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Quantitative assessment of vitamin C content by Titration Method in selected samples in the local market in Al-Abyar Libya.

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Abstract:
Vitamin C, also known as ascorbic acid, is a water-soluble vitamin that plays an essential role in human health due to its antioxidant properties. This study aimed to determine the vitamin C content in seven (7) commercial orange juice samples using the iodometric titration method. The analysis was successfully carried out using this method, which is simple, accurate, and suitable for routine laboratory applications. The average results showed variations in vitamin C concentration among the analyzed samples. Sample 3 recorded the highest vitamin C content with a value of 0.027mol\L, while sample 5 showed the lowest content with a value of 0.0057mol\L. These findings indicate differences in vitamin C levels among commercial orange juices, which may be attributed to variations in juice type, processing methods, and storage conditions.
Keywords: Vitamin C, Ascorbic Acid, Iodometric Titration, Chemical Analysis.

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التقييم الكمي لمحتوى فيتامين سي بطريقة المعايرة في عينات مختارة من السوق المحلي في مدينة الابيار –ليبيا

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الملخص:

فيتامين ج، المعروف أيضًا باسم حمض الأسكوربيك، هو فيتامين قابل للذوبان في الماء، ويلعب دورًا أساسيًا في صحة الإنسان بفضل خصائصه المضادة للأكسدة. هدفت هذه الدراسة إلى تحديد محتوى فيتامين ج في سبع 7عينات من عصير البرتقال التجاري باستخدام طريقة المعايرة اليودية. وقد أُجري التحليل بنجاح باستخدام هذه الطريقة، التي تتميز بالبساطة والدقة والملاءمة للتطبيقات المختبرية الروتينية. أظهرت النتائج تباينًا في تركيز فيتامين ج بين العينات المُحللة. سجلت العينة رقم 3 أعلى محتوى من فيتامين ج بقيمة 0.027مول\لتر، بينما سجلت العينة رقم 5 أدنى محتوى بقيمة 0.0057 مول\لتر. تشير هذه النتائج إلى وجود اختلافات في مستويات فيتامين ج بين عصائر البرتقال التجارية، والتي قد تُعزى إلى اختلافات في نوع العصير وطرق المعالجة وظروف التخزين.

الكلمات المفتاحية: فيتامين ج، حمض الأسكوربيك، المعايرة اليودية، التحليل الكيميائي.

1. Introduction:

Vitamin C, also known as ascorbic acid, (Figure 1) is classified as a water-soluble vitamin, meaning it is not stored in the body for long periods and must be consumed regularly through dietary sources, since the human body is unable to synthesize vitamin C; adequate intake depends primarily on the consumption of fruits and vegetables. (Sandrika et al; 2023)

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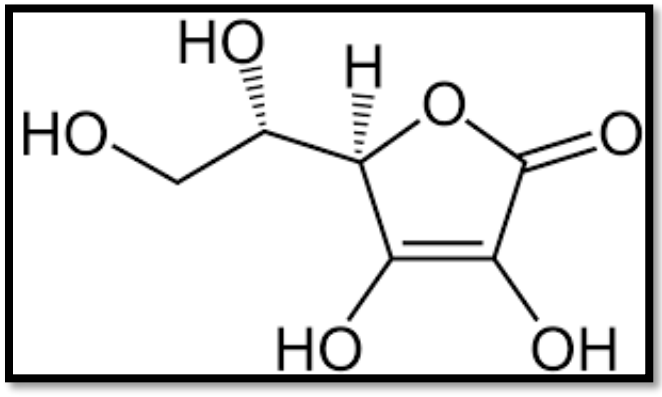

Figure 1. Structure of ascorbic acid

Vitamin C is an essential organic compound required by the human body in small amounts to support normal metabolic processes; it plays a vital role in strengthening the immune system and protecting the body against various diseases.

Vitamin C is involved in numerous biochemical reactions within the body, highlighting its essential role in various physiological processes, ranging from bone formation to wound healing and scar tissue repair generally, vitamin C is considered non-toxic, as adverse effects are rare when consumed within normal dietary limits. To maintain optimal health and reduce the incidence of common colds, it is important to ensure that the body receives an adequate and consistent supply of vitamin C. (Mussa, & Sharaa, 2014)

Vitamin C is abundantly found in fresh fruits and vegetables, particularly citrus fruits and their juices, making dietary intake the primary and most effective means of meeting the body's requirements.

Individual vitamin C requirements vary depending on age and gender. The recommended daily intake of vitamin C is approximately 90mg for adult men and 75 mg for adult women, Vitamin C deficiency can lead to several health problems such as bleeding gums, easy bruising, mouth ulcers, delayed wound healing, and joint pain. Generally, vitamin C is widely available in various types of fruits and vegetables, making adequate intake achievable through a balanced diet. (Wang et al; 2018)

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Problem of Research

A major challenge in the local beverage industry is the lack of transparent nutritional labeling. Many commercial canned juices available in the market are marketed as healthy dietary choices, yet their packaging completely lacks any labeled values regarding their Vitamin C (Ascorbic Acid) content. This absence of labeling leaves consumers uninformed about the actual nutritional value they receive. Furthermore, because Vitamin C is highly sensitive to heat and oxygen during processing and packaging, the total amount of the vitamin could be drastically low. Therefore, this research analytically investigates these unlabeled commercial brands to establish a baseline of their actual Vitamin C content, ensuring consumer awareness and evaluating product quality

The primary objective of this study is to quantitatively determine the vitamin C content in selected juice samples obtained from the local market in Al-Abyar. For products in which the vitamin C content is not specified on the packaging, the study aims to measure and report its concentration. For products that provide labeled vitamin C values, the experimentally determined results will be compared with the manufacturer's declared values to evaluate their accuracy and consistency.

2. Material & Methods

2.1 Redox titration using iodine solution.

This method determines the vitamin C concentration in a solution by a redox titration using iodine. Vitamin C, also known as ascorbic acid or L (+)-Ascorbic acid. Iodine is added in the course of titration, the ascorbic acid is oxidized to dehydroascorbic acid, while the iodine is reduced to iodide ions. (Satpathy et al; 2021)

$$\text{Ascorbic acid} + \text{Iodine } (I_2) \rightarrow 2\ I^- + \text{Dehydroascorbic acid}$$

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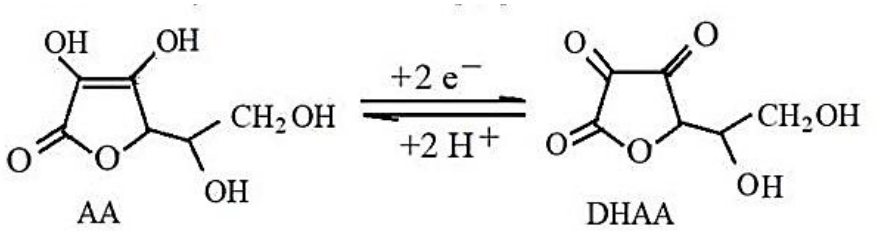

Due to this, the iodine formed is instantly reduced to iodide as long as there is any ascorbic acid present in the solution. When all the ascorbic acid has been oxidized, the excess iodine is free to react with the starch indicator, forming a blue-black starch-iodine complex; this is the endpoint of the redox titration. (Elgailani et al; 2017)

2.2. Sampling

The study samples were collected from the local market in Al-Abyar, Libya. (Table 1) A total of seven juice samples were purchased from different retail outlets to ensure a representative selection of products available in the local market.

The samples were stored under refrigerated conditions and subsequently analyzed using iodometric titration to accurately estimate the vitamin C content.

Table 1 Names of Commercial fruit juices

Symbol	1	2	3	4	5	6	7
Commercial fruit juices	Sun top (Saudi)	Original juice	Çankaya (soft drink)	Green orange	Sun top (Libya)	Silvei	Serene

2.3 Chemicals and reagents.

All the reagents were of analytical grade. Deionized water was used throughout the study. (Nielsen, 2024)

- Starch indicator solution (5%)
- Iodine solution (0.1 mol L^{-1}).

2.4 Preparation of sample

10 mL of the sample solution was pipetted into a 250mL conical flask, and 1 mL starch indicator solution was added. Then the

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sample solution was titrated with 0.1mol L^{-1} iodine solution. The titration's endpoint was identified as the first permanent trace of a dark blue-black color due to the starch-iodide complex. Each titration was repeated three times to ensure the precision and reproducibility of the results. (Pathy, 2018)

3. Result and Discussion

The quantitative determination of Vitamin C (Ascorbic Acid) concentration across seven commercial juice samples was successfully conducted using iodometric titration.

Calculation:

As iodine solution is taken as the standard solution, it is taken as 0.1mol \L

$$(M \times V)_{\text{Ascorbic}} = (M \times V)_{\text{iodine}}$$

$$M = \frac{M \times V}{V}$$

$$M = \frac{0.1 \times 10}{V}$$

Which v= mean burette readings

The experimental data obtained, including the initial and final burette readings, the calculated difference for each trial, their respective means, and the final molar concentrations, are shown in table 2.

Table 2 The experimental data and the final molar concentrations

Sample	Initial burette reading	Final burette readier	Difference	Mean±SD	Amount of vitamin C (mol\L)
1	0.0 1.2 3.2	1.2 3.2 5.7	1.2 2 2.5	1.9±0.54	0.019
2	0.0 2.4 4.2	2.4 4.2 7.1	2.4 1.8 2.9	2.37±0.45	0.023

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Sample	Initial burette reading	Final burette readier	Difference	Mean±SD	Amount of vitamin C (mol\L)
3	12.1 14.4 16.1	14.4 16.1 18.6	2.3 1.7 2.5	2.17±0.34	0.027
4	0.0 0.8 1.4	0.8 1.4 2	0.8 0.6 0.6	0.67±0.09	0.0067
5	2.8 3.3 4	3.3 4 4.5	0.5 0.7 0.5	0.57±0.09	0.0057
6	9.3 11.6 14.5	11.6 14.5 16	2.3 2.9 1.5	2.23±0.57	0.022
7	16 18.1 20	18.1 20 21.9	2.1 1.9 1.9	1.97±0.09	0.0197

A detailed analysis of the results reveals a significant variation in the Ascorbic Acid content among the different juice samples. Sample 3 exhibited the highest concentration of Vitamin C with a recorded value of 0.027 mol/L (corresponding to a mean iodine titre volume of 2.17 mL). This was followed closely by Sample 2 and Sample 6, which demonstrated concentrations of 0.023 mol/L and 0.022 mol/L, respectively. Samples 1 and 7 showed moderate amounts, yielding nearly identical concentrations of 0.019 mol/L and 0.0197 mol/L.

In figure 2 conversely, the lowest concentrations of Vitamin C were observed in Sample 4 (0.0067 mol/L) and Sample 5 (0.0057 mol/L). These two samples required noticeably smaller volumes of the standard iodine solution (means of 0.67 mL and 0.57 mL, respectively) to reach the permanent starch-iodine blue endpoint.

This wide analytical disparity aligns with the local findings of Ben Mussa (2014) and Benhameda (2026), which highlighted high chemical volatility and rapid degradation of natural ascorbic acid within the regional market due to warehousing and temperature fluctuations.

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To evaluate the true dietary value of the analyzed beverages, the molar concentrations of all seven samples were calculated based on a standard 100 mL reference volume and compared against the human Recommended Dietary Allowance (RDA) of 75 to 90 mg/day.

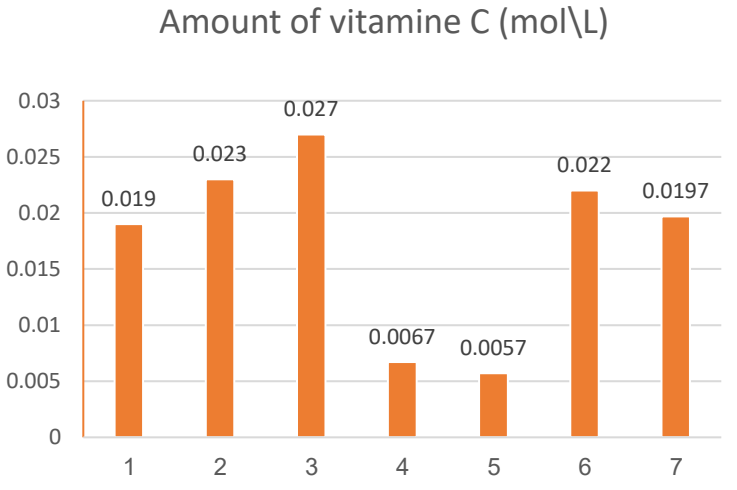

Figure 2 Average Vitamin C Concentration in Commercial Orange Juice Samples

The analytical data demonstrates that even a small volume of 100 mL from any of the seven unlabeled commercial samples is sufficient to cover and surpass the minimum daily baseline requirement for adults. The high-yield group (Samples 3, 2, and 6) delivered exceptional concentrations ranging from 0.022mol\L to 0.027mol\L (about 387.5 mg to 475.5 mg per 100 mL), providing roughly 430% to 528% of the required daily intake due to industrial fortification.

Conversely, the low-yield group (Samples 4 and 5) provided the lowest dietary baseline, with Sample 5 yielding 0.057 mol\L (about 100.4 mg per 100 mL). Although Sample 5 still satisfies about 111% of the basic adult RDA, its sharp nutritional deficit compared to the peak samples clearly underscores how industrial processing without

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fortification dramatically dilutes the ultimate antioxidant quality delivered to the consumer.

4. Conclusion

The aim of this study was to analyze the vitamin C content in commercial orange juice samples using the iodometric titration method, was successfully determined using the iodometric titration method, in seven orange juice samples. Based on the results obtained, the highest vitamin C content was recorded in Sample 3 (0.027 mol\L), while the lowest vitamin C content was found in Sample 5 (0.0057 mol\L). These findings indicate variations in vitamin C concentration among the analyzed commercial juice samples, which may be attributed to differences in processing, storage conditions, and manufacturing practices.

5. Recommendations

Based on the analytical findings and conclusions of this study, the following recommendations are proposed to enhance product quality, consumer awareness, and future academic research:

1. Industrial food control authorities should enforce strict regulations compelling all local and importing beverage manufacturers to clearly declare the exact concentration of Vitamin C (Ascorbic Acid) on their nutritional facts labels.
2. Periodic quality control testing should be implemented on commercial juices across local markets to ensure that products maintain a minimum acceptable nutritional standard throughout their shelf life.
3. Maintaining a strict cold storage chain during the distribution and warehousing of commercial juices is vital, as lower temperatures significantly retard both enzymatic and non-enzymatic oxidation of Ascorbic Acid.
4. Future researchers should couple iodometric titration with advanced instrumental techniques, such as High-Performance Liquid Chromatography (HPLC) or potentiometric titration, to cross-validate results and eliminate potential visual endpoint errors in highly colored juices.

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