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Determination of Physico-chemical Analysis of Different Soft Drinks Brands in Raipur City

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Abstract: *Since soft drinks are consumed by many people all over the world, research into their qualitative and quantitative analysis is essential. We examined ten different soft drink brands that we got from the Raipur, Chhattisgarh, local market in order to achieve this. While pH, conductivity, density, potassium, sodium, and total soluble solids were estimated quantitatively, carbon dioxide, glucose, sucrose, ascorbic acid, phosphates, caffeine, and alcohol were analysed qualitatively. The different techniques determined this physico-chemical analysis. The obtained results showed that the phosphates and carbon dioxide in these soft drinks caused them to be highly acidic, ranging from 2.834±0.218. Because of the soluble ions, all of the soft drinks had a high conductivity. In a similar vein, the high sugar content made the density greater than that of water. At 1.0346±0.075 mg/L, the concentration of total soluble solids—most commonly known as sucrose—was likewise high. The majority of cold beverages have a small amount of calcium (7.8±2.240 mg/L), a small amount of sodium (23.4±8.925 mg/L), and a potassium concentration of 45±32.468 mg/L. Calcium concentration, on the other hand, is extremely low. A titrimetric method was used to quantify the acid strength; the maximum concentration of acid is 167.942±119.178 mg/L.*

Key Words: *Soft drinks, Identification, Qualitative analysis, Flame photometer.*

1. INTRODUCTION:

The beverage industry in Raipur, Chhattisgarh, has expanded quickly in the past few years. A broad variety of products, including soft drinks, squashes, fruit juices, milk, energy drinks, and more, are now produced by this industry [1–5]. The beverage industry in Raipur has grown by 30% more in the last few years, according to the statistics. Additionally, it has been noted that Raipur is home to over 170 beverage industrial units [6–10]. There are two categories for beverages: alcoholic and non-alcoholic, with the latter further divided into hot and cold varieties [11–14].

The early 1959s saw the advent of the cold drink/soft drink era, but due to the industry's attraction and profitability, numerous multinational corporations introduced their products in a variety of flavours under various brand names, including Sprite, 7up, Pepsi, Mountain Dew, Fanta, Mirinda, etc. People drink these beverages based on their moods and body temperatures. For example, it's commonly thought that Sprite, Fanta, and Mirinda make you feel lighthearted, while Pepsi and Coke make your heart and brain work harder. Soft drink brands and varieties abound, distributed nationwide by diverse brewing industries [15–20]. These beverages are frequently drink on a daily basis, particularly after engaging in taxing activities like sports and hard labour [21]. Additionally, because of their reasonably low costs, they are widely consumed on leisure and relaxation excursions and are provided to the public for events like traditional marriages, weddings, funerals, etc. [22]. Soft drinks are highly consumed because of their distinct flavour and taste as well as their capacity to slake thirst [25]. These qualities are determined by the ingredients included, which include sugar for sweetness, carbonated water (water compressed with carbon dioxide to relieve extreme thirst), and flavouring agents for enhancing drink flavour [26]. Soft drinks offer more than just flavour; they also include nutrients and health benefits to the body in the form of vitamins, phosphates, acids, and antioxidants [27–30]. However, because soft drinks are consumed in large quantities and are in high demand, quality control may be difficult to maintain throughout the production process, particularly during sterilisation and purification.

Additionally, it has been reported that certain heavy metals, including cadmium, lead, mercury, arsenic, zinc, and others, can be found in soft drinks. These heavy metals may be a result of environmental pollution from food, fruits, and subsurface and surface water used in production [32].

In light of the aforementioned information, the current study was carried out to investigate the quantitative or qualitative analysis of soft drinks that were gathered from the Raipur local market. Ten distinct cold drink brands that were gathered from the Raipur, Chhattisgarh, local market were examined in this study using various experimental methods.

2. MATERIALS AND METHODS:

SAMPLE COLLECTION

Ten soft drinks of different companies were collected from market of Raipur area during April 2023. **Figure 1.** Their names are presented in **Table 1**.

Figure 1: Representation of the various soft drinks collected from the local market.

Table:1 Collection of the soft drink samples

S. No	Sampling Date	Name of Soft drinks Samples	Code	No. of sample (250 mL)
1	25/04/2023	FENTA	FT	1
2	25/04/2023	MIRINDA	MI	1
3	25/04/2023	SLICE	SI	1
4	25/04/2023	COCA COLA	CC	1
5	25/04/2023	PEPSI	PE	1
6	25/04/2023	7UP	7U	1
7	25/04/2023	SPRITE	SP	1
8	25/04/2023	MOUNTAIN DEW	MD	1
9	25/04/2023	APPY	AP	1
10	25/04/2023	THUMS UP	TU	1

3. METHODOLOGY :

Reagents & Chemicals

All the chemicals used for this research work were of analytical grade and purchased from Sigma Aldrich.

Preparation of Solutions: The preparation of different aqueous solutions used for this research work is listed below.

Preparation of Fehling's solution

Fehling solution A was prepared by dissolving 7 g copper sulphate in 100 mL distilled water with 2-3 drops of sulphuric acid, resulting in a blue solution. Fehling solution B was prepared by mixing 35 g potassium titrated in 100 mL water with 12 g of sodium hydroxide resulting in a clear solution. These were used for the detection of reducing sugars.

Iodine solution

2 g of potassium iodide and 1.3 g iodine were mixed in a minimum amount of water. When dissolved, the solution was marked up to 1 L. Potassium iodide solution 5 g of potassium iodide was dissolved in 25 mL distilled water and stored in a brown coloured bottle used in redox titration for alcohol.

Acidified potassium dichromate solution

125 mL of distilled water was taken into a 500 mL conical flask. 70 mL concentrated sulphuric acid was added with constant shaking. After cooling the flask, 0.75 g of potassium dichromate was added, mixed, and diluted up to the mark with distilled water.

4. ANALYSIS OF SOFT DRINKS :

The physical parameters such as temperature, pH, EC, TDS and Salinity were examined in the laboratory at department by using the HANNNA made sensors (model no. pH7200) Various other chemical parameters such as TH, Ca^{2+}, Na^{+}, K^{+}, Li^{+}, $CaCO_3$, PO_4^{3-} etc. were also analyzed in the soft drinks samples. The Na^{+}, K^{+}, Ca^{+} and Li^{+} ion concentration was determined by the flame photometer (SYSTRONIC FLAME PHOTOMETER 130)

Test for Carbon Dioxide

As soon as the bottles were opened, 10 mL of the sample for each brand of soft drinks was added to 6 mL of lime water (calcium hydroxide). The change of lime water from colourless to milky confirmed the presence of dissolved carbon dioxide in soft drinks [5-10]. **Figure 2**

$Ca(OH)_2$ (s)+ CO_2 (g) → $CaCO_3$ (s) + H_2O (s)

Test for Reducing Sugar

2 mL of a mixture of Fehling's A and Fehling's B solutions was added to 3 mL of soft drink of each brand in a test tube and heated in a water bath for 10 min. Brown colored precipitates indicated the presence of reducing sugar in soft drinks [5-10].

Test for Phosphate

20 mL of soft drinks were taken in the test tubes, and the ammonium molybdate with a few drops of concentrated nitric acid was added to the test tubes. The solutions were heated, and the appearance of yellow precipitates confirmed the presence of phosphate ions in the soft drinks [5].

Test for Ascorbic Acid

20 mL of soft drink with 150 mL of distilled water and 1 mL of starch indicator solution (0.5 %) was added to a conical flask. The mixture was titrated against 0.005 M iodine solution, and a permanent trace of a dark blue-black color due to the starch-iodine complex formed [26].

Total Soluble Solids

20 mL of soft drink in a China dish heated slowly until all the soft drink evaporated. The remaining black residue was cooled and collected, which indicates the presence of total soluble solids, mainly sucrose [20].

Determination of Chloride (Cl^-) Ion, pH, EC and TDS analysis

The Cl^- ion concentration was determined using by precipitation titration method use $AgNO_3$ solution, chromate indicator, and distilled water use. The extracted ash was used for the analysis of pH and EC by using pH/EC meter (HANNA ANALYZER HI 991300, 8424, 9142 pH/EC METER).

Determination of TH, Ca^+ Analysis (Titrimetric Method)

The different soft drinks samples were analysed for dissolved carbon dioxide (CO_2), total hardness (TH), Calcium hardness (Ca^{2+}) and chloride (Cl^-) by using titration method dissolved CO_2, TH, Ca^{2+} and Cl^- were calculated in milligram per liter (mg/L). (**Figure 2)**

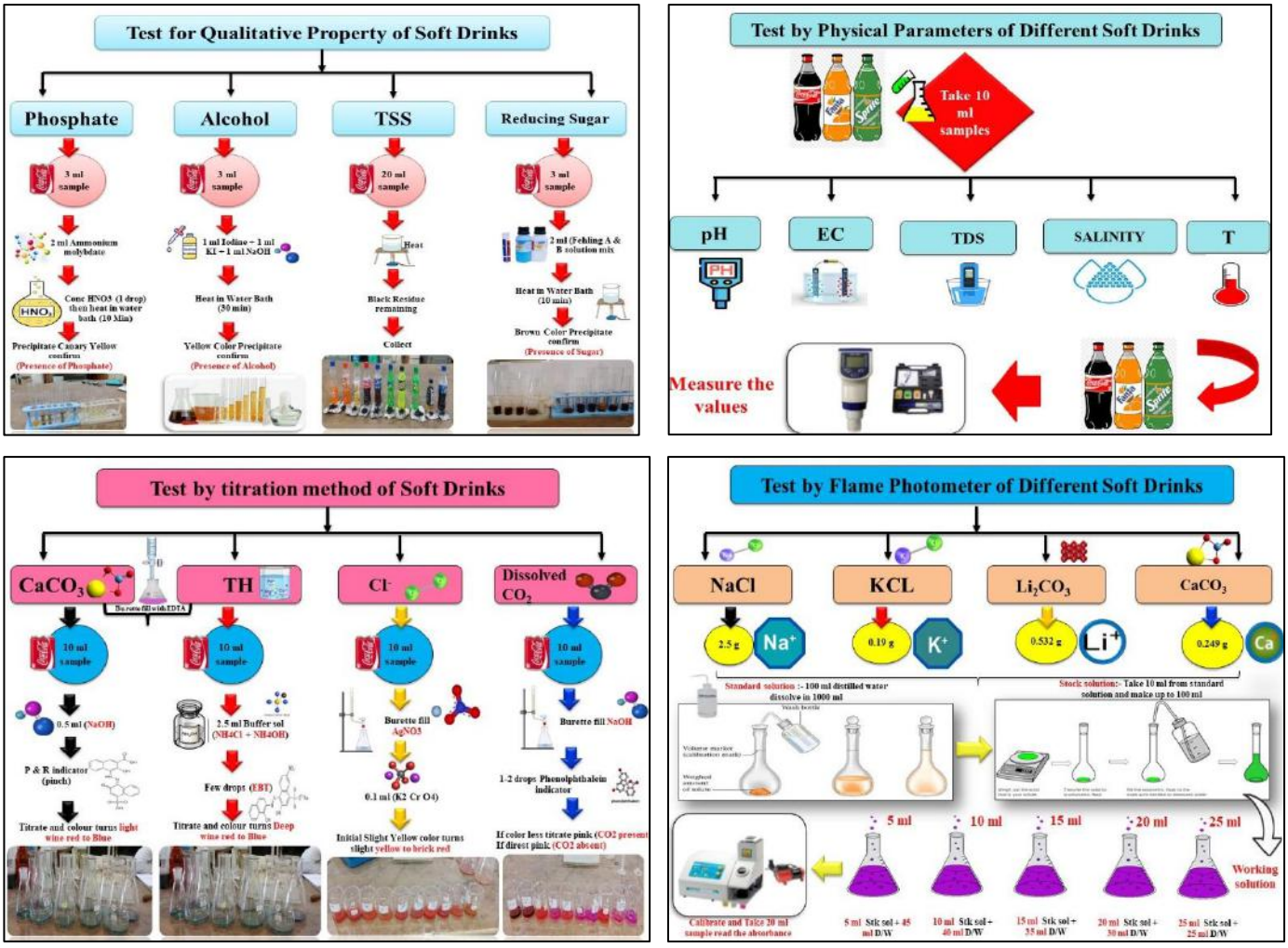

Figure 2 : Representation of qualitative property of different soft drinks samples

5. RESULT AND DISSCUSSION

Physico-chemical properties of soft drink samples

Soft drink consumption dramatically increased over the past few decades. These cold drinks contain a high amount of sugar and acid, which cause serious health problems, especially in children. These soft drinks are supposed to be safe according to customer thinking. Therefore, it is necessary to educate costumer about the ingredients of cold drinks. For this purpose, we use the titrimetric method, which is supposed to be precise, accurate, and cheap. The method described by AOAC with slight modifications were used for qualitative and quantitative analysis. According to the results, all soft drinks contain dissolved carbon dioxide (CO_2) [33], giving fizzy effects and as an ultimate taste quencher. This CO_2 is present in the form of carbonic acid, which causes serious and dangerous effects on human health, especially in children [34]. According to the literature, the pH of soft drinks must be 2.5 to 3.5 due to the presence of acids [35]. This low pH is necessary for killing gastro-intestinal bacteria but causes enamel erosion. In this study, all samples are acidic in nature with a pH range of 2.834±0.218 supposed to be more acidic due to low pH.

Physical characteristics of the soft drink samples

The maximum and minimum concentration of pH, EC, TDS, Salinity and Temperature are ranged from 2.34-3.30, 520-1352µs , 343-870 mg/L ,248-594mg/L and 28.5-29.8 the mean value of the different soft drink samples are as follows 2.834 ± 0.218, 11±197.029µs , 565.4±127.596 mg/L, 411±94.259 and 29.12±0.251 respectively. (**Table 2**) The highest Concentration of pH is been found in sample TU i.e (Thums Up) and the highest concentration of EC is found in sample TU i.e. (Thums Up) and the highest concentration of TDS is been found in sample TU i.e.(Thums up).**Figure 3**.

Table 2: Physical parameters of various soft drink samples

S. No.	Sampling Date	Code	Colour	pH	EC (µs/cm)	TDS (ppm)	T (°C)	Salinity (ppm)
1	26/04/2023	FT	Orange	2.76	647	438	28.8	319
2	26/04/2023	MI	Orange	2.75	593	395	29.5	280
3	26/04/2023	SI	Orange	3.18	1064	696	29.8	504
4	26/04/2023	CC	Dark Brown	2.43	1256	842	29.7	594
5	26/04/2023	PE	Dark Brown	2.42	1157	763	29.1	563
6	26/04/2023	7U	White	3.3	647	432	29	315
7	26/04/2023	SP	White	3.21	550	364	29	263
8	26/04/2023	MD	Light Green	2.95	520	343	28.7	248
9	26/04/2023	AP	Pale Yellow	3	775	511	28.	372
10	26/04/2023	TU	Dark Brown	2.34	1352	870	28.7	652

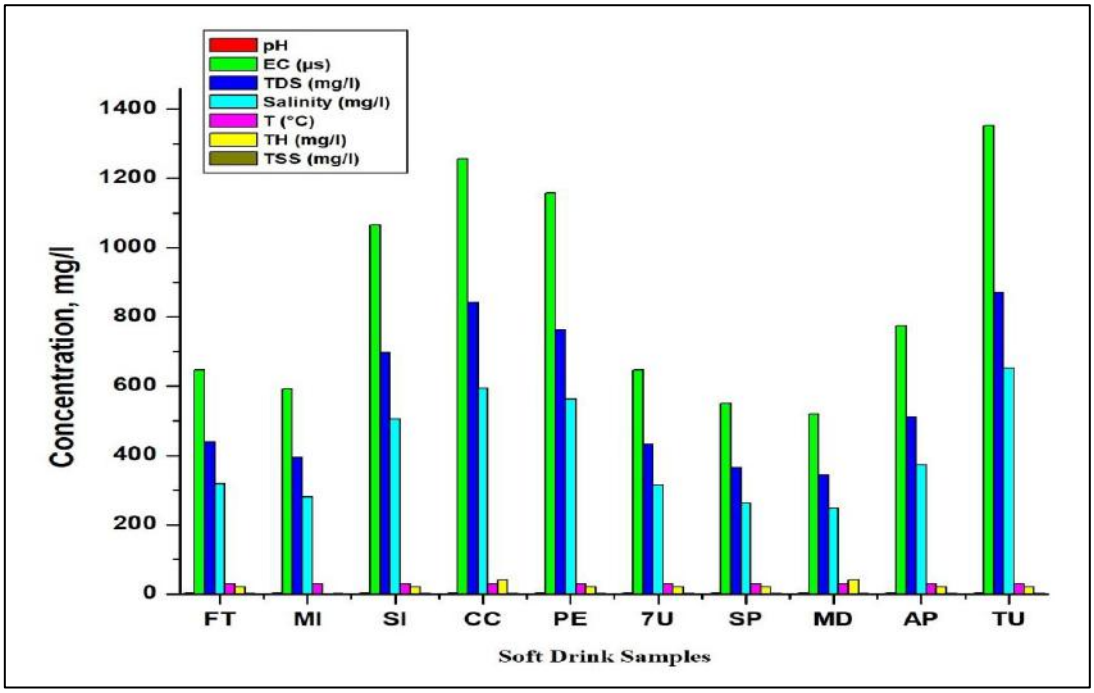

Figure 3 : Representation of various physical parameters and total concentration of the various physical parameters in different soft drinks

Chemical characteristics of Soft drink samples

The standard method of analysis was used to analyse the chemical parameters, which are listed in Table 4. The findings indicate that dissolved carbon dioxide (CO_2), which produces fizzy effects and serves as the ultimate taste enhancer, is present in all soft drinks [36]. Carbonic acid, which is this CO2's form and has detrimental effects on people's health, particularly in young children, is present [37]. The literature states that because soft drinks contain acids, their pH should be between 2.5 and 3.5. Although enamel erosion results from this low pH, it is essential for eliminating gastrointestinal bacteria. All of the study's samples have an acidic pH range of 2.834±0.218, meaning that their low pH makes them appear more acidic. Using the precipitation titration method with AgNO3 solution, chromate indicator, and distilled water, the Cl-ion concentration was ascertained. TH, $CaCO_3$, dissolved CO_2, Cl^-, Na^+, K^+, Li^+, and Ca^+ have total concentrations of 220.198, 260.234, 5896.4, 1679.42, 234, 450, 12, and 78 mg/L, respectively. In every sample, the higher concentration has been discovered. **Figure 4**.

Sugar, both reducing and non-reducing, makes up a significant portion of all soft drinks [38]. The contents of the reducing sugar (glucose) and non-reducing sugar (sucrose) were estimated qualitatively. These sugars, which are the source of sweetness and diabetes, are present in high concentrations in all of the samples. Table 4 presents the expected outcomes. Soft drinks have a higher density than water due to their high sugar content; their density ranges from

1.01±0.01 to 1.1±0.00, while water has a density of 0.99 g/mL.The literature states that soft drinks may contain traces of alcohol, but the WHO limit states that the concentration must be less than 0.5%. **Table 3**

It is anticipated that inadequate sterilisation may cause certain bacterial contaminations to ferment sugar into alcohol [39]. Both qualitative and quantitative testing was done on alcohol in beverages. Using the redox titration method described in AOAC, quantitative estimation was performed. Phosphorus is a crucial component of DNA, RNA, cell membranes, bones, teeth, and muscle soreness. It also aids in cell repair and kidney waste removal. Phosphates are naturally occurring compounds that are acidic in nature. Phosphoric acid, which adds tartness, boosts flavour, and inhibits bacterial growth in soft drinks, is the primary form of phosphates. **Table 3**

A very small amount of phosphoric acid is present in cold drinks, but this low concentration is also dangerous for human health [35]. According to WHO, 500 mg phosphoric acid per cold drink is considered safe, while more than 4000 per day causes serious health problems. Phosphates were confirmed qualitatively, and among 10 brands, (MI, SI, PE, & UP, SP, MD, AP, and TU) gave positive tests for **phosphates while remaining do** not contain phosphates. Ascorbic acid, also known as vitamin C and antioxidant, fights against bacterial infections, detoxifies reactions, and increases immunity [26]. A very few soft drinks (FT, MI, SI, CC, PE, 7U, SP, MD, AP, TU) among the tested cold drinks contain ascorbic acid. The presence of ascorbic acid was checked by a qualitative test. Total soluble solids (TSS) were checked according to the reported method, and the resulting values were converted into The high value of TSS indicated a large amount of sugars (sweet flavor) in soft drinks as in **SP(Sprite)**while a low value indicates tart flavor as in **AP(Appy) and TU(Thums Up).** Calcium carbonate level in the soft drink samples was carried out with the range of 20.018-80.072 mg/L and the mean concentration value of the calcium carbonate in soft drink samples is 26.0234±15.529 mg/L. The highest chloride ion concentrations were obtained **in FT i.e. Fenta** . Chloride ion level in the soft drink samples was carried out with the range of 24.99-529.83 mg/L and the mean concentration value of the Chloride in soft drink samples is 167.94±111.597 mg/L. The highest chloride ion concentrations were obtained in **AP i.e. Appy. (Table 4)** Dissolved CO_2 level in the soft drink samples was carried out with the range of 347.6-954.8 mg/L and the mean concentration value of the dissolved CO_2 in soft drink samples is 589.64 ± 119.178 mg/L. The highest dissolved CO_2 concentrations were obtained in Sample SI i.e Slice. Sodium level in the soft drink samples was carried out with the range of 4-46 mg/L and the mean concentration value of the Sodium in soft drink samples is 23.4 ± 8.925 mg/L. The highest Sodium ion concentrations were obtained in AP i.e. sample Appy. Potassium level in the soft drinks samples was carried out with the range of 12-176 mg/L and the mean concentration value of the potassium in soft drinks samples is 45±32.468 mg/L. The highest potassium ion concentrations were obtained in Slice i.e SI. Lithium level in the soft drinks samples was carried out with the range of 0-3 mg/L and the mean concentration value of the lithium in soft drinks samples is 1.2±0.570 mg/L. The highest lithium ion concentrations were obtained in Slice i.e. sample SI. Calcium level in the soft drinks samples was carried out with the range of 4-17 mg/L and the mean concentration value of the calcium in soft drinks samples is 7.8±2.240 mg/L. The highest lithium ion concentrations were obtained in Slice sample SI. **Table 4.**

Table 3: Chemical characteristics of soft drink samples., mg/l

S.No.	Date	Sample	$CaCO_3$	Cl^-	CO_2	Na^+	K^+	Li^+	Ca^+
1	29/04/2023	FT	80.072	369.88	646.8	20	17	0	8
2	29/04/2023	MI	40.036	354.88	620.4	20	12	0	6
3	29/04/2023	SI	40.036	89.97	954.8	26	176	3	17
4	29/04/2023	CC	0	49.98	356.8	12	87	2	6
5	29/04/2023	PE	0	24.99	347.6	6	59	1	4
6	29/04/2023	7U	20.018	99.96	572	44	12	1	8
7	29/04/2023	SP	20.018	69.97	484	33	12	1	7
8	29/04/2023	MD	40.036	54.98	501.6	23	14	1	6

9	29/04/2023	AP	20.018	529.83	840.4	46	22	1	10
10	29/04/2023	TU	0	34.98	572	4	39	2	6

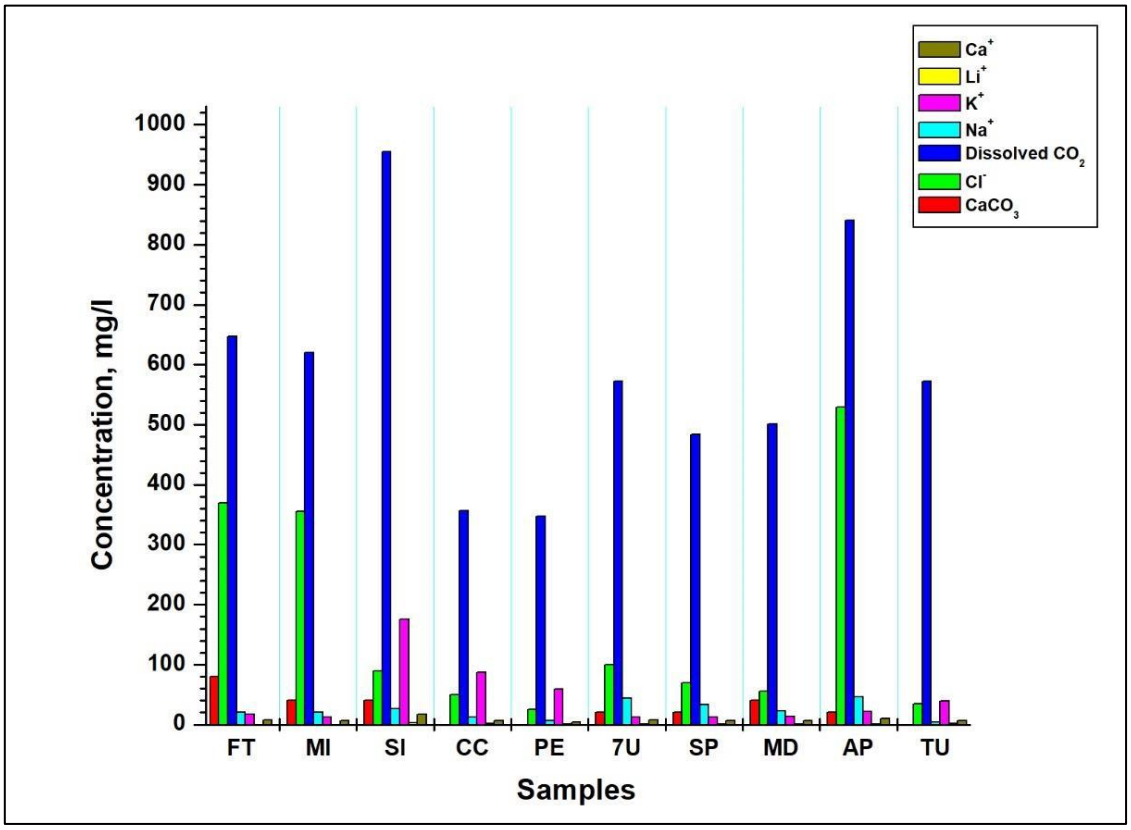

Figure 4: Total concentration of the various chemical parameters in different soft drinks sample

Table 4: **Qualitative estimation of carbon dioxide, phosphates, alcohol, sucrose and ascorbic acid in soft drinks.**

S.No	Samples	Alcohol	Phosphate	Sucrose	CO_2	Ascorbic acid
1	FT	+	-	+	+	+
2	MI	+	+	+	+	+
3	SI	-	+	+	+	+
4	CC	-	+	+	+	+
5	PE	+	+	+	+	+
6	7U	-	+	+	+	+
7	SP	+	+	+	+	+
8	MD	-	+	+	+	+
9	AP	-	+	-	+	+
10	TU	-	+	+	+	+

6. CONCLUSION :

We deduced from the study's findings that all soft drink brands have a distinct flavour due to their high concentration of phosphates, carbon dioxide, and sugar (sucrose and glucose). Most soft drinks contain alcohol, which is a depressant because it depresses the central nervous system. Just seven of the test cold drink brands—FT (Fenta), MI (Mirinda), PE (Pepsi), and SP (Sprite)—contain alcohol; the remaining brands don't. Because of their high sugar content, soft drinks have a higher acidity, are more conductive, and are denser than water. Given the importance of sodium and potassium to a healthy body, potassium levels in all tested cold drinks range from 45 to 32.468 mg/L, while sodium levels range from 23.4 to 8.925 mg/L. Likewise, calcium plays a critical role in the development of bones and can be found in very small amounts (7.8±2.240 mg/L) in all soft drinks. This dissertation study also found that high concentrations of these cold drinks can lead to dehydration, dryness, increased confusion, slowed heart rate, fatigue, pains, and increased thirst because they contain sodium, potassium, and phosphates. They can also cause obesity and heart disease due to the sugar in them, cause tooth decay due to acids, cause alertness due to caffeine, and depress the central nervous system due to alcohol.

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