KMC Journal
[A Peer-Reviewed, Open-Access Multidisciplinary Journal]
ISSN 2961-1709 (Print)
Published by the Research Management Cell
Kailali Multiple Campus, Dhangadhi
Far Western University, Nepal
DOI: https://doi.org/10.3126/kmcj.v5i2.58242

Quality Assessment of Soft Drinks Available at Local Market in Surkhet

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Abstract

Soft drinks have been reported to contain some toxic substance and other unwanted material beyond the acceptable limits in some countries including Nepal. Therefore, the main objective of this study was to access the quality and characteristics of selected soft drinks found in Birendranagar, Surkhet. Fifteen samples of marketed soft drinks were collected from the market. Qualitative test for the presence of reducing sugar, phosphates, alcohol and carbon dioxide in the samples were carried out. Quantitative test were also done for hardness, pH, iron content ammonia, chloride and also density measurement for ensuring the quality of available soft drinks. The presence of high sugar content in the sample and also the acidity of sample also indicate the presence of contaminants in the available sample. The pH value of Coca-Cola (2.5), highly acidic in nature, total hardness in Mountain Dew sample is found to be 350 mg/lit whereas for Pepsi is 76 mg/lit. Therefore, the quality of marketed soft drinks must be regulated by the regulatory bodies.

***Keywords*:** Acidity, qualitative analysis, hardness, health hazard

Introduction

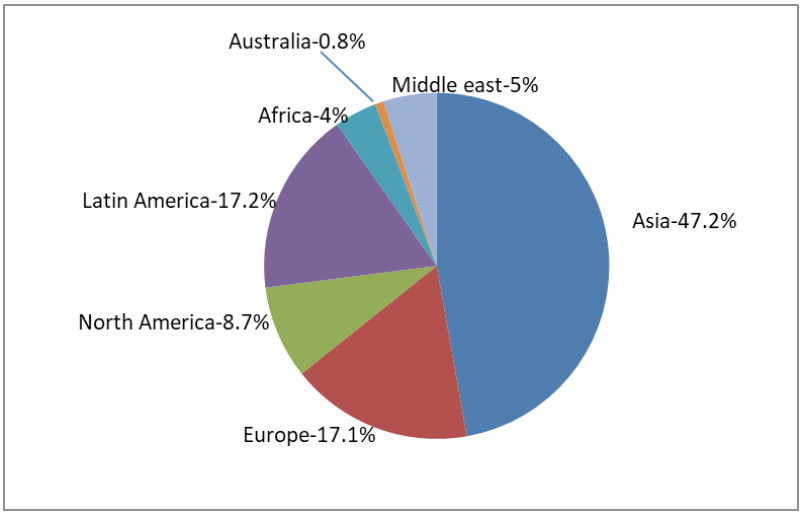
Soft drinks are non-alcoholic water-based flavoured drinks that are optionally sweetened, acidulated and carbonated. Some carbonated soft drinks also contain caffeine; mainly the brown-coloured cola drinks (Darkwah et al., 2020). Soft drinks are non-alcoholic carbonated beverages that are widely consumed all over the world and also in Nepal. They are typically made up of carbonated water, high fructose corn syrup, artificial flavours and colours, caffeine and phosphoric acid. They are popular due to their refreshing taste and accessibility, but they have also been linked

to several health concerns (Ashurst et al., 2016). Soft drinks are popular all over the world. They are widely available, affordable, and come in a variety of flavours. Soft drinks are also heavily marketed with companies spending billions of dollars each year on advertising. This has contributed to the perception that soft drinks are a normal part of everyday life (Gupta et al., 2015). Soft drinks have been around since the late 1700s when carbonated water was first introduced as a health tonic. It was believed that carbonated water had healing properties and could cure various ailments. In the 1800s, pharmacists began adding flavours to carbonated water to make it more palatable. This led to the creation of the first soft drink, which was called soda water. The popularity of soft drinks began to soar in the 1900s with the introduction of Coca-Cola and Pepsi-Cola. These two companies dominated the soft drink market and continue to do so today. Soft drinks are now a multi-billion dollar industry, and they are consumed by people all over the world (Magomya et al., 2015; Sharaitifar et al., 2020).

Globally, carbonated soft drinks are third most consumed beverages. Per capita annual consumption of carbonated soft drinks is nearly four times the per capita consumption of fruit beverages (Source: Data from the Beverage marketing Corporation, as reported by the Canadian Soft drink Association). Soft drink consumption is growing by around 5% a year. The global carbonated soft drink market size was estimated at USD 221.55 billion in 2020 and is expected to reach USD 237.04 billion in 2021 in Nepal.

Figure1

Global Beverage Consumption 2021



(Source: Canadean)

The nutritional content in soft drinks is high value of sugar, calories and other artificial ingredients. For example, a 12-ounce can of soda drinks contains around 140 calories and 10 teaspoons of sugar, which can contribute to weight gain and other health problems. In addition, some drink contains caffeine and other stimulants that can have negative effects on the body **(**Bleich et al., 2012). The quality of soft drinks also depends on the quality of water used during the manufacturing of soft drinks and also in packaging and certainly in the distribution and storage of cold drinks (Burlakoti et al., 2020).

Consumer behavior is another important area of research when it comes to soft drinks. Studies have shown that the marketing and advertising of these beverages can influence consumer behaviour, particularly among children and teenagers (Vartanian et al., 2007). For example, a 2017 study found that exposure to soft drinks advertising was associated with huger consumption of these beverages among children and teenagers while soft drinks are very popular (Basu et al., 2013). Soft drinks are high in sugar and calories, which can lead to obesity, diabetes and other health problems. They are also acidic and can erode tooth enamel over time (Malik et al., 2010). Additionally, soft drinks can lead to dehydration, as they can cause the body to loose water more quickly than it is replaced (Powell et al., 2013). A 2014 review of the literature found that consumption of sugar-sweetened beverages was associated with an increased risk of obesity and type 2 diabeties, while a 2016 study found that frequent consumption of soft drink was associated with an increased risk of metabolic syndrome (Powell et al., 2014).

The quality of soft drinks was identified by following factors (Fernandez et al., 2011).

Taste

The taste of soft drinks is an essential factor in determining their quality. It is crucial to ensure that the soft drinks have a balanced flavor, with no off-tastes or excessive sweetness.

Appearance; The appearances of soft drinks, including their color and clarity, and is also important. A high quality soft drinks should have a consistent color and should not appear cloudy or hazy.

Aroma

The aroma of soft drinks can also impact their quality. A good soft drink should have a pleasant, appealing aroma that compliments its flavour.

Nutritional Content

The nutritional content of soft drinks is also important, as excessive sugar or other additives can negatively impact the drinks quality. A high quality soft drink should have reasonable sugar content and not contain any harmful ingredients.

Packaging

The packaging of soft drinks can also affect their quality. A good soft drink should be packaged in a clean, properly sealed container that maintains the drink's refreshness and prevents contamination (Naveena et al., 2010).

Factor affecting the quality of soft drinks are as follows:

Water Quality

Water is a major component of soft drinks, and its quality can have a significant impact on the taste, appearance, and overall quality of the beverage. Poor water quality can result in off-flavours, odors, and cloudiness in the final product. Therefore, it is important for soft drink manufacturers to use high-quality water in their production processes (World Health Organization Report, 1996).

Ingredient Quality

The quality of the ingredients used in soft drink production can also impact the quality of the final product. For example, the quality of sugar, flavorings, and colorings can all affect the taste and appearance of the beverage (Nwachukwn et al., 2016).

Manufacturing Process

The manufacturing process can also impact the quality of soft drinks. For example, the amount of carbonation in the drink can be affected by the temperature and pressure used during the carbonation process. Similarly, the time and temperature used during pasteurization can impact the flavor and aroma of the final product (Albani et al., 2017).

Storage Conditions

The way soft drinks are stored can impact their quality. Exposure to light, heat, and air can cause the drink to lose its carbonation and flavor. For example, storing soft drinks in warm temperatures can lead to off-flavors and decreased carbonation (Lee et al., 2019).

Packaging

The type of packaging used can also impact the quality of soft drinks. Glass bottles,

plastic bottles, and cans can all affect the taste and carbonation of the drink. For example, some studies have found that soft drinks stored in cans have higher levels of carbonation than those stored in plastic bottles (Moraes et al., 2021).

Transportation: The way soft drinks are transported can also impact their quality. Rough handling and extreme temperatures can cause the drink to lose its carbonation and flavor. For example, exposure to high temperatures during transport can cause soft drinks to develop off-flavors and aromas (Buhmann et al., 2020).

Methods and Procedures

Study Area

Fifteen samples of soft drink were purchased from the local market of Birendranagar, Surkhet valley. Soft drinks were selected according to their popularity and frequency of the consumption. Among them eight widely consumed soft drinks such as Coca- Cola, Fanta, Sprite, Pepsi, Mountain Dew, were collected for analysis. Similarly, five fruit juices with different flavor such as real fruit, litchi, were selected for analysis. Furthermore, different energy drink sample were also collected from local market of Birendranagar for analysis. All the soft drinks were purchased in pet bottles and fruit juices were purchased in paper pack. The samples were diluted as per requirement.

Following are list of fifteen brands of soft drinks were collected Birendranagar, Surkhet.

Table 1

List of Fifteen Different Brands of Soft Drinks

S.N.	Soft Drink Brand	Sample Code	S.N.	Soft Drink Brand	Sample Code
1	Mountain dew	SD 1	9	Litchi	SD 9
2	Fanta	SD 2	10	Excess juice	SD 10
3	Sprite	SD 3	11	Real fruit	SD 11
4	Coca-cola	SD 4	12	Apple cider	SD 12
5	Pepsi	SD 5	13	Sting	SD 13
6	Cute dew	SD 6	14	Red bull	SD 14
7	Tropicana slice	SD 7	15	Mania energy	SD 15
8	Frooto	SD 8			

Following water quality tests were conducted for above samples as per standard methods:

S.N.	Test as per standard method	Nepal Drinking water standard
1	pH	6.5-8.5
2	Acidity (mg/lit)	500
3	Hardness (mg/lit)	500
4	Chlorides (mg/lit)	250
5	Iron (mg/lit)	0.3
6	Ammonia (mg/lit)	1.5

The following soft drink was analyzed as qualitative and quantitative test.

Qualitative Analysis

Fehling's Test for Reducing Sugar

About 3 ml of each test sample was measured into dry test tubes. About 3 ml of distilled water was measured into another tube as control. About 2 ml of Fehling's reagent (A and B) were added to all the tubes containing the drink samples. The tubes were kept in water bath for 5 min and the development of red precipitate indicated a positive test.

Test for Alcohol

About 4 ml of the test samples was measured into separate well-labeled test tubes and 1ml of iodine solution was added followed by 1 ml of potassium iodide

solution and 1 ml of sodium hydroxide solution. The mixtures were boiled at 100 °C in a water bath for 30 min. The appearance of a yellow colored precipitate confirmed the presence of alcohol in the soft drinks.

Test for Phosphate

About 3.0 ml of each test sample was measured into separate test tubes and 2 ml of 2 molar Ammonium Molybdate was added. The mixture was acidified with about 2 ml of 2 M HNO_3 and heated in a water bath for 10 min. The formation of a bright yellow precipitate layer of ammonium Phosphomolybdate indicates the presence of phosphate ions.

Test for Carbondioxide

As soon as samples were opened, about 3ml of each sample was added to 2ml of 2 M $Ca(OH)_2$. The change of lime water color from colorless to milky confirmed the presence of dissolved carbon dioxide in the soft drinks.

Test for Sucrose

5ml sample of each brand of cold drinks were taken in separate China dishes and were heated very strongly until changed occurs. Black colored residue left confirmed the presence of sucrose in cold drinks.

Physicochemical Analysis

Determination of pH

The pH of drink samples was determined using a Mettler pH meter (Seven Compact pH/ion S220, China). About 5ml of each analytical sample was measured using a micropipette and homogenized in 50ml of distilled water. The pH meter was calibrated and sufficient time was allowed for stabilization prior to reading.

Titratable Acid Determination

About 5 g of each sample was weighed into 200 ml capacity conical flask, diluted with 50ml distilled water and titrated against 0.5 N NaOH using 2–3 drops of phenolphthalein as indicator. The percentage titratable acidity was calculated as follows:

Titratable Acidity (%) = titre × Normality of titrant × 192.12 × 100 Weight of sample ×1000

The 192.12 is the molar mass for citric acid.

Fehling's Solution Test

Small sample of each brand of cold drinks were taken in separate test tubes

and a few drops of Fehling's A & B solution were added in equal amount. The test tube was heated in a water bath for 10 min appearance of reddish-brown precipitate confirmed the presence of glucose.

Density Measurement

The empty beaker is weight and 10ml of sample was added in beaker. The sample and beaker weight and note down. The difference of empty beaker and sample with beaker gives the mass of cold drinks which is divided by volume of sample to give density.

Estimation of Chloride

Prepare N/50 $AgNo_3$ solution in a 500ml volumetric flask and 2% of $K_2Cr_2O_4$ solution in 50 ml volumetric flask. Then, take 50 ml of each sample in 250 ml conical flask and 2 ml of 2% $K_2Cr_2O_4$ is add and titration against the standard $AgNo_3$ solution till a faint red color precipitate appears.

Total Hardness

Prepare 0.01M EDTA solution and NH_4OH- NH_4Cl buffer solution of P^H 10 in a volumetric flask. Take 50ml of each soft drink (sample) in a 250ml conical flask and add 2ml of buffer solution having P^H 10 and add a few drop of Solochrome black indicator and the mixture is titrate with the standard EDTA solution from burette until the wine red color changes to pure blue which give the total hardness of given sample of soft drinks.

Estimation of Iron

For the determination of Fe, at first the double beam spectrophotometer should be calibrated and calculate λ_{max}.The λ_{max} for iron is λ_{max}= 510 nm. Then the absorbance of each soft drink sample observe under double beam spectrophotometer with the help of these absorbance value of each sample the amount of iron present in each sample can be determined.

Results and Discussion

The different samples include CO_2 test, Alcohol test, Fehling's test, Phosphate test and Sucrose test etc. the result of these test are shown in the table below where + sign means presence and – sign indicated the absence of the test.

Table 2

Analysis of Soft Drinks for Various Parameter

Soft drink code	Soft drink brand	CO2 test	Alcohol test	Fehling's test	Sucrose test	Phosphate
SD 1	Mountain dew	+	+	+	+	+
SD 2	Fanta	+	+	+	+	+
SD 3	Sprite	+	+	+	+	+
SD 4	Coca-cola	+	+	+	+	+
SD 5	Pepsi	+	+	+	+	+
SD 6	Cute dew	+	+	+	+	+
SD 7	Tropicana slice	+	+	+	+	+
SD 8	Frooto	-	-	+	+	+
SD 9	Litchi	-	+	-	+	+
SD 10	Ex-cess juice	-	-	-	+	+
SD 11	Real fruit	-	-	+	+	+
SD 12	Apple cider	+	+	+	+	+
SD 13	Sting	-	+	+	+	+
SD 14	Red bull	-	+	+	+	+
SD 15	Mania energy	-	-	+	+	+

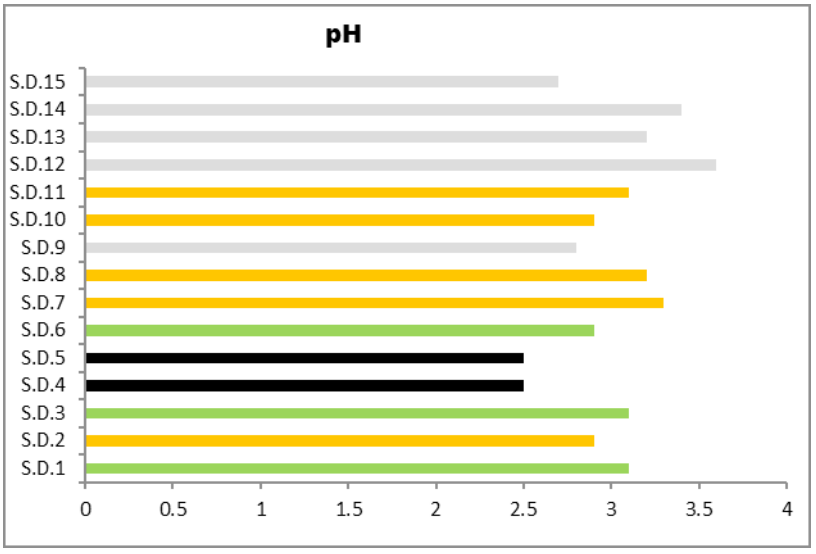
+ve indicates the presence, -ve sign indicates absence

pH: The pH of all the soft drinks which is representative of the negative logarithmic of concentration of hydrogen ions in the drinks. Soft drinks are generally acidic because of the presence of citric acid and the phosphoric acid. pH values of soft drinks of different brands are different due to variation in amount of acid contents. Here, the pH value of Pepsi (2.5), Coca-Cola (2.5), Mania energy drink (2.7), Litchi (2.8), Fanta (2.5), Excess (2.9) have lower than 3whereas pH value of apple cider(3.6),Red bull(3.4), sting(3.2), Slice(3.3) are higher than 3.pH of a soft drink can affect its taste, color, and overall quality. Soft drinks are typically acidic, with a pH ranging from 2.5 to 4.5. The pH level can affect the stability of the drink's ingredients and can impact its shelf life. A low pH can make a soft drink taste sour or acidic. High acidity can also cause the drink to corrode metal cans or other packaging materials over time, which can lead to leaks or contamination. On the other hand, a higher pH can make a soft drink tasteless acidic and sweeter. However,

excessively high pH levels can lead to a bitter or soapy taste, which can also negatively impact the drink's quality. The pH of a soft drink can also affect its color and appearance. For example, if the pH is too low, the drink can become cloudy or hazy. Alternatively, if the pH is too high, the drink can lose its color and become transparent. Low pH in soft drink also have impact on consumer health (Singh et al., 2006).

Figure 2

pH of Soft Drinks Sample



Density

The density determination was performed at room temperature and pressure. The result of the analysis is shown in table 3.

Table 3

Density of Different Soft Drinks

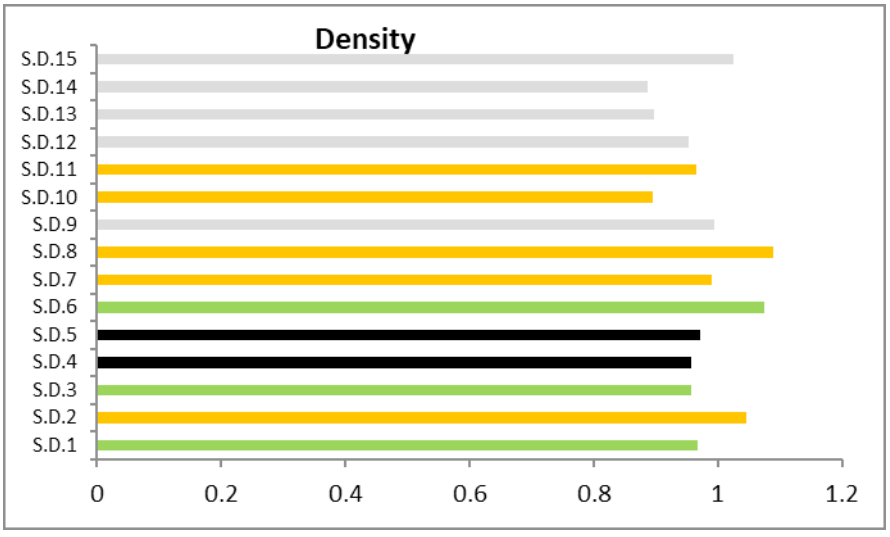
Soft drink code	Soft drink brand	Weight of beaker (gm)	Weight of beaker +10 ml of sample	Weight of sample(gm)	Density (gm/ml)
S.D 1	Mountain dew	49.60	59.722	9.64	0.964
S.D 2	Fanta	49.60	60.066	10.46	1.046
S.D 3	Sprite	49.60	59.17	9.57	0.957
S.D 4	Coca-cola	49.60	59.17	9.57	0.957
S.D 5	Pepsi	49.60	59.31	9.71	0.971
S.D 6	Cute dew	49.60	60.35	10.75	1.075

S.D 7	Tropicana slice	49.60	59.50	9.9	0.99
S.D 8	Frooto	49.60	60.50	10.9	1.09
S.D 9	Litchi	49.60	59.54	9.94	0.994
S.D 10	Ex-cess juice	49.60	58.56	8.96	0.896
S.D 11	Real fruit	49.60	59.25	9.65	0.965
S.D 12	Apple cider	49.60	59.14	9.54	0.954
S.D 13	Sting	49.60	58.58	8.98	0.898
S.D 14	Red bull	49.60	58.47	8.87	0.887
S.D 15	Mania energy	49.60	59.86	10.26	1.026

From analysis it was found that density of soft drinks sample is nearly one, Fanta (1.046), Cute dew(1.075), Frooto (1.09) and Mania (1.026) are little higher than one and other sample(red bull) is lower than one.

Figure 3

Density of Soft Drink Sample



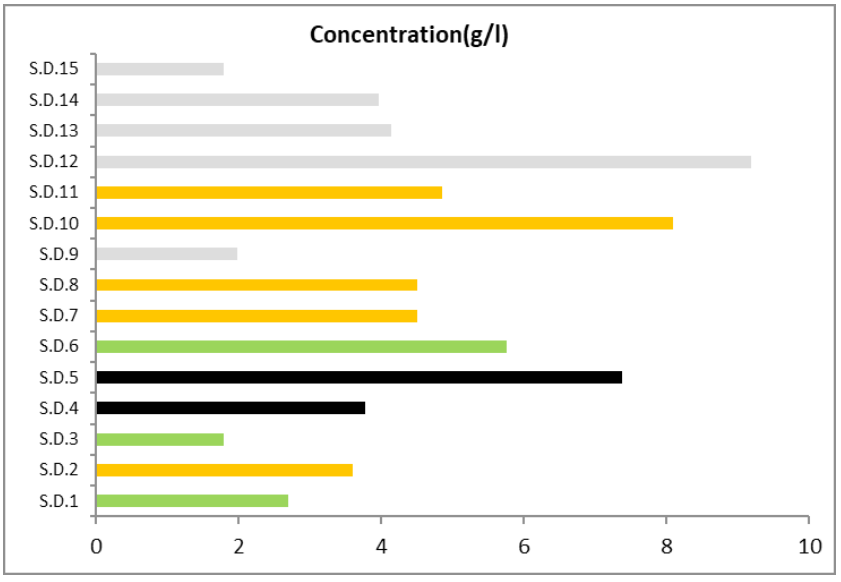
Density of a soft drink can impact its taste, texture, and carbonation level, all of which can affect the overall quality of the beverage. A higher density may make a drink taste sweeter because there are more dissolved solids, such as sugar, in the liquid. Conversely, a lower density may make a drink taste less sweet. A denser drink may feel thicker or more viscous, while a less dense drink may feel more watery. The density of a soft drink can also affect its level of carbonation. Carbon dioxide gas is dissolved in the liquid to create the bubbles in a carbonated soft drink. The higher the density of the liquid, the more carbon dioxide can dissolve in it, leading to a more carbonated drink (Aloh et al., 2015).

Fehlings Test

Fehling's test detects the presence of reducing sugar in a sample. The presence of reducing sugar in the test solution is indicated by the presence of red color in the solution. Positive result in the Fehling's test indicates presence of glucose, fructose and lactose or presence of reducing sugar in the sample. The negative result of the Fehling's test indicates the presence of non-reducing sugar such as sucrose, starch etc. Reducing sugars, such as glucose and fructose, are commonly added to soft drinks as sweeteners. While these sugars can enhance the flavor and taste of the soft drink, their excessive use can have negative effects on the quality of the drink (Agbazue et al., 2014). From analysis it was found that soft drink sample like cider (9.18) is high whereas sample like sprite, mania drink, and litchi have only 2g/l. High levels of reducing sugar can make the drink overly sweet and sticky, leading to a cloying or unpleasant sensation in the mouth. Effect of reducing sugar on soft drink quality is its impact on the drink's shelf life. High levels of reducing sugar can create an ideal environment for microbial growth, which can lead to spoilage and contamination of the drink. This can result in a shortened shelf life and decreased quality of the drink. Furthermore, excessive consumption of soft drinks containing high levels of reducing sugar can have negative effects on human health, including an increased risk of obesity, type 2 diabetes, and other health problems. In conclusion, while reducing sugar can enhance the taste of soft drinks, its excessive use can negatively impact the texture, shelf life, and overall quality of the drink, as well as have negative health effects.

Figure 4

Fehlings Test for Soft Drink Samples

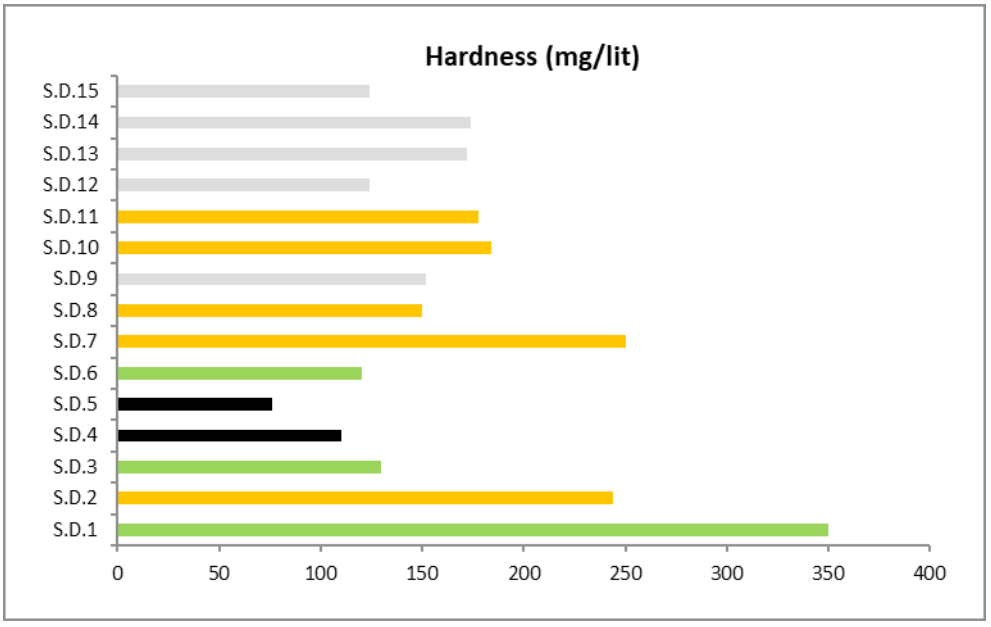


Hardness

Hardness of soft drinks is those minerals such as calcium and magnesium that dissolved contains in the soft drink having positive electric charge. The presence or absence of hardness minerals in soft drinks sample is not known to pose a health risk to users. Water having hardness more than 180 mg/lit considered as very hard. As we know all the soft drinks contain very hard water. The highest and lowest hardness are of mountain dew (350 mg/lit) and Pepsi (76 mg/lit) respectively.

Figure 5

Hardness of Soft Drink Samples



Over all the hardness of water can impact the taste, clarity, carbonation and shelf life of a soft drink. More high concentration of minerals in water can interfere with the solubility of carbon dioxide gas, which effects the carbonation and makes soft drink flatter or less carbonated. Hard water also affect the shelf life of a soft drink. The minerals in hard water can promote bacterial growth, leading to spoilage or fermentation over time.

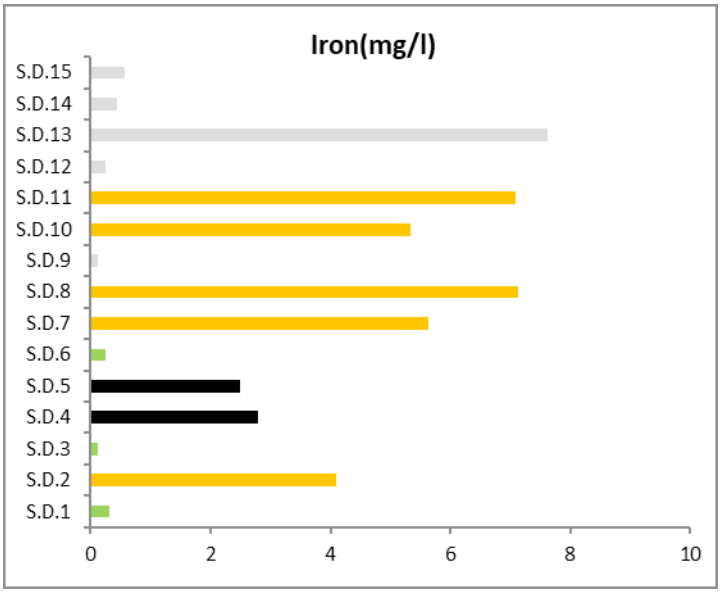
Iron

Iron (Fe) is a mineral that can potentially be present in soft drinks, either as a naturally occurring element or as a result of contamination. But high concentrations of iron make water unsuitable for drinking. From analysis it was found that maximum soft drinks sample contain high concentration of iron and other samples

like sprite (0.128 mg/l) contain low concentration of iron as recommended in Nepal Drinking Water Quality Standard. However, if the concentration of iron in a soft drink is too high, it can affect the taste and color of the drink. Iron can impart a metallic taste to the soft drink, which is generally considered unpleasant (Dey et al., 2013). Additionally, iron can react with other compounds in the drink, leading to changes in color and appearance. For example, iron can react with certain acids in the drink, leading to the formation of a brownish color and the appearance of sediment. Moreover, excessive intake of iron can be harmful to human health, especially in vulnerable populations such as infants, young children, pregnant women, and people with certain medical conditions. High concentrations of iron in soft drinks can be a potential health hazard, especially if they are consumed regularly.

Figure 6

Iron Content in Soft Drink Samples



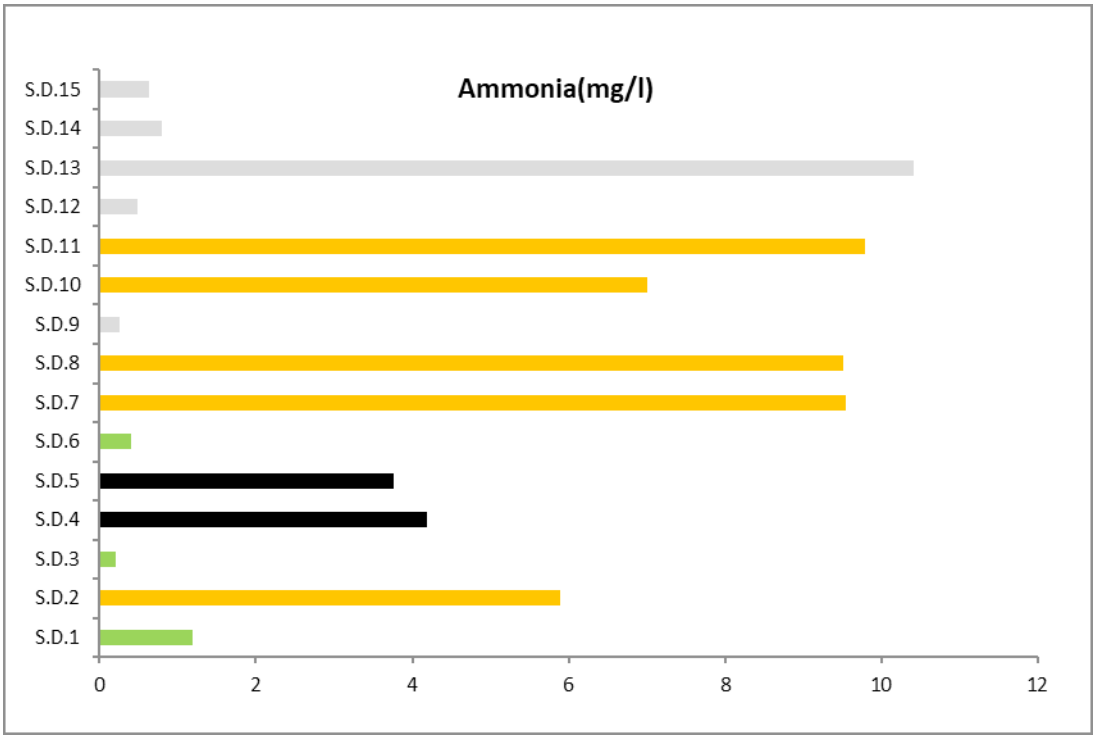
Ammonia

Ammonia concentration higher than 1.5gm/l makes water unsuitable for drinking; therefore high concentration of ammonia in water should not be used in soft drink manufacturing. Ammonia (NH_3) is a highly basic compound that can have a significant impact on the taste and quality of soft drinks. If present in high concentrations, ammonia can impart a strong, unpleasant odor and taste to the drink, which is generally considered undesirable. The highest ammonia concentration content was in Sting (10.4 mg/l) and the lowest is 0.21 mg/l for sprite samples.

Ammonia can also react with certain compounds in the soft drink, leading to the formation of other compounds that can affect its flavor and texture. For example, ammonia can react with amino acids or proteins in the drink, leading to the formation of bitter-tasting compounds that can negatively impact the taste of the drink. In general, the concentration of ammonia in soft drinks should be carefully controlled to ensure that it does not negatively impact the taste or quality of the drink. Soft drink manufacturers typically use strict quality control measures to ensure that the ammonia levels in their products remain within safe and desirable ranges.

Figure 7

Ammonia Content in Soft Drink Samples

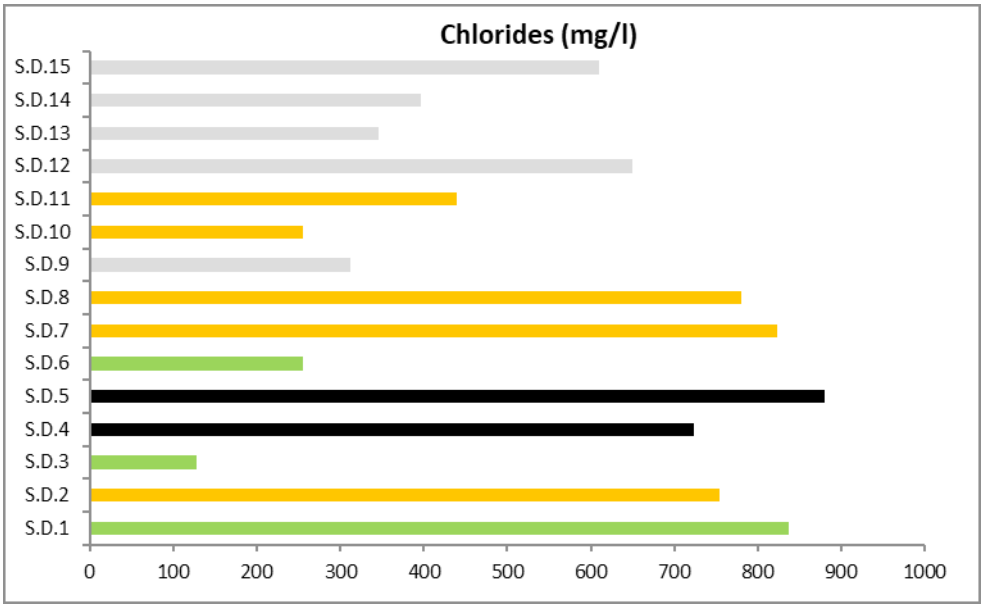


Chlorides

Chloride are widely are widely distributed in nature as the salt of sodium (NaCl), Potassium (KCl), and Calcium ($CaCl_2$). The highest Chloride content was 836.62 mg/l for mountain dew and the lowest was 87.916 mg/l for pepsi. The salty taste in soft drinks is due to the presence of chlorides ions and associated cations.

Figure 8

Chlorides Content in Soft Drink Samples



The permissible limit of chloride in water is 250 mg/l as per as Nepal Drinking Water Standard. Chloride ions (Cl^-) can have an impact on the flavor, acidity, and carbonation of soft drinks. In general, chloride ions can enhance the sour or tart flavor of a drink and also increase its perceived saltiness. Additionally, chloride ions can affect the carbonation of a soft drink. At high concentrations, chloride ions can react with carbon dioxide (CO_2) to form carbonic acid, which can increase the acidity of the drink and affect its carbonation levels.

Conclusion

This study gives us sight of qualitative and quantitative analysis which includes the major water quality parameters of fifteen popular brands of soft drink available in Birendranagar, Surkhet. Qualitatively, most of the samples contain carbon dioxide, alcohol, phosphate and fehling's test for reducing sugar. This study also focuses on the water quality parameters. Most of the soft drinks were having very low pH value (highly acidic) which is highly undesirable and are also impact on consumer's health. Higher concentration of chlorides and ammonia has also had adverse effect on health. As soft drinks are popular and widely available, they can also have negative effects on health, so it is important to consume soft drinks in moderation and should be aware of their impact on the body. The aim of this study is to make awareness about the bad effects of soft drinks on public health of people especially youth and children.

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