# MOISTURE DETERMINATION OF BAGASSE AND SHREDDED CANE USING A MICROWAVE OVEN

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**Abstract**

The technique of microwave drying for shredded cane and bagasse samples was investigated. It was found that the precision and accuracy of this method were similar to those of the oven drying method normally used by the Sugar Industry Central Board at factories. The microwave method has the advantage of enabling more samples to be dried in a shorter time than is possible in the existing oven drying method, thus making this technique economically more attractive.

## Introduction

The Sugar Industry Central Board (SICB) cane testing laboratories use draughted hot air ovens for the determination of the moisture content of bagasse and shredded cane. In these ovens the sample of cane or bagasse rests on a steel tray with a nylon gauze base and a current of hot air is drawn through it. These ovens take one hour to dry a 300 g sample of bagasse or a 500 g sample of shredded cane at 105°C for the moisture determination. The draughted ovens are difficult to maintain at 105°C for long periods of time and require frequent maintenance. The purpose of this investigation was to establish a quick and economical method for the moisture determination of bagasse and shredded cane using a microwave oven.

Microwave ovens have been successfully used for decreasing food cooking times for the housewife and, to a lesser extent, in industry. The microwaves excite the water molecules causing them to vibrate very fast thus generating the intense heat which cooks the food.

In this work the heat generated by the microwaves caused evaporation of water and eventually the drying of the bagasse or shredded cane sample. A microwave oven and a draughted drying oven, the latter normally used to determine moisture in shredded cane and bagasse, were each tested for precision by sub-sampling a single, well-mixed sample twelve times. Six sub-samples were dried in the microwave oven and six in the draughted oven.

To obtain an indication of how well the two methods agreed, single run-of-the-mill samples were sub-sampled twice, one sample being dried by the microwave method and one in the draughted oven.

The data obtained above were compared with data obtained from the SICB where two moisture ovens were compared in a similar way.

## Equipment

(a) Sharp Model R—9410E

This model has a rotating glass turn-table which was replaced by a teflon one to cut down on heat build-up.

There are five power variables which can be pre-selected in any order for any length of time i e

| | | |
|---|---|---|
| Full power | = | 100% power, 650 watt |
| Roast | | 70% of full power |
| Simmer | | 50% full power |
| Defrost | | 30% full power |
| Hold | | 0% power |

When the sample becomes dry, i e no moisture is left to absorb the microwaves, the excessive build-up of microwaves may damage the magnetron. To prevent this, the microwave oven was fitted with a small glass condenser coil through which water flows at a constant rate from a cylinder which has a constant head of water. The constant water flow rate ensures that microwaves are absorbed at a constant rate during all drying experiments.

(b) Samples were dried in re-usable cardboard containers (15 cm x 22 cm x 5 cm) specially manufactured for microwave use. These containers should be pre-dried before use.

(c) A perspex rack was specially constructed so that the microwave oven could dry four samples simultaneously.

## Procedure

*Bagasse*

Four 50 g samples can be dried simultaneously in the microwave oven using the specially manufactured perspex stand. At first it was necessary to establish whether the bagasse could be brought to dryness without sample degradation. A 50 g sample of bagasse was dried at 105°C for 4 hours in a standard laboratory oven and the moisture content calculated from the mass loss observed. Other samples of the same bagasse were dried for increasing lengths of time at "full power" and the moisture loss calculated. Graphs were plotted of moisture loss vs time at "full power" (see Figure 1). From this is can be seen that the samples reached maximum moisture loss after 35 minutes at "full power". All subsequent bagasse samples were dried for 35 minutes at "full power". It should be noted that for the purposes of Figure 1, a standard laboratory oven was used to establish the oven moistures on the graph and not a draughted SICB oven.

Precision tests were performed for bagasse in the microwave oven and the draughted ovens at the Illovo SICB laboratory. A sample of bagasse was well mixed and sampled twelve times. Six samples of 50 g were dried by microwave for 35 minutes and six of 300 g by moisture oven for 1 hour. This procedure was repeated for 3 samples. Mean relative standard deviations (RSD) were 0,52% and 0,51% for microwave and draughted oven moistures respectively.

Single, run-of-the-mill samples were sub-sampled twice — one 50 g sample was dried by microwave oven for 35 minutes and one 300 g sample by draughted oven for 1 hour. Thirty-six tests were performed and the mean difference between the microwave and SICB oven moistures was found to be −0,08%.

Single, run-of-the-mill samples were sub-sampled three times — one 50 g sample was dried by microwave oven for 35 minutes and the other two 300 g samples by two separate draughted SICB ovens for one hour each. This was to include a comparison between two draughted ovens as well as between microwave and draughted ovens. In 12 tests the mean moisture percentages of microwave oven, SICB oven 1 and SICB oven 2 were 55,22%, 55,58% and 55,28% respectively.

*Shredded cane*

Four 100 g samples can be dried simultaneously in the microwave oven. A drying programme was established using the variable power settings. Full power could not be used for the full drying time because the sample was found to char before

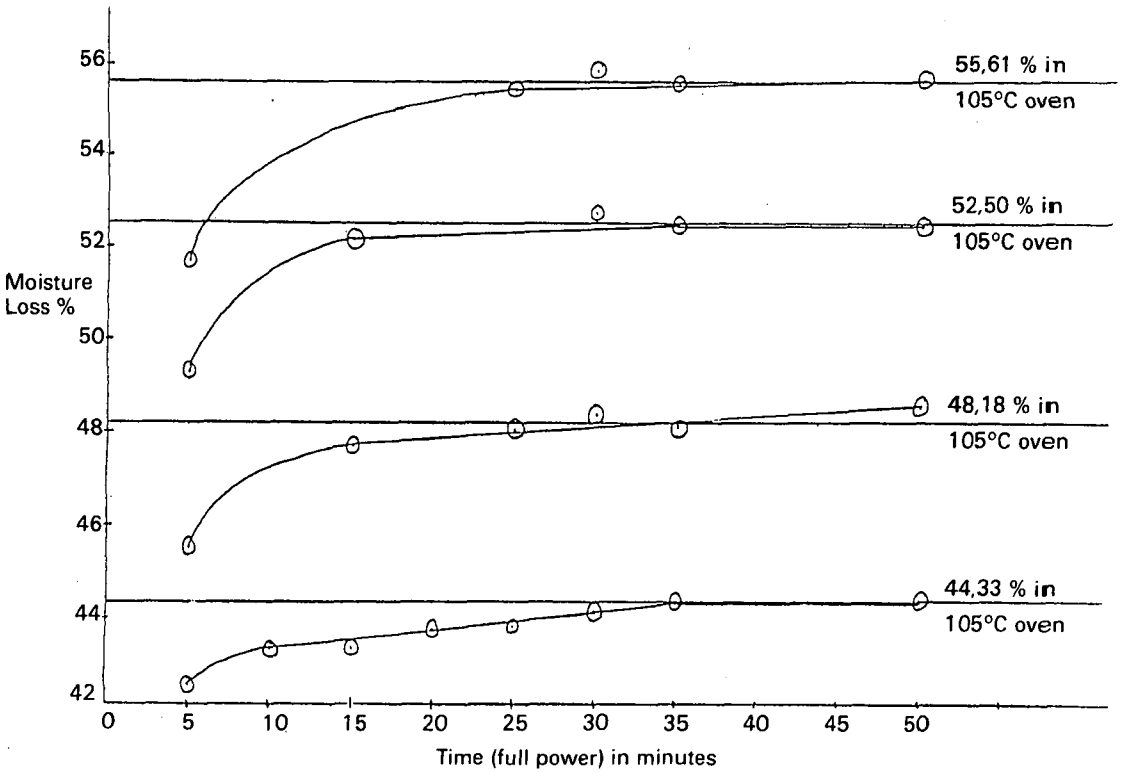


**FIGURE 1** Drying curves for four bagasse samples using the Microwave oven.

maximum moisture loss had been reached. The following programme was decided on after comprehensive trial runs:

| | |
|---|---|
| Full power | 17 mins |
| Roast | 5 mins |
| Defrost | 38 mins |
| Total | 60 mins |

The above was selected to give the fastest drying time with no apparent sample charring.

A precision test was performed for shredded cane in the microwave oven: a sample of shredded cane was well mixed and sub-sampled eight times. These eight 100 g samples were dried in the microwave oven according to the programme set out above. The RSD was 0,44%.

Single, run-of-the-mill samples were sub-sampled twice — one 100 g sample was dried by microwave oven and one 500 g by draughted oven to compare accuracy. Thirty-seven tests were performed and the mean difference between microwave and draughted SICB oven moistures was found to be +0,19%.

Data obtained from the SICB comparing two draughted ovens showed that for 21 tests the mean difference between the moisture contents of shredded cane in two different ovens was −0,06%.

## Discussion

All the data obtained were analysed statistically and in each case it was found that there was no significant difference between the two methods. The statistical data are summarised in Tables 1 and 2. From these tables it can be seen that the precision and accuracy of moisture determination of both bagasse and shredded cane by the microwave method are of the same order as those of the SICB method.

**TABLE 1**

**Summary of Precision Tests of Bagasse and Shredded Cane**

| | | Mean Moisture % | | Std. Dev. | | R.S.D. % | |
|---|---|---|---|---|---|---|---|
| Product | | M.wave | Oven | M.wave | Oven | M.wave | Oven |
| Bagasse | 1 | 53,80 | 54,17 | 0,18 | 0,27 | 0,33 | 0,50 |
| | 2 | 58,08 | 57,32 | 0,33 | 0,24 | 0,57 | 0,42 |
| | 3 | 57,11 | 57,29 | 0,37 | 0,35 | 0,65 | 0,61 |
| Cane | 1 | 66,83 | - | 0,29 | - | 0,44 | - |

**TABLE 2**

**Summary of Precision and Accuracy of Microwave and Drying Oven Methods for Bagasse and Cane**

| 1. Bagasse | Microwave vs. Oven | Oven vs. Oven |
|---|---|---|
| Mean difference | −0,08 | −0,09 |
| S.D. of difference around mean difference | 1,38 | 0,82 |
| n | 36 | 52 |
| 2. Cane | | |
| Mean difference | +0,19 | −0,06 |
| S.D. of difference around mean difference | 0,98 | 0,93 |
| n | 37 | 21 |

## Conclusion

The microwave method for moisture determination of bagasse and shredded cane is as efficient in both precision and accuracy as the SICB draughted oven method.

The microwave method has the following advantages:

(a) Four 50 g (bagasse) or 100 g (cane) samples can be dried simultaneously compared with a single sample in the drying oven. However, because the precision for the smaller samples used in the microwave determination is of the same

order as that of the large samples used in the draughted ovens, it seems feasible that small samples could be determined by the SICB method by dividing the steel tray into segments thus also determining four samples simultaneously.

(b) The microwave method takes 35 minutes (bagasse) or 60 minutes (cane) to dry four samples whereas the moisture oven takes one hour in each case to dry one sample.

(c) Microwave ovens are relatively maintenance free.

(d) The microwave oven (R1 000) compares favourably in price with the Labotec oven (R1 600).

## Recommendation

During a project review meeting, where the results of this investigation were discussed, it was recommended that the SICB investigate the suitability of microwave drying of bagasse and shredded cane for industrial use.

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