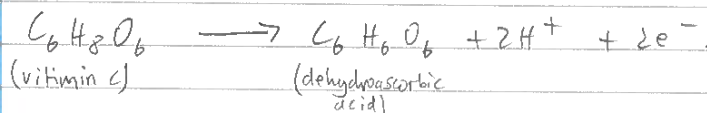
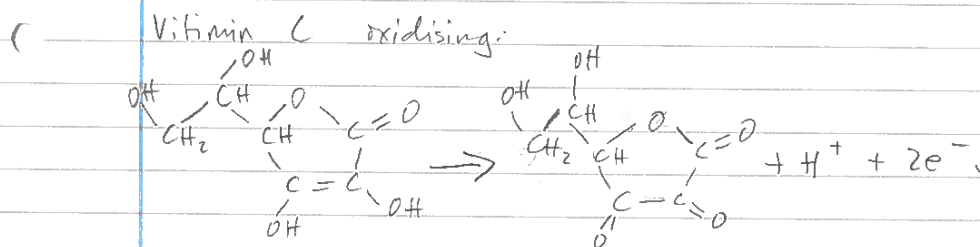


Candidate evidence

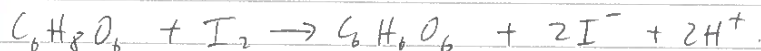
Title: Vitamin C Concentration in Orange Juice.

Aim: To determine the concentration of vitamin C in different orange juices.

Underlying Chemistry: Vitamin C is an example of an antioxidant. Antioxidants are often added to foods to prevent them from oxidising (spoiling). This happens as the antioxidant oxidises, instead of the food - so stopping the food from oxidising.



(When vitamin C reacts with iodine, it is termed a redox reaction, a redox reaction is one in which oxidation and reduction both take place.



The vitamin C loses two electrons, so is oxidised, and the iodine gains two electrons, so is reduced. In this reaction, vitamin C is the reducing agent - it 'gives' electrons to iodine. The iodine is the oxidising agent - it 'accepts' electrons from the vitamin C.

A titration is used to accurately calculate the concentration of a solution. To do this, the unknown solution is reacted with a solution of known concentration. A precise volume of the unknown solution is transferred to a conical flask using a pipette, and small volumes of the known solution are added until the reaction is complete. A burette is used to add precise volumes of the known solution and an indicator (i.e. colour change) is used to determine the end-point of the reaction. From the reaction's equation, the concentration of the unknown solution can be calculated.

Method: Add the orange juice and some starch to a conical flask, and titrate with iodine until a blue-black colour is seen. As iodine is a strong dye, gloves were worn to prevent hands from getting stained.

Data from Tesco: orange juice smooth (from concentrate).

by Experiment:

Volume of iodine	rough	1	2	3	4	5
start volume (cm ³)	0.0	11.3	24.2	35.0	46.4	57.7
end volume (cm ³)	11.3	24.2	35.0	46.3	57.3	68.7
titre (cm ³)	11.3	12.9	10.8	11.3	11.0	11.0

The Grower's Harvest: orange juice smooth (from concentrate).

Volume of iodine	rough	1	2	3	4
start volume (cm ³)	21.2	32.0	42.8	53.6	64.4
end volume (cm ³)	32.9	44.5	56.1	67.7	79.3
titre (cm ³)	11.7	11.5	11.3	11.1	11.0

Tesco: orange juice smooth (not from concentrate).

Volume of iodine	rough	1	2	3	4
start volume (cm ³)	31.2	5.6	15.0	24.4	35.3
end volume (cm ³)	40.7	15.0	24.9	35.3	45.4
titre (cm ³)	9.5	9.4	9.9	10.4	10.1

My Results:	Type of orange juice	average titre (cm ³)	concentration of vitamin C (mg/100ml)
(Tesco: orange juice smooth (from concentrate).	11.35	49.9
	The Grower's Harvest: orange juice smooth (from concentrate)	9.9	43.6
	Tesco: orange juice smooth (not from concentrate).	10.0	44.0

Sample calculation for - Tesco: orange juice smooth (from concentrate).

$$\begin{aligned} \text{average titre} &= \frac{11.3 + 11.4}{2} \\ &= \underline{\underline{11.35 \text{ cm}^3}} \end{aligned}$$

Volume of orange juice used: 10 cm³

concentration of iodine used: 0.0025 mol l⁻¹.

Volume of iodine used: 11.35 cm³.
= 0.01135 L

$$n = CV$$

$$= 0.0025 \times 0.01135$$

$$= \underline{\underline{0.00028375 \text{ mol}}} \leftarrow \text{moles of iodine used,}$$

As, 1 mol of iodine = 1 mol of vitamin C.

0.00028375 mol of iodine = 0.00028375 mol of vitamin C

$$n = \frac{m}{\text{GFM}}$$

GFM of vitamin C = 176g

$$0.000028375 = \frac{m}{176}$$

$$m = 0.004994g \leftarrow \text{mass of vitamin C in } 10\text{cm}^3$$

$$\begin{aligned} \text{Concentration} &= 0.004994g/10\text{cm}^3 \\ &= 0.004994g/10\text{ml} \\ &= 0.04994g/100\text{ml} \\ &= \underline{49.94\text{mg}/100\text{ml}} \end{aligned}$$

internet
source:

Testo: orange juice smooth (from concentrate):

Typical Values	Per 100ml	One glass (150ml)
Energy	199kJ / 47kcal	299kJ / 70kcal
Fat	0.0g	0.0g
Saturates	<0.1g	<0.1g
Carbohydrate	10.5g	15.8g
Sugars	10.5g	15.8g
Fibre	0.0g	0.0g
Protein	0.5g	0.8g
Salt	<0.01g	<0.01g
Vitamin C	25mg (31%NRV)	38mg (48%NRV)
* Reference intake of an average adult (8400 kJ / 2000 kcal)	-	-
As sold	-	-

(1)

The Grower's Harvest: orange juice smooth (from concentrate):

Typical Values	Per 100ml	Per 150ml
Energy	199kJ / 47kcal	298kJ / 70kcal
Fat	<0.1g	<0.1g
Saturates	<0.1g	<0.1g
Carbohydrate	10.5g	15.8g
Sugars	10.5g	15.8g
Fibre	<0.1g	<0.1g
Protein	0.5g	0.8g
Salt	<0.01g	<0.01g
Vitamin C	25.0mg (31%NRV)	37.5mg (47%NRV)
* Reference intake of an average adult (8400 kJ / 2000 kcal)	-	-
As sold	-	-

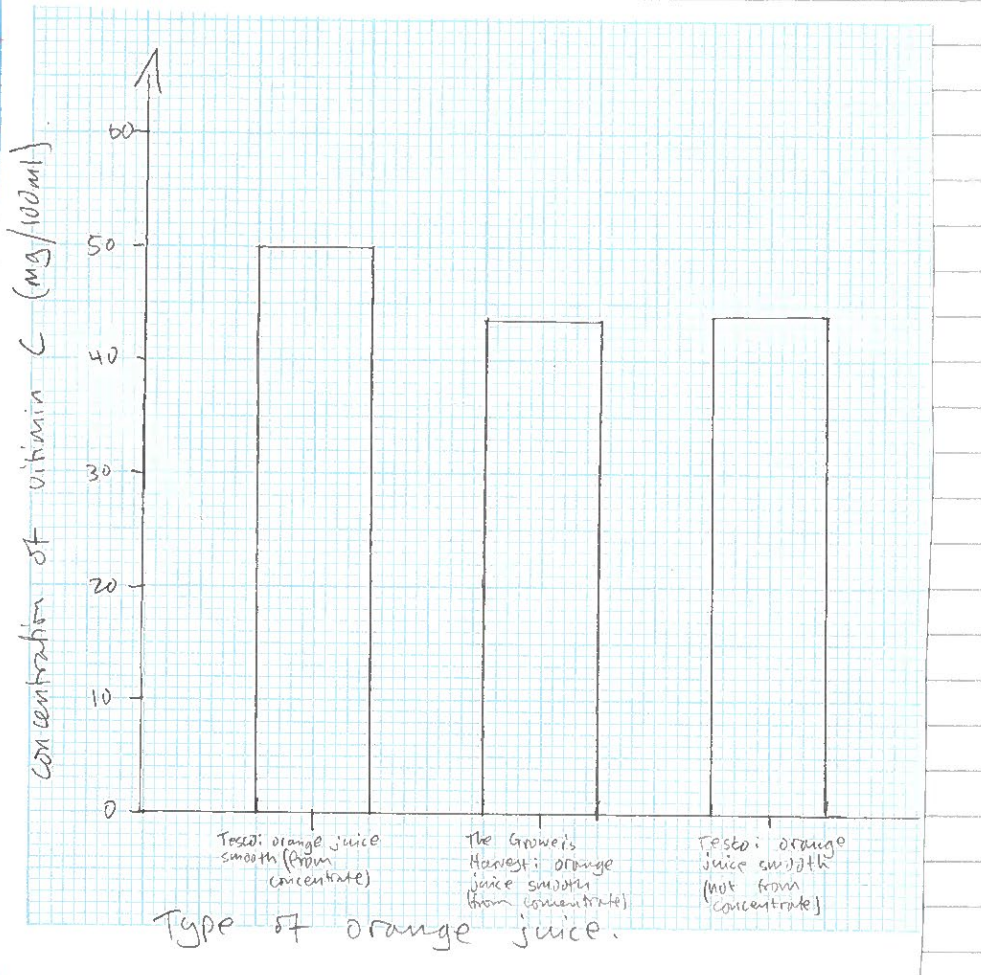
(2)

Tesco: orange juice smooth (not from concentrate):

Typical Values	Per 100g / Per 100ml	A serving contains
Energy	181kJ / 43kcal	272kJ / 64kcal
Fat	0g	0g
Saturates	0g	0g
Carbohydrate	10.0g	15.0g
Sugars	10.0g	15.0g
Fibre	0.1g	0.2g
Protein	0.6g	0.9g
Salt	<0.01g	<0.01g
Vitamin C	28mg (35%NRV)	42mg (53%NRV)
* Reference intake of an average adult (8400 kJ / 2000 kcal)	-	-

(3)

Graph:



Analysis:

Type of orange juice	Vitamin C concentration (mg/100ml)	
	my results	internet source
Tesco: orange juice smooth (from concentrate)	49.4	25
The Grower's harvest: orange juice smooth (from concentrate)	43.6	25
Tesco: orange juice smooth (not from concentrate)	44.0	28

Table to easily compare my results with the internet source.

All of my results are higher than the internet source's values. The internet source's values for 'Tesco: orange juice smooth (from concentrate)' and 'The Grower's Harvest: orange juice smooth (from concentrate)' are the same, both have a vitamin C concentration of 25 mg/100ml. My results, however, have two different values for the vitamin C concentration in those juices, 49.9 mg/100ml for 'Tesco: orange juice smooth (from concentrate)' and 43.6 mg/100ml for 'The Grower's Harvest: orange juice smooth (from concentrate)'. The internet source's results show that 'Tesco: orange juice smooth (not from concentrate)' has a higher vitamin C concentration than the other two juices, at 28 mg/100ml. My results, however, show the vitamin C concentration for 'Tesco: orange juice smooth (not from concentrate)' to be 43.6 mg/100ml, very similar to 'The Grower's Harvest: orange juice smooth (from concentrate)'.

Conclusion: As my results and the internet source's values are quite different and show no correlation, no conclusion can be drawn about the concentration of vitamin C in the different orange juices.

Evaluation: The internet source is reliable, because all food must comply with strict food standards, so any information about a food product must be very accurate. The internet source's values will have been calculated by food scientists, to a high degree of accuracy and reliability.

All of my results were different (much

higher) than the internet source's values. This could be due to the colour change (starch indicator - turns blue-black) being difficult to see. As the orange^{juice} was a deep orange colour, it was hard to pin-point the exact moment the colour change occurred so making my results less accurate. To combat this, I could make a standard solution of the orange juice, so diluting it and making the orange colour less intense. This would make it easier to pin-point precisely when the colour change occurred - improving the accuracy of my results.

The internet source states that the values for Vitamin C concentration are 'typical values' (i.e. an average value taken from several samples). To improve the accuracy of my results (similar to the internet source), I could carry out a titration on a few bottles of the same orange juice and take an average of the Vitamin C concentration.

- References:
- 1: <https://www.tesco.com/groceries/en-GB/products/254859516>, accessed on 15/01/20.
 - 2: <https://www.tesco.com/groceries/en-GB/products/300474469>, accessed on 15/01/20.
 - 3: <https://www.tesco.com/groceries/en-GB/products/255595843>, accessed on 15/01/20.