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A Comparative Study of Concentration of Caffeine and Benzoic Acid in Various Soft Drink Samples

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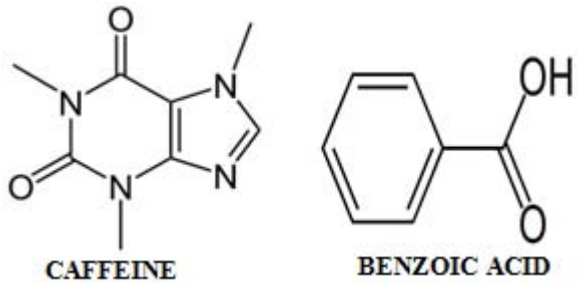
Abstract: ***This study includes a quantitative method for the determination of caffeine,benzoic acid and total acid content in different samples of soft drinks by using UV-Visible Spectrophotometer and pH meter.It is observed that the concentration of Caffeine is highest in Pepsi and least in Mountain dew and the concentration of benzoic acid is found to be highest in Mountain dew and least inPepsiamong the samples (Pepsi, Mountain dew, Fanta andLimca) studied. The total acid content isfound to be highest in Fanta and least in Pepsi. After expelling carbonic acid in the form of CO_2 , Pepsi is found to be more acidic. The carbonic acid content is also highest in Fanta and least in Pepsi.The pH of all soft drink samples selected are determined and found to be around 3 . So consumption of large amount of these soft drinks having high acid content leads to teeth decay due to loss of enamel. Thuson the basis of various data recorded it is concluded that the concentration of caffeine , benzoic acid and acid content are different in different soft drinks.***

Keywords: Caffeine,Benzoic acid,Soft drinks

1. Introduction

Soft drinks comes under the category of junk food products. This is because of their nutritional value is less and fat, sugar, salt and calories contents are high. A soft drink is a beverage that containsCarbonate water,Sweetener, Flavoring agents,Preservatives like salts of benzoic acid, Caffeine, Coloring agents etc.[1].Caffeine is a white crystalline Xanthine alkaloid which is bitter in taste.It acts as a stimulating drug.Presence of caffeine causes adverse effect on human's cardiovascular system[2].Benzoic acid is a white crystalline solid.Its salts are used as food preservatives.High amount of benzoic acid (added as preservative) is harmful for liver and it disturbs carbohydrate metabolism which may lead to accumulation of fat causing obesity and impairment of liver also affects removal of toxic waste materials from body which leads to several metabolic disorders. Thus consumption of soft drinks having large quantity of benzoic acid causes severe health hazards.



Both caffeine and benzoic acid are aromatic in natureand absorb ultraviolet radiation.So for the estimation of Caffeine and benzoic acid spectrophotometric method has been used.

2. Experimental

1. Estimation of [caffeine] and [benzoic acid]

For the determination of caffeine and benzoic acid[3,4], Spectrophotometric method[5] is used.100 ml stock standard solution of benzoic acid was prepared by dissolving 0.0122gm of benzoic acid in double distilled waterand made upto100 ml in avolumetric flask (100 ml). Stock standard solution of caffeine was prepared by dissolving 0.0194gm Caffeine in 100 mldouble distilled water in a volumetric flask (100 ml). Inorder to determine the suitable wavelengths,the spectral absorption curve for each of the components was scannedand from thoseabsorption values, the ratio of absorbance (O.D) of the components at a number of wavelengths calculated. A plot of the ratio of absorbanceversus wavelength was drawn and the wavelengths corresponding to the maximum and minimum of the plot has been selected as the suitable wavelengths for carrying out the measurement of the absorbance of the mixture of caffeine and benzoic acid.Absorbance of thesoftdrink samples andthat of the known solutions of purecompounds(Benzoic acid and Caffeine)were measuredat the wavelengths selected in above step. The concentration of Benzoic acid and Caffeine in the soft drink samples are calculated by the equation**,** Absorbance of soft drink sample (mixture of two components concerned) = [(Absorbance due to $A/C_{A'})\times C_A$] + [(Absorbance due to $B/C_{B'})\times C_B$. Where A=caffeine, B=Benzoic acid, C_A=Concentration of Caffeine in soft drink sample, C_B=Concentration of Benzoic acid in soft drink sample, $C_{A'}$=Concentration of pure Caffeine solution, $C_{B'}$=Concentration of pure Benzoic acid solution.By solving the two simultaneous equations obtained for the absorbance of the soft drink samples at the two wavelengths selected, the concentration of caffeine and benzoic acid are calculated.

2. Determination of Total Acid content

pH metric estimation is followed for estimating the total acid content and of carbonic acid content in the samples selected. 20 ml of soft drink samples were titrated against0.5M NaOH solution pH metrically.Before titrating thesamples ,NaOH solution was standardized using standard oxalic acid solution.The pH meter was calibrated[6,7]before starting the experiment.

3. Results and Discussion

The results of experiments conducted for the estimation of caffeine and benzoic acid are concluded in Table-1,2&3.The concentration of Caffeine is highest in Pepsi and least in

Mountain dew and the concentration of benzoic acid is found to be highest in Mountain dew and least in Pepsi among the samples (Pepsi, Mountain dew, Fanta and Limca) studied.

Table 1

Wavelength (nm)	Absorbance of pure caffeine solution(A)	Absorbance of pure benzoic acid solution(B)	Ratio of absorbance of A to B (A/B)
200	0.606	0.603	1.0049
210	0.775	0.773	1.0026
220	0.924	0.921	1. 0032
230	1.069	1.067	1.0019
240	1.095	1.098	0.9973
250	1.062	0.827	1.2841
260	1.039	0.629	1.6519
270	0.992	0.694	1.4294
280	0.974	0.519	1.8767
290	0.953	0.059	16.1525
300	0.107	0.012	8.9167
310	0.013	0.009	1.4444

Table 2: Absorbance of various soft drink samples at two wavelengths selected

Soft drinks Sample	Absorbance at 240 nm (minima)	Absorbance at 290 nm (maxima)
Pepsi	0.291	0.146
Limca	0.262	0.095
Fanta	0.256	0.093
Mountain dew	0.360	0.078

Table 3

Sample	Concentration of Caffeine (mol/lit)	Concentration of benzoic acid (mol/lit)
Pepsi	1.45×10^{-4}	1.2×10^{-4}
Limca	0.89×10^{-4}	1.5×10^{-4}
Fanta	0.86×10^{-4}	1.44×10^{-4}
Mountain dew	0.58×10^{-4}	2.62×10^{-4}

The pH of all soft drink samples[7] selected are determined and shown in Table-4. The pH of all the samples are found to be around 3 .

Table 4

Soft drink sample	pH
Fanta	3.02
Pepsi	3.22
Limca	3.12
Mountain Dew	3.04

The results of total acid content estimation according to 0.5M NaOH are shown inTable-5, Fig 1,2& Table-7. The total acid content is found to be highest in Fanta and least in Pepsi.

Table 5

Volume of 0.5M NaOH added(ml)	pH (Pepsi)	pH (Limca)	pH (Fanta)	pH (Mountain dew)
0	3.22	3.12	3.28	3.02
1	3.51	3.59	3.43	3.21
2	3.73	3.71	3.56	3.38
3	3.92	3.86	3.70	3.59
4	4.10	4.09	3.84	3.72
5	4.32	4.17	3.97	3.86
6	4.51	4.31	4.09	4.03
7	4.67	4.50	4.21	4.23
8	4.85	4.68	4.31	4.35
9	5.26	4.89	4.41	4.54
10	5.54	5.19	4.57	4.89
11	5.95	5.39	4.69	5.07
12	6.84	5.71	4.88	5.30
13	8.28	6.02	5.11	5.53
14	8.62	7.09	5.32	5.78
15	8.80	8.21	5.49	6.10
16	8.82	8.51	5.73	7.44
17	8.87	8.71	6.09	8.36
18	8.95	8.81	6.72	8.65
19	9.03	8.83	8.16	8.78
20	9.05	8.94	8.65	8.84

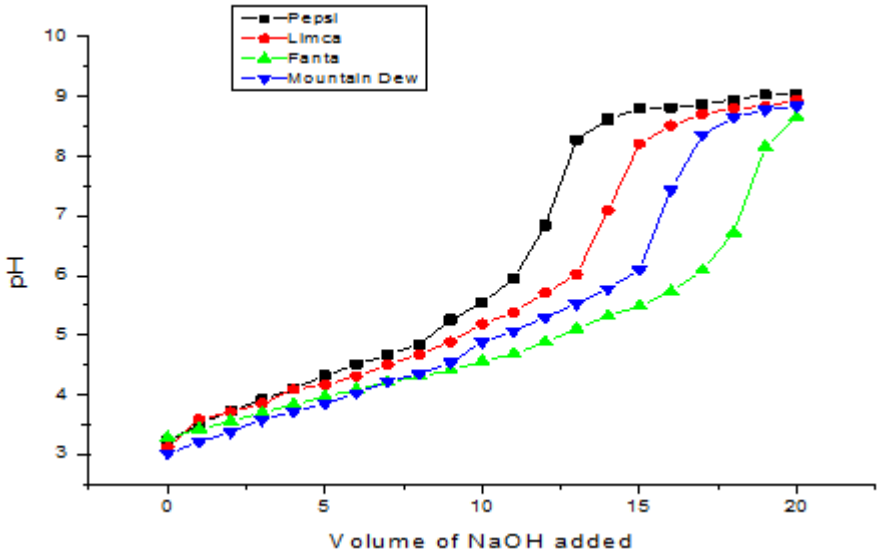


Figure 1

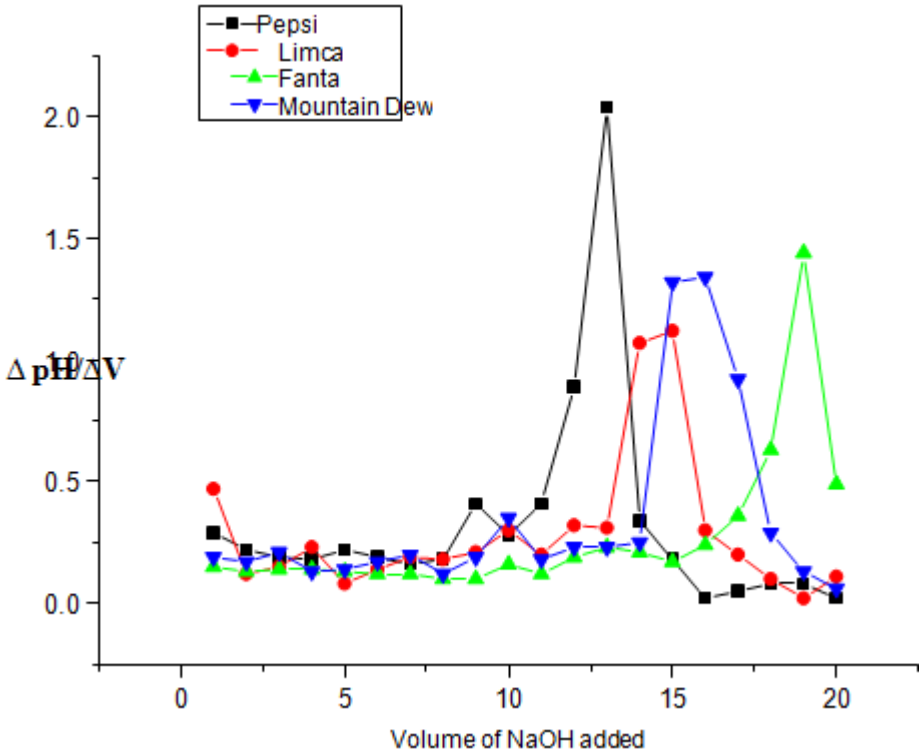


Figure 2

In order to estimate the carbonic acid content, pH metric titrations were carried out by titrating the samples with 0.5M NaOH solution after expelling CO_2 from the samples. The results are given in the Table-6, Fig-3,4&in Table-7. Even though after expelling CO2, Limca is found to be least acidic among the samples,the carbonic acid content is found to be highest in Fanta and lowest in Pepsi(Table-7).

Table 6: (After expelling CO_2)

Volume of 0.5M NaOH added(ml)	pH of Pepsi	pH of Limca	pH of Fanta	pH of Mountain dew
0	3.28	3.26	3.36	3.07
1	3.56	3.68	3.61	3.42
2	3.81	3.94	3.86	3.96
3	4.01	4.29	4.08	4.22
4	4.21	4.56	4.40	4.46
5	4.45	4.94	4.68	4.81
6	4.67	5.31	4.94	5.25
7	4.87	5.86	5.30	5.71
8	5.23	7.74	5.67	6.36
9	5.59	8.59	6.18	8.56
10	6.11	8.97	8.39	8.94
11	7.89	9.06	8.87	9.15
12	8.38	9.21	9.04	9.27
13	8.51	9.27	9.18	9.36
14	8.72	9.36	9.27	9.44
15	8.76	9.40	9.34	9.53

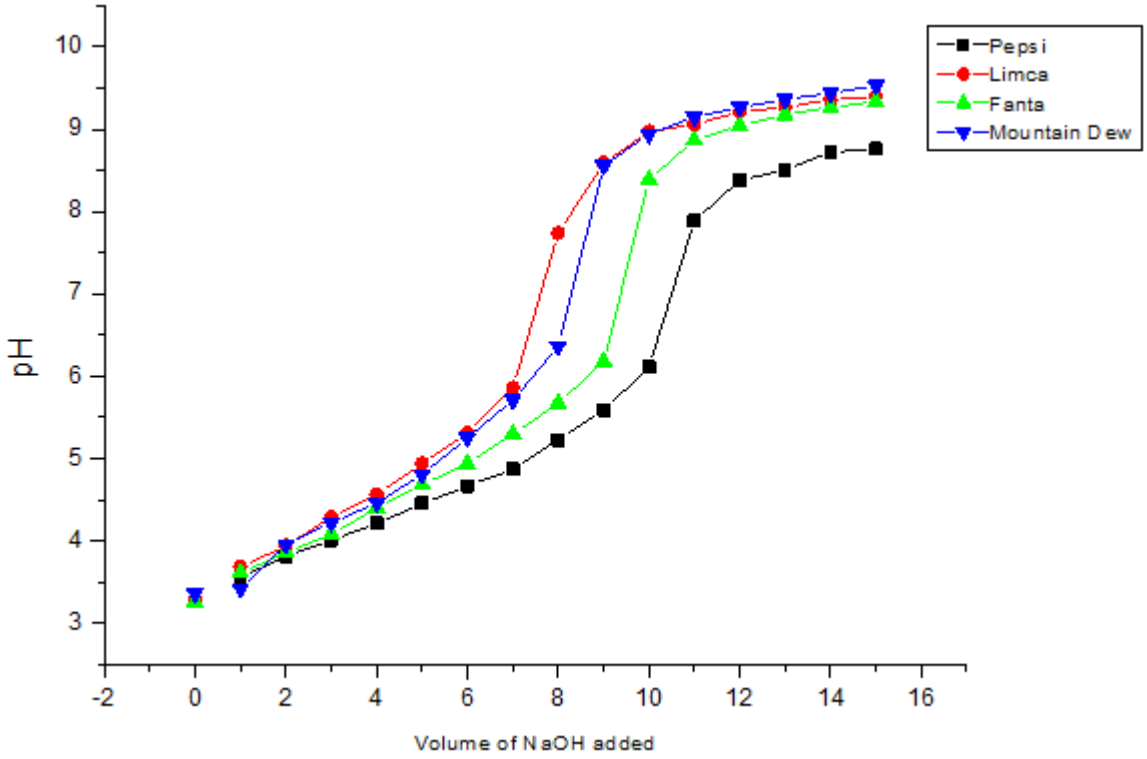


Figure 3

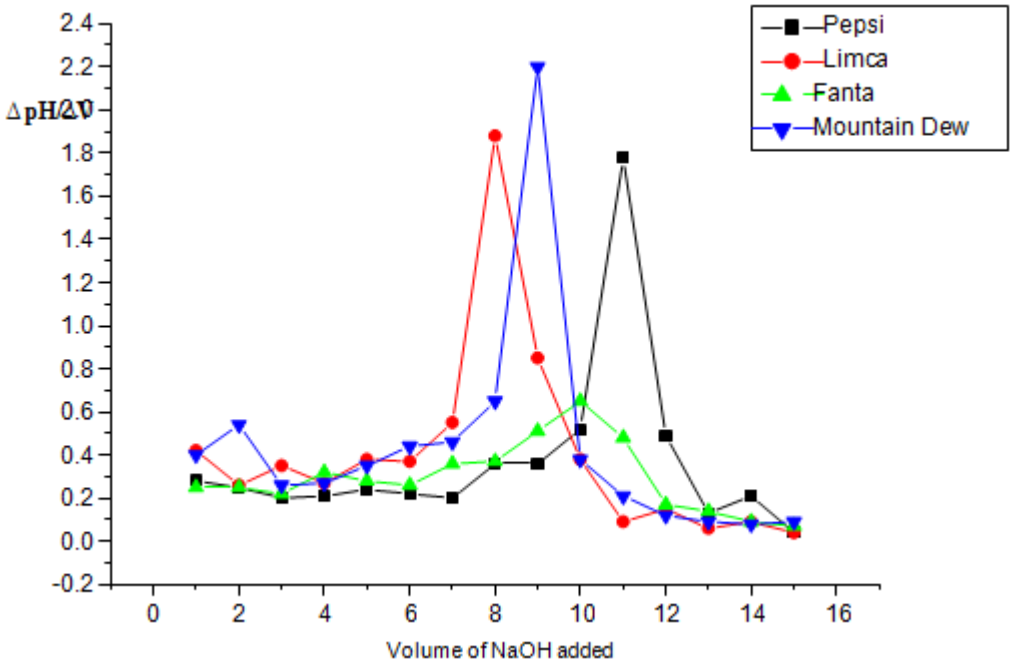


Figure 4

Table 7

Sample	Total Acid content(a)	Acid content after expelling CO_2(b)	Content of Carbonic acid (a-b)
Pepsi	**0.3125**	**0.2625**	**0.05**
Limca	**0.3625**	**0.1875**	**0.175**
Fanta	**0.4625**	**0.2375**	**0.225**
Mountain Dew	**0.3875**	**0.2125**	**0.175**

4. Conclusion

Estimation of Caffeine and Benzoic acid using UV-Visible spectrophotometer shows that the concentration of Caffeine is highest in Pepsi and least in Mountain dew among the samples (Pepsi, mountain dew, Fanta, Limca) studied. Caffeine is linked to anxiety and sleep disruption (or insomnia) when consumed in excess, also excess of caffeine leads to increase in blood pressure which may result into hypertension.Salts of benzoic acid are used as food preservatives The concentration of benzoic acid is found to be highest in mountain dew and least in Pepsi.The concentration of caffeine and benzoic acid are in the permissible limit in all the soft drink samples studied.

.Estimation of Acid content of soft drinks samples have been carried out using pH meter. The total acid content is found to be highest in Fanta and least in Pepsi.The pH of all soft drink samples selected are found to be around 3. Among the soft drinks Fanta is highly acidic when carbonic acid present in it but after expelling carbonic acid in the form of CO_2, Pepsi is found to be more acidic. Thus consumption of large amount of these soft drinks having high acid content leads to teeth decay due to loss of enamel.From the present study it is clear that largeconsumption of soft drink products in daily life can lead to several problems related to health.

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