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Nutraceuticals profiling of queen and king varieties of pineapple (*Ananas comosus*) (Pineapple)

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Abstract

Locally available two varieties of pineapple (*Ananas comosus*) i.e. King and Queen were evaluated for their comparison of selected biochemical parameters. The biochemical parameters studied in peel, pulp and juice of fruit. The enzymatic antioxidant studied were Polyphenol oxidase, Catalase, Ascorbate peroxides, Guaiacol peroxidase whereas the non-enzymatic parameters studied were Total flavonoids, Total phenol, Carotenoids and Alkaloid. The minerals studied were Phosphorus, Magnesium, Potassium, Sodium, and vitamins were thiamine, Folic acid, Riboflavin, Vitamin C. All were maximum in peel, pulp and juice of King and minimum in Queen. In general, King was found to have more antioxidant than Queen. Though pulp and juice is generally consumed but peel of Queen and king pineapple studied were also found to have significant amount of antioxidant in them.

Keywords: Queen, King, antioxidants, enzyme, vitamin, phenol

1. Introduction

Pineapple [*Ananas comosus* (L.)] is a member of the Bromeliaceae family and is the third most important fruit crop in the tropical regions of the world after banana and citrus fruit in terms of production. Pineapple is one of the commercially important fruit crops of India. Total world production is estimated to be 14.6 million tons of fruits. India is the fifth largest producer of pineapple with an annual output of about 1.2 million tonnes (Baruwa, 2013) [1]. Pineapple is important source of carbohydrates, sugar, organic acid, vitamins, crude fiber and minerals. Bromelain enzyme acts as a natural detox that is good for digestive system and helps to maintain ideal weight and balanced nutrition (Hossain and Shaheen, 2015) [7]. It has also been known for its anti-inflammatory and anti-clotting properties (Debnath *et al.*, 2012) [3]. Pineapple contains considerable calcium, potassium, fiber, and vitamin C. It is low in fat and cholesterol. It is also a good source of vitamin B₁, vitamin B₆, copper and dietary fiber. Bioactive compounds are extra nutritional constituents that typically occur in small quantities in food and can influence the health of living beings. The main bioactive components in pineapple are phenolic compounds, ascorbic acid, β-carotene, and flavonoids. Pineapple is rich sources of β-glucan, proteoglycan, lectin, polysaccharides, triterpenoids, diateryfibre, lentinan, steroids, glycopeptides, terpenes, saponins, xanthones, coumarins and alkaloid. India may be considered as the home of pineapple (*Ananas comosus* L. Merr.). There are various varieties of pineapple available in India but only two varieties King and Queen are most popular and commercially cultivated. The plant of King Variety is a short 1–1.5 meter herbaceous perennial with 30 cm or more trough-shaped with pointed leaves 30–100 cm long, surrounding a thick stem. It is a late-maturing pineapple variety and is the leading commercial variety in India. Fruit weighs 2-3kg, and big in size, oblong in shape, slightly tapering towards the crown. The fruit with broad and shallow eyes becomes yellow when fully ripe. The flesh is light yellow. Recommended areas of grown in India are Tamil Nadu, Karnataka, Assam, Arunachal Pradesh, Andaman and Nicobar Islands, Goa, Odisha, Bihar and Jharkhand.

The queen pineapple is an herbaceous perennial, which grows to 1.0 to 1.5 meters tall. The plant has a short, stocky stem with tough, waxy leaves. In appearance, its fruit are rich yellow in colour, weighing 0.9-1.3 kg each. The flesh is deep golden yellow, less juicy than King, crisp textured with pleasant aroma and flavor. Eyes are small and deep, requiring a thicker cut when removing the skin.

The leaves are brownish –red, shorter and spiny recommended areas in India are Tripura, Assam, Meghalaya, Karnataka, Bihar, Jharkhand, Nagaland, Tamil Nadu, Odisha and Bihar. It is early maturing variety in India.

2. Materials and Methods

2.1 Collection and identification of samples

Both the varieties were collected from local market of Allahabad and were authenticated from horticulture department.

2.2 Biochemical parameters

The following biochemical parameters were studied in peel, pulp and juice of above mentioned two varieties of pineapples.

2.3 Assay of polyphenol oxidase (PPO)

Assay of polyphenol oxidase activity in peel, pulp and juice was carried out according to the procedure of Liu *et al.* (2005) [11]. The reaction mixture contained 1.0ml of 0.1 M catechol. 1.9 ml phosphate buffer (pH 7.0, 0.1 M) and 0.1 mL of peel pulp and juice incubated for 10 min. at 30°C. A control solution was prepared by adding catechol solution (1ml) to 3 ml of phosphate buffer and was shaken well and absorbance at 420nm recorded with a spectrophotometer.

2.4 Assay of Catalase (CAT)

Assay of catalase activity in peel, pulp and juice was carried out according to the procedure of Hossti and Frost (1994) [8]. The mixture was contained in a final volume 2.0 ml, 0.1 ml of supernatant. 1.0 ml of phosphate buffer (0.1M, pH7) and 0.4 ml of distilled water to which 0.5 ml of H₂O₂ solution was added to initiate the reaction, for control H₂O₂ solution was left out. After incubating for 1 min at room temperature the reaction was stopped by addition of 2 ml potassium dichromate acetic acid reagent. The sample was kept in boiling water cooled and read the absorbance at 570 nm against control.

2.5 Assay of Ascorbate peroxidase (APX)

Weighed 0.5 gm sample and ground in a cool mortar pestle and suspended in a 1.5 ml homogenization buffer. Centrifuged the suspension at 14000 rpm for 30 minutes at 4°C and the supernatant was used for the enzyme assay. The reduction in ascorbate concentration was recorded by reading the absorbance at 290 nm continuously for 180 seconds.

2.6 Assay of Guicol peroxidase (GPX)

In the test cuvette, the reaction mixture comprising of 3.0 ml phosphate buffer (pH 7, 0.5mM), 50 µl guaiacol solution, 100 µl enzyme sample and 30 µl H₂O₂ solution was taken. The observation was recorded at 436 nm with spectrophotometer.

2.7 Estimation of total phenol

Weighed exactly 0.5 to 1.0g of the sample and ground them in pestle and mortar in 10 times volume of 80% ethanol. Centrifuged the homogenate at 10,000 rpm for 20 min. saved the supernatant, re-extracted the residue with five times the volume of 80% ethanol centrifuged and pooled the supernatant and evaporated to dryness. The residue was dissolved in a 5 ml of distilled water. We pipetted the aliquots (0.2 to 2 ml) into test tube, made up the volume to 3 ml with water. Folin-Ciocalteu reagent (5 ml) was added in each and every tube. After 3 minutes, added 2 ml of 20% Na₂CO₃ solution to every tube. Mixed thoroughly placed the tubes in

boiling water for exactly one min. cooled and measure the absorbance at 650 nm against a reagent blank and prepared a standard curve using different concentration of catechol.

2.8 Estimation of total flavonoids

Estimation of total flavonoids content in peel, pulp and juice was carried out according to the procedure of Chang *et al.* (2002) [2]. The reaction mixture consisted of 0.5 ml potassium acetate, 1.0 ml methanol, 0.5 ml of (1.2%) aluminum chloride and 1ml of sample (1mg ml⁻¹).Incubated at room temperature for 30 min. The absorbance of all samples was measured at 415 nm. Quercetin was used as positive control.

2.9 Estimation of carotenoid

We took 2g of sample and ground in 20ml of distilled methanol. The solution filtered until and the extraction was repeated until the tissue was free from pigments. The filtrate were pooled and partitioned thrice with equal volume of peroxide-free ether during initial extraction. Evaporated the combined ether (upper layer) in hot water bath maintained at 35 °C and dissolved the residue in minimum quantity of ethanol. Added 60% aqueous KOH at the rate of 1ml for every 10 ml of ethanol extract to saponify. The mixture was left overnight at room temperature. Added equal volume of water and partitioned twice with ether. Evaporated the combined ether layer as before and dissolved the residue in 10 ml of ethanol and measured the absorbance of this solution at 450 nm.

2.10 Estimation of alkaloid

5g of each sample were weighed into a 250 ml beaker and 200 ml of 20% acetic acid in ethanol was added and covered to stand for 4 hrs. This was filtered and the extract was concentrated using water both to one-quarter of the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until the precipitation was completed. The whole solution was allowed to settle and the precipitate was collected by filtration and weighed.

2.11 Determination of potassium

Determination of potassium content in peel, pulp and juice was carried out according to the procedure of Jackson (1996) [9]. Extract potassium from 2.0gm plant sample. Evaporated 10-15ml of extracted sample to dryness to reduce the HCl concentration. Added 2 drops of 1% Phenolphthalein and 10% NaOH drop wise (2 drops) until phenolphthalein turns distinctly red. Evaporated to dryness on a steam plated (as evaporation proceeds, the solution colour should remain pink. Added 2ml of ammonium free 1N HCl and 1 small drop of this HCl solution of the sample to a spot plated and test for ammonium with Nesler's reagent. We allow evaporating the solution to dry out HCl and to extract potassium completely and read the color intensity at 620nm against reagent blank.

2.12 Determination of sodium

Determination of Sodium content in peel, pulp and juice was carried out according to the procedure of Hill (1997) [6]. Sodium is extracted from 3g of plant sample. Ash solution was transferred to a 100 ml volumetric flask. Added 5ml of 5% solution of magnesium acetate, 30 ml of Conc. Ammonia, shake vigorously and leave for some time. Added 15ml of uranyl magnesium acetate reagent and stirred vigorously for about 15sec or until a precipitate forms. Washed the precipitated of sodium uranyl magnesium acetate twice with 2ml of the solution of magnesium uranyl acetate and then five

times with 96% alcohol saturated with the tripal salt and transferred the precipitate and dried in an oven at 150 °C for not more than one hour. Multiplied the weight of precipitated by 0.0150 to obtain the amount of sodium (Na) and calculated the amount of Na.

2.13 Determination of magnesium

Determination of magnesium content in peel, pulp and juice was carried out according to the procedure of Piper (1995)^[13]. Transferred 5.0 gm plant sample and heated over on a hot plate at low heat. Moisten the ash with little water and added 40ml of dilute HCl (1:1) into the covered basin carefully to avoid any loss by effervescence and added 1ml of conc. HNO₃ to oxidize any ferrous salts and evaporated the contents to dryness. Concentrated the filtrated from the calcium precipitation to about 100ml and 5ml of HCl. Heated to boiling, added 10ml of sodium citrate, 10-15ml of sodium phosphate and neutralize with diluted ammonia (1:1). Allowed the precipitated to stand overnight and washed thoroughly with diluted ammonia (1:50) until free from chlorine. Ignite the filter paper and precipitate. Multiplied the weight of Mg₂P₂O₇ by 0.2187 to obtain the amount of Mg.

2.14 Determination of phosphorus

Determination of phosphorus content in peel, pulp and juice was carried out according to the procedure of Fiske and Subbarao (2002)^[5]. Weighed accurately known amount (0.3-0.5g) of powdered dry material and mixed with 3 times its weight of fusion mixture. Mixture was heated in a porcelain dish until a white ash obtained and cooled to room temperature, and then extracted with 10% TCA, filtered and made the volume up to 200ml with TCA. Pipetted out 2 ml of the extracted into a test and made up the volume to 4.2ml with water. Added 0.6ml of acid molybdate reagent, mixed and added 0.2ml of ANSA reagent to each tube. After 10min, read the absorbance at 660 nm against the blank.

2.15 Estimation of thiamine

Determination of thiamin content in peel, pulp and juice was carried out according to the procedure of Sadashivam and Manickam (1992)^[14]. Sample (5g) was weighed into a 250 ml conical flask and slowly added 100ml of 0.1N H₂SO₄ without shaking stopper the flask. Pipetted out 10 ml of the extract into 100 ml separating funnel. Added 3ml of 15% NaOH into each separating funnel immediately followed by 4 drops of ferricyanide solution, and added 1 spatula full of sodium sulphate directly into the separating funnel. The clear extract was collected from the top using a Pasteur pipette. Prepared a set of sample blanks by pipetting out 10ml of extract and followed the above procedure but omits addition of ferricyanide and took the absorbance of the extract at 366 nm.

2.16 Estimation of folic acid

Determination of folic acid content in peel, pulp and juice was carried out according to the procedure of Sadashivam and Manickam (1992)^[14]. The sample containing about 100 mg of folic acid is added in a 100 ml flask. Added about 50ml of K₂HPO₄ solution, and heated the mixture to a temperature not above 60°C with swirling until the sample is properly dispersed and make up the volume to 100-ml with K₂HPO₄ solution. Filtered or centrifuge the solution. An aliquot of the clear solution containing about 1mg of folic acid was transferred to a 100 ml volumetric flask. Diluted with K₂HPO₄ solution and used this solution for colour

development and estimation of folic acid as per the standard method. Read the colour of the iso-butyl alcohol at 550 nm.

2.17 Estimation of riboflavin

Determination of folic acid content in peel, pulp and juice was carried out according to the procedure of Sadashivam and Manickam (1992)^[14]. Accurately 2 g of ground sample was weighed and added 75 ml 0.1 NH₂SO₄ to it and added 5ml of 2.5M sodium acetate solution. The solution is now at approximately pH 4.5 and transferred to 100ml volumetric flask and made the volume with water. Filtered the content through Whatman No. 2. First few ml were discarded and the filtrate was used for riboflavin estimation fluorimetrically.

2.18 Estimation of ascorbic acid:

Determination of Sodium content in peel, pulp and juice was carried out according to the procedure of Sadashivam and Manickam (1992)^[14]. Ground 0.5 of sample using 25 ml 4% oxalic acid solution centrifuged and collected the liquid. Added bromine water drop wise with constant mixed, the extract turns orange yellow, Made up to a known of volume (25) with 4% oxalic acid solution. Pipetted out 10-100µg standard dehydroascorbic solution into a of tubes and volume made up to 3ml by adding distilled water. Added 1 ml of DNPH reagent followed by 1-2 drops of thiourea to each tube. Mixed the contents of the tubes thoroughly and incubated at 37°C for 3h. After incubation dissolved the orange red osazone crystals formed by adding 7ml of 80% sulphuric acid and measured the absorbance at 540 nm.

3. Results and discussions

3.1 Specific polyphenol oxidase activity in peel, pulp and juice

The results of polyphenol specific enzyme activity in peel, pulp and juice of selected pineapple varieties are presented in the table1. In general, the higher polyphenol oxidase specific enzyme activity was observed in peel, pulp and juice of both varieties of pineapple. In case of pulp, Queen has greater polyphenol oxidase activity (27.11 ± 0.070) than King (25.83 ± 0.050). In case of juice, Queen has greater amount of Polyphenol oxidase specific activity (24.53 ± 0.05) than King (21.590 ± 0.040). In case of peel, King has greater polyphenol oxidase specific activity (4.860 ± 0.150) than Queen (3.800 ± 0.140). The statistical analysis also showed significantly higher polyphenol oxidase specific activity in pulp followed by juice and peel of selected Queen. The results of present study are in accordance with the similar study done by Uma *et al.* (2012)^[19] and Sushma *et al.* (2013)^[16].

3.2 Specific Catalase activity in peel, pulp and juice

The results of catalase activity content in peel, pulp and juice of selected pineapple varieties are presented in the table 1. In general, higher catalase activity was observed in peel, pulp and juice of both varieties of pineapple. In case of peel, King has greater catalase activity (66.91 ± 0.040) content than Queen (64.23 ± 0.150). In case of juice, King has greater amount of catalase activity (52.360 ± 0.030) than Queen (51.180 ± 0.040). In case of pulp, King has lower catalase activity (48.17 ± 0.030) than Queen (50.18 ± 0.065). The statistical analysis also showed significantly higher catalase activity in peel followed by pulp and juice of selected King. The similar results were also found by Uma *et al.* (2012)^[19] and Sushma *et al.* (2013)^[16].

3.3 Ascorbate peroxides content in peel, pulp and juice

The results of ascorbate peroxides activity content in peel, pulp and juice of selected pineapple varieties are presented in the table 1. In general, the higher ascorbate peroxidase activity content was observed in peel, pulp and juice of both varieties of pineapple. In case of peel, King has greater ascorbate peroxidase activity (14.82 ± 0.14) content than Queen (13.55 ± 0.040). In case of pulp, King has greater ascorbate peroxidase activity (10.34 ± 0.070) content than Queen (9.640 ± 0.030). In case of juice King has greater amount of ascorbate peroxidase activity (8.67 ± 0.050) content than Queen (7.83 ± 0.030). The statistical analysis also showed significantly higher ascorbate peroxides activity in peel followed by pulp and juice of selected King variety. The results of present study are in accordance with the similar study done by Uma *et al.* (2012)^[19].

3.4 Guicol peroxides content in peel, pulp and juice

The results of guiacol peroxides activity content in peel pulp and juice of selected pineapple varieties are presented in the table 1. In general, the higher guiacol peroxides activity content was observed peel, pulp and juice of both varieties of pineapple. In case of peel, King has greater guiacol peroxidase activity (71.96 ± 0.122) content than Queen (70.53 ± 0.144). In case of pulp, King has greater guiacol peroxidase activity (30.30 ± 0.11) content than Queen (28.70 ± 0.077). In case of juice, King has greater amount (29.70 ± 0.144) than Queen (26.89 ± 0.025). The statistical analysis also showed significantly higher guicol peroxides activity in peel followed by pulp and juice of selected King variety. The results of present study are in accordance with the similar study done by Uma *et al.* (2012)^[19].

3.5 Total phenol content in peel, pulp and juice

The results of total phenol content in peel, pulp and juice of selected pineapple varieties are presented in the table 1. In general, the higher total phenol content was observed in peel, pulp and juice of both varieties of pineapple. In case of pulp, King has greater total phenol content (53.79 ± 0.034) than Queen (50.68 ± 0.055). In case of juice, King has greater amount (49.20 ± 0.063) of total phenol content than Queen (47.50 ± 0.046). In case of peel, King has greater total phenol content (40.03 ± 0.046) than Queen (38.10 ± 0.157). The statistical analysis also showed significantly higher total phenol content in peel followed by pulp and juice of selected King variety. The results of present study are in accordance with the similar study done by Lu *et al.* (2014)^[12] and Sushma *et al.* (2013)^[16].

3.6 Total flavonoids content in peel, pulp and juice

The results of total flavonoids content in peel, pulp and juice of selected pineapple varieties are presented in the table 1. In general, higher total flavonoids content activity content was observed in peel, pulp and juice of both pineapple varieties. In case of pulp, King has greater total flavonoids content (14.12 ± 0.071) than Queen (11.28 ± 0.036). In case of juice, King (13.09 ± 0.15) has greater amount of Queen (10.53 ± 0.13). In case of peel, King has greater total flavonoids content (3.19 ± 0.143) than Queen (3.68 ± 0.240). The statistical analysis also showed significantly higher total flavonoids content in peel followed by pulp and juice of selected King pineapple. The

results of present study are in accordance with the similar study done by Lu *et al.* (2014)^[12] and Sushma *et al.* (2013)^[16].

3.7 Total Carotenoid content in peel, pulp and juice

The results of total carotenoide content in peel pulp and juice of selected pineapple varieties are presented in the table1. In general, the higher total carotenoide content was observed in peel, pulp and juice of both varieties of pineapple. In case of pulp, King has greater total carotenoid content (3.350 ± 0.43) than Queen (2.340 ± 0.058). In case of juice, King has greater amount of total carotenoid content (2.00 ± 0.053) than Queen (1.98 ± 0.48). In case of peel, King has greater total carotenoid content (1.98 ± 0.80) than Queen (1.570 ± 0.158). The statistical analysis also showed significantly higher total carotenoide content in peel followed by pulp and juice of selected King variety.

3.8 Total Alkaloid content in peel, pulp and juice

The results of total alkaloid content in peel, pulp and juice of selected pineapple varieties are presented in the table1. In general, the higher total alkaloid content was observed in peel pulp and juice of both varieties of pineapple. In case of peel, King has greater total alkaloid content (0.050 ± 0.34) than Queen (0.040 ± 0.016). In case of juice, King has greater total alkaloid content (0.040 ± 0.250) than Queen (0.040 ± 0.016). In case of pulp, King has greater total alkaloid content (0.030 ± 0.250) than Queen (0.020 ± 0.032). The statistical analysis also showed significantly higher total alkaloid content in peel followed by pulp and juice of selected King variety.

3.9 Phosphorus content in peel pulp and juice

The results of phosphorus content in peel, pulp and juice of selected pineapple varieties are presented in the table 2. In general, higher phosphorus content was observed in peel, pulp and juice of both varieties of pineapple. In case of juice, Queen has greater amount (9.75 ± 0.037) of phosphorus than King (9.25 ± 0.149). In case of pulp, Queen has greater phosphorus content (7.89 ± 0.039) than King (7.56 ± 0.079). In case of peel, Queen has greater phosphorus content (3.45 ± 0.047) than King (3.23 ± 0.149). Statistical analysis also showed significantly higher phosphorus content in peel followed by pulp and juice of Queen. The results of present study are in accordance with the similar study done by Sairi *et al.* (2004)^[15] and Sushma *et al.* (2016)^[17].

3.10 Magnesium content in peel, pulp and juice of selected varieties in pineapple

The results of magnesium content in peel, pulp and juice of selected pineapple varieties are presented in the table 2. In general, the higher magnesium content was observed in peel, pulp and juice of both varieties of pineapple. In case of juice, King has greater amount (13.710 ± 0.039) of magnesium than Queen (12.480 ± 0.224). In case of pulp, King has greater magnesium (11.080 ± 0.038) content than Queen (10.060 ± 0.225). In case of peel, King has greater magnesium content (6.030 ± 0.038) than Queen (5.660 ± 0.225). The statistical analysis also showed the significantly higher magnesium content in peel followed by pulp and juice of selected King variety. The similar results are also reported by Kadar *et al.* (2010)^[10].

Table 1: Enzymatic antioxidants and Non- enzymatic contents in pineapple

S. No.	Variety	King			Queen		
		Peel	pulp	Juice	Peel	Pulp	Juice
I. Enzymatic antioxidants							
1.	Polyphenol Oxidase	4.860 \pm 0.150	25.830 \pm 0.050	21.590 \pm 0.040	3.800 \pm 0.140	27.110 \pm 0.070	24.530 \pm 0.050
2.	Catalase	66.910 \pm 0.040	48.170 \pm 0.030	52.360 \pm 0.030	64.230 \pm 0.150	50.180 \pm 0.050	64.230 \pm 0.150
3.	Ascorbate Peroxidase	14.824 \pm 0.140	10.341 \pm 0.070	8.674 \pm 0.050	13.552 \pm 0.040	9.640 \pm 0.030	7.833 \pm 0.030
4.	Guaiacol oxidase	71.960 \pm 0.122	30.300 \pm 0.110	29.700 \pm 0.144	70.530 \pm 0.144	28.470 \pm 0.077	26.890 \pm 0.025
II Non- enzymatic							
1.	Total phenol	40.030 \pm 0.046	53.798 \pm 0.034	49.200 \pm 0.063	38.100 \pm 0.157	50.680 \pm 0.055	47.500 \pm 0.046
2.	Total flavonoids	3.190 \pm 0.143	14.120 \pm 0.071	13.090 \pm 0.150	3.680 \pm 0.240	11.280 \pm 0.036	10.530 \pm 0.130
3.	Carotenoids	1.980 \pm 0.80	3.350 \pm 0.430	2.000 \pm 0.530	1.570 \pm 0.158	2.340 \pm 0.058	0.749 \pm 0.443
4.	Alkaloid	0.050 \pm 0.40	30.300 \pm 0.110	0.040 \pm 0.250	0.040 \pm 0.016	0.020 \pm 0.032	0.030 \pm 0.033

Table 2: Minerals and Vitamins contents in pineapple

S. No.	Variety	King			Queen		
		Peel	pulp	Juice	Peel	Pulp	Juice
III Minerals							
1.	Potassium	8.071 \pm 0.350	19.800 \pm 0.150	16.950 \pm 0.340	6.620 \pm 0.144	15.620 \pm 0.470	13.860 \pm 0.450
2.	Phosphorus	3.230 \pm 0.149	7.560 \pm 0.079	9.250 \pm 0.05 09	3.450 \pm 0.047	7.890 \pm 0.039	9.750 \pm 0.037
3.	Sodium	1.980 \pm 0.80	0.758 \pm 0.335	0.898 \pm 0.335	2.830 \pm 0.554	0.564 \pm 0.443	0.749 \pm 0.443
4.	Magnesium	6.030 \pm 0.049	11.080 \pm 0.038	13.710 \pm 0.038	5.660 \pm 0.225	10.060 \pm 0.225	12.480 \pm 0.225
IV Vitamins							
1.	Thiamine	0.130 \pm 0.048	0.200 \pm 0.038	0.180 \pm 0.038	0.160 \pm 0.159	0.240 \pm 0.059	0.210 \pm 0.049
2.	Riboflavin	0.500 \pm 0.054	0.120 \pm 0.054	0.100 \pm 0.044	0.700 \pm 0.149	0.140 \pm 0.071	0.120 \pm 0.059
3.	Folic acid	1.360 \pm 0.540	5.180 \pm 0.079	4.150 \pm 0.450	1.590 \pm 0.046	6.250 \pm 0.035	5.290 \pm 0.035
4.	Vitamin C	2.360 \pm 0.350	8.920 \pm 0.154	7.470 \pm 0.240	2.190 \pm 0.340	6.930 \pm 0.170	6.000 \pm 0.250

3.11 Potassium content in peel, pulp and juice

The results of potassium content in peel, pulp and juice of selected pineapple varieties are presented in the table 2. In general, the higher potassium content was observed in peel, pulp and juice of both varieties of pineapple. In case of pulp, King has greater potassium content (19.80 ± 0.150) than Queen (15.620 ± 0.470). In case of juice, King has greater amount of potassium (16.950 ± 0.340) than Queen (13.860 ± 0.450). In case of peel, King has greater potassium content (8.071 ± 0.350) than Queen (6.620 ± 0.144). The statistical analysis also showed the significantly higher potassium content in peel followed by pulp and juice of selected King. The results of present study are in accordance with the similar study done by Udeme *et al.* (2013)^[18].

3.12 Sodium content in peel, pulp and juice

The results of sodium content in peel, pulp and juice of selected varieties of pineapple are presented in the table 2. In general, higher sodium content was observed in peel, pulp and juice of both varieties of pineapple. In case of peel, King has greater sodium content (2.97 ± 0.033) than Queen (2.830 ± 0.554). In case of juice, King has greater amount of sodium (0.898 ± 0.335) than Queen (0.564 ± 0.443). In case of pulp, King has greater sodium (0.758 ± 0.337) content than Queen (0.749 ± 0.443). The statistical analysis also showed the significantly higher sodium content in peel followed by pulp and juice of selected King variety. The results of present study are confirmed with the similar study done by Sairi *et al.* (2004)^[15].

3.13 Riboflavin content in peel, pulp and juice

The results of Riboflavin content in peel, pulp and juice of selected pineapple varieties are presented in the table 2. In general, higher riboflavin content was observed in peel, pulp and juice of both varieties of pineapple. In case of peel, Queen has greater riboflavin content (0.700 ± 0.149) than

King (0.500 ± 0.154). In case of pulp, Queen has greater riboflavin content (0.140 ± 0.071) than King (0.120 ± 0.054). In case of juice, Queen has greater amount (0.120 ± 0.059) of riboflavin than King (0.100 ± 0.044). The statistical analysis also showed significantly higher riboflavin content in peel followed by pulp and juice of selected Queen Pineapple. The results of present study are in accordance with the similar study done by Dipak and Ranajit (2004)^[14].

3.14 Thiamin content in peel, pulp and juice

The results of Thiamin content in peel, pulp and juice of selected pineapple varieties are presented in the table 2. In general, higher thiamin content was observed in peel, pulp and juice of both varieties of pineapple. In case of pulp, Queen has greater riboflavin content (0.240 ± 0.059) than King (0.20 ± 0.038). In case of juice, Queen has greater amount of riboflavin (0.210 ± 0.049) than King (0.180 ± 0.038). In case of peel, Queen has greater thiamin content (0.160 ± 0.159) than King (0.130 ± 0.048). The statistical analysis also showed significantly higher thiamin content in peel followed by pulp and juice of selected Queen. The results of present study are in accordance with the similar study done by Dipak and Ranajit (2004)^[14].

3.15 Folic acid content in peel, pulp and juice

The results of Folic acid content in peel, pulp and juice of selected pineapple varieties are presented in the table 2. In general, higher folic acid content was observed in peel, pulp and juice of both varieties of pineapple. In case of pulp, Queen has greater folic acid content (6.250 ± 0.035) than King (5.180 ± 0.079). In case of juice, Queen has greater amount of folic acid (4.150 ± 0.450) than King (5.290 ± 0.035). In case of peel, Queen has greater folic acid content (1.590 ± 0.046) than King (1.360 ± 0.046) variety. The statistical analysis also showed significantly higher folic acid content in peel followed by pulp and juice of selected Queen.

3.16 Ascorbic acid content in peel, pulp and juice

The results of ascorbic acid content in peel, pulp and juice of selected pineapple varieties are presented in the table 2. In general, higher folic acid content was observed in peel, pulp and juice of both varieties of pineapple. In case of pulp, King has greater ascorbic acid content (6.25 ± 0.035) than Queen (5.18 ± 0.079). In case of juice, King has greater amount of

ascorbic acid content (4.15 ± 0.450) than Queen (5.29 ± 0.035). In case of peel, King has greater ascorbic acid content (1.59 ± 0.046) than Queen (1.36 ± 0.046). The statistical analysis also showed significantly higher ascorbic acid content in peel followed by pulp and juice of selected King variety.

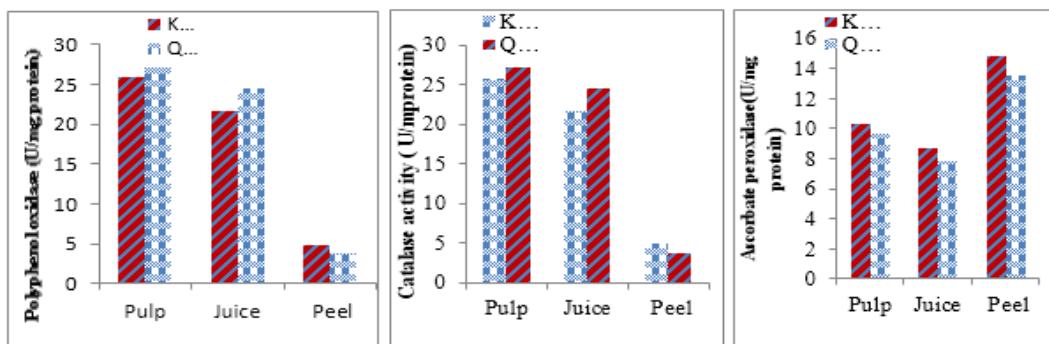


Fig. 1: Polyphenol oxidase, Catalase and Ascorbate peroxidase activity in peel, pulp and juice of selected pineapple varieties

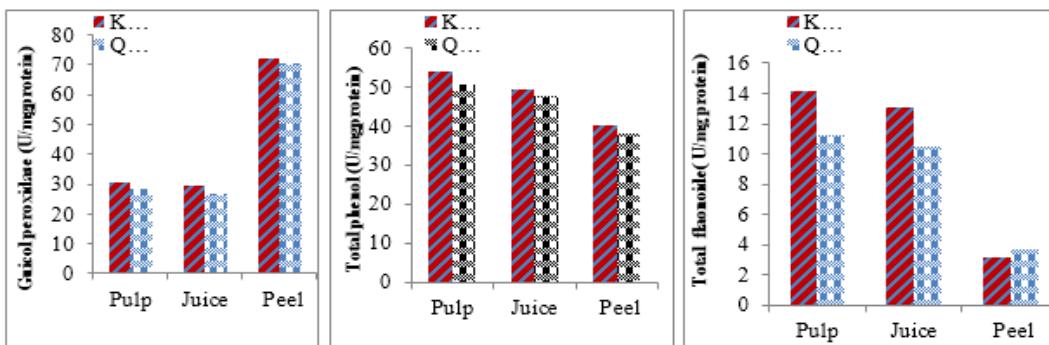


Fig. 2: Guiacol peroxidase, Total phenol and Total flavonoid content in peel, pulp and juice of selected pineapple varieties

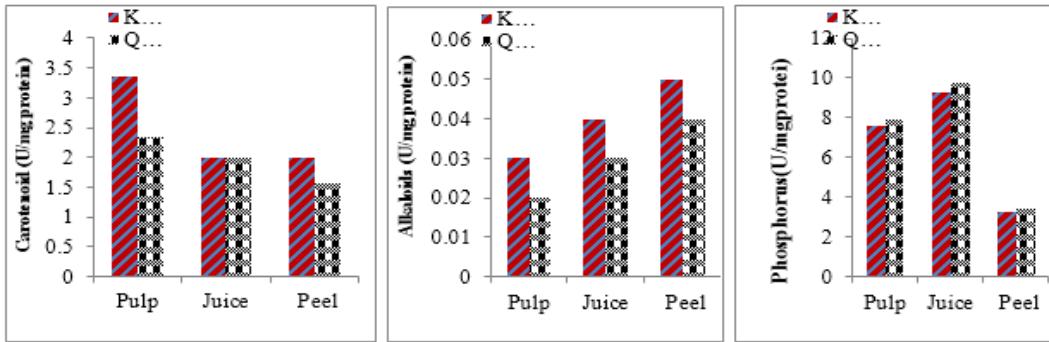


Fig. 3: Total Carotenoid, Alkaloid and Phosphorus content in peel, pulp and juice of selected pineapple varieties

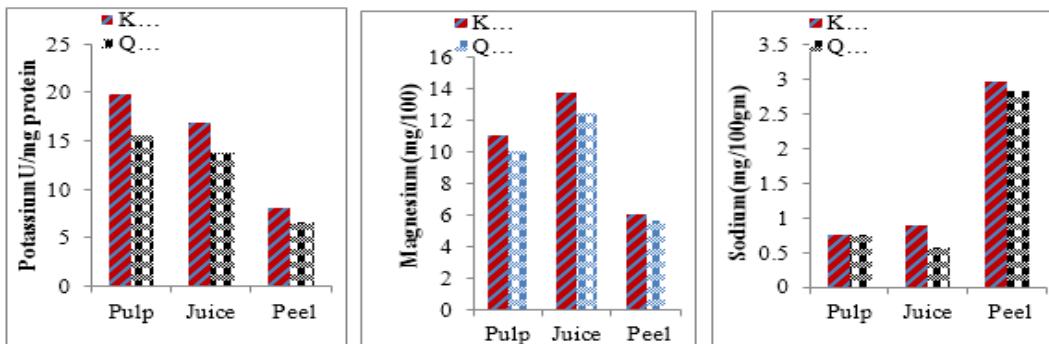


Fig. 4: Potassium, Magnesium and Sodium content in peel, pulp and juice of selected pineapple varieties

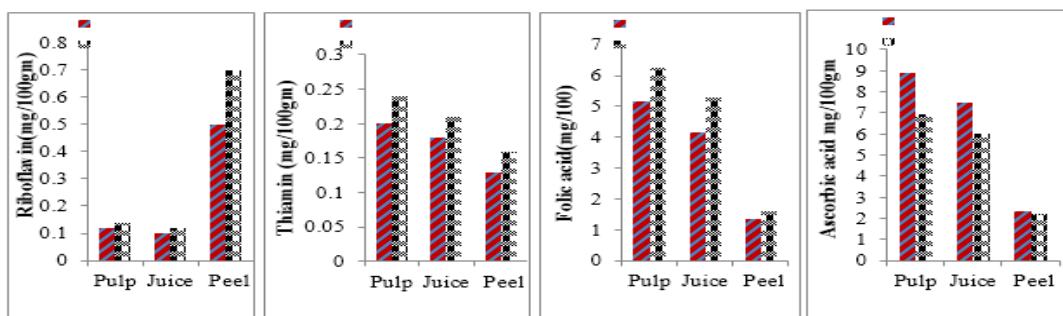


Fig. 5: Riboflavin, Thiamin, Folic acid and Ascorbic acid content in peel, pulp and juice of selected pineapple varieties

4. Conclusion

On the basis of above investigation it can be concluded that out of two selected varieties of pineapples, King variety peel, pulp and juice were found to have more minerals, vitamins, enzymatic and non enzymatic antioxidants in comparison to Queen varieties.

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