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EFFECT OF IRRADIATION DOSE ON SENSORY CHARACTERISTICS AND MICROBIOLOGICAL CONTAMINATION OF CHOSEN SEASONINGS

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Key words: seasonings, irradiation, sensory characteristics volatile flavour compounds, microbiological contamination.

The effects of gamma irradiation (3, 5, 7, 10 kGy) on sensory characteristics, volatiles constituents and microbiological contamination of several seasonings were studied. The dose of 3 KGy reduced microflora effectively, and did not cause evident changes in aroma. Complete sterilization, however, required 7 or 10 kGy, particularly in the case of paprika. Such doses substantially changed the smell and taste of seasonings. Is some of them (paprika, mustard, coriander), the total volatiles content increased after radiation.

Seasonings are commonly used in food production becoming an indispensable component of our foodstuffs mainly due to their aroma and also other factors, such as medical or preserving action. The specific components of seasonings are essential oils and substances of pungent or spicy taste such as alkaloids, tanning agents and glycosides.

There is a considerably high demand for seasonings in Polish meat industry which so far has been, using mostly imported seasonings such as black pepper, pimento, nutmeg, and cardamon. Local herbal seasonings, however, can be a good substitute for them, but all are significantly contaminated microbiologically and this can enhance spoilage of the products to which they afre added. Traditional sterilization methods (high temperature) bring about losses of volatile components of the aroma. Chemical methods using ethylene or propylene oxide can cause formation of toxic compouns such as isomers of chlorohydrin, chloropropanol and others [8, 11]. Moreover, total removal

of ethylene oxide from the treated product is very difficult [8]. Other methods used, e.g. UV radiation, do not ensure a sufficient degree of sterilization [7]. Irradiation of seasonings is currently becoming more and more popular in the worl [1, 9, 14, 15]. It was shown that irradiation produces the best sterilization effect [8, 14].

The aim of this research was to select the dose of gamma radiation for sterilizing herbal seasonings. Which would ensure the appropriate microbiological purity of the seasonings, leaving the aroma basically unchanged.

EXPERIMENTAL

MATERIAL AND METHODS

The studied material were the following herbal seasonings of the 1986 crop purchased from the Herbapol and Inopol companies in Poznań: coliander, white mustard, pungent paprika, sweet paprika, marjoram, garlic and caraway. Seasonings after irradiation were stored for up to 6 months at room temperature.

IRRADIATION OF SEASONINGS

The seasonings packed in polyethylene bags were irradiated in the Departament of Nuclear Engineering of the Poznań University of Agriculture. The source of irradiation apparatus RCHM-gamma-20 containing Co^{60} of initial activity 12,000 Ci. The irradiation temperature was 30^0 C. Doses of 3, 5, 7 and 10 kGy were used.

SENSORY ANALYSIS OF SEASONINGS

The sensory characteristics were assessed by a trained ten-member panel. The analysis involved tiangle difference tests of smell and taste of seasonings suspended in 4% starch gel before and after irradiation. The seasonings were added to the carrier in 0.38% concentration. The results were read out from statistical tables [3] at the singnificance level of $\lambda = 0.05$.

GAS CHROMATOGRAPHY ANALYSIS OF SEASONINGS VOLATILES

Volatile compounds in the seasonings were determined by gas-chromatography in the essential oils of the seasonings (marjoram, coliander, caraway) obtained by Deryng's method [6] or in concentrated distillates (pungent and

sweet paprika, white mustard) obtained by Likens-Nickerson's method [10]. Separation of volatile aromatic compounds was carried out in a Varian Areograph model 2740 gas-chromatograph using a glass columm (2mx2mm i.d.) packed with Carbowax 20M Ultrabond in conditions of programmed temperature from 60° (2) to 195°C (15') at the rate of 6° C/min.

The volatile compound content was calculated from the area of peaks measured with the CDS-111 integrator and expressed in mg/100g of the product on the basis of internal standard added to the samples in considerable amounts prior to distillation. The odour of each separated fraction was determined by means of smelling the eluate from the gas-chromatograph column.

MICROBIOLOGICAL ASSESSMENT OF SEASONINGS

The control and irradiated seasoning samples were evaluated microbiologically by means of the following factors [4]:
— total mesophilic bacterial count,
— spore number,
— coli test,
— entercocci test,
— mesophilic-anaerobic test,
— termophile-anaerobic test,
— total mould count.

RESULTS

SENSORY EVALUATION OF SEASONINS BEFORE AND AFTER IRRADIATION

The sensory assessment of the seasonings suspended in starch gel using the triangle difference test, that for doses of 3 and 5 kGy no significant differences in smell and taste of the seasonings appeared after irradiation. However, signifinat changes occurred at 7 kGy for coliander, caraway, pungent paprika and garlic, and at the dose of 10 kGy also for marjoram and sweet paprika.

The evaluation carried out after 3 and 6 month of storing (Tab. 1) did not reval significant differences only for the dose of 3 kGy. At 5 kGy after 3 months there appeared differences for caraway and both paprikas which were not found directly after irradiation. At the dose of 7 kGy significant changes occurred for all seasonings except marjoram, and at 10 kGy for all seasonings with no exception. Assessment after 6 months yielded the same results.

Table 1. Sensory evaluation of seasonings after radiation by the triangle test (at significance level $\lambda = 0.05$)

Seasoning	Dose (kGy)							
	3		5		7		10	
	Smell	Taste	Smell	Taste	Smell	Taste	Smell	Taste
directly after radiation								
Marjoram	–	–	–	–	–	–	–	+
Caraway	–	–	–	–	+	+	+	+
Coriander Sweet	–	–	–	–	+	+	+	+
Paprika Pungent	–	–	–	–	–	–	–	+
Paprika White	–	–	–	–	+	+	+	+
Mustard Garlic	–	–	–	–	–	–	–	–
Powder	–	–	–	–	+	+	+	+
after 3-months of storage								
Marjoram	–	–	–	–	–	–	+	+
Caraway	–	–	+	+	+	+	+	+
Coriander Sweet	–	–	–	–	+	+	+	+
Paprika Pungent	–	–	+	+	+	+	+	+
Paprika White	–	–	+	+	+	+	+	+
Mustard Garlic	–	–	–	–	+	+	+	+
Powder	–	–	–	–	+	+	+	+
after 6-months of storage								
Marjoram	–	–	–	–	–	–	+	+
Caraway	–	–	+	+	+	+	+	+
Coriander Sweet	–	–	–	–	+	+	+	+
Paprika Pungent	–	–	+	+	+	+	+	+
Paprika White	–	–	–	–	+	+	+	+
Mustard Garlic	–	–	+	+	+	+	+	+
Powder	–	–	–	–	+	+	+	+

Abr. + significant change – no significant change

The changes is smell and taste after irradiation were either augmentation of smell intensity, as in case od marjoram, or its weakening (garlic), or even the formation of off— odour, particulary in caraway and coliander.

CHROMATOGRAPHIC ANALYSIS OF VOLATILE COMPOUNDS IN SEASONINGS

The volatile compounds in the seasonings ware analysed with the gas-chromatography method. The data concerning total volatiles content in the seasonings before and after irradiation are given in Tab. 2. In case of marjoram, caraway and coliander, the separation was carried out in concent-

rated essential oils obtained from these seasonings with Deryng's method. For marjoram 18 fractions were obtained, for caraway 13, and for coliander 18. No new compounds with off odours other than in the control samples were found on the chromatograms of irradiated seasonings. Only for coliander at irradiation dose of 10 kGy an increase in the total volatile compound content took place.

Table 2. Total volatiles content in seasonings before and after radiarion (mg/100g)*

Seasoning	Dose (kGy)					
	0		7		10	
Marjoram	859.7	(17.9)	862.4	(24.9)	801.2	(26.6)
Caraway	2298.5	(90.8)	1884.2	(91.2)	2031.9	(87.4)
Coriander	971.9	(45.7)	1167.5	(50.3)	1549.5	(50.4)
Sweet Paprika	31.9	(0.9)	44.6	(1.2)	49.5	(1.3)
Pungent Paprika	11.6	(07)	19.6	(1.1)	19.6	(0.9)
White Mustard	5.9	(0.3)	14.3	(0.6)	16.9	(0.6)

* Values in this table are means of four deterinations; standard deviations in brackets

For other seasonings containing relatively small amounts of essential oils (sweet and pungent paprika, mustard), the volatile compounds were separated in concentrated distillates. For sweet paprika 31 fractions were obtained, for pungent paprika 36 fractions, and for mustard 24. In these seasonings a considerable increase in some fractions was found, this being reflected in the increase of the total volatiless compound. The increase for both paprikas was up to 50% as compared to the contral, and for mustard it was threefold. However, also in these seasonings no formation of new fractions with off odour was found.

MICROBIOLOGICAL ASSESSMENT OF SEASONINGS BEFORE AND AFTER IRRADIATION

The microbiological tests revealed rather large differences in the general contamination of each herbal seasoning. The most contaminted was coliander and the least were mustard and garlic. The total mesophilic bacterial count was 98×10^6 for coliander and 7×10^2 for mustard. The mesophilic spore number was similar and amounted to 46×10^4 for coliander and 4×10^1 for mustard (Fig. 1). Also coliander had the highest mould count: 25×10^5 (Fig. 2). The analysis of changes also revealed the highest contamination of coliander: its coli test was 10^{-4} (Tab. 3).

The microbiological analysis of seasonings following irradiation indicated that the irradiation effect on microorganism content depended on the kind

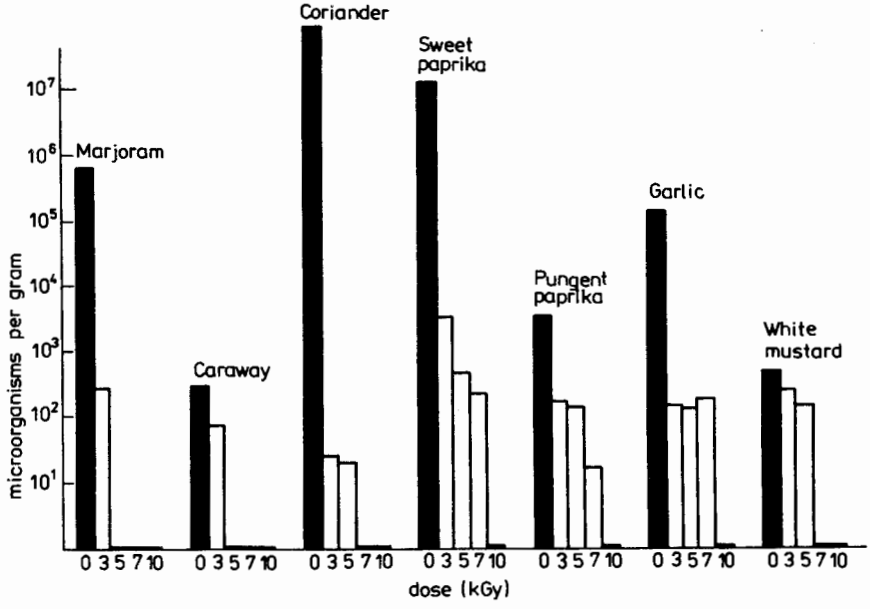

Fig. 1. Effect of gamma irradiation on bacterial content in seasonings

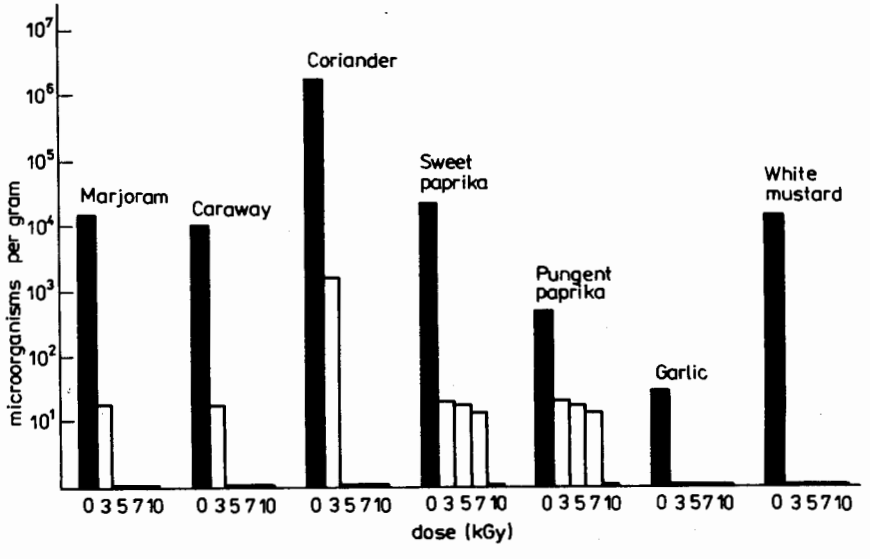

Fig. 2. Effect of gamma irradiation on molds content in seasonings

Table 3. Coli test in seasonings before and after radiation

Dose (kGy)	Seasoning						
	Marjoram	Caraway	Cariander	Sweet Paprika	Pungent Paprika	Garlic Powder	White Mustard
0	10^{-3}	10^{-2}	10^{-4}	10^{-1}	10^{-3}	0	0
3	10^{-1}	0	0	0	0	0	0
5	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0

of seasoning and the dose applied. It can be concluded that in all cases the 3 kGy dose effectively lowered the number of microorganisms (Fig. 1 and 2, Tab. 3) to the level enabling their use as seasonings. However, it did not eliminate them completely. Such an effect was obtained with 5 kGy for marjoram and caraway 7 kGy for coliander and mustard and 10 kGy for both paprikas and garlic. The microorganisms in the paprikas were particularly resistant to irradiation, especially in sweet paprika.

DISCUSSION

Irradiation of seasonings is justified by their considerable microbiological contamination an imperfect of the sterilization methods used so far.

Doses from 8 to 10 kGy are most commonly used in the world to sterilize food [8. According to Farkas [5] the best dodes for seasonings are 5 to 8 kGy. In our research we used doses of 3, 5, 7 and 10 kGy and examined their influence on sensory characteristics, volatile compounds content and microbiological contamination of seasonings.

The sensory assessment of the seasonings carried out with the triangle difference method did not reveal significant differences in smell and taste at doses of 3 and 5 kGy. Only 7 and 10 kGy (depending on the kind of herb) statisctically significant differences were found in all seasonings exept for mustard. However, after 3 months of storage significant changes appeared in some herbs also for the 5 kGy dose. According to Farkas [5] changes in organoleptic parameters of seasonings can appear at doses from 7.5 kGy. Other authors do not find any important effect on smell and taste of seasonings of the doses from 1 to 10 kGy [2, 9, 12, 13].

However, the perceived changes were basically unconfirmed in the present stage of research by chromatographic analysis which failed to show the formation of new fractions of off odours directly after irradiation with doses of

7 and 10 kGy. It showed, for some seasonings (paprika, coliander, mustard), significant increass in some fractions and related increases in the total content of volatile compounds. Increases of total volatiles without qualitative changes in the composition in some irradiated seasonings were observed by Saptura et. al. [12] and Farkas [5], Bachman et al. [2], examining caraway and cardamon, did not find changes in volatile compounds content after irradiation.

The microbiological tests revealed great differences in the contamination of each seasoning. Worth noticing is the high degree of coliander contamination and the high resistance of microorganisms in sweet paprika to irradiation. For this last seasoning, total elimination of microorganisms was achieved with the 10 kGy dose. The lowest used dose, 3 kGy, effectively reduced microorganisms in all seasonings, but it did not eliminate them completely. In some seasonings bacterial spores could still be found after the dose of 7 kGy. Farkas [5] calls the 3 kGy dose the „pasteurizing" one.

In all it can be stated that only the dose of 3 kGy did not produce significant changes in smell and taste of seasonings, both directly following irradiation and after storing. This dose does not eliminate microorganisms complety.

CONCLUSIONS

1. Irradiation of seasoning can bring about some changes in their sensory characteristics depending on the dose—level and kind of seasoning.
2. Analysis of smell and taste of the seasonings suspended in the carrier did not reveal statistically significant changes ofter the 3 kGy dose. Changes appeared at 7 and 10 kGy, and deepened during storage.
3. Increases quantity of total volatile compounds after irradiation were found in coriander, pungent and sweet paprika and mustard.
4. Irradiation of the seasonings with 3 kGy effectively reduced the of microorganisms (though it did not eliminate them completely) to the level permitting their use in food products. However, full sterilization requires higher doses 7 or even 10 kGy.

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WPŁYW WIELKOŚCI DAWKI NAPROMIENIOWANIA NA WŁAŚCIWOŚCI SENSORYCZNE I ZAKAŻENIA MIKROBIOLOGICZNE WYBRANYCH PRZYPRAW ZIOŁOWYCH

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Streszczenie

Zbadano wpływ napromieniowania na cechy organoleptyczne oraz stan mikrobiologiczny wybranych przypraw ziołowych: kolendry, kminku, majeranku, papryki słodkiej, papryki ostrej, gorczycy białej i czosnku. Stosowano promieniowanie gamma dawkami 3, 5, 7, 10 kGy. Przyprawy były analizowane przed i po napromieniowaniu pod względem mikrobiologicznym, sensorycznym oraz zawartości związków zapachowych. Na podstawie wyników tych analiz ustalono, że dawka 3 kGy skutecznie redukowała obecne w przyprawach drobnoustroje choć nie eliminowała ich całkowicie. Jednocześnie dawka ta nie wywoływała widocznych zmian aromatu przypraw. Pełna sterylizacja, zwłaszcza niektórych przypraw jak papryka słodka, wymagała dawki 7, a nawet 10 kGy. Takie dawki powodowały jednocześnie istotne zmiany cech sensorycznych przypraw. Analiza związków lotnych zapachowych wykonana metodą chromatografii gazowej wykazała dla niektórych przypraw/kolendra, ostra i słodka papryka, gorczyca/znaczny przyrost całkowitej zawartości związków lotnych.

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