

Electrical Conductivity and pH of Indian spices

Alekhya Kodavatiganti

Student, ISC Class 12, Delhi Public School, 36 Aroozoo Avenue, Singapore 539842

Submitted: 10-07-2021

Revised: 20-07-2021

Accepted: 23-07-2021

ABSTRACT:

Electrical conductivity of spices is shown to reflect its mineral content and calorific properties. The physiological relevance of the pH when consumed as food or medicine is discussed. Conductivity measurements were made with digital conductivity meter and pH with a pH meter. A linear relationship was found between electrical conductivity and ash content as well with calorific values. A lower pH was observed in clove among the spices selected. The calorific values and the ash content were taken from the website of spices board. Results have shown that pepper, garlic, mint, dill seeds had a higher pH values compared to the others tending to alkalinity. Dry ginger, Fennel seeds, Cumin seeds, Dill seeds, cardamom had higher electrical conductivity signifying a larger mineral content.

Key words: Conductivity, pH, spices, Ash content, calorific value

I. INTRODUCTION

Since Ancient civilization, spices have been widely used for their flavour and properties which make them important for culinary, medicinal, and other uses. Spices were one of the world's most traded product and has been continuously increasing over the years. In 2019, the global spices market was valued at about 11.5 billion U.S. dollars for the year 2019 and it is likely to surge by 3.89% CAGR from 2019 to 2025, expanding its valuation to about 14.5 billion U.S. dollars by the end of 2025 (Nils-Gerrit Wunsch). India produces almost 75 out of 109 varieties of spices listed by ISO (International Organisation for standardization) and participates in almost half of the global trading of spices making it world's largest producer, consumer, and exporter of spices. As per ITC news, the most trading spices were pepper and ginger. Among all the classified spices, saffron which is used widely in cosmetics and medicines is the most expensive spice selling for about \$6000 for a kilogram.

II. ELECTRICAL CONDUCTIVITY OF SPICES

Foods especially liquid foods are found to conduct electricity. The charge carriers in metals are electrons whereas ions are charge carriers in foods. These ions carry the charges as the mass of ions while moving along the electrical field. Electrical conductivity is determined by the concentrations and the mobility of the ions. Ingredients and temperature can affect the ion mobility. Electron hopping takes place between the ions or molecules under a strong electric field. Electrical properties are important in processing foods with Pulsed Electric Fields, Ohmic Heating, Induction Heating, Radio Frequency, and Microwave Heating. These properties are also useful in detection processing conditions or in determining the quality of foods. All the spices have high antioxidant properties and research has shown that electrical conductivity and pH values are related with antioxidant properties. Hence a measure of electrical conductivity becomes an important and a new tool which can help proper food preparation as well in medicinal preparations. The number of available hydrogen ions in a certain volume of water is indicated by the value of pH. The lower the value of pH indicates a higher antioxidant property and good electrical conductivity. pH value of 2.8 can cause an irritation on the lining of the esophagus and can lead to heartburn and stomach issues upon high consumption. Spices such as cinnamon, curry powder, ginger, mustard, and chili pepper are among the most alkaline. Several chemical compounds present in spices present antimicrobial activity and inhibit the growth of pathogens in meat and other foods and such properties make them unique and given them aroma amongst many properties.

III. REVIEW OF LITERATURE:

Phenolic compounds, flavonoids, terpenes form the base of properties and are main components of spices. For example, cinnamaldehyde in clove is related to its antibacterial activity. Cinnamaldehyde, pinene in cinnamon are responsible for its antimicrobial activity. There are a variety of phenolic compounds

which possess these properties and some of them are common among spices (Chaieb et al., 2007). Very less literature is available for the electrical conductivity and pH of spices and their dependence on antioxidant properties and hence this study is undertaken for about 17 commonly available spices at home. Review of literature shows that many studies on spices were related to the biomedical (Sobhana et al, 2000, Srinivas et al, 2003) and nutritional aspects (Singh et al 2003, Uma et al 2005) of Indian spices whereas Biophysical investigations of spices are not mostly observed and hence this study becomes relevant.

IV. EXPERIMENTAL SET UP FOR MEASUREMENTS OF ELECTRICAL CONDUCTIVITY, PH

- The spice samples selected for the study are cleaned thoroughly and made in a powder form with mortar and pestle. Aqueous solutions are

made using 25 gm of spice powders with 60 ml of water of distilled water. The solutions are filtered, and the filtered solution is used for taking observations on electrical conductivity and pH.

- The conductivity and pH are taken by yieryi TDS PH Meter PH/TDS/EC/Temperature Meter with pH accuracy of +/- 0.03 , EC with accuracy of +/- 1 % and resolution of 0.01mS/cm and temperature accuracy of +/- 0.1⁰ C and resolution of 0.1⁰C. Proper calibration was ensured for all the measurements taken. The temperature at which these values were taken was constant.
- A graph is plotted between the conductivity and calorific value as well with ash content. The values of calorific value and ash content were taken from the website of Spices board and a regression equation was given,

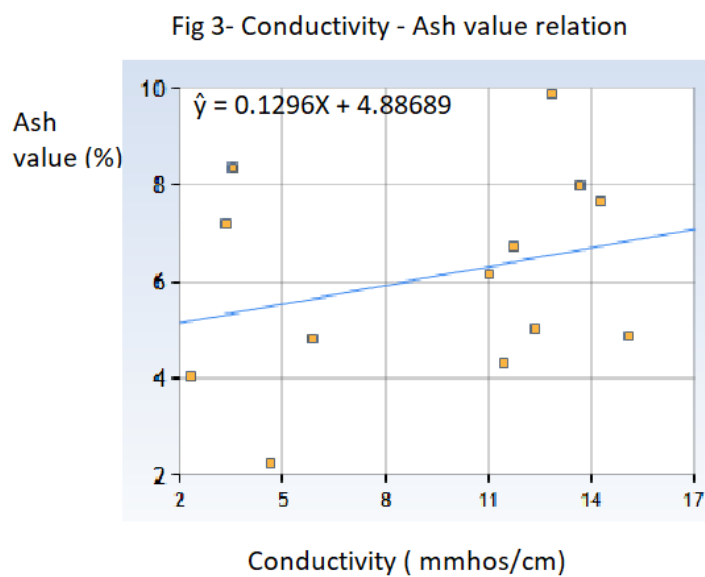
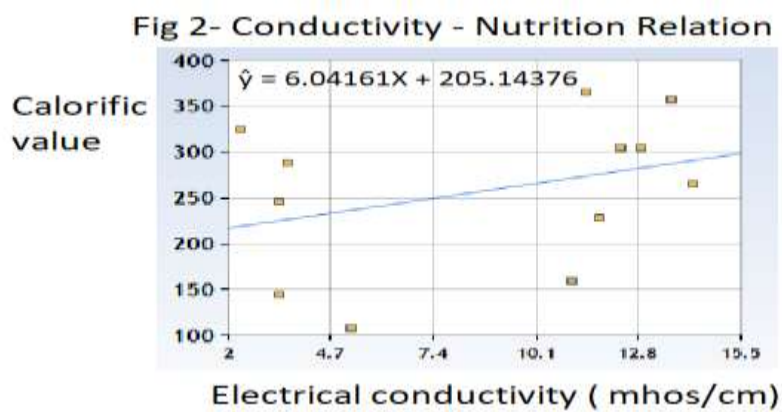
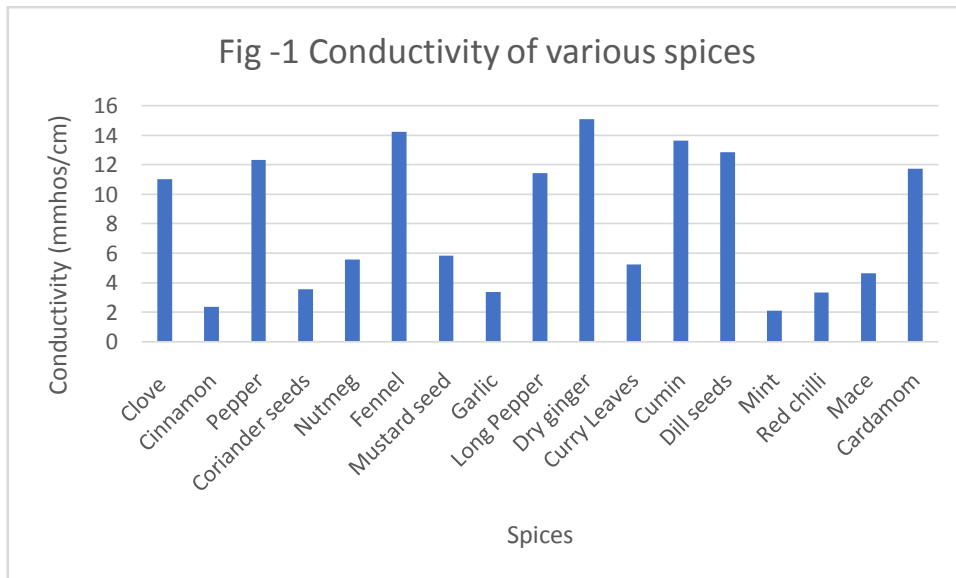
V. DATA PRESENTATION

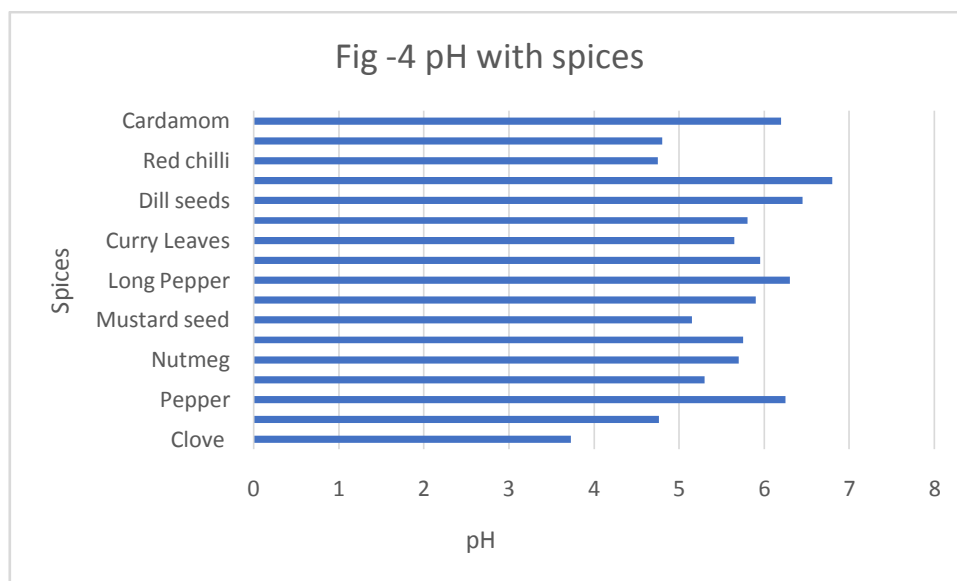
Table 1- - Common names & botanical names of common spices

Common Name	Botanical name
Basil	Ocimumbasilicum
Black pepper	Piper nigrum
Cardamon	Elattoria cardamom
Clove	Syzygiumaromatcim
Ginger	Zingiber officinales
Melegueta pepper	Aframomummelegeueta
African cardamon	Aframomumdanielli
Nutmeg	Myristica fragans
Rosemary	Rosmarinus officinalis
Pepper	Capsicum annum
Tamarind	Tamarind indica

Table 2: Spices with their observed electrical conductivity and pH values

S.No.	Spice	Electrical conductivity (mmhos/cm)	pH	Calorific value (kilo calories)	Ash content
1	Clove	11.03	3.73	159	6.15
2	Cinnamon	2.34	4.76	325	4.05
3	Pepper	12.35	6.25	304	5.03
4	Coriander seeds	3.55	5.3	288	8.35
5	Nutmeg	5.56	5.70	472	2.45
6	Fennel	14.25	5.75	265	7.68
7	Mustard seed	5.85	5.15	541	4.83
8	Garlic	3.35	5.9	145	NA
0	Long Pepper	11.43	6.3	365	4.31
10	Dry ginger	15.10	5.95	67	4.89
11	Curry Leaves	5.25	5.65	108	NA
12	Cumin	13.65	5.80	358	8.00
13	Dill seeds	12.86	6.45	305	9.88
14	Mint	2.1	6.80	48	NA
15	Red chilli	3.34	4.75	246	7.2
16	Mace	4.65	4.80	437	2.26
17	Cardamom	11.75	6.2	229	6.73





VI. RESULTS & DISCUSSION:

- Conductivity measures the water's ability to conduct electricity. Pure, distilled water is a poor conductor of electricity. Na, Cl, Ca, Mg are some of the common ions in water that conduct electric current and conductivity can also happen due to some dissolved salts and other inorganic chemicals. Sugars, oils, alcohol do not conduct electricity as they do not form ions. Hence a larger conductivity implies a larger availability of mineral content in that spice
- Apart from medicinal values and in food preparations spices like cardamom, ginger also find place in the preparation of healthy beverages. Our measurements of electrical conductivity of spice solutions were compared with their ash content and calorific values taken from spices board of India website. From Figure 1 and 2, it is observed that a linear relationship exists between electrical conductivity and ash content as well with the calorific values. Calorific values were taken from the website of spice board of India (Spice board) An electrical conductivity (K higher than 10) reflects high mineral content and high nutrition value. Table 2 shows the values of pH and conductivity values for the spices selected.
- An examination of the table reveals that clove has highest pH of 3.85 ie highly acidic among the selected spices. The pH value of food preparations and in ayurvedic medicines can be modified by suitable addition of suitable quantities of spices. For examples, asafoetida, coriander, curry leaves etc. From table 2 pepper, garlic, mint, dill seeds had a higher pH

values compared to the others tending to alkalinity. Dry ginger, Fennel seeds, Cumin seeds, Dill seeds, cardamom had higher electrical conductivity signifying a larger mineral content.

- Buddha et al (2014) has measured the electrical conductivity variation with temp for lab-squeezed juice of orange, pineapple and found a linear relation with temperature. Cristian et al (2017) have conducted experiments to study the electrical conductivity of nutrient solutions. They found that the size, yield and dietary metabolites significantly increased at the high electrical conductivity values in lycopene, ascorbic acid, and phenolic contents. They also found that the electrical conductivity is higher in organic tomatoes.
- Unal et al (2013) has studied the physical and nutritional properties of few spices particularly fennel seeds and found that their physical properties except density and rupture forces have increased with increase of moisture. Hence, we can establish that the study of physical properties, electrical properties as well chemical properties of spices should give us an good understanding about their anti-oxidant properties. Singh et al (2007) has studied that the physical properties of cumin seeds with moisture and understood that they were related to their antioxidant nature. Black pepper is mainly preferred in the powder form that invariably requires the properties of the pepper for the design of the process and grinder. The thermal properties of black pepper was investigated by Bhupendra et al (2016) over a temperature range of -45 to 5°C, while,

the breaking characteristics of the black pepper at ambient (36°C) and at a moisture content of 3.90% dry basis. These results were useful in determining the grinding temperature of cryogenic grinding of black pepper.

- Ayurveda, an ancient Indian system of medicine details the medicinal properties of all the herbs and their therapeutic values. Many experiments and research studies have established the therapeutic efficiency of these herbs and spices as they contain many active compounds. These studies are validated through the modern experimental techniques and pharmacological studies. Lemanska et al (2001) have observed that the pH dependent behaviour in spices is related to hydroxyl deprotonation resulting in increase of antioxidant potential upon formation of deprotonated forms. Maria et al (2016) have studied the effects of pH on antioxidant properties of common medicinal herbs and observed that the antioxidant activity of these plants has decreased at alkaline pH thus increasing the prooxidant activity.

VII. CONCLUSION:

The electrical conductivity of all the spices selected ranged from 2.1 to 15 mmhos/cm whereas pH ranged between 3. And 6.8. However, these fitted relationships need to be validated with a wider range of samples and should be taken up further. The values of electrical conductivity can give us an insight into the mineral content and their composition can be taken up as further detailed study. This study of bio physics measurements such as conductivity should be helpful for researchers to further investigate into their properties and which can find a suitable application in pharma, food as well cosmetic industries.

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