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Nutritional Electric Parameter Associated with Physiochemical Changes in Bottle Gourd (*Lagenaria siceraria*) Fruit

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Abstract
A comprehensive study was conducted to understand the biophysical and biochemical changes in bottle gourd (*Lagenaria siceraria*) fruit under different storage conditions. We report for the first time these changes manifested as a varying Nutritional Electric Parameter (NEP), measured using a self-designed Digital Bimetallic Potentiometer (DBPM). A group of bottle gourds was monitored over a 9-day period under refrigerated (20°C) and ambient room temperature (27°C) regimes. The results indicate that the transportation of electric charges, found in the form of mineral clusters and chemical compositions such as vitamins and carbohydrates, vary significantly with thermal stress. Under ambient conditions, the fruit exhibited a more rapid decline in cellular integrity, while refrigerated samples showed higher stability in NEP values, suggesting that low-temperature storage effectively preserves the mobility of ionic clusters and the overall nutritional status of the fruit.

Keyword: Nutritional Electric Parameter (NEP), Mobility, Digital Bimetallic Potentiometer, Cluster, Elemental Charges, Bottle Gourd (*Lagenaria siceraria*).

Introduction

In India, bottle gourd (*Lagenaria siceraria*), commonly known as lauki, is a versatile and highly nutritious vegetable belonging to the Cucurbitaceae family. It is cultivated extensively in subtropical regions across Asia, Africa, and the Americas, with India being a preeminent global producer. The fruit is a staple in South Asian cuisines and holds significant value in Ayurvedic medicine due to its anti-inflammatory, antimicrobial, and antioxidant properties.

Bottle gourd is characterized by a high-water content (92%–96%), making it an ideal medium for studying the "electrome"—the collection of electrical signals produced by ionic transport. It contains essential minerals such as Potassium (87 mg), Sodium, and Iron, alongside bioactive compounds like Vitamin C (10–13 mg) and triterpenoids known as cucurbitacin. As the fruit matures or undergoes post-harvest senescence, its biophysical properties—such as pulp firmness and acidity—change, directly impacting the mobility of its internal ionic clusters.

While previous studies have explored the biochemical profile of *Lagenaria siceraria*, the variation of mineral electric charges as a function of storage temperature remains a significant research gap. This study utilizes the Nutritional Electric Parameter (NEP) to fill this gap, providing a quantitative measure of physiochemical stability during storage.

Materials and Methods

The experimental group consisted of bottle gourds procured from local markets and subjected to two storage regimes: refrigerated (20 °C) and ambient (27 °C). Observations were recorded daily for nine days using a self-designed Digital Bimetallic Potentiometer (DBPM).

The value of NEP represents electrical charges of the cluster of elemental minerals transported per unit dielectric constant in the sample of a *Lagenaria siceraria* and reveals the mechanism how the nutritional electric charge transportation changes day to day at different controlled temperature.

DBPM was designed using two wires of copper and aluminum as shown in figure -1. Both wires of length 10 cm, diameter of 2 mm, were kept apart at 1 cm, with the help of two rubber blocks. (Jaaffrey *et al*., 2025) [1]

The sharp ends of both wires are pricked deep inside Bottle gourd to obtain in meter d.c. potential difference which is generated by the group of elemental electric charges transported under the dielectric properties of the matter contained in our sample (Bottle gourd). In principle Copper and Aluminium metal wires have different electron densities between them in their conduction band and thus develop an electric field ($-\frac{dV}{dx}$) as a differential function of distance (x) with in gap (d). In fact, this electric field mobilizes the clusters of electric charges (ne) of Bottle gourd available in the form of free ions (transferring of electrons among atoms or molecules of vitamins, carbohydrate, minerals, metallic compounds etc. in sample). Equation according to electrostatics may be written as,

$$-\frac{dV}{dx} = \frac{ne}{4\pi\varepsilon k x^2}$$

Where, dv = potential difference between two wires, ε = Electric permittivity in vacuum and k= Dielectric constant of *Lagenaria siceraria*.

In order to look for effective and collective mobilities of cluster of electric charge in sample system we need integration of the entire potential difference dv. On integration with respect to ‘x’ under the limits between ‘d’ and ∞= Infinity, we get as

$$-\int_0^V dV = \frac{ne}{4\pi\varepsilon k}\int_\infty^d \frac{dx}{x^2}$$

Or

$$-V = \frac{ne}{4\pi\varepsilon k}\left[-\left(\frac{1}{x}\right)\Big|_\infty^d\right]$$

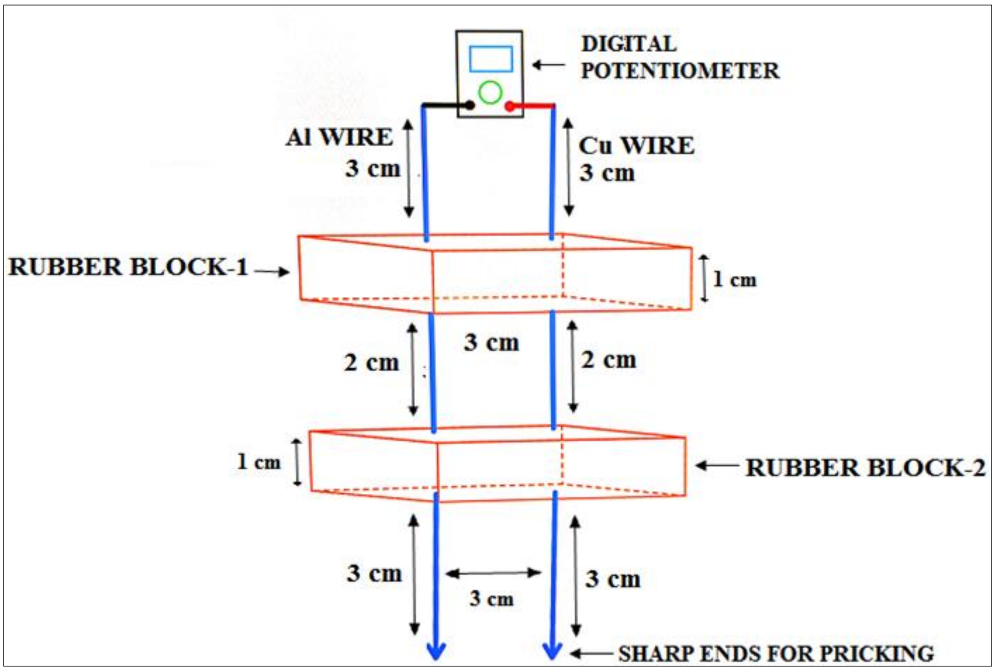

Fig 1: Rudimental labelled diagram of Digital Bi-metallic Potentio-Meter (DBPM).

Now total measurable potential voltage becomes,

$$V = \frac{ne}{4\pi\varepsilon k d}$$

As matter of fact, the, different clusters of electronic charges transported per unit dielectric constant of study sample may be written as

$$\frac{n}{k} = \frac{V(4\pi\varepsilon d)}{e}$$

Where physical quantity, $\frac{n}{k}$ is called Nutritional Electric Parameter (NEP) measured in the physical unit of “different clusters of electric charge transported to per dielectric constant”. More the value of $\frac{n}{k}$ more is the electrical nutrition value and vice-versa. It unravels fruits to be energy packed cellular system.

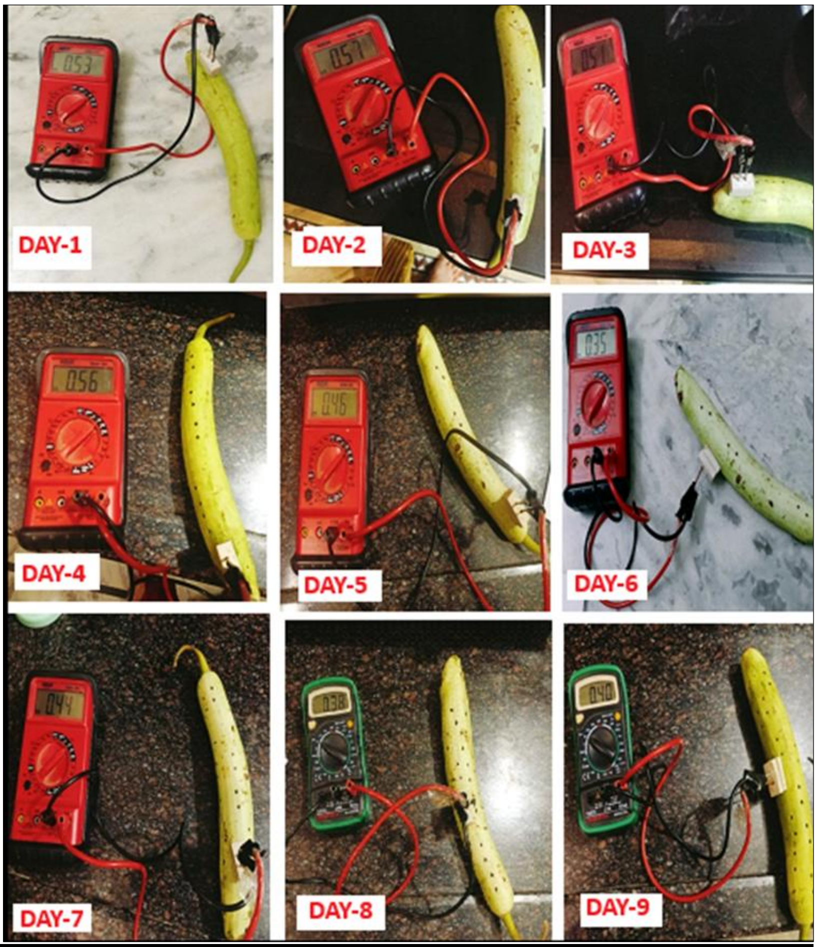

Fig 2: In fridge, Lauki (*Lagenaria siceraria)* was kept for 9 days under observation at constant regulated temperature of 20^{o} C.

Fig 3: Out of fridge, the Lauki (*Lagenaria siceraria*) was under observation for 9 days at room temperature (almost constant) of 27^{o}C in the month of October.

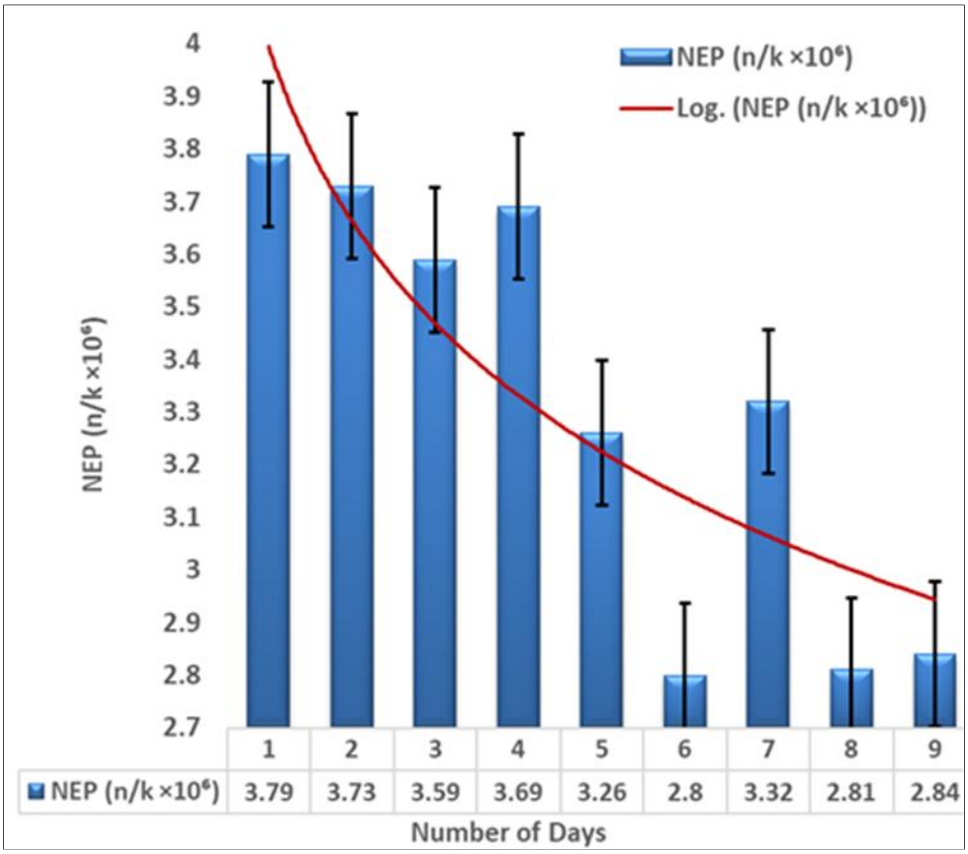

Fig 4: In fridge, 9 days measured voltage by DBPM for Lauki (*Lagenaria siceraria).*

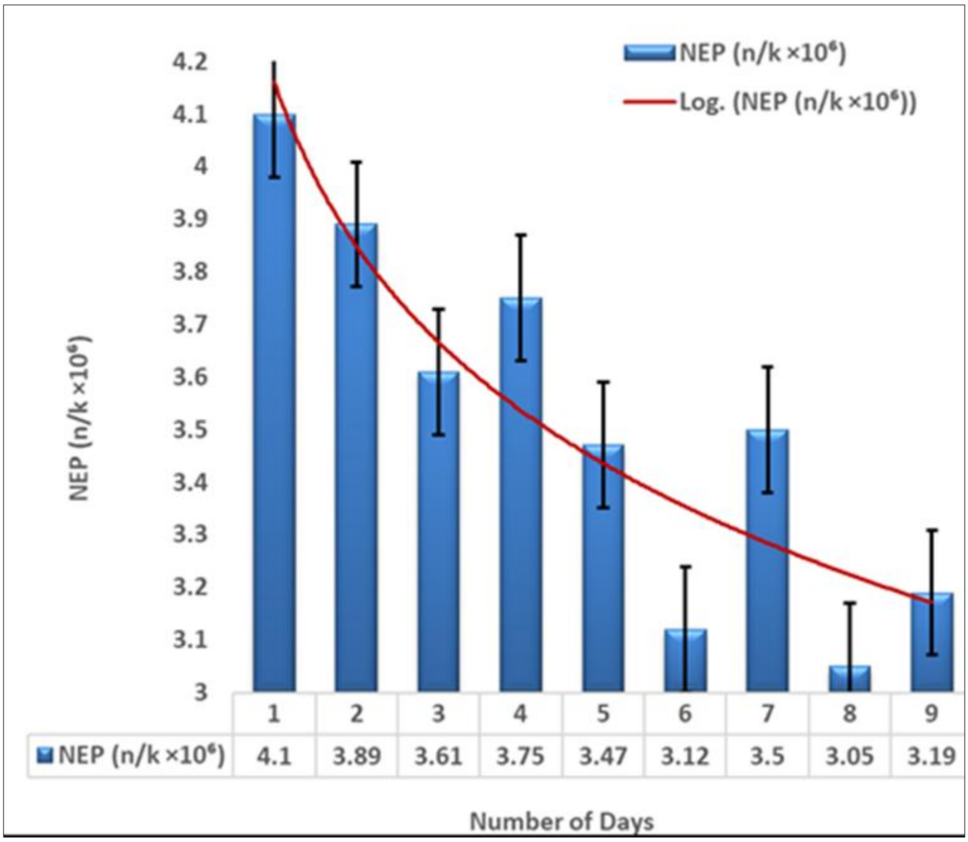

Fig 5: Out of fridge, 9 days measured voltage by DBPM for Lauki (*Lagenaria siceraria).*

Theoretical Framework

The working principle of the DBPM is based on the different electron densities in the conduction bands of the bimetals, which develop an electric field (-dV/dx) across the fruit's dielectric matter. According to electrostatics:

$-dV/dx = ne / (4\pi\varepsilon k x^{2})$

Where:

- V= Potential difference
- n = Number of clusters of electronic charges

- e = Elemental charge (1.6 \times 10^{-19}C)
- ε = Electric permittivity in vacuum
- k = Dielectric constant of the fruit cellular tissue

By integrating between the distance (d) and infinity, the measured voltage is expressed as:

V = ne / (4$\pi\varepsilon$kd)

The Nutritional Electric Parameter (NEP), defined as the clusters of electric charge transported per unit dielectric constant (n/k), is derived as:

n/k = (V(4$\pi\varepsilon$d)) / e

For this study, the constant (4$\pi\varepsilon$ d/e) in MKS units is estimated to be 6.94 times 10^{6}.

Data analysis and Results:

The measured potential differences '**V**' has been analyzed using computer software "Origin" after simplifying formula of NEP (Nutrition Electric Parameter) of *Lagenaria siceraria* sample as

$$\frac{n}{k} = \frac{(4\pi\varepsilon d)V}{e} = 6.94\text{x}10^6 \text{ v}$$

Where constant ($\frac{4\pi\varepsilon d}{e}$) value in MKS system is computed to be $6.94\text{x}10^6$.

The computed values of NEP from the measurement of potential difference 'V' can further be justified by another formulation with regards to different mobile atomic clusters carrying electric changes present with the minerals and other ingredients of *Lagenaria siceraria*. Let N_i be the number of atomic clusters of different variety exist in *Lagenaria siceraria* of mass 'm' with their different atomic weights $(A.W.)_i$ and collectively give rise NEP which can be written in the form of mathematical equations as give below

$$\frac{n}{k} = \frac{emN_a}{k}\sum_{i=1}^{N}\frac{N_i}{(A.W.)_i}$$

$$= 1.46\text{x}10^5 \left(\sum_{i=1}^{N}\frac{N_i}{(A.W.)_i}\right)$$

Where 'e' ($1.6\text{x}10^{-19}$ coulomb) is multiple charges on ionic atoms, and N_a is Avogadro number ($6.02\text{x}10^{23}$ numbers of atoms per mole). The term $\sum_{i=1}^{N}\frac{N_i}{(A.W.)_i}$ represents a series summation of N_i atomic clusters of different Atomic Weights $(A.W.)_i$ available in a sample of *Lagenaria siceraria*. The value of Dielectric constant of *Lagenaria siceraria* taken to be k = 70 at 25^{o}C at frequency 10^8-10^9 Hz. (Wen-chuan, Guo *et al.*, 2007). Based upon these data, the estimated values of NEP are given in table-2 which are in good agreements with the observed value of NEP given in table-1 prove the authencity of results reported for Lauki.

Observations

Physical properties

Bottle Gourd (*lagenaria siceraria*) has apparent physical properties which can be easily measured using measuring flask, sensitive chemical balance and calliper in laboratories. A Bottle Gourd is easily available in city markets. It is delicious and consumed as food. The following physical properties are measured for each Bottle Gourd in study for our used sample. Data below show for one of the Bottle Gourd only and in analysis average values of nine Bottle Gourd have been used.

1. Volume = 254 c.c.
2. Weight = 148 gram
3. Average density = 0.582 gm/c.c.
4. Colour = light green

Physical measurements were taken daily. The bottle gourd samples typically exhibited an average density of approximately 0.58 g/c.c. and a moisture content exceeding 96%. Potential difference (V) was recorded for both storage conditions. For the refrigerated group, ten real-time data points were taken each day to compute the Mean and Standard Error.

Table 1: Bio-potential Data for Refrigerated Storage (20 °C)

Day	Mean Voltage ($\bar{x}$)	Standard Error	NEP (n/k) ($\times10^6$)
1	0.546	0.0102	3.79
2	0.538	0.0286	3.73
3	0.517	0.0142	3.59
4	0.532	0.0832	3.69
5	0.470	0.0232	3.26
6	0.403	0.0459	2.80
7	0.479	0.0311	3.32
8	0.405	0.0532	2.81
9	0.409	0.0490	2.84

Table 2: Bio-potential Data for Ambient Storage (27 °C)

Day	Observation (V)	Condition	NEP (n/k) ($\times10^6$)
1	0.59	Out of Fridge	4.1
2	0.56	Out of Fridge	3.89
3	0.52	Out of Fridge	3.61
4	0.54	Out of Fridge	3.75
5	0.50	Out of Fridge	3.47
6	0.45	Out of Fridge	3.12
7	0.46	Out of Fridge	3.19
8	0.44	Out of Fridge	3.05
9	0.46	Out of Fridge	3.19

Results and Discussion

The results indicate that the Nutritional Electric Parameter (NEP) is a sensitive indicator of the fruit's physiological state. In the refrigerated group (20°C), the NEP showed high stability for the first four days (3.79 \times 10^{6} to 3.69 \times 10^{6}) before a significant drop on Day 6 (2.80 \times 10^{6}), representing a decline in cellular activity. A variance spike on Day 4 (0.0832) suggests the onset of cellular heterogeneity and the breakdown of synchronized bio-electrical cues.

In contrast, the ambient storage group (27°C) started with a higher NEP (4.10 \times 10^{6}), likely due to increased ionic mobility at higher temperatures. however, this group experienced a steeper and more consistent decline, reaching a "senescence threshold" by Day 6. While the final voltage at Day 9 (0.46 V) appears higher than the fridge group (0.409 V), this may be attributed to moisture loss concentrating the remaining electrolytes rather than a preservation of freshness.

The decrease in NEP is critically correlated with the degradation of minerals like Potassium and Calcium, as well as the breakdown of pectin by Pectinase enzymes, which leads to tissue softening. The refrigerated environment (20°C) effectively slows metabolic respiration and the Q

{10} effect, thereby maintaining a more stable n/k value for an extended period.

Conclusion

This study confirms that the Nutritional Electric Parameter (NEP) measured via DBPM serves as an objective bio-electrical impedance marker for assessing the freshness and nutritional status of *Lagenaria siceraria*. Refrigerated storage at 20°C significantly delays the onset of advanced senescence compared to ambient storage. For optimal nutritional value, bottle gourd should be consumed within the first four days of harvest, after which a substantial loss of bio-electrical resilience and a decline in n/k parameter (up to 25%) are observed.

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References

1. Jaaffrey SNA, Parihar S, Ranka S, Baregama S. Nutritional electric parameter associated with physiochemical changes in apple (*Malus domestica*) fruit. Indian Journal of Fundamental and Applied Life Sciences. 2025;15:30-38.
2. United States Department of Agriculture (USDA). Nutritional composition of *Lagenaria siceraria* (raw). National Nutrient Database. 2024.
3. Levin Lab. Bioelectric signaling and the transition to senescence in keratinocytes. Levin Lab Publications. 2025.
4. Kumar S, Rai PK. Standardization of different doses and durations of electric and magnetic field seed treatment on bottle gourd. Indian Journal of Applied Research. 2024.
5. Banti M. Review on electrical conductivity in food: the case of fruits and vegetables. World Journal of Food Science and Technology. 2020;4(4):80-89.
6. Hasegawa Y, *et al*. Plant physiological activity sensing by bioelectric potential measurement. Procedia Engineering. 2016;168:630-633.

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