COLOUR CHANGES OF DRIED ONION TREATED IRRADIATION AND OZONATION

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Abstract:

Food industry generally uses dehydrated spices and vegetables in manufacture of soups, sauces, packet foods, etc.. Colour and quality changes during antimicrobial treatments or storage may cause serious loss of value. In recent work the effect of gamma irradiation and ozone treatment on colour of dried sliced onion was investigated. It was found that the storage and gamma irradiation caused unbeneficial dark colour changes, while ozone significantly caused favourable lighter colour. The aim of our work was to prove what kind of chemical transformations cause the colour and quality changes of dried onion.

Keywords:

Allium cepa, colour changes, ozonation, irradiation, dried onion , reducing sugars

1. INTRODUCTION

There are several methods for microbial decontamination of dried foods, for example fumigation with ethylene oxide, gamma irradiation or ozone treatment [1]. Gamma irradiation in food processing has been extensively studied. It is very effective in reducing postharvest food losses, ensuring hygienic quality, thus it is extensively used method for food decontamination [2,3]. On the other hand numerous costumer particularly in Europe are prejudiced to irradiated foodstuff because of the creation of radiolytic products, including „free radicals" by food irradiation.
Ozone is effective against microorganisms, it is used for sterilization and deodorization of several places: water supplies, hospital rooms, and recently, it is increasingly used in agriculture and food industry [4]. This method seems to be very effective for food decontamination without any health or environmental risks.

Our earlier experiments have showed that both irradiation and ozone treatment are appropriate for reducing microbial count below the permitted limit, but the gamma irradiation was more effective than ozone treatment. Gamma irradiated dried onion showed changes in colour. Ozone treatment has not caused any colour change, the colour and organoleptic properties of ozonated dried onion was the same as the untreated sample [5].

The aim of recent work is to investigate the quality changes in treated matter, thus the presence of free radicals in irradiated and ozone treated dried onion by means of ESR method and the colour changes caused by irradiation.

The colour change of the irradiated dried onion may be caused by the Maillard reaction. It is generally initiated by a condensation between amino acids and reducing sugars. The reaction proceeds to form hundreds of products by a series of consecutive and parallel reactions including oxidations, reductions and aldol condensations, among others. The presence of reducing sugars (i.e. fructose and glucose) in an onion bulb can have major effect on the non-enzymatic browning. In this work the results of preliminary studies are presented which are aimed to prove the presence of Maillard reactions in this system.

2. Materials and methods

Common bulb onion (*Allium cepa L.)* were purchased from a local vegetable-drying company (Droginvest Kft, Szeged). The onion was dried after slicing operation by a multi-stage conveyor-type dryer. The moisture content of dried onion slices was about 50 g/kg. For gamma irradiation 0.05 kg of the samples were aerobically packed in PVC containers. Gamma irradiation was carried out in a ^{60}Co irradiator operated at a dose rate of 0.3 Gy s^{-1}. The applied dose levels were 0, 2, 4, 6 and 8 kGy. Absorbed doses were checked by Fricke method [6].

Ozone was generated from oxygen by a flow-type ozone-generator operating silent electric discharge. The ozone containing gas continuously was flowing throughout a reactor containing 0.05 kg of the sample during the treatment. The treating time was 60 min in all cases, the flow rate was 1 dm^3 min^{-1}. The final ozone concentration was followed by an UV spectrophotometer (WPA Lightwave 2000) at 254 nm and it was $3{,}6\times10^{-5}$ and $3{,}6\times10^{-6}$ $mol\times dm^{-3}$. The treated samples were packed in a polyethylene container.

Microbiological analysis: Total aerobic bacteria were enumerated by the spread plate method using standard plate count agar, and by incubating plates at 37°C for 48 h.

The ESR measurements were carried out on 0,1 g powder form samples with a BRUKER 106 ESR spectrometer at room temperature. The parameters used in the ESR measurements were chosen on the basis of the CEN standard (CEN 1787, 1996)[7].

The colour of the untreated and treated samples was determined by a Hunter Labscan type colorimeter. 10 g onion samples were placed into a standard glass container to measure CIE Lab values. CIE L*, a* and b* values were instrumentally calculated. Lightness, L*, is a quantity that measures the percentage of total solar spectral reflectance in relation to a pure white surface; a* is a measure of the degree red-green; and b* characterise the quantity yellow-blue. Colour difference values of treated samples against untreated samples (CIE ΔE*) were calculated on the basis of CIE L*, a* and b* values. Measurements were performed 10 times, than the results were averaged.

For the chromatographic analysis the aliquots of 1 g dry samples were diluted in 50 ml of a 20/80 (v/v) water – ethanol solution and extracted by reflux for 1 h. The extract was filtered through a Whatman paper filter (No.1), adjusted to 50 ml with 70% ethanol and concentrated in a rotary evaporator. Raffinose was added as internal standard. [8]

HPLC analysis was carried out with the Varian LC Star system, incorporating a pump (9012), an autosampler (9100), a diode-array detector (9065) and a PC computer with Varian Star 5.3 software. Separations were made on a BST Rutin 10 APS column, (4.0 × 250 mm, 10 µm particle size), with acetonitrile-water (80-20 v/v) as mobile phases. The solvent flow rate was 1.00 cm^3 min^{-1}; the sample volume was 20 mm^3. The absorbance of the eluate was recorded in the range 190–367 nm.[9]

3. Results and discussion

The cell counts of total aerobic bacteria of untreated samples ranged 2.3×10^3 colony forming unit (CFU) g^{-1} was not higher than the standard allowed maximum values for dried onion. Results of the microbiological analysis of the irradiated samples (Fig. 1.) show that in the function of irradiation dose the total number of colonies were decreased significantly.

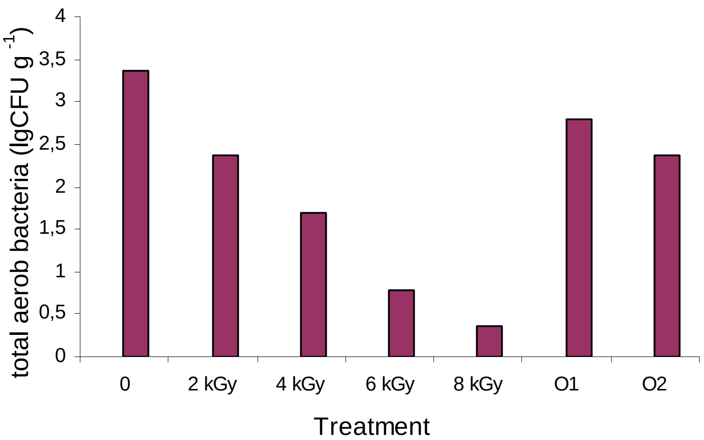

Fig.1. *Mean total aerobic microorganism populations (log10 CFU/g) in irradiated and ozone treated (O1: $3,6\times10^{-6}$ mol dm^{-3}, O2: $3,6\times10^{-5}$ mol dm^{-3} ozone concentrations)*

The ozone treatment caused only slight reduction of counts – it is corresponding to 2 kGy gamma irradiation.

The ESR measurements were carried out on the untreated, gamma irradiated and ozone treated samples too. Fig. 2. and Table 1 show that irradiation increases the ESR intensity of dried onion, while the ozonation has no significant effect on the number of free radicals. This means, that ozone treatment of foods have less health risk than irradiation.

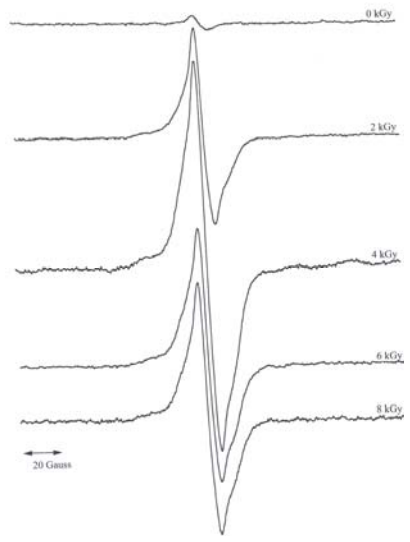

Fig. 2. *ESR spectra of untreated and irradiated dried onion.*

Table 1. *Average ESR intensity values of treated and untreated dried onion samples.*

	ESR intensity						
	Control	2 KGy	4 KGy	6 KGy	8 KGy	O1	O2
average	2,008	20,898	38,036	32,598	25,013	1,741	1,012
dev.	0,610	3,243	2,972	6,575	9,327	0,753	0,466

Colour changes of irradiated onion were observed. The results show (Fig. 2.) that the lightness (L* values) and yellow colour co-ordinates (b* values) of onion samples decreased with increasing dose, while green-red colour co-ordinates (a* values) increased. This means that the colour of irradiated onion became darker and more brown, causing quality damage of the samples.

At the same time only slight colour change was observed during ozonation, colour co-ordinates L*, a* were changed. The ozone treated onion became lighter and less red, while there were no significant changes in yellowness of the samples.(Fig.3.)

The lighter colour means better quality, thus in an other series of experiments it was examined that the ozone could disappear the negative colour changes caused by irradiation. The ozone treatment caused lighter and less brown colour in the irradiated samples too. The effect of irradiation and ozonation on the colour can be demonstrate by the total colour difference ΔE*, calculated according to Eq. 1.:

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \qquad (1)$$

where ΔL*=L*(t)-L*(0); Δa*=a*(t)-a*(0); Δb*=b*(t)-b*(0) are the differences calculated for treated dried onion (t) and the original untreated dried onion (0). (Fig. 4.)

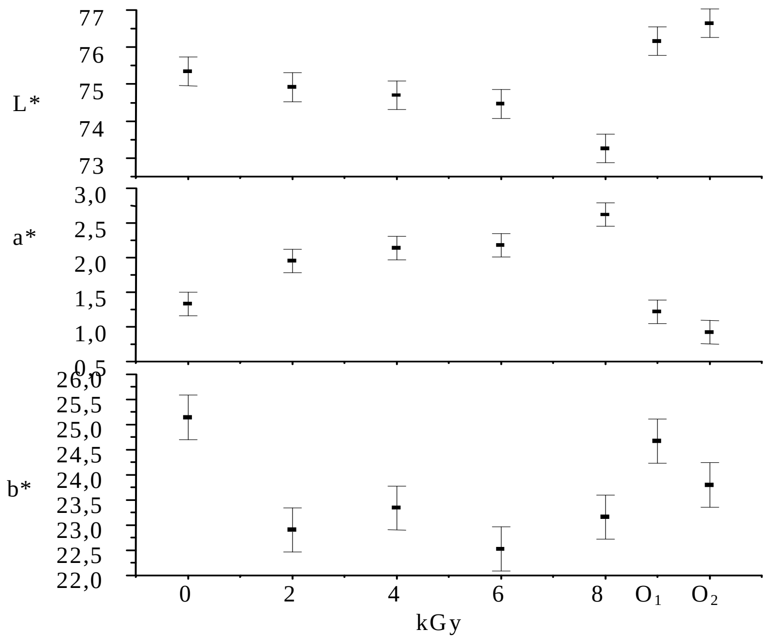

Fig. 3. *CIE Lab values of the untreated and treated dried onion in the function of applied dose.*

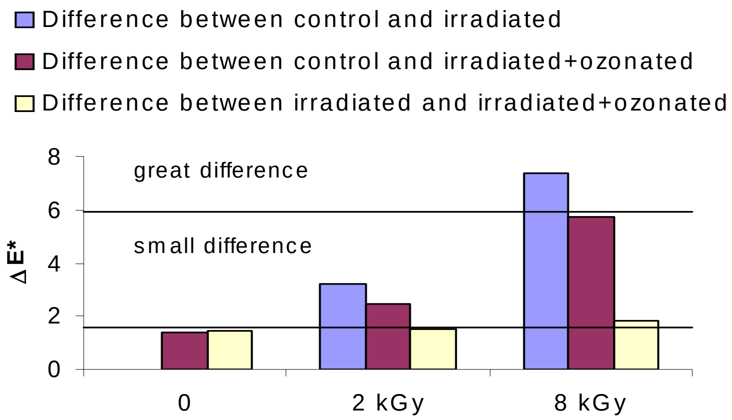

Fig. 4. *Total colour difference (ΔE*) between of the control and irradiated, the control and the irradiated+ ozonated, and the irradiated and irradiated+ozonated samples*

These results show, that the ozonation slightly can compensate the colour changes caused by irradiation, but this compensation effect of ozone is smaller than the browning effect of irradiation. Nevertheless the effect of ozone could be enough to improve the quality of poor dried onion.

The presence of reducing sugars (i.e. fructose and glucose) in an onion bulb can have major effect on the non-enzymatic browning. The effect of the irradiation and the ozonation on amount of reducing sugars was investigated. It was found that the amount of reducing sugars did not changed significantly, the sugar content of the samples practically unchanged. At the same time in the chromatogram of non-structural carbohydrates of treated samples some new peak were observed, and the evaluation of the chromatograms showed that these components are colour (yellow). These components may be originated from the Maillard reaction. Identification of these components is in progress.

4. Conclusions

The effect of gamma irradiation and ozonation on the quality of sliced, dried onion was investigated. Both method decrease the total microbial count, the ozone treatment equivalent to about 2 kGy irradiation dose. However the irradiation is more efficient sterilizer, it has negative effect too: it causes quality damaging colour changes, and increase the of free radicals content. At the same time the ozone has positive effects: it causes lighter colour, and does not forms radicals. Therewith ozone may diminish the colour changes caused by irradiation.

5. Acknowledgements

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6. References

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