Determination of Sugar Content in Soft Drinks Using Polarimetric Method

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Abstract:

The sugar content in various soft drinks has been carried out using a polarimetric technique. For this, colourless carbonated soft drinks like Sprint, Sprite and 7UP were chosen. Within the error limit, the values obtained were matched with the values printed on the bottles. It is to be noted that, we have avoided coloured soft drinks from the study because of their dark colour.

Key Words: Soft drinks, Sugar content, Optical Rotation, Polarimeter

1. Introduction

Soft drinks are non-alcoholic beverages with colouring agents, flavouring agents and natural or artificial compounds as sweetening agents as their chief components, besides water. Some of them are carbonated drinks. The overuse of soft drinks makes human body overloaded with sugar; thereby damaging the internal organs it increases the chances of lifestyle diseases like diabetes, high blood pressure and heart related problems. The excessive intake of soft drinks causes softening of bones in children. Child obesity is also another ill effect of soft drink consumption. Dehydration and Calcium depletion are some of the problems related to excess soft drink consumption.[1-4] Ramasami *et. al.* has done comparative studies to estimate sugar in soft drinks by using different techniques, namely Density, Refractometry, Infrared Spectroscopy and Statistical Methods.[5] Aloh G. S. *et. al* has studied the sugar content in soft drinks using EDTA Method.[6] Al-Mhanna *et. al.* has done the analysis of the sugar content in food products by using Gas Chromatography, Mass Spectrometry and Enzymatic Methods.[7] A. Debebe *et. al.* has used modern techniques like HPLC to estimate the sugar contents in alcoholic beverages.[8] In this paper, we have attempted to study sugar contents in soft drinks

using polarimetry method. Literature survey has shown that only few studies have done in estimating the sugar in soft drinks by using polarimetric methods. We have followed the procedures reported in the book *Advanced Practical Physical Chemistry*, J.B.Yadav[9] and also took the support of web site https://apniphysics.com/viva/specific-rotation-sugar-solution for our studies.

2. Materials and Method

Soft drinks are purchased from the market. For polarimetric studies, Half Shade Manual Polarimeter has used. Sodium Vapour Lamp has used for illumination.

3. Results and Discussion

3.1. Determination Percentage Composition of Sugar using Polarimeter

1. Weight out 50g of sugar and dissolve it in distilled water up to the mark in 250ml, in a volumetric flask. If the rotation is not clear, it is diluted to 75, 50, 37.5 and 25 cm^3 of the solution to 250ml separately in a volumetric flask, so as to get 15, 10, 7.5 and 5% solutions.
2. The glass tube is cleaned from both sides and is filled with distilled water.
3. The tube is mounted on the frame and the sodium lamp is switched on. The analyzer is looked through an eyepiece connected with the rotating scale.
4. Two equal portions of dark and bright could be seen, that could be interchanged by rotating the analyzer.
5. The analyzer first rotated it in the clockwise direction and then in the anticlockwise until the circular field of view becomes bright.
6. The readings are noted

7. Similarly second and third readings are taken for both the directions, which is in the absence of sugar solution.
8. The average of the readings in both directions is taken.
9. Now the polarimeter is filled with sugar solution.
10. It is mounting on the frame carefully.
11. The same procedures are repeated as done in the case with distilled water.
12. The analyzer first takes the reading in the clockwise and then in the anticlockwise direction. The other readings are also taken similarly.
13. The difference in the value between the sugar and water solution will give the angle of rotation.
14. The experiment is repeated with different sugar solutions with varying concentrations.
15. The room temperature and length of the tube used in this experiment are noted.
16. The angle of rotations for soft drinks is also measured similarly.

The polarimeter readings for the determination of zero point are shown in Table 1 and those for calculating the angle of rotation (α) is shown in Table 2. The Calculated angle of rotation (α) and Specific rotation(S) are shown in Table 3.

Table 1. DETERMINATION OF ZERO POINT

	No.	Conce-ntration	Clockwise (a)			Anticlockwise (b)		
			MSR	VSR	Total	MSR	VSR	TOTAL
Distilled Water	1		90	5	90.05	275	9	275.09
	2		91	7	91.07	273	4	273.04

	3		92	6	92.06	274	6	274.06
	4		90	5	90.05	273	9	273.09
				Mean(a)	90.8075(a)		Mean(b)	273.82(b)

Table 2. DETERMINATION OF ANGLE OF ROTATION

Vernier I (a) = 90.8075

Vernier II (b) =273.82

	Number	Concen-tration (%)	Vernier I (a')			Vernier II (b')		
			MSR	VSR	Total	MSR	VSR	Total
Sucrose	1	25	99	8	97.555	277	8	278.055
	2		96	3				

	1 2	37.5	99 97	5 10	98.075	284 282	7 7	283.07
Sucrose solution	1 2	50	102 102	9 4	102.066	289 285	6 9	287.076
	1 2	75	104 106	4 2	105.03	290 287	7 6	288.565
	1 2	100	116 118	3 2	117.025	299 291	5 9	295.05

The optical activity of a substance is expressed in terms of specific rotation. S, and calculated by the formula,

$S = \theta / LC$

Where 'θ' is the angle of rotation expressed in degree, The length of tube is expressed as L in decimeter (1 decimeter = 10 cm) and the concentration is expressed in C in g/mlin the solution. The unit of specific rotation is degree/(decimetre) x (g/ml).

If the length of the solution (tube) is in L cm, C = mass of the substance (M) / volume (V).

Then,

Specific rotation = (θ X V) / (L X M)

Table 3. SPECIFIC ROTATION OF VARIOUS SUCROSE SOLUTIONS

Percentage	Angle of rotation (α)	Specific Rotation
5%	5.491	54.91
7.5%	8.258	55.05
10%	12.246	61.23
15%	14.483	48.27
20%	23.72	59.30

The average value of Specific Rotation for sucrose solution as 55.75 and this value is taken to calculate the concentration of sugar in soft drinks and is tabulated in Table 4.

TABLE 4. PERCENTAGE OF SUGAR CONTENT IN VARIOUS SOFT DRINKS

Sl no	Soft drinks	Clockwise vernier I	Anticlockwise vernier II	α value	(%) of sugar
1	Sprint	101.06	284.54	10.486	9.40%
2	7UP	99.54	288.55	11.731	10.52%
3	Sprite	106.045	287.535	14.476	12.90%

4. Conclusion

The sugar content in the branded soft drinks was studied using polarimetric method. The values obtained were within the range of what is printed on their bottles (8 to 13%), showing the feasibility of usage of polarimetry in determining the sugar content of colourless soft drinks, fruit juices and beverages.

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The Lonely Runner Conjecture

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Abstract

Suppose there are *n* runners in a circle, initially at the same position. Assume the circle has unit length, and all the runners start with constant, but distinct speeds. A runner is said to be *lonely* at a time if the person is away from all others at least by a distance of 1/*n* unit. The lonely runner conjecture states that every runner will be lonely at some point in time. In this note, we will discuss this unsolved problem and present the known results so far.

Introduction

Imagine a circular track, with unit circumference for simplicity. Let there be two runners at the starting point. This is not a usual running game in which the first one who reaches the finishing point is the winner. Instead, we are considering the case where the runners have a constant speed throughout; also, the speed of each runner is different from the other. Moreover, the runners continue to run even after finishing a lap – they keep on running through the circular track without stopping. This means that the runner with the greater speed among them is ahead while the other runner is behind. At some point in time, the runner who is ahead will cross the other runner since they are not stopping. Hence, there will be a time t_0 at which the faster runner is ahead of the slower runner by a distance of ½ unit measured along the circumference of the track. This means, they are away from each other by ½ unit, or one is *lonely* in the sense that the other person is away by a distance of ½ unit.