Evaluation of Orange Peel Oil Oxygen Absorption and Sensory Freshness

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Introduction

Flavoring oils, commonly called essential oils, are extracted and concentrated from many types of plant materials to be used as a flavoring ingredient in food products. However, oxidation of the oil will cause the flavor profile to change due to the decomposition and the formation of off flavor compounds. Oxidation can be caused by the presence of enzymes, light, or oxygen. This experiment looks at determining how much oxygen is required to change the flavor profile of orange oil from a fresh state.

Procedure

Warburg Apparatus Analysis for Determining Oxygen Absorption

Calibration
The Warburg apparatus, pictured to the right, was filled with water to determine the total volume of the system. The manometer marking volume was determined by measuring water weight differences between markings and converting weight to volume using water density at 23°C.

Measurement
A flask containing 2.133 g of orange oil was attached to the Warburg apparatus. The attached flask then was placed in a 40°C water bath for a 3 day period. Over that period, the mercury height difference was recorded and the stopcock was opened, replenishing oxygen, on a daily basis.

Calculation
The mercury height measures pressure differences which can be related to the oxygen absorption with the equation below:

$$X = HK = H\left(\frac{(TV - SV) \cdot T_0 \cdot 10^3}{P_o \cdot T}\right)$$

Where X is the oxygen absorbed (μL), H is the mercury height change (mm), TV is the total volume and SV is the sample volume (cm³), To is the Standard Temperature (K), Po is the Standard Pressure (mmHg), T is the bath temperature (K).[1]

R-Index Evaluation of Freshness

Sample Preparation
Orange oil was incubated for 1, 2, 3, and 6 days in a 40°C water bath. The fresh and aged oils were diluted to 200 ppm in water.

Testing
Eighteen panelists were asked to smell, then taste, the fresh and aged orange oil samples. They rated the samples as fresh or unfresh and if they were sure or unsure.
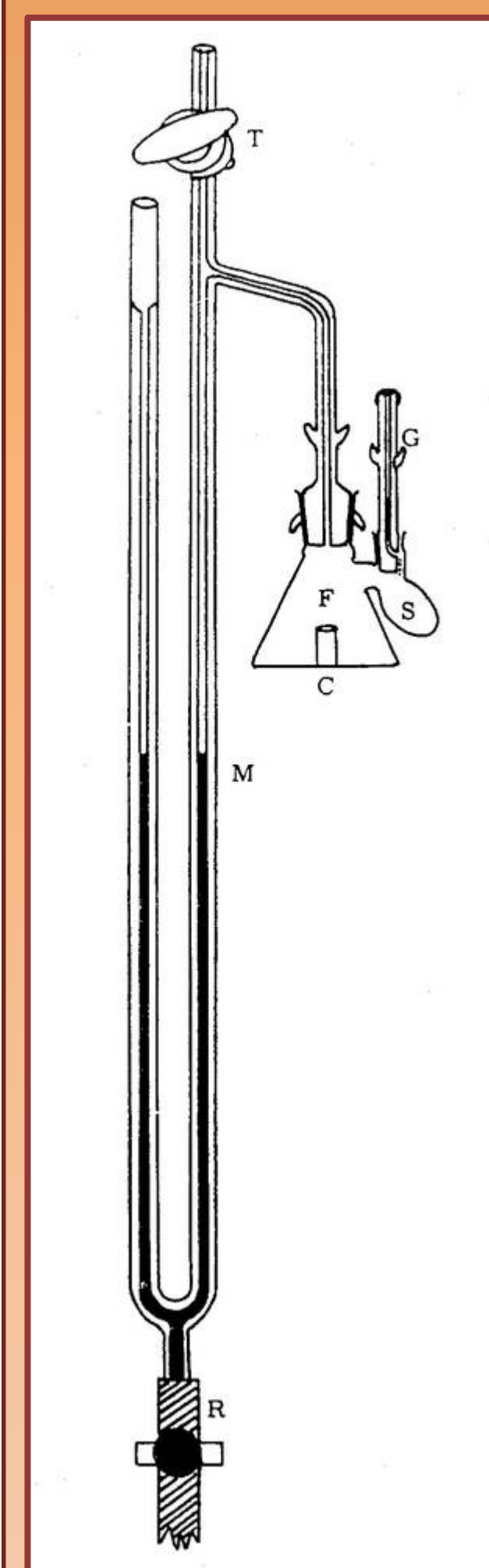

Figure 1. The Warburg apparatus consists of a mercury containing manometer and a side arm which attaches to a flask.[2]

Results
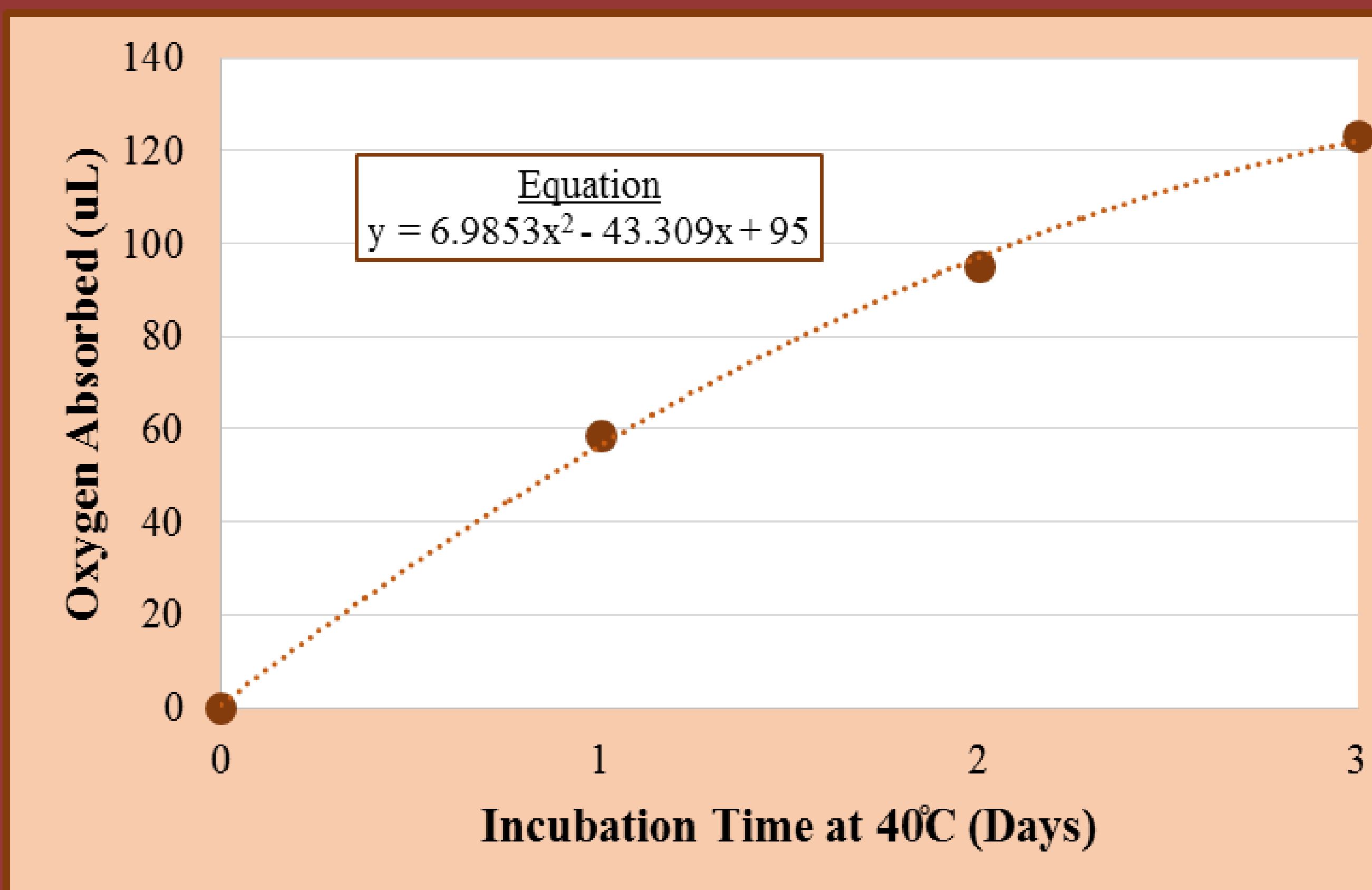

Equation
$y = 6.9853x^2 - 43.309x + 95$

Figure 2. Oxygen Absorbed by Orange Oil at 40°C Determined using a Warburg Apparatus
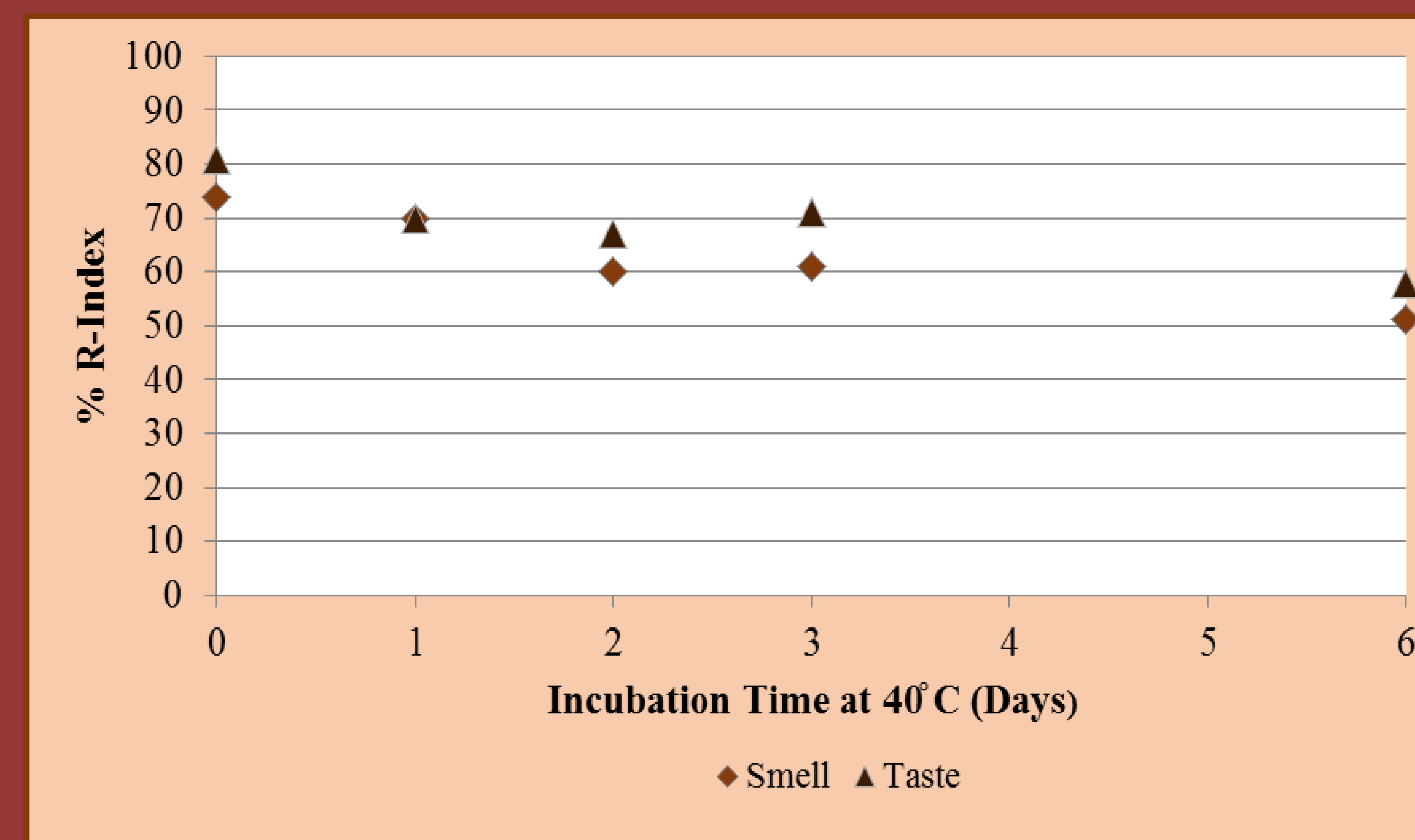

Figure 3. The Effect of Time on the Freshness of Orange Oil as Determined by a Sensory Panel [3]

Conclusion

One hundred fifteen μL of oxygen were absorbed by a 2.133 g sample of orange oil over the course of 3 days. One apparatus failed to measure pressure difference, so only one set of data was used. In literature, plots of oxygen consumption over time of storage have been exponential.[4] The observed decrease may be due to a depletion in oxygen within the apparatus. The sensory panelists found it harder to detect fresh flavors as the oils became more aged. An R-index of 100% indicates the panelists were sure the samples were fresh. The panelists had a hard time identifying the fresh sample possibly due to an unskilled pallet or the samples were too diluted to detect differences. No exact time can be identified as the oil becoming spoiled.

Limitations

There was limited opportunity to replenish the oxygen in the Warburg apparatus. Unfortunately, the oxygen could only be replenished once a day due to schedule conflicts which limited the oxygen supply. The orange oil samples were too dilute for some panelists to detect differences, but a higher concentration of oil would have caused dispersibility issues in the water.

Future Experiments

Manometers will be checked more frequently in the beginning of the experiment and air will be pushed through the system to ensure oxygen is not a limiting factor. Sensory panelists will be better trained in detecting flavor differences between oils. A wider range of samples should be tested over the coarse of several panel sessions to better identify a time where the freshness begins to degrade.

Works Cited
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