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**Research Article**

# Electrical transport in three different citrus fruit juices; bitter Lemon, Grape and sweet Orange

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***ABSTRACT***

*The electrical properties of three different citrus fruit juices (i.e bitter lemon, grape and sweet orange) were investigated at electric field values 0.05-3.00 V/m. Fresh and certified ripe samples of the fruits were obtained and the juices extracted using suitable juice extractor. The current through the samples were found to increase gradually with voltage from minimum to maximum values. A small current through all the samples at low voltages below a critical point (i.e. decomposition potential) was observed in all the samples. The averaged decomposition potentials for the three samples were 0.56 V, 0.45 V and 0.30 V for bitter lemon, grape and sweet orange juices. The conductances of the three samples were also found to increase with increase in volume. This is an indication that the concentration of the samples increases with increase in volume. The sweet orange sample had the highest value of the decomposition potential, followed closely by grape orange, while bitter orange had the least conductance. However, the bitter orange had the highest range of conductance followed by sweet orange and then, grape juice.*

**Keywords:** Citrus juices, current- voltage, conductance, decomposition potential.

## INTRODUCTION

The significance of seedless fruits in the society had called for numerous researches for their adaptation in various facets of life. The uses of these juices range from food supplements and the preparation of portions, to recent discovery of the ability of some in the generation of several milivolts for domestic uses.

Varieties of research had been carried out on fruit juices with interesting challenges to scientist all over the world. The effects of temperature and total solid content on the thermal conductivity of some liquid food samples were investigated with the liquid foods of total solid content between 10-60% measured by a transient heat flow method using twin probes at temperatures ranging from 10-50$^{o}$C [1]. The result of the investigation showed that the thermal conductivity of the samples could be represented as a function of both temperature and total solid content. The observed values were also found to compare favourably with values obtained using standard structural models for thermal conductivity. The electrical conductivity of apple and sour juice concentrates having 20-60% soluble solids were investigated with the solution chemically heated by applying five different voltage gradient (20-60V/m) [2]. The electrical conductivity relations depending on temperature, voltage gradient and concentration were obtained, which were significantly affected by temperature and concentration.

Studies have been carried out on some variety of seedless quava juices as affected by temperature and concentration [3; 4; 5; 6; 7; 8; 9; 10]. These investigations revealed that the apparent viscosity and density decreased with increase in temperature while the heat capacity increases as the concentration increased.

Recently, rapid and quantitative determination of sodium monofluoroacetate in dilute fruit juices and tap water was performed by using microchips contact less conductivity detection [11]. A separation buffer consisting of 20 mM citric acid and histidine at pH 3.5 enabled the detection of the monofluoroacetate (MFA) anion in diluted apple juice, cram berry juice and orange juice without lengthy sample pretreatments. The calibration curves for MFA in diluted juices were linear over the range of 500 microg/L-50 mg/L. The total analysis time for detecting the MFA anion in fruit juices was less than 5 minutes, which represents a considerable reduction in analysis time compared with other analytical methods currently used in food analysis. Other thermal and thermoelectric predictions on various juice materials had also been made. Details can be found in the literatures [12; 13; 14; 15; 16]. Studies on the conductance and electrolytic decomposition potential of lime juice [17] showed that the conductance of the juice increased with increase in volume/concentration. The electrolytic decomposition potential was also found to be 0.91V.

Despite the numerous uses of the varieties of citrus juices, their electrical characteristics in relation to the consumption and application in daily life are yet to be harnessed to ascertain their implications in various uses. It is the aim of this research to investigate the conductivities of different types of citrus fruits commonly found and consumed in the immediate environment of the research.

## MATERIALS AND METHOD

The materials as well as the method adopted in this research are similar to those adopted in previous study [17]. In particular, the lime and grape juices used in the study were obtained from certified ripe samples of each type, with the juices extracted using appropriate juice extractor. The sieved juices were poured into a graduated beaker and current-voltage characteristics measured with the aid of a digital multimeter/voltmeter (MPA 201-type) following the procedure in the study [17]. Measurements were recorded within thirty minutes of extraction of the juice. This was done to reduce the effect of fermentation as a result of the exposure of the juice to air. The pH values of the samples were also determined with the aid of an appropriate pH meter in order to ascertain their conformity with the standard values.

## RESULTS AND DISCUSSION

The measured pH values for the samples are 3.60, 3.35 and 2.50 for bitter lemon, grape and sweet orange juices respectively. These are in agreement with the standard values for the materials.

The results of the current-voltage characteristics for the three samples are shown in figures 1, 2 and 3 at voltage range 0.05-3.00 V varied over volumes 0.5 CC-5.0 CC. The current in all the three samples increases gradually with voltage from minimum to maximum values. A small current through all the samples at low voltages below a critical point (i.e. decomposition potential) was observed in all the samples. This situation prevails until it suddenly increases and then becomes linear. The small current below the decomposition potential is attributed to the product of electrolysis deposited at the electrodes which invariably tend to diffuse slowly back into the solution. To account for the small loss by diffusion, a small current need to pass through the solution to compensate for the lost material. Since the diffusion is continuous, the current flow must also be continuous, hence, the small, steady current observed below the decomposition potential.

Table 1 shows the values of the decomposition potentials and the conductance of the three samples at different volumes. The averaged decomposition potentials for the three samples were 0.56 V, 0.45 V and 0.30 V for bitter lemon, grape and sweet orange juices. The conductances of the samples were also found to increase with increase in volume. This indicates that the concentration of the samples increases with increase in volume. The sweet orange sample had the highest value of the decomposition potential, followed closely by grape orange, while bitter orange had the least conductance. However, the bitter orange had the highest range of conductance followed by sweet orange and then, grape juice.

## SUMMARY AND CONCLUSION

Fuit juices have significance uses in everyday life. Its uses include among other the generation of several milivolts for domestic uses, as food supplements and making potions in some African societies. The averaged decomposition potentials for the three samples were

0.56 V, 0.45 V and 0.30 V indicate that the sample can be used to generate low voltages in the laboratory especially for the determination of the characteristics of microbial activities in response to charged environments. The conductance of the samples was also found to increase with increase in volume, an indication that the concentration of the samples increases with increase in volume.

**Table 1:** Decomposition potentials (V) and the Conductance ($\Omega^{-1}$) for different volumes of the samples.

| Volume (CC) | Bitter Orange | | Grape | | Sweet Orange | |
|---|---|---|---|---|---|---|
| | Decomposition Potential (V) | Conductance ($\Omega^{-1}$) | Decomposition Potential (V) | Conductance ($\Omega^{-1}$) | Decomposition Potential (V) | Conductance ($\Omega^{-1}$) |
| 0.5 | 0.56 | 0.52 | 0.45 | 0.13 | 0.30 | 0.10 |
| 1.0 | 0.55 | 0.53 | 0.44 | 0.13 | 0.30 | 0.12 |
| 1.5 | 0.56 | 0.55 | 0.45 | 0.14 | 0.29 | 0.14 |
| 2.0 | 0.56 | 0.57 | 0.45 | 0.15 | 0.31 | 0.15 |
| 2.5 | 0.54 | 0.59 | 0.46 | 0.15 | 0.30 | 0.17 |
| 3.0 | 0.56 | 0.59 | 0.45 | 0.16 | 0.30 | 0.19 |
| 3.5 | 0.56 | 0.60 | 0.45 | 0.17 | 0.30 | 0.19 |
| 4.0 | 0.57 | 0.61 | 0.44 | 0.19 | 0.31 | 0.20 |
| 4.5 | 0.56 | 0.62 | 0.45 | 0.23 | 0.30 | 0.21 |
| 5.0 | 0.56 | 0.65 | 0.45 | 0.26 | 0.30 | 0.24 |

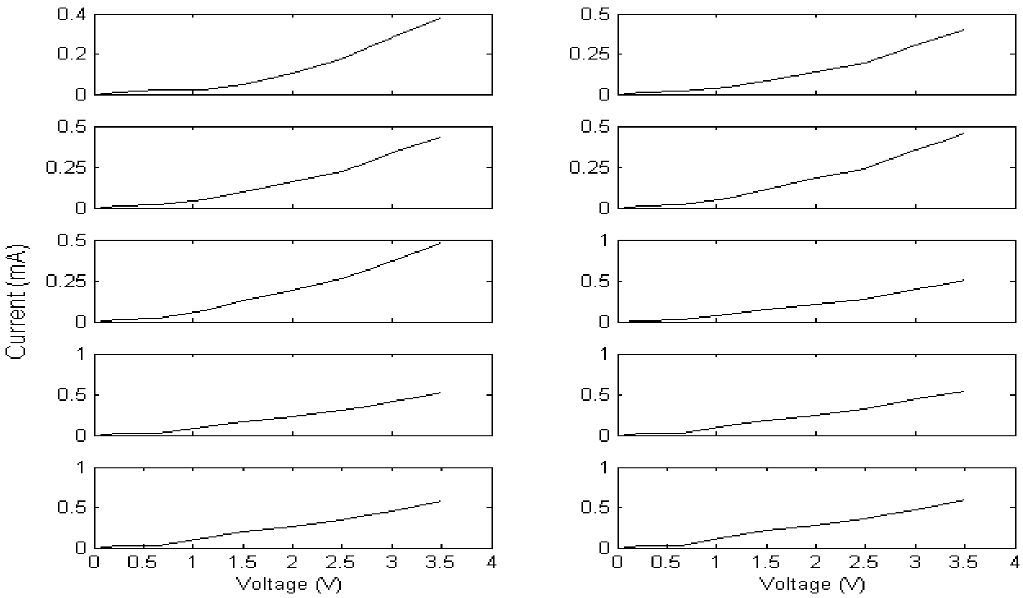

Figure 1: Voltage-Current Characteristic for Bitter Lemon

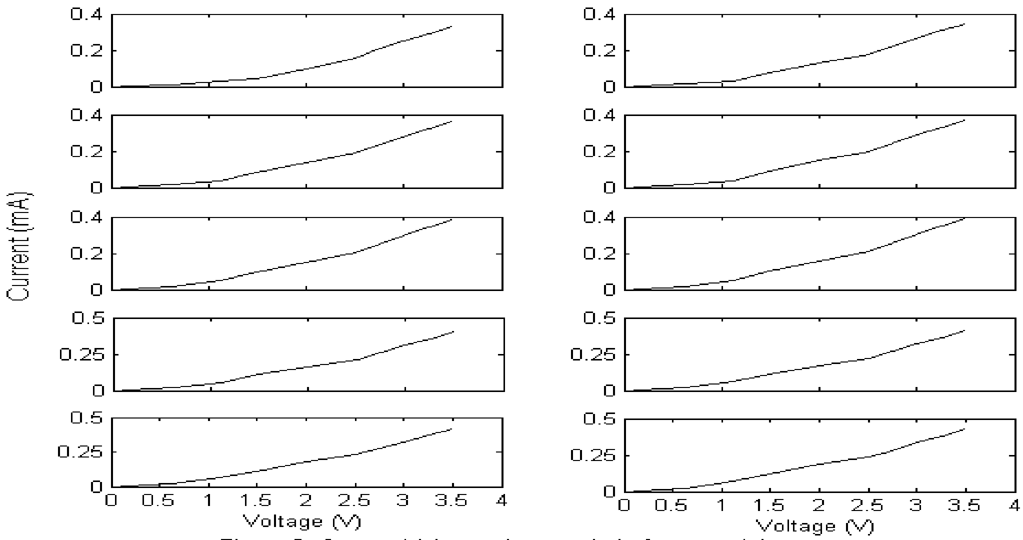


Figure 2: Current-Voltage characteristic for grape juice

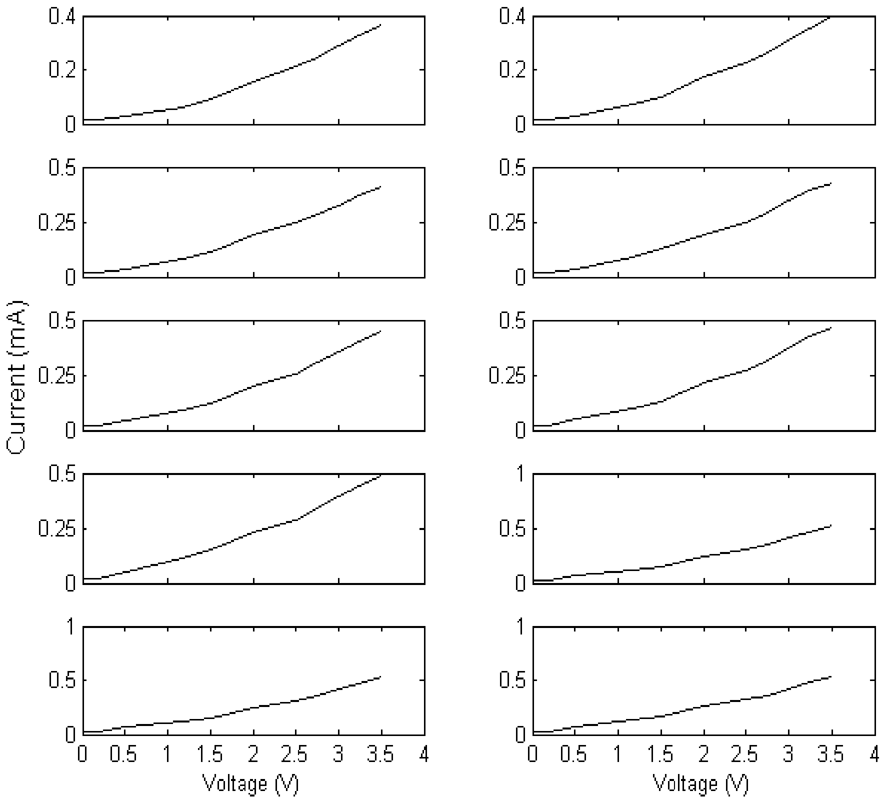


Figure 3: Current-Voltage characteristi for sweet orange3

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