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Determination of Chemical Parameters of Fruits Available in the Markets of Pokhara, Nepal

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ABSTRACT

The main objective of this paper is to determine the chemical parameters: pH, optical density (OD), electrical conductivity (EC), percentage of moisture content, total ash, silica, dietary fiber, total acid, vitamin C, total reducing sugar, and formaldehyde content, of selected fruits (apple, banana, coconut, grape, litchi, mango, mousambi, papaya, pineapple, pomegranate and watermelon) available in the markets of Pokhara. Chemical parameters were analyzed by using standard methods in the Research Laboratory of Prithvi Narayan Campus Pokhara, Nepal from 15th March 2022 to 14th June 2022. The pH content ranged from 3.17 to 5.40 indicating acidic nature of all the fruit juices. Electrical conductivity was maximum for coconut juice (818 $\mu S\ cm^{-1}$) followed by pomegranate, grape, mousambi and pineapple whereas that of mango was minimum (246 $\mu S\ cm^{-1}$). Maximum to minimum value of moisture content, total ash, dietary fiber, titratable acidity and vitamin C were from 93.59% (for watermelon) to 72.80% (for coconut), 1.705% (for banana) to 0.360% (for watermelon), 4.52% (for coconut) to 0.35% (for watermelon), 0.098368% (for coconut) to 0.022448% (for watermelon), and 0.049354% (for mousambi) to 0.004121% (for grape) respectively. The highest value for total reducing sugar was recorded in Papaya (2.913269%) whereas lowest value observed in coconut (0.2106619 %). Washable formaldehyde content was ranged from 0.01942085% (for grape) to 0.00038287% (for watermelon). The observed chemical parameters of fresh fruits as analyzed by using standard methods are in agreement with previously published values. This study shows that fruit samples are nutritious and fit for fresh eating by consumers.

KEYWORDS: Antioxidant, apple, chemical constituents, colorimeter, dietary fiber

INTRODUCTION

Fruits are always great sources of energy. The physical and chemical characteristics are the important qualitative and quantitative indexes of fresh fruits as well as different fruit products like jam, juices, puree, vinegar, jelly, soups, soup powder, frozen slices, canned slices and nectars. Eating enough fruits regularly lowers the risk of chronic diseases, makes people look younger, makes a person hydrated, provides the content of antioxidants, dietary fiber, vitamins and minerals, helps to make the skin glorious, boosts brain power and energy, and helps to stabilize blood sugar, activate the digestive system (Kaparapu et al., 2020; Liu, et al., 2000; Van Duyan et al., 2000). Most of the edible varieties of fruits are very important sources of nutrient components like water, proteins, lipids and fatty acids, organic acids, carbohydrates, dietary fiber vitamins (A, B, C, D, E, K) and minerals, both macronutrients and micronutrients. Macronutrient minerals are calcium (Ca), potassium (K), magnesium (Mg), phosphorus (P) and nitrogen (N), and micronutrient minerals include manganese (Mn), copper (Cu), Iron (Fe), zinc (Zn), cobalt (Co), sodium (Na), chlorine (Cl), Iodine (I), fluorine (F), sulphur (S) and selenium (Se). Dietary fiber has benefits like modulation of intestinal function, weight control, reduction of serum cholesterol and blood pressure, lowering the risk of coronary diseases (Mayer et al., 2000; Rimm et al., 1996; Martin et al, 2011). The chemical properties pH, optical density (OD), electrical conductivity (EC) of juice, moisture content, total ash, silica, dietary fiber, titratable acidity, vitamin C, total reducing sugar and formadehyde contents of eleven selected fruits: apple (*Malus domestica*: shayu), banana (*Musa acuminata*: kera), coconut (*Cocos nucifera*: nariwal), grape (*Vitis vinifera*: angoor), litchi (*Litchi chinensis*: lichee), mango (*Magnifera indica*: aanp), mosambi (*Citrus paradise*: mousam), papaya (*Carica papaya*: mewa), pineapple (*Ananas comosus*: kathar), pomegranate (*Punica granatum*: anar) and watermelon (*Citrullus lanatus:* kharbuja) available in the markets of Pokhara were analyzed.

Abundant researches have been carried out on the chemical properties of single fruit juice, mixed fruit juices, mixed vegetable and fruit juices and other related topics. Agbaje et al. (2020) analyzed the five fruits such as apple, mango, orange, papaya, and pineapple juices from different brands and reported the percentage values for pH, moisture, total ash, crude fiber and reducing sugar. An analysis of physicochemical properties of fruits sold in the local markets of Pokhara was conducted and reported the physical and chemical constituents on the report by Subedi (2022). Sultana et al. (2018) carried out the study on the quality analysis of fruits, vegetable and fish available in the local markets of southern district in Bangladesh. An analysis of physiochemical properties of commercial fruit juices sold in the local markets of Port Harcourt, Nigeria had been carried out by Gbarakoro et al. (2020) using standard methods. Othman (2009) had conducted the research on the physical and chemical composition of storage-ripened papaya fruits of eastern Tanzania, Dares Salaam. An assessment of physicochemical and phytochemcial properties of six apple varieties cultivated in district Nagar and Hunza Gilgit Baltistan, Pakistan had been carried by Azher et al., (2020) and presented moisture, ash, titratable acidity, reducing sugar and pH content. Similarly, Samir and Gehan (2015), Onyeneto et al. (2015), Nonga et al. (2014), Farid and Enani (2010), and Narain and Ilango (2015) etc. had conducted the research related to the chemical constituents of fruit juices.

No research is conducted on the chemical properties of these selected fruits in the local markets of Pokhara. Fruits are the important sources of minerals including essential nutrient elements, carbohydrates, proteins, dietary fibers, vitamins, bioactive compounds, and folic acid. Therefore, it is essential to conduct this community health related research to explore the chemical constituents of different fruits available in the local market. The result of the research is supposed to be beneficial to the researcher, dietitians and nutritionists, fruit consumers and producers in the community.

The main objectives of the study are to determine the chemical parameters of selected fruits available in the markets of Pokhara and to compare analyzed parameters with each other and with the standard reported values. Selected samples of fruits were collected from Pokhara Metropolitan city and their chemical properties were analyzed in the chemistry research laboratory of Institute of Science and Technology (IoST), Prithvi Narayan Campus, Pokhara, Nepal.

MATERIALS AND METHODS

Scientific Equipments and Apparatus

The most important scientific equipments used in the analysis are centrifugate, colorimeter, electric balance, electric blender, electric drying oven, electric Juicer, electric water through, micro-oven, muffle furnace, electric shaker, PH meter, colorimeter, etc. Glassware required for this research process were air condenser, beakers, Buchner funnel, burette, burner, conical flasks, desiccators, filter papers, funnel, glass rod, glass tube, measuring cylinder, mortar and pestle, muslin cloth, pipette, silica or platinum dish, spatula, stand with clamps, suction filtration set, test tube holder, volumetric flasks, watch glass and weighing bottle.

Chemicals and Reagents

Important chemicals and reagents of analytical grade required during the research process are acetic acid, acetone, ammonia, ammonium chloride, ammonium oxalate, ascorbic acid, carbon tetrachloride, citric acid, conductivity water, copper sulphate, distilled water, Fehling's solutions, glucose, hydrochloric acid, methylene blue indicator, iodine, nitric acid, oxalic acid, phenolphthalein indicator, potassium chloride, potassium iodide, potassium permanganate, silver nitrate, sodium bicarbonate, sodium carbonate, sodium hydroxide, sodium thiosulphate, sodium potassium tartarat, starch and sulphuric acid.

The Study Area

Shree Complex of Pokhara Metropolitan 8, situated almost at the central part of Nepal, 200 km west from the capital city Kathmandu, with an elevation of approximately 822 m, latitude 28.266 N and longitude 83.968 E, was selected as the sample collection area. All the chemical parameters of selected fruit samples were analyzed in the research laboratory of Department of Chemistry, IoST, Prithvi Narayan Campus, Pokhara.

Sample Collection and Extraction of Juice

Different varieties of fruit samples were collected from the Shree Complex market of Pokhara 8. Eleven fruit samples of different species were selected by random the sampling method and then authenticated by the botanical scientist. The samples were washed with tape water thoroughly then distilled water at last to remove clay, sand and dirt. But the samples which were used for washable formaldehyde estimation were not washed. Mass of collected cleaned fresh fruit samples was measured with the help of electric balance with peel and shell. The weighed fruit sample was chopped into slices after removing shell and blended by means of a blender to extract juice. Extracted juice was filtered through muslin cloth to get juice as filtrate and volume was measured in a cylinder with a micro scale. Cleaned fruit samples and extracted juices were stored in refrigerator at selected temperature.

Chemical Analysis: Experimentation

The listed chemical parameters were analyzed by using standard methods. They include the following:

Determination of pH of Fresh Juice

PH of fresh fruit juice samples was determined by AOAC Method (AOAC, 2010) using digital microprocessor pH meter attached with glass electrode.

Determination of Optical Density (OD)

Optical density of diluted fruit juice (1:1) was determined by using auto-digital photo colorimeter with reference to distilled water at wavelength of maximum absorption and was expressed in relative color unit (CU).

Determination of Electrical Conductivity (EC)

Electrical conductivity of fruit juice was measured by using calibrated conductivity meter with conductivity cell and expressed in μS cm^{-1} unit.

Specific conductance (L_s) = Observed conductance (L) × Cell Constant (K)

If the temperature of solution is different from the given standard solution, then correction factor was used to calculate accurate conductance.

Corrected valve of conductance = Observed conductance × cell constant × correction factor.

Determination of Moisture Content

The moisture content of fruit sample was determined by using Ranganna's method in which sample was dried in electric oven or muffle furnace. In this method, weight lost by fresh fruits due to evaporation of water was measured (Ranganna, 1986) gravimetrically. The fresh raw fruit sample was taken in pre-heated (110 ^oC for 2 hour) and pre-weighed silica or platinum dish and then heated in electric oven or muffle furnace at 55 ^oC for 4 days or at 70 ^oC for 16-18 hours. The sample was cooled in desiccators and weighed. The process of heating, cooling and weighing was repeated to get constant mass of dry moisture free sample.

Determination of Total Ash Content

Ash content of fruit samples was determined gravimetrically by using Ranganna's method. Fixed mass of raw sample was heated first at 300 ^oC for few hours, and then heated at 420 ^oC for overnight or at 550^oC for 5-7 hours. The sample was cooled in desiccators and weighted. The process of heating, cooling and weighing was repeated till a constant weight was obtained.

Determination of Silica Content

Silica content in fruits represents the percentage of ash, insoluble in acid (HCl). Silica content was estimated by Ranganna's method (1986). The ash content obtained from certain mass (w = 20 g) of fresh fruit sample was treated with 40 to 50 ml 1:1 HCl carefully, heated over water bath for 30 minutes by covering it to get dry mass. Another 10 ml 1:1 HCl and water was added in basin to dissolve soluble salts, filtered by using the Whatman 44 filter paper, residue in basin and paper was washed with dilute HCl, and then distilled water. The filter paper was retained to dish, ignited, and heated in muffle furnace at 450 ^oC for one hour, cooled and weighed to get constant mass, which represents an approximate silica content.

Determination of Dietary Fiber

Dietary fiber is non-digestible carbohydrate and lignin in plants. It was determined by Ranganna's method (1986) and method of Chandak et al., (2017). Certain mass of fresh raw fruit sample was shaded/oven dried to fixed mass. Dry mass was extracted with ether (at 35°C and then 38°C) to remove the fat content. Dried material was refluxed with 200 ml of 0.25 N sulphuric acid for 30 minutes. An acid refluxed material was filtered first through muslin cloth and then through fluted filter paper and then washed with boiling water until washing was no acidic. The material (residue) was again refluxed with 200 ml of 0.25 N sodium hydroxide solutions for 30 minute, filtered first through muslin cloth and then through fluted filter paper. Residue was washed with three 50 ml portion of hot water and by 25 ml alcohol at last. Residue was transferred in preheated and weighed silica dish.

The sample was dried at 110 °C for 3 hours in drying oven or muffle furnace. The content was cooled in desiccators and weighed to get fixed weight of moisture free mass (w_1 g say). This dried content (w_1 g) was ignited at 600 ºC for 30 minute in muffle furnace (or over burner) to get ash. Ash was cooled in desiccators and weighted to get constant mass (w_2 g say).

$$\% \text{ Dietary fiber} = \frac{\text{Mass of moisture free treated sample } (w_1\,g) - \text{Mass of ash } (W_2 g)}{\text{Mass of raw sample taken } (w\,g)} \times 100$$

Determination of Titratable Acidity (Total Acid)

Total titratable acidity of fresh fruit juices is due to presence of organic acids and was determined by using methods provided by "Manual of methods of analysis of food, vegetable and fruits" (Government of India, 2016). It was estimated by titration fruit juice with standard alkali (NaOH) solution in presence of phenolphthalein as an indicator and was expressed as anhydrous citric acid percentage, g/100 g sample (Ranganna, 1986).

Determination of Vitamin C (Ascorbic acid)

The content of vitamin C in fruit samples was determined by iodometric titration method (Alam et al., 2019). Ascorbic acid reacts with iodine solution to form dehydroascorbic acid and iodide ions (I^-). At the end point of titration, the color of indicator (starch) charges from colorless to dark blue.

Determination of Total Reducing Sugar

Amount of total reducing sugar in fresh fruit juice sample was determined by redox titration method by using standard Fehling's solution (Vishnoi,1996). Cane-sugar (sucrose) present in solution was first hydrolyzed by acid to glucose and fructose and then total soluble reducing sugar (glucose, fructose and reduced sucrose) in solution was estimated.

Estimation of Formaldehyde

The formaldehyde content present in the fresh fruit samples was determined by iodometric titration method (Vishnoi,1996). Only washable formaldehyde present on the surface of fruits was estimated by oxidising it with known excess amount of hypoiodite solution (iodine + NaOH). The unreacted hypoiodite is acidified and the liberated iodine is treated against standard sodium thiosulphate solution using starch as an indicator to determine exact iodine consumed by formaldehyde.

RESULTS AND DISCUSSION

Results

The recorded chemical properties of eleven samples of fresh fruits and fresh juices are listed in the following tables.

Table 1

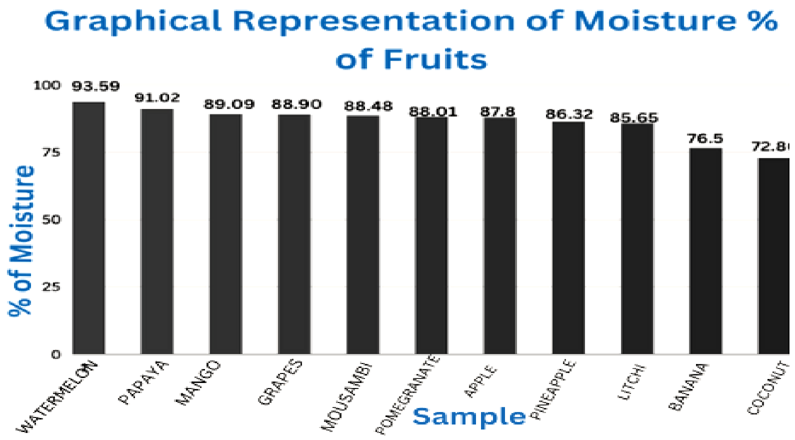
Amount of pH, Optical Density (OD), Electrical Conductance (EC), Moisture Content, Total Ash, Silica and Dietary Fiber Content in Fresh Fruit Juices (% in g/100g)

Name of Fruits	PH	OD (CU)	EC (µS cm^{-1})	Moistur Content (%)	Total Ash (%)	Silica Content (%)	Dietary Fiber (%)
Apple	3.75	0.12	270.0	87.8	1.500	0.010	2.87
Banana	5.40	0.69	325.0	76.5	1.705	0.0261	3.00
Coconut	4.9	0.21	818.0	72.80	0.890	0.036	4.52
Grapes	3.75	0.43	454.0	88.90	1.430	0.022	0.63
Litchi	4.29	0.16	389.0	85.65	0.860	0.0215	0.76
Mango	4.50	0.22	246.0	89.09	1.285	0.0195	1.87
Mousambi	3.17	0.45	460.0	88.48	0.525	0.005	2.87
Papaya	4.0	0.22	275.0	91.02	0.680	0.010	2.11
Pineapple	3.52	0.21	454.0	86.32	0.900	0.005	2.01
Pomegranate	3.86	0.47	685.0	88.01	6.600	0.0225	4.33
Watermelon	5.23	0.20	349.0	93.59	0.360	0.0055	0.35

Table 1 presents the pH of juice as hydronium ion concentration, optical density of fruit juice in CU unit and EC of fresh juice in µS cm^{-1}unit. EC reflects the presence of ionic species in fruits. It gives the amount of moisture content, total ash, silica and dietary fiber content in edible part of fresh fruits in percentage weight by weight unit as determined by gravimetric method of analysis.

Figure 1

Graphical Representation of Percentage of Moisture in fruits



The graphical presentation of percentage of moisture content in the sample of fruits is given in bar diagram of Figure 1 in the decreasing order from watermelon to coconut indicating greatest amount of water in watermelon and lowest amount in coconut.

Table 2

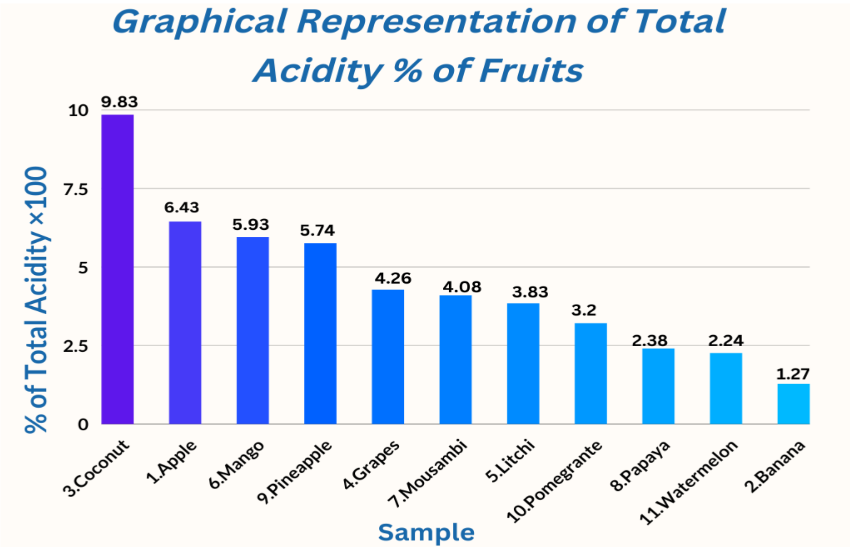
Observed Values of Total Titratable Acidity, Vitamin C (Ascorbic Acid), Total Reducing Sugar and Formaldehyde Content in Fresh Fruits (%, g/100 g)

Name of Fruits	Total Acidity (%)	Vitamin C (%)	Reducing Sugar (%)	Formaldehyde (%)
Apple	0.06435248	0.0044246	0.65936979	0.00647191
Banana	0.012711964	0.007977805	1.45193302	0.00591743
Coconut	0.098368483	0.0049968	0.21066190	0.002359141
Grapes	0.042620872	0.00411218	2.80312986	0.0194208548
Litchi	0.03830866	0.0392810	1.43469278	0.0071132187
Mango	0.05939934	0.03056054	0.593006733	0.003251625
Mousambi	0.040811004	0.0493547	1.261809	0.005133079
Papaya	0.02387632	0.02709089	2.91326983	0.003487835
Pineapple	0.05744385	0.018418756	0.53963221	0.00184337
Pomegranate	0.03208775	0.009977014	1.21611078	0.0045301013
Watermelon	0.0224480	0.005957259	1.57692308	0.000382876

Above table 2 shows the recorded values of total acidity, vitamin C, total reducing sugar and formaldehyde content present in samples in fresh fruit in percentage weight by weight in fresh fruits with peel and shell as determined by respective techniques.

Figure 2

Graphical Representation Percentage of Acidity in Fruits



The notable acidity of fruits as presented in Figure 2 is due to the presence of soluble organic acids, acidic ions and hydrogen ion concentration. The figure shows acidity in decreasing order from coconut to banana. More acidic percentage of coconut may due to presence of large number of acidic ions in coconut water inside coconut fruit.

Figure 3

Graphical Representation Percentage of Vitamin C in Fruits

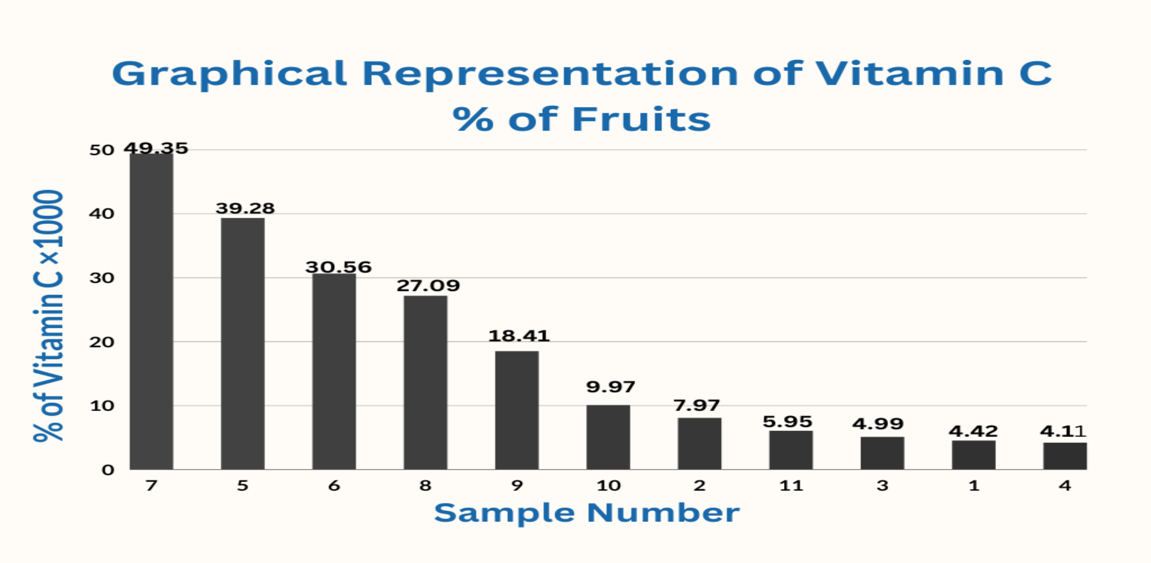


Figure 3 displays the vitamin C content of eleven sample fruits in the decreasing order from sample number 7 (mousambi) followed by samples 5 (litchi), 6 (mango) and 8 (papaya) to the sample number 4 (grape). The result indicates that citrus fruits are important sources of vitamin C.

Figure 4

Graphical Representation of Total Reducing Sugar in Fruits

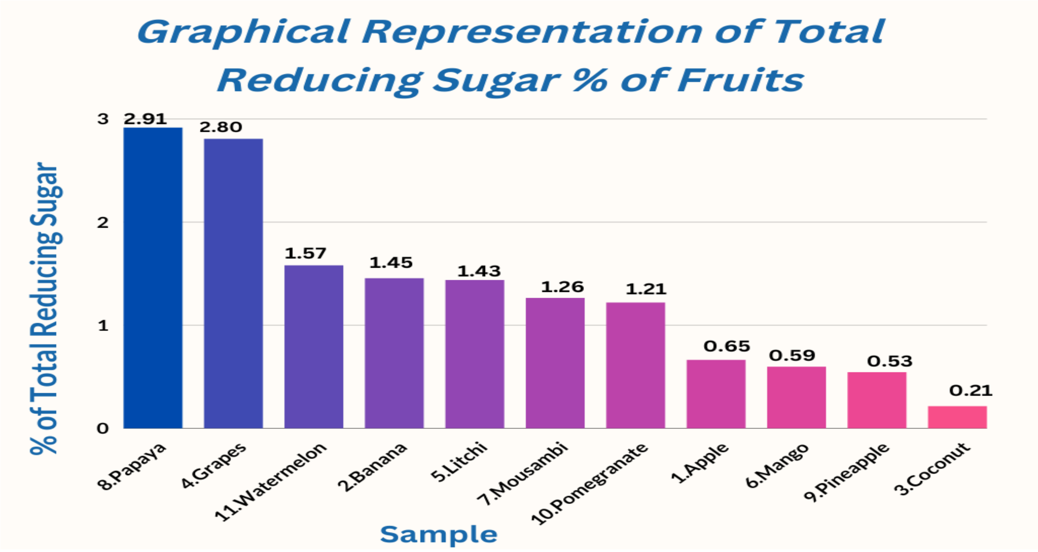
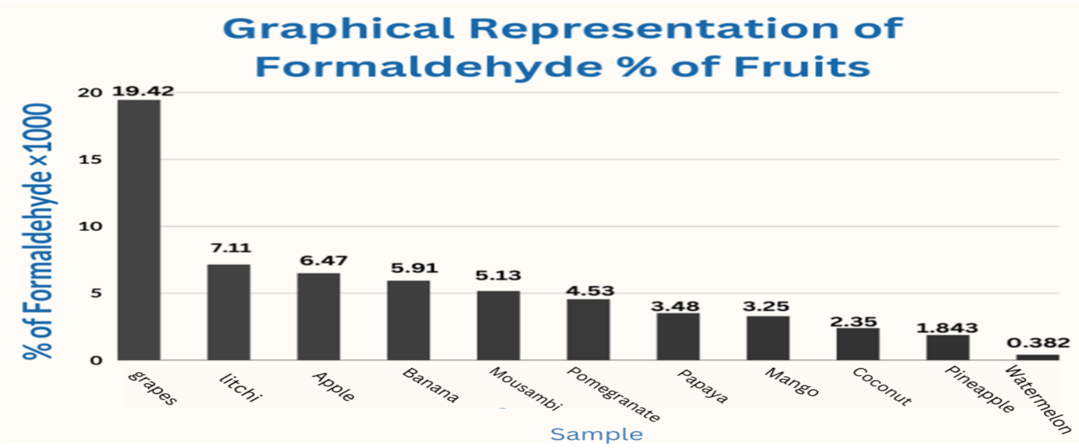


Figure 4 shows the total amount of reducing sugar present as glucose, fructose and reduced sucrose in fruit juices as determined by titration with Fehling solution. The result in the bar graph shows that papaya and grape are the major source whereas watermelon, banana, litchi, mousambi and pomegranate are intermediate sources, and apple, mango, pineapple and coconut are the minor sources of reducing sugar.

Figure 5

Graphical Representation of Percentage of Formaldehyde in Fruits



The chart presented in Figure 5 explains the percentage of washable formaldehyde in the fruit samples in decreasing order from grape to watermelon, which is the sum of naturally occurring formaldehyde and externally added formaldehyde for artificial ripening. The figure shows that the externally added formaldehyde for artificial ripening was more in grapes, quite less in other samples but negligible in watermelon.

Discussion

The observed results for pH, optical density, electrical conductivity, composition of moisture, total ash, silica content and dietary fiber of fresh fruit juices as presented in Table 1 are comparable with each other and with reported values. The pH value of all the fresh sample juices was less than the neutral value (7) indicating acidic nature of all fruit juice samples. The order of fruit juices with decreasing pH order was: banana (5.40) > watermelon (5.23) > coconut (4.90) > mango (4.50) > litchi (4.29)>papaya (4.00) > pomegranate (3.86) > apple (3.75) > grapes (3.75) > pineapple (3.52) > mousambi (3.17). These values are within the FAO permissible standard range (Gbarakoroet al., 2020). The optical density (OD), the degree to which a refractive medium retards the transmitted rays of light, measures both absorption and scattering of light of the colorless and colored constituent particles present in the juice. In the present result, OD value of 1:1 diluted juices ranged from 0.12 (for apple) to 0.69 (for banana) indicating light absorption and scattering capacity was maximum for banana juice and minimum for apple juice as observed by using auto-digital colorimeter with reference to distilled water (OD = 0.00) atλ_{max} = 540 nm. The chain of fruits for decreasing order of OD was banana, pomegranate, mousambi, grape, mango = papaya, coconut = pineapple, watermelon, litchi and apple.

Electrical conductivity (EC) of fresh fruit juice represents the presence of ionic species in it and was measured by using the conductivity meter with the conductivity cell. Conductivity value depends on the concentration, number and types of ions, viscosity and temperature of solution, presence of sugar content, storage duration of fruits and filed strength. Electrical conductivity of coconut juice (coconut water + coconut milk) is maximum (818 μS cm^{-1}) followed by pomegranate, mousambi, grapes and pineapple whereas that of mango is minimum (246 μScm^{-1}) among the eleven sample juices. EC of pure water is 0.05 μScm^{-1} and for drinking water is 200-800 μS cm^{-1}. The results showed that all the fresh fruit juices are the good conductor of electricity. EC is applicable in Ohmic heating, pulsed electric field, nondestructive quality evaluation of fruits and vegetables, food processing technology, defect analysis, frost sensitivity evaluation, freezing tolerance evaluation and maturity index determining process (Banti, 2020). The analyzed result showed that the moisture content was ranged from 72.80% (for coconut) to 93.59% (for watermelon), total ash from 0.360% (for watermelon) to 1.705% (for banana), silica content from 0.0055% (for watermelon) to 0.036% (for coconut), and mass of dietary fiber from 0.35% (for watermelon) to 4.52% (for coconut). The fresh watermelon fruit is the most water containing fruit whereas coconut is the least water containing fruit. The order of fruits with decreasing moisture content is: watermelon, papaya, mango, grapes, mousambi, pomegranate, apple, pineapple, litchi, banana and coconut. The reported value of moisture content for apple, grapes, watermelon and papaya is 85.6, 81.3, 91.52 and 88.83% respectively (Nielson, 2010). The percentage of different forms of water is present in sample depends on the pre or post-harvest time, species and types of sample, nature of cultivated soil, climate and geographical condition of sample cultivated land. The moisture content is the quality factor in the preservation of products, processed foods and packaging foods (Bradly, Jr. 2010).

The silica content in fruits is the acid (conc. HCl) insoluble part of total ash. The recorded percentage of silica is very small, but comparable to each other, ranging from 0.005% (for mousambi) to 0.036% (for coconut). The total ash content of fresh fruit sample represents mineral content and inorganic residue in it. The ash value ranges from 0.036% (for watermelon) to 1.705% (for banana). These observed values of ash for fresh fruits are comparable with the reported values of mango, coconut, pineapple and citrus for fruit juices given by Gbarakoro et al., 2020. The dietary fiber of tested fresh fruits ranged from 0.35% (for watermelon) to 4.52% (for coconut). The recorded values for apple, banana and pineapple are 2.81%, 3.0% and 2.01% respectively whereas the reported values by Vicente et al. (2014) are 2.4%, 2.6% and 1.4% respectively. The recorded values of pH, moisture, total ash and crude fiber % are well comparable with the reported values by Agbaje et al., (2020). The recorded result shows the proportional relation of dietary fiber, silica content and total ash content for most of the fruits.

The experimentally observed values of titratable acidity, ascorbic acid (vitamin C), total reducing sugar and formaldehyde content for a sample of fresh fruits as listed in Table 2 are comparable with each other and with the reported results of different authors. Titratable acidity, as % of citric acid, ranged from 0.022448% (for watermelon) to 0.09836848% (for coconut). The acidity values are inversely related with the pH values of most of the fruit juices. Total acidity was due to presence of various organic acids like maleic acid, oxalic acid, citric acid, tartaric acid, lactic acid, acetic acid and oleic acid, and free hydrogen ion concentration in fruit juices. The acidity percentage of fruit influences the color, flavor, taste and maturity of fruits (Anvoh, et al., 2009). The ascorbic acid content of the fruit juice ranged between 0.0041218 % (for grape) and 0.0493547 % (for mousambi). The observed values for litchi, mango and papaya were relatively greater among the eleven samples of fresh fruit juices. These samples contained relatively low amount of ascorbic acid in compared to reported values by (Alam et al., 2019) in which ascorbic acid (Vitamin C) ranges from 2.96 mg per100 ml (for litchi) to 70 mg per100 ml (for orange) among 22 commercial fruit drinks. Kaparapuet al. (2020) reported the vitamin C content of apple, banana, grapes, mango and papaya as 4.6, 8.7, 6.5, 36.4, and 60.9 mg per hundred ml respectively. The ascorbic acid is an essential antioxidant, defenses tissue destruction, supports in forming connective tissue destruction, supports in forming connective tissues, bones teeth and blood vessels helps the body to hill cuts and wounds as well as it keeps our teeth and gum healthy (Alam, et al., 2019: Burubai & Amber, 2014). The recorded values of vitamin C for papaya (0.2709089, % g/100 g) and mousambi (0.0493547, % g/100 g fresh fruit) are in agreement with the reported values of papaya (62 mg/100 g) and citrus fruits (31-53 mg/100 g) (Vicente et al., 2014). Papaya has nutritional, therapeutic, chemo protective and antioxidant properties (Saeed et al., 2014).

The result of total reducing sugar including reducing sucrose for eleven samples of fresh fruits reported in Table 2 ranges from 0.21066190 % (for coconut) to 2.91326983 % (for papaya) having increasing order: coconut, pineapple, mango, apple, pomegranate, mousambi, litchi, banana, watermelon, grapes and papaya. The observed result shows that papaya and grapes have a relatively larger amount of reducing sugar whereas coconut, pineapple and mango contain relatively a lower amount of reducing sugar. Low sugar containing fruits are more beneficial for maintaining good health. These recorded values are in good agreement with reported values from different authors (Nielson, 2010; USDA, 2009; Ramasami et al., 2003). The formaldehyde content of samples of fruit presented in Table 2 shows that grape contains the highest amount of it, followed by litchi, apple and banana. The formaldehyde content value in these fruits is slightly greater than naturally occurring formaldehyde content but externally added amount of it was almost absent in watermelon, pineapple, coconut, mango, papaya, pomegranate and mousambi. WHO recommended naturally occurring formaldehyde for apple, banana, grapes, litchi, mango, papaya, pineapple and pomegranate that is 13.4, 14.8, 15.7, 6.7, 10.8, 55.7, 20.8, 6.7 ppm respectively (Nowshad et al., 2018). According to Sadia et al. (2020), concentration of formaldehyde in mango, apple and grape is ranged from 1.45 to 11.65, 1.42 to 11.77 and 0.93 to 14 mg/100g respectively for the research conducted in the local markets of Dhaka, Bangladesh.

The recorded results of the chemical parameters analyzed by using standard methods are in agreement with the standard values and previously published results by different authors. Chemical parameter varies with species, maturity stage, cultivar, post-harvest storage condition, nature of soil, climate and season in which fruits are cultivated. The submitted result of percentage of moisture, total ash, silica, and dietary fiber content is the amount in grams per edible 100 g portion of fresh fruit. An amount of total acid, vitamin 'C', total reducing sugar and the formaldehyde content is expressed in grams per 100 g of fresh fruit with peel and shell.

CONCLUSIONS AND RECOMMENDATIONS

Chemical parameters such as pH, OD, EC, moisture, total ash, silica, dietary fiber, total acid and vitamin C were total reducing sugar, and washable formaldehyde of fresh fruits apple, banana, coconut, grapes, litchi, mango, mousambi, papaya, pineapple, pomegranate and watermelon were determined in the chemistry research laboratory of Prithvi Narayan Campus, Pokhara by using standard methods. The analyzed parameters for these fruits are well comparable to each other and with the previously published results. Based on the observed chemical parameters, experimental fruits are nutritious and healthy for consumption by the consumers.

The current study provides the firsthand chemical information of eleven commercial fruits that will be supportive for other researchers, consumers, producers and fruit processing industries. Further researches with a large number of physicochemical parameters along with toxic additives for a series of edible fruits are recommended.

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