Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2021 18(2): 1107-1117. **OPEN ACCESS**

Effect of γ-Irradiation on the overall quality and Storage Stability of Stevia-Based Guava Drink

Syed Abdul Majeed Shah[1], Abdul Sattar Shah[2], Muhammad Imran[3], Sana Noreen[3*], Malik Muhammad Hashim[4], Abdul Jabbar[5], Bahisht Rizwan[3], Madiha Khan Niazi[6], Affifa Sani[6], Farooq Hassan[7], Fatima Raza[6], Tanweer Aslam Gondal[8], Ishtiaque Ahmad[9] and Umar Bacha[10]

[1]Department of Food Science & Technology, the University of Haripur, **Pakistan**
[2]KP Food Safety & Halal Food Authority, Peshawar, **Pakistan**
[3]University Institute of Diet and Nutritional Sciences, Faculty of Allied Health Sciences, The University of Lahore, Lahore, **Pakistan**
[4]Institute of Food Science & Nutrition, Gomal University D. I. Khan, **Pakistan**
[5]Department of Clinical Medicine, University of Veterinary and Animal Sciences, Lahore, **Pakistan**
[6]University Institute of Diet and Nutritional Sciences, The University of Lahore, Lahore, **Pakistan**
[7]Almajeed College of Eastern medicine, Hamdard University, Karachi, **Pakistan**.
[8]School of Exercise and Nutrition, Faculty of Health, Deakin University, Victoria 3125, **Australia**
[9]Department of Dairy Technology, University of Veterinary and Animal Sciences, Lahore 54000, **Pakistan**
[10]School of Health Sciences, University of Management and Technology, Johar Town, Lahore, **Pakistan**
***Correspondence:** sananoreen.rizwan@gmail.com **Received 16-01-2021, Revised: 26-03-2021, Accepted: 30-03-2021 e-Published: 05-04-2021**

The present study was conducted in NIFA Peshawar. Stevia-based guava drink was exposed to gamma irradiation and evaluated for Sensory quality and Physico-chemical parameters during storage intervals. Different irradiation doses (0.5, 1.0, 1.5, 2.0, and 2.5kGy) were applied to extend the shelf life of guava drink. The samples were analyzed for physicochemical analysis pH, Acidity, Ascorbic acid, Total phenolic compounds, sensory characteristics like Color, Taste, Flavor, Overall acceptability and Total viable count at 15 days' interval for total storage period of 90 days. The samples were stored at low temperature 4±2 ^{0}C. The results revealed that, the pH of the guava drink decreased in all samples. Initially the pH (4.17) recorded which gradually decreased to (2.86) at the end of the storage period. On the other hand, the increase in acidity was found in total samples of guava drink. The highest percent increase was observed in GD_5 (54.32%) while lower percent increase was found in GD_0 (48.15%). Ascorbic acid content was significantly decreased from 19.01mg/100ml to 1.65mg/100ml. The highest percent increase was observed in GD_5 (80.15%) while lowest was observed in GD_0 (72.82%). The Total Phenolic Compounds were increased from 684µg GAE/ml to 1163.64 µg GAE/ml. The maximum increase (80.15%) was observed in GD_5 while minimum (72.82%) was observed in GD_0. Gamma irradiation significantly reduced the total viable count of guava drink during storage. The organoleptic evaluation of the guava drink samples showed significant (P<0.05) decrease in parameters like flavor, taste and Overall acceptability. For the color, flavor, taste and overall acceptability maximum 8 score was given treatment GD_2 while minimum 2.2 score was given to treatment GD_0. Statistical analysis showed that both the irradiation and storage intervals have significant effect on the physicochemical and sensory quality of stevia-based guava drink. Guava drink irradiated at 1.0 kGy irradiation dose (GD_2) was found most acceptable among all the samples, on the basis of microbial and sensory characteristics.

Keywords: Gamma irradiation, Preservation, Guava drink, Microbial, Organoleptic

INTRODUCTION

Guava is a small tasty fruit with yellowish color and magnificent flavor scientifically known as (Psidium guajava L.) belongs to Family (Myrtaceae) has got valuable importance and accepted for its cultivation in a wide range of environments (Salim et al. 1998). Currently in Pakistan many districts produce guava on large scale. In the province of Punjab guava is grown on 57611 hectares area and produce (41464tones) of guava, covering area of (8529 hectares) Sindh produces (63544 tones) of guava, in Baluchistan guava cover an area of (529 hectares) and producing (2570tones) of guava, (26785, 15025 tones) of guava is produced in Khyber Pakhtunkhwa from an area of (1573, 1784 hectares) in two seasons that is Kharif and Rabi respectively (Aslam & Amin, 2015). Guava fruit is entirely fit to be eaten.

Because of its nutritious profile and low price, it is said that Guava is poor's man apple. It has medicinal properties like it helps in diarrhea and stomach related problems. The per 100g consumption of fruit provide , Carbohydrates 13.9-14.3 g, Protein 0.90-1.1 g, Fat 0.2-0.53 g, Calories 37-49, Crude Fiber 5.40g, Iron, 0.27 mg, Calcium 17mg, Carotene 373 µg, Vitamin A 21.01, Niacin 1.081 mg, vitamin C 228mg, Folates 49 µg, Niacin 1.084 mg, Vitamin E 0.73 mg, Vitamin K 2.6 µg, Potassium, 417 mg, Calcium, 18 mg, Magnesium 22 mg, Manganese, 0.150 mg, Phosphorus, 11 mg, Zinc, 0.23 mg, Lycopene 5204 µg. (Finkenstadt, 2019). Steviol glycoside is a sweet compound which is present in the leaves of "Stevia rebaudiana" specie and vastly cultivated for extraction of its sweet compounds. It is used as alternate of sucrose under the common name of Stevia (Abdullateef & Osman, 2012). Joint Food & Agriculture Organization, World Health Organization, Expert Committee on Food Additives, and Codex Alimentarius approved the use in soft drinks, juices, and foods (Chattopadhyay et al., 2019). Stevia is about 200-300 times sweeter than sugar; hence it is used in the food formulation along with bulking sweeteners (Cadena et al. 2013) studied the suitability of stevia as a sweetener in peach juice. Sweet and bitter after taste were determined both in peach and water. The results conclude that 160mg/L of stevia can be replaced by 34g/L of sugar in peach juice. On the other hand, using stevia sweeteners which contains 97% rebaudioside, in mango nectar, did not show any off-flavor in sensory tests (Song et al. 2006). The significant improvement in tamarind colour and antioxidants in carrot juice was observed which were treated with dose rate of 0-5 kGy (Omayio et al. 2019). It has noted in their research that 3 kGy significantly reduced the microbiological growth of mango wine. Therefore, the aim of the present study was to evaluate the effect of gamma irradiation and cold storage on the physicochemical parameters, organoleptic attributes and to extend the shelf life of stevia-based guava drink.

MATERIALS AND METHODS

This study work was carried out in Food and Nutrition Division (FND), Nuclear Institute for Food and Agriculture (NIFA), Peshawar.

Pre-processing

Best quality of guava fruit was purchased from local market. The guava fruit was then subjected to washing, in order to remove dust, dirt, and microbial load from the surface of fruit.

Preparation of drink

Washed guava fruit was subjected to grading, trimming, crushing and filtering. Muslin cloth was use to remove the seeds from pulp. 18% Guava pulp, 82% water and 0.5g/liter stevia was used to make drink, and the concentration of guava pulp was higher than (15%) and lower than (2025%) that as used by AOAC, 2013 (Ibarra Mayorga et al., 2019) in their ready to serve beverages.

Packaging

The guava drink was then packed in pre-washed 250 ml plastic bottles. The data was noted in interval of 0, 15, 30, 60, 75 and 90 days.

Irradiation process

The guava drink was then exposed to Cobalt for γ radiation of different doses. After irradiation, the samples was stored at lowtemperature in refrigerator for 90 days

PLAN OF STUDY

500 mg/L stevia, 18000 mg/L guava pulp, and 820 ml water used during formulation of stevia-based guava drink. Different irradiation doses like 0.5 kGy, 1.0 kGy, 1.5 kGy, 2.0 kGy and

2.5 kGy were applied and store at low temperature.

PHYSICOCHEMICAL ANALYSIS Titratable acidity (%)

Titratable acidity was measured in percent as explained in AOAC, 2012 (Ibarra Mayorga et al., 2019) standard method by Titrating the guava drink samples against the 0.1 N NaOH solutions.

Ascorbic acid

The total ascorbic acid in guava drink was measured by titration procedure as mentioned in AOAC (2012) method (Ibarra Mayorga et al. 2019).

pH.

The AOAC (2012) standard procedure was followed for pH determination.

Total phenolic compounds

Total phenolic compounds in the Guava drink were determined with Folin-Ciocalteus method as described by (Larmond, 1977).

Microbial study

Total Viable Count (CFU/100ml)

Standard procedure was followed to estimate the total number of viable microorganisms present in stevia-based guava drink as explained by (Steel & Torrie, 1986) in manual of food quality control.

Organoleptic characteristics

Guava drink was tested for (color, taste, flavor and overall acceptability) by panel using Hedonic scale ranging from (1 to 9) suggested by (Harder et al. 2009).

Statistical analysis

The data was analyzed statistically by CRD design and experiment had 2 replications for each treatment. Factor 1 contained, (control, 0.5kGy, 1.0kGy, 1.5kGy, 2.0kGy, and 2.5kGy) while Factor 2 contained interval of days that is (0, 15, 30, 45, 60, 75 and 90). Total number of 2treatments was 84 and 2 bottles from each treatment was used for physicochemical and organoleptic characteristics tests. LSD for means was estimated at 5 percent error as suggested by (Leite et al. 2006).

RESULTS

pH

The data regarding effect of irradiation on the pH of guava drink during a storage period of 90 days is depicted in (Figure 4.1.) A significant variation of pH content was found in all the irradiated samples. Primarily the value regarding pH was noted as GD_0 (4.17), GD_1 (4.16), GD_2 (4.15), GD_3 (4.13), GD_4 (4.11), and GD_5 (4.09) whichgradually decreased to GD_0 (3.08), GD_1 (3.04), GD_2 (3.01), GD_3 (2.97), GD_4 (2.91), and GD_5 (2.86). The maximum mean value was recorded for GD_0 (3.63) followed by GD_1 (3.60) while minimum mean value was recorded for GD_5 (3.48) followed by GD_4 (3.51). According to comparison, both irradiation and storage temperature effect significantly the pH of guava drink.

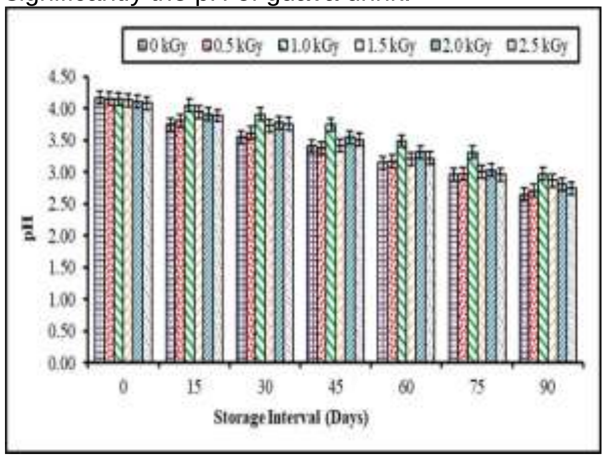

Figure 1: Effect of gamma irradiation and storage intervals on pH of stevia based guava drink

Our results are similar to the findings of (Memon et al. 2020) who observed decrease in pH of kiwi nectar as increase in irradiation dose. The decline in pH content of irradiated kiwi samples was also obtained by (Guerreiro et al. 2016) and decrease in pH values of irradiated green onion (Selambakkannu et al. 2011). Irradiation significantly decreased the pH content of cherry tomatoes as reported by (Saleh, 2013) The change of pH may be attributed to the formation of oxidizing components formed by degradation and this reaction is increased by irradiation (Arjeh et al. 2015). The decrease in pH might be due to the radiolysis of guava drink during irradiation process. Irradiation play an important role in chemical changes (Thakur & Arya, 1993) which might lead to the decline of pH. Decrease in pH of the guava drink in return leads to increase in acidity has been confirmed by several researchers.

The statistical analysis represents that in throughout storage period different irradiation doses and storage intervals had a significant ($P<0.05$) effect on the pH of stevia-based guava drink.

Acidity (%)

The acidity of the stevia-based guava drink increased in 90 days of storage interval as shown in (Figure.2) Increasing trend was noticed in all irradiated samples as well as in controlled samples during the storage period. Initially the value regarding acidity was noted as GD_0 (0.28), GD_1 (0.29), GD_2 (0.31), GD_3 (0.33), GD_4 (0.35), and GD_5 (0.37) which gradually incr

eased to GD_0 (0.54), GD_1 (0.57), GD_2 (0.62), GD_3 (0.68), GD_4 (0.76), and GD_5(0.81). The highest percent increase was found in GD_5 (54.32%) while the lowest percent increase was observed in GD_0 (48.15%).

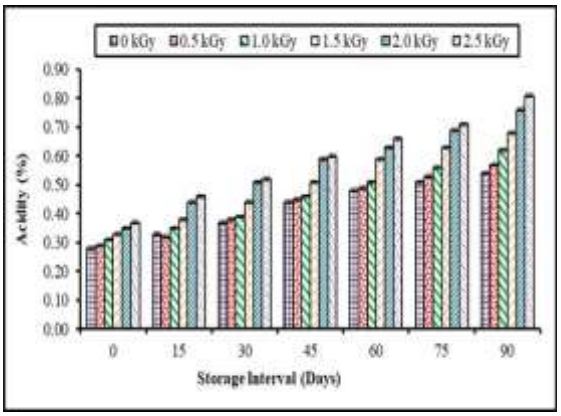

Figure 2: Effect of gamma irradiation and storage intervals on acidity of stevia based guava drink

The tendency of increasing in acidity is similar to the study of (Monju et al. 2013) they observed increase in mango pulp after irradiation dose from 0 to 2 kGy and storage of 9 months. (Selambakkannu et al. 2011) studied the effect of irradiation on nectar of kiwi fruit and concluded that 0.5 kGy irradiation dose presented an increase in the acidity (Saleh, 2013) studied on the effect of irradiation on the sensory and chemical changes in sweetened orange juice and mango pulp, they observed increase in acidity of juice during total period of storage. Increase in acidity due to the release of citric acid from the juice or it might be due to the degradation of free sugars into carboxylic acids from the juice by radiolysis (Arjeh et al. 2015). Or it might be due to increase in degradation of pectin substance in guava drink (Thakur & Arya, 1993). The statistical analysis represent that in throughout storage period different irradiation doses and storage intervals had a significant ($P<0.05$) effect on the titratable acidity of stevia based guava drink.

Ascorbic acid (mg/100ml)

The data regarding the effect of gamma irradiation on ascorbic acid content of guava drink during a storage period of 90 days are represented in (Figure 4.3). The results showed that the ascorbic acid content of guava drink was 19.01 mg/100 ml (GD_0), 18.99 mg/100 ml (GD_1), 18.91 mg/100 ml (GD_2), 18.86 mg/100 ml (GD_3), 18.81 mg/100 ml (GD_4), 18.76 mg/100 ml (GD_5) at day 0, and it reduced to 3.96 mg/100 ml (GD_0), 3.45 mg/100 ml (GD_1), 2.95 mg/100 ml (GD_2), 2.05 mg/100 ml (GD_3), 1.88 mg/100 ml (GD_4), and 1.65 mg/100 ml (GD_5) respectively at the end of the total period of storage. The maximum percent decrease of ascorbic acid in guava drink was observed in GD_5 (91.20%) while lowest decline was recorded in GD_0 (79.17%).

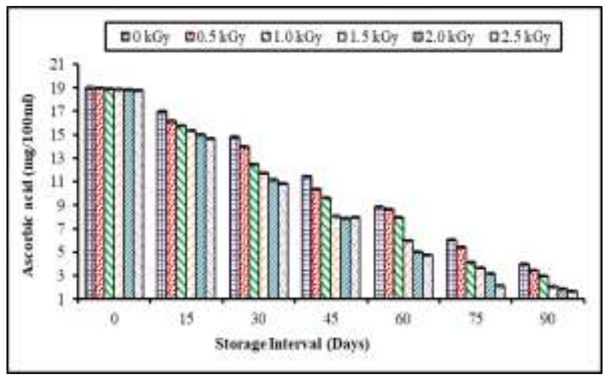

Figure 3: Effect of gamma irradiation and storage intervals on ascorbic acid (mg/100ml) of stevia based guava drink

(Monju et al. 2013) reported that the ascorbic acid content of mango juice was reduced due to irradiation upto 70% and 94% during storage. The ascorbic acid content of carrot and kale juices shows significant decreases with the increase in irradiation dosage, and the stored irradiated samples showed slightly higher levels than the non-irradiated control samples (Kausar et al. 2016). (Selambakkannu et al. 2011) found that a 50% reduction in ascorbic acid was observed in kiwi fruit nectar at 1 and 2 kGy doses (El-Beltagi et al. 2019) observed that reduction in ascorbic acid is significantly higher in the ashitaba and kale juices in dosage ranges from 1 to 5 kGy. Ascorbic acid is the most sensitive water-soluble vitamin to irradiation, and gamma irradiation causes partial conversion of ascorbic acid to dehydroascorbic acid (Kim et al. 2007) Subsequently, the oxidation of ascorbic acid will change its reduced form to become the oxidized form or known as dehydroascorbic acid. The dehydroascorbic acid goes through hydrolysis to 2,3diketogulonic acid, which then polymerizes and forms other nutritionally inactive products (Jo et al. 2012) ascorbic acid content converted to dehydroascorbic acid increased by irradiation (Kilcast, 1994). The statistical analysis represents that in throughout storage period different irradiation doses and storage intervals had a significant (P<0.05) effect on the ascorbic acid of stevia based guava drink.

Total Phenolic Compound

The initial total phenolic compounds observed for guava drink was (684.72µg GAE/ml) to (1163.89µg GAE/ml) which increased to (2518.96µg GAE/ml) to (5864.65µg GAE/ml), evaluated at 15 days interval for total period of 90 days as shown in (Figure 4.4). Maximum percent increase in total phenols was recorded in GD_5 (80.15%) followed by GD_4 (78.55%), while minimum percent increase in total phenols was observed in GD_0 (72.82%) followed by GD_1 (73.47%).

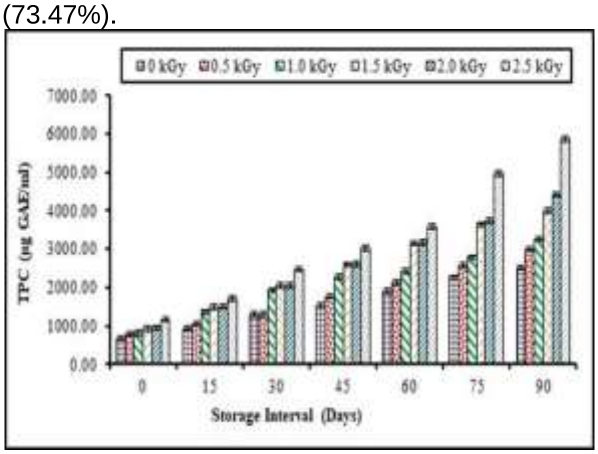

Figure 4: Effect of gamma irradiation and storage intervals on total phenolic compounds (µg GAE/ml) of stevia based guava drink

The effect of gamma irradiation on fruit juices shows an increase in the total phenol content, which could be the effect of the direct and indirect mechanisms of gamma rays. The direct mechanism could be due to the release of phenolic compounds from glycosidic components and degradation of larger phenolic compounds into smaller ones. The indirect mechanism is due to the radicals from radiolysis of water, which may break the glycosidic bonds of procyanidin trimer, tetramer, pentamer, hexamer, leading to the formation of procyanidin monomer, and it increases the total phenol content (Balaswamy et al. 2014). The total phenol content of the mango juice, both fresh and stored, increases from 2.2% to 12.3% and from 8.8% to 21.1%, respectively, as the irradiation dose increases from 1 to 5 kGy (Monju et al. 2013).The total phenolic content of the carrot juice was higher in the irradiated samples and increased further during the storage period (Polydera et al. 2003). (Balaswamy et al. 2014) also showed a similar result of an increase in total phenolic contents of ready to use tamarind juice as the irradiation dosage increases, but no significant change was observed during storage. The polyphenols of ashitaba and kale juices increased slightly at 1 kGy dosage and increased significantly at 3 and 5 kGy (Ferreira-Lima et al. 2013). Others authors have previously observed this phenomenon and reported a possible increment of polyphenolic compounds associated to the microbial growth or to reactions between oxidized polyphenols and formation of new compounds of antioxidant character during juice storage (Noreen et al. 2012) In addition, must be considered the possibility that during juice storage, some compounds could be formed and react with the Folin–Ciocalteu's reagent and significantly enhance the phenolic content. Usually, Folin-Ciocalteu's method is used for determination of the total phenolic content; however, this reagent is nonspecific, due to this method is affected by the presence of reducing sugars, aromatic amines, sulphur dioxide, ascorbic acid, organic acids and other natural compounds present in fruit juices, making the results often unstable. The statistical analysis represents that in throughout storage period different irradiation doses and storage intervals had a significant (P<0.05) effect on the total phenolic compound of stevia-based guava drink.

Total Viable Count

The data regarding the effect of gamma irradiation on total viable count of guava drink during a storage period of 90 days are represented in (Figure 4.5). The results showed that the total viable count of guava drink was 800CFU/ml in (GD_0) and in 200CFU/ml (GD_1) which increased to 6100CFU/ml in (GD0) and 1200CFU/ml in (GD_1) respectively.Maximum increase was found (86.89%) in GD_0 while minimum (83.33%) in GD_1. There was no colony forming units seen in other guava drink samples.

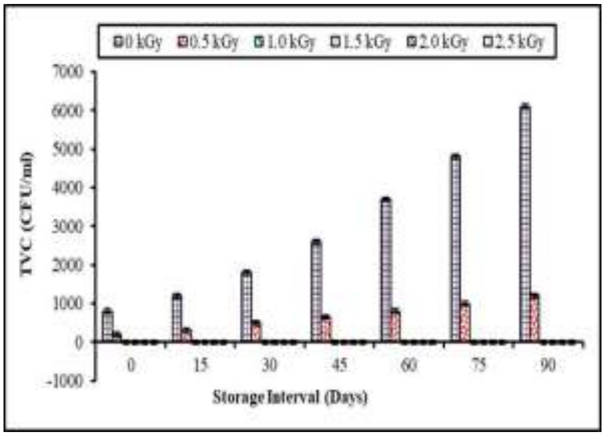

Figure 5: Effect of gamma irradiation and storage intervals on total viable count(CFU/ml) of stevia based guava drink

The results were in accordance with the reports by (Lado & Yousef, 2002) on mango wine, (Ferreira-Lima et al. 2013) on sour cherry juice and (Balaswamy et al. 2014) reported that the number of total bacterial in ashitaba, kale juice and tamarind juice decreased in a dose-dependent manner after irradiation and grew very slowly during the storage (Ferreira-Lima et al. 2013). found that 2kGy irradiation dose is enough to reduce and stop the microbial growth in pomegranate juice during storage. The researcher (Ibarra Mayorga et al. 2019) found no bacterial population after applying 3kGy irradiation dose on carrot and kale juices. Inactivation mechanism of microorganisms by gamma radiation is not completely explained. Based on the previous findings, Irradiation has a significant effect on microbes by causing irreversible changes to their DNA which leads elimination and growth of microbial population as reported by (Ferreira-Lima et al. 2013). Gamma radiation may denature proteins or remove hydrogen atoms from the bases of the DNA strands by generating hydroxyl radicals from water (Mexis, & Kontominas, 2009) In the present study, it was found that irradiation dose of 1 kGy was enough to completely inactivate microbial loads in the steviabased guava drink. The statistical analysis represents that in throughout storage period different irradiation doses and storage intervals had a significant ($P<0.05$) effect on the total viable count of steviabased guava drink.

Colour

Initially the mean score of judges for color of guava drink of GD0 to GD5 was (8, 8, 8, 8, 8 and 8) which was gradually decreased to (2.5, 5, 7, 7, 7 and 7) respectively at the end of total period of 3 months as shown in (Figure 2.7). Maximum mean score for colour (7.43) was noticed in GD_2 followed by GD_3 GD_4 and GD_5, whereas minimum was found in GD_0 (4.36), followed by (6.50) in GD_1. The highest percent fall in colour was observed in GD_0 (68.75%) followed by GD_1 (37.50%) while lowest was recorded in GD_2 (12.50%) followed by GD_3 GD_4 and GD_5 respectively

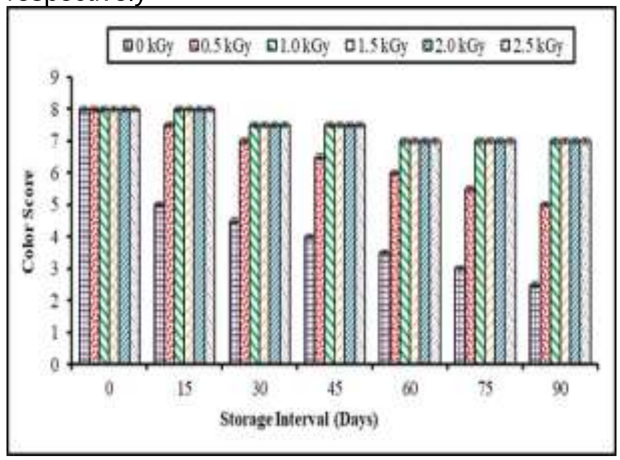

Figure 6: Effect of gamma irradiation and storage intervals on color score of stevia based guava drink

The color is not affected by irradiation as reported by (Yun et al. 2010) in ready to eat sorghum porridge meal & ready to eat spinach relish (Puligundla et al. 2017), in pistachio nuts (McDonald et al. 2013) in red wine and (Ferreira-Lima et al. 2013) in kale juice. The statistical analysis represents that in throughout storage period different irradiation doses and storage intervals had a significant ($P<0.05$) effect on the color of stevia-based guava drink.

Flavour

Initially the mean score of judges for flavour of guava drink of GD_0 to GD_5 was (8, 8, 8, 7.5, 6.75 and 6.5) which was gradually decreased to (2, 3, 6, 4.5,3 and 3) respectively at the end of total period of 3 months as shown in (Figure 2.6). Maximum mean score for flavour (7) was noticed in GD_2 followed by GD_3 (6), whereas minimum was found in GD_0 (4), (4.93) in GD_5 followed by GD_4 (4.96). The highest percent fall in flavour was observed in GD_0 (75%) followed by GD_1 (62.50%) while lowest was recorded in GD_2 (25%) followed by GD_3 (40%).

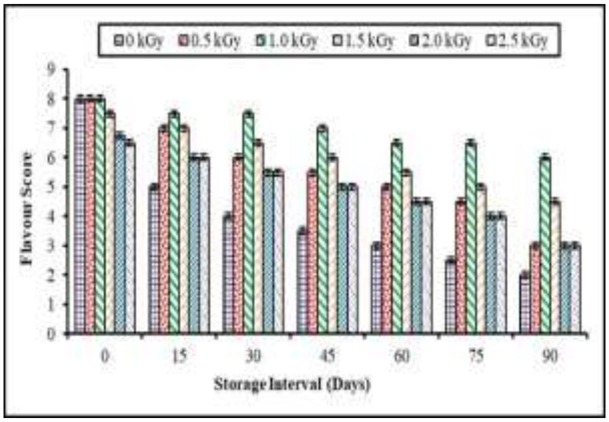

Figure 7: Effect of gamma irradiation and storage intervals on flavor score of stevia based guava drink

The change in flavour as increased in irradiation dose is also reported by several researchers, like (Datta, 2010) in cocoa beverage, (Fan et al. 2011) in juice and pulp of 'Hamlin' and 'Navel' oranges. [12] by applying 10 kGy dose of irradiation on tamarind juice reported strong off flavor. Development of off flavors might be the cause by irradiation of lipids substances into lipid peroxidases or the formation of ketones, aldehydes, sulfur compounds and free radicals might be the reason of flavor degradation. [47] Suggested that hydrogen sulfide, methane-thiol, methyl sulfide, dimethyl disulfide, and dimethyl trisulfide may be the cause of flavor which is formed by irradiation. The statistical analysis represents that in throughout storage period different irradiation doses and storage intervals had a significant ($P<0.05$) effect on the flavor of stevia-based guava drink.

Taste

Initially the mean score of judges for Taste of guava drink of GD_0 to GD_5 was (8, 8, 8, 7.5, 6.75 and 6.5) which was gradually decreased to (2, 3, 6, 4.5, 3 and 3) respectively at the end of total period of 3 months as shown in (Figure 2.8). Maximum mean score for Taste (7.0) was noticed in GD_2followed by GD_3 (6.0), whereas minimum was found in GD_0 (4.0), (4.93) in GD_5 followed by GD_4 (4.96). The highest percent fall in colour was observed in GD_0 (75%) followed by GD_1 (62.50%) while lowest was recorded in GD_2 (25%) followed by GD_3 (40%).

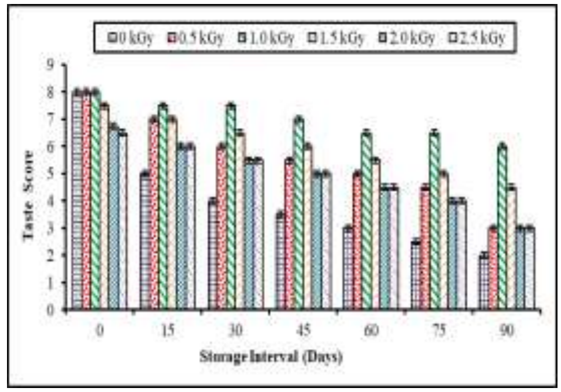

Figure 8: Effect of gamma irradiation and storage intervals on taste score of stevia based guava drink

The decrease in taste score are also in agreement with previous studies of (McDonald et al. 2013) who found that gamma irradiation significantly affected the taste of sorghum porridge meal and beef burger respectively (Balaswamy et al. 2014) noted extremely unlikable taste by irradiating tamarind juice with high dose of gamma radiation. Natural ingredients and red wine for manufacturing traditional meat products. (Fan et al. 2011) found off taste in manufacturing of different meat products by using several ingredients and red wine by exposing to gamma radiation. Base on taste panelist revealed that both pistachio and peanuts exposed to higher than 3kGy gamma irradiation dose found unacceptable for consumption as reported by (Datta,2010) reported that taste of Cashew nuts significantly reduced by applying 1.5kGy irradiation dose. (Balaswamy et al. 2014). Reported strong off-taste in ready to use tamarind juice after applying 10-kGy irradiation dose. The statistical analysis represents that in throughout storage period different irradiation doses and storage intervals had a significant ($P<0.05$) effect on the taste of stevia-based guava drink.

Overall acceptability

Guava drink was evaluated for overall acceptability after every 15 days interval up to 3 months of total storage period as shown in (Figure 4.9). The data showed that maximum score for overall acceptability (8.0, 8.0, 8.0, 7.7, 7.2 and 7) was found for (GD_0, GD_1, GD_2, GD_3, GD_4 and GD_5) which gradually decreased to (2.2, 3.7, 6.3, 5.3, 4.3 and 4.3) at the end of the storage interval. GD_0 (72.92%) followed by GD_1 (54.17%) showed highest percent decreased while minimum was observed for GD_2 (20.83%) followed by GD_3 (30.43%) during the storage period.

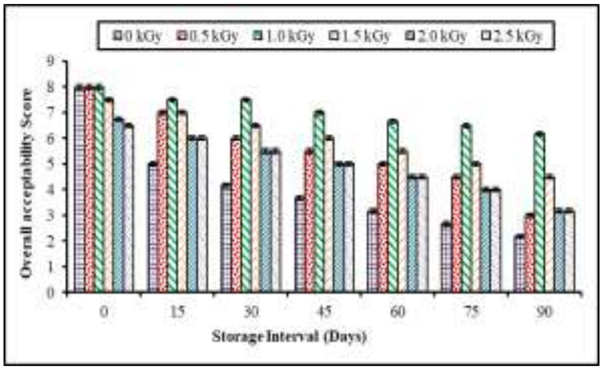

Figure 9: Effect of gamma irradiation and storage intervals on overall acceptability score of stevia based guava drink

The decrease in overall acceptability scores of guava drink might be due to degradation of different parameters during storage that is Color, flavor, and taste The results are also in accordance with previous studies of (McDonald et al. 2013) who reported a decline in organoleptic score in meal exposed to gamma irradiation. (Arjeh et al. 2015) evaluated the effect of irradiation doses on green onions and found decline in overall acceptability score. reported that sensory (taste, flavour and colour) score for licorice was reduced after applying different irradiation doses. Similarly decrease was observed by several scientists, (Horta, 2019) in sensorial profile after exposing to different gamma irradiation dose and also reported that products treated with high irradiation doses (520 kGy) were unfit for human consumption. (Arjeh et al. 2015) find significant difference in the overall sensory scores of the irradiated and control fresh mango juice samples. The overall acceptance of the irradiated ready to use tamarind juice was found different after exposing to gamma irradiation mentioned by (Balaswamy et al. 2014) in their research study.

The statistical analysis represents that in throughout storage period different irradiation doses and storage intervals had a significant ($P<0.05$) effect on the taste of stevia-based guava drink.

CONCLUSION

The current research work was designed to evaluate the effect of irradiation on stevia-based guava drink. The present study showed that different gamma irradiation doses (0.5-2.5 kGy) significantly affected the pH, acidity, ascorbic acid, total phenolic compounds and microbial profile. In fact, off-taste and off-flavor caused due to 1.5, 2.0 and 2.5 kGy irradiation doses. However, among all the irradiation doses 1.0 kGy was enough to reduce the microbial load, and maintained the color flavor, taste of stevia-based guava drink and recommended for extension of shelf life.

RECOMMENDATIONS

On the basis of this investigation, an integrated approach of 1.0 kGy irradiation dose is recommended for extended storage of guava drink.

A few suggestions are however made for future endeavors:

Further study should be carried out to analyze the absorbed doses.

More study should be carried out to evaluate the antioxidant activity.

Additional research studies are needed to evaluate the effect of irradiation on mineral profile of stevia-based guava drink.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

The principal author is grateful to NIFA Peshawar for providing research facilities. I am very thankful to The University of Agriculture Peshawar Pakistan for technical support.

AUTHOR CONTRIBUTIONS

Conceived and designed the experiments: SAM, ASS and MI. SN, MMH, AB, BR, MKN, AS, FH, FR and TAG analyzed the data: SAM and ASS contributed reagents/ materials/ analysis tools: SAM, IA and UB wrote the paper:

REFERENCES

Abdullateef, R.A. and Osman, M., (2012). Studies on effects of pruning on vegetative traits in Stevia rebaudiana Bertoni

(Compositae). International Journal of Biology, 4(1), p.146.

Alighourchi, H. and Barzegar, M., (2009). Some physicochemical characteristics and degradation kinetic of anthocyanin of reconstituted pomegranate juice during storage. Journal of Food Engineering, 90(2), pp.179-185.

Andrew, W., (1992). Manual of quality control 4. Rev. 1. Microbiological analysis. FAO. Food and Nutrition Paper]. Washington, USA: FAO.

Arjeh, E., Barzegar, M. and Sahari, M.A., (2015). Effects of gamma irradiation on physicochemical properties, antioxidant and microbial activities of sour cherry juice. Radiation Physics and Chemistry, 114, pp.18-24.

Aslam, D.M. and Amin, S., (2013). Fruits, vegetables and condiments statistics of Pakistan 2011-2012. Government of Pakistan Ministry of National Food Security and Research, Islamabad.

Balaswamy, K., Rao, P.P., Rao, G.N., Nagender, A. and Satyanarayana, A., (2014). Production of low calorie ready-to-serve fruit beverages using a natural sweetener, stevia (Stevia rebaudiana L.). Focusing on Modern Food Industry, 3, pp.59-65.

Cadena, R.S., Cruz, A.G., Netto, R.R., Castro, W.F., Faria, J.D.A.F. and Bolini, H.M.A., (2013). Sensory profile and physicochemical characteristics of mango nectar sweetened with high intensity sweeteners throughout storage time. Food Research International, 54(2), pp.1670-1679.

Chattopadhyay, S., Raychaudhuri, U. and Chakraborty, R., (2014). Artificial sweeteners–a review. Journal of food science and technology, 51(4), pp.611-621.

Datta, A., 2010. ordering South Asia: War, violence and displacement in 1971. Harvard University.

El-Beltagi, H.S., Aly, A.A. and El-Desouky, W., (2019). Effect of Gamma irradiation on some biochemical properties, antioxidant and antimicrobial activities of Sakouti and Bondoky dry dates fruits genotypes. Journal of Radiation Research and Applied Sciences, 12(1), pp.437-446.

Fan, X. and Thayer, D.W., (2002). γ-Radiation influences browning, antioxidant activity, and malondialdehyde level of apple juice. Journal of agricultural and food chemistry, 50(4), pp.710-715.

Fan, X., Lee, E.J. and Ahn, D., (2011). Volatile sulfur compounds in foods as a result of ionizing radiation. In Volatile sulfur compounds in food. American Chemical Society.pp.243-258.

Ferreira-Lima, N.E., Burin, V.M. and Bordignon-Luiz, M.T., (2013). Characterization of Goethe white wines: influence of different storage conditions on the wine evolution during bottle aging. European Food Research and Technology, 237(4), pp.509-520.

Finkenstadt, V.L., (2019). Historic Role of the United States Department of Agriculture in Food Production, Quality, and Security. In Chemistry's Role in Food Production and Sustainability: Past and Present. American Chemical Society.pp.17-25.

Guerreiro, D., Madureira, J., Silva, T., Melo, R., Santos, P.M., Ferreira, A., Trigo, M.J., Falcão, A.N., Margaça, F.M. and Verde, S.C., (2016). Post-harvest treatment of cherry tomatoes by gamma radiation: Microbial and physicochemical parameters evaluation. Innovative Food Science & Emerging Technologies, 36, pp.1-9.

Harder, M.N.C., De Toledo, T.C.F., Ferreira, A.C.P. and Arthur, V., (2009). Determination of changes induced by gamma radiation in nectar of kiwi fruit (Actinidia deliciosa). Radiation Physics and Chemistry, 78(7-8), pp.579-582.

Horta, M.G., (2019). Irradiação gama e adição de extrato de alecrim em hambúrguer de carne bovina congelado: efeito na qualidade. pp.17-25.

Ibarra Mayorga, E., Llanes Iglesias, J.E. and Rodríguez Sánchez, B., (2019). Caracterización nutricional del biofloc desarrollado con agua del Pacífico ecuatoriano para el cultivo de Litopenaeus vannamei. Cuban Journal of Agricultural Science, 53(4), pp.395-402.

Jo, C., Ahn, D.U. and Lee, K.H., (2012). Effect of gamma irradiation on microbiological, chemical, and sensory properties of fresh ashitaba and kale juices. Radiation Physics and Chemistry, 81(8), pp.1076-1078.

Kausar, H., Parveen, S., Saeed, S., Ishfaq, B. and Ali, M.A., (20160. Development and standardization of ready to serve aloe vera lemon functional drink. Journal of Environmental Science, Toxicology and Food Technology, 10(4), pp.47-52.

Kilcast, D., (1994). Effect of irradiation on

vitamins. Food Chemistry, 49(2), pp.157-164.
Kim, D., Song, H., Lim, S., Yun, H. and Chung, J., (2007). Effects of gamma irradiation on the radiation-resistant bacteria and polyphenol oxidase activity in fresh kale juice. Radiation Physics and Chemistry, 76(7), pp.1213-1217.
Kondapalli, N., V. Sadineni, P. S. Variyar, A. Sharma and V. S. R. Obulam. (2014). Impact of γ-irradiation on antioxidant capacity of mango (Mangifera indica L.) wine from eight Indian cultivars and the protection of mango wine against DNA damage caused by irradiation. Process Biochem. 49(11): 1819-1830.
Lado, B.H. and Yousef, A.E., (2002). Alternative food-preservation technologies: efficacy and mechanisms. Microbes and infection, 4(4), pp.433-440.
Larmond, E., (1977). Laboratory methods for sensory evaluation of food. Research Branch, Canada Dept. of Agriculture.
Lee, J. W., J. K. Kim, P. Srinivasan, J.-i. Choi, J. H. Kim, S. B. Han, D.-J. Kim and M. W. Byun. (2009). Effect of gamma irradiation on microbial analysis, antioxidant activity, sugar content and color of ready-to-use tamarind juice during storage. Food Science and Technology. 42(1): 101-105.
Leite, D.T.S., Gêa, A.S. and Arthur, V., (2006). Efeito de diferentes doses de radiac-ao nas caracterısticas fısico-quımicas de kiwi minimamente processado.
McDonald, H., Arpaia, M.L., Caporaso, F., Obenland, D., Were, L., Rakovski, C. and Prakash, A., (2013). Effect of gamma irradiation treatment at phytosanitary dose levels on the quality of 'Lane Late'navel oranges. Postharvest biology and technology, 86, pp.91-99.
Memon, N., Gat, Y., Arya, S. and Waghmare, R., (2020). Combined effect of chemical preservative and different doses of irradiation on green onions to enhance shelf life. Journal of the Saudi Society of Agricultural Sciences, 19(3), pp.207-215.
Mexis, S.F. and Kontominas, M.G., (2009). Effect of γ-irradiation on the physicochemical and sensory properties of hazelnuts (Corylus avellana L.). Radiation Physics and Chemistry, 78(6), pp.407-413.
Monju, M.B., (2013). Studies on processing of low calorie mango jam using stevia as sugar supplement (Doctoral dissertation).
Noreen, S., Khan, S.J., Chouhdary, S., Fatima, A. and Ejaz, N., (2012). Evaluation of Aloe vera barbadensis for its antimicrobial, phytochemical and ethnobotanical status. Journal of Medicinal Plants Research, 6(49), pp.5876-5880.
Omayio, D.G., Abong, G.O., Okoth, M.W., Gachuiri, C.K. and Mwang'ombe, A.W., (2019). Current Status of Guava (Psidium Guajava L) Production, Utilization, Processing and Preservation in Kenya: A Review. Current Agriculture Research Journal, 7(3), pp.318-331.
Parpinello, G. P., versari, A., Castellari, M., and Galassi, S. (2000). Stevioside as a replacement of sucrose in peach juice: sensory evaluation. J Sens. Stud. 16(5): 471484.
Polydera, A.C., Stoforos, N.G. and Taoukis, P.S., (2003). Comparative shelf life study and vitamin C loss kinetics in pasteurised and high pressure processed reconstituted orange juice. Journal of Food Engineering, 60(1), pp.21-29.
Puligundla, P., Song, K. and Mok, C., (2017). Effect of γ-irradiation on Microbiological, Biochemical and Sensory Qualities of Commercial Powdered Cocoa Beverage Premix. Chiang Mai Journal of Science, 44(2), pp.375-382.
Saleh, M.A.M., (20130. Effect of gamma irradiation on the storage and vitamin C concentration of allium cepa onion samples.
Salim, A.S., Simons, A.J., Waruhiu, A., Orwa, C. and Anyango, C., (1998). Agroforestree database: a tree species reference and selection guide (No. CD 631.58 A281). ICRAF, Nairobi (Kenya).
Selambakkannu, S., Bakar, K.A., Ming, T.T. and Sharif, J., (2011). Effect of gamma and electron beam irradiation on textile waste water. Jurnal Sains Nuklear Malaysia, 23(2), pp.pp-67.
Shilangale, R.P. (2014). Effects of ɣ Irradiation Dose on Sensory Acceptability of a Ready-to-Eat Spinach relish and Sorghum Porridge Meal. Food Nutri. 5: 2105-2114.
Song, H.P., Kim, D.H., Jo, C., Lee, C.H., Kim, K.S. and Byun, M.W., (2006). Effect of gamma irradiation on the microbiological quality and antioxidant activity of fresh vegetable juice. Food Microbiology, 23(4), pp.372-378.
Steel, R.G. and Torrie, J.H., (1986). Principles and procedures of statistics: a biometrical approach. McGraw-Hill.
Thakur, B.R. and Arya, S.S., (1993). Effect of

sorbic acid on irradiation-induced sensory and chemical changes in sweetened orange juice and mango pulp. International journal of food science & technology, 28(4), pp.371-376.

Tiitto, R. (1985). Phenolic constituents in the leaves of northern willows. methods for the analysis of certain phenolics. J. Agri. Food Chem. 33(2): 213-217.

Yun, H.J., Kim, H.J., Jung, Y.K., Jung, S., Lee, J.W. and Jo, C.R., (2010). Effect of natural ingredients and red wine for manufacturing meat products on radiation sensitivity of pathogens inoculated into ground beef. Food Science of Animal Resources, 30(5), pp.819-825.