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INVESTIGATION OF THE EFFECT OF STORAGE ON SOME PROPERTIES OF COLOURED SOFT DRINKS SOLD IN NIGERIA

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ABSTRACT

The effect of prolonged storage on some properties of coloured soft drinks sold in Nigeria was ascertained through this research. Eleven bottles, each of six different brands of coloured soft drinks sold in Nigeria, were purchased from the 9th-mile area of Enugu State. Five bottles of each brand were exposed to sunlight. In comparison, five bottles of each brand were stored at room temperature. The pH, titrable acidity, total soluble solid content (TSSC) and specific gravity were ascertained after 3, 6, 9, 12 and 15 weeks of storage. In contrast, each bottle was analysed before storage to serve as a control. The results showed that the pH decreased with increased storage time for both conditions. The pH value before storage was 2.93 for sample 1, 3.09 for sample 2, 3.08 for sample 3, 3.61 for sample 4, 2.90 for sample 5 and 2.92 for sample 6. There was a steady decrease in the pH for all the samples up to the 15th week. The titrable acidity increased with an increase in storage time. The maximum values for titrable acidity were observed for sunlight-exposed samples in the 12th week (0.122%) for sample 1, at 15th week (0.1026%) for sample 2, at 15th week (0.0073%) for sample 3, at 6th week (0.0690%) for sample 4, at 15th week (0.149%) for sample 5 and at 15th week (0.130%) for sample 6. The TSSC increased with an increase in storage time for both storage conditions. TSSC was initially 7.56 brix^{0} for sample 1, 9.50brix^{0} `for sample 2, 0.00^{0} brix for sample 3, 0.02^{0} brix for sample 4, 11.18^{0}brix for sample 5 and 0.00^{0}brix for sample 6. The specific gravity increased with increased storage time at both storage conditions. The specific gravity before storage was 1.0313 for sample 1, 1.0338 for sample 2, 1.0001 for sample 3, 1.0429 for sample 4, 1.0458 for sample 5 and 1.0497 for sample 6. It can be concluded that the specific gravity, TSSC and acidity of the soft drinks increased with storage time, while the pH decreased with storage time.
Keywords: computed soft drinks, titrable acidity, total soluble solid content,

INTRODUCTION

Carbonated beverages are widely consumed in Nigeria and are still controversial regarding public health and public policy. Over the years, numerous studies have been conducted into the possible links between soft drink intake and medical problems, the results of which, however, remain highly contested. Soft drinks contain different ingredients, both

nutritive and non-nutritive, which are added for one reason or the other. However, certain ingredients may be hazardous to health if consumed in large quantities, and there is widespread concern about preservatives and sweeteners. Soft drinks are typically believed to contain large amounts of sugar (Onyemelukwe *et al.*, 2006). These drinks are usually carbonated; carbonation makes them more acidic, sharpens flavour and taste (Taylor, 2006) and helps preserve them longer (Korzeniewska, 2005). Therefore, while there is a trend to produce an ever wider range of more specialist soft drinks, there is also pressure to minimise artificial additives and ingredients. Soft drink containers are often stored under unpredictable conditions for several months before consumption; therefore, it is essential to understand whether the storage conditions may affect the quality of these beverages in PET bottles. It is also necessary to understand if storage time and temperature can affect the content of these beverages in PET bottles.

MATERIAL AND METHODS

Sample collection

Six different PET-bottled coloured soft drinks sold in Nigeria were purchased from the Ninth Mile area of Enugu State.

Table 1: carbonated soft drinks used.

Sample code and names	Batch number	Manufacturing date	Expiry date	Number of drinks purchased	Producers
Swan orange	1047090413	23/04/13	08/10/13	11	UAC foods
Pepsi	830413R14:49	23/04/13	22/10/13	11	7-up bottling company
Fanta	A0601:4839	17/02/13	16/08/13	11	Coca-cola company
Mirinda pineapple	160413B23:11	16/04/13	15/10/13	11	7-up bottling company
Mirinda orange	AA413B2137	10/04/13	09/10/13	11	7-up bottling company
Teem bitter lemon	560413808:52	26/04/13	25/10/13	11	7-up bottling company

Sample preparation

Before storage, one bottle of each of the six different brands of carbonated soft drinks was analyzed to ascertain their pH, titrable acidity, sugar content (TSSC) and specific gravity, and these bottles served as controls. Thirty (30) bottles (i.e., five bottles of each brand of the beverages) were kept at room temperature, and another thirty bottles were exposed to sunlight. The following tests were carried out: change in pH, TSSC test, change in specific gravity and titrable acidity after 3 weeks, 6 weeks, 9 weeks, 12 weeks and 15 weeks of storing the drinks in the two different storage conditions.

pH Determination

The pH of the samples was measured using a pH meter. A portion (50ml) of the juice was measured into a beaker, the pH meter electrode was immersed, and the reading was recorded. The recordings were taken at room temperature.

Titrable Acidity Determination

A 10ml diluted product (10% solution of the sample) was titrated with 0.1M KOH solution until the substance reached a pH value between 8.2 and 8.4, corresponding to the endpoint of phenolphthalein (AOAC, 1995). Readings were taken with a pH meter (Techmel and Techmel). When this value was reached, the spent KOH was noted, and the acidic percentage of the substance was calculated using the following equation, with the result being expressed as a percentage of citric acid.

$$\text{Acidity (\% citric acid)} = \frac{100 \; x \; V \; x \; Nap \; x \; F \; x \frac{meg}{g} \; (citric)}{volume \; of \; sample} \quad (1)$$

Where V=Volume of KOH, Nap=Normal Concentration of KOH, F= Normality Correction Factor, Meg/g =Miliequivalent per gram of Citric Acid, Sample =Volume of sample taken.
NB: Nap =0.IN,Volume of sample = 10ml, F =0.007, Meg/g Citric Acidic = 23.35.

Specific Gravity Determination

A clean density bottle was dried in an oven at 105^{o}_{C}, cooled inside a desiccator and weighed to constant weight. It was filled with distilled water and weighed again. The distilled water was poured away, and the bottle rinsed with ethanol. The bottle was filled with the sample, and the weight was taken (Amerine and Oguh, 1980). The specific gravity of the sample was calculated thus;

$$\text{Specific Gravity} = \frac{mass \; of \; sample}{mass \; of \; distilled \; water} \quad (2)$$

Determination of sugar or TSSC

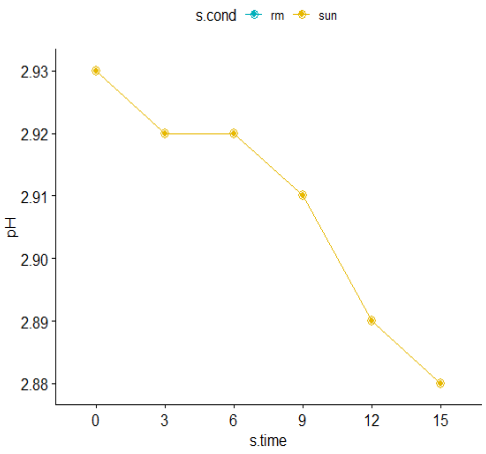
The readings were done using a refractometer. Results are reported in ^{o}Brix or g/100ml.

RESULTS AND DISCUSSION

Effects of storage time and storage condition on pH levels

The pH for samples 1, 4 and 5 were initially 2.93, 3.61 and 2.90 and changed to 2.88, 3.57 and 2.82 (room temp) and 2.88, 2.82 and 2.88 (sunlight) after 15 weeks of storage. This change was tested statistically at both storage conditions and different storage times, and the following were obtained: The change in the pH of sample 1 was statistically significant ($P<0.05$) under different conditions and storage times. The change in pH of sample 4 was significant ($P<0.05$) between (0-12, 0-15, 3-15, 6-15, 9-12 and 9- 15) weeks of storage. Change in pH for sample 5 was statistically significant ($P<0.05$) between (0-6, 0-9, 0-12, 0-15, 3-9, 3-12, 3-15, 6-9, 6-12, 6-15, 9-15 and 12-15) weeks of storage. The change in the pH of samples 2, 3 and 6 were initially 3.09, 3.08 and 2.92 and changed to 3.03, 3.04 and 2.88 (room temp) and 3.02, 3.03 and 2.88 (sunlight), respectively, after 15 weeks of storage.

This change in the level of pH was tested statistically. The following were observed: Statistically, a significant change ($P < 0.005$) was observed in the pH of sample 2 between (0-6, 0-9, 0-12, 0-15, 3-6, 3-9, 3-12, 3-15, 6-12, 6-15 and 9-15) weeks of storage. There was no significant change in the pH of samples 6 and 3 under different storage conditions and times. This gradual decrease in pH has an effect as a lower pH does not allow pathogenic microorganisms to grow and hence acts as a preservative (Yadav *et al.*, 2013). Similar trends were reported by Hamaran and Amutha (2007) in a case of banana and sapota beverages stored at different temperatures for 180 days. The observed increase in the acidity of soft drinks may be due to the presence of carbon dioxide (CO_2) and acidity regulators (Yadav *et al.*, 2013).



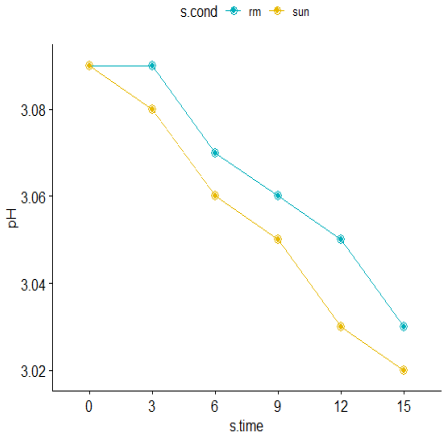


Figure 1: Effects of storage time and storage and storage condition on pH levels for sample 1

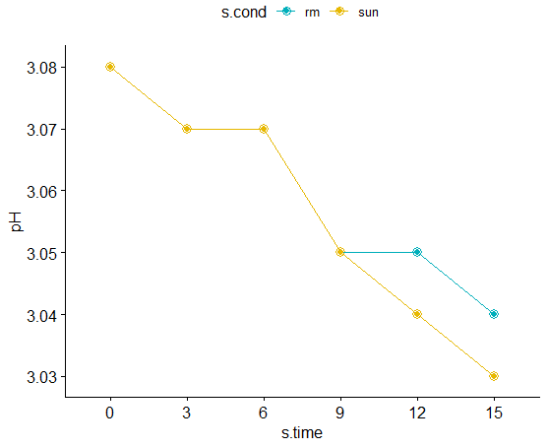


Figure 2: Effects of storage time condition on pH levels for sample 2

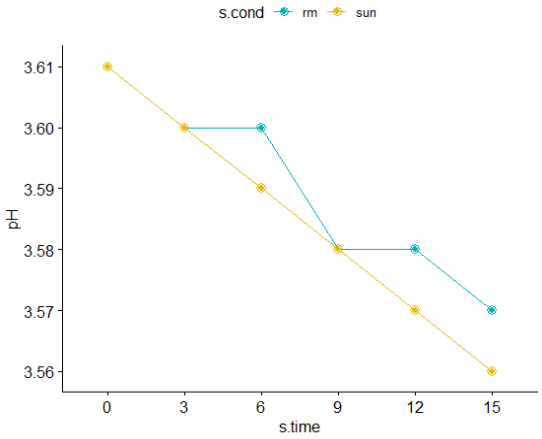


Figure 3: Effects of storage time and storage storage condition on pH levels for sample 3

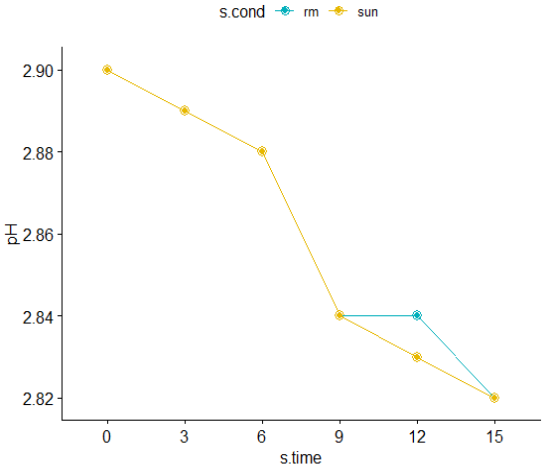


Figure 4: Effects of storage time and condition on pH levels for sample 4

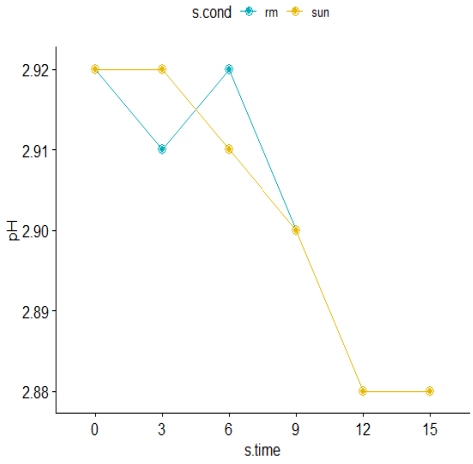


Figure 5: Effects of storage time and and condition on pH levels for sample 5

Figure 6: Effects of storage time condition on pH levels for sample 6

Effects of storage time and storage condition on Total soluble solid content (TSSC) levels

The TSSC for samples 1, 4 and 5 were initially 7.80, 10.50 and 11.80 and changed to 9.00, 10.63 and 14.00 (room temp) and 9.26, 10.94 and 14.20 (sunlight) after 15 weeks of storage. This change was tested statistically at both storage conditions and different storage times. The following were obtained: The change in the TSSC for sample 5 was statistically significant ($P<0.05$) between (0-3, 0-6, 0-9, 0-12, 0-15, 3-9, 3-12, 3-15, 6-9, 6-12 and 6-15) under different conditions and different storage time. There was no significant change in the TSSC of sample 4 under different storage conditions and storage

time. Change in TSSC for sample 1 was statistically significant (P<0.05) between (0-6, 0-9, 0-12, 0-15, 3-9, 3-12, 3-15, 6-9, 6-12, 6-15, 9-15 and 12-15) weeks of storage.

The change in the TSSC of sample 2, sample 3 and sample 6 were initially 9.50, 0.00 and 0.00 and changed to 9.61, 0.49 and 0.231 (room temp) and 9.80, 0.51 and 0.260 (sunlight) respectively after 15 weeks of storage. This change in the pH level was tested statistically, and the following was observed: The TSSC of samples 2 and 6 under different storage conditions and storage times did not significantly change (P> 0.05). Statistically, a significant change (P < 0.005) was observed in the TSSC for sample 3 between (0-3, 0-6, 0-9, 0-12, 0-15, 3-12, 3-15, 6-12, 6-15, 9-12 and 9-15) weeks of storage.

The increase in TSSC might be due to converting insoluble polysaccharides into reducing sugars (Yadav *et al.*, 2013). It may also be due to the hydrolysis of sugars by acids, which might have degraded disaccharides to monosaccharides (Chia *et al.*, 2012). Increased TSSC contents during the storage period is in correlation with the findings of Sirohi *et al.*, (2005), who observed similar increased TSSC in Whey-based mango herbal mint beverage during storage and attributed it to the solubilization of the insoluble portion of the product due to the presence of acids (ascorbic and citric acid) in mint and ginger. The TSSC stored at room temperature was lower compared to sunlight-exposed samples.

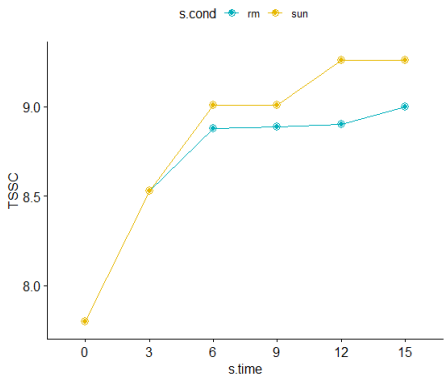


Figure 7: Effects of storage time and storage condition on TSSC levels for sample 1

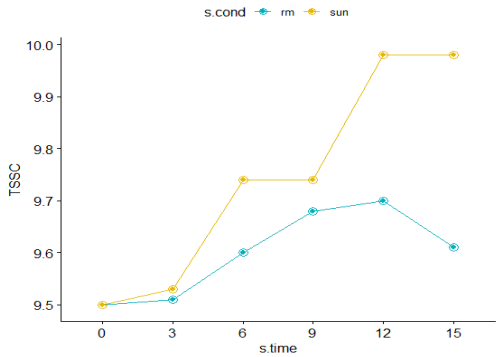


Figure 8: Effects of storage time and storage condition on TSSC levels for sample 2

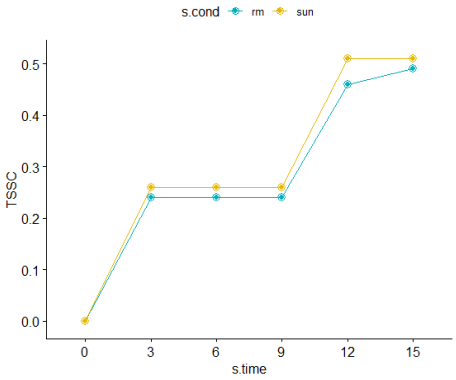


Figure 9: Effects of storage time and storage condition on TSSC levels for sample 4

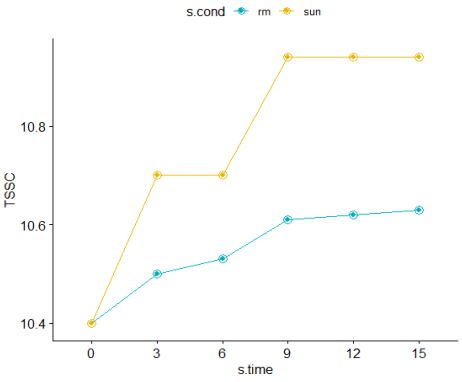


Figure 10: Effects of storage time and storage condition on TSSC levels for sample 5

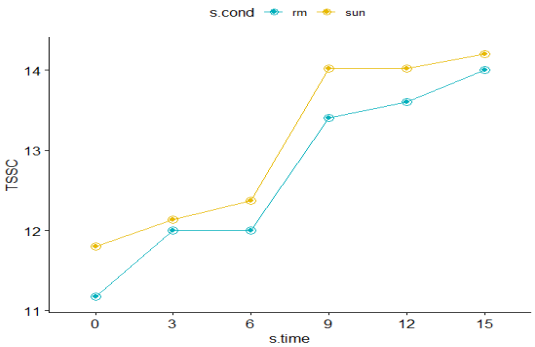


Figure 11: Effects of storage time and storage storage condition on TSSC levels for sample 5

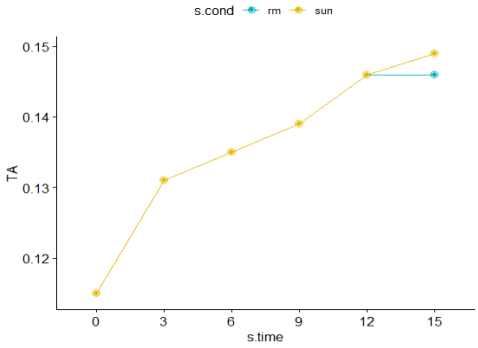


Figure 12: Effects of storage time and condition on TSSC levels for sample 6

Effects of storage time and storage condition on (Titrable Acidity) TA levels

The TA for sample 1 and sample 2 were initially 0.120 and 0.093 and changed to 0.122 and 0.102 (room temperature) and 0.122 and 0.103 (sunlight), respectively. The change in TA was tested statistically, and the following were obtained: Under different storage conditions and times, the change in TA for sample 1 was insignificant ($P > 0.05$). The TA for sample 2 was significant ($P > 0.05$) between (0-3, 0-6, 0-9, 0-12, 0-15, 3-12, 3-15, 6-12, 6-15, 9-12 and 9-15) of storage.

The TA for samples 3, 4, 5, and 6 were initially 0.069, 0.066, 0.115, and 0.110 and changed to 0.073, 0.068, 0.146, and 0.127 (room temperature) and 0.073, 0.069, 0.149, and 0.130 (sunlight), respectively. The change in TA was tested statistically, and the following were obtained: There was no significant change in the TA of sample 4 under different storage conditions.

The change in TA of Fanta was statistically significant ($P < 0.05$) between (6-9, 6-15 and 9-12) weeks of storage under different conditions. The change in the TA of sample 5 was significant ($P< 0.05$) at different

storage conditions and times except between 12 – 15 weeks of storage. The change in the TA for sample 6 was significant (P< 0.005) between (0-3, 0-6, 0-9, 0-12, 0-15, 3-6, 3-9, 3-15, 6-12, 6-15, 9-12 and 9-15) weeks of storage.

The increase in titrable acidity may be due to the presence of carbon dioxide (CO_2), citric acid, and other acid regulators purposely added to soft drinks during preparation. These are added to soft drinks to improve their taste and act as a preservative.

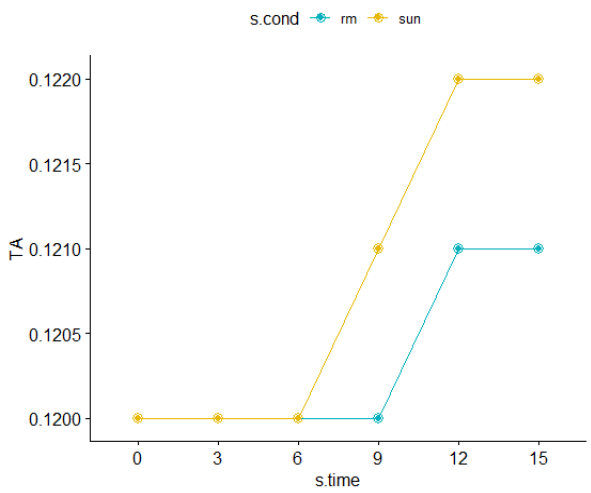


Figure 13: Effects of storage time and storage storage condition on TA levels for sample 1

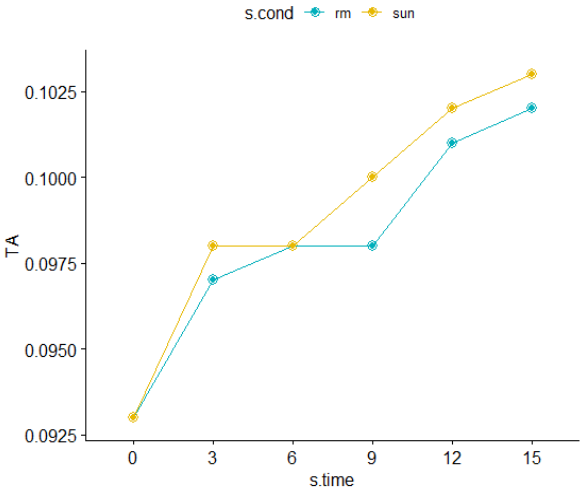


Figure 14: Effects of storage time and condition on TA levels for sample 2

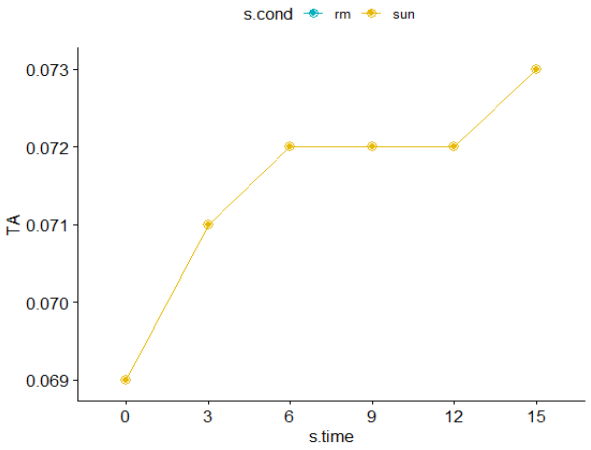


Figure 15: Effects of storage time and storage storage condition on TA levels for sample 3

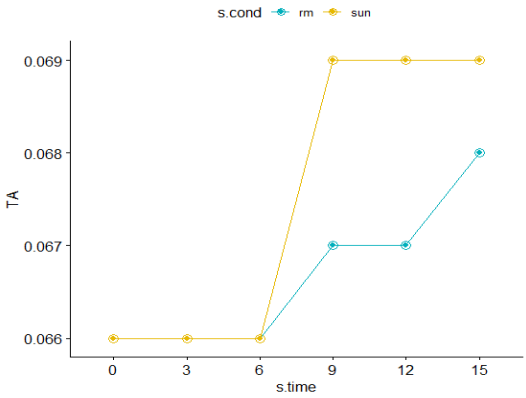


Figure 16: Effects of storage time and condition on TA levels for sample 4

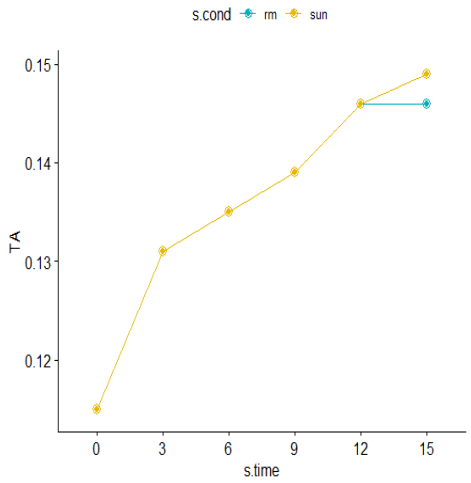


Figure 17: Effects of storage time and storage condition on TA levels for sample 5

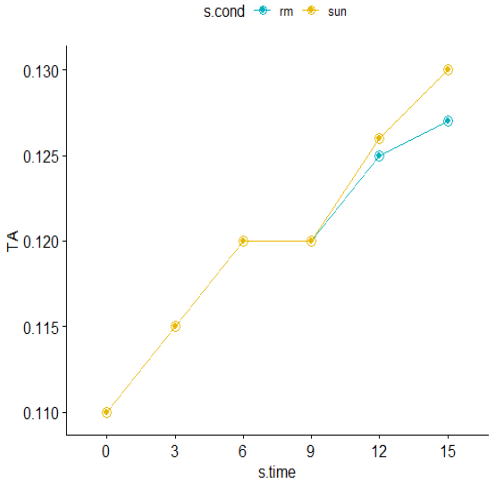


Figure 18: Effects of storage time and storage condition on TA levels for sample 6

Effects of storage time and storage condition on specific gravity (SG) levels

The SG for sample 1, sample 2, sample 3, sample 4, sample 5 and sample 6 were initially 1.0345, 1.0338, 1.0001, 1.0429, 1.0458 and 1.0497 and changed to 1.0365, 1.0403, 1.0018, 1.0440, 1.0520 and 1.0516 (room temperature), and 1.0368, 1.0406, 1.0020, 1.0442, 1.0577 and 1.0608(sunlight), respectively after 15 weeks of storage. The change in SG was tested statistically, and the following were obtained: There was no significant change in the SG of sample 6 after 15 weeks of storage under different storage conditions.

The change in the SG for sample 1 was significant between (0-3, 0-6, 0-9, 0-12 and 0-15) weeks of storage. The change in the SG for sample 3 was significant between (0-3, 0-6, 0-9, 0-12, 0-15, 3-12, 3-15, 6-12; 6-15, 9-12 and 9-15) weeks of storage. The change in the SG for sample 2 was significant between (0-3, 0-6, 0-9, 0-12, 0-15 and 6-15) weeks of storage. The change in the SG for sample 5 was significant between 0-12 and 0-15 weeks of storage. The change in the SG for Mirinda pineapple was statistically significant between (3-9, 3-12, 3-15, 6-9, 6-12 and 6-15) weeks of storage.

The observed increase in the samples' specific gravity may be due to sugar's activities, which are directly evidenced by the rise in TSSC contents with storage time. The effects of storage on the specific gravity of soft drinks agree with those reported by Akande *et al.,* (2014).

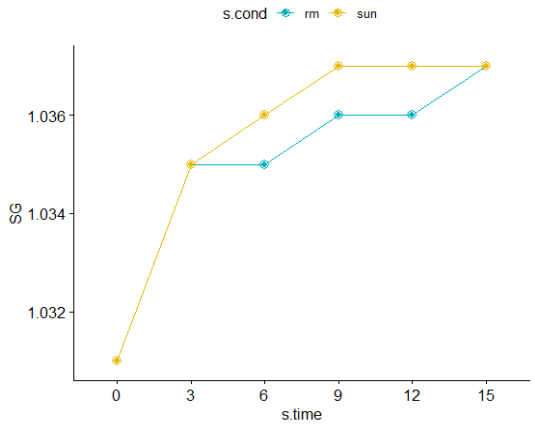


Figure 19: Effects of storage time and storage storage condition on SG levels for sample 1

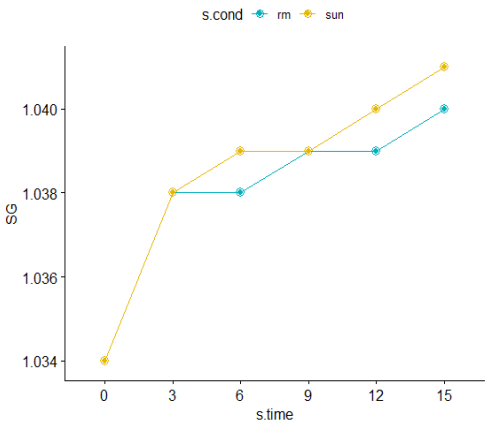


Figure 20: Effects of storage time and condition on SG levels for sample 2

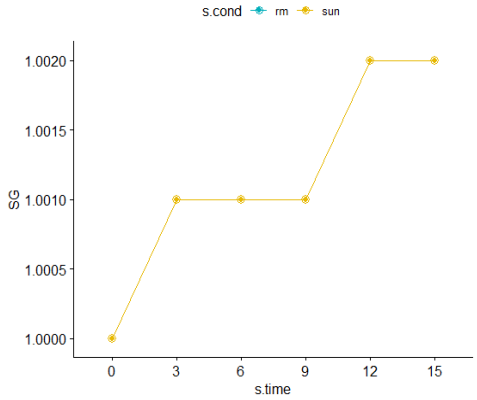


Figure 21: Effects of storage time and storage storage condition on SG levels for sample 3

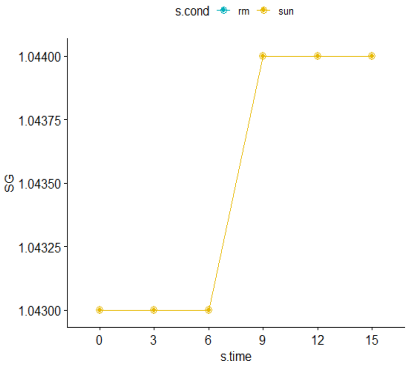


Figure 22: Effects of storage time and condition on SG levels for sample 4

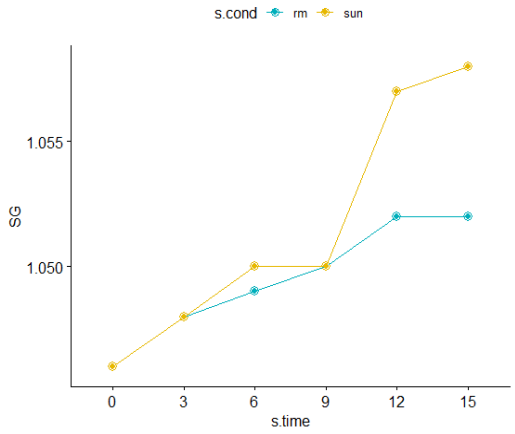


Figure 23: Effects of storage time and storage storage condition on SG levels for sample 5

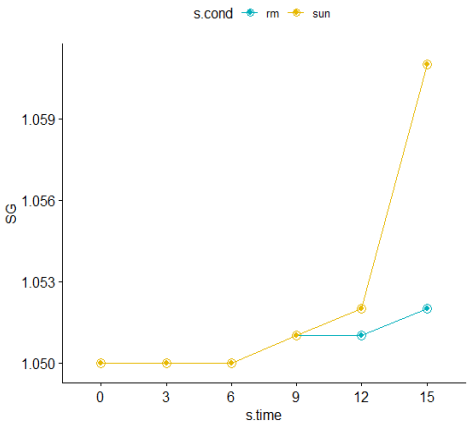


Figure 24: Effects of storage time and condition on SG levels for sample 6

CONCLUSION

The following conclusions can be drawn based on the findings:

The pH decreased with storage time. This decrease was statistically significant between some weeks of storage. However, the change in the pH of Fanta and Teem was not statistically significant after 15 weeks of storage at different storage conditions and times.

The TSSC of the studied samples was found to be higher under sunlight than at room temperature. The increase was not statistically significant (P >0.05) at both storage conditions and storage time in Teem and Pepsi.

Apart from the Mirinda pineapple, which showed no significant change in the TA at different storage conditions and times, the studied samples' TA was higher under sunlight than at room temperature. The increase was statistically significant ($P < 0.05$) between some weeks of storage at both storage conditions and storage time. The SG of the studied samples increased with time.

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