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FLOW CHARACTERISTICS OF SAGE AND PEPPERMINT LEAVES

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A b s t r a c t. The separation of the desirable parts of a medicinal plant in air flow is a widely applied procedure. Therefore there has been established the goal to measure flow characteristics of sage (*Salvia officinalis* L.) and peppermint (*Mentha piperita* L.) leaves. Leaves were picked from stem and classified according to dimensions in four (sage) and three (peppermint) fractions. The description of fraction collectives according to dimensions, after either manual or laboratory screen sorting, and data entering into log-normal distribution paper, is given by median and standard deviation. The flow characteristics defined by the air velocity of fluidization of a material layer show the possibility of separating sage leaves and stems, due to a significant difference in velocity values, 1.75 m s^{-1} maximum for leaves and 3.35 m s^{-1} for stems. Due the difference in flow characteristics the separation of different peppermint leaves fractions is also possible. The values of air velocity of fluidization for large peppermint leaves and stems were not significantly different, 3.50 m s^{-1} and 4.18 m s^{-1}, respectively. Therefore, for their separation, a machine with more homogenous air velocity field is required.

K e y w o r d s: medicinal plants, flow characteristics, peppermint, sage

INTRODUCTION

The separation of parts of medicinal herbs aimed to set apart desirable from undesirable components, as well as sorting, most frequently according to dimensions, is a processing step which can not be avoided [5]. It makes possible the isolation of plant parts having active substances from those possessing only small concentrations or none. At the same time other undesirable constituents like weed or dust can be removed. The separation is based on difference of physical characteristics of constituent parts of the material for treatment. Most frequently met in practice is separation based on differences in dimension, shape, flow characteristics, coefficient of friction and rolling resistance [4]. Application of separation in air flow by various winnowing machines or vertical 'zigzag' separators is rather widespread. Designers and constructors should be acquainted with flow characteristics of components that are being separated in order to be able to design a corresponding device. Successful separation means that the flow characteristics of these parts must be sufficiently different. In available literature no data were found concerning the flow characteristics of medicinal plants. Therefore, a goal was defined to determine the flow characteristics of sage and peppermint medicinal plants most frequently grown by local growers. In both plant species, the active substances are found in their leaves. After separating the leaves from the stem a mixture of leaves of various dimensions and stems is obtained. The leaf mass consisted of a small number of complete leaves and parts of crumbled leaves of various dimensions. The fractions of different leaf dimensions are separated by using the mechanical separators with screens. It is postulated that the flow characteristics of the individual leaf fractions are different and also that they significantly differ from the stem flow characteristics to enable separation with the air separators.

MATERIAL AND METHOD

Sage (*Salvia officinalis* L.) and peppermint (*Mentha piperita* L.) of the first harvest and the second year of production, cultivated at the Department of Medicinal Plants, Institute of Field and Vegetable Crops, Novi Sad, were used. The sample were prepared after the harvest of 1995. Mesurements were taken from July to October 1995. Stems were separated after manual leaf picking. By using screen separators with nominal openings 4, 12 and 16 mm the leaves and crumbled leaves were sorted into fractions according to their size. The various fractions of leaf dimensions presented in Table 1 were obtained. In the case of peppermint there was no fraction over 16 due to the small quantities of material in that fraction. The remaining naked stems were cut into 50 mm length making it possible to work with a device for determinating flow characteristics. The dry matter content was 89 ±0.5 % for all samples, which coresponds to usual storage humidity.

A widespread method for expressing particle size [3,7] was used to describe, for each fraction, the dimensions of leaves and crumbled leaves. It was supposed that leaf dimensions in one fraction could be described by logarithmic normal distribution, which is rather spread in size collectives generated by scrambling or chopping of plant material.

The particles of each fraction were classified into groups according to dimensions. Leaf parts smaller that 10 mm were classified into groups by laboratory screens with normal openings ranging from 0.63 to 6.3 mm with the application of basic row R 10 [8]. Larger particles were sorted manually according to dimensions into diapasons of 10, 16, 20, 31.5, and 50 mm. Mean geometric values were used as representative values for particles smaller than 10 mm. Particles larger than 10 mm were manually sorted within the group and representative values determined. This was necessary since particles, particularly complete leaves, differed in both length and width. The mass of material of the individual groups was measured and the percentage and cumulative percentage of undersized particles calculated.

For each group five measurements were taken, and since it was found that some values do not differ significantly from the mean value, the mean value was used for treatment and presentation. Data were plotted into a logarithmic normal probability graph paper [7,9] for a representative dimension of the group. A representative straight line was defined using the regression analysis of linearized co-ordinates of certain points, pairs: value of cumulative percent undersized particles - representative dimension of the group, while on the basis of the regression coefficient an estimation was made to determine whether the obtained values could be represented by a straight line. On the basis of data drawn on the logarithmic normal probability graph paper, median and standard deviation were estimated and used to describe a separate fraction of leaves or crumbled leaves according to their dimensions.

The flow characteristics of a layer of plant material were expressed in values of pseudovelocity

Table 1. Sage and peppermint fractions obtained after shelling from stems and classification on screens with nominal openings of 4, 12 and 16 mm

Generation of fraction	Fraction	Sage	Peppermin
Passing through 4 mm screen	Under 4	x	x
Over 4 mm screen, under 12 mm screen	4-12	x	x
Over 12 mm screen, under 16 mm screen	12-16 (over 12*)	x	x
Retained on the 16 mm screen	Over 16	x	-

* For peppermint.

of air, hereinafter - air velocity, at which the individual fluidization phases in air flow occur. The device shown in Fig. 1, was used to measure flow characteristics of a material layer [1,2].

The fan - 1 generates an air flow which passes through the measuring pipe - 2 which is long enough to provide the correct measurement of air velocity at the measuring orifice - 3. The buffer - 4 calms down the pulsing of the air flow produced by fan's operation. The Laminator - 5 equalisies the field of velocity over the cross section. The plant sample is placed on the perforate plate - 6 of the vertical glass pipe - 8. The static measuring rings - 9 makes it possible to determine the pressure drop through the layer of material, while the screen -10 contains the material when brought to the fluidization phase. The air flow - air velocity - is regulated by damping of the fan on the inlet side and by opening the disloading opening at the outlet side.

The pressure drop, which served for calculating air velocity, was measured at the measuring pipe - 2, orifice - 3, by using a device within an accuracy of 0.013 Pa. The measuring method is described in DIN 1952 [6]. The same device was used to measure the pressure drop through the material layer, by attaching it to the static measuring rings - 9. On the basis of the obtained data the specific pressure drop (Pam^{-1}) was calculated.

The experiment was performed in five replications for each leaf and stem fraction. Values of air velocity, which gradually increased, and the pressure drop through the material layer were measured. The glass pipe made it possible to observe the behaviour of the material with each increase an air velocity. Special attention was paid in measuring the values of air velocity and pressure drop through the material layer in the 'blubber' phase, phase of creation of 'canals' phase and the complete fluidization of material layer. On the basis of the obtained data the dependence of specific pressure drop on air velocity were plotted using computer program.

RESULTS AND DISCUSSION

The regression coefficients for the points on logarithmic normal probability graph paper representing cumulative percent of particle

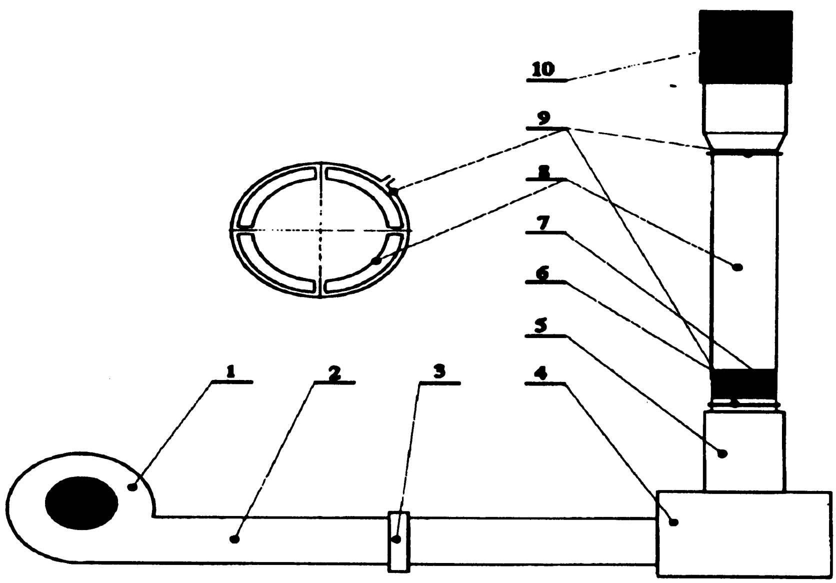

Fig. 1. Device for the adjustment of flow characteristics of plant material, [1]. 1 - fan, 2 - measuring pipe, 3 - orifice, 4 - buffer, 5 - air velociy uniformer, 6 - perforate plate, 7 - sample of plant material, 8 - glass pipe, 9 - measuring ring, 10 - screen.

dimensions of the individual classes were always over 0.85 and in the majority of cases even over 0.95. This confirms that the collective of particle dimensions may be represented as a logarithmic normal distribution. The obtained data of the individual fractions are shown in Table 2.

It was noticed during the measuring that some of the treated particles had been cracked during the laboratory screening, leading to the conclusion that the obtained median values were somewhat lower than the real ones. Since the mass part of the smallest particles is minute, the error can be neglected. In Fig. 2 the dependence of specific air pressure drop through the material layer from air velocity in the individual peppermint leaf fractions and stems is shown. The same was obtained for sage.

The air velocity values at which the individual fluidization phases of material layer took place are given in Table 3. According to the data the hypothesis that the flow characteristics of certain leaf fractions are different is confirmed, as well as that the flow characteristics of steme significantly differ from that of leaves. In sage, an increase in leaf size was accompanied at the beginning with a decrease, and then with an increase, in the air velocity resulting in the fluidization of material layer. Differences of air velocity resulting in fluidization are small. Therefore with an insufficiently perfect device for separation in air flow, and unequal field of air velocity, it would not be possible with certainty to separate the individual fractions. Since the air velocity of 3.35 m s^{-1} at which stem fluidization

Table 2. Median and standard deviation of leaves fractions

Deviation of leaves fractions	Sage				Peppermint		
	Under 4	4 - 12	12 - 16	Over 16	Under 4	4 - 12	Over 12
Median (mm)	3.6	16.5	39	70	1.8	5.8	16.5
Standard deviation (mm)	0.85	1.16	0.58	0.77	0.48	0.75	0.32

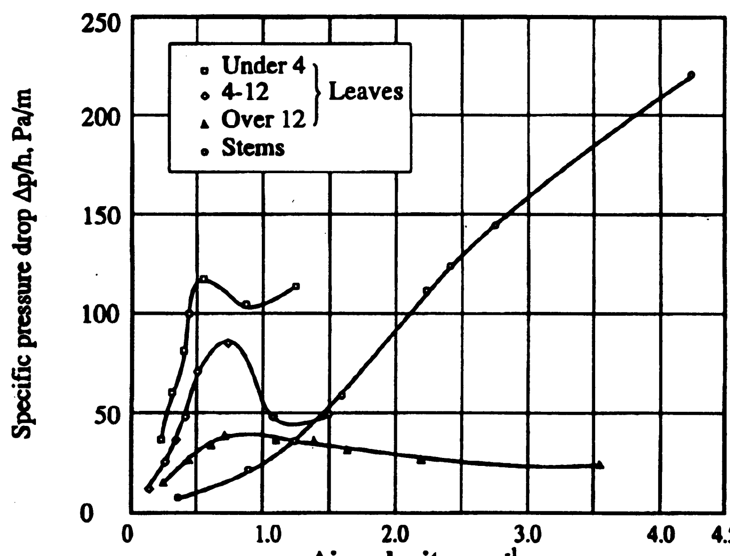

Fig. 2. The dependence of the specific pressure drop through material layer on air velocity in different peppermint leaves fractions and stem.

Table 3. Values of air velocity for the fluidization phases of the material layer - different sage and peppermint leaves fractions and stem

Phase of fluidization	Air velocity ($m\ s^{-1}$)								
	Sage					Peppermint			
	Under 4	4 - 12	12 - 16	Over 16	Stem	Under 4	4 - 12	Over 12	Stem
Blubber	0.58	0.62	0.99	1.25	2.25	0.52	0.68	0.71	2.33
Valves	0.73	0.75	0.99	1.48	2.70	0.79	1.04	1.36	2.78
Fluidization	1.25	1.33	1.24	1.75	3.35	1.18	1.47	3.50	4.18

occurred is considerably higher than the highest value of leaf fluidization of 1.75 m s^{-1}, a successful separation of leaves from stem can be expected.

In peppermint a regular increase in air velocity resulting in fluidization as leaf size increased was obtained enabling the separation of leaves under 4 and 4-12 from those over 12. Air velocity in the case of fluidization of material layer of a fraction over 12 was 3.50 m s^{-1} being considerably higher than that causing fluidization of fractions under 4 and 4-12 (1.18 and 1.47 m s^{-1}, respectively). On the other hand, it is less different from the air velo-city causing peppermint stem fluidization (4.18 m s^{-1}). In other words, separation of large from small leaves in air flow is possible while a successful separation of stems from large leaves requires the maximum homogenous air flow field in the device for separation as it is in 'zigzag' separators while not in simple winnowers.

CONCLUSIONS

The hypothesis that, in relation to the size, flow characteristics of different fractions of sage and peppermint leaves are different and that flow characteristics of stems differ from those of leaf fractions is confirmed. On the basis of the obtained values of pseudoair velocity enabling material layer fluidization, one may conclude that separation of sage fractions is almost not attainable, whereas separation of stems from leaves is certain. In peppermint the separation of the largest leaves from smaller fractions in air flow separators is attainable. Separation of peppermint stem from largest leaves requires a device with a homogenous field of air velocity, since the air velocity at fluidization of material layer varies to a smaller extent.

The obtained results will help designers and constructors in their efforts to design adequate devices for separation of sage and peppermint in air flow.

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