International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

The Effect of Gamma Irradiation on Physical Parameters and Proximate Composition of Tomatoes

Kalyani .B[1], Manjula .K[2]

[1]Research Scholar, Food Technology Division, Department of Home Science, Sri Venkateswara University, Tirupati, India

[2]Assistant Professor, Food Technology Division, Department of Home Science, Sri Venkateswara University, Tirupati, India

Abstract: ***Vegetables were important foods and highly beneficial for the maintenance of health and prevention of diseases. There was a need to extend the shelf life of vegetables as a whole were considered as natural caches of nutrients gifted to human beings. The fresh tomatoes were treated with gamma irradiation and evaluated the physical and proximate analysis. Irradiation causes minimal modifications in flavor, color, nutrients, taste and other quality attributes of food. Tomatoes were irradiated at 0.25 kGy and 0.75 kGy doses. The physical and proximate analysis was analyzed in the control and experimental samples. The results indicate that there was a significant difference between the control and experimental samples at 1% level in color, moisture, fiber, carbohydrates and protein. There was no significant difference in weight in control and experimental samples. The overall results indicate that no nutrient loss was observed in experimental samples and in some experimental samples some of values were slightly increased when compared to control samples.***

Keywords: Vegetables, Irradiation, Tomatoes, Nutrients & Physical analysis

1. Practical Applications

Tomatoes was used in huge quantity and regularly used as either fruit or vegetable. There was a need to preserve and extend the shelf life of tomatoes. Tomatoes was processed and preserved in different forms but not as such. Non-thermal and minimally processed technology with minimal nutrient loss like gamma irradiation was employed for tomatoes to observe the nutrient loss and shelf life. A low dose of 0.25 and 0.75 kGy was applied for irradiation of tomatoes.

2. Introduction

A significant impact of globalization on horticulture has been an increasing demand for quality improvement and the wider adoption of quality standards for fruit, vegetable and salad commodities. Tomato (*Lycopersiconesculentum*ill.) is a major horticultural crop with an estimated global production of over 120 million metric tons[1].Since the time between fruit harvesting and consumption might be up to several weeks and during this period biochemical changes could happen that affect the nutritional value added of fruit or vegetables and shelflife.

The irradiation of food products is a physical treatment involving direct exposure to electron or electromagnetic rays, for their long time preservation and improvement of safety and quality [12]**.** Cobalt^{60} produces electromagnetic γ-rays which are similar to light but with much higher energy. This source of energy is being used for deinsectization, slowing the fruit ripening, elimination of pathogenic bacteria and parasites, and destruction of micro-organisms (33, 2000). Low dose of irradiation can be used to prolong the shelf life of many fruits and vegetables by reducing microbial spoilage, reducing the rate of respiration and delayed ripening.

Decontamination of food by ionizing radiation is a safe, efficient, environmentally clean and energy efficient process. Irradiation is particularly valuable as an end product decontamination procedure. Radiation treatment at doses of 2–7 kGy—depending on condition of irradiation and the food—can effectively eliminate potentially pathogenic nonspore forming bacteria including both long-time recognized pathogens such as *Salmonella* and *Staphylococcus aureus* as well as emerging or ‘‘new’’ pathogens such as *Campylobacter*, *Listeria Monocytogenes* or *Escherichia coli* O157:H7 from suspected food products without affecting sensory, nutritional and technical qualities. Radiation treatment is an emerging technology in an increasing number of countries and more-and-more clearances on radiation decontaminated foods are issued or expected to be granted in the near future[6].

Tomato is one of the most important "protective foods" because of its special nutritive value. It is one of the most versatile vegetable with wide usage in Indian culinary tradition. Tomatoes are used for soup, salad, pickles, ketchup, puree, sauces and in many other ways. It is also used as a salad vegetable. Tomato has very few competitors in the value addition chain of processing.

Tomato has long been used as food both in cooked as well as raw form. The deep red colouration of ripened tomato fruit is due to the presence of lycopene, a form of β- carotenoid pigment which forms the precursor of Vitamin A and hence is of great nutritional value. It is a rich source of water and its composition includes 95%. Today with an increased number of ailments of vision, these fruits rich in carotenoid pigment forms of prime importance to minimize the problems related to vision. Also tomato forms a major food component because of its wide distribution and application in a number of food stuffs either in Asian our European dish.

The tomato has significant popularity in today's market, both as a processed ingredient and as a fresh fruit. As a whole product, tomatoes maintain a delicate tissue structure that is extremely susceptible to chilling injury, mechanical damage and the presence of microorganisms. The shelf stability ranges from three days to three weeks depending on the time of harvest. Food retail and food service outlets are interested in minimally processed tomatoes for convenience and product standardization; however there is a need to improve food safety and the shelf life of these products. Irradiation has been proven to inhibit microbial growth, delay ripening and extend the shelf life of fruits and vegetables [5], however data specific to minimally processed tomatoes is lacking. Therefore, the objective of this research was to investigate the physical and impacts of gamma irradiation on fresh tomatoes.

3. Material and Methods

Sample collection

The fresh mature ripe tomatoes were purchased from the local market at Hyderabad. The tomatoes were cleaned and blotted on a paper to remove the traces of water and packed in high density polyethylene covers which are suitable for radiation processing. The size of the sample pack was 500g.

Irradiation

Most fresh fruits and vegetables will tolerate ionizing radiation at 0.25kGy with minimal detrimental effects on quality. At doses between 0.25 and 1.0 kGy, some commodities can be damaged. The relative tolerance of fresh fruits and vegetables is influenced by many factors; Commodity Factors: Type of commodity and cultivator, production area and season, maturity at harvest, initial quality and post-harvest handling procedures. Irradiation procedures: Dose, Dose rates, environmental conditions during irradiation, temperature and Atmospheric conditions [2].

Based on the available literature on radiation processing of foods, 0.25 and 0.75 kGy were chosen for the current study and the samples were irradiated. The process of radiation was carried out using the Gamma Irradiation chamber (Model–GC-5000) with radiation source – Cobalt ^{60}.

Color Measurement

The color of tomato samples was analysed by using the Color - Hunter lab manual for Color Flex spectro colorimeter Master color data (CEILAB 10 /D65). The tomato color was measured at frequent intervals during storage period to know the differences between the samples. In color measurement the L* value indicates Lightness, a* indicates hue and b* indicates the value of brightness of the samples.

Weight

The initial and final weights of mushrooms and tomatoes were weighed to compare the differences in control and experimental samples. The weighing was done by using the digital weighing balance.

Proximate analysis

Proximate analysis includes major indicators of nutrition value of food namely, Protein, Fat, Ash and Moisture. Carbohydrate is calculated based on this four test results (100 %-Protein-Fat-Moisture-Ash). The proximate analysis of tomato samples was carried out with standard AOAC procedures.

4. Moisture

Principle

Loss in mass, expressed as a % undergone by the product under specific conditions. A test portion is dried at a temperature of 100 to 105^{0}c under conditions; thereby loss is mass expressed as a moisture loss in tomatoes [4].

Equipments Used: Hot air oven and Desiccators

Procedure: Take a Petri dish with a sufficiently tight fittings lid. Note down the weight of empty Petri dish as $W_{1.}$Weigh about 5g of rice (test portion) into a Petri dish with a lid. Note down the exact weight $W_{2.}$ (Test portion distributed so as to give a mass per unit area of not more than 0.3 g (cm^2) Dry in hot air oven at 100 to 105^{0}c for 4 hours or till such time constant weight is obtained. Cool in desiccators and take the weight (W_3).

Calculations

$$\text{Loss on drying (Moisture) \%} = \frac{W_2\text{-}W_3 X100}{W_2\text{-}W_1}$$

Crude Fiber Content

Moisture and fat free sample was treated with 0.255NH2SO4 and 0.313N NaOH and then washed with ethanol and ether. It was then transferred to a crucible, dried overnight at 80-100^{0}C and weighed (W1) in an electric balance. The crucible was heated in a muffle furnace at 600^{0}C for 6 hours, cooled and weighed again (W2). The difference in the weights (W1-W2) represents the weight of crude fiber [9].

Carbohydrate content

The content of the available carbohydrate was determined by the following equation [9]:
Carbohydrate (g/100g sample) = [100 – (Moisture + Fat + Protein + Ash + Crude Fiber)].

Protein content

The protein was analysed by using the Protein -Leco Analytical Manual, Equipment –Automatic Protein Analyzer. The amino nitrogen in various nitrogenous compounds in biological samples get converted into total organic nitrogen in Lecoanalyzer by combustion of sample through Doumas method, thereby protein content is arrived at Automatic Protein Analyzer .

Enter blank weight by default as 0.500 and press analyze button. Automatically protein percent will be displayed. Repeat blanks until the instrument is stabilized. Blank correction can be done. Take around 0.2 grams of standard ETDA (Ethylene Tetra Di Amine) and analyze 4-5 times.

Correct the standard. Standard value for EDTA is around 9.40-9.70% nitrogen. Standard is calibrated so that standard corrected value falls within range. Take around 0.2g m of sample in triplicate using aluminium foil and note down the weights as W1, W2, W3 grams. Enter the sample weights in the instrument and analyze for protein percent and note down as P1, P2, P3%. Take average protein content in the sample as g%. Analyze samples in triplicates and note the average protein content in g%.

Statistical analysis

The statistical analysis was done by using SPSS-20 version. The control and experimental samples was analyzed by using the paired sample test, ANOVA (repeated measures mixed model ANOVA).

5. Results and Discussion

Environmental conditions have strong impact on most of the quality traits of tomato such as color and firmness of fruits and food products were affected by heat, cold, water, moisture and storage time (cause). Different symptoms of quality deterioration, like too low or too rapid coloring, fruit softening and moulds breakdown, could have been pronounced during the storage of tomatoes [8].

Effect of Radiation on Color of Tomatoes

The color of the tomato samples were analyzed in control and experimental samples. The significant difference at 1% level was observed in between the control and experimental samples of tomatoes. (Table no.1)

Table 1: Effect of Radiation on Color of Tomatoes

Parameters	Control Mean ± SD	0.25 Mean ± SD	0.75 Mean ± SD	F- VALUE
L	34.7±0.01	36.44±0.11	40.75±0.06	5669.43**
A	25.60±0.01	32.87±0.06	33.85±0.02	41548.56**
B	13.79±0.04	15.07±0.02	19.55±0.04	29046.22**
Weight	100±2.00	100.67±0.58	100±1.00	0.250

* - Significant at 5% value

**- Significant at 1% level

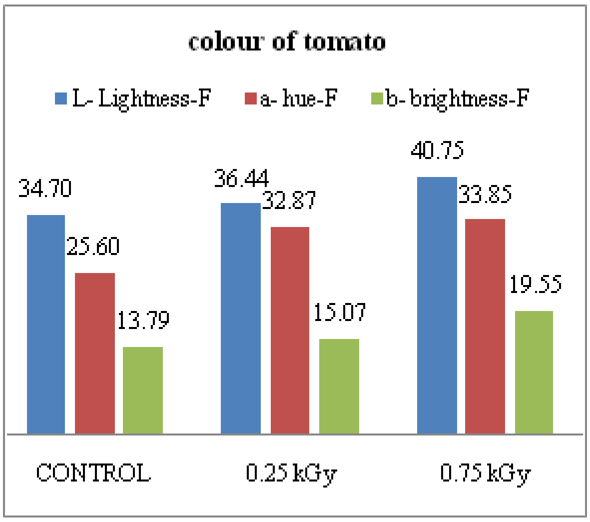

Figure 1: Color of tomatoes in control and experimental samples

The colour values of L, a and b in tomatoes was increased by radiation processing in both 0.25kGy dosage and 0.75kGy dosage when compared with control sample. The L value of color was 31.83 in control, 31.95 in 0.25kGy and 32.45 in 0.75kGy. The a value of color was 30.24 in control, 30.59 in 0.25kGy and 30.74 in 0.75kGy. The b value of color was 16.04 in control, 17.27 in 0.25kGy and 17.49 in 0.75kGy.

Tomato fruits go through several stages of development during their maturation process. During early stages, the fruit continues to grow in size and remains green, typically requiring 40-50 days. Once the fruit has reached full size (called "mature green"), changes in pigment begin to take place, causing the green to fade to light green then to the appropriate pigments for that particular cultivar, be it red, pink, yellow or orange. Ripening and color development in tomatoes is governed primarily by two factors: temperature and the presence of a naturally occurring hormone called "ethylene"[10].
The darkness and redness of color of tomatoes was increased but yellowness decreased with time while on 1st day they were greenish yellow to yellowish red in color. This was usually happened because of the presence of own photoreceptors that ripen the mature green tomatoes even after harvest [3].

Effect of Radiation on Weight of Tomatoes

The tomato samples were weighed at frequent intervals. A slight difference was observed in control and experimental samples, this was due to the weight variations, chemical changes and evaporation of water from the fruit surfaces occurred during the processing. No significant difference was observed in weight in between the control and experimental samples of tomatoes. (Table.No.1)

As weight loss is one of the indications of deterioration, degrading the quality and loosing the quantity. The effect of temperature is shown clearly that at lower temperature the loss of weight is less and becoming higher as the temperature increases. The weight loss could be due to senescence or more desiccation of tomatoes as these processes are higher at higher temperature [8].

Effect of Radiation on Proximate Analysis of Tomatoes

The proximate analysis of tomatoes was analyzed in control and experimental samples. The results indicate that 1% significant difference was observed in between the control and experimental samples. The results of the proximate analysis of tomatoes were tabulated in Table No.2.

Moisture: The moisture % in tomatoes in control was 91.87 whereas in 0.25kGy dosage it was increased to 92.7 and in 0.75kGy it was decreased to 91.13. Moisture content of foods is influenced by type taken, variety and storage condition of tomatoes or any fruit/vegetable. Some times in market different types of varieties are mixed, that may affect the nutrient proportion of that particular fruit/vegetable [13].

Fiber: The fiber content of the tomatoes was decreased in experimental samples when compared to the control. The fiber % in control was 0.69, 0.64 in 0.25kGy and 0.48 in 0.75kGy.

Carbohydrate: The carbohydrate % in tomatoes was decreased in 0.25kGy when compared to control, whereas in 0.75kGy only a slight variation was observed. The carbohydrate % in control was 6.47, 5.35 in 0.25kGy and 6.43 in 0.75kGy.

Table 2: Proximate analysis of tomatoes in control and experimental samples

Parameters	Control Mean ± SD	0.25 Mean ± SD	0.75 Mean ± SD	F-VALUE
Moisture %	91.87±0.15	92.70±0.36	91.13±0.25	25.52**
Fiber %	0.69±0.02	0.64±0.01	0.48±0.03	97.02**
Carbohydrate %	6.47±0.15	5.35±0.08	6.43±0.28	33.42**
Protein %	0.83±0.03	0.58±0.03	0.70±0.02	82.76**

* - Significant at 5% value
**- Significant at 1% level

Protein: The protein % in tomatoes was decreased in 0.25kGy when compared to control, whereas in 0.75kGy only a slight variation was observed. The protein % in control was 0.83, 0.58 in 0.25kGy and 0.70 in 0.75kGy. Mehta and Nair (2011) reported a reduction in protein content at higher doses.

Rukhama et.al., reported that the study on gamma irradiation, stated that the dose of 3 kGy may be effectively used for the shelf life extension without causing the drastic changes in nutrient content of canned tomato paste. Yaqvob Mami et,al. stated that irradiation significantly affected the protein content of button mushroom. The amounts of protein continually decreased from day 1 to day 16. Murr and Morris had pointed that protein degradation, as indicated by protease activity and the level of free amino acid in the tissue. Increased during postharvest maturation of the mushroom, and they assumed that the assimilation may function as the source of C or N.

6. Conclusion

The results of study show that there was no huge nutrient losses were observed by radiation processing. The radiation processing cannot effect the physical parameters and as well as proximate analysis of tomatoes. The effect of radiation will depend on many parameters like growth, temperature and storage conditions.

References

[1] A Review of Recent Research on Tomato Nutrition, Breeding and Post-Harvest Technology with Reference to Fruit Quality. (F.A.O. 2007)
[2] Abdel-Kader, A.S., L.L. Morris and E.C. Maxie, 1968. Physiological studies of gamma irradiation of tomato fruits. I. Effect on respiratory rate, ethylene production and ripening. Proc. Amer. Hort. Sci., 92: 553-567.
[3] Alba, R., M.M. Cordonnier -Pratt and L.H.Pratt, 2000. Fruit-localized phyto chromes regulate lycopene accumulation independently of ethylene production in tomato. Plant Physiol., 123;363-370.
[4] AOAC, 2005. Association of Official chemist, Official methods of analysis AOAC, 18Th edition, Washington D.C.
[5] Chervinand Boisseau, 1994; Hagenmaier and Baker, 1997, 1998;Howard et al., 1995; Prakash et al., 2000a, b,
[6] Farkas. J, Irradiation as a method for decontaminating food-A review, International Journal of Food Microbiology 44 (1998) 189–204
[7] Food Research International, 33 (2000) 719±724.
[8] Herregods, M., 1971.storage of tomatoes. Acta Hortic., 20:137-143.
[9] Raghuramulu N, Madhavan NK, Kalyanasundaram S. A manual of laboratorytechniques. National institute of nutrition ICMR. 1983; 142:319-320.
[10] Rosie Lerner. B, Tomatoes Not Ripening. Purde garden News.,Sep. 2006.
[11] Rukhama Haq, Sidra Akram, Neelma Munir*, Faiza Saleem and Shagufta Naz, Influence of gamma radiation on nutrient contents of canned tomato paste,*Mycopath*(2014) 12(1): 53-57.
[12] Urbain, W.M., 1986. Food Irradiation. Academic Press, Orlando, FL: New York. Enwere NJ (1998). Foods of Plant Origin. Afro-orbis publishers, Nsukka, Nigeria.pp 124-145.
[13] Wilkerson ED, Anthon GE, Barrett DM, Sayajon GFG, Santos AM, Rodriguez-Saona LE, 2013. Rapid assessment of quality parameters in processing tomatoes using hand-held and benchtop infrared spectrometers and multivariate analysis. *J.Agric. Food Chem.*, **61**: 2088-2095.
[14] Mehta AK, Nair R, 2011. Use of Gamma Irradiation for Prolonging Shelf Life of Garden Pea (*PisumsativumL.*). *Nuclear Tech. Food Agric.*, **12**: 38-45.
[15] Yaqvob Mami, Gholamali Peyvast, Farhood Ziaie, Mahmood Ghasemnzhad and Vahid Salmanpour, "Improvement of shelflife and postharvest quality of white button mushroom by electron beam irradiation, Journal of food processing and preservation 30 (2014), Pg No. 1673-1681.