RADIATION EFFECTS ON SOME PHYSICO–BIOCHEMICAL CHANGES IN PISUM SATIVUM

Mohammad Wahid, Niaz Mohammad* , Mohammad Jawaid Durrani*
and Abdus Sattar

*(Nuclear Institute for Food and Agriculture, * NWFP Agricultural University, Peshawar, Pakistan)*

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ABSTRACT

Effect of irradiation treatment (0.5, 1.0, 2.0 and 4.0 kGy) on fresh pea cultivars was investigated. Results indicated that significant decrease in colour (% transmittance) and ascorbic acid occurred due to storage period. Higher irradiation treatments showed a significant difference in colour retention in both the cultivars. Visual observation indicated no sprouting until 6th days after which sprouting started in both the cultivars irrespective of radiation treatments. At higher irradiation dose (4.00 kGy) sprouts died soon after emergence. Peas irradiated at 2.0– 4.0 kGy doses showed rottage after 9–12 days of storage in both the varieties. Higher irradiation doses enhanced the rate of rot compared with lower doses. p-8 was more resistant to rottage than Moon cultivar of pea.

Keywords: Peas Radiation Rottage Sprouting Ascorbic acid

1 INTRODUCTION

Pea occupies a special position among chief sources of vegetable protein and its essential amino acid contents compare well with those of legumes and FAO recommendation[1,2]. The crop is grown world-wide, but because of sensetivity to extreme climate, largely confines to the temperature regions or cooler seasons of warmer places. At peak harvest, the production of this vegetables is more than its actual demand in the markets in Pakistan and several other Asian countries. Small portion of the produce is processed but during storage they also start sprouting which results in the nutritive and economic losses.

The use of ionizing radiation offers new promise in food preservation[3,4]. Since less work has been carried out on peas, this work was initiated to study the influence of radiation on some physico–biochemical changes in peas.

2 MATERIALS AND METHODS

Pea cultivars such as Moon and p-8 were obtained from the Agricultural

Research Institute, Tarnab, Peshawar. The samples were sorted for pods of uniform shape and colour and irradiated with 0.5, 1.0, 2.0 and 4.0 kGy in Cobalt-60 Gamma Researcher Unit (Issledovatel USSR) having a total activity of 2.05×10^{11}Bq.

About 50 pea pods were separated, weighed and stored at room temperature (16–22 °C; R.H. 65–70%). During storage these were regularly weighed and percent weight losses calculated. Pods were also observed for rot attack and sprouting. The samples were analysed for moisture, crude protein, crude fibre and total mineral matter (ash), sugars and alcohol insoluble solids according to AOAC[5]. The moisture and total solids were determined in a drying oven at 105°C until constant weight. For total colour, the method of Papadopulou[6] was used in which 2g fresh crushed peas were taken and kept overnight in darkness with 30ml of a mixture (1:1) of trichloroacetic acid (TCA–10%) and ethanol. The mixture was filtered and the extracted colour was measured on a spectrophotometer at 420nm for percent transmittance against the blank containing only TCA and ethanol (1:1) solution. Titrimetric Dye method of 2,6–dichlorophenolindophenol was employed for determination of ascorbic acid[8]. Data regarding chemical changes were analysed by the Analysis of Variance with least significant difference (LSD) between treatments and storage interval means[7].

3 RESULTS AND DISCUSSION

Physical evaluation The pea samples were fresh, green and attractive in the beginning of the experiment. During storage the colour of the peas progressively become pale and light green instead of dark green. Brownish patches appeared after 12 days in all the samples. Sprouting was not observed in Moon and p–8 during the initial 6 days after which it occurred in both the varieties. The unirradiated peas sprouted with long (0.5–1.5 cm) and healthy sprouts. Peas irradiated with 0.50–2.0 kGy also sprouted but the sprout–length was quite reduced (0.2–0.4cm) with weak and stunted growth of pale yellow colour. At higher dose (4.0 kGy) sprouts appeared but died immediately after emergence. Sprouting pattern was similar in both the cultivars. Fruits and vegetables exhibit progressive physiological breakdown during storage and such changes are controlled by the activities of enzyme systems and hormones which in turn are influenced by the environmental conditions[8]. Stimulatory and inhibitory effects of ionizing radiation on sprout inhibition and growth and differentiation of plant tissue has been widely reported[9,10]. It was reported by Harber[11] that radiated wheat grains germinated with no accompanying cell division and produced seedlings, normal in many anatomical and physiological respects. The resultant gamma plantlets grew to a final height of about 2 cm by expansion of cells originally present in the embryo. Similar to present studies, Jordan and Harber[12] observed that after irradiation (5.0 kGy) of wheat (Lemhi 66), germination took place and cell division

rose from a marely detectable quantity (cytokinins) to an amount similar to that in seedlings from an unirradiated control.

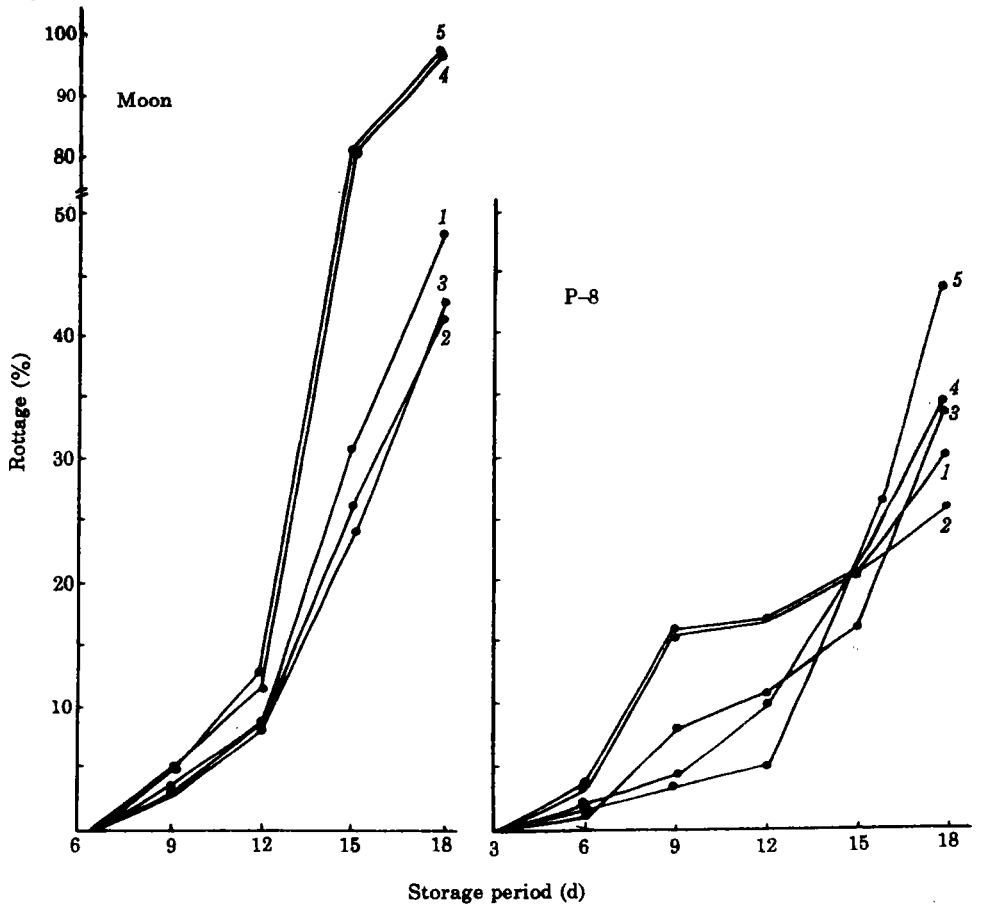

Fig.1 Effect of radiation and storage on ascorbic loss in pea cultivars

1. Control 2. 0.50 kGy 3. 1.00 kGy 4. 2.00 kGy 5. 4.00 kGy

Rottage data indicated (Fig.1) that there was no rot attack upto 3rd day in p-8 and 6th day in Moon; however during later storage it increased consistently. Moon was somewhat resistant to rot in the beginning but heavily affected at the terminal storage. There was comparatively less rottage in radiated samples on 6th day but then it increased considerably reaching 41.7-96.5% in Moon and 26.0-46.8% in p-8 on 18th day. The results of statistical analysis showed that radiation doses and storage time significantly affected the sprouting pattern. Radiation has been shown to increase shelf life of fruits and vegetable by delaying ripening, reducing microbial load and inhibiting sprouting[8]. However, lower doses were found to be ineffective in reducing rottage in potatoes and onions[13]. Pattern of changes in sprouting and rottage observed in peas are particularly different from potatoes and onions.

Biochemical analysis The results on proximate composition of pea are presented

in Table 1. The pea varieties slightly varied in regard to potential nutrients including carbohydrates determined by difference. The average energy values were 341 and 366 kJ/100g of Moon and p-8 respectively. Pea varieties contained 24.25 and 22.50% total solid, 17.94 and 18.42% alcohol insoluble solids, 18.90 and 16.40 mg ascorbic acid while total sugar contents were 5.86 and 6.05% in Moon and p-8 respectively. The results of present study are generally congruent to the literature values. Watt and Merril[14] reported that green pea contained about 78% moisture, 6.3% protein, 0.4% fat, 14.50% total carbohydrates, 2.0% fibre, 0.9% ash and food value of 352 kJ per 100g.

Table 1

Composition of pea cultivars

S. No.	Constituent		Moon	p-8	Mean S.D	CV
01	Moisture	%	75.75	77.50	76.62±1.24	1.6
02	Protein	%	7.60	6.48	7.04±0.70	11.3
03	Fat	%	0.41	0.53	0.47±0.08	18.1
04	Fibre	%	1.75	1.72	1.74±0.02	1.2
05	Mineral matter (ash)	%	1.13	1.08	1.11±0.04	3.2
06	Carbohydrates	%	13.36	12.71	13.04±0.46	3.5
07	Total solids	%	24.25	22.50	23.38±1.24	5.3
08	Alcohol insol. solids	%	17.94	18.42	18.18±0.34	1.9
09	Sugars	%	5.86	6.05	5.95±0.13	2.3
10	Ascorbic acid (mg/100g)		18.90	16.40	17.65±1.77	10.0
11	Food energy (kJ/100g)		366.47	341.35	353.91±17.75	5.0

Values are the average of 2-3 determinations on fresh weight basis SD= Standard deviation CV = Coefficient of variability (samples standard deviation expressed as a percentage of sample mean)

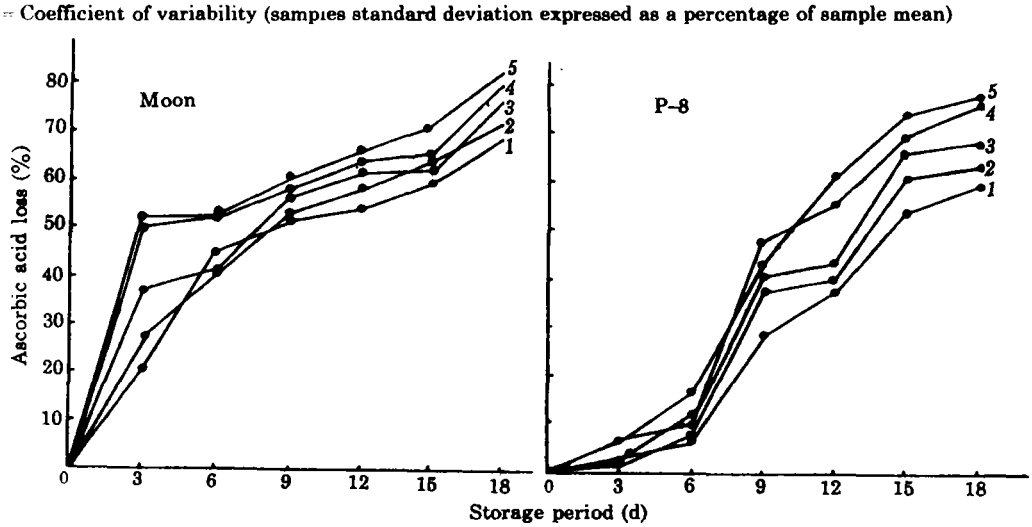

Fig.2 Effect of radiation and storage on rot attack in pea cultivars

1. Control 2. 0.50 kGy 3. 1.00 kGy 4. 2.00 kGy 5. 4.00 kGy

Fresh samples of Moon and p-8 contained 19.00 and 16.20 mg/100g of ascorbic acid (Fig.2). During storage, significant loss of this vitamin occurred in both the varieties.

The mean values of vitamin decreased to 8.50 and 9.45mg/100g in Moon and p-8 during 18 days respectively. Irradiation immediately had almost no effect on this vitamin but during later storage radiated samples showed greater losses than unradiated ones in both the cases and higher doses resulted in significantly higher losses than lower ones. When the peas were kept for 18 days at ambient conditions (16–22°C), the loss of ascorbic acid reached to 56.42–66.79% in Moon and p-8 cultivars. According to literature[14] the average ascorbic acid of edible portion of green peas ranged 20–27mg/100g. Clark[15] reported excessive destruction of ascorbic acid in fruits with dose of 200 krad. Maxie *et al*[16] observed that radiation induced changes in vitamins and pigments were not limiting and major alterations occur at only higher doses. The effect of ionizing radiation on the nutritional value of food is not markedly different in degree from that of other processing techniques[16].

Table 2

Total colour of peas as affected by irradiation and storage

Cultivar/ Treatment	kGy	(Colour percent Transmittance)							
		0	3	6	9	12	15	18	Mean
Moon	0.0	60	58	51	45	44	44	44	49.4
	0.5	60	58	51	45	45	44	44	49.6
	1.0	60	58	51	45	44	44	44	49.4
	2.0	60	58	52	46	45	44	44	49.4
	4.0	60	58	52	46	45	44	44	49.8
p-8	0.0	64	64	61	54	54	52	50	57.0
	0.5	65	64	61	54	54	53	50	57.6
	1.0	64	64	62	55	54	53	50	57.4
	2.0	64	64	62	55	54	53	50	57.4
	4.0	64	64	62	54	54	53	50	57.3
Treatment (kGy) Mean	0.0	62	61	56	50	49	48	47	53.3[a]
	0.5	62	61	56	50	49	48	47	53.4[a]
	1.0	62	61	56	50	49	48	47	53.3[a]
	2.0	62	61	57	50	49	48	47	53.4[a]
	4.0	62	61	57	51	50	49	47	53.8[b]
Cultivar Mean	Moon	59.6	58.0	51.4	45.7	44.7	44.4	44.1	49.7[b]
	p-8	64.8	64.5	61.6	55.0	54.7	53.1	50.0	57.8[a]
	Mean	62.2[a]	61.2[a]	56.8[c]	50.3[d]	49.7[e]	48.8[f]	47.1[g]	

Figures bearing the same letters are not significant different ($P < 0.05$) storage at toom temperature (16–22°C, R.H.65–70°%)

The results on total extracted colour of peas are presented in Table 2. The average transmittance values were 59.6 and 64.8% in the beginning in Moon and p-8 respectively, which changed to 44.1 and 50.0% after 18 days. The apparent green colour of pea samples also faded with storage in all the samples. Statistical analysis of the data indicated significant influence of treatment and storage time on colour values ($P < 0.05$). The extent of change in colour was greater in samples radiated at higher dose (4.0 kGy) than other treatments tested. Kadir[17] reported that in ripe tomatoes the

orange red colour was retained longest by 0.50 kGy dose of gamma rays. The same authors also observed that irradiation of tomatoes with electron accelerators upto 3 MeV gave little perceptible differences in colour. Farkas *et al*[18] noticed that with higher doses (10.2–20.0 kGy), brown pigment of dates was deminished. Snauwaert *et al*[19] reported that only A and B types of chlorophyll were found in freshly harvested peas, and upon irradiation upto 2 Mrad no visible changes in colour occurred.

REFERENCES

[1] Gane A J. The pea crop. London: Butter Worth, 1985: 3.

[2] FAO/WHO. Nutrition meeting report series No. 37. Rome: FAO. 1965.

[3] AECL Atomic Energy Canada Limited. Radioisotopes application hand book. Ottawa, 1967. 22:26.

[4] *IAEA Food Irradiation News letters*, 1981, 5:3.

[5] AOAC association of official analytical chemists. 14th ed. Washington, D.C., 1984.

[6] Papadopoulu C P. Radiation and radioisotopes applied to insects of agricultural importance. Vienna: IAEA, 1964: 485.

[7] Little J M, Hill F J. Statistical method in agricultural research. Agri Extension Univ of California, 1972. 75.

[8]Bergers W W A. External report No.4, Inst for Atomic Sciences in Agricult. The Netherlands: Wageningen, 1975.

[9] Sawyer R L, Dallyn S L. *Amer Potato J*, 1955, 32:141.

[10] Venketeswaran S, Partanen C R. *Radiat Bot*, 1966, 6:13.

[11] Whitesan G E ed. Radiation cell biology. New York:Academic Press, 1972: 231.

[12] Jordan M R, Harber A H T. *Radiation Botany*, 1974, 14:219.

[13] Khan I and Wahid M. Food preservation by irradiation. Vienna:IAEA, 1978: 63.

[14] Watt B K, Merril A L. Composition of foods. USDA hand book No. 8. 1975.

[15] Clark I D. *J Appl Rad Isotopes*, 1959, 6:175.

[16] Maxie E C, Sommer N F, Mitchel F G. *Disinfestation of fruits by irradiation*. Vienna: IAEA, 1971: 93.

[17] Kadir A S. *Ref Report USAEC, USDA*, 1964, 34:80.

[18] Farkas J, Al-Charachafchy F, Al-Shaikhaly *et al. Acta Alimentaria*, 1974, 3:151.

[19] Snauwaert F, Tobback P P, Verbees J *et al. J Food Sci*, 1985, 5:117.