

FINAL REPORT

1. Institute Code No : Tech.I(176)
2. I.C.A.R. Code No: P-I-94/14-ICI-N10/1160
3. Name and Address of Research Institute/Centre:
Central Plantation Crops Research Institute, Ksaragod - 671124, Kerala.
4. Project Title : Design of a low cost Cashewnut moisture meter.
5. Name and Designation of Project Leader : K.Madhavan, Sr.Scientist,
Electronics and Instrumentation
6. Name(s) and Designation of Project Associates including Project Leader and work to be done:

Sl No:	Name and Designation	Time spent	Work done
1	K.Madhavan, Sr.Scientist	20 man months	1. Design of a moisture meter and sensor. 2. Fabrication of moisture meter and sensor. 3. Testing. 4. Calibration of the instrument against standard air oven method

7. Location of Research Project with complete address (Division/Section/Sub-Centre)
Post Harvest Technology, Physiology & Biochemistry Division,
CPCRI, Kasaragod

8. Date of start : April 1994

9. Date of termination : April 1998

10. (a) Objectives (Not more than 150 words)

The moisture content of raw cashew is as high as 25% with an average of 15%. High moisture content causes deterioration of the kernel due to mould, bacteria or enzyme action. Affected nuts may lose their nutty taste and aroma which would result in loss of quality. Drying the nuts immediately after harvesting is essential to preserve their quality by bringing down the moisture content to 6-8% (d.b.). At present there is no instrument available in the market to estimate the moisture content of raw cashew nut. Cashew farmers and the

processing units should be able to note the m.c. available in their cashew stock to ensure quality. Price of cashew can be fixed by reducing a percentage of total cost for the extra % of moisture available in their product. More over India imports large quantity of raw cashew nuts to meet the domestic demand of processing units. Imports of raw cashewnut into India during Jan. to June 97 amounted to 98881 M.T. valued at Rs.30740.71 lakhs. So if there is excess moisture available in the lot , the loss of foreign exchange will be large. So, the objective of the project is to design a low cost cashewnut moisture meter to read the % m.c. in raw cashewnut.

(b) Practical Utility including background information (Not more than 150 words)

The instrument is a quality testing machine. Cashewnuts having high m.c. lose their nutty taste, aroma & quality. Such nuts when processed, give spotted and tainted kernel. So, the utility of this project is that the quality of the cashewnut can be checked and monitored in the course of drying or after drying using this instrument.

11. Technical Programme:

1994-95

1. Design of a moisture meter (Resistance method)
2. Design of suitable sensor
3. Fabrication of a moisture meter & sensor
4. Testing

1995-96

1. Design of moisture meter (Capacitance method)
2. Design of a suitable sensor
3. Fabrication

1996-97

1. Calibration of the moisture meter against standard air oven method
2. Testing

1997-98

1. Modification of moisture meter to suit for oilpalm seeds
 2. Calibration of the instrument against standard air oven method
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12. Final Report:

In 1994 - 95, the Cashewnut moisture meter was designed and fabricated applying the principle of electric conductivity. It consisted of an audio oscillator, pre-amplifier, resistance bridge, main amplifier and digital panel meter. The sensor was designed in the form of a mini screw press. Samples are loaded in the sensor cylinder to the marked height and the piston is screwed inwards so that it makes good surface contact with the samples. The bottom plate of the screw press and the piston act as the two electrodes of the sensor.

The instrument was tested. The disadvantage of the sensor was that the electrical resistance of the sample varied with the application of pressure by the piston electrode and it was difficult to keep the pressure constant to keep the output reading stable.

During 1995-96, this instrument was re designed. Here, the design was done according to the theory of electrolytic capacitance. The dielectric property of cashewnut varies with the moisture content available in the cashewnut, the higher the m.c, the higher the dielectric value. Electrolytic capacitance $C = \frac{K A}{d}$, where K is the dielectric value; A, the area of cross section of the parallel plates of the capacitor and 'd', the distance between the plates. When A & d are fixed, C varies according to K. Applying this principle, the cashew moisture meter was designed. The instrument was designed in the 'Schering Bridge' form. This is an AC bridge particularly suitable for small capacitance. The instrument consists of a high frequency oscillator of 1MHz, a pre amplifier, a capacitance bridge, a main amplifier and an A to D converter with digital display (Fig.1 & 2). Here, the raw cashewnut acts as the dielectric of the unknown capacitor C_x fixed on one arm of the Schering Bridge. C_x consists of two parallel brass plates of 22 gauge (14.5 x 10 sq.cm), which is fixed 2.2 cm apart. This gap is selected to accommodate the cashew samples, breadth wise. Samples can be loaded from top and unloaded from bottom by sliding the base plate of the sensor. base plate of the sensor.

Initially, the Schering Bridge is balanced with known value of capacitances. When the sensor compartment is filled with cashew, depending on the m.c. in it, the bridge unbalances and output current flows. This can be read in the output meter and this value is proportional to the m.c. of raw cashewnut.

Calibration

The instrument is calibrated against standard air oven method. First, raw cashewnut is filled up in the sensor compartment. As the size of the cashew is not uniform, it is difficult to pack the samples tightly in the compartment, but try to pack it as far as possible. The instrument reads in microamperes. The same sample is weighed and kept in the oven for drying, till the entire moisture is removed. The difference in weight of the sample before and after the drying gives the moisture content of the sample. The

$$\% \text{ m.c. on dry basis} = \frac{W_1 - W_2}{W_2}$$

where W_1 = Weight of sample before drying

W_2 = Weight of sample after drying

The experiment was repeated with samples of different moisture content. The reading was statistically analysed and suitable equation formulated for calibration of the meter.

The cashew samples were dried in the sun and rate of drying was also analysed and plotted. It took 2 days (16hrs) for sundrying of raw cashewnut to bring down the m.c. from 14.5% to 7.75%.

A graph was plotted taking output current in microamperes in the Y-axis and % m.c. of raw cashewnut in X-axis.

The equation for calibration is $y = -24.59 + 10.28x - 0.29x^2$

$$r^2 = 0.97$$

The calibration chart is shown in Table.

The size of the cashewnut samples is not generally uniform and the shape of the nut is also not of any standard shape / specification and so there will be always air gap in the sensor compartment and this air gap also varies with the size of the nuts loaded in the sensor. The net result is that the dielectric of the capacitor is a combination of cashew and air and so the reading on the moisture meter for the same sample loaded at different times will be different. This error was calculated to be 10 to 12% (aprox.)

Calibration of the cashewnut moisture meter for oil palm seeds

The moisture content of oil palm seeds is to be calculated for seed selection and breeding. So, the seednut samples were collected from CPCRI Research Centre, Palode and then used for calibration against standard air oven method. Here also, the packing of the samples in the sensor compartment cannot be tight because of the difference in the size and shape of the oilpalm seeds.

The calibration chart and graph are shown.

The calibration equation is $y = 2.52 + 0.42x$

$$r^2 = 0.91$$

The moisture meter was fabricated and calibrated according to the calibration equation shown above.

13. Approximate expenditure incurred in the Project: (Give reasons for variation, if any, from original estimated cost)

Rs 3,00,000/- . The reasons for variation from the original estimated cost is

- i. the rise in DA of the staff
- ii. the project was extended for 1 more year to estimate the m.c. of oil palm seeds.

14. Publications and material (one copy each to be supplied with this proforma)

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- a) Research papers - Nil
- b) Popular articles - Nil
- c) Reports : Reportd in the Institute Annual Reports 1995, 1996, 1997 & 1998 and in the Institute Research Highlights during 1995, 1996 & 1997.

d) Seminars and workshops (Relevant to the Project) in which the Scientists have participated:

1 Participated in the Research Council Meeting of NRC Cashew during 1996, 1997 & 1998 and demonstrated the working of the instrument and presented the reports..

2 Presented a paper on Design of a cashewnut Moisture meter in the XIII th PLACROSYM held at Coimbatore on 16-18th Dec.98

e) Material developed (such as new varieties of crops or breeds of farm animals, implements, products etc.)

- i. Cashew moisture meter (battery operated)
- ii. Cashew moisture meter (AC)
- iii. Moisture meter to measure the m.c of oil palm seeds
- iv. Cashew moisture meter working on the principle of electric conductivity

15. Details (Nos. etc.) of Field/Laboratory Note books and final material and their location

Available in the Laboratory.

16. Comments / suggestions of Project Leader regarding possible future line of work that may be taken up arising of this project:

One drawback of this instrument is that the error in the reading is about 10 to 12%. This is because the size of the cashew samples will not be same and the size of the nut is not of any standard specification and so, air gap in the sample compartment will not be uniform. This error can be reduced if the m.c. of the same sample is taken 3 times and the average is taken. Further research work is required to design a better sensor device or to overcome this problem.

17. Signatures with name of Project Leader and Associates:

K.Madhavan

Madhavan

18. Signature (with comments, if any) of Head of Division/Section/Station:

V. I. Rajagopal

19. Signature (with comments, if any) of Director:

Ch. Ramesh