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ANALYTICAL DETECTION METHODS FOR GAMMA-IRRADIATED FRESH APPLES

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ABSTRACT

For distinguishing irradiated from unirradiated apples chemiluminescence (CL) intensities of fresh apples were measured using luminol and lucigenin reactions. The results revealed that the CL values obtained from fresh samples were irreproducible and scattered in case of control and irradiated (0.2, 0.4, 0.6, 0.8, and 1.0 kGy) apples. However, when CL of the charred and ashed (mineral matter) samples was retaken, it was found that there were marked differences in CL intensities of treated and untreated samples, It was observed that the data pertaining reaction of mineral matter with luminol and lucigenin was dose dependent. Electrical conductivity of whole apples and their 20 per cent slurry in distilled water also gave promising results.

INTRODUCTION

Irradiation treatment extends shelf-life and enhances hygienic quality of food materials. An expert committee of IAEA/FAO/WHO has already recommended that foods irradiated up to an overall average dose of 10 kGy are safe for human consumption (Anonymous, 1991). In order to harmonize international marketing of irradiated food materials, there is a need to standardize analytical methods which can help in identifying irradiated food stuffs. World-wide efforts are continued in this regard (Bogl & Heide, 1985; Delincee, 1992). Physico-chemical changes associated with irradiation treatment are nominal and difficult to be detected by simple means. There is a need for suitable sensitive and reliable method to be standardized to facilitate the identification of irradiated food materials. In Pakistan preliminary work on identification of irradiated spices and dried fruits has been conducted (Khan *et al.*, 1993; Ahmad *et al.*, 1995). A commercial food irradiator is likely to be installed at Lahore along with Pakistan Radiation Services (PARAS) and it is, therefore, necessary to develop some routine identification method for irradiated fresh fruits and vegetables to help in implementation of irradiation technology in food preservation and/or for quarantine purposes.

MATERIALS AND METHODS

Fresh red apples were obtained from the fruit market at Peshawar. The apples were irradiated at the dose levels of 0.2, 0.4, 0.6, 0.8, and 1.0 kGy using ISSLEDOVATEL (CIS) gamma source with dose rate of 1.9 kGy/hr. Chemiluminescence (CL) intensities of the fresh apples were taken using luminol and lucigenin photosensitizing reactions with the help of Bio-Orbit 1250 luminometer, the composition of these reagents has already been reported (Sattar *et al.*, 1987). Due to widely dispersed data the method for CL measurements was modified by using charred and ashed (mineral matter) apples instead of fresh samples. Electrical conductivity (μ-mho) of fresh whole apples was taken by puncturing the fruit by stainless steel pins using model ABB/10 sproule electrolytic conductivity cell UK. The EC of the blended (20%) apples in distilled water was also measured. In view of the wide variation in the values the data were analyzed statistically by measuring means and coefficient of variability (CV).

RESULTS AND DISCUSSION

Initial experiments on CL intensities using luminol and lucigenin reaction with fresh apples showed inconsistent results with wide variations. It was, therefore, desired to measure the CL of mineral matter of the apples. The results of CL values of charred and ashed samples are given in Table-1. There was significant difference (more than double) in the CL values of unirradiated and irradiated samples. The data clearly show that on the basis of CL values obtained from the reactions of charred material with both the photosensitizers, irradiated samples can be identified, similar pattern was observed from the results of mineral matter of apples. It was further found that the data of mineral matter were almost dose dependent and quite consistent. The means and CV of the data were

Table-1. Chemiluminescence intensities (mV) of irradiated fresh apples

Material	Sample No.	Radiation Doses (kGy) 0	0.2	0.4	0.6	0.8	1.0
				Luminol reaction			
Apple-charred	1	27.5	33.3	35.3	38.6	40.0	40.0
	2	26.5	31.3	32.5	38.4	40.0	42.0
	3	26.0	32.0	33.4	38.5	40.0	40.7
	Mean	26.67	32.2	33.7	38.5	40.0	40.7
	CV	3.75	3.15	4.23	0.26	0.00	2.84
Apple-ashed	1	3.4	6.52	6.55	6.90	7.0	8.3
	2	3.0	6.42	6.24	7.00	7.8	8.5
	3	3.2	6.50	6.30	7.00	7.8	8.5
	Mean	3.2	6.48	6.36	6.97	7.5	8.4
	CV	6.25	0.82	2.58	0.83	13.27	1.37
				Lucigenin reaction			
Apple-charred	1	13.5	25.8	26.5	25.5	27.5	31.5
	2	18.5	20.8	25.8	24.0	27.0	28.0
	3	17.0	24.0	25.5	27.0	27.0	28.1
	Mean	16.33	23.53	25.93	25.5	27.17	29.2
	CV	15.71	10.76	3.86	5.88	1.06	3.42
Apple-ashed	1	99.8	120.0	100.0	100.0	110.0	100.0
	2	87.7	150.0	120.0	98.0	100.0	120.0
	3	77.0	130.0	110.0	96.0	100.0	130.0
	Mean	88.17	133.33	110.0	98.0	103.3	116.67
	CV	12.94	11.46	0.91	1.02	5.69	13.09

measured and wide differences between irradiated and unirradiated samples were observed. Determination of CV is especially appropriate under conditions where there are extreme values or when it is desired to express variations as a percentage of the average around which the deviations are taken. Although CL intensities of irradiated spices, dried fruits and some other materials have been reported to be much higher than their unirradiated counterparts (Bogl, 1990; Ahmad *et al.*, 1995). The use of the ashed material for CL measurements has been presented for the first time in these and related recent studies. The application of EC technique for detecting irradiated foods has been tried in Pakistan (Khan *et al.*, 1993; Sattar *et al.*, 1995) and abroad (Ehlermann, 1972; Hayashi, 1986). However, it was consistently reported that reproducibility is the factor which limits its usage. Further, it was not possible to determine the absorbed dose of the irradiated materials.

Electrical conductivity values (μ-mho) of the whole fruit as well as its slurry (20%) in distilled water are presented in Table-2. The results revealed that there was increasing trend in the EC values as the radiation dose increased from 0-1.0 kGy in both using whole fruit and slurry. These preliminary experiments on fresh apples indicate that chemiluminescence and electrical conductivity measurements can detect the irradiated samples from unirradiated controls. However, this technique needs to be further improved with regard to accuracy, reproducibility, and measurement of absorbed doses.

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Table-2. Electrical conductivity values of irradiated fresh apples

Irradiation doses (kGy)	EC (μ-mho)	
	Whole fruit	Slurry (20%)
Unirradiated control	95.0	591.0
0.2	100.0	600.0
0.4	170.0	750.0
0.6	240.0	800.0
0.8	270.0	900.0
1.0	250.0	800.0
Mean	187.5	740.17
CV	41.3	16.51

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