CHAPTER 5
CONCLUSION

The developed moisture meter for dried longan aril was based on the principle of electrical capacitance. This indirect measurement provided a quick and convenient measurement of moisture contents which would be beneficial for dried longan trading. This was compared to the direct method that was inconvenient and was subjective to experience of each farmer.

The current direct method of moisture content measurement for dried longan aril is a time consuming process which takes at least 8 hours and must be performed by a skilled agriculturist. This research investigated the relationship between the moisture content of longan aril and its electrical capacitance. This information is helpful in decreasing the measurement time in the conventional method. From the preliminary study, the average moisture content of whole fresh longan was 76% Wb which was compared to the average moisture content of commercial whole dried longan of 13.5% Wb. The weight ratio of whole fresh to dried longan was 3.34:1. In case of whole dried longan, the moisture content level at the skin surface, aril, and seed were 6.37 %, 19.36 %, and 9.78 % Wb, respectively. Therefore, longan aril was selected to be used in the moisture content measurement.

The designed moisture meter (Figure 3.1) was an original instrument used to determine the moisture content level of aril dried longan. The meter consisted of five components: a direct current power supply circuit, an oscillator circuit, a divider circuit, a computation unit, and a display circuit. The moisture content level obtained using electrical capacitance was evaluated by a pre-determined relationship between the moisture content and the electrical properties of dried longan aril. The process commenced by the generation of a square wave by an oscillator circuit. The instrument utilized integrated circuit number ICL8038. A sample of dried longan aril was placed in a cylinder with a diameter of 25 millimeters and a length of 14 millimeters with a connecting lead attached to both sides of the cylinder. In order to generate a pulse signal, a lead must be connected to the cylinder which replaced the external capacitor of ICL8038 circuit. A pulse signal was obtained by dividing the frequency 980 KHz by 32 which was subsequently measured using a specific microprocessor PIC16F458. The computation process to determine the level of moisture content was obtained by PIC16F877 based on the electrical capacitance. Finally, the moisture content level was then sent for display on the LCD screen.

The experimental results from 1,500 samples indicated the quadratic relationship between the moisture content, dielectric constant, and electrical capacitance of dried longan aril. The electrical capacitance of dried longan aril increased with the moisture content. The average electrical capacitances of 4.044, 5.2406, 7.5007, 10.210, and 12.288 picofarad (pF) as well as dielectric constants of 13.022, 16.874, 24.151, 32.875 and 39.566 were achieved for the moisture content levels of 10, 14, 18, 22, and 25% Wb, respectively, at bulk density 1300 kg/m^3.

The average electrical capacitances of 4.323, 5.246, 7.579, 10.926, and 13.013 picofarad (pF) and dielectric constant of 13.932, 16.893, 24.402, 35.181, and 41.900 were attained for the moisture content levels of 10, 14, 18, 22, and 25% Wb, respectively at bulk density 1450 kg/m^3.

The average electrical capacitances of 4.442, 5.277, 7.584, 11.121, and 13.210 picofarad (pF) and dielectric constant of 14.303, 16.991, 24.419, 35.807, and 42.535 were achieved for the moisture content levels of 10, 14, 18, 22, and 25% Wb, respectively at bulk density 1600 kg/m^3.

The bulk density of dried long aril in the cylinder should be high enough to be applied to our system. It is recommended to set the aril sample weight to 10 grams for our moisture measurement system. This will lead to the bulk density of 1.45 g/cm^3. The moisture content can be estimated from the capacitance by using the equation $y = -0.104x^2+3.397x^2-1.927$, where x denotes the electrical capacitance (pF) and y denotes the moisture content (% Wb).

The quadratic equation used in describing the moisture content from the capacitance was $y = -0.104x^2+3.397x^2-1.927$, where x denotes the electrical capacitance (pF) and y denotes the moisture content (% Wb) at bulk density level of 1450 g/cm^3. The invented meter worked very well as evident from the blind testing experiments. The MAE was 0.721% Wb with the corresponding accuracy and precision of 96.8% and 0.9871, respectively.

The regression models based on multilayer perceptrons (MLP) and support vector regression (SVR) were also proposed to predict the moisture content of dried longan aril from its dielectric constant. The performances of the proposed models were compared with that of linear regression and second-, third-, fourth-order polynomial regression models. The results using four-fold cross validation suggested that the SVR models achieved the best prediction performances, while the MLP models, polynomial regression models and linear regression models were next in line ordering from best to worst. The results also suggested that the bulk density of dried longan aril in the plastic container affected the prediction performances for the linear and polynomial regression models. However, this effect was very little when the MLP or SVR was applied. Therefore, both MLP and SVR models are the good choices for the system in that they provide very little prediction error and also provide robustness to the bulk density variation.