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Research Article

Application of electron beam irradiation for the preservation of mixed fruit jam and assessment of mineral content during storage

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Abstract

The aim of the present investigation was to evaluate the mineral content of mixed fruit jam processed by electron beam irradiation instead of addition of chemical preservatives. The freshly prepared mixed fruit jam was exposed to electron beam irradiation at doses of 2.5 kGy, 5.0 kGy, 7.5 kGy and 10 kGy. The irradiated and control samples were stored at room temperature. The minerals sodium, potassium, phosphorus and calcium in the irradiated and control jams were evaluated at different time intervals. After irradiation and storage, minimal changes were observed in mineral content of mixed fruit jam at this dose levels (2.5 to 10 kGy) and it may not be affected the nutritional quality of the product compared to control samples. Therefore, the results suggest that the electron beam irradiation could be useful in preserving the mixed fruit jam without impairing the mineral content of jam after irradiation.

Keywords: Mixed fruit jam, Electron beam irradiation and Minerals.

Introduction

Mixed fruit jams retain the characteristics of two or more fruits and getting the product with higher nutritional value and pleasant sensory properties and thereby adding value and creating the possibility of getting importance in the consumer market. Jam is a traditional food product, commonly consumed as desert, bread spread, and cake toppings. Jam is an intermediate moisture food which is prepared by boiling fruit pulp with sugar, pectin, acid and other ingredients. It is light to dark brown in color, thick and spreadable in consistency, with creamy flavor and provides a good source of energy, vitamins and minerals. The jam quality are affected during the storage period based on the quality of the raw material used, recipe selection, processing conditions, method of preservation and storage conditions (Haffner *et al*., 2003; Redalen and Haffner, 2002; Wicklund *et al*., 2005; Kvikliene *et al*., 2006). The food products such as jams, jellies, sweets and juices were usually preserved by heat treatment with the addition of chemical preservatives (Battey *et al*., 2002). It is affected during storage and the speed of changes in products like formation of darkening, syneresis and changes in acidity, antioxidant properties, water activity and texture of the products (Khouryieh *et al*., 2005; Policarpo *et al*., 2007).

Food irradiation is the processing of food products by ionizing radiation and it is one of the preservation method to control the food borne pathogens, reduction of microbial load, sprout inhibition, insect infestation, preserve the nutritional quality and extend the shelf life of food products (Ramathilaga and Murugesan, 2011). According to the International Atomic Energy Agency (IAEA), more than 50 countries approved the use of irradiation for preservation of about 50 different types of food products. The irradiation has been used for several years in food preservation and satisfying quarantine requirements in trade, there is a little debate on the issue of health concerns over the nutritional quality changes of food products after irradiation. The quality evaluation of food products is useful to improve the processing conditions for getting the better quality products. Therefore, the aim of this present study was using the electron beam irradiation to preserve quality of the mixed fruit jam and to evaluate the mineral content of mixed fruit jam after irradiation.

Materials and Methods

Preparation of mixed fruit jam

The fruits papaya, banana, mango, apple, pine apple and guava were procured with the optimum stage of maturity for jam production from local wholesale market at Tirunelveli, Tamil Nadu. The fruits were washed in running tab water, peeled and cut into small pieces. Pulping of fruits by pass through a sieve and ground into suitable consistency with using a mixer. The pulps were taken in equal proportions from various fruits used in this study; it has mixed with sugar and boiled in stainless steel kettle till the end point was reached. The end point was determined by looking bubbles at the sides of the vessel while heating and plate method. A drop of boiling mixture was taken on a stainless steel plate, cool and tilt the plate when the mixture moved as a single mass, if jam ready to set. Finally, the acidity of jam was adjusted to pH 3.4 with lemon juice (source of citric acid) in the finished product (Singh *et al*., 2009). After, jam was placed in glass jars and it cooled down to room temperature.

Electron Beam Irradiation

The freshly prepared mixed fruit jam product was packed in polypropylene bags (6 × 6 cm) and exposed to Electron beam radiation at Microtron Centre, Mangalore University, Mangalagangothri, Karnataka, India. The conditions of the Microtron accelerator were maintained as: Dose rate, 3kGy min^{-1}; Beam energy, 8MeV; Electron pulse current, 15mA; Beam Uniformity, 8 × 8 cm. The samples were exposed to double side irradiation for uniform in dose delivery. The dose levels applied to jam were 2.5, 5.0, 7.5 and 10 kGy. The absorbed dose was measured by using chemical dosimetry. Similarly**,** packed samples without irradiation were used as control. All samples were stored at room temperature (Ramathilaga and Murugesan, 2011).

Minerals Analysis

Preparation of sample for minerals analysis

One gram of sample was weighed and it was taken in crucible and ashed in muffle furnace (temperature 600ºC). The ash was taken in a digestion flask and digested with a mixture of concentrated nitric acid, sulfuric acid and perchloric acid. Then it was cooled to room temperature. The digested material made upto a known volume with distilled water.

Phosphorous

Phosphorus was estimated by reacting with molybdic acid to form phosphomolybdate complex. It reduced to form a blue coloured solution of molybdenum complex on reaction with amino-naphthosulphonic acid. The blue colour appears due to it reaction with phosphorous which was present in the sample. It was read at 640 nm in spectrophotometer against a blank. The phosphorous present in the sample was calculated from the standard graph (Mazumdar and Majumder, 2003).

Potassium and Sodium

The aliquot of digested material was atomized in a pre-calibrated flame photometer. The percentage of light emitted is directly proportional to the amount of potassium and sodium present in the sample was measured by flame photometer at a specific wavelength 766.5 nm, 589 nm for potassium and sodium, respectively (AOAC, 1984).

Calcium

The titrimetric estimation of calcium was performed by precipitating it as calcium oxalate. The precipitate was dissolved in the sulphuric acid and the amount of calcium dissolved in the acid was determined by titrating against a standard potassium permanganate solution. The end point was determined by appearance of pink colour and persists for few minutes. One ml of 0.01N $KMnO_4$ solution is equivalent to 0.002 g of calcium, from this the amount of calcium present in the sample was calculated (Mazumdar and Majumder, 2003). All the experiments were carried out in triplicates. The data obtained from the study were expressed as the mean value of three replicates ± standard deviation.

Results

The phosphorus content of electron beam irradiated and non-irradiated jam were studied and it was presented in the Figure 1. The phosphorus content of jam was recorded in the range of 47.28 to 49.05 mg/100g of sample and it was found to be 48.66, 48.39, 48.77, 48.42, 48.51 mg/100g of sample in control and 2.5 kGy, 5 kGy, 7.5 kGy, 10 kGy of irradiated jam, respectively. After irradiation, no significant differences were observed in the phosphorus content of jam. At the end of storage, the phosphorus content of jam were 0.08%, 0.12%, 0.08%, 0.39%, 2.56% reduced in control and 2.5 kGy, 5 kGy, 7.5 kGy, 10 kGy of irradiated jam, respectively. The potassium content of irradiated and non-irradiated jam was studied and it was given in the Figure 2. The potassium content of jam was recorded between 47.00 and 47.33 mg/100g of sample. After irradiation of jam it was found to be 47.10, 47.30, 47, 47.20, 47.30 mg/100g in control and 2.5 kGy, 5 kGy, 7.5 kGy, 10 kGy, respectively. The potassium content of jam was not altered by radiation doses and storage.

The sodium content of jam was evaluated after irradiation (Figure 3), it was found to be 17.41, 17.22, 17.15, 17.28, 17.37 mg/100g of sample in control and 2.5 kGy, 5 kGy, 7.5 kGy, 10 kGy, respectively. At the end of storage period, the sodium content of jam were recorded as 17.38, 17.21, 17.14, 17.26, 17.36 mg/100g of sample in control and 2.5 kGy, 5 kGy, 7.5 kGy, 10 kGy, respectively. Both irradiation and storage, does not significantly affect the sodium content of jam. The irradiated jam was tested for the effect of electron beam irradiation on calcium content and it was given in the Figure 4. In jam, the calcium content was found in the range of 11.16 to 11.25 mg/100g of sample. After irradiation calcium content were recorded as 11.23, 11.24, 11.22, 11.23, 11.23 mg/100g of sample in control, 2.5 kGy, 5 kGy, 7.5 kGy, 10 kGy and during storage it was 11.19, 11.17, 11.19, 11.17, 11.21 mg/100g of sample, respectively.

Discussion

In general, after irradiation the macronutrients like protein, lipid and carbohydrates quality does not loss (WHO, 1999) and micronutrients like minerals also shown to remain stable (Diehl, 1995). Irradiation of different commercially available cats diets (25 - 50 kGy) and showed no significant differences in the macronutrients, minerals, vitamins, and fatty acids composition of the irradiated diet compared with non-irradiated diets (EFSA, 2011). Electron beam irradiation of mixed fruit jam did not significantly influence the overall composition of minerals. After irradiation and storage, slight variations were observed in mineral content of mixed fruit jam. These results are agreement with the Bhat *et al*. (2008), the changes in the mineral composition at this dose levels (2.5 to 10 kGy) are minimal and may not be hinder the nutritional quality of the product. The efficiency of using electron beam irradiation in preservation of grains, pulses, spices, sprouted seeds, dehydrated vegetables and tea leaves has been well documented with minimal quality loss than chemical treatment, gamma irradiation and other conventional treatments (Hayashi, 1998; Hayashi *et al*., 1998; Hayashi and Todoriki, 2001; Castell-Perez, 2004; Kottapalli *et al*., 2006).

Figure 1. Effect of electron beam irradiation on the phosphorus values of mixed fruit jam

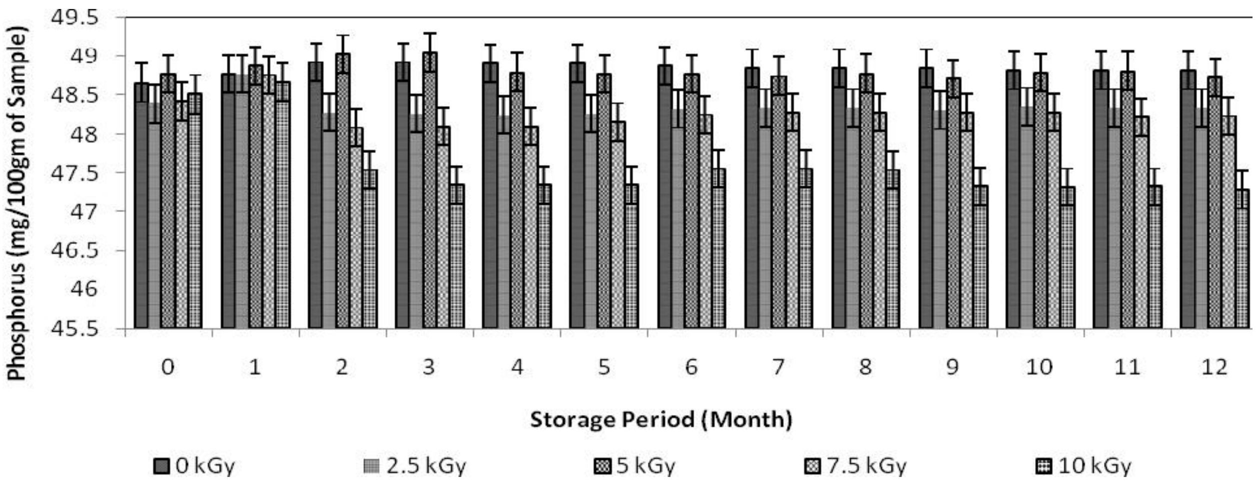


Figure 2. Effect of electron beam irradiation on the potassium content of mixed fruit jam

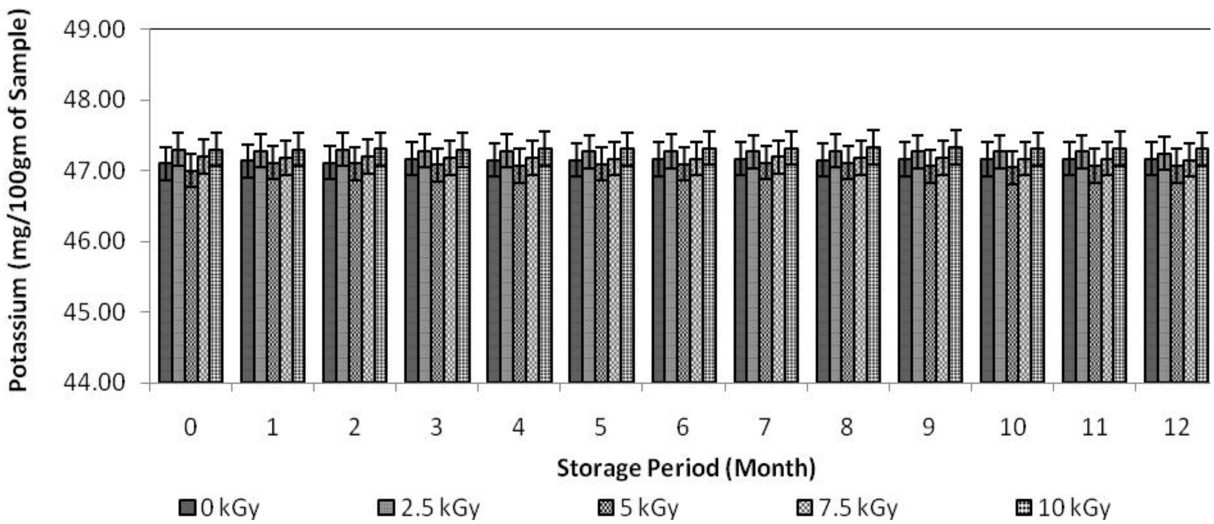


Figure 3. Effect of electron beam irradiation on the sodium content of mixed fruit jam

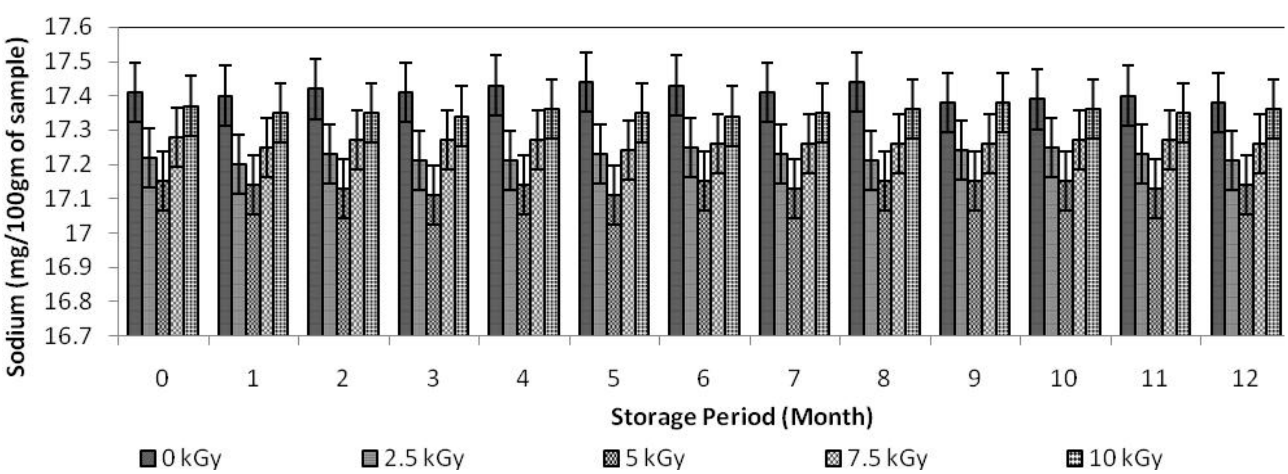
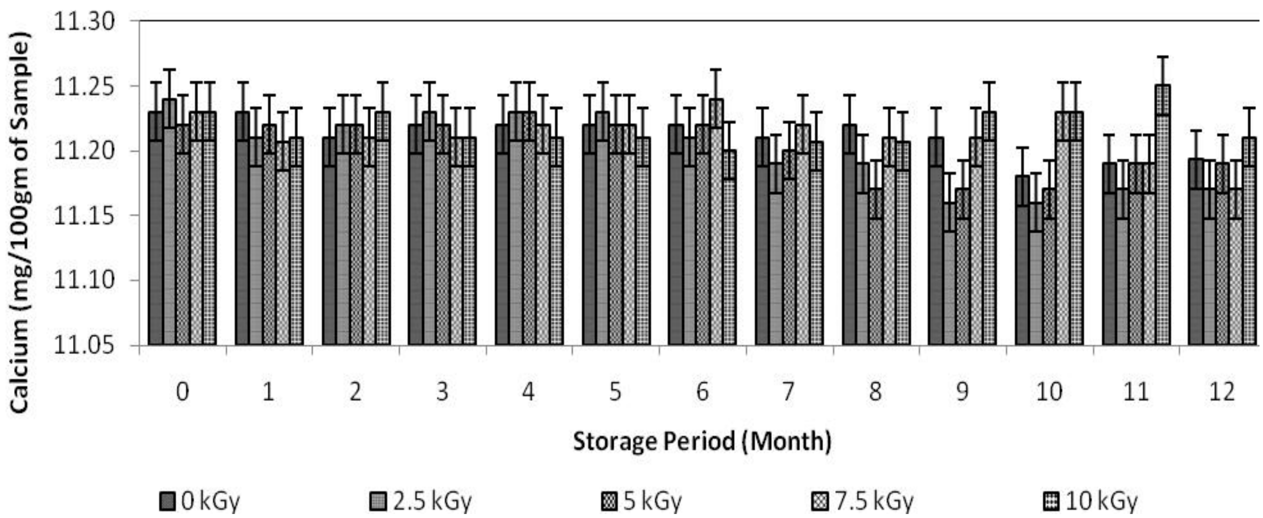


Figure 4. Effect of electron beam irradiation on the calcium content of mixed fruit jam



Conclusion

The jams are prepared from combination of different fruits pulps which is a rich source of carbohydrates, vitamins, minerals and dietary fibers that are essential components for normal growth and development. The minerals studied in mixed fruit jam were not significantly altered by irradiation. The safety and nutrient quality of food products could be improved by electron beam irradiation and efficient than other conventional food processing practices in shelf life extension when this technology to be exploited as one of the alternatives for chemical treatments.

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