



APPLICATION OF γ - IRRADIATION AND CHITOSAN SKIN COATING FOR EXTENSION OF STORAGE LIFE IN MANGO FRUIT

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ABSTRACT

Present study was conducted at Post Harvest Research Centre, AARI, Faisalabad, Pakistan during 2018 to observe effect of gamma irradiation and chitosan in combination and separately on the shelf life of mango fruit. Highly significant differences were recorded for studied quality parameters except pH for different treatments. The minimum weight loss (1.85%±1.87) was observed in mangoes treated with irradiated chitosan and maximum firmness (14.95Kg±1.81) was also retained in the same treatment. During storage, weight loss, TSS and pH followed an increasing trend while, a decreasing trend in firmness and acidity was pragmatic. Skin coating of irradiated chitosan proved better as compared to non-irradiated chitosan coating and gamma irradiation.

KEYWORDS: Gamma irradiation, chitosan coating, mango, shelf life, TSS, Pakistan.

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INTRODUCTION

Mango fruit (*Mangifera indica* L.) is one of the main and popular fruits in Pakistan and considered as the "king of fruits" because of its popularity in tropical regions. Pakistan is ranking 4th in export of mango (Maqbool *et al.*, 2007). In 2016-17 the export of Pakistani mango was 61.509 thousand tons having worth of Rs. 5958.893 million (PBS). In Pakistan, mango was grown in an area of 174601 hectares with a production of 1716882 tons (GoP, 2014). Besides, its delicious taste and captivating flavor with multifarious color, it has a comparatively high calories content of 60 Kcal/100 g fresh weight. It is also an important source of various minerals i.e. potassium (168 mg), iron (160 µg), and vitamins such as ascorbic acid (36.4 mg), retinol (1082 IU), β -carotene (445µg) and Pantothenic acid (160 µg) (USDA, 2016).

Preservation of freshness and wholesomeness of food commodity is becoming more challenging with the consumer requirements. There is a need of preservation techniques that prevent biochemical activities of enzyme. Food manufacturers are looking for safe and natural food preservers because of health issues caused by the use of synthetic chemicals (Sonti, 2003).

Mango displays a distinctive climacteric behavior, characterized by a post harvest climaxing of respiration and simultaneous production of ethylene, the ripening hormone (Sharma, 2008). Mango being a highly perishable fruit possesses a very short shelf life and reach to respiration peak of ripening process on 3rd or 4th day after harvesting at ambient temperature

(Abbasi, 2009). This short life span seriously bounds the commercial transport of mango fruit to distant market. Soft texture of mango and high amount of sugars increases the susceptibility to postharvest pathogenic infestations. Constant use of fungicides to control postharvest losses and to prolong the post-harvest life of fruit cause pathogen resistance against fungicide. User concerns about the fungicide residues on the surface of fruit and its influence on the surroundings, has demanded the formation of eco- friendly bio preservative (Mari *et al.*, 2014). It is the need of time to develop better and improved mango storage techniques for prolonged shelf life with acceptable quality in order to earn foreign exchange. Edible coatings and irradiation of perishable commodities have attained considerable attention during contemporary years. Natural edible biopolymer chitosan is derived from chitin deacetylation, having antimicrobial activities against a wide range of microorganisms (Devlieghere *et al.*, 2004; Lan, 2000). Other edible coatings such as aloe vera gel and pectin have been employed in nectarine and mango by different researchers (Ahmed *et al.*, 2009; Moalemiyan *et al.*, 2012).

Ionizing radiation, another source of preserving food stuff is also being applied for improving storage life of different fruits and vegetables, as these have confirmed capacity of inhibiting the proliferation of microbes. ⁶⁰Co and ¹³⁷Cs are reported to stop bacterial and fungal growth (Kaferstein and Moy, 1993).

This study was designed to elucidate the effect of γ - irradiation associated with chitosan coating on

preservation of mango fruit by delaying ripening process and its influence on the quality as well as physicochemical characteristics of the mango fruit.

MATERIALS AND METHODS

This study was conducted at Post Harvest Research Center, AARI, Faisalabad, Pakistan during the year 2018. Mango fruits (cv. Chaunsa) fruit was harvested from the orchard. Mature fruits without mechanical injuries and infection were chosen and dipped in the sodium hypochlorite (200ppm) solution and then dried in air. The high molecular weight chitosan (Daejung, Korea) coating was prepared by mixing 1.5% chitosan in acetic acid (1%) solution (Romanazzi *et al.*, 2009). Irradiation experiments were conducted at Pakistan Radiation Services (PARAS), Lahore, Pakistan. Gamma (γ) radiations from ^{60}Co source at 350Gy were applied to irradiate chitosan solution and mangoes. Mango fruit without irradiated/non-irradiated chitosan coating and irradiation were also stored as control. Treated fruits (irradiated/non-irradiated chitosan coating and irradiation) and control were stored in cardboard boxes at room temperature ($25\pm 2^\circ\text{C}$) for four weeks.

Physico-chemical parameters i.e., firmness, weight loss, acidity, pH and total soluble solids (TSS) were determined in treated and untreated mango fruit. Weight loss percent of fruit samples (5 fruits per replication) was determined at the start and at the end of each storage interval. Fruit weight was measured with digital balance at the interval of five days. The difference in initial and final fruit weight during that storage period was considered as total weight loss. Percent weight loss was calculated according to following equation.

$$\text{Weight loss (\%)} = \frac{\text{Fresh weight} - \text{weight after storage}}{\text{Fresh weight}} \times 100$$

Firmness of fruit was measured using a penetrometer (PCE-FM 200) of 8mm plunger. Digital refractometer (HANNA, HI 96801) was used to determine TSS levels of fruit according to method outlined in AOAC (Anon., 1990).

Acidity were measured by digital acidity meter (model GMK-835F). Mango fruit juice pH was recorded using

digital pH meter (Model: IQ 150) according to method No. 981.12b delineated in AOAC, 1990 (Anon., 1990). Data were recorded in triplicate for each experiment and averaged facts were subjected to CRD factorial ANOVA by using statistical software Statistix 8.1.

RESULTS AND DISCUSSION

Significant changes were recorded for studied quality parameters except pH in mango during storage period and results for mean values in (Table 1). Minimum weight loss percent was noted in mangoes coated with irradiated chitosan ($1.85\% \pm 1.87$) followed by fruits treated only with chitosan ($2.15\% \pm 2.10$). Maximum firmness (14.85 kg) was noted in irradiated and chitosan treated mango fruit against, least firmness in mangoes set aside as control (11.35 kg). The lowest percentage of TSS ($9.09\% \pm 2.11$) was recorded in γ -irradiated chitosan treatment followed by chitosan treated mangoes ($9.85\% \pm 2.77$). Maximum pH was determined in mangoes kept as control treatment (3.81) whereas, irradiated chitosan coating treated mangoes possessed the lowest pH (3.72 ± 1.64). The highest acidity (1.81%) was observed in mangoes treated with irradiated chitosan trailed by chitosan treated mangoes (1.18%).

The course of storage are presented in Table 2. An increasing trend was recorded in percent weight loss during storage and it was maximum ($4.94\% \pm 0.92$) on 25th day of storage. Firmness of fruits decreased gradually with the passage of storage and on the last day, mean value was $8.58\text{Kg} \pm 2.86$ as compared to that on the start of storage ($16.04\text{Kg} \pm 0.26$). Similarly, TSS was found to be significantly increased during the study period. The highest TSS ($17.34\% \pm 4.35$) was found in fruits on 25th day of storing. Similarly, pH also exhibited an increasing trend during storage and it was the highest (5.77 ± 0.28) on 25th day followed by 20th day of storage (5.48 ± 0.05). A decrease in acidity was recorded with the passage of time. In the start of study, $2.09\% \pm 0.43$ mean acidity was noted which declined upto $0.74\% \pm 0.53$ at the end of the trial.

Mango fruit is high in nutritive value and a rich source of antioxidants. It's a perishable fruit which

Table 1. Mean Values for the Effect of Chitosan Skin Coating and Gamma-irradiation on Selected-Storage Quality Parameters of Mango

Treatments	Parameters				
	Weight Loss (%)	Firmness (Kg)	TSS (%)	pH	Acidity (%)
Control	3.54 ^a ±2.31	11.35 ^c ±4.41	13.66 ^a ±5.09	3.81 ^a ±1.47	0.99 ^b ±0.80
γ -irradiated	2.45 ^b ±1.90	11.92 ^{bc} ±3.32	12.57 ^a ±4.99	3.78 ^a ±1.44	1.17 ^b ±0.67
Chitosan treated	2.15 ^{bc} ±2.10	13.31 ^b ±2.45	9.85 ^b ±2.77	3.69 ^a ±1.45	1.18 ^b ±0.26
γ -irradiated chitosan treatment	1.85 ^c ±1.87	14.95 ^a ±1.81	9.09 ^b ±2.11	3.72 ^a ±1.64	1.81 ^a ±0.25

*Mean values with same letters are statistically not significant

Table 2. Mean Values of storage quality parameters in Mango after γ -irradiation and Chitosan Skin Coating Treatment during the Course of Storage.

Days of Storage	Parameters				
	Weight Loss (%)	Firmness (Kg)	TSS (%)	pH	Acidity (%)
0	0.0 ^e ±0	16.04 ^a ±0.26	7.52 ^d ±0.093	2.40 ^d ±0.14	2.09 ^a ±0.43
5	0.7 ^d ± 0.97	15.1 ^a ±1.26	8.77 ^{cd} ±1.49	2.62 ^{cd} ±0.12	1.54 ^b ±0.29
10	1.74 ^c ±1.09	14.62 ^{ab} ±1.38	9.32 ^{cd} ±1.67	2.84 ^c ±0.04	1.28 ^{bc} ±0.39
15	3.14 ^b ±0.79	12.69 ^b ±1.38	10.74 ^c ±1.99	3.39 ^b ±0.43	1.07 ^{bcd} ±0.58
20	4.49 ^a ±0.92	10.28 ^c ±3.23	14.07 ^b ±3.68	5.48 ^a ±0.05	0.99 ^{cd} ±0.47
25	4.94 ^a ±0.92	8.58 ^c ±2.86	17.34 ^a ±4.35	5.77 ^a ±0.28	0.74 ^d ±0.53

*Mean values with same letters are statistically not significant

is credited to colossal physiological postharvest processes due to enzymatic reactions. Slowing down of these physiological processes could be employed in minimizing postharvest losses and increasing shelf life of fresh commodity (Mahajan *et al.*, 2014). Different researchers have worked on the application of skin coatings and irradiation for enhancement of storage life of perishable agricultural crops (Vargas *et al.*, 2008).

Polygalacturonase, pectinesterase and other enzymes are associated with the cell wall breakdown result in firmness loss which in return is associated with the ripening of mango fruit (Narain *et al.*, 1998). Irradiation causes splitting of longer chitosan molecules into smaller bits which increase its solubility and efficacy as skin coating (Rafaat and Sahl, 2008). This could be the reason of less weight loss and high firmness in irradiated chitosan coated mangoes during present studies. During fruit ripening, an increase in polygalacturonase and pectin-esterase activities results in depolymerization of pectin substances and reduced oxygen availability slows down these activities in skin coated fruits (Jitareerat *et al.*, 2007).

During contemporary trials, less contents of TSS may be credited to reduced degradation of carbohydrates and glycosides into subunits in irradiated chitosan treated mangoes. Sindhu and Singhrot (1996) reported less TSS contents in fruits coated with sesame oil as compared to control. Kulkarni *et al.*, (2010) proposed that skin coating may seal the stomata and lesser juice is formed due to dehydration. As the storage period progressed, TSS was found to be increased which could be ascribed to acid hydrolysis and polysaccharides deposition with the passage of storing time. Bisen *et al.* (2012) reported gradual increase in TSS during storage in guava and lime, respectively (Omayma *et al.*, 2010).

The change in pH is due to change in metabolic activity (Jitareerat *et al.*, 2007). Coatings slowed the changes on pH and total acidity and delay fruit senescence effectively. Shao *et al.* (2012) reported that semi permeable chitosan film modified the internal atmosphere of fruit i.e., the endogenous carbon dioxide and oxygen concentration resulting

in delay ripening (Ghasemnezhad *et al.*, 2010). The fruit acidity is very important to determine its quality and acceptability. The high or very low values of the acidity are not suggested. Reduction in acidity during storage is due to the conversion of acids into sugars and their consumption in the metabolic processes of fruit. Doreyappa and Huddar (2001) stated the similar pattern in different mango varieties during storage. Jiang *et al.* (2004) also described that titratable acidity decreased during storage in longan fruit treated with the chitosan coating.

It could be concluded that irradiated skin coatings could be employed for increasing the shelf life of mango, although further experiments are needed to study more complex metabolic changes during storage in the fruit to explore extra dimensions. Irradiated chitosan proved best among all the studied treatments.

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CONTRIBUTION OF AUTHORS

S. No.	Author name	Contribution	Signature
1.	Irrum Babu	Design and conducted the experiment and wrote the manuscript	
2.	Zarina Yasmin	Critically reviewed the manuscript	
3.	Rabia Kanwal	Helped in Analysis	
4.	Muhammad Asghar	Supervised the experiment	
5.	Riffat Tahira	Helped in manuscript technical write-up	