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Preservation of Potatoes by Nuclear Techniques

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Abstract

Potatoes (Varieties: Cardinal and Patrones) were irradiated at a dose of 0.10 kGy in Co-60 Irradiator and stored at 20°C for a period of 4 months. There was 5 and 3 per cent rotting in control and 9 and 5 per cent rotting in irradiated tubers in Cardinal and Patrones respectively at the end of 4 months storage period. The sprouting percentage at the end of 4 months was 51 and 59 in unirradiated tubers in Cardinal and Patrones varieties whereas no sprouting was observed in the irradiated potatoes in both the varieties. The weight loss was more (8.3 and 6.6 %) in the control than the irradiated tubers (6.7 and 5.7 %) in Cardinal and Patrones varieties at the end of 4 months storage period. Effect of radiation and storage was significant on ascorbic acid but negligible on sugars. Sensory quality was improved as a result of radiation treatment. The cost economics for food irradiation based on a source strength of 59 kCi was Rs. 290 per tonne.

Introduction

Potato is the most important vegetable which occupies a prominent position among the food crops cultivated in Pakistan. It is grown throughout the country. It is the crop which gives the highest tonnage of human food per unit area in the world. Pakistan produces three potato crops per annum such as autumn or winter crop, spring or summer crop and hill crop. The autumn crops is the major crop for production of potatoes.

Since there are no effective and economic preservation methods available, a large quantity is lost due to sprouting and rotting. Storage of potatoes is a serious problem especially during the humid and hot summer months (April-September). About 25 per cent produce is estimated to be stored in the cold storage (3-4°C) and the rest is either marketed immediately after harvest or stored for short duration under ambient conditions. It is believed that the deterioration of potatoes amounts to about 10-20 per cent in Pakistan (Khan and Muhammad, 1975) and more than 20 per cent in India (Thomas *et al.*, 1979). Chemical sprout inhibitors are not used in Pakistan.

In order to avoid huge post-harvest losses, radiation preservation is the potential preservation technique to ensure uniform supply to the market and control wide fluctuation in the price of this commodity (Khan and Muhammad, 1975). Low doses can successfully control sprouting in potatoes so as to extend its storage ability for a period upto one year or so. The gamma radiation doses of 0.10 kGy completely inhibit sprouting in potatoes and onions thereby increasing the shelf-life for more than 6-8 months (Khan, 1973). Rotting of potatoes during storage in tropical countries is a serious problem. It has been reported that rotting increased with an increase in storage temperature of irradiated and unirradiated tubers (Khan and Wahid, 1978). Earlier workers reported complete inhibition of sprouting in potatoes and onions by exposing to ionizing radiation (Nair *et al.*, 1973, Roushdy *et al.* 1973). Chowdhry and Rahman, 1973 reported weight loss of

potatoes from 33-10 per cent by irradiation at 8-10 Krad and safely store for 9 months at ambient temperature and humidity.

The purpose of this study was to determine the optimum radiation doses for preserving potatoes under the suitable storage conditions.

Materials and Methods

Sampling: The potatoes (Varieties: Cardinal and Patrones) were procured from the farmers field at the time of harvest during the month of May. The material was stored for 2 weeks at ambient conditions to remove the field heat. Eight tones of the material was used and half of samples were irradiated with a dose of 0.10 kGy in Co. 60 Irradiator in NIFA, Peshawar. The irradiated and unirradiated samples were stored for a period of 4 months at 20±2°C and 50-60 per cent relative humidity.

Visual Observations: The treated and untreated samples were regularly examined during storage for the changes in colour, texture and core condition. The tubers were opened by cutting with stainless steel knife and difference between the irradiated and unirradiated lots were noted for core conditions.

Weight Losses: Tubers of uniform shape and size were selected and marked. During storage all the samples were regularly weighed and losses in each case was recorded.

Rotting and Sprouting: In order to study the incidence of rot and sprouting, 100 tubers in each sample were marked and examined regularly during storage. The rot attack and sprouting was expressed also in per cent.

Determination of Ascorbic Acid and Sugar Content: The ascorbic acid was determined by the dye method i.e. the reduction of 2,6-Dichloro-phenolindophenol by ascorbic acid (Anonymous, 1966). The sugar content i.e. reducing, non-

reducing and total sugars were determined by Lane and Eynon method (Brownwell *et al.*, 1957).

Organoleptic Evaluation: The standard procedures were adopted for sensory evaluation during the investigation (Larmond, 1970). The potatoes were washed, cut into pieces for preparing potato chips and french fries. The products were judged by a panel of 10 experienced senior scientists using hedonic scale.

Cost Economics: The cost economics of irradiation was calculated for a source strength of 50 kCi and a throughput rate of 20 t/h. For this purpose the total production of potatoes in the area was considered to be 100,000 tones, 50 per cent of which was estimated to be available for irradiation, the rest being consumed fresh.

Results and Discussion

The rot attack examined is shown in Table 1, which shows that there was no incidence of rot till 8 weeks and even after 16 weeks of storage, there was only 9 and 5 per cent rotting in Cardinal and patrones varieties respectively. The rot attack was somewhat higher in irradiated samples (5-9 per cent) than their control (3-5 per cent). Patrones gave better results as compared to Cardinal variety to resist the rot attack. Higher rot attack has also been observed by Khan and Wahid, 1978 in irradiated tubers than in control in one of the large scale experiments. Thomas *et al.*, 1979 also studied the effect of irradiation on potatoes and found that potatoes untreated and treated at 0.1-0.25 kGy dose (temperature 15°C) showed similar rates of spoilage. The observations of the sprouting in potato varieties are compiled in Table 1 which shows that sprouting started after 7 weeks and increased upto 51 per cent in Cardinal and 59 per cent in Patrones after 16 weeks in unirradiated tubers. Irradiation doses of 0.10 kGy completely inhibited the sprouting in stored potatoes. Many research workers have reported that a radiation dose of 0.09-0.10 kGy was sufficient to inhibit sprouting in various varieties of potatoes (Khan and Muhammad, 1975).

The loss in weight was noted during storage in all the samples and the data recorded in Table 2. The weight loss increased during storage from 3.6 per cent (8 weeks) to 8.3 per cent (16 weeks) and from 2.5 per cent (8 weeks) to 6.6 per cent (16 weeks) in untreated Cardinal and Patrones varieties respectively. Moreover, it was observed that the loss in weight was more in unirradiated than in irradiated tubers of both the varieties. The weight loss in vegetables mainly depends on the storage conditions i.e. the temperature and rel. humidity. Diehl, 1990 observed no difference in weight loss in irradiated and unirradiated potatoes in storage. Nazir *et al.*, 1971 reported that unirradiated potatoes with higher weight loss could be due to germination and the resultant increased surface area in the control as compared to sprout-inhibited tubers in the irradiated samples.

It was observed that there was no change in colour and texture of the irradiated tubers and the core condition was also identical with unirradiated tubers. Thus small doses of irradiation do not produce any significant change in the colour and texture of potatoes. The change in ascorbic acid content due to storage and irradiation treatment are shown in Table 3. Fresh Cardinal and Patrones potatoes contained 18.1 and 19.8 mg/100 gms of ascorbic acid which decreased to 12.9 and 12.4 mg/100 gms after 16 weeks. There was a gradual and significant loss of this vitamin during storage. It was noted that immediately after irradiation, the irradiated tubers showed a significant fall of ascorbic acid content as compared to their control samples. All the potatoes which were irradiated gave significantly lower values of this vitamin throughout the storage period. Brownwell *et al.*, 1957 reported that irradiation of 10 Krad could cause some loss of ascorbic acid in potatoes and higher doses had pronounced effects.

The results of reducing, non-reducing and total sugars of potato varieties have been summarized in Table 4. Cardinal and Patrones varieties contained 2.7 and 2.0 per cent, 1.4 and 1.5 per cent and 4.1 and 3.6 per cent of reducing, non-reducing and total sugars respectively. Some changes were observed in all the sugars after 16 weeks storage period. The concentration of total sugars remained similar during storage in irradiated and unirradiated potato varieties. Thomas *et al.* (1979) observed higher reducing sugar and sucrose contents in irradiated tubers as compared to control after 24 weeks. The results obtained in our experiment are in agreement with most of the workers, who studied the effect of irradiation and storage under similar conditions. The results of organoleptic evaluation of the treated and untreated potatoes during storage are given in Table 5. Potato chips and french fries were prepared from all the tubers under investigation. No immediate difference was noted by any one of the 10 judges in the taste of the products and almost all the samples got similar score in the beginning. They showed nearly similar values even after 16 weeks. However, the values for the products, prepared from irradiated tubers were slightly higher than their corresponding control samples. No significant changes in the colour of chips and french fries were noted during storage in irradiated and unirradiated tubers. Thomas *et al.* 1979 reported that the taste of cooked, control and irradiated potatoes, stored at 5-7°C, was similar upto a month of storage. At 8 months storage, the tasters showed a definite preference for the irradiated potatoes. Khan and Wahid, 1978 compared the irradiated, CIPC-treated and control potatoes of Desiree and Ultimas varieties for organoleptic properties. They reported that chips and french fries prepared from irradiated potatoes were preferred to those from control and CIPC-treated samples.

For cost economics, total production of potatoes in the growing area was estimated to be 100,000 tones and out of this 50 per cent produce was considered to be available for irradiation whereas the rest for fresh consumption. The

Table 1: Rotting and sprouting in irradiated and unirradiated potatoes during storage

Storage period (weeks)	Rotting				Sprouting			
	Cardinal		Partones		Cardinal		Partones	
	0	0.10 kGy	0	0.10kGy	0	0.10kGy	0	0.10kGy
0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	13	0
16	5	9	3	5	51	0	59	0

The values are expressed in per cent and the average of 100 tubers.

Table 2: Loss of weight in irradiated and unirradiated potatoes during storage

Storage period (weeks)	Cardinal		Patrones	
	0	0.10 kGy	0	0.10 kGy
0	0.0	0.0	0.0	0.0
8	3.6	2.2	2.5	1.4
16	8.3	6.7	6.6	5.7

The value are expressed in per cent and the mean values of 20 tubers.

Table 3: Changes in ascorbic acid in irradiated and unirradiated potatoes during storage

Storage period (weeks)	Cardinal		Patrones	
	0	0.10 kGy	0	0.10 kGy
0	18.1	17.6	17.8	17.4
8	14.1	8.30	16.2	9.40
16	12.9	6.20	12.4	6.70

The values are the average of three determinations and expressed in mg/100 gms of wet sample.

Table 4: Effect of irradiation and storage on reducing, non-reducing and total sugars of potatoes during storage

Sugars	0 week		8 weeks		16 weeks	
	Cardinal	Patrones	Cardinal	Patrones	Cardinal	Patrones
Red. Sugars						
Control	2.7	2.0	2.7	2.1	2.8	2.5
Irradiated	2.9	2.1	2.9	2.4	3.0	2.8
Non-Red						
Control	1.4	1.5	1.4	1.5	1.5	1.6
Irradiated	1.2	1.7	1.2	1.7	1.3	1.6
Total Sugars						
Control	4.1	3.6	4.2	3.6	4.3	4.2
Irradiated	4.2	3.9	4.2	4.1	4.4	4.7

The value are the average of three determinations and expressed in gm/100 gms of wet sample.

Table 5: Effect of irradiation and storage on the organoleptic qualities of potato chips/french fries

Storage period weeks	Potato Chips				Potato French Fries			
	Cardinal		Partones		Cardinal		Partones	
	0	0.10 kGy	0	0.10 kGy	0	0.10 kGy	0	0.10 kGy
0	8.7	8.5	8.5	8.4	8.5	8.5	8.6	8.4
8	7.6	8.4	7.6	7.6	7.6	7.6	7.5	7.8
16	7.4	7.6	7.5	7.8	7.8	6.3	7.6	7.4

The values are the average ratings of 10 judges. The numerical values indicate: Like extremely - 10, dislike extremely -1.

cost of irradiating potatoes from a source strength of 50 Ci and throughput rate of 20 t/h was determined to be Rs. 290.00 per tonne.

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