Some Electrical Properties of Wild Mango Seed ad Mucuna (Flagellipes Sp) Seed At Different Temperature And Moisture Contents

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Abstracts

Electrical resistivity and conductivity of wild mango (irvingia gabonensis) seed and mucuna (flagellipes sp.) seed was determined at a temperature range of 20-50^{0}F and different moisture contents. The result showed fluctuations between minimum and maximum value at these range of temperature tested and at the same moisture content. Electrical resistivity of mucuna ranged between 9.51 x10^5 and 1.80 x10^{6}Ωm while that of wild mango ranged between 4.22 x10^5 and 5.63 x10^5 Ωm. Electrical conductivity of mucuna lies within 1.14 x10^{-6} and 1.46 x10^{-6} s/m, while for wild mango, it was 2.63 x10^{-6} and 3.05 x10^{-6} s/m. The increase and decrease in the values of the electrical resistivity and conductivity were inconsistent with the thickness and diameter of the products. Results showed that temperature and moisture contents had a more significant effect.

Key words: **receptivity, conductivity, temperature, moisture contents**

Introduction

Agricultural products are of great importance in human nutrition and health. They supply vital nutrient to the diet, provide variety in foods and make them appetizing and more attractive (Abdul 1989). They also provide raw materials for pharmaceutical industries. Some of these agricultural products have been underutilized; among them are mucuna (flagillipes sp.) and wild mango (irvingia). Mucuna is the third largest among flowering plants, consisting of approximately 650 genera and 20,000 species [1]. It is the second most important plant source of animal nutrition. The seeds often have a hard coat and sometimes bear a U-shaped line called a pleurogram 15] . Many varieties of the Mucuna seed are used in the food and pharmaceutical industries. Nutritional importance of Mucuna seeds as a rich source of protein supplement in food has been documented [2].

Irvingia with a common name wild mango, African mango or bush mango is a genus of Africa. They bear edible mango- like fruits and are especially valued for their fat and protein rich seed [3]. As a natural fiber, it slows the gastric erupting process and helps you maintain a sense of fullness for longer periods. When used correctly, it demonstrated impressive results in the areas of weight loss, leptin control and health benefits [4]. Many agricultural product are harvested mostly when relatively fresh but are later dried to preserve them, which destroy its freshness and alter its useful primary constituents. However, in the Recent past electrical treatment has become acceptable in processing of biomaterials [5]. This borders on the need to keep the product fresh and retain its original food value. [6] reported that electric current flowing through biomaterials decreased the microbial count and, improve the quality of the product. The application of electrical treatment in the processing of biomaterials requires the knowledge of electrical properties and their effects on processing [7]. The apparent electrical conductivity of biomaterial is influenced by a combination of physico-chemical properties including soluble salts, fiber content and mineral composition, water content, bulk density, organic matter and temperature. Since this physico-chemical, properties differ from one biomaterial to another; their electrical properties will also vary. Thus, electrical properties of biomaterial has become an important area of research in post harvest processing of some agricultural products [8,9,10]. Therefore, electrical conductivity information is useful in sorting of materials, checking proper heat treatment of materials and inspecting of heat damage of material. It will also help the food and post harvest processors to apply electrical stimulation to inactivate harmful pathogens that can contaminate them and freshly preserve them. In addition, an understanding of electrical resistivity and conductivity behavior of biomaterial will enable us, to optimize, the electrical parameters that could be used in designing appropriate processing equipment. In general electrical resistivity of conductors increases with temperature while the electrical resistivity of semi-conductors and insulators decreases with increasing temperature. In both cases, the electron-phonon interaction can play a key role. As the temperature of a material decreases, the temperature dependence of resistivity follows a power law function of temperature as demonstrated by the Bloch-Gruneesen formula. However, a better approximation of the temperature dependence of the resistivity of a semi-conductor and insulator is given by the Steinhart-Hart equation. This research was undertaken to generate result that will serve as an implicit indicator of those factors that can be adjusted to improve electrical treatment of agricultural products.

Materials and Methods

Mucuna and Irvingia (Figs. 1 and 2) used in the research were sourced, from the open market because there is no known plantation for these crops. They are local plants that mostly grow in the wild. The seeds were sorted of dirt and chaff after removal from the pod and thoroughly cleaned

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Fig.1: Mucuna flagellipes seed

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Fig 2: Irvingia gabonensis (wild mango) seed

The seeds were weighed individually using a digital weighing scale, grouped based on theirweight and the modal weight group was chosen for the experiment. The seeds were kept at a room temperature inside a sealed polythene bag to obtain a uniform moisture distribution throughout the seeds [11]. The seed coats were removed because of the glossy nature of the seed coats, which makes water absorption difficult. The cotyledon was splinted into two longitudinally through the helium. The axial dimensions of the seeds were determined using digital veneer callipers. The split cotyledons were conditioned by soaking in warm distilled water inside a calibrated beaker (250ml) for 24-72 h to absorb enough moisture, then each seed was removed, cleaned and placed in a refrigerator at 20- 50˚F for 3 h. A direct current digital resistance probe (DT92 series) was used for resistance measurements. To maintain a steady voltage, the probe was powered through a converter using a Sawafuji generator (SH 3200 EX, 50HZ, Phase 1ø, rated power 2.4 - 2.6KVA) with maximum DC output of 12V. The probe was left in place for 60 seconds before the resistance value was recorded. Resistance measurements were taken at a moisture content of 6.75 – 84.6% db for Irvingia and 18.7 – 65.7% db for Mucuna over a temperature range of 20-50˚F. The internal temperatures were measured at two different points of the sample using a thermocouple. Electrical resistivity were determined mathematically using the general formula.

$$\partial = \mathcal{R}\frac{A}{\lambda} \qquad (1)$$

Where R is electrical resistance of a uniform seed (biomaterial) measured in ohms Ω.

A is the cross sectional area measured in m^2.

λ is the major diameter of the seed measured in m

The cross-sectional area was given by

$$A = \frac{\pi d^2}{4} \qquad (2)$$

Where d is the diameter of the biomaterials measured in m.

The electrical conductivity was taken as the inverse of the electrical resistivity.

Results and Discussion

Effects of Temperature on Electrical resistivity of Irvingia Gabonensis and Mucuna Flagellipes

Temperature is one of the important factors that affect the flow of electricity. The resistivity of the biomaterials (Irvingia Gabonensis and Mucuna Flagellipes) decreased with an increase in temperature (Figure 3 and Figure 4). The lower resistivity at higher temperature than at lower temperature indicates that the biomaterials behave as either an insulator or a semi-conductor [10] [12]. This appears to be an important parametric consideration for the agro processors and food engineers, to design the temperature dependent equipment for processing biomaterials.

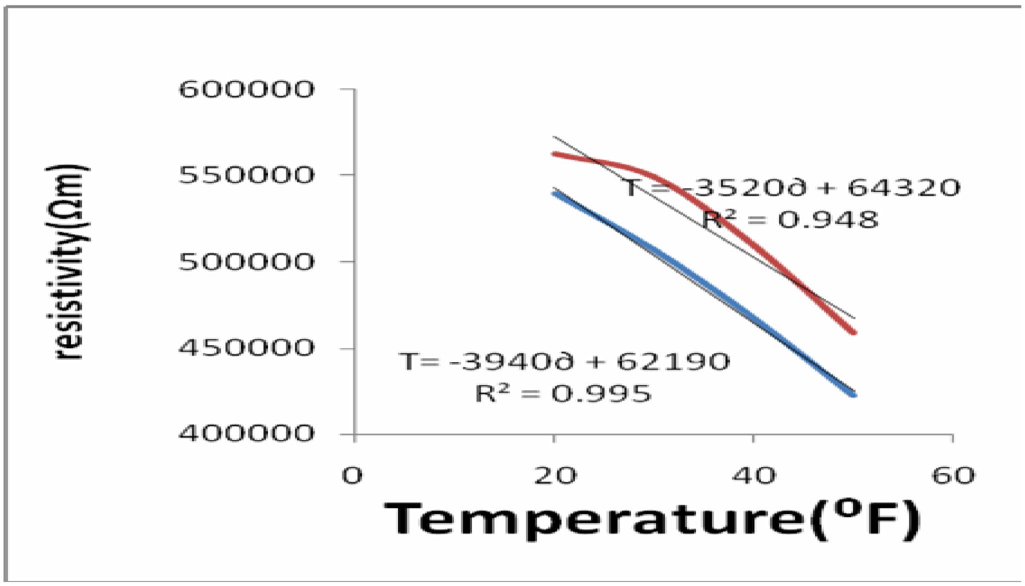


Figure 3. Mean value of electrical resistivity at different temperature of Irvingia gabonensis

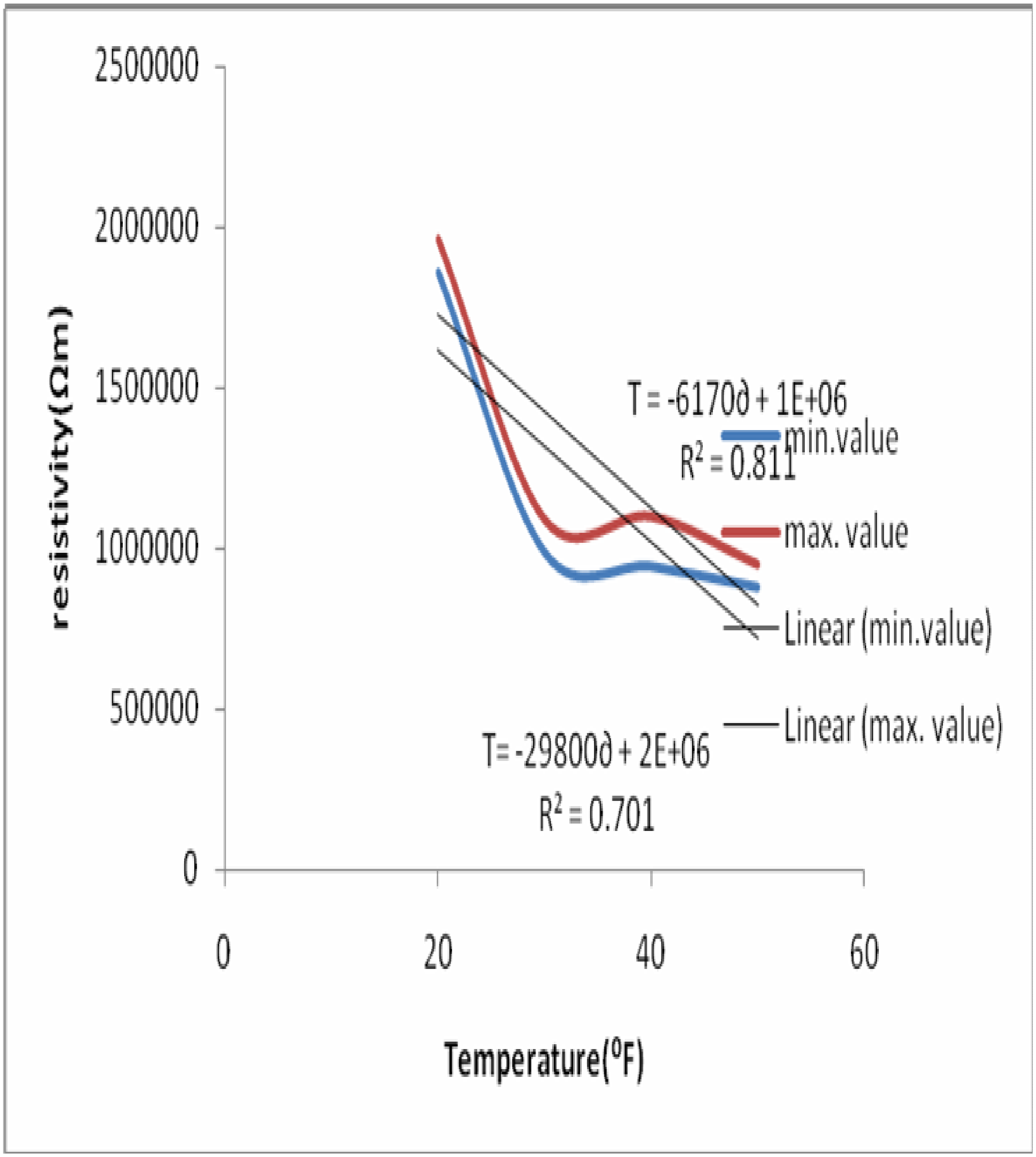


Figure 4: Average mean value of electrical resistivity at different temperature of Mucuna

Flagellipes

Figures 3 and Figure 4 show the effect of temperature on electrical resistivity of wild mango and Mucuna flagellipes at 20°–50°F. The electrical resistivity of these materials fluctuated between a minimum and maximum value at 5% confidence level. [13] suggested that this might be the result of cells or tissues of the biomaterials moving from one physiological state to another. This could also be the result of an uneven temperature distribution within the sample [10], or the presence of ice crystals within the sample[14]. A linear regression was performed between temperature and resistivity at different temperatures. It showed very high correlation coefficient for minimum and maximum values of resistivity for wild mango (R^2 = 93.9% and 94.5%), as well as for Mucuna flagellipe (R^2 = 70% and 81.1%)

Effects of Temperature on Electrical Conductivity of Irvingia Gabonensis and Mucuna Flagellipes

The effect of temperature on electrical conductivity of Irvingia gabonensis and Mucuna flagellipes at 20^0F-50^0F as shown in figure 5 and 6.The conductivity increases with increase in temperature. Electrical conductivity is a measure of how well a material accommodates the movement of electric charge. It is a ratio of the current density to the electric field strength. In addition, electrical conductivity is a very useful property since values are affected by such things as substances chemical composition and stress state of the structure. Therefore, electrical conductivity information is useful in sorting of materials, checking proper heat treatment of materials and inspecting of heat damage of material. In addition, these are very useful in the design of the temperature dependent equipment in the processing of biomaterial like ohmic heaters.

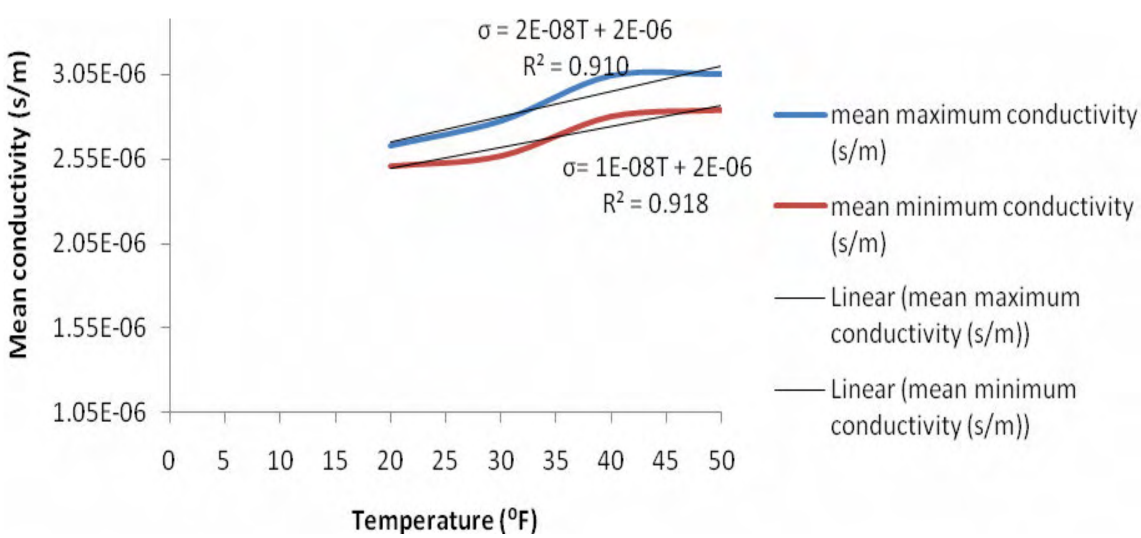
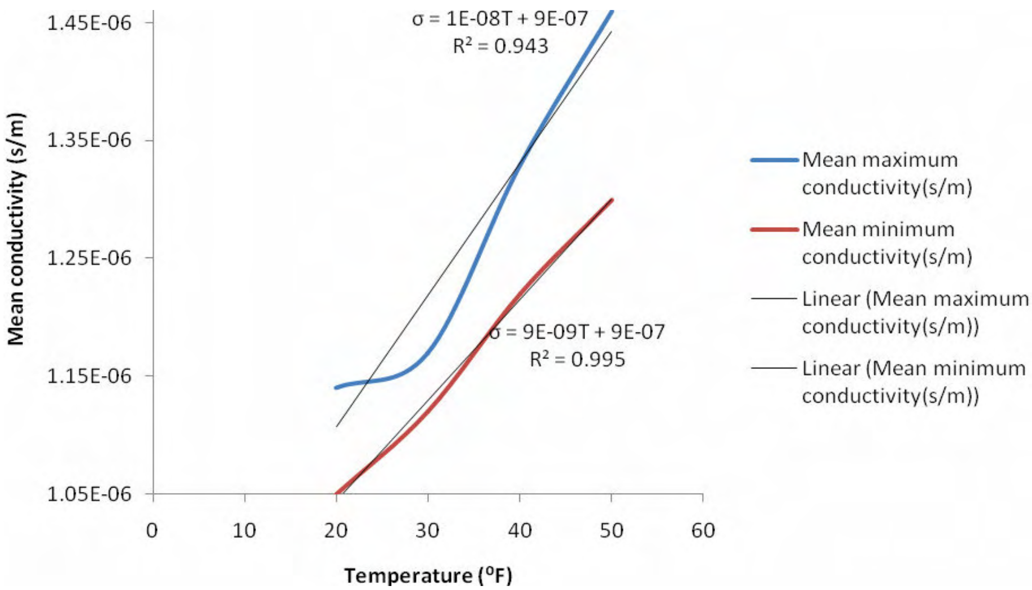


Figure 5: mean value of electrical conductivity at different temperature of Irvingia Gabonensis



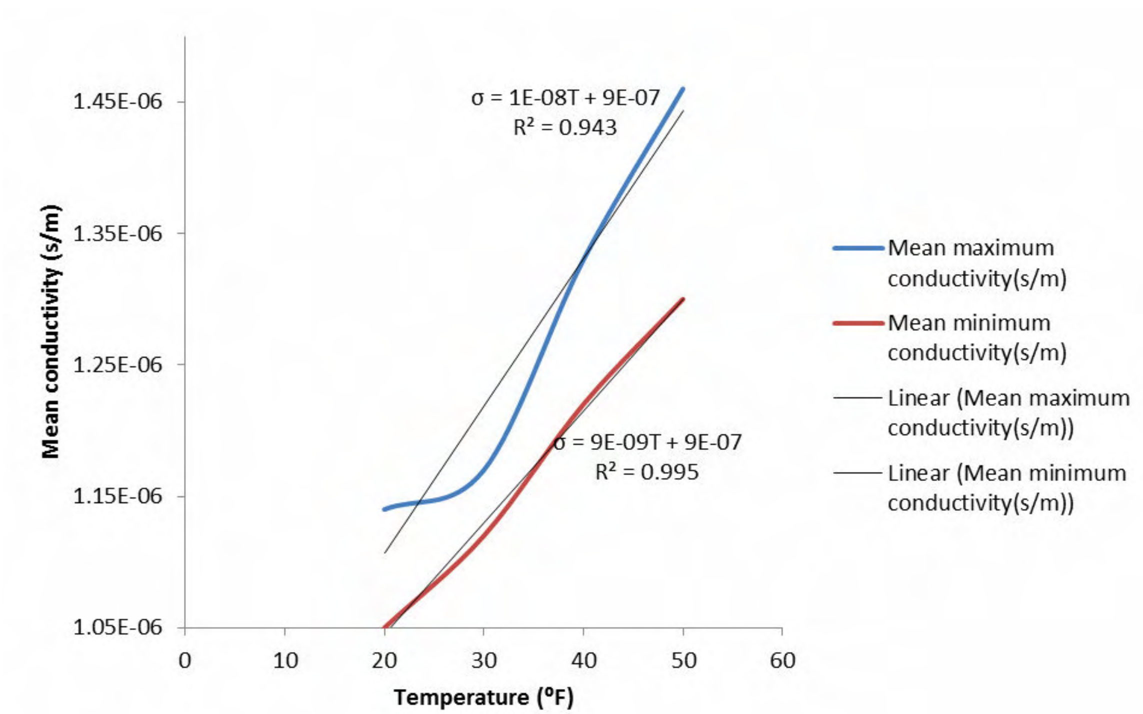


Figure 6: mean value of electrical conductivity at different temperature for Mucuna Flagellipes

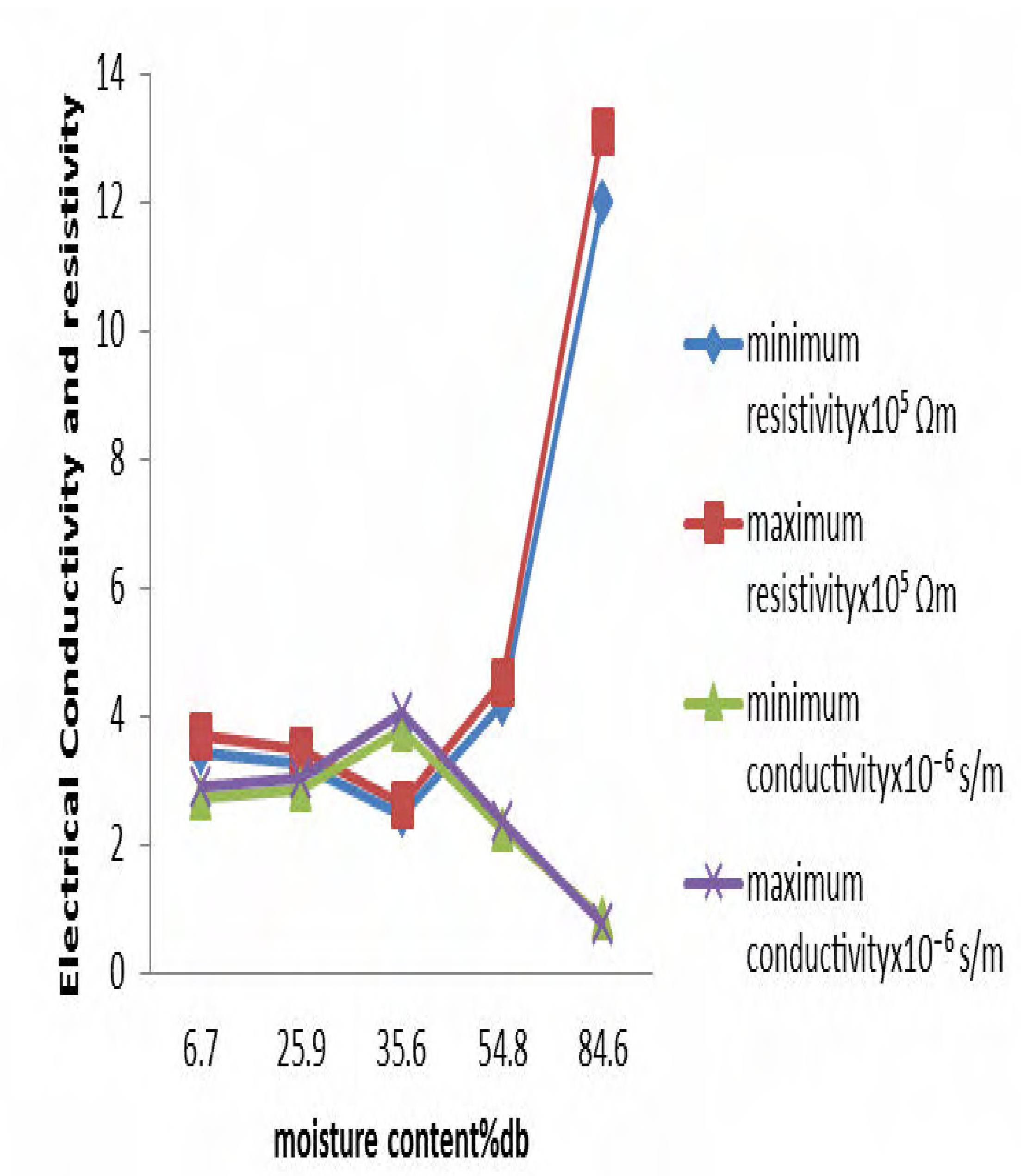


Figure 7: relationship between moisture content and Electrical Conductivity and resistivity of Irvingia Gabonensis at 30^{0}F

Table 1: Average Values of some physical properties of MucunaFlagellipesand Irvingia Gabonensis at 30°F (-1.1^{0}C)

Mucuna Flagellipes				Irvingia Gabonensis			
Moisture content (%)db	Average Weight (g)	Average Thickness (mm)	Average Major diameter (mm)	Moisture content (%)db	Average Weight (g)	Average Thickness (mm)	Average Major diameter (mm)
18.7	2.73	2.61	25.25	6.7	1.11	1.55	25.58
27.4	2.93	2.62	26.52	25.9	1.31	1.60	25.78
50.8	3.47	2.92	31.37	35.6	1.41	1.64	26.33
64.8	3.79	3.57	31.60	54.8	1.61	1.84	27.67
65.7	3.81	3.66	31.90	84.6	1.92	3.29	30.50

Figure 7 and 8 generally showed that the resistivity of both products decreased at the first stage and started to increase as the moisture content increased. However, the reverse was found for the conductivity. According to [10] level of Moisture present in a biomaterial, influences sample condition, which in turn would have influenced electrical properties. The increase in resistivity and decrease in conductivity was found to occur for both seeds at moisture content of about 50%db and above.

Conclusion

Electrical resistivity and conductivity of wild mango (irvingia gabonensis) and mucuna (flagellipes sp.) was determined at a temperature range of 20-50^{0}F and different moisture contents. The result showed fluctuations between minimum and maximum value at these range of temperature tested and at the same moisture content. Electrical resistivity of mucuna ranged between 9.51 x10^5 and 1.80 x10^{6}Ωm while that of wild mango ranged between 4.22 x10^5 and 5.63 x10^5 Ωm. Electrical conductivity of mucuna lies within 1.14 x10^{-6} and 1.46 x10^{-6} s/m, while for wild mango, it were 2.63 x10^{-6} and 3.05 x10^{-6} s/m. The increase and decrease in the values of the electrical resistivity and conductivity were inconsistent with the thickness and diameter of the products. Results showed that temperature and moisture contents had a more significant effect

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