POTENTIAL USAGE OF GAMMA RADIATION ON SENSORY EVALUATION, BIOCHEMICAL PROPERTIES ALONG WITH HEAVY METALS ANALYSIS OF DIETARY FIBER OBTAINED FROM PINEAPPLE PEEL

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ABSTRACT

Agro-industries plays a significant role for nutrition intake; however, they produce a considerable quantity of fruits and vegetables wastes or byproducts during processing that are mostly unused. Production of value-added products from the generated wastes could be a possible tool for the waste management in this sector. The present work was aimed at production of value-added dietary fiber from pineapple peel and investigate the potential effects of gamma irradiation at different doses (5, 10, 20, 30 and 40 kGy) on this dietary fiber in respect with sensory evaluation, biochemical properties and heavy metal analysis. There was no significant effect of radiation found on appearance, color, flavor, taste and texture in the dietary fiber. Significant reduction in lipid content was seen in fiber irradiated with 30 kGy dose compared to untreated fiber. Besides, irradiation has no significant effect on moisture, ash content and calcium of dietary fiber. Irradiated dietary fiber showed decreased total phenol content than the unirradiated sample. Irradiation with 30 and 40 kGy doses increased protein content compared to control dietary fiber. PIXE analysis showed there was no Lead and Cadmium heavy metal in pineapple peel dietary fiber.

ABSTRAK

Agro-industri memainkan peranan penting untuk pengambilan nutrisi; walau bagaimanapun, mereka menghasilkan sejumlah besar sisa buah-buahan dan sayur-sayuran atau produk sampingan semasa pemprosesan yang kebanyakannya tidak digunakan. Pengeluaran produk nilai tambah daripada sisa terjana boleh menjadi alat yang mungkin untuk pengurusan sisa dalam sektor ini. Kerja-kerja ini bertujuan untuk menghasilkan serat pemakanan nilai tambah daripada kulit nanas dan menyiasat potensi kesan penyinaran gamma pada dos yang berbeza (5, 10, 20, 30 dan 40 kGy) pada serat pemakanan ini berkaitan dengan penilaian deria, biokimia. sifat dan analisis logam berat. Tiada kesan ketara sinaran yang ditemui pada rupa, warna, rasa, rasa dan tekstur dalam serat makanan. Pengurangan ketara dalam kandungan lipid dilihat dalam serat yang disinari dengan dos 30 kGy berbanding dengan serat yang tidak dirawat. Selain itu, penyinaran tidak mempunyai kesan ketara ke atas kelembapan, kandungan abu dan kalsium serat makanan. Serat pemakanan yang disinari menunjukkan penurunan jumlah kandungan

fenol daripada sampel yang tidak disinari. Penyinaran dengan dos 30 dan 40 kGy meningkatkan kandungan protein berbanding dengan serat pemakanan kawalan. Analisis PIXE menunjukkan tiada logam berat Plumbum dan Kadmium dalam serat pemakanan kulit nanas.

Keywords: Dietary fiber, Gamma radiation, Biochemical properties, PIXE

INTRODUCTION

Dietary fiber is a substance obtained from plants that functions as a polymer matrix with varying physico-chemical and biochemical properties inside the gastrointestinal tract. Some health disorders and diseases, including constipation, hemorrhoids, colon cancer, etc., may be prevented by dietary fiber. Finding new dietary fiber sources (such as mango fruit, passion fruit, pomegranate, sweet potato, and algae) with particular bioactive elements that may provide the conventionally commercialized goods new beneficial characteristics is of growing interest (Esparza-Martínez et al. 2016; Akoetey et al. 2017; Hu et al. 2018a; Routray and Orsat 2019; Chen et al. 2020; Charoensiddhi et al. 2022).

Pineapple is one of the most abundant fruits in the world, and most of its production is used in processing. It is consumed as canned slices, chunks, dice, or fruit salads and in the preparation of juices, concentrates, and jams (Salvi and Rajput, 1995; Irani et al. 2018). It can preserved as frozen storage of slices (Bartolomé et al. 1995; Zzaman et al. 2021). By-products obtained from industrial processing of pineapple represent 25.35% of the fruit, and the peel is the major constituent. They have been used to produce alcohol, citric acid, vinegar, bromelain, wine, sugar syrup, wax, sterols, and cattle feed (Kodagoda and Marapana 2017; Irani et al. 2018; Ngwasiri et al. 2022). Pineapple peel, a high fiber part of pineapple fruit, is considered as a potential fiber source (Larrauri et al. 1997; Selani et al. 2014; Huang et al. 2020).

The dietary fiber content and composition of pineapple flesh had been reported by different authors (Lund and Smoot 1982; Mengesha et al. 2013; Meena et al. 2022). As a result, the various polysaccharide fractions from the pineapple's ethanol-insoluble residue were extracted by Voragen et al. in 1983, and Bartolome et al. in 1995, reported on the partial characterization of the hemi cellulosic fraction from the pineapple fruit cell wall.

Any classification based on physico-chemical and physiological characteristics derived from the typical constituents of dietary fiber (lignin, uranic acids, neutral sugars) cannot be regarded as a novelty. It is important to consider additional characteristics when choosing a new source, such as antioxidant activity related to minor ingredients (polyphenols, flavonoids, carotenoids, etc.) (Larrauri et al. 1997). The source of fiber is also important because various arrays of plant cells can affect fiber properties.

The dietary fiber market is fiercely competitive. There are good numbers of cereals that are commercially available in the market providing the major sources of dietary fiber for consumers. Nevertheless, it is well-known that dietary fibers from fruits are of greater quality than those from cereals because they include a higher proportion of soluble dietary fiber and bioactive related components (Yangilar 2013).

Gamma rays (as γ) are a form of electromagnetic radiation or light emission of high frequency having shorter wavelength (below about 10 picometers) carry a lot of energy. The gamma rays are emitted from a nucleus or produced by sub-atomic particle interactions, such as electron-position annihilation on radioactive decay. Its wavelength is so short that a single incident photon can cause significant damage to the living cell. This means that gamma radiation is able to destroy micro-organisms in a process called irradiation. It is widely used for sterilizing medical-surgical equipment (disposable syringes, etc.)(Harrell et al. 2018), removing decay-causing bacteria from many foodstuffs (Alfarobbi and Anggraini 2018), preventing fruit and vegetables from sprouting to maintain freshness and flavor (Shams et al. 2023) and so on. The technique is also used in the treatment of conservation and restoration of arts objects, ethnology and archaeology (Cortella et al. 2020; Cemmi et al. 2023).

In this study, we also discussed Proton Induced X-ray Emission (PIXE), which is based on atomic fluorescence created by energetic protons and the analysis is performed by measuring the characteristic X-rays emitted from the dietary fibre samples of pineapple. PIXE is well adapted to measure major, minor and trace elements in different sample matrices such as biomedical, environmental, agricultural and industrial samples. PIXE is a multi-elemental analytical technique and is capable of measuring elements from Aluminum (Al) up to Uranium (U) in a single experiment. Moreover, PIXE is used for analyzing blood samples for certain trace elements such as zinc, iron, copper, phosphorus, chlorine, and rubidium (Ashok Kumar et al. 2002; Huszank et al. 2017). Elemental investigation of Syrian medicinal plants was carried out with PIXE (Rihawy et al. 2010). Heavy metal was also determined in agricultural soil of south-western seashore area in Bangladesh by PIXE (M. R. Rahman et al 2017). PIXE analysis is an important non-destructive method biological sample such as teeth (Rautray et al. 2010; Pessanha et al. 2017).

The main objective of this study was to investigate the effects of gamma radiation in different doses (5, 10, 20, 30 and 40 kGy) on Sensory evaluation, Biochemical properties (moisture content, protein, lipid content, ash content and total phenol content) of pineapple dietary fiber and PIXE analysis for tracing heavy metal (Lead and Cadmium) element in dietary fiber.

MATERIALS AND METHODOLOGY

Sample Collection and Preparation

Pineapple (***Ananas comosus L. Merr.***) peels were collected from a local market of Savar, located at 23.850077 °N, 90.25907 °E in Dhaka district at the central part of Bangladesh. All the samples were transported to the laboratory of Food Safety and Quality Analysis Division, Institute of Food and Radiation Biology (IFRB), Atomic Energy Research Establishment, Savar, Dhaka.

Figure 1. Pineapples & Pineapple peels

The moisture content of pineapple peels was reduced by drying them for 5 hr at 100 °C after being cut into small pieces and cleaned subsequently with hot and cold water to remove impurities.

By using the AOAC method, dietary fiber was recovered from dried peels (AOAC 2019). A 500 mL beaker containing 5g of dry pineapple peels filled with 200 mL of 1.25% H_2SO_4 and allowed to boil for 30 minutes. This mixture's volume was maintained constantly by adding distilled water on a regular basis and maintained smooth boiling by adding a glass rod into the beaker.

The mixture was then run through a cotton cloth for filtering. Litmus paper was used to test the residue's acid-free status after it had been cleaned with hot water.

The materials were next put into a 500 mL beaker, to which 1.25% NaOH was added while continuing the previous operation. After filtering, the material was rinsed with hot water to remove any remaining alkali, and

litmus paper was used to confirm this. The residue was cleaned with acetone and 95% ethanol before being dried at 105 °C for 6 hr.

Figure 2. Dietary fiber

Irradiation of Dietary Fiber

For each treatment, 10±1g of dietary fiber were extracted, dried in an oven for an hour at 105 °C, and then put into polythene bags measuring (25cm × 15cm) and tightly sealed. The product name was labeled on the sealed polythene bags before they were irradiated with doses at 5, 10, 20, 30, and 40 kGy including control dose to evaluate experiment precisely. The samples were exposed to radiation using a 50kCi ^{60}Co gamma source (dose rate 6.4 kGy/hr) at the Institute of Food and Radiation Biology (IFRB), Atomic Energy Research Establishment, Savar, Dhaka. In order to assess the hydration content both treated and untreated fiber samples were kept in desiccators at room temperature.

Sensory Evaluation

Sensory evaluation of dietary fibers was carried out by tasting testing panel using the Hedonic scales (Peryam and Pilgrim 1957; Lim et al. 2009).

A panel of five judges with ages ranging from 25-40 years was chosen for consistency and reliability of judgment. They were instructed to evaluate color, flavor, and texture scoring rate on a 9 point of Hedonic scale, in which 0-2 are disliked extremely, 3-5 are disliked, 6-8 are acceptable or good and 9 are chosen as excellent in terms of color, flavor and texture. The preference differences were evaluated by statistical analysis of the data for variance.

Biochemical Analysis

Various chemical analyses were performed based on moisture content, protein, lipid content, ash content and phenol content for dietary fiber.

Determination of Moisture Content

Moisture content of the control dietary fiber and irradiated (irradiated 5, 10, 20, 30 and 40 kGy doses) dietary fibers were determined according to (AOAC 2019).

About 1.0 gm sample was taken in a pre-weighed crucible (pre-washed and dried at 100 °C). Then the crucible was placed in an oven at about 105 °C for 5 to 6 hours. Then the crucible was cooled in a desiccator and the weight was taken. The difference in the weights of initial and the constant dry weight gave the moisture content. Alternatively, the moisture content can also be determined directly using moisture determination balance. The moisture content was calculated by the following equation:

Moisture content (g/100 g of the sample)

$$= \frac{Initial\ weight\ of\ the\ sample - Dry\ weight\ of\ a\ sample}{Weight\ of\ a\ sample} \times 100$$

Determination of Total Protein Content

The Micro -Kjeldahl method was used to measure the protein content of the sample (Chromý et al. 2015; Hu et al. 2018b). At first 2 gm sample was taken for each experiment and were poured in a cleaned and dried "Micro-Kjedhal" flask (100 mL) to which 2 gm of digestion mixture and 25 mL of pure concentrated sulfuric acid were added and the mixture was digested by heating at 315 ^{0}C for 5-6 hours till the mixture became clear. Glass beds were added to prevent bumping during digestion. The digested products were then cooled and 30 mL of digested product was transferred to a 100 mL volumetric flask and made up to 100 mL with distilled water. Then 5mL from diluted digest was transferred in "Kjedhal" dilution apparatus and distilled with 100 mL of 30% NaOH. The distillate was collected in excess of 2% boric acid solution with indicator and was titrated by 0.01N HCl. Similar digestion and distillation processes were carried out for blank samples. The percentage of nitrogen was calculated using the following formula,

$$\%\ of\ nitrogen = \frac{S \times N \times 14 \times C}{A \times W \times 1000} \times 100$$

where,

S is the Titration reading for sample,

N is the Strength of HCl (0.01N),

C is the Volume made up to the digest,

A is the Aliquots of digest taken,

W is the Weight in gm of the sample.

The protein content was obtained by multiplying the nitrogen value by 6.63. Therefore, % of crude protein is equal to the % of nitrogen × 6.63.

Determination of Lipid Content

The lipid content was determined quantitatively by extraction with a mixture of chloroform methanol (2:1) and a little amount of sodium chloride (0.9%) as recommended by (AOAC 2019). At first 1g of Control and irradiated samples was taken in a mortar and homogenized. An adequate amount of sand was added and grinded gently by a pestle. 10 mL of chloroform-methanol (2:1) mixture was added into the above sample and homogenized properly. Then that was filtered through a filter paper (11 cm) which was collected into a pre-weighed test tube. After that 1 mL of 4% $CaCl_2$ solution was added and the system was kept overnight. The supernatant was separated from the upper portion of the test tube and the test tube was kept into the oven till drying the mixture. After drying out, the test tube was again weighed.

$$\%\ of\ lipid = \frac{Final\ weight\ of\ the\ test\ tube - Initial\ weight\ of\ the\ test\ tube}{Weight\ of\ sample\ taken} \times 100$$

Determination of Ash Content

Ash content was determined by AOAC method ((AOAC 2019). The dietary fibers were dried in oven for 1 hour at 105 °C. 1.0 g of dried dietary fibers was placed into previously ignited and cooled crucibles. The crucibles were placed on a burner and heated first over a low flame till all the material charred. Then the crucibles were kept in a muffle furnace for about 3-5 hours at about 600 °C till the ashes became almost white or grayish white in color. The crucibles were allowed to cool in furnace to less than 200 °C and then placed into desiccators. They were allowed to cool and then crucibles and ash were weighed. To ensure the completion of ashing the crucibles

were again heated in the Muffle furnace for about ½ hour, cooled, and weighed. The percentage of ash content was calculated by the following formula:

$$Ash\ content\ \left(g/100\ g\ of\ sample\right)=\frac{Weight\ of\ ash}{Weight\ of\ sample\ taken}\times 100$$

Determination of Total Phenol

1g of dietary fiber was placed into the test tube and 10 mL 75% ethanol was added (Shaver et al. 2011). The samples were run by vortex for 10 minutes and centrifuged for 10 minutes at 4000 rpm. After centrifuging, the extract was filtered into test tubes 0.1mL extract and 9 mL distilled water was added into test tubes. 0.5 mL diluted extract was taken into test tubes. 2.5 mL FCR (1:10) and 2 mL Na_2CO_3 (7.5%) were added to the test tube and vortexed properly. After two hours, OD was taken into 765 nm.

Determination of Calcium Content

Actually, calcium was determined by precipitating it as calcium oxalate and by titrating the solution of oxalate in dilute sulfuric acid against standard potassium permanganate (Ranganna 1986; Islam et al. 2022). At first the ash (obtained from the previous experiment) in the crucible was moistened with 1 mL of distilled water and 5 mL of 30% HCl. The mixture was then evaporated to dryness in a boiling water bath. Another 5 mL of HCl was added and the solution was evaporated to dryness as before. Then 4 mL of 30% HCl and a few mL of distilled water were added and the solution was warmed over a boiling water bath and filtered into a 100 mL volumetric flask using "Whatman" filter paper. For the estimation of calcium, this mineral solution was used. Now, about 25 mL of mineral solution was diluted to about 150 mL distilled water. A few drops (approximately 2 drops) of methyl red indicator were added and the mixture was then neutralized with ammonia till the pink color changed to yellow. Then 10 mL 6% ammonium oxalate solution was added and the mixture was heated to boiling point. The mixture was then allowed to boil for a few minutes and glacial acetic acid was then added till the color became distinctly pink. The mixture was then kept in an oven at low temperature to settle down the precipitate.

A drop of ammonium oxalate solution was added to the supernatant to ensure that the precipitation was completed. The precipitate was filtered through filter paper and washed gradually by pouring water over the funnel with filter paper with its contents, till it was free from oxalate, which was again ensured by observing that the water washing the precipitate was absolutely colorless.

The precipitate was transferred into a beaker by piercing a hole in the filter paper and washing it down gradually pouring 10 mL of 2N sulfuric acid. After washing, the solution was heated to about 70 °C and titrated against N/100 $KMnO_4$. The calcium content was determined by the following formula:

Calcium content (mg of Ca/100 g of sample)

$$=\frac{Titration\ value\times 0.2\times Total\ volume\ of\ mineral\ solution}{Volume\ of\ mineral\ solution\ taken\times Weight\ of\ sample\ taken\ for\ ashing}\times 100$$

PIXE Analysis

For PIXE analysis, all dietary fiber samples were dried at 100 °C and then grounded by agate motor. The grounded samples were made pellets (~200 mg weight) by pressing at a pressure 5 tons per cm^2 using hydraulic press. The size of the pellets was about 13 mm in diameter and 1mm in thickness. Standand reference material pellets were also prepared by the same method.

The pellets were irradiated with a proton beam of energy 2.5 MeV produced by 3 MW Tandem Accelerator at Atomic Energy Research Establishment, Savar, Dhaka, Bangladesh (M. R. Rahman et al 2017). The measuremeants were done with a beam spot 2 mm in diameter and a low beam current of 10-20 nA. The exposure was carried out for 5-10 minutes to get a good x-ray counts. The x-ray data acquisition were performed by an

ORTEC detector, pulse processing electronics and a MCA card interfaced to a PC. The software GUPXWIN package was used to analyze the spectra to determine the concentration of the heavy metal in the samples.

Statistical Analysis

Statistical procedures were performed using SPSS for Microsoft version 17.0 software package (SPSS Chicago, IL). Data were processed and visualized using Microsoft Excel (Microsoft Office 2019, Ver. 16.0.10730.20102) and OriginPro 2019b (Ver. 9.6.5.169, OriginLab Corporation). To determine significant difference between treatments the least significant difference (LSD) at $P < 0.05$ was used.

RESULTS AND DISCUSSION

Effect of Gamma Radiation on Sensory Assessment

Sensory analysis of dietary fibers was carried out by Hedonic scale for irradiated (5, 10, 20, 30, and 40 kGy) and control samples. The Figure 3 represented the effect of gamma radiation on the appearance, color, flavor, test, and texture of the dietary fibers. Firstly, the appearance of the dietary fibers (represented by black square in Figure 3) was not significantly affected by radiation. Samples irradiated with doses of 10 kGy and 20 kGy showed the favorable appearance compared to the other irradiated samples. Apparently, good quality in color was found in samples treated with 5 kGy and 10 kGy doses compared to control sample. Samples treated with doses of 30 kGy and 40 kGy showed slightly lower color preference than other samples. In case of color liking of the dietary fiber radiation has no significant effect.

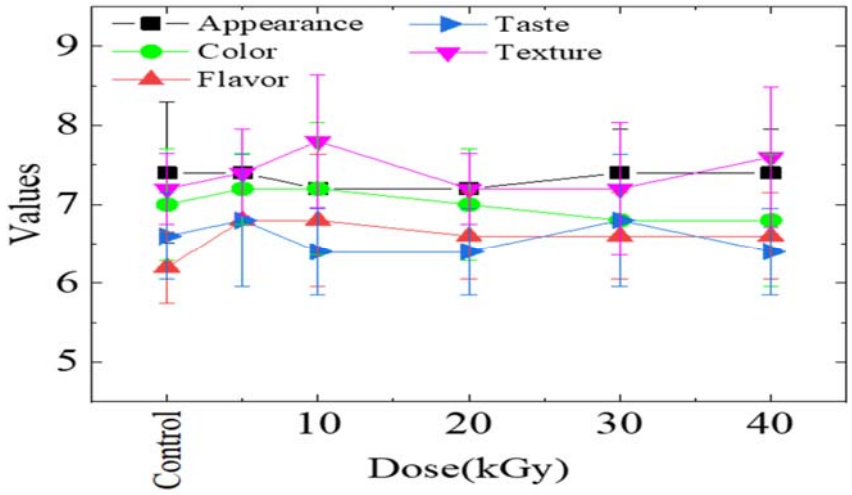

Figure 3. Effects of radiation on appearance, color, flavor, taste, and texture of dietary fibers extracted from pineapple peel

Furthermore, the results indicated that radiation did not significantly affect the flavor of the dietary fibers. Both the control and irradiated samples were acceptable in terms of flavor, as shown by the red upper triangle in Figure 3. But the lowest rate of flavor value was found in control sample. The highest liking value for flavor was found at 5 and 10 kGy samples and moderately higher liking of taste was found at 30 kGy (as blue right triangle in Figure 3). The lowest value of taste liking was observed in samples exposed to 10, 20 and 40 kGy doses-compared to the others. However, both control and irradiated samples were found to be acceptable in terms of taste. The texture of both control and irradiated dietary fiber shown in Figure 3 and the highest acceptability of texture was found in samples irradiated with 10 kGy. The statistical analysis of texture showed no significant

differences between control and irradiated sample (as irradiated by the pink lower triangle in Figure 3). Texture value was found to be acceptable in both control and irradiated samples. In case of all sensory assessments for the dietary fibers, LSD were also calculated. The values of LSD are as follows 0.86, 0.91, 0.84, 0.86, and 0.91 for the appearance, color, flavor, taste, and texture of the dietary fibers, respectively.

Effects of Radiation on Biochemical Properties

Gamma irradiation effect on biochemical properties (ash, protein, lipid, calcium, moisture, and total phenol content) of dietary fiber extracted from pineapple peel was investigated. The ash content of the control and irradiated dietary fibers was presented as black square in Figure 4. The ash content slightly decreased with increasing radiation doses from control to 10 kGy. The highest rate of ash content was determined at 20 kGy, and lowest value of ash content was found at 30 kGy. Irradiation did not have a significant effect on ash content. Figure 4 (as represented by green circle) showed the effect of radiation on protein content. The data indicated that protein content significantly decreased at 10 kGy compared to the control. Among all other treatments, the highest protein content was found at 30 and 40 kGy.

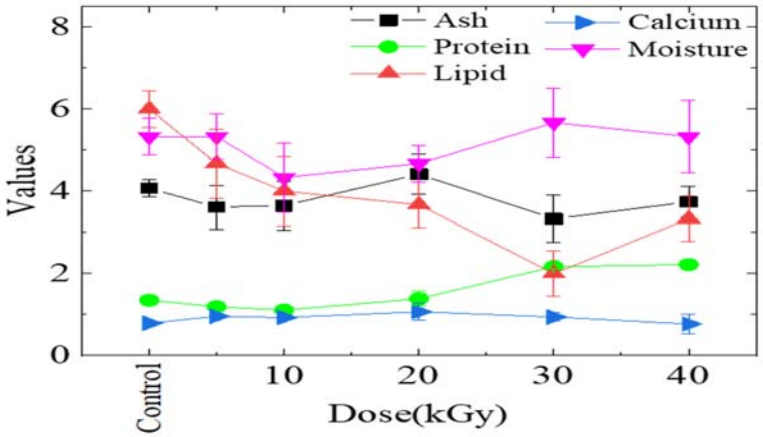

Figure 4. Effects of radiation on biochemical properties of dietary fibers extracted from pineapple peel

Lipid content was determined in both irradiated and control fiber. Present findings for lipid content showed that radiation has positive effect on lipid content (as red upper triangle in Figure 4). Dietary fiber treated with 30 kGy gamma radiation had significantly lower lipid content (2%) than all other treatments. Fiber treated with 5, 10, 20, and 40 kGy showed significantly lower lipid content compared to untreated fiber (6%). Raghavendra et al. 2004 found that the physical treatment such as water wash, hot water wash, boiling water wash and pressure-cooking of coconut dietary fiber could not reduce the fat content significantly. So, it can be claimed that the gamma radiation has a greater impact on the fat content of dietary fiber than physical or thermal treatment. This may be due to the degradation of fat at higher radiation doses. The blue right triangle in Figure 4 represents the calcium content of the control and irradiated dietary fibers. The calcium content increased from control dietary fiber to 5 kGy irradiated dietary fiber and then sharply decreased at 10 kGy and again decreased up to 40 kGy. Dietary fibers treated with 40 kGy showed the lowest calcium content. While those treated with 20 kGy represented the highest value. We also investigated the effect of the moisture content on the control and irradiated dietary fibers, shown in Figure 4 with pink lower triangle. The moisture content was found to decrease slightly with increasing radiation doses from 5 kGy to 10 kGy and then increased up to 30 kGy, With the highest rate of moisture content being determined at 30 kGy. However, the lowest value of moisture content was found at 10 kGy. Furthermore, the moisture content found at the control, 5 kGy, and 40 kGy was the same. In order to account for such variations in biochemical properties among the dietary fibers, LSD was also calculated. The

values of LSD are as follows: 0.86, 0.16, 1.25, 0.25, and 1.45 for the ash, protein, lipid, calcium, and moisture of the dietary fibers, respectively.

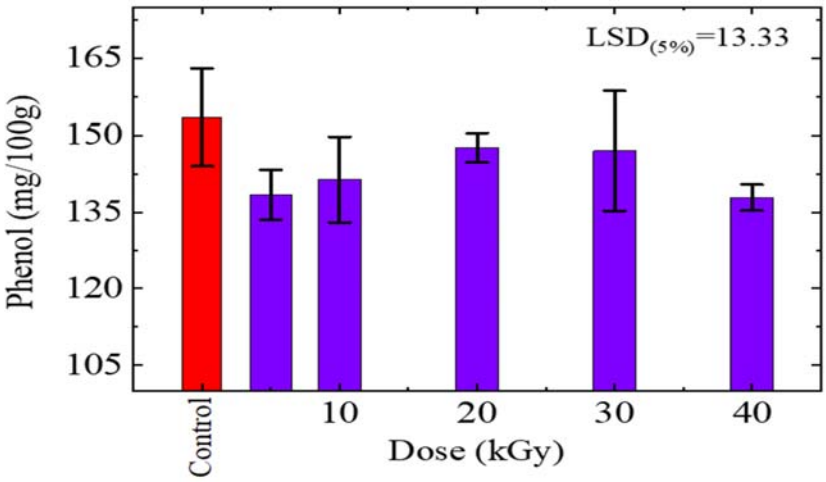

Figure 5. Effects of radiation on the phenol content of dietary fibers extracted from pineapple peel

In our experiment, the total phenol content of the dietary fibers control and irradiated dietary fibers were presented in Figure 5. The phenol content was found to decrease from control dietary fiber to the 5 kGy irradiated dietary fiber and then increased up to 30 kGy. However, the phenol content sharply decreased again at 40 kGy. Dietary fiber treated with 5 kGy showed the lowest phenol content and the control dietary fiber representing the highest value. The value of LSD for the phenol content of the dietary fibers was found to be approximately 13.33. Present findings revealed that radiation has negative impact on the total phenol content of dietary fiber.

PIXE Analysis for Heavy Metals in Dietary Fiber

Heavy metals are important environmental pollutants, second only to pesticides in terms of environmental impact. They are a threat to the environment and human health due to their no-biodegradable characteristics, meaning they can be retained indefinitely in the ecological systems and the food chain. Moreover, dietary fiber has a strong affinity towards heavy metals. Therefore, monitoring heavy metals at trace levels is an increasingly important issue, especially in medical and food application (Pérez-López et al. 2008). Many techniques are used for heavy metal determination but we choose PIXE because of its sensitivity. The amount of Pb^{2+}, $Cr^{3+}$and Cd^{3+}in the dietary fiber sample was determined by PIXE (presented in Table 1), the concentrations of the heavy metals Pb^{2+} and Cd^{3+} were found to be zero. Here, the spectrum for control dietary fiber which are irradiated with 10, 20, and 40 kGy doses are shown in Figure 6.

Table 1. PIXE analysis data for control dietary fiber and irradiated (5, 10, 20, 30 and 40 kGy) dietary fibers

Sl.	Dose	P (ppm)	K (ppm)	Ca (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)
1	F-C	3512	156	77.3	20	13.1	4.46
2	F-05	3677	120	66.1	18.8	11.4	5.95
3	F-10	11028	101	62.3	32.1	28.7	33.3
4	F-20	12498	82.1	44	26.5	23.5	6.5
5	F-30	10824	61.9	42.7	18	13.3	6.94
6	F-40	8949	90.3	52	18.3	13.8	5.35

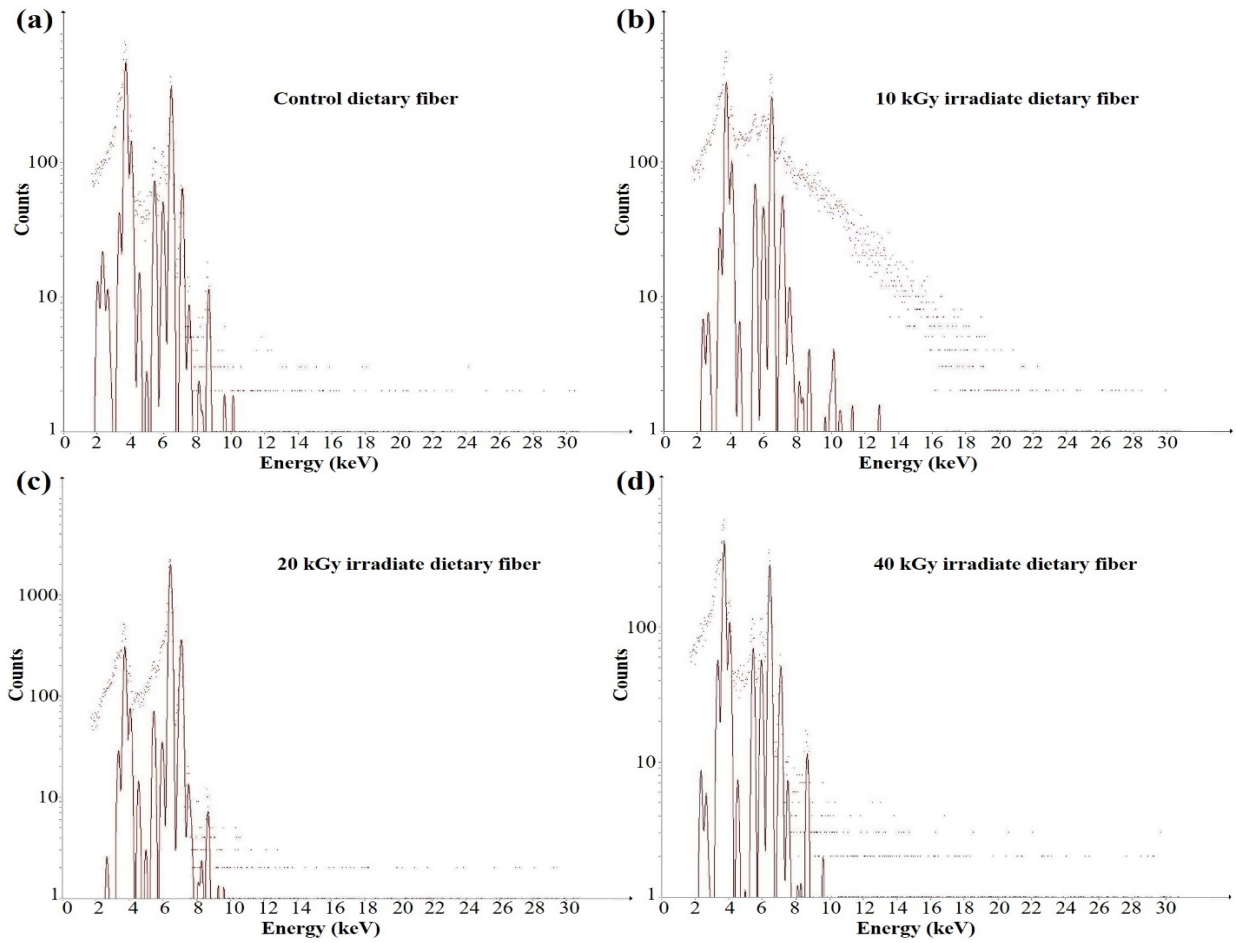

Figure 6. Spectrum for control dietary fiber and irradiated (exposed to 10, 20, and 40 kGy doses) dietary fibers

CONCLUSION

Our research has found that Pineapple peel can be an excellent source of dietary fiber. To improve sensory evaluation and biochemical properties of dietary fiber by gamma radiation, different doses of gamma radiation were applied to dietary fiber extracted from pineapple peel. Our experiment suggest that irradiated dietary fibers may be incorporated to high fiber foods as low-calorie bulk ingredient for functional and hypoglycemic effect. Sensory evaluation revealed that radiation did not negatively impact dietary fiber`s taste, color, flavor and texture. Therefore, the irradiated improved dietary fiber can be incorporated in any food as functional food supplement. Our research has also demonstrated that a wide range of dietary fibers can be included in food products without necessarily negatively affecting the physical and nutrition properties of the product. However careful selection of the fiber is important to ensuring the optimal quality of the products in terms of consumer acceptance. Further investigation is required before making any final conclusion.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there is no known conflict pertaining to this research work that may appear to influence this study.

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