus*

„Seventeen isolates from soil samples exposed to 5 to 9 kGy fell into 11 taxonomic groups, five of which contain known ionizing-radiation-resistant species; these isolates included eight isolates belonging to the genera *Deinococcus, Hymenobacter, Kineococcus, Kocuria,* and *Methylobacterium*. „

F.A. Rainey, K. Ray, M. Ferreira, B.Z. Gatz, M.F. Nobre, D. Bagaley, B.A. Rash, M. Park, A.M. Earl, N.C. Shank, A.M. Small, M.C. Henk, J.R. Battista, P. Kämpfer and M.S. da Costa (2005): Extensive Diversity of Ionizing-Radiation-Resistant Bacteria Recovered from Sonoran Desert Soil and Description of Nine New Species of the Genus *Deinococcus* Obtained from a Single Soil Sample. *Appl Environ Microbiol*., 71(9): 5225–5235.

Table 1
Prevalence of micro-organisms in the test sample[a]

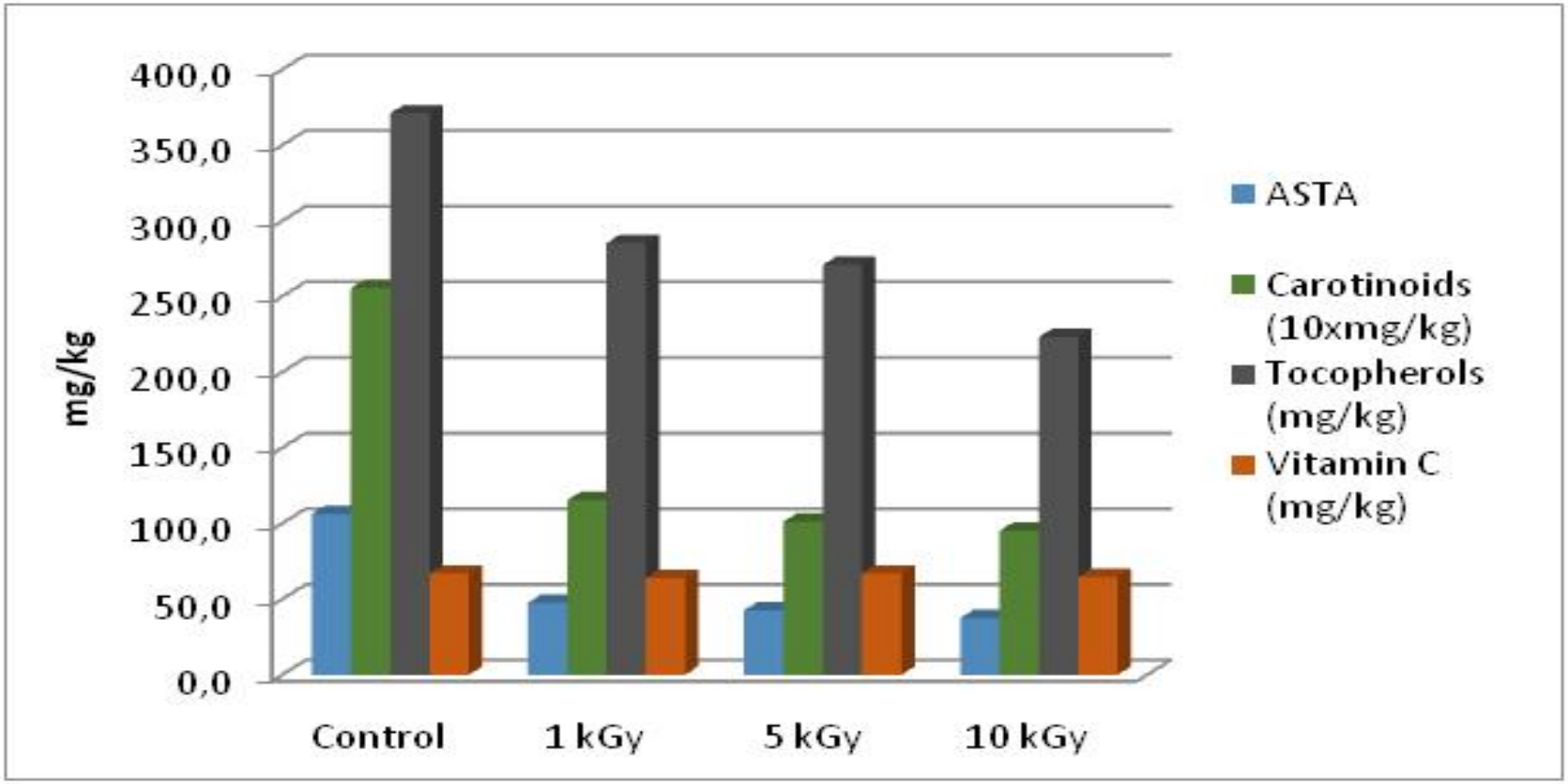
Contaminant	Radiation dose (kGy)				
	0.0	2.5	5.0	7.0	10.0
Aspergillus flavus	+ + +	+ + −	+ − −	− − −	− − −
Aspergillus niger	+ + +	+ + −	+ − −	− − −	− − −
Penicillium spp	+ + +	+ + −	+ − −	− − −	− − −
Fusarium spp	+ + +	+ + +	+ + −	− − −	− − −
Bacillus cereus	+ + +	+ + +	+ + −	+ + −	− − −
Bacillus subtilis	+ + +	+ + +	+ + −	+ − −	− − −
Micrococcus spp	+ − −	− − −	− − −	− − −	− − −
Staphylococcus spp.	+ + −	+ + −	+ − −	+ − −	− − −
Clostridium spp.	+ + +	+ + +	+ + +	+ + −	+ − −

[a]Each + or − symbolizes, respectively, presence or absence of the micro-organism in one of triplicate plates.

P.C. Onyenekwe, G.H. Ogbadu, Seiji Hashimoto (1997): The effect of gamma radiation on the microflora and essential oil of Ashanti pepper (*Piper guineense*) berries. *Postharvest Biology and Technology,* 10, 161-167.

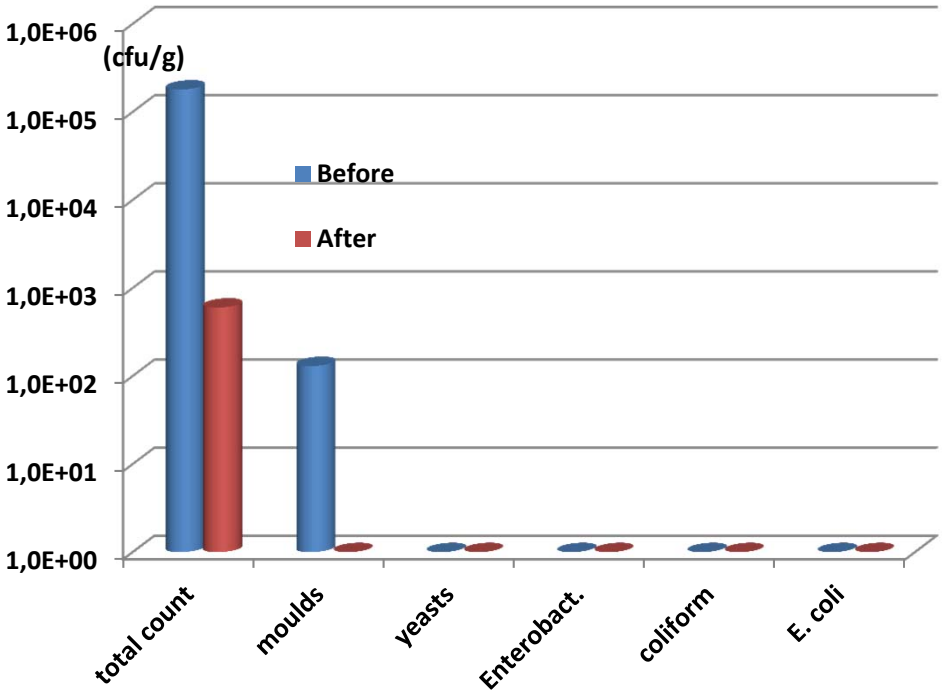
Effect of irradiation on the bioactive components and colour of spice paprika powder

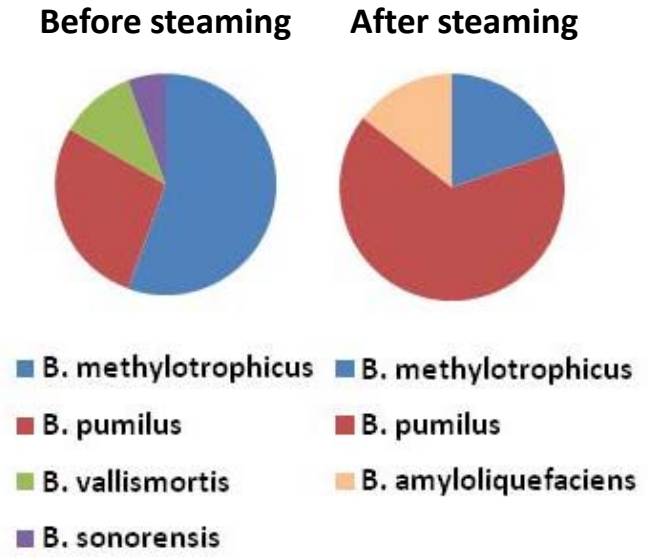
The concentration of the bioactive components as carotinoids, tocopherols, vitamin C, and the ASTA were analysed. The total carotinoid content and ASTA related to it decreased from 2555.6 mg/kg to 1154.7, 1012.6, and 952.5 mg/kg and from 106.3 to 47.6, 42.7, and 37.6, respectively. The total tocopherol content decreased to 76.9%, 73.0%, 60.2%



Effect of steaming on the microbial contamination of spice paprika powder

Steam treatment (saturated dry steam, 108-125 °C for 20-120 sec) reduced mesophilic aerobic total bacterial count from 1.8×10^5 cfu/g to 6.0×10^2 cfu/g, and moulds from 1.3×10^2 cfu/g to under the detection limit. Yeasts, coliforms, *Escherichia coli*, and *Enterobacteriaceae* could not be detected in the samples.

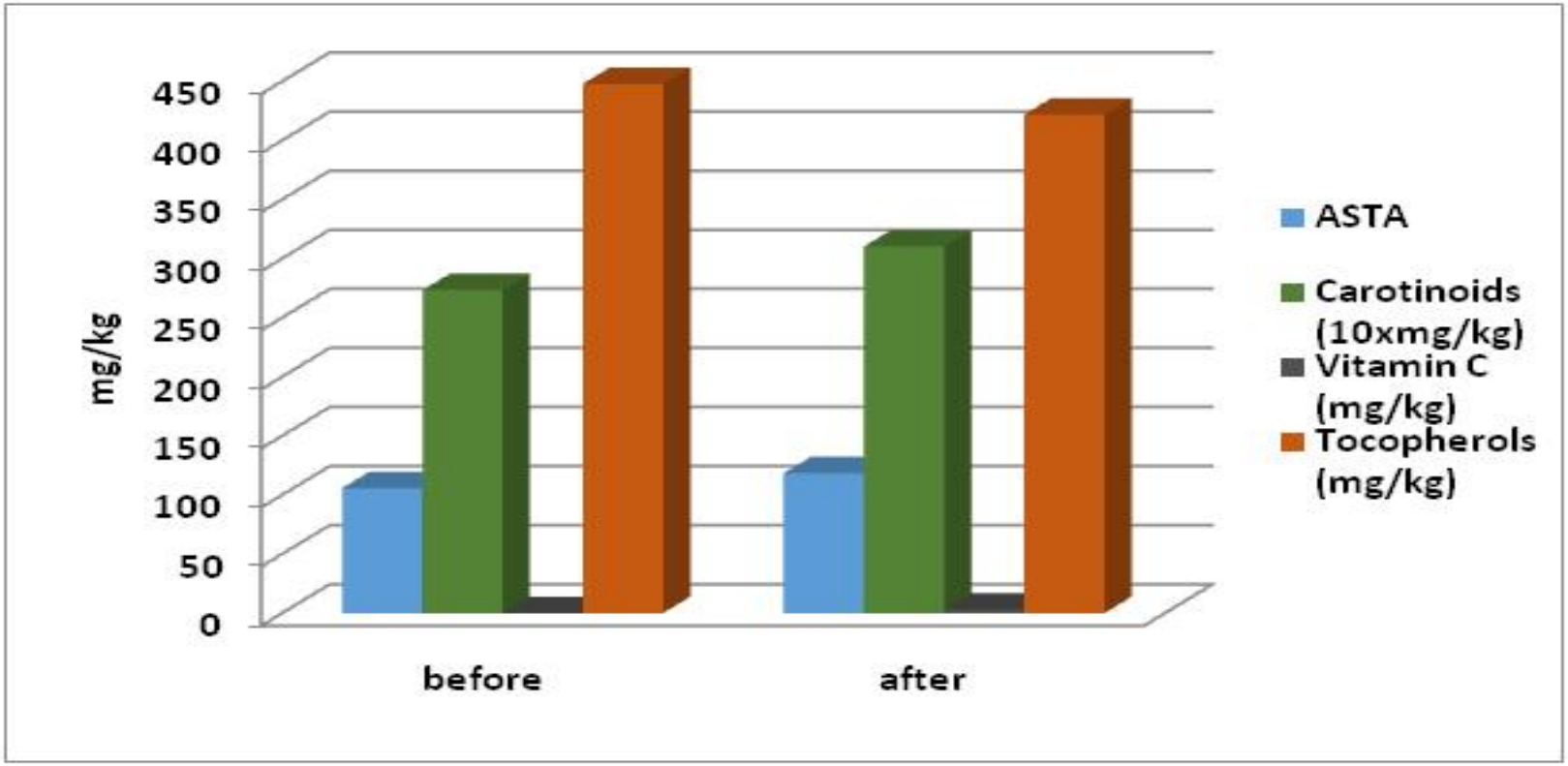




B. methylotrophicus, B. pumilus, B. vallismortis, B. sonorensis, and *B. amyloliquefaciens* represented 99% of the dominant bacteria, regardless of treatment.

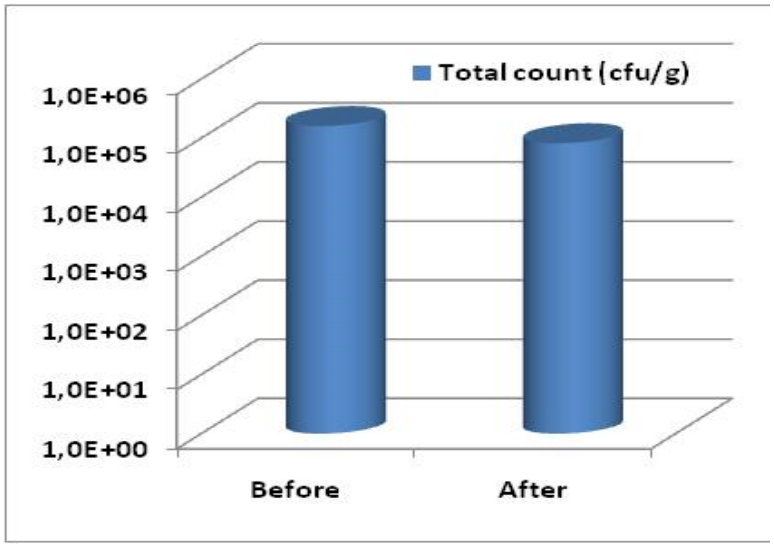
Effect of steaming on the bioactive components and colour of spice paprika powder

During steaming the concentration of total carotinoids, tocopherols, vitamin C, and ASTA changed slightly, no significant alteration could be detected. The colour of the sample changed (ΔE) by 3.85, while the total carotinoid content and ASTA changed from 2733 mg/kg to 3102 mg/kg and from 106 to 118, respectively. The total tocopherol content decreased by 6%. These results confirm that steaming provides good possibility to decrease the microbial contamination without damaging bioactive compounds or quality parameters



Alternative decontamination methods microwave heating

Microwave heating

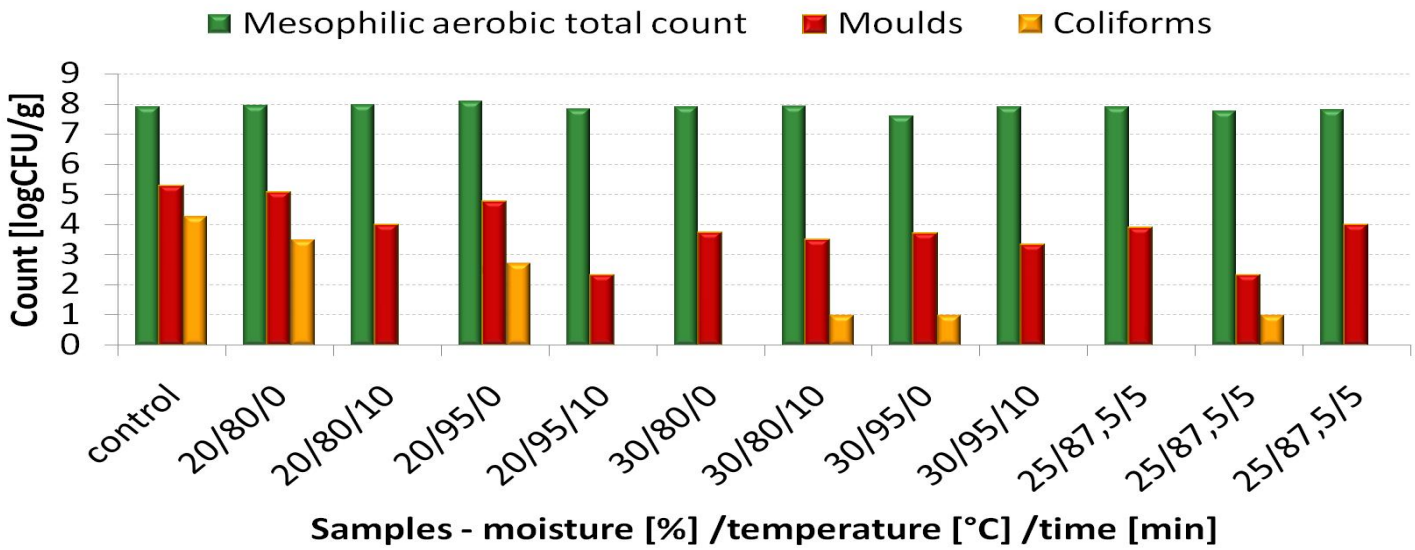


Microwave heating was performed by Daewoo Kor-630A laboratory equipment (800 W, treatment moisture content: 20.3%, treatment temperature: up to 95 °C, total treatment time: 100 s (30 g sample, 1.5 mm layer thickness) with 20 s heating periods). No relevant reduction of the mesophilic aerobic total bacterial count could be observed following the treatment. The colour of the paprika powder got darker and had a brownish character.

Sample	L*	a*	b*	ΔE
Control	34.74 ±0.24	34.96 ±0.12	35.24 ±0.04	
Treated	31.76 ±0.03	33.51 ±0.01	30.53 ±0.40	**5.76**

Microwave heating with continuous stirring

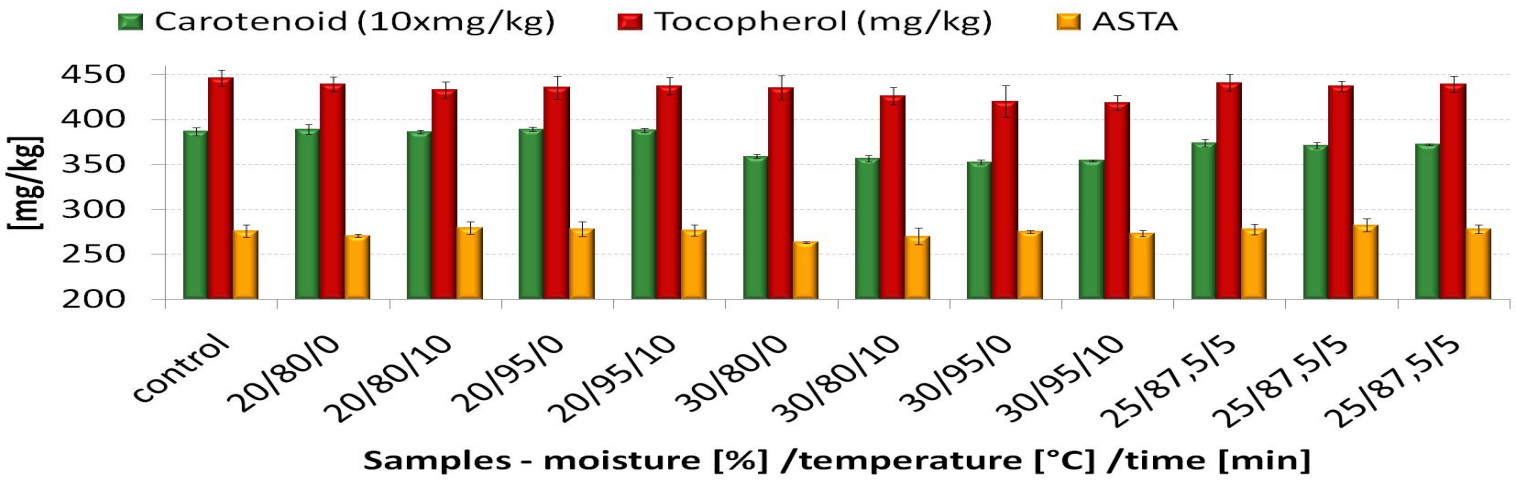
The continuous stirring of the samples ensures homogenous treatment temperature, thus avoiding darkening and burning. For this process, 3 parameters were set: initial moisture content, (20%, 25%, 30%), treatment temperature (80 °C, 87,5°C, 95 °C), and temperature keeping time (0 min, 5min, 10 min). Microbiological properties (mesophilic aerobic total count, mould, yeast, *Escherichia coli*, coliforms), colour (CIELab), and via HPLC total carotenoid and tocopherol compounds were measured from the samples. After the treatments, the samples were post-dried to the initial value in terms of comparability.



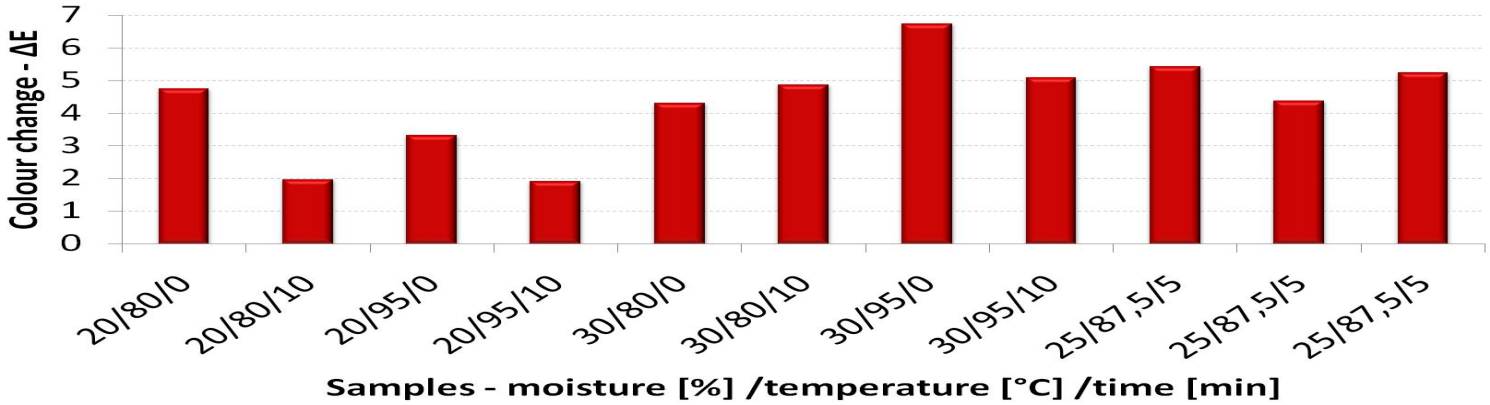
The mesophilic aerobic total count was not affected by microwave treatment. Mould counts and number of coliforms were significantly reduced by the treatment.

Alternative decontamination methods – microwave heating with agitation

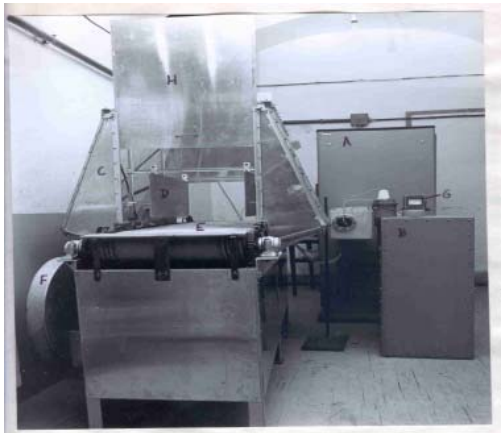
Microwave treatment at higher initial moisture content reduced the microbial contamination, but also reduced carotenoid and tocopherol contents, and ASTA values.



Colour change was barely visible, especially at lower initial moisture content.

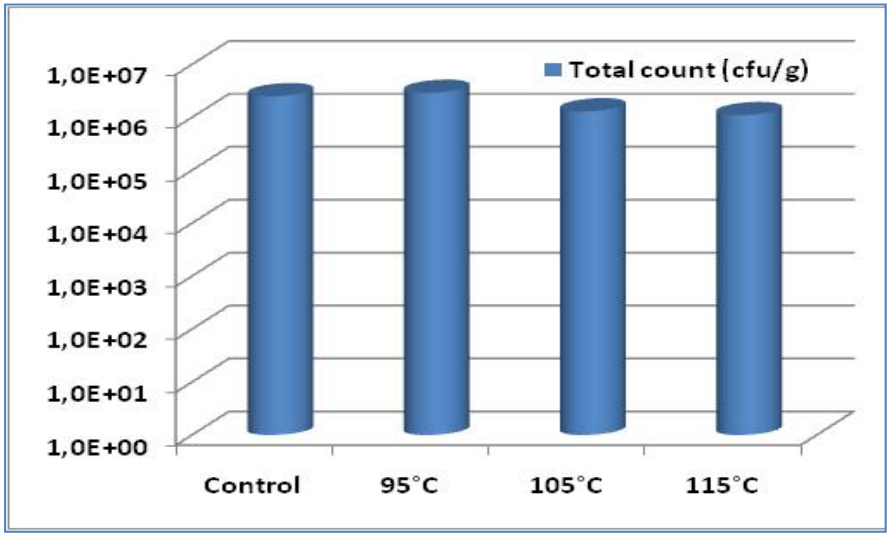


Alternative decontamination methods – radiofrequency treatment



Radio frequency treatment was done by Laboratory equipment with 10 kW Brown Boveri generator, 13.5 MHz (treatment moisture content: 20.3%, treatment temperature: up to 95,105, 115°C, total treatment time: 50-90 s (100 g sample in 105x35x70 mm wooden box) with 30 sec heating and cooling periods). The microbial load of the samples showed no reduction even for the most severe treatment. The colour of all treated samples were significantly darker than the control, they had a burnt character.

Radiofrequency teatment



Sample	L*	a*	b*	ΔE
Control	36.68 ±0.00	37.11 ±0.00	38.58 ±0.00	
Treated 95 °C	31.80 ±0.02	32.32 ±0.14	30.56 ±0.58	**10.54**
Treated 105 °C	33.85 ±0.01	26.33 ±0.03	21.72 ±0.07	**20.21**
Treated 115 °C	28.09 ±0.04	26.14 ±0.06	24.71 ±0.03	**19.66**

Thank You for Your Attention!