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EFFECT OF MICROWAVE VACUUM DRYING ON PROTEIN AND CHLOROPHYLL CONTENTS OF BLIND NETTLE (Urtica urens L.)

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Abstract

The effects of time, energy, and operational mode of microwave drying on the protein and chlorophyll contents of blind nettle extract were studied. Comparison of the modes showed that drying was faster in the normal than in the impulse mode. The kinetics of water loss followed a saturation-type behaviour. A virtual but significant increase in protein concentration was observed for the normal-mode, 300 W treatment. A constantly high energy input for a long time might damage proteins through the Maillard reaction.

Normal-mode technique did destroy part of the chlorophyll content. It was concluded that the faster the drying, the more chlorophyll remained.

Keywords: microwave vacuum drying, herbal extracts, protein, chlorophyll, blind nettle.

Introduction

Conventional drying procedures of foods need a long time or large amounts of energy. In many cases use of vacuum during the drying process has been proved to be advantageous. Recently, an interesting variant of this technique, microwave vacuum drying, has been developed and has become popular in food processing (WIESENHÖFER and WESTERMEIER, 1989). Microwave vacuum drying has been especially useful in drying pastes, powders or porous materials. In Hungary, microwave vacuum drying has been used for producing instant herbal extracts, teas and instant coffees. In microwave vacuum dryers, as with conventional microwave equipment, the heat needed for drying is generated by the absorption of electromagnetic radiation by the molecules of the substance to be dried. The energy is transformed into kinetic energy, especially by water. The increase in kinetic energy makes the molecules vibrate more intensively. This process is followed by a temperature increase and evaporation of water. The warming up is homogeneous. Therefore, no temperature gradient is generated across the sample, thus the drying process is in a steady state. The vacuum produced in the dryer lowers the vapour pressure of the liquid, thus, the combination of vacuum and microwave energy results in a gentle but quick drying.

A literature search has provided no information regarding the effects of microwave vacuum drying on nutritionally or pharmaceutically relevant compounds. The scope of the present study was therefore to investigate if microwave vacuum drying has any destructive effect on the sample being dried.

As a test material, a dried extract of blind nettle was chosen, due to its significance in homoeopathic medicine.

Materials and Methods

Microwave Vacuum Drying

Equipment: Labotron 600 A PVI, Industries Micro-Ondes Internationales, France.
Operational modes: (1) Normal: operation with continuous microwave energy input. 300 W or 600 W for given time periods. (2) Impulse: operation with microwave energy input, (300 W for 10 s and 0 W for 13 s) or (600 W for 10 s and 0 W for 13 s) for given time periods. Operational times: 1, 3, 5, 7, 10 or 15 min.

Nettle Samples

Preparation: Freshly harvested leaves of blind nettle (Urtica urens, L.), solar-dried, were extracted with hot water for 15 min, then filtered off. The extract was concentrated and crystalline maltodextrin was added (40%, DM basis) to the extract. The mixture was spray-dried with an outlet air temperature of 80 °C (original sample). The original sample was then remoisturized up to 30% moisture content. 5–5 grams of this paste were then microwave vacuum dried.

Microwave Experiments

Samples in open glass containers were placed symmetrically on the rotating disc of the equipment and covered by a glass bell. Three parallel samples were used in each experiment. Microwave vacuum treatments were carried out in the two operational modes for different operational times. The samples were then powdered and analysed.

Analytical Methods

Moisture content: AACC method (Amer. Assoc. Cereal Chemists, 1969).
Protein content: Lowry method in a continuously flowing ('Contiflo') system (LÁSZTITY et al., 1975).
Chlorophyll content: AOAC method (Assoc. Official Analytical Chemists, 1970).

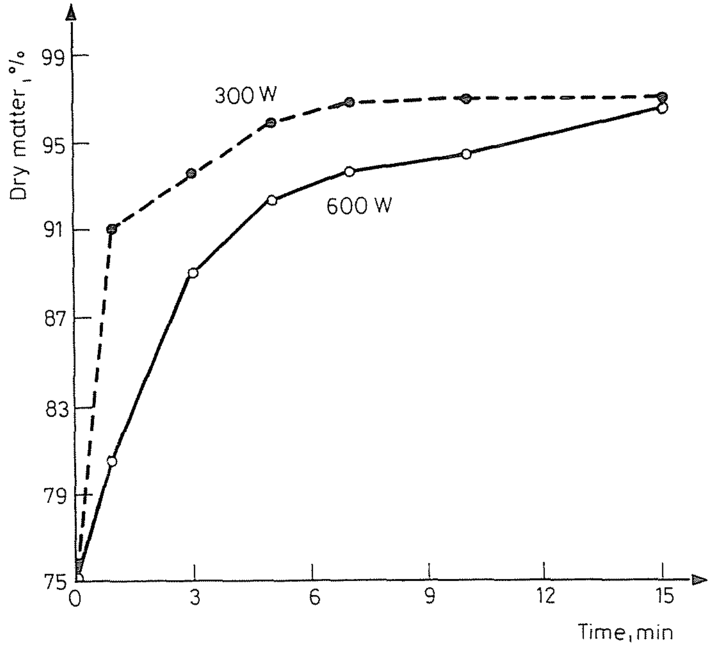

Fig. 1. Change of dry matter content. Mode: normal

Results and Discussion

The results of analysis are summarized in *Table 1* and demonstrated in (*Figs. 3–6*). Changes in dry matter content as a function of time are shown in *Figs. 1–2*.

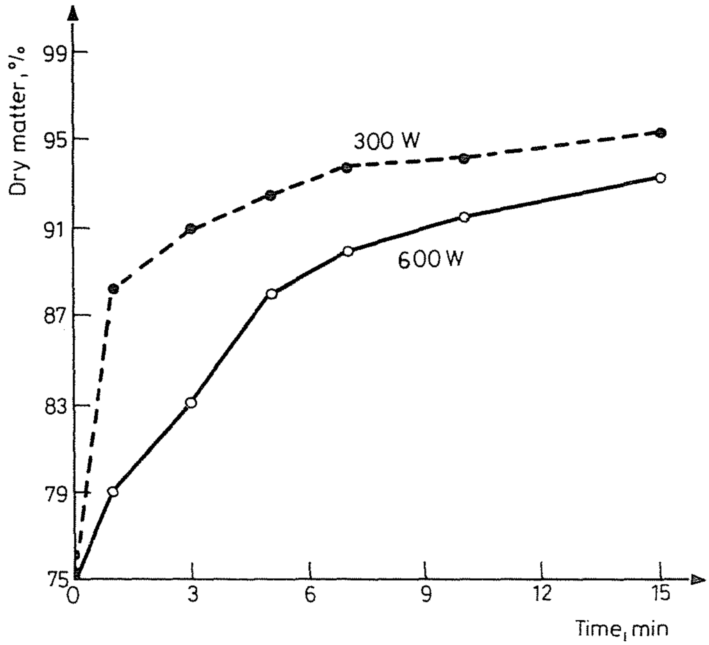

Fig. 2. Change of dry matter content. Mode: impulse

The higher the energy input, the faster the drying process regardless of the mode used (*Figs. 1–2*). Comparison of the modes showed that drying was faster in the normal than in the impulse mode. The kinetics of water loss followed a saturation type behaviour which is a general characteristic. In *Figs. 3–4* the time-dependent changes in protein contents determined are shown. A virtual but significant increase in protein concentration could be observed in the normal mode, 300 W treatment, which can be explained by assuming that microwave vacuum drying makes proteins more available, i.e. more reactable with e. g. Folin reagent. It seems, however, hard to explain why the lower the energy input the better the availability of proteins in the normal mode. A constantly high energy input for a long time might damage proteins through the occurrence of Maillard-type reactions, etc. This virtual increase in protein content could not be observed so evidently in the impulse mode. It may reflect that the impulse technique is more gentle than the normal mode. The normal-mode technique did, however, destroy part of the chlorophyll content. As the destruction was larger at lower energy input (*Fig. 5*), it was concluded that the faster the drying, the more chlorophyll remains protected. A small energy input for a long time may destroy more chlorophyll than higher energy for a short time.

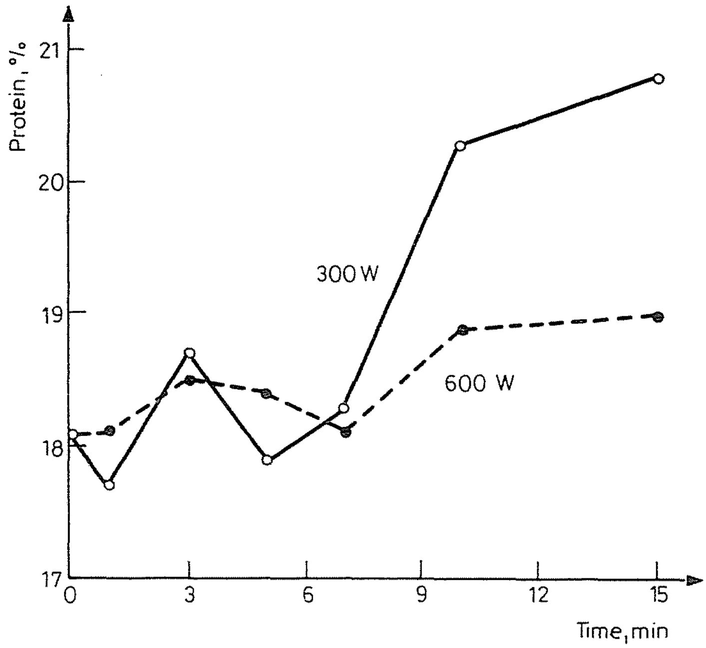

Fig. 3. Change of protein content. Mode: normal

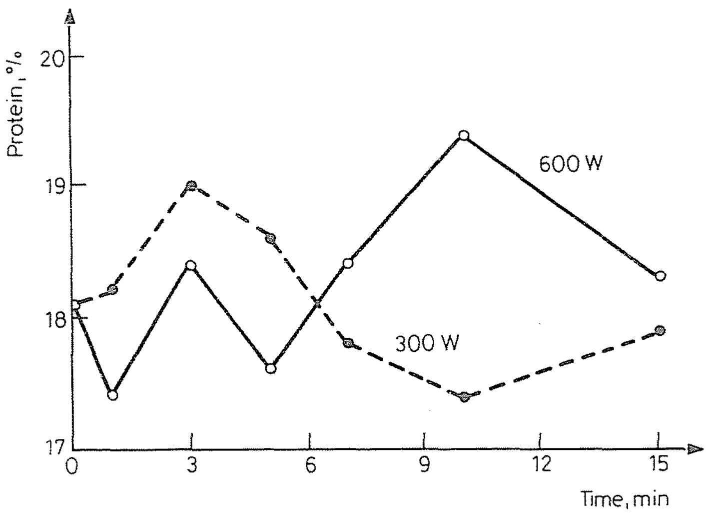

Fig. 4. Change of protein content. Mode: impulse

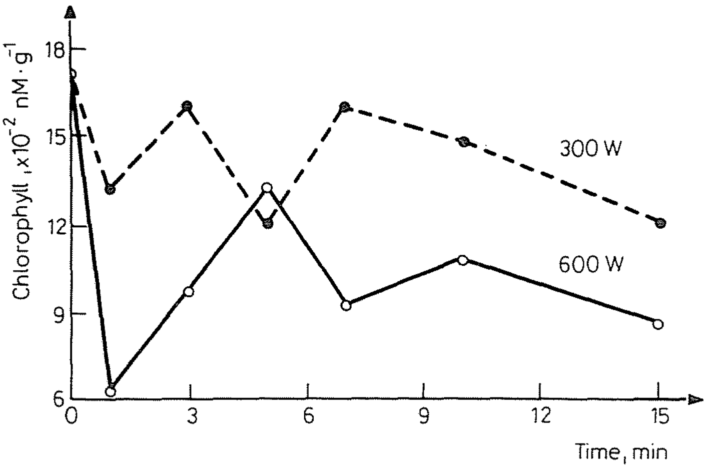

Fig. 5. Change of chlorophyll content. Mode : normal

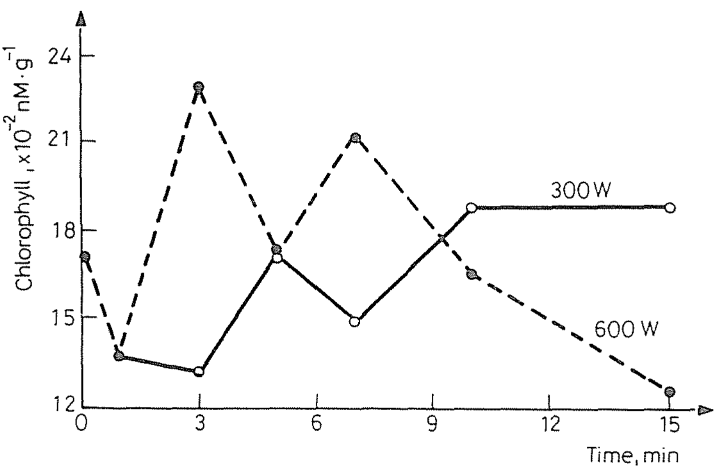

Fig. 6. Change of chlorophyll content Mode: impulse

In the impulse mode (*Fig. 6*) the above observation was but partly valid: over the 9 min treatment the higher energy input resulted in greater loss of chlorophyll.

Table 1
Average values* of protein and chlorophyll contents (DM basis), microwave vacuum dried blind nettle samples.

Sample	Operational mode	Operational time (min)	Power (W)	Protein (%)	Chlorophyll (nmol/g)
1+	–	–	–	18.1	1711
2	n	1	300	17.7	629
3	n	–	300	18.7	972
4	n	5	300	17.9	1316
5	n	7	300	18.3	915
6	n	10	300	20.3	1087
7	n	15	300	20.8	858
8	n	1	600	18.1	1316
9	n	3	600	18.5	1602
10	n	5	600	18.4	1201
11	n	7	600	18.1	1602
12	n	10	600	18.9	1487
13	n	15	600	19.0	1204
14	i	1	300	17.4	1373
15	i	3	300	18.4	1316
16	i	5	300	17.6	1716
17	i	7	300	18.4	1487
18	i	10	300	19.4	1888
19	i	15	300	18.3	1888
20	i	1	600	18.2	1373
21	i	3	600	19.0	2288
22	i	5	600	18.6	1716
23	i	7	600	17.8	2116
24	i	10	600	17.4	1659
25	i	15	600	17.9	1258

* Based on three determinations
\+ Original sample
n Normal
i Impulse

Microwave vacuum drying was found to be suitable for drying herbal extracts. It was important to adjust the modes, energy inputs and time for achieving quick but gentle drying. In the normal mode smaller energy input proved to be efficient and more useful. With the impulse technique a higher energy input made the drying process faster but contributed more significantly to the loss of the active compound than a smaller energy input.

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