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IMPACT OF PRESSURE ON THE BEHAVIOUR OF AROMATIC COMPOUNDS DURING THE MICROWAVE-VACUUM DRYING PROCESS LEAFS OF PARSLEY

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Abstract. The aim of this paper was to describe the influence of applied pressure during the process of microwave-vacuum drying on the behaviour of aromatic compounds in leafs of parsley. The SDE *(Simultaneous Distillation and Extraction)* method was used to acquire the extract. The testing of the extract acquired was performed using a gas chromatography. Four characteristic compounds were obtained during the examination and the degree of their degradation in the function of pressure was determined. It was proved that the microwave-vacuum method is characterised by lower degradation of particular compounds than during the convective process. Moreover, in two cases we observed a meaningful increase compared to the fresh material. During the work we did not observe any significant influence of the pressure range applied on the reaction of aromatic compounds in leafs of parsley.

Keywords: microwave-vacuum drying, leaf parsley, aromatic compounds

INTRODUCTION

The microwave drying method has many advantages resulting from the specific properties of microwaves. An example may be short drying time as compared to methods used till today (Szarycz *et al.* 2002). The use of partial vacuum during the microwave drying can considerably shorten the drying process, i.e. the time of contact between the material and oxygen (Drouzas *et al*. 1996). Reduced pressure results in a drop of the water boiling point, and thus of the process temperature. Through this, precious constituents contained in fruits and vegetables (proteins, vitamins) are not destroyed as it happens during conventional methods (Szarycz *et al*. 2003).

In the vegetable processing industry, besides vegetables processed for various types of additives, a big role is played by condimental vegetables having the task of giving a meal a specific smell and taste. Those vegetables are often used in the form of dry additives. Conventional drying methods lead to a significant degradation of nutritive and aromatic compounds. An ongoing testing program is performed at the Institute of Agricultural Engineering of the Agriculture University of Wrocław on the application of the microwave-vacuum method for the drying of vegetables and fruits. The examinations performed till today have demonstrated that this method allows to maintain, for instance, vitamins at the level of 60%. Additionally, we found that drying shrinkage occurring during microwave vacuum drying can be described as little compared to shrinkage caused by convective drying (Szarycz *et al*. 2003b). In the case of aroma compounds, pre-examination proved small degradation. In the meantime, the other two cases showed an increase of aroma content compared to fresh material.

The foregoing taken into account, the aim of the tests was to determine the impact of the application of pressure on the behaviour of aromatic compounds dried using the microwave-vacuum method.

MATERIALS AND METHODS

Leafs of parsley of the Vita variety was used during the testing. The material, cleaned and washed, was split into three groups: the first one to be subjected to testing for the level of aroma compounds included in fresh material, the second one to be dried with the microwave-vacuum method using three pressure ranges, the third one being convection-dried material.

The microwave-vacuum drying process was performed on a test stand located at the Institute of Agricultural Engineering in Wrocław, as presented in Figure 1. In order to determine the impact of pressure on the behaviour of aromatic compounds, the following pressure ranges were selected: 2-4, 4-6 and 6-8 kPa. The microwave power applied was 480 W.

To make a comparison of the impact of the microwave-vacuum drying method, the convection drying process was performed, on the drying stand as shown in Figure 2. The drying air temperature was 60^{o} C and the velocity of the drying agent flow was 0.4 m s^{-1}. The microwave-vacuum and the convective drying processes were repeated three times each.

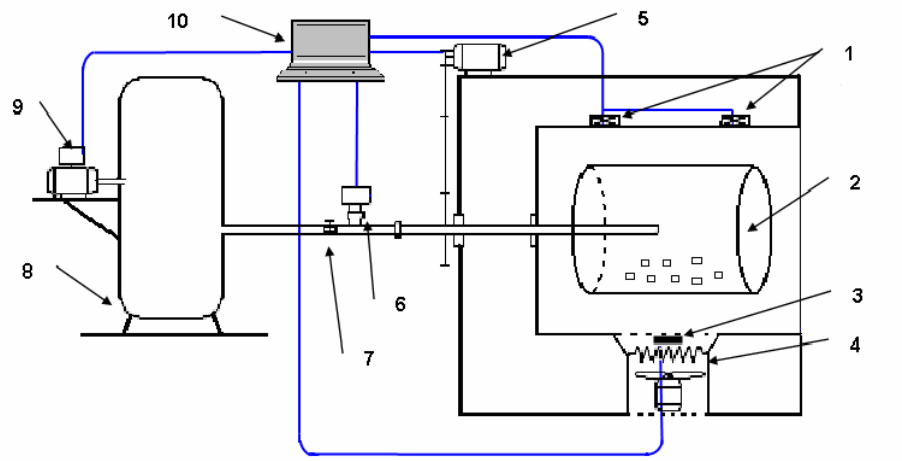

Fig. 1. Scheme of microwave-vacuum drying stand
1– magnetron, 2 – drying chamber, 3 – temperature sensor, 4 – heaters, 5 – electric motor and gear, 6 – vacuum meter, 7 – cut-off valve, 8 – equalizing tank, 9 – vacuum pump, 10 – computer

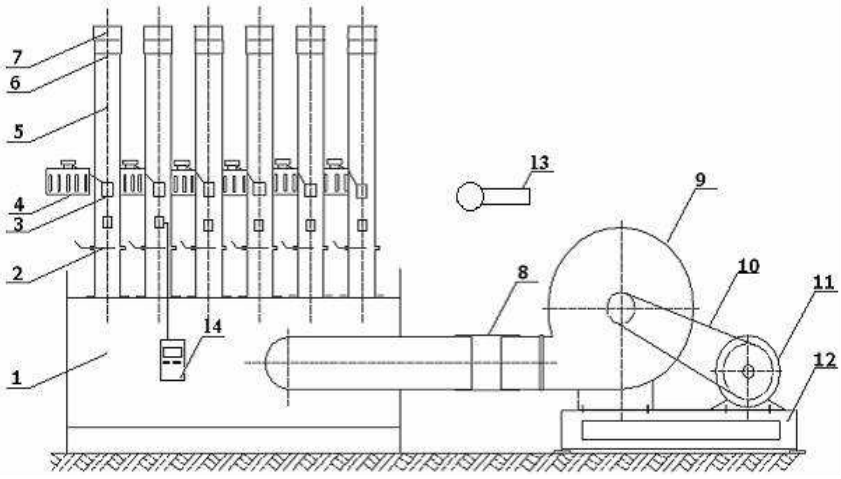

Fig. 2. Scheme of convection drying stand

1 – surge tank, 2 – regulating bolt, 3 – heating element, 4 – autotransformer, 5 – air supply channel, 6 – sustaining element, 7 – dried material basket, 8 – flexible link, 9 – fan, 10 – belt transmission, 11 – electric motor, 12 – sustaining element, 13 – air speed in particular column was measured with hand operated wing anemometr A– 1200 M2, 14 – electric appliance used to read out the temperature TP 03

Upon drying, individual material portions were subjected to testing of the behaviour of aromatic compounds on the test stand as demonstrated in Figure 3. A method of simultaneous distillation with water steam and extraction (the so-called SDE method, *Simultaneous Distillation and Extraction*) was used (Godefroot *et al.* 1981). In the method, the test material in the amount of ca. 5 g (dried material) or ca. 20 g (fresh material) is placed into a distilling flask (A) together with distilled water and an aqueous solution of foam-reducing agent. An organic solvent that does not mix with water, with a density higher than that of water (dichloromethane was used), is poured into the other flask. The warming-up of both the flasks is initiated and the distillation process starts in both of them. In the portion of the apparatus where the test material is to be found, the distillation with water steam occurs; the condensed distillate containing volatile (aromatic) substances is extracted in part C. The extract obtained this way flows down via arm D to flask B (here follows a gradual concentration of volatile substances contained in the biological material), on the other hand, the rafinate is returned to flask A and, through this, the process can be practically run over any period of time.

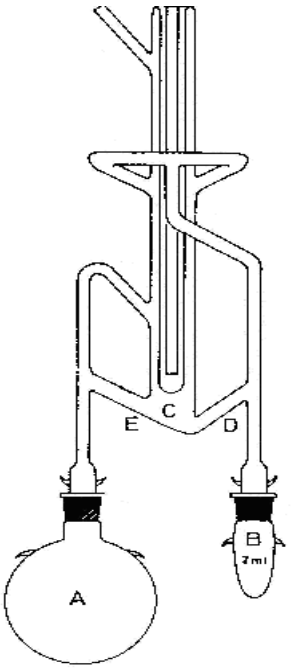

Fig. 3. Examining stand based on the Likens-Nickerson method

The gas chromatograph, type Agilent Technologies 6890 N, provided with a capillary column HP-5 (30 m, 0.32 mm i.d., 0.25µm film) and a flame-ionization detector, H_2 carrier gas, 2 ml min^{-1} flow, was used for the testing of obtained extract (Godefroot *et al.* 1981).

The fresh organic extracts acquired were tested by means of capillary gas chromatography (GC). Signals from four major constituents of the mixture of volatile substances contained in parsley were determined on obtained chromatograms. The ratio of the area of selected constituents per one gram of the vegetal fresh material dry substance was determined. We gave the average scores gained during the examination, including those gained during microwave-vacuum and

convective drying, moreover we included the fresh material. In order to make the comparison easier, the obtained results were converted to percentages for the fresh material, whereby individual compounds in the fresh material were treated as 100% of the given compound.

RESULTS AND DISCUSSION

The presence of four major constituents was found in the extract from parsley leaves as obtained with the Likens-Nickerson (SDE) method. They were identified using GC/MS. Those were – in the sequence of retention times in the capillary gas chromatography – limonen (*1*), a hydrocarbon having the summary formula, $C_{10}H_{12}$ (*2*), 4-metoxy-6-(2-propenyl)-1,3-ben-zodioxol (*3*), and apiol (*4*). In the examinations conducted till today using the microwave-vacuum method for the acquisition of dried material, it has been found that the reaction of vitamin shapes at the level of 60%. It has also been found that the pressure does not have, within a certain range, any impact on the drying kinetics. The microwave warming-up results in a considerable shortening of the drying time, which is due to limited contact with oxygen (Szarycz *et al.* 2002). An additional reduction of the contact with oxygen can be obtained by using reduced pressure. A considerable pressure reduction results in a drop of the water boiling point, and so for 2 kPa water boils at 16^{o}C and for 8 kPa it boils at 42^{o}C.

Table 1. Results of percentage analysis of the content of individual compounds

Compounds	Microwave-vacuum drying (%)			Convection drying (%)
	Pressure (Kpa)			
	2-4	4-6	6-8	
(*1*)	69,6	70	70,8	67,6
(*2*)	131	131,2	132,8	51,9
(*3*)	65,4	64,1	66,8	52,1
(*4*)	253	255,1	257,7	98

Table 1 presents the results of analyses as expressed with percentage retention of individual compounds in relation to those contained in the fresh material, being considered as 100% of each of them. It follows from performed analyses that for applied convection drying we have to deal with a degradation of individual aromatic compounds, starting with 2% for apiol (*4*), ending with up to 48% for com-

pound (*2*). With the application of reduced pressure with a simultaneous microwave warming-up, we have to deal with a much lower degradation for the compounds limonen (*1*) and compound (*3*), shaping at the level of 30%. For the other two compounds there followed an increase – for apiol (*4*) by 155% and for compound (*2*) by 31%. This rise can be produced by a considerable limitation of oxygen in the process duration by using a reduced pressure with the consequent significant reduction of the water boiling point. The rise in the amount of some compounds can also be associated with chemical transformations occurring inside the material, stimulated by the interference of microwaves. The statistical analysis performed did not show any meaningful influence of pressure on particular aromatic compounds reaction in the case of drying leaf parsley using the microwave-vacuum method.

CONCLUSIONS

1. During the microwave-vacuum drying no substantial impact of pressure within selected pressure ranges on the degree of reaction of aromatic compounds in leaf parsley was found.
2. In the dried material obtained by means of the microwave-vacuum drying we have to deal with a degradation reaching 30% for limonen (*1*) and compound (*3*), and for the other compounds there followed a rise for apiol (*4*) – by ca. 155% and for compound (*2*) by ca. 31% in relation to their contents in the fresh material.
3. The convection drying produced a degradation starting with 2% for apiol (*4*) and ending with as much as 48% for compound (*2*).

REFERENCES

Szarycz M., Kramkowski R., Kamiński E., 2002. Application of microwaves for the drying of alimentary products. Part II. Consequences of the microwave power control (in Polish). Problemy Inżynierii Rolniczej 2, 55-63.

Godefroot M., Sandra P., Verzele M.,1981. New method for quantitative essential oil analysis. Journal of Chromatography. 203, 325-335.

Szarycz M., Kamiński E., Jałoszyński K., Szponarska A., 2003. Analysis of microwave drying of parsley in reduced pressure conditions. Part I. Drying kinetics of blanched and non-blanched parsley (in Polish). Acta Scientiarum Polonarum, series Technika Agraria, 2(2) ,17-27.

Drouzas A. E., Schubert H., 1996. Microwave application in drying of fruits. Journal of Food Engineering, 28, 203-209

Szarycz M., Kamiński E., Jałoszyński K., Szponarska A., 2003. Analysis of microwave drying of parsley in conditions of low pressure. Part II. The shrinkage during drying and rehydration of dried material, (in Polish). Acta Scientiarum Polonarum, series Technika Agraria, 2(2), 29-36.

WPŁYW CIŚNIENIA NA ZACHOWANE ZWIĄZKÓW AROMATYCZNYCH W CZASIE SUSZENIA MIKROFALOWO-PRÓŻNIOWEGO PIETRUSZKI NACIOWEJ

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S t r e s z c z e n i e. Celem pracy było określenie wpływu zastosowanego ciśnienia w czasie suszenia mikrofalowo-próżniowego na zachowanie związków aromatycznych w pietruszce naciowej w odniesieniu do materiału świeżego i suszonego konwekcyjnie. Do pozyskania ekstraktu wykorzystano metodę SDE (*Simultaneous Distillation and Extraction*). Badania uzyskanego ekstraktu przeprowadzono przy użyto chromatografu gazowego. Wyróżniono cztery charakterystyczne związki i określono ich stopień degradacji w zależności od ciśnienia. Wykazano, że metoda mikrofalowo-próżniowa charakteryzuje się dużo mniejszą degradacją poszczególnych związków w odniesieniu do suszenia konwekcyjnego, a w przypadku dwóch z nich nastąpił znaczący wzrost w odniesieniu do materiału świeżego. W czasie badań nie stwierdzono istotnego wpływu zastosowanego zakresu ciśnień na zachowanie związków aromatycznych w pietruszce naciowej.

S ł o w a k l u c z o w e: suszenie mikrofalowo-próżniowe, pietruszka naciowa, związki aromatyczne