

A RAPID METHOD TO DETERMINE MOISTURE CONTENT IN GREEN LEAF, WITHERED LEAF AND MADE TEA, USING A MICROWAVE OVEN

M T Ziyad Mohamed,
K Raveendran, W S Botheju, S H Priyanthi and L Jayasinghe
(*Tea Research Institute of Sri Lanka, Talawakelle, Sri Lanka*)

The moisture content in withered leaf is critical in tea processing, irrespective of the type of manufacture. The moisture content of made tea at the drier mouth, and of graded tea, is a crucial indicator in determining the quality of made tea. The gross out-turn of made tea to green leaf depends directly on the moisture content of the green leaf. Hence, if the moisture content of the green leaf is known, the gross out-turn can be predicted.

Although moisture meters are available to determine moisture content in made tea, there are no meters or quick methods available for determining moisture content in green leaf or withered leaf. The present paper introduces a simple and rapid method to determine moisture content in green leaf, withered leaf and made tea, using a microwave oven and an electronic balance.

Key words: Moisture content, microwave oven, tea

INTRODUCTION

In black-tea manufacture, green leaf is harvested and processed into black tea. The unit operations in this process are withering, rolling, roll-breaking, fermenting, drying and grading.

Withering is the foremost operation in black-tea processing. The plucked green tea leaves contain 70–83% moisture (on wet-weight basis). The primary objective of withering is to prepare the leaves for rolling by making the leaf-tissues flaccid and permeable, so that there will be a proper mixing of their chemical constituents during rolling. During this process, the moisture content is brought down to either 55–58% (in the case of orthodox or orthodox-rotorvane manufacture) or to 68–70% (in the case of CTC manufacture).

Properly-withered leaves help subsequent operations in producing good quality tea. Any variation in moisture content, even a difference of $\pm 1\%$ (on wet-weight basis), could affect the quality of the end-product. Hence the moisture content in the withered leaf is critical in tea processing, irrespective of the type of manufacture, and

the gross out-turn of made tea to green leaf depends directly on the moisture content of the green leaf.

The degree of wither, that is the ratio of made tea (MT) to withered leaf (WL) expressed as a percentage (% MT/WL), is either judged by the Factory Officer, or calculated by dividing the weight of total made tea by the weight of total withered leaf at the end of the day. Judgement by the Factory Officer is subjective and, as a result, wide variations are observed in practice. The calculation, MT/WL, is also not accurate, since there could be wide fluctuations among batches. For example, one batch could have a degree of wither of 50% MT/WL, and another batch 40% MT/WL, showing an average value of 45% MT/WL which is considered desirable. However, such averages are somewhat misleading and as a consequence, the quality of the made tea can be affected.

Private tea-factory owners, who process leaf from small-holders and green leaf suppliers, are concerned about the nett out-turn of made tea to green leaf (MT/GL), because their expenditure on green leaf depends on this factor. An experiment conducted in the low country (0-600 m above mean sea level), indicated a good correlation between the nett out-turn and moisture content in the green leaf (Ziyad Mohamed *et al.*, 2003). At present, the out-turn is calculated at the end of processing.

The moisture content of made tea at the drier mouth, as well as of graded tea, are crucial elements in determining the quality of made tea. There are moisture meters available to check the moisture content of made tea. These meters work either on the capacitance principle or on exposure to infra-red radiation. All these meters need calibration, and the accuracy of readings is questionable. In the case of infra-red moisture meters, the readings are not reliable when there is voltage fluctuation in the power supply. Hence, in order to obtain accurate measurements, the instrument should be coupled to a voltage stabilizer.

At present, the moisture content of green leaf, withered leaf and made tea is determined by the standard oven method, that is by determining the weight loss of a leaf sample placed in an oven at $102 \pm 3^{\circ}\text{C}$ for four hours. A more rapid method to determine the moisture content of green leaf, withered leaf and made tea would certainly be useful. In this paper, a simple, easy and rapid method of determining the moisture content of green leaf, withered leaf and made tea using a microwave oven and an electronic balance is described.

Microwave heating of foods is greatly affected by the presence of water which is a major absorber of microwave energy (Decareau and Peterson, 1986; Nelson and Kraszewski, 1990). As a consequence, the higher the moisture content, the better the resultant heating effect. The ability of a material to couple with microwave energy

depends on its dielectric properties. Two factors, which affect the dielectric properties of food materials, are the charge effects due to the concentration of ionic species, and the dipole effect due to moisture. Most organic constituents of food can be considered as di-electrically inert compared to aqueous ionic fluids or water, and are therefore considered as being largely transparent to microwave energy (Silveira *et al.*, 1999).

Tsang and Frutani (1989) described a fast and accurate method for determining the percentage of moisture content in macadamia nuts using a household microwave oven.

MATERIALS AND METHODS

A known quantity of the sample (20 or 25 g in the case of green leaf and withered leaf, and 10 g in the case of made tea) is exposed to microwave irradiation for a period of time until the weight of the sample becomes constant. The difference in weight gives the moisture content in the sample. The readings from the microwave method were compared for accuracy with the standard oven method.

A domestic microwave oven (Model MS - 283 MC Gold Star, a turn table model), capable of operating at a frequency of 50 Hz, was used in these trials.

The wattage corresponding to different power settings in this oven are as follows:

100% power-900 w
80% power-650 w
60% power-400 w
40% power-200 w
20% power-100 w

An electronic balance with an accuracy of ± 0.01 g was used. However, if this method is used only to determine the moisture content of green leaf and withered leaf, an electronic balance with ± 0.1 g accuracy would be adequate.

When samples are exposed to microwave irradiation, moisture is lost from them owing to a build-up of heat. The amount of moisture lost was calculated from the weight loss of the samples.

Several samples of green leaf (GL), withered leaf (WL) and made tea (MT), with varying moisture contents, were tested in this experiment at various power settings and periods of exposure in the microwave oven. After testing several samples, the recommended power settings and the corresponding periods of exposure were derived. These are summarized below.

	<u>Power settings</u>	<u>Period of exposure</u>
GL	80%	10 - 11 minutes*
WL	80%	10 - 11 minutes*
MT	100%	5 minutes, and thereafter every minute until the weight of the samples becomes constant

* The total exposure period in the microwave oven would be about 10-11 minutes for two samples, and 7-8 minutes for one sample.

Several samples of green leaf, withered leaf and made tea, with varying moisture contents, were tested in this experiment at the power settings and the periods of exposure established. The data obtained for the three types of samples, *vis-à-vis* data obtained using the standard oven method, are presented in Table 1.

In the case of made tea, samples were initially exposed for five minutes, and the weight loss determined every one minute thereafter. In the case of green leaf and withered leaf samples, it is advisable to turn the sample over after an exposure to the microwave irradiation of about three minutes, in order to avoid adherence of the samples to the test container.

Table 1. Change in weight of samples of green leaf, withered leaf, and made tea, when exposed to microwave irradiation.

Period of exposure (min) / Sample	Final weight of sample (g) at the end of exposure							M.C (%) (***)	M.C (%) (std)
	5	6	7	8	9	10	11		
GL (20 g)	5.38	4.96	4.82	4.74	4.70	4.65	4.65	76.75	76.70
WL (20 g)	7.05	6.87	6.83	6.80	6.79	6.77	6.77	66.14	66.10
MT (10 g)	9.65	9.62	9.60	9.60	9.60			4.00	4.00

GL - green leaf; WL - withered leaf; MT - made tea
 MC% (***) - moisture content using microwave oven
 MC% (std) - moisture content using standard oven

RESULTS AND DISCUSSION

A comparison of the results using the two methods (Table 1) confirms that the moisture content of each sample could be determined within a short period of time, using the microwave method. The performance of the microwave oven could vary among models. Therefore, the settings (the power level and the period of exposure to microwaves), and the weight of the leaf samples, should be adjusted accordingly. This calibration is very simple when determining the moisture content in green leaf and in withered leaf.

A lower power setting of the microwave oven is used when determining the moisture content in green leaf and withered leaf. The samples would tend to burn or scorch if full (100%) power is used. In the microwave method, green leaf and withered leaf remain green after moisture is removed but, in the standard oven method, the leaf samples turn brown owing to scorching.

However, unlike for green leaf and withered leaf, 100% power should be used for made tea and graded tea samples as the moisture present in them is very low. It is important that the samples be spread out in the dish, and heaping avoided, in order to achieve uniform heat build-up in them. For graded teas, the period of exposure has to be varied from grade to grade, and for some grades the calibration is tedious.

It can be concluded that the method described here is an effective and rapid method to determine moisture content in green leaf and withered leaf. However, calibration could be tedious when this method is used for determining moisture content in made tea or graded tea.

REFERENCES

- Decareau R V and Peterson R A 1986 *Microwave Processing and Engineering*. Ellis Horwood Publishers, Chichester, U.K.
- Tsang M M C and Frutani S C 1989 Rapid moisture content determination of macadamia nuts by microwave drying. *Hort. Sci* 24, 694–695.
- Nelson S O and Kraszewski A W 1990 Dielectric properties of materials and measurement techniques. *Drying Technology* 8, 1123–1142.
- Silveira A M, Raghavan G S V and Meda V S 1999 Dielectric properties at varying temperatures of strawberries pre-treated, osmotically dehydrated and microwave dried. *ASAE International Meeting*, Paper No. 993147.
- Ziyad Mohamed M T, Galahitiyawa G and Chandrasa P B 2003 Nett outturn of made tea to green leaf in low country. *SL J Tea Sc.* 68, 48-56.