THE EFFECT OF GAMMA RADIATION ON POTATO TUBER ROT IN EGYPT

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INTRODUCTION

Potato (Solanum tuberosum L.) is considered one of the most important vegetable crops, Large amounts of this crop are kept under ordinary storage conditions. This freq-uently lead to many problems among which are sprouting, che-mical changes, loss of water, and dry matter, besides physio-logical and pathological disorders (El-Nashaby, Fawzia, 1985).

Nowadays, the use of ionizing radiation for food preser-vation appeared to be considered one of the most important peaceful applications of nuclear energy. A joint Expert committee on the Wholesomeness of Irradiated Food (JECFI,1981), concluded in 1981 that irradiation of food at the appropriate dose up to an overall average dose of 10 K Gy presents no toxicological hazard and introduces no special nutritional or microbiological problems, (WHO, 1981).

Irradiation of potato tubers has been used for inhibit-ion of sprouting and other morphological changes. As of April,1988 , 29 countries have been used γ irradiation com-mercially for sprout inhibition of potatoes, (Anonymous, 1988). Japanese Food additive laus do not allow use of chemicals applied in the United States and other countries to keep potatoes from sprouting during storage and depend only on gamma irradiation. The Japanese have operated the Commercial Shihoro Potato Irradiator that has irradiated an average of 30,000 tons of potatoes per year (Umeda, 1983).

However, the gamma irradiation doses that inhibited sprouting of potato tubers for relatively long periods cause a considerable rising of rot incidence (El-Sayed 1978). The post- harvest disease control of potatoes is complicated because the minimum inhibitory effective dose for rot fungi is relatively high, which might damage certain characteristics of the potato tuber, (Beraha, Louis et al.,1959).

This depressive effect of radiation on the immune machanisms, as represented by increasing rot incidence, has been attributed to the effect of radiation on lowering the capacity of potato tissue to form the natural antifungal compounds in response to infection (Metlitskii, 1967), in addition, γ irradiation induces remarkable inhibition in both chlorophyll and solanine in potato tubers and the extract of the later one represents the major fungitoxic compound, (Dharhar, 1969).

This investigation aimed to study the effect of sprouting inhibiting doses of γ irradiation on the natural resistance of potato tubers to Fusarium dry rot, the role of total glycoalkaloid and phytoalexin in disease resistant were studied. Different treatments were suggested to overcome the side effects of gamma irradiation, were also investigated in order to minimize the damage caused by gamma irradiation.

REVIEW OF LITERATURE

Causal Organisms :

Fusarium tuber rot of potato, caused by several species of the (Fusarium fungus) is one of the most economically important diseases of stored potatoes (Carpenter, 1915). Boyd (1952), mentioned that *Fusarium* spp. are the most important causes of tuber decay.

Ayers (1956), reported that the major species of the Fusaria inducing this disease were *Fusarium roseum* L k. ex. Fr. ' Avenaceum', *F. roseum* 'Sambucinum', and *F. solani*(Mart.) Appel et Wr. 'Coeruleum', of which *F. roseum* 'Sambucinum' and *F. solani* 'Coeruleum' were the most destructive ones.

Boyd (1972), demonstrated that potato (*Solanum tubercsum* L.) tuber rots caused by various species of Fusaria (*Fusarium roseum* Lk. ex Fr. f. Sp. *Sambucinum*: *F. roseum* 'Avensceum', *F. solani* (Mart.) var. Appel & Wr. Coeruleum (Sacc.) Booth; and *F. oxysporum* (Schlect.)) are a major cause of both storage and stand losses worldwide.

Meanwhile, Begel (1978), found that storage diseases of potatoes are divided into two major categories, fungal and bacterial. Fungal diseases are caused mainly by species of phoma or Fusarium giving e.g. dry rot, gongrene or silver scurf.

Valeria _et al_. (1983), observed that Fusarium dry rot, a disease of white potato tubers, is caused by several members of the genus _Fusarium_, the most important causal agents being _Fusarium roseum_ 'Sambicium', _Fusarium roseum_ 'Avenaceum' and _Fusarium solani_ 'Coeruleum'.

Hammerschmidt (1984), found that inoculation of potato tuber slices with a pathogen (_Fusarium roseum_ f. sp._sambucium_) penetrated into potato tuber slices and caused a gradual softening and darkening for these tissues, while inoculation of potato tuber slices with pathogens of other plant species (_Clodosporium cucumerinum_ and _F. roseum_) caused only a yellow discoloration in the host cell walls.

Effect of Gamma Irradiation on Sprouting and Weight Losses:

Heiligman (1957), found that sprouting occurred normally in the untreated controls and was completely inhibited in all lots treated with 15 or more kilorep. The lots treated with 5 kilorep and stored at 13 C had not sprouted after one months storage, but had developed many small(less than ¼ inch long) abnormal sprouts after two month's storage. Those stored at 22 C had developed about 20 per cent as many sprouts as the untreated control after one month storage, and about 34 per cent as many sprouts after two month's storage. In the lots treated with 10 Kilorep, only a rare sprout occurred in those stored at 22 C and none was noted in the lots stored at 13 C. The weight loss through sprouting was negligible in all samples.

Metlitsky et al. (1957), reported that gamma radiation applied to potatoes inhibits the mitotic activity of the cells irreversily both in the buds and in the parenchyma of tubers.

Schwrimmer et al. (1957), noticed that initiation of sprouting was observed on the control potatoes at both 40 F. and 70 F. within two weeks after the start of the irradiation experiments. At both temperatures, the sprouts continued to grow, the rate of growth being much smaller in the case at 40 F., as expected. At this temperature, the tubers with both 5,200 and 14,000 rad showed no evidence of sprouting until after 35 weeks, when extremely small bud-like structures appeared in most of the eyes. When the low-dosage-treated potatoes were stored at 70 F, considerable growth occurred in 2 weeks and the sprouts continued to grow. The high-dosage treated potatoes exhibited evidence of germination at 70 F, in that small buds appeared which were less than one millimeter in diameter and similar to those which appeared after 35 weeks at 40 F. However, these buds did not continue to grow upon further storage at 70 F.

Potato tubers treated with gamma irradiation showed a decrease in weight losses compared with the untreated ones. The doses giving the smallest losses in weight and dry matter were observed for 10 K rad applied, while higher doses produced greater losses (Kubicki, 1961).

Matthee (1963), found that a dosage of 44 K rad applied either immediately after harvest or a month later prevented tubers of Up-to Date and Arran chief from sprouting over a 5 month storage period.

Kahan and Temkin (1968), reported that six K rad doses for potatoes were insufficient to give sprouting control after the shortest storage period of 5 weeks, while 10 and 14 K rad controlled sprouting during all inspection periods tested (24 weeks). Eighty percent of the control potatoes stored at room temperature had 15 mm long sprouts after 6 weeks. About 50% of those stored at 4 and 8 C showed incipient sprouts up to 2 mm long which increased after 3 weeks at room temperature to 100% sprouting of 15 mm long sprouts.

Metlitsky et al. (1968), reported that gamma radiation applied to potatoes inhibits the mitotic activity of cells and the inhibition of mitosis is due to the inhibition of nucleic acid synthesis. Chachin et al (1972), showed that gamma irradiation affected the nucleic acid synthesis which was depressed in the meristemic tissues and consequently inhibited sprouting of onion and potatoes.

Abdalla (1973), found that potato tubers, 3 months after harvest at the dose levels of 10 and 14 K rad reduced markedly the sprout percentage with the period of storage ranging from 5 to 10 months after harvest.

Effects of gamma irradiation on the mass loss, specific gravity, firmness, sprouting and rotting of five varieties of potatoes grown in South Africa have been studied. Doses of up to 15 K rad inhibit sprouting without detrimental effects on the other physical properties. Excessive mass loss, shrinkage, and rotting found in some varieties are ascribed to unsuitable storage conditions rather than to irradiation (Winchester, 1975).

Baraldi (1978), indicated that ionizing radiation, if used properly is able to preserve potatoes for long term storage better than traditional methods based upon refrigeration and chemicals. In this respect several conditions should be carefully taken into account, proper variety, health of tubers (including absence of wounds at time of irradiation), minimum handling before, during and after irradiation, adequate interval between harvesting and irradiation. Care should be taken in selecting such conditions as temperature, humidity and ventilation during storage as well as providing as gentle means of transporation as possible (for instance, using wooden pallet boxes rather than sacks).

Mazon *et al.* (1978), found that 9 and 12 K rad, if applied during the resting period completely inhibited sprout of potato tubers, they also indicated that irradiation reduced the commerical weight loss after 6 months 10-15 % while it was 30% for untreated controls.

Auda and Khalaf (1979), observed that doses of 15 to 20 K rad caused some physical damage to potatoes stored in an incubator at 4 to 10 C. This damage was also observed when potatoes have been stored at room temperature sprouting appeared after 30 to 60 days storage. The best results were obtained when a dose of 10 to 12 K rad was used.

Okamoto *et al.* (1980), stored irradiated onions and potatoes for 5 to 8 months in natural conditions. They found that the time of sprouting of irradiated samples was delayed as compared to that of unirradiated, and the sprout inhibition to be more effective not only by heavier irradiation dose but by irradiation under higher dose rate also.

The irradiation of vegetables, such as potatoes or onions with doses of the order of 100 Gy (10 K rad) prevents sprouting. This effect is irreversible. Greening of the skin of white potatoes in the presence of light is inhibited. Suberization (wound healing) is prevented. With white potatoes there are varietal differences in the response to