
NOTA TÉCNICA:

DETERMINATION OF MOISTURE CONTENT FROM GUACO WITH MICROWAVE OVEN

Ronicely Pereira Rocha¹, Evandro de Castro Melo², Lauri Lourenço Radunz³

ABSTRACT

This study was done to develop a quick method to determine moisture content of guaco's leaves (*Mikania glomerata* Sprengel), to assist in research on medicinal and aromatic plants. Guaco's leaves with moisture content between 7 to 82 % w.b. were exposed in a microwave oven set at 340, 570, 660 or 880 W, for 3, 4 or 5 minutes. In order to determine the regression equations, the results of moisture content determined by the microwave method were correlated with the values determined with standard gravimetric method. The most appropriate power and exposure time combination was found to be 660 W for 3 minutes. The microwave oven appears to be a viable alternative for determination of moisture content of guaco's leaves.

Keywords: drying, drying time, dry matter, *Mikania glomerata* Sprengel, stove.

RESUMO

DETERMINAÇÃO DO TEOR DE ÁGUA DE GUACO COM FORNO MICROONDAS

Objetivo deste estudo foi desenvolver um método rápido para determinar o teor de água das folhas de guaco (*Mikania glomerata* Sprengel), focando no apoio a pesquisa sobre plantas medicinais e aromáticas. Um forno de microondas foi utilizado para essa finalidade. Folhas de guaco com teor de umidade de 7 a 82% b.u. foram utilizados nos testes. Quatro níveis diferentes de calibração de energia (340, 570, 660 e 880W) e três períodos de tempo de exposição à radiação (3, 4, 5 minutos) foram usados para determinar o teor de água de folhas de guaco. A fim de determinar as equações de regressão, os resultados do teor de água encontrado utilizando-se o método de microondas foram correlacionados com os valores encontrados com o método padrão (método gravimétrico). Os resultados mostraram que a potência e tempo exposição mais adequados foram 660W e 3 minutos, respectivamente. O forno de microondas mostrou-se alternativa viável para a determinação do teor de água de folhas de guaco.

Palavras-chave: secagem, tempo de secagem, matéria seca, *Mikania glomerata* Sprengel, estufa.

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1- Agronomist, Post-doctorate student in Agriculture Engineering, Department of Agricultural Engineering, UFV - ronicely.rocha@ufv.br

2- Agronomist, Professor, Department of Agricultural Engineering, UFV - evandro@ufv.br

3- Agronomist, Professor, Department of Agricultural Engineering, UFFS - laurilr@gmail.com

INTRODUCTION

The use of medicinal plants is part of a competitive market, which includes pharmaceuticals, food, cosmetics and perfumery markets. In pharmaceuticals, plant extracts are especially relevant due to the use of their active substances as prototypes for medicine development and as sources of raw material, to obtain both pharmacological and adjuvant. Medicinal plants are also used to obtain medicines made exclusively from plant extracts such as phytotherapeutic medicines, whose use is limited by various factors including: cultivation, harvest period, climatic factors, humidity, brightness, part of the plant, transportation method, storage, drying process and extraction process which may all modify the composition of the products, directly affecting safety and efficiency (CALIXTO, 2001; SCHENKEL *et al.*, 2003).

Guaco (*Mikania glomerata* Sprengel), belonging to the *compositae* family, is a native plant of South America. It is a perennial, climbing plant with smooth wooden brown cylindrical branches, and green leaves with flat margins. Flowers grow in either round or oblong clusters along the stem and achene fruit are also found. Flowering does not occur in all regions of Brazil but is most common in the south. The plant is mainly used for medical purposes, especially as bronchodilators and is useful for treating respiratory tract diseases (flu, cough, snoring, bronchitis and asthma). It is also employed in rheumatism, neuralgia, febrifuge, depurative and cicatrizing (LOW *et al.*, 1999).

Water is an important component of many natural and man-made products. In agricultural production, moisture content is the single most important factor that determines the proper time for harvest, and optimum conditions for safe storage, and is also used in price determination. With the advent of precision farming and highly automated and computerized agricultural processes, there is a growing need to determine moisture content in real-time. Standard reference methods require oven-drying of a few samples under prescribed conditions for a few hours and sometimes days. These techniques are time-

consuming and sometimes inadequate when large amounts of material are involved (TRABELSI & NELSON, 2007). The determination of moisture content is a fundamental procedure for monitoring the drying process of agricultural products. Values considered safe for adequate storage of the product are known and should be respected for the maintenance of product quality during storage (VALENRINI *et al.*, 1998).

Microwave generates rapid volumetric heating of the material by altering the electromagnetic field to interact primarily with the water molecules and ions in food materials (DATTA, 2001). Advantage of microwave rapid heating is renowned for numerous applications, such as, heating (SAKIA *et al.*, 2005), thawing (TAHER & FARID, 2001), blanching (CHEN *et al.*, 1971), pasteurization and sterilization (WANG *et al.*, 2003), and drying (ADU & OTTEN, 1996; FENG & TANG, 1998; FENG *et al.*, 1999; GOKSU *et al.*, 2005; KHRAISHEH *et al.*, 2004; KROKIDA & MAROULIS, 1999; TULASIDAS *et al.*, 1995; ZHANG, *et al.*, 2009).

According to Hanna & Sharma (1988), you can use the microwave oven to determine the moisture content of a product with the exposure time to evaporate the water fixed. In order to ensure product quality and stable production, request on-line and nondestructive measurement, then realize the on-line closed-loop control to the entire production technological process, which propose higher requirement for the moisture content measurement method. Using the microwave oven for the material moisture content measurement can achieve the on-line real-time accurate measurement, and has good reliability and strong ability, also is insensitive to the influence of the color, the structure of the material and so on, besides, it can examine the measurement result has the representation, therefore it has the broad application prospect (VARITH *et al.*, 2007).

It is necessary to employ efforts to determine the exposure time and the correction factor for each product (MATA & GURJÃO, 1997). Unlike grains and seeds, which have methods for rapid determination of moisture content (HANNA & SHARMA, 1988; TRABELSI & NELSON, 2007; UYSAL *et al.*, 2009), processing of

medicinal plants is difficult to determine the end of the drying process. In this case has only the experience of the producer or the use of gravimetric method. With possible improvements on product quality attributes and drying process efficiency, microwave exhibits a great potential to be used for medicinal plants drying. Therefore, microwave drying to optimize quality, drying time and energy consumption is of great challenge for researchers.

Although many investigations have been carried out on microwave drying systems in the foodstuffs, little detailed analysis is available in the literature on the determination of moisture content of medicinal plants with microwave oven. A rapid determination of guaco's moisture content would be beneficial for a number of research aims. Our research objectives were to develop, characterize and evaluate the determination of moisture content from guaco's leaves using microwave oven while retaining other quality attributes comparable to that of commercial one (gravimetric method).

MATERIALS AND METHODS

The specie (*Mikania glomerata* Sprengel) utilized for drying process and determination of moisture content was cultivated at the Phytotechnic Department's Experimental Area at the Federal University of Viçosa – UFV (Minas Gerais, Brazil). The guaco's plants had one year when it was harvested.

The plants were harvested between 7:00 and 8:30 am and the material was forwarded immediately to the laboratory for selection, moisture content determination and subsequent drying. Selection included the removal of plant parts that: were in the decomposition stage (advanced ripening), contained pests or diseases, as well as other plants or parts of those which were present then the remaining sample was homogenized.

To carry out the tests, a microwave oven, Panasonic brand, with the following features was used: Capacity 40 L, voltage of 127 V, current 8.1 A, frequency 60 Hz, output power up to 900 W, velocity plate of 3 rpm. Preliminary tests

were performed with the microwave oven, where permanence times of product were 2, 3, 4 and 5 minutes combined with powers of 340, 570, 660 and 880 W, relating the results obtained with the values obtained by gravimetric method. The reason to use those combinations of time and power were that the majority of drying research with commercial microwave oven use powers between 300 to 900 W (ADU & OTTEN, 1996; CASADA & WALTON, 1985; CHAN ET AL., 2009; CRESPO ET AL., 2007; FENG & TANG, 1998; FENG ET AL., 1999).

According to the results obtained in preliminary tests, were chosen the permanence time of the product inside the microwave oven of 3, 4 and 5 minutes and the power of 660 W. For determination of moisture content by microwave oven method was used and fresh guaco's leaves with 82% wet basis and leaves previously dried with 77, 68, 57, 44, 26, 19 and 7% w.b. A fixed-bed dryer with upward air flow was used, equipped with a liquefied petroleum gas burner for heating the drying air, as described by Radünz et al. (2006).

The leaves were dried filling the tray with 0.5 kg per treatment. The control of drying air temperature was done with an automatic controller, with a variation of ± 2 °C, as described by Jesus et al. (2001). Temperature data was taken with the use of thermocouples, previously calibrated and placed in pre-set points of the dryer and coupled to an automatic data acquisition system (ADAS) that registered their values in a microcomputer. The drying air velocity was tracked by an anemometer.

After drying, the samples were packed in polyethylene bags (40 μ m) and stored in refrigerated chamber at 5 °C, until being submitted to determination of moisture content by microwave oven.

Each moisture content treatment was performed nine repetitions. On the basis of comparison for each repetition of tests in a microwave oven was performed in parallel determination of the moisture content by the gravimetric method. This method, recommended by Asae Standards (2000) for forage and similar plants, was done by placing 25 g of the product in a oven with forced air circulation at 103 ± 2 °C for 24 h, each done in triplicate.

To calculate the amount of water removed

from the guaco's leaves was used the following equation:

$$M_n = \left(\frac{W_w - W_d}{W_w} \right) 100 \quad (1)$$

where

M_n = moisture content (%) of material n, wet base

W_w = wet weight of the sample, gram; and

W_d = weight of the sample after drying, gram

To conduct the experiment, a randomized block statistical design was used, with three repetitions. In order to analyze the effects of quantitative factors on the considered characteristics, simple regression analysis was utilized. The criteria to define a more adequate regression model were: regression variance analysis ($P < 0.05$); the determination coefficient (R^2) and significance of regression parameters.

RESULTS AND DISCUSSION

Preliminary results indicated that the appropriate powers to the gravimetric method were 660 and 880 W, with exposure time of 3, 4 and 5 minutes. To conduct the tests were chosen the power 660W for economic reason, because the power of 880W removed the same proportion of water from guaco's leaves, while the powers of 340W and 570W removed only partially the moisture and those were discarded for this reason.

Correlating the moisture content obtained by gravimetric method with the ones obtained from microwave oven, using regression analysis, could obtain the equations of adjust linear. Table 1 shows the exposition time with their respective equations of adjust linear and coefficients R^2 .

Casada & Walton (1985) studied the determination tobacco moisture content by microwave oven heating. The moisture content of tobacco leaves were from 9

to 23% w.b. Samples of 50 g were heated for 18 s at maximum power of 625 W in a home microwave oven. Accuracy is improved with shredded samples by reducing the uneven heating that occurs with whole leaf samples thus lowering the standard error for the prediction equation from 1.04% w.b. to 0.68% w.b. They concluded that much of the remaining uneven heating is due to the inadequacy of the oven.

Figures 1, 2 and 3 show the analysis of residues for the three adjustment equations obtained by linear regression.

Observing Table 1 and Figures 1 to 3, could be concluded that the power of the 660 W and the three exposure times (3, 4 and 5 minutes) can be used as a method to determine the moisture content of guaco's leaves, because, by analyzing the coefficients R^2 , it was certificated that values were very close for the three exposure times, and the analysis of residues showed little dispersion.

However, as the three times can be employed, we recommend the use of shorter time (3 min), due to make the determination of moisture content faster and to reduce electricity consumption. It is Important to make sure that the work and conclusions are obtained for determining the moisture content of leaves from guaco and it is not possible to generalize the results for the other medicinal and aromatic plants, requiring further studies to other species in order to adjust the exposure time and the power of the microwave oven to determine the moisture content.

Crespo *et al.* (2007) utilized a microwave oven with two powers (400 and 900 W) and exposure time of 6 up to 8 minutes to determine moisture content of four forage species (*Medicago sativa* L., *Trifolium repens* L., *Trifolium pratense* L. and *Thinopyrum ponticum* Barkw. & D.R. Dewey). The authors concluded that the use of the microwave oven allows a quick and consistent moisture content determination in both powers and times studied, reducing significantly the drying time (6 to 8 min) compared to the standard evaluation (24 h).

Table 1. Exposition time with their respective equations of adjust and coefficients R^2

Time (minutes)	Equations	R^2
3	$Y = 0.97550X + 2.87409$	0.99359
4	$Y = 0.96832X + 3.07914$	0.99014
5	$Y = 0.98046X + 2.13670$	0.99460

Y = moisture content (w.b.) and X = time (min)

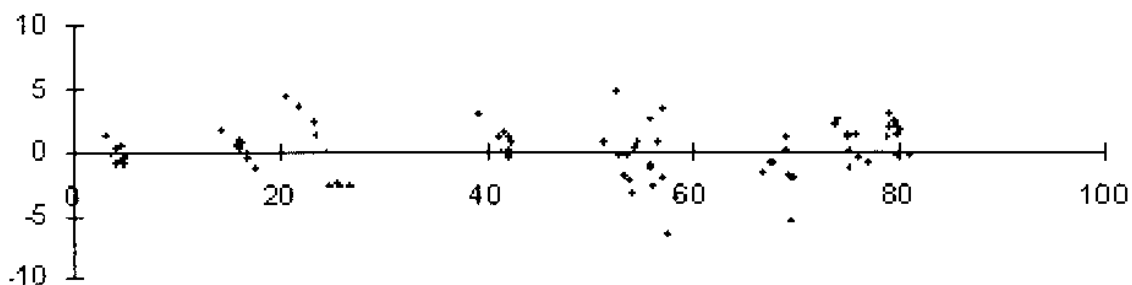


Figure 1. Analysis of residues for the exposure time of 3 minutes

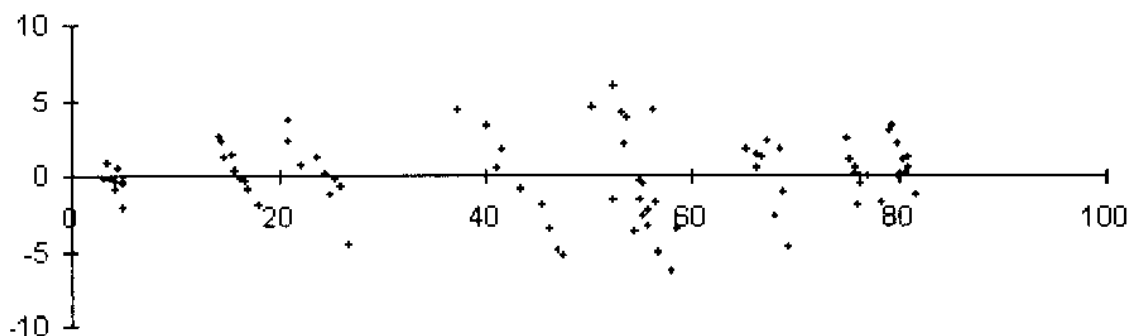


Figure 2. Analysis of residues for the exposure time of 4 minutes

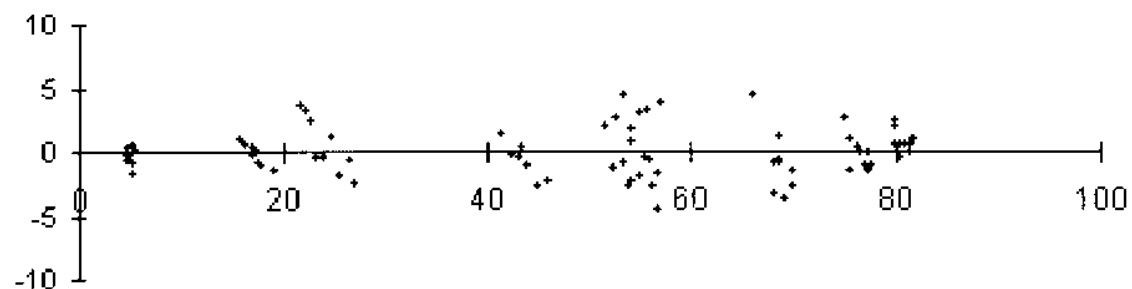


Figure 3. Analysis of residues for the exposure time of 5 minutes

Chan et al. (2009) studied the effects of different drying methods on the antioxidant properties of leaves of ginger species (*Alpinia zerumbet*, *Etilingera elatior*, *Curcuma longa*, and *Kaempferia galanga*). For each microwave-drying test, to determine the moisture content, 1 g of fresh leaves were dried in a microwave oven at 800 W for 4 min. This combination of exposure time and power were satisfactory for determinate moisture content of all ginger species.

CONCLUSIONS

- The power of 660 W and the three (3, 4 and 5 min) exposure times of leaves from *Mikania glomerata* inside the microwave oven were feasible to determine the moisture content in

the moisture range (7 up to 82% w.b.) studied, reducing significantly the drying time (3 to 5 min) compared to the gravimetric method (24 h); and

- It is recommended the shortest time (3 min) due to lower electricity consumption.

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