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Determination of the proximate composition and total antioxidants of the locally available fruits

Naseem Akhtar[1]*, Muhammad Hasan Abdullah[2], Muhammad Huzaifa[3], Muhammad Arfan-ul-Haq[4], Maryam Sarfraz[1], Waqar Ahmad[1], Muhammad Abubakar Siddique[1] and Muhammad Asghar[5]

[1]Biochemistry Section Post Harvest Research Center, Ayub Agricultural Research Institute (AARI) Faisalabad, Pakistan
[2]University of Agriculture Faisalabad, Pakistan
[3]University of Engineering and Technology Lahore, Pakistan
[4]Institute of Soil Chemistry and Environmental Sciences, Ayub Agricultural Research Institute (AARI) Faisalabad, Pakistan
[5]Post Harvest Research Centre, Ayub Agricultural Research Institute (AARI) Faisalabad, Pakistan

*Corresponding author: Naseem Akhtar (nasimsajjad235@gmail.com)

Abstract

The Biochemistry Section at the Ayub Agricultural Research Institute (AARI) in Faisalabad served as the research hub for our study throughout 2020-21. We delved into the antioxidants and biochemical parameters found in an array of fruits including peach (*Prunus persica*), grapes (*Vitis vinifera*), grapefruit (*Citrus paradisi*), lychee (*Litchi chinensis)*, fig (*Ficus carica*), plum (*Prunus domestica*), sweet lime (*Citrus limetta*), Kuranda (*Carissa carandas*), kiwi (*Actinidia deliciosa*), and pear (*Pyrus communis*). These fruits offer vital nutrition like Vitamin C, ranging from 2.49 in fig to 48.7 in sweet lime, mineral matter is minimum (0.34%) in pear and maximum 6.19% in Lychee, crude fiber was highest (7.26%) in kuranda and lowest (0.82%) in Grapefruit, crude fat was less than 1 in all the fruits except kuranda having crude fat 1.66%. crude protein was also less than one in most of the fruits under study except Fig (2.05%), Plum (3.33%) and Kuranda (1.16%). Total antioxidants were higher in Peach (94.1%) followed by Plum (88.5%), Sweet lime (84.6%) and Fig (83.9%) while lowest value was observed in Kuranda (10.4%). Their adequate consumption not only fortifies the immune system but also serves as a shield against afflictions. Phenols packed abundantly within fruits, stand out as some of the most nutrient-rich components. Total phenols were ranging from 13.8 µg GAE/mL (Grapefruit) to 1182.5 µg GAE/mL (Kuranda). Total sugar lies between 6% (Plum) to 14.3% (Luchee). This paper delves deep into an exhaustive analysis of bioactive compounds, exploring their antioxidant capacities within the most widely cultivated fruits. Our exploration identifies that all the fruits are useful due to one or more nutritious elements. Our findings conclusively advocate the regular consumption of fruits, emphasizing their pivotal role in fostering nutrition and safeguarding against diseases.

Keywords: Antioxidants, Biochemical composition, Minerals, Nutrition, Vitamins

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Introduction

Antioxidants present in food significantly contribute to safeguarding our health. Scientific findings consistently highlight their role in diminishing the risk of chronic ailments like cancer and heart disease. Fruits and vegetables are notably rich in antioxidants, specifically phenolic and ascorbic acids. Emphasis has been placed on advocating the consumption of raw or fresh fruit due to the substantial health benefits they offer to humanity's well-being (Liu et al., 2000; Martin et al., 2002). Most fruits are abundant sources of multivitamins, dietary fiber, and minerals. Compounds such as various phenolics found in these fruits act as potent antioxidants potentially reducing the risk of diseases (Grassmann et al., 2002). Free radicals, generated during cellular metabolic activities in biological systems, possess high reactivity. While a definite quantity of these mixtures aids the body's immune functions positively, unsuitable dietetic ways and régimes can prompt oxidative stress. This inequity among free radical construction and the body's antioxidant protection mechanisms manifests via various molecular damage biomarkers (Soares et al., 2019; Dhalaria et al., 2020). The resulting health implications have sparked a growing societal emphasis on adopting healthier consumption habits, including the ingestion of antioxidant complexes (Forni et al., 2021; Khan et al., 2021).

Global dietary guidelines underscore the significance of eating vegetables and fruits as a preventive measure against diseases. Apart from their macro and micronutrient content, these foods harbor phytochemical compounds celebrated for their properties of antioxidant (Ali et al., 2020). Many marketable brands have even industrialized goods augmented with antioxidants sourced from vegetables and fruits apples, mushrooms and oranges. Recognizing the pivotal role of antioxidants demands not just the attention of nutritionist and doctors in identifying suggested consumption levels and their health effects, but also an calculation of technical viability in

harnessing these compounds in the context of the globular frugality in nutraceuticals (Belwal et al., 2020).

Flavonoids operate through three distinct pathways in their antioxidant action: they eliminate reactive oxidative species, stimulate endogenous mechanisms via gene expression, and inhibit the formation of nitrogen species and reactive oxygen (Dhalaria et al., 2020; Dias et al., 2021; Khan et al., 2021). However, the full health assistances of flavonoids to the human body are inadequate because of their low captivation and early conversion into byproducts that may not possess the same activity of metabolic and biological as the primary compounds (Farooqui & Farooqui, 2018). Selenium, a component in antioxidant enzymes like glutathione peroxidase, plays a significant role in catalyzing reduction reactions and protecting cells. Magnesium participates in numerous enzymatic reactions, while zinc, a vital trace element, acts as a cofactor for numerous enzymes, contributing to antioxidant processes and shielding molecules from oxidation (Marreiro et al., 2017; Olechnowicz et al., 2018). Our study aimed to ascertain the nutrition and antioxidant potential of commercially accessible fruits. This involved evaluating the crude protein, crude fat, crude fiber, mineral matter antioxidant capacity, total phenolic compounds and ascorbic acid of selected fresh fruits.

Materials and Methods

Conduction of the present study was carried out at the laboratory of Biochemistry Section, existed in AARI, Faisalabad through the year 2022-23 to find out the nutritional status and antioxidants of plum (*Prunus domestica*), sweet lime (*Citrus limetta*), Kuranda (*Carissa carandas*), kiwi (*Actinidia deliciosa*) and pear (*Pyrus communis*) peach (*Prunus persica*), grapes (*Vitis vinifera*) grapefruit (*Citrus paradisi*), lychee (Litchi chinensis) fig (*Ficus carica*). Fruits were purchased from a nearby market. Samples of fruits were washed, wiped and made dry at room temperature, pressed to get their juice/pulp and analyzed for pH, TSS, acidity, total phenol, total antioxidant activity, total sugar, Vitamin C, dry matter and other proximate analysis.

Fruit materials

The fruits material was got from the nearby market situated at Model bazar Jhang road Faisalabad. The samples were sent immediately after their arrival and consumed for analysis. Half of the fruits were processed for juice/pulp extraction and others cut into small pieces and placed at 65 ^{o}C for drying and later used for proximate analysis. The edible parts were analyzed according to habits of usual consumer. Fruits were peeled out and seeds were removed of all fruits undergo examination.

pH

To determine pH, digital pH meter was used after standardizing the pH meter with the help of pH 4 and pH 9 buffer solutions(Kalra, 1995).

Total soluble solids (TSS)

Total soluble solids were calculated using refractometer and standardizing it with distilled (Ercisli, 2007).

Acidity

Took 10 g of sample, 50 mL of distilled water and few drops Phenolphthalein indicator in a beaker (Berezin et al., 1995). We calculated the acidity by the following formula:

$$\text{Acidity (\%)} = \frac{\text{Reading x0.0064}}{wt\ of\ sample} \text{x } 100 \qquad \text{(Equation 2.1)}$$

Total phenolics

The protocol followed by Folin–Ciocalteu method (Waterhouse, 2002) was observed to find out total phenolic contents. Suitably extracted samples were added in of Folin–Ciocalteu reagent (0.2 mL), and few minutes later, added of sodium carbonate (20% w/v) (0.8 mL) was mixed. Heat of 100 ^{o}C for 1 min was given to the mixture. Cooled the mixture and took the reading in absorbance mode at 750 nm. Standards were prepared with Gallic acid, and results were expressed as micrograms of Gallic acid equivalents (GAE) per mL of juice. Each sample was analyzed thrice.

Total antioxidant activity

For determination of antioxidant capacity the protocol described by (Magalhães et al., 2006) was followed. Briefly stock solution was made by mixing 0.004 g of DPPH in 100 mL of methanol. DPPH (0.004%) was used as a blank and to prepare sample extraction mixture (Methanol: acetone: HCl in 90: 0: 8: 2) was prepared. The pulp of each fruit weighed 1 g and vortexed with 5 mL extraction mixture. Centrifuged the vortexed sample and took supernatant for further use. Extracted plant sample 0.5mL was mixed with 5 ml of a 0.004% methanol mixture of DPPH. The mixed material was stored at room temperature for 35 min in the dark. The colour will change from violet to yellow. The reading was determined as absorbance of 517 mm via a spectrophotometer (UV-VIS). Calculation was carried out via following equation:

$$[\%\ \text{DPPH Activity}] = [(A_0\text{-}A) / A_0] \text{ x } 100 \qquad \text{(Equation No 2.2)}$$

Where A_0 – absorbance of DPPH solution with methanol, A-absorbance of a DPPH solution with a tested extract solution (test). Experiments were run in triplicate and the results were given to as average values with S.D. (standard deviation).

Total sugar

Took 20 g sample (20 ml pulp or juice) in volumetric flask (250 ml). Added distilled water, 25 ml 15 ml lead acetate and potassium oxalate solution respectively. Made the volume to 250 ml using distilled water and sieved. Took 25 ml filtrate, 5 ml HCl and some water. Left for 24 hours for complete hydrolysis. Then exactly neutralized it with about 5N NaOH using phenolphthalein indicators and made the volume. Took Fehling's solutions (10 ml) in a beaker and added some water and heated it to boiling. Took sample in titrating burette and allow the solution to flow drop wise into the Fehling's solution containing conical flask continuing slow boiling till end point (brick red color). Add some drops of methylene blue for clear end point(Casterline Jr et al., 1999).

Vitamin C (Ascorbic acid)

Using the reagents Oxalic acid solution (0.4%), Dye (dichlorophenol indophenol) (42 mg of NaHCO3 + 52mg dye in 200mL distilled water stirr, filter and store in cool dark place use within three days) and Ascorbic acid solution (0.1%). Ascorbic acid (vitamin C) was determined by the protocol given by (Pegg et al., 2010). Briefly dye was standardized with ascorbic acid (0.1%) of known concentration to know the mL of dye needed for 1 mL dye for ascorbic acid. Titrated 1 mL of ascorbic acid solution and 1.5 mL of oxalic acid against dye to pink end point. Samples were analyzed by taking 30, 50 g pulp and making volume 100 mL with oxalic acid and filtering through cheese cloth. Then 5 mL of filtered samples were titrated against dye and calculated by the following formula:

$$\text{Ascorbic acid (Vitamin C mg/100 g)} = \frac{1xR1xVx100}{RxWxV1}$$

(Equation 2.3)

Dry matter

Dry the sample in steel dish at 105 °C for two hours. Removed the sample along with dishes and placed into desiccator. Instantly covered it and allowed the samples in dishes to cool up to room temperature. Weighed the samples along with dishes. Recorded weight of both dish and sample. We calculated the dry matter by the following formula:

$$\text{Total DM (\%)} = \frac{\text{Dry Weight of Sample and Dish - Tare Weight of Dish}}{\text{Initial Weight of Sample and Dish - Tare Weight of Dish}} X100$$

(Equation 2.4)

Crude fat

Crude fat was determined by extracting fat with ether. Boiling and subsequently condensing of Ether after passing through sample. A sample of weight 2.5 g was taken into oven dried previously extracted filter paper sheet (3 x 4 inches). Placed the sample, enclosed in filter paper sheet into the thimble and fixed in the Soxtec extraction apparatus under the condenser. Then poured 40 mL in the solvent beaker and placed on the hot plate of the apparatus. The tap water was turned on and started the extraction for 1 hour. After one hour the extraction will be completed, removed the thimbles along with samples. Allowed the samples to become dry at room temperature. Weighed the samples and calculated via formula as described by Thiex (Thiex et al., 2012):

$$\text{Crude Fat} = \frac{\text{Wt of ether extract}}{\text{Wt of samples}} \times 100$$ (Equation 2.5)

Crude fiber

A moisture free and ether extracted sample (2 g) was oven dried. The samples were then digested with 1.25% H_2SO_4 (200 mL) solution in a glass container and heated for 30 minutes on a hot plate. The heated material was then filtered by cheese cloth and washed thrice with distilled water. The residues were collected from the cheese cloth and mixed in 200 mL NaOH (1.25%) solution and boiled for half an hour at hot plate again. The mixture after boiling was filtered, gave washing with distilled water thrice and 1 with acetone. Collected the residues from the cheese cloth and transferred them to a pre-weighed crucible. Crucible was placed in hot air oven at temperature of 105 °C for 24 hours till there was no change in weight. Noted the dry weight of sample along with crucible, ignited the sample along with crucible by placing at 595 °C in a muffle furnace for 4 hours. White ash was obtained (Thiex et al., 2012). Weight was recorded again and calculated the crude fiber by following formula

$$\text{Crude fiber(\%)} = \frac{\text{wt.of oven dried sample} - \text{wt.of ash}}{\text{wt.of fat free sample}} \times 100$$

(Equation 2.6)

Crude protein

The Kjeldahl procedure, described by Thiex (Thiex et al., 2012) was followed to measure the protein content of sample. Protein contents are the measure of a ratio of protein to nitrogen for a specific food. For determination of crude protein, the samples were boiled with sulfuric acid to transform nitrogen of protein and other compounds into NH_4SO_4. Selenium was used as catalyst along with K_2SO_4 and $CuSO_4$ at 370°C on hot plates. The digested samples were cooled. The distillation apparatus was used to distillate the samples, using NaOH and distilled water where boric acid was used as carrier. The nitrogen as ammonia released and captured in boric acid solution which was then titrated against N/10 H_2SO_2. A blank sample was run to compare the samples. The volume of H_2SO_4 titrant required for this blank was subtracted from each determination.

$$\text{Nitrogen (\%)} = \frac{\text{Acid Used x Normaility of acid} \times 0.014 \times 100}{\text{wt.of sample in g}}$$

(Equation 2.7)

Crude protein (dry wt. basis) = N × 6.25

Ash (Mineral matter)

For mineral matter determination the weight of oven dry crucible was noted. Tared the weight of crucible and weighed 4 g sample in crucible. The samples contained in the crucibles were heated at 600 ºC in the furnace for 4 hours. Samples were converted into white ash after ignition (Thiex et al., 2012). Samples (Ash) along with crucible were weighed and mineral matter content was determined as under:

$$\text{Mineral matter}\,(\%) = \frac{\text{Ash weight}}{\text{wt.of sample}} \times 100 \quad \text{(Equation 2.8)}$$

Results

Ingesting fruits was raised in the past decade, because they have good taste, attractive contour, and are nutritious and healthy. Antioxidants are the main component of fresh fruits that is very effective against the deterrence of worsening illness and oxidants produced in the bod under stress. Fresh juice of the samples was squeezed to analyze for the TSS, pH, acidity, total phenol, total sugar, Vitamin C, crude protein, dry matter, crude fiber, crude fat mineral matter and total antioxidant activity protocol is giving as under,

pH

Table 1 showed the results of pH for fresh fruits juices. The pH of all the fruits lies in the highly acidic range except in kuranda (6.6 ± 0.87) and fig (5.31± 0.16) which is acidic to neutral. Regarding all other fruits, higher pH was found in peach (4.61± 0.37) followed by lychee (4.32± 0.6) and minimum was present in pear (2.64±0.026).

Total soluble solids (TSS)

TSS was significantly varied among different fruits (Table 1). Soluble solids varied from (09-15) °Brix. Kuranda had the highest TSS (15.6 ± 0.42) among others which is shown in Table 1. Lychee had 15.3 °Brix while kiwi and grapes had 14.5 ± 0.67 and 14.6 ± 0.16°Brix respectively. The lowest TSS was observed in grapefruit (9.5 ± 1.04). Fig (13.97± 0.48), pear (13.8± 0.23), peach (12.3 ± 0.17) and plum (12.29 ± 1.32) were statistically equal.

Acidity

The titrable acidity among the fruits is given in Table 1. From this result it is observed that sweet lime showed highest acidity (2.01 ± 0.67%) followed by Pear (1.92±0.046) kuranda (1.64 ± 0.81%) and kiwi (1.62± 0.08%). The lowest acidity was observed in Fig pulp (0.18 ±0.07). The acidity of all other listed fruits lied between these.

Total phenols (TCP)

Significantly higher total phenols were found in kuranda (1182.5± 23.81µg GAE/mL) whereas the lowest value of phenol contents was noted in grapefruit (13.8 ± 5.07µg GAE/mL) and lychee (17.5 ± 0.92 µg GAE/mL). Bigger value of TCP was detected in kiwi (993.1± 6.26 µg GAE/mL) sweet lime (889.4 ± 20.05µg GAE/mL) plum (551.7 ± 16.88µg GAE/mL) and fig pulp (405 ± 12.2 µg GAE/mL).

Table 1 Nutritional analysis of fruits

Fruits	TSS (%)	pH	Acidity (%)	Total phenols (µg GAE/mL)
Peach	12.3 ± 0.17	4.61 ± 0.37	0.43± 0.07	463 ± 6.07
Grapes	14.6 ± 0.16	3.71 ± 0.06	0.46 ± 0.08	368 ± 4.07
Grapefruits	9.5 ± 1.04	3.65 ± 0.32	0.67 ±0.09	13.8 ± 5.07
Lychee	15.3± 1.37	4.32 ± 0.6	0.72 ±0.03	17.5 ± 0.92
Fig	13.97 ± 0.48	5.31± 0.16	0.18 ±0.07	405 ± 12.2
Plum	12.29 ± 1.32	3.37 ± 0.21	0.963±0.096	551.7 ± 16.88
Sweet lime	10.5 ± 0.27	3.72 ± 0.77	2.01 ± 0.67	889.4 ± 20.05
Kuranda	15.6 ± 0.42	6.6 ± 0.87	1.64 ± 0.81	1182.5± 23.81
Kiwi	14.5 ± 0.67	3.8 ± 0.57	1.62± 0.08	993.1± 6.26
Pear	13.8 ± 0.23	2.64 ± 0.026	1.92±0.046	256.7±7.8
P value	0.02	0.01	0.002	0.04

Total antioxidant activity

Higher antioxidant activity was found in peach (92.17±0.304%) and plum (88.47 ± 0.55%) followed by sweet lime (84.6 ± 2.09%). The lowest value was observed in kuranda (10.4 ± 0.85%). all other given fruits have antioxidant activity between these extremes (Table 2).

Total sugar

Significantly variable values were observed regarding total sugar (Table 2). Maximum sugar content was noted in lychee (14.3 ± 1.02%) followed by Kuranda (13.8 ± 0.64%) and grapes (13.7 ± 1.05%) which were statistically at par. Among

others which is shown in Table 2, peach had 11.2 ± 1.17% while fig and grapefruit had 10.6 ± 0.77 and 8.6 ± 0.67% respectively. The lowest total sugar was observed in sweet lime (2.31 ± 0.01%).

Vitamin C

Vitamin C reduces with the maturing of the fruit (Ezeh Ernest et al., 2017). Among all the given fruits, sweet lime and grapefruit was determined to hold the higher quantity of the Vitamin C (48.7 ±1.31 and 47.1±1.104 mg/100 g respectively) and least by fig pulp (2.49 ± 0.45 mg/100 g) (Table 2). Kiwi (25.1±2.44 mg/100 g) and lychee (28.28± 3.003 mg/100 g) also had good quantity of Vit C. All other fruit under consideration have the range of 5-13 mg/100 g regarding Vitamin C.

Proximate analysis

Proximate analysis is designated to determine the nutrition of the analyzed material in research. It is based on ash content, carbohydrate, water, crude protein, lipid and crude fiber. It is evident from the results that there is momentous dissimilarity in the dry matter, ash content, crude protein, crude fiber and crude fat among fruits.

Dry matter

Significantly different values were observed regarding dry matter (Table 2). Maximum dry matter content was noted in grapes (28.83±0.84%) followed by fig and kiwi (17.6 ± 1.09 and 17.3 ± 1.17% respectively) which were statistically at par with each other. Among others which is shown in Table 2, peach had 16.07±1.46%, while plum (13.7 ± 1.27%) and kuranda (12.8 ± 1.06%) also had considerable quantity of dry matter. Grapefruit had the lowest value 8.72 ±0.60%.

Table 2 Biochemical analysis of fruits

Fruits	Total antioxidants (% DPPH activity)	Total sugar (%)	Vitamin C (mg/100 ml)	Dry matter (%)
Peach	94.15±0.30	11.2 ± 1.17	6.07±0.38	16.07±1.46
Grapes	64.9± 3.42	13.7 ± 1.05	5.00±1.06	28.83±0.845
Grapefruits	77.7±0.58	8.6 ± 0.67	46.1±1.10	9.62 ±0.60
Lychee	67.02± 3.08	14.3 ± 1.02	28.28± 3.00	10.8 ±0.76
Fig	83.98 ± 1.61	10.6 ± 0.77	2.49 ± 0.45	17.6 ± 1.09
Plum	88.47 ± 0.55	6.0 ±0.14	8.25 ± 1.12	13.7 ± 1.27
Sweet lime	84.6 ± 2.09	2.31 ± 0.01	48.7 ±1.31	8.62 ± 0.87
Kuranda	10.4 ± 0.85	13.8 ± 0.64	13.9 ± 0.52	12.8 ± 1.06
Kiwi	73.9 ± 1.41	7.86 ± 0.37	25.1± 2.44	17.3 ± 1.17
Pear	72.2± 2.78	9.94 ± 0.52	3.14 ± 0.42	11.3± 1.07
P value	0.002	0.013	0.004	0.014

Crude fat

Considerably variable values were observed in the case of crude fat (Table 3). Maximum crude fat was observed in kuranda (1.66±0.09%) and sweet lime had the lowest (0.21±0.07%). Among other fruits which are shown in Table 3 crude fat ranges between (0.25 to 0.77%).

Crude fiber

Crude fiber significantly varied as given in Table 3. Maximum crude fiber was noted in Kuranda (7.26±1.07%) followed by fig (4.65±0.43%) and kiwi (4.56±0.05%). Among other fruits which is shown in Table 3 the lowest value was observed in grapefruit (0.82±0.06%) while crude fiber in other was ranges from 1.36±0.06% to 2.16±0.16%.

Crude protein

Protein is the most important component in fruit. The quantity of protein was calculated comparatively less in pear (0.36 ±0.049%). The total protein content of plum was 3.33±0.53% which is the highest of all followed by fig (2.05±0.24%). Protein of other fruits lied in range of 0.64 – 1.16%. Table 3 expresses the difference in protein content amid given fruit samples.

Mineral matter

Significantly variable values were observed regarding Mineral matter (Table 3). Maximum matter was noted in lychee (6.19 ± 0.36%) followed by Kiwi (3.57±1.03%) and grapefruit (3.19 ± 0.472%) which were statistically at par with each other. Among other fruits which are shown in Table 3 plum had 1.5±0.03%, while fig (0.95 ± 0.16%) and kuranda (1.02±0.02%) also had reasonable percentage of mineral matter. The lowest mineral matter was observed in pear (0.34 ± 0.03%).

Table 3 Proximate analysis of fruit

Fruits	Crude fat (%)	Crude fiber (%)	Crude protein (%)	Mineral matter (%)
Peach	0.35± 0.02	2.16±0.05	0.88±0.01	0.55 ± 0.02
Grapes	0.27 ± 0.03	1.26 ±0.06	0.64±0.14	0.47 ± 0.02
Grapefruits	0.45±0.03	0.82±0.06	0.67±0.04	3.19 ± 0.47
Lychee	0.25 ±0.04	1.36±0.06	0.97±0.07	6.19 ± 0.36
Fig	0.38±0.07	4.65±0.43	2.05±0.24	0.95 ± 0.16
Plum	0.77±0.13	2.06 ± 0.36	3.33±0.53	1.5±0.03
Sweet lime	0.21±0.07	2.09±0.14	0.77 ±0.07	0.46 ±0.03
Kuranda	1.66±0.09	7.26±1.07	1.16 ± 0.17	1.02±0.02
Kiwi	0.44±0.03	4.56±0.05	0.82 ±0.08	3.57±1.03
Pear	0.29±0.06	2.16±0.16	0.36 ±0.05	0.34 ± 0.03
P value	0.005	0.005	0.001	0.024

Discussion

Fruits stand as excellent sources of diverse antioxidants, comprising a multitude of antioxidant elements that differ among various fruits, species and climates. These antioxidants are vital elements that should accompany our fruit intake. Despite certain foods being more nutrient-rich, fruits reign supreme as the paramount source of antioxidants, their potency varying based on factors like ripeness, species, and climate. Consequently, fruits hold immense promise as agents that promote health and prevent diseases. Fruits are naturally self-sufficient for Phenolic acids as antioxidant capabilities (Süntar & Yakıncı, 2020; Thakur et al., 2020). These metabolites arise from aromatic rings, such as benzene, substituted with carboxylic acids or hydroxyl groups, and offer advantages over flavonoids due to their free form, aiding in absorption and solubility in the digestive system (Chen et al., 2020). They can be categorized as benzoic or hydroxybenzoic acids and cinnamic acids, contributing to biochemical scavenging effects that combat free radicals (Bento-Silva et al., 2020; Cory et al., 2018). Phenolic acids demonstrate high efficiency in reducing various oxidant compounds intricate in oxidative stress and cell damage, while also contributing positively to the body's immune response (Cory et al., 2018; Tresserra-Rimbau et al., 2018).

The well-established antioxidant benefits of fruits are balanced mix of vitamins and minerals, countering free radicals that may cause injury to our body's biomolecules (Miranda-Díaz et al., 2020). However, some studies suggest that certain compounds with antioxidant capacity may also act as pro-oxidants. While environmental factors are implicated in these activities, further research is warranted to conclusively understand how antioxidants may behave as pro-oxidants (Rahal et al., 2014). Flavonoids operate through three distinct pathways in their antioxidant mechanism, involving the removal of oxidative species, triggering internal mechanisms through gene expression, and inhibiting the formation of reactive oxygen or nitrogen species through chelation or oxidative enzymatic activities (ROS and RNS) (Dhalaria et al., 2020; Dias et al., 2021; Khan et al., 2021). The advantageous impact of minerals found in fruits and vegetables stems from their ability to maintain water balance within cell membranes, thereby ensuring electro-neutrality, and acting as essential cofactors for enzymes (Fellows, 2017).

Our findings concerning the dry matter content (Table 2) of fruits aligned with previous studies by (Tayyeb et al., 2017; Garuba et al., 2018; Kookal & Thimmaiah, 2018). Fruits typically exhibit high moisture content, classifying them as highly perishable. The dry matter content aligns with standard compositional features of fruits, as described in literature (Slavin & Lloyd, 2012). Moisture loss in samples from the open market might have contributed to increased total solid content, consequently enhancing nutrient concentration. The protein content of the fruits ranged from 0.36% to 3.33% (Table 3), consistent with reported literature (Wasagu et al., 2013; Tayyeb et al., 2017; Kookal & Thimmaiah, 2018; Oyeyinka & Afolayan, 2019). Proteins, essential as life's building blocks, are predominantly associated with animal sources, although certain fruits contain proteins, albeit not as abundantly as animal products. A diet rich in proteins aids in muscle building, metabolism enhancement, and bolstering immunity. Fruits are recommended as one of the sources of protein intake. Concerns regarding protein's impact on acid production underscore the importance of higher fruit and vegetable intake rather than reduced protein intake due to the alkalizing effect these foods provide (Heaney & Layman, 2008).

The lipid/crude fat content among the fruits ranged from 0.21% to 1.66% (Table 3), showing significant variation ($P \leq 0.05$) across different fruits, consistent with previous literature findings (Tayyeb et al., 2017; Oyeyinka & Afolayan, 2019). Lipids serve as crucial energy sources, holding twice the energy value of carbohydrates. They also play fundamental roles in the structure and function of biological membranes and act as precursors for various hormones (Berdanier, 1995). Regarding ash content/mineral matter (Table 3), our findings aligned with reported literature (Tayyeb et al., 2017; Garuba et al., 2018; Oyeyinka & Afolayan, 2019). Ash, the inorganic residue after complete oxidation of organic food components, represents the total mineral content in food. High ash content in samples indicates a rich source of minerals, a trait well-established in numerous studies confirming fruits as significant mineral sources. The crude fiber content in these fruits ranged from 0.82% to 7.26%. This content showed a similar pattern to

the ash content. Comparatively, our findings regarding crude fiber content aligned with previous reports by (Onifade et al., 2013; Garuba et al., 2018).

The crude fiber content (Table 3) serves as an indicator of the dietary fiber composition of fruits and vegetables, considering that only the edible portions were analyzed. Fruits are recognized for their fiber provision, associated with reduced cardiovascular diseases and obesity (Slavin & Lloyd, 2012). Dietary fiber, an indigestible food component, adds bulk to gastrointestinal content, stimulating peristalsis and maintaining normal bowel function, among other health benefits (Berdanier, 1995). The variations in these results are likely due to environmental factors. Moreover, the variability in vitamin C (Table 2) levels in fruits is influenced by multiple factors such as fruit genetics, growing conditions, use of fertilizers, harvest time, storage, and ripening conditions (Richardson et al., 2018; Lee & Kader, 2000). For instance, while kiwifruit contains vitamin C levels similar to oranges, these contents are nearly six times higher than that in bananas and watermelon when measured on an edible flesh weight basis (Lintas et al., 1991; Richardson et al., 2018). Variations in vitamin C content among different cultivars have been observed, with significant differences between them (Richardson et al., 2018). Vitamin C plays a crucial role in the immune system, especially in leukocytes, the body's defense cells. The correlation between kiwifruit's vitamin C content and its total antioxidant activity has been noted (Lim et al., 2014). Factors like cultivar, soil characteristics, climate, and sample preparation methods significantly impact nutrient concentrations in fruit species (Celik et al., 2007).

Furthermore, among various fruits, there's a wide range of phenolic contents and antioxidant capacities (Table 2). Kuranda, kiwi, sweet lime, peach, plum, and fig demonstrated relatively high total phenolic content and antioxidant capacities determined using the DPPH test. Conversely, grapefruit and lychee exhibited relatively lower levels. The antioxidant capacity of strawberries, recognized to be 1540 ORAC units per 100 g (Ahuja et al., 2012), was found to be behind that of grapes and blackberries (Gu et al., 2004). Grapes are known for their high polyphenol content, primarily due to their abundance in proanthocyanidin and flavonoids (Gu et al., 2004). Most fruits with high antioxidant capacity also exhibited elevated levels of ascorbic acid. This variation in phenolic and ascorbic acid contents, as well as antioxidant capacities, was determined through the DPPH method in fresh fruits (Table 3). Based on global data, certain fruits (like strawberry, grape, banana, berries) and vegetables (such as peppers, broccoli, and spinach) consistently showcase high antioxidant levels. Discrepancies in reported data stem from diverse factors like extraction methods (Tabart et al., 2007), cultivar differences (Howard et al., 2003), ripeness variations (Navarro et al., 2006), and seasonal weather conditions impacting production (Markus et al., 1999).

Modern consumers prioritize nutritional qualities, yet comprehensive analyses evaluating antioxidant capacity often focus on select fruits. Preserving the phenolic content in fruits significantly influences their quality, impacting enzymatic browning reactions and enhancing their nutritional value through antioxidant capacity. Notably, some fruits demonstrated an increase in antioxidant capacity post-purchase, akin to observations in fruits stored at different temperatures (Ayala-Zavala et al., 2004). Studies on broccoli showed a decline in antioxidant capacity, emphasizing the role of packaging in maintaining antioxidants during storage (Serrano et al., 2006). For bananas, a marked decrease in phenolic content and antioxidant capacity was noted, contrasting findings that highlighted an increase in antioxidant capacity in banana skins during storage (Kondo et al., 2005). Similarly, apricots displayed reduced antioxidant capacity when stored at low temperatures (Bartolini et al., 2005). Concerning ascorbic acid levels, stability was generally observed, though some instances recorded a decrease, while others reported an increase during storage under varying conditions (Jiménez et al., 2003). Typically, fruits visually deteriorate before experiencing significant losses in antioxidant capacity. However, there's a trend of increased polyphenolic content accompanying elevated antioxidant capacity, affirming the evolving nutritional value of fruits and vegetables.

Conclusion

The biochemical analysis of different fruits was explored. These data state that kuranda is nutritious, determined mainly by the great extent of TSS, neutral pH, higher phenolic, crude fat and crude fiber than other fruits. Results indicated that the amount acidity, antioxidants, total sugar and vitamin C differs in diverse fruits. Amid all the chemical components, dry matter was observed greater in grapes whereas higher crude protein was found in plum. It is concluded that sweet lime and grapefruits are the plushest bases of vitamins such as Vit C, minimum daily requirement may be fulfilled by a single fruit. There was not much difference in crude fat, fiber and protein among the fruits. It is revealed from these results that fruits carry high nutrition, healthy contents and low-calorized. However, peach and plum are higher in antioxidants and are recommended as healthier than all the given fruits.

References

Ahuja, J., Montville, J. B., Omolewa-Tomobi, G., Heendeniya, K. Y., Martin, C. L., Steinfeldt, L. C., Anand, J., Adler, M. E., LaComb, R. P., & Moshfegh, A. J. (2012). USDA food and nutrient database for dietary studies, 5.0–documentation and user guide. *US Department of Agriculture, Agricultural Research Service, Food Surveys Research Group: Beltsville, MD, USA*.

Ali, M. Y., Sina, A. A. I., Khandker, S. S., Neesa, L., Tanvir, E., Kabir, A., Khalil, M. I., & Gan, S. H. (2020). Nutritional composition and bioactive compounds in tomatoes and their impact on human health and disease: A review. *Foods*, *10*(1), 45.

Ayala-Zavala, J. F., Wang, S. Y., Wang, C. Y., & González-Aguilar, G. A. (2004). Effect of storage temperatures on antioxidant capacity and aroma compounds in strawberry fruit. *LWT-Food Science and Technology*, *37*(7), 687-695.

Bartolini, S., Viti, R., & Zanol, G. (2005). Apricot cultivars and cold storage affect the total antioxidant capacity and glutathione content in fruit. XIII International Symposium on Apricot Breeding and Culture 717,

Belwal, T., Pandey, A., Bhatt, I. D., & Rawal, R. S. (2020). Optimized microwave assisted extraction (MAE) of alkaloids and polyphenols from Berberis roots using multiple-component analysis. *Scientific Reports*, *10*(1), 917.

Bento-Silva, A., Koistinen, V. M., Mena, P., Bronze, M. R., Hanhineva, K., Sahlstrøm, S., Kitrytė, V., Moco, S., & Aura, A.-M. (2020). Factors affecting intake, metabolism and health benefits of phenolic acids: do we understand individual variability? *European Journal of Nutrition*, *59*, 1275-1293.

Berdanier, C. (1995). Advanced nutrition: Macronutrients. *Journal of Optimal Nutrition*, *4*, 13-13.

Berezin, O. Y., Tur'yan, Y. I., Kuselman, I., & Shenhar, A. (1995). Alternative methods for titratable acidity determination. *Talanta*, *42*(4), 507-517.

Casterline Jr, J. L., Oles, C. J., & Ku, Y. (1999). Measurement of sugars and starches in foods by a modification of the AOAC total dietary fiber method. *Journal of AOAC International*, *82*(3), 759-765.

Celik, A., Ercisli, S., & Turgut, N. (2007). Some physical, pomological and nutritional properties of kiwifruit cv. Hayward. *International Journal of Food Sciences and Nutrition*, *58*(6), 411-418.

Chen, J., Yang, J., Ma, L., Li, J., Shahzad, N., & Kim, C. K. (2020). Structure-antioxidant activity relationship of methoxy, phenolic hydroxyl, and carboxylic acid groups of phenolic acids. *Scientific Reports*, *10*(1), 2611.

Cory, H., Passarelli, S., Szeto, J., Tamez, M., & Mattei, J. (2018). The role of polyphenols in human health and food systems: A mini-review. *Frontiers in Nutrition*, *5*, 87.

Dhalaria, R., Verma, R., Kumar, D., Puri, S., Tapwal, A., Kumar, V., Nepovimova, E., & Kuca, K. (2020). Bioactive compounds of edible fruits with their anti-aging properties: A comprehensive review to prolong human life. *Antioxidants*, *9*(11), 1123.

Dias, M. C., Pinto, D. C., & Silva, A. M. (2021). Plant flavonoids: Chemical characteristics and biological activity. *Molecules*, *26*(17), 5377.

Ercisli, S. (2007). Chemical composition of fruits in some rose (Rosa spp.) species. *Food Chemistry*, *104*(4), 1379-1384.

Ezeh Ernest, Okeke Onyeka, Ozuah, A. C., & Onwubiko R. O. (2017). Comparative assessment of the effect of ripening stage on the vitamin c contents of selected fruits grown within Nsukka Axis of Enugu State. *International Journal of Environment, Agriculture and Biotechnology*, *2*(2), 712-714.

Farooqui, A. A., & Farooqui, T. (2018). Importance of fruit and vegetable-derived flavonoids in the Mediterranean diet: molecular and pathological aspects. In *Role of the Mediterranean diet in the brain and neurodegenerative diseases* (pp. 417-427). Elsevier.

Fellows, R. P., Dahmen, J., Cook, D., & Schmitter-Edgecombe, M. (2017). Multicomponent analysis of a digital Trail Making Test. *The Clinical Neuropsychologist*, *31*(1), 154-167.

Forni, C., Rossi, M., Borromeo, I., Feriotto, G., Platamone, G., Tabolacci, C., Mischiati, C., & Beninati, S. (2021). Flavonoids: A myth or a reality for cancer therapy? *Molecules*, *26*(12), 3583.

Garuba, T., Mustapha, O., & Oyeyiola, G. (2018). Shelf life and proximate composition of tomato (*Solanum lycopersicum* L.) fruits as influenced by storage methods. *Ceylon Journal of Science*, *47*(4), 387-393.

Grassmann, J., Hippeli, S., & Elstner, E. F. (2002). Plant's defence and its benefits for animals and medicine: role of phenolics and terpenoids in avoiding oxygen stress. *Plant Physiology and Biochemistry*, *40*(6-8), 471-478.

Gu, L., Kelm, M. A., Hammerstone, J. F., Beecher, G., Holden, J., Haytowitz, D., Gebhardt, S., & Prior, R. L. (2004). Concentrations of proanthocyanidins in common foods and estimations of normal consumption. *The Journal of Nutrition*, *134*(3), 613-617.

Heaney, R. P., & Layman, D. K. (2008). Amount and type of protein influences bone health. *The American Journal of Clinical Nutrition*, *87*(5), 1567S-1570S.

Howard, L. R., Clark, J. R., & Brownmiller, C. (2003). Antioxidant capacity and phenolic content in blueberries as affected by genotype and growing season. *Journal of the Science of Food and Agriculture*, *83*(12), 1238-1247.

Jiménez, A., Romojaro, F., Gómez, J. M., Llanos, M. R., & Sevilla, F. (2003). Antioxidant systems and their relationship with the response of pepper fruits to storage at 20 °C. *Journal of Agricultural and Food Chemistry*, *51*(21), 6293-6299.

Kalra, Y. P. (1995). Determination of pH of soils by different methods: collaborative study. *Journal of AOAC International*, *78*(2), 310-324.

Khan, J., Deb, P. K., Priya, S., Medina, K. D., Devi, R., Walode, S. G., & Rudrapal, M. (2021). Dietary flavonoids: Cardioprotective potential with antioxidant effects and their pharmacokinetic, toxicological and therapeutic concerns. *Molecules*, *26*(13), 4021.

Kondo, S., Kittikorn, M., & Kanlayanarat, S. (2005). Preharvest antioxidant activities of tropical fruit and the effect of low temperature storage on antioxidants and jasmonates. *Postharvest Biology and Technology*, *36*(3), 309-318.

Kookal, S. K., & Thimmaiah, A. (2018). Nutritional composition of staple food bananas of three cultivars in India. *American Journal of Plant Sciences*, *9*(12), 2480-2493.

Lee, S. K., & Kader, A. A. (2000). Preharvest and postharvest factors influencing vitamin C content of horticultural crops. *Postharvest Biology and Technology*, *20*(3), 207-220.

Lim, Y. J., Oh, C.-S., Park, Y.-D., Eom, S. H., Kim, D.-O., Kim, U.-J., & Cho, Y.-S. (2014). Physiological components of kiwifruits with in vitro antioxidant and acetylcholinesterase inhibitory activities. *Food Science and Biotechnology*, *23*, 943-949.

Lintas, C., Adorisio, S., Cappelloni, M., & Monastra, E. (1991). Composition and nutritional evaluation of kiwifruit grown in

Italy. *New Zealand Journal of Crop and Horticultural Science*, *19*(4), 341-344.

Liu, S., Manson, J. E., Lee, I.-M., Cole, S. R., Hennekens, C. H., Willett, W. C., & Buring, J. E. (2000). Fruit and vegetable intake and risk of cardiovascular disease: the Women's Health Study. *The American Journal of Clinical Nutrition*, *72*(4), 922-928.

Magalhães, L. M., Segundo, M. A., Reis, S., & Lima, J. L. (2006). Automatic method for determination of total antioxidant capacity using 2, 2-diphenyl-1-picrylhydrazyl assay. *Analytica Chimica Acta*, *558*, 310-318.

Markus, F., Daood, H., Kapitany, J., & Biacs, P. (1999). Change in the carotenoid and antioxidant content of spice red pepper (paprika) as a function of ripening and some technological factors. *Journal of Agricultural and Food Chemistry*, *47*(1), 100-107.

Marreiro, D. D. N., Cruz, K. J. C., Morais, J. B. S., Beserra, J. B., Severo, J. S., & De Oliveira, A. R. S. (2017). Zinc and oxidative stress: current mechanisms. *Antioxidants*, *6*(2), 24.

Martin, A., Cherubini, A., Andres-Lacueva, C., Paniagua, M., & Joseph, J. (2002). Effects of fruits and vegetables on levels of vitamins E and C in the brain and their association with cognitive performance. *The Journal of Nutrition, Health & Aging*, *6*(6), 392-404.

Miranda-Díaz, A. G., García-Sánchez, A., & Cardona-Muñoz, E. G. (2020). Foods with potential prooxidant and antioxidant effects involved in Parkinson's disease. *Oxidative Medicine and Cellular Longevity*, *2020*(1), 6281454.

Navarro, J. M., Flores, P., Garrido, C., & Martinez, V. (2006). Changes in the contents of antioxidant compounds in pepper fruits at different ripening stages, as affected by salinity. *Food Chemistry*, *96*(1), 66-73.

Olechnowicz, J., Tinkov, A., Skalny, A., & Suliburska, J. (2018). Zinc status is associated with inflammation, oxidative stress, lipid, and glucose metabolism. *The Journal of Physiological Sciences*, *68*(1), 19-31.

Onifade, T., Aregbesola, O., Ige, M., & Ajayi, A. (2013). Some physical properties and thin layer drying characteristics of local varieties of tomatoes. *Agriculture and Biology Journal of North America*, *4*(3), 275-279.

Oyeyinka, B. O., & Afolayan, A. J. (2019). Comparative evaluation of the nutritive, mineral, and antinutritive composition of *Musa sinensis* L. (Banana) and *Musa paradisiaca* L. (Plantain) fruit compartments. *Plants*, *8*(12), 598.

Pegg, R. B., Landen, W., & Eitenmiller, R. R. (2010). Vitamin analysis. *Food Analysis*, *4*, 179-200.

Rahal, A., Kumar, A., Singh, V., Yadav, B., Tiwari, R., Chakraborty, S., & Dhama, K. (2014). Oxidative stress, prooxidants, and antioxidants: The interplay. *BioMed Research International*, *2014*, 761264.

Richardson, D. P., Ansell, J., & Drummond, L. N. (2018). The nutritional and health attributes of kiwifruit: A review. *European Journal of Nutrition*, *57*, 2659-2676.

Serrano, M., Martinez-Romero, D., Guillen, F., Castillo, S., & Valero, D. (2006). Maintenance of broccoli quality and functional properties during cold storage as affected by modified atmosphere packaging. *Postharvest Biology and Technology*, *39*(1), 61-68.

Slavin, J. L., & Lloyd, B. (2012). Health benefits of fruits and vegetables. *Advances in Nutrition*, *3*(4), 506-516.

Soares, C., Carvalho, M. E., Azevedo, R. A., & Fidalgo, F. (2019). Plants facing oxidative challenges—A little help from the antioxidant networks. *Environmental and Experimental Botany*, *161*, 4-25.

Süntar, I., & Yakıncı, Ö. F. (2020). Potential risks of phytonutrients associated with high-dose or long-term use. In *Phytonutrients in Food* (pp. 137-155). Elsevier.

Tabart, J., Kevers, C., Sipel, A., Pincemail, J., Defraigne, J.-O., & Dommes, J. (2007). Optimisation of extraction of phenolics and antioxidants from black currant leaves and buds and of stability during storage. *Food Chemistry*, *105*(3), 1268-1275.

Tayyeb, M., Achakzai, N. R. S. U. K., Rehman, S. U., Akhtar, W., Baseer, K., & Sabir, M. (2017). Mineral profile and proximate analysis of fresh and waste water irrigated cabbage from Quetta Balochistan. *Pure and Applied Biology*, *6*(3), 882-888.

Thakur, M., Singh, K., & Khedkar, R. (2020). Phytochemicals: Extraction process, safety assessment, toxicological evaluations, and regulatory issues. In *Functional and preservative properties of phytochemicals* (pp. 341-361). Elsevier.

Thiex, N., Novotny, L., & Crawford, A. (2012). Determination of ash in animal feed: AOAC official method 942.05 revisited. *Journal of AOAC International*, *95*(5), 1392-1397.

Tresserra-Rimbau, A., Lamuela-Raventos, R. M., & Moreno, J. J. (2018). Polyphenols, food and pharma. Current knowledge and directions for future research. *Biochemical Pharmacology*, *156*, 186-195.

Wasagu, R., Lawal, M., Shehu, S., Alfa, H., & Muhammad, C. (2013). Nutritive values, mineral and antioxidant properties of Pistia stratiotes (Water lettuce). *Nigerian Journal of Basic and Applied Sciences*, *21*(4), 253-257.

Waterhouse, A. L. (2001). Determination of total phenolics. In R. E. Wrolstad (Ed.), Current protocols in food analytical chemistry (pp. I1.1.1-I1.1.8). John Wiley & Sons.