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EFFECT OF COLD DRYING ON CHEMICAL, MICROBIOLOGICAL AND SENSORY CHARACTERISTICS OF AROMATIC HERBS

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Abstract
The aim of this research was to evaluate the impact of cold drying, compared to traditional drying, on the quality of four different aromatic herbs. Despite these preliminary data did not show important differences on chemical, microbial and sensory characteristics of the herbs submitted to the two treatments, cold drying deserves attention for the advantages on the energy balance of the process and the possibility of recovering vegetation water usable in food and cosmetic preparations.

Keywords*: cold drying, traditional drying, aromatic herb, antiradical activity.*

1. Introduction

Aromatic herbs are usually marketed as dry. Dehydration is a powerful tool to obtain a quite stable product with an extended shelf-life and, thus, merchantability. However, drying process can lead to modification in the appearance, composition and quality of the raw material (Hamrouni-Sellami *et al.*, 2013).

In aromatic herb processing chain, cold drying represents an innovative technique that exploits the dehydrating action of cold and dry air, with possible advantages in terms of product quality, and with the opportunity of recovering vegetation water usable in food and cosmetic preparations (Orphanides *et al.*, 2016). The aim of this study was to evaluate the impact of cold drying, compared to traditional drying, on the quality of four different Italian aromatic herbs.

This experimentation is part of ESSICA project (Interreg V France-Italy, ALCOTRA 2014-2020), focused on process innovation in aromatic herb chain, in order to obtain high quality products and, thus, increase producer competitiveness. The partnership includes four members: TERRE di SAVOIA Association, DISAFA (Department of Agricultural, Forest and Food Sciences, University of Turin), FRANCEAGRIMER (Etablissement National des Produits de l'Agriculture et de la Mer), CRIEPPAM (Centre Régionalisé Interprofessionnel d'Expérimentation en Plantes à Parfum, Aromatiques et Médicinales).

2. Material and method

Four different herbs (savory, mint, lemon balm and mallow) produced in Italy (Piedmont region) were collected between July and October 2018 and submitted to both traditional drying and cold drying. The cold drier was provided by Northwest Technology (Boves, Cuneo, Italy). Time and temperature parameters used for traditional drying processes varied according to each specific herb: savory was dried at 42 °C for 24 h, lemon balm at 39 °C for 24 h, mallow at 45 °C for 36 h and mint at 38 °C for 24 h. Regarding cold drying, the temperature was set at 30 °C for all the four herbs, and the treatment was of 48 h, with the exception of mallow samples that needed 72 h to reach humidity values lower than 10%.

The quality of the herbs, before (fresh herbs) and after cold and traditional drying treatments, was evaluated by microbiological, chemical, and sensory analysis. The following microbial groups were analysed: mesophilic aerobic count on Plate Count Agar (PCA), at 30 °C for 72 h, xerophile moulds and yeasts on Dichloran Glycerol Agar (DG18) at 25 °C for 96 h, *Enterobacteriaceae* on Violet Red Bile Glucose Agar (VRBG) at 37 °C for 24 h, *Bacillus cereus* on *Bacillus cereus* Selective Agar (Pemba) at 30 °C for 24 h.

Total Phenolic Content (TPC) and Radical Scavenging Activity (RSA) were evaluated and compared in fresh and dried herbs according to the protocol of Barbosa-Pereira *et al.* (2018). TPC and RSA were measured by using 96-well microplates and a BioTek Synergy HT spectrophotometric multi-detection microplate reader (BioTek Instruments, Milan, Italy). Gallic acid standard solutions (100-500 μM) were used for calibration of total phenolics determination. Trolox (25-300 μM), a water-soluble analogue of vitamin E, was used as standard for antiradical activity determination. All determinations were performed in triplicate.

For each of the aromatic herbs under study, 0.5 g of sample were suspended in 20 mL of 1:1 water-ethanol mixture and homogenized until uniform consistency, using an Ultra-Turrax homogenizer (T25, Ika Works Inc., USA). The homogenates were centrifuged, filtered and stored at −20 °C until analysis.

TPC was quantified adapting the Folin–Ciocalteu method (Singleton and Rossi, 1965). Twenty microliter of sample extract were pipetted to the corresponding well of the plate with 100 μL of Folin-Ciocalteu aqueous reagent (diluted tenfold) and 75 μL of a 7.5% sodium carbonate solution. The plate was incubated for 2 h at 25 °C in the dark, after that the absorbance was read at 740 nm against a blank. The concentration of the total phenolic compounds was expressed as mg of gallic acid equivalents (GAE)/g of dry weight.

RSA of the herb extracts against the stable DPPH radical was assessed according to the method of von Gadov *et al.* (1996). To each of the 96 wells, 20 μL of extract solution were added to 180 μL of a DPPH solution (120 μM in ethanolic solution 80%). The plate was vigorously shaken and left to stand in the dark for 30 min at 25 °C. The decrease in DPPH absorbance was measured at 517 nm, and the inhibition percentage (IP) of radical DPPH was calculated according to the following equation:

$$IP\ (\%) = [(A_0 - A_{30})/A_0] \times 100$$

where A_0 is the absorbance at initial time and A_{30} is the absorbance at 30 min. The radical scavenging activity values (RSA) of each sample were expressed as μmol TE/g of dry weight.

The sensory evaluation of the samples was performed with a duo-trio difference test (ISO 10399, 2017), by a group of twenty trained panelists. The test had the objective of verifying the differences between traditional and cold drying procedures. The panelists received a reference sample (identified as T) and two unknown samples (coded with 3 random numbers) where one was the same as the reference sample. The three samples were arranged side by side in white plastic cup. The number of correct responses was compared to the critical number of correct responses in a 'duo-trio' difference test for significance with an $\alpha = 0.05$.

One-way variance analysis with Duncan test were performed on microbiological and chemical data by using Statistica ver. 13.3 (Tibco Software Inc., USA).

3. Results and discussion

TPC and RSA decreased in both traditional and cold dried herbs compared to fresh samples (Table 1), as expected. Not significant differences were detected between herbs submitted to cold and traditional drying, with the exception of savory samples; in this case, the traditional drying technique seemed more preservative and differences between fresh and dried samples were limited.

Despite drying has not to be considered a sanitization technique, an evaluation of the microbial quality of the herbs was carried out. In general, microbial counts were comparable in fresh herbs and dried samples (Table 2). Not significant differences were detected in most of the samples, in particular between fresh herbs and cold dried samples. On the contrary, in few samples, the temperature used in traditional drying seemed to encourage microbial growth. For example, *Enterobacteriaceae*, in

mallow, were about 10 cfu/g lower in fresh and cold dried samples compared to traditionally dried herbs. Similarly, *Enterobacteriaceae* and xerophile moulds, in savory, and mesophilic aerobic population, in mallow, increased of about 10^2 cfu/g in traditional dried samples compared to the fresh and cold dried herbs.

Table 1. Total Phenolic Content (TPC) and Radical Scavenging Activity (RSA) in fresh and dried aromatic herbs.

	TPC[1]		RSA[2]	
Aromatic herb	Mean	SD	Mean	SD
Mallow^{F}	$30,07^{b}$	± 6,29	$249,61^{b}$	± 20,07
Mallow^{TD}	$11,46^{a}$	± 1,11	$53,38^{a}$	± 6,25
Mallow^{CD}	$12,92^{a}$	± 0,93	$62,52^{a}$	± 3,71
significance	***		***	
Lemon balm^{F}	$144,17^{b}$	± 9,96	$804,24^{b}$	± 75,58
Lemon balm^{TD}	$111,60^{a}$	± 5,34	$629,23^{a}$	± 24,75
Lemon balm^{CD}	$99,72^{a}$	± 10,11	$568,29^{a}$	± 47,56
significance	***		***	
Mint^{F}	$154,02^{b}$	± 17,22	$1014,93^{b}$	± 49,32
Mint^{TD}	$65,43^{a}$	± 1,45	$373,21^{a}$	± 8,24
Mint^{CD}	$73,47^{a}$	± 3,31	$424,05^{a}$	± 22,31
significance	***		***	
Savory^{F}	$71,85^{b}$	± 3,62	$316,19^{b}$	± 22,61
Savory^{TD}	$67,19^{b}$	± 2,30	$322,76^{b}$	± 10,36
Savory ^{CD}	$54,78^{a}$	± 4,96	$258,00^{a}$	± 19,64
significance	***		***	

[1]Gallic Acid Equivalents mg/g dry weight – [2]Trolox µM/g dry weight
F-fresh samples; TD-traditionally dried samples; CD-cold dried samples
Means followed by different letters are significantly different at $p<0.05$ – Significance: *** $p<0.001$
Data are expressed as mean value ± standard deviation (SD) of three analysis

Table 2. Microbial population counts (Log_{10} cfu/g herb) in fresh and dried aromatic herbs

	[1]PCA	[1]DG18 moulds	[1]DG18 yeasts	[1]VRBG	[1]PEMBA
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Mallow^{F}	7,70 ± 0,34	$5,07^{ab}$ ± 0,31	$6,16^{a}$ ± 0,33	$5,40^{a}$ ± 0,38	<100
Mallow^{TD}	9,29 ± 0,23	$4,52^{a}$ ± 0,22	$4,67^{b}$ ± 0,23	$6,71^{b}$ ± 0,32	<100
Mallow^{CD}	7,78 ± 0,17	$5,53^{b}$ ± 0,12	$6,24^{a}$ ± 0,14	$5,67^{a}$ ± 0,25	<100
significance	ns	*	*	*	
Lemon balm^{F}	$7,63^{a}$ ± 0,12	6,00 ± 0,09	$5,61^{a}$ ± 0,11	$7,12^{a}$ ± 0,09	<100
Lemon balm^{TD}	$7,49^{a}$ ± 0,16	5,57 ± 0,16	$6,03^{b}$ ± 0,07	$6,11^{b}$ ± 0,31	2,42 ± 0,03
Lemon balm^{CD}	$6,94^{b}$ ± 0,05	5,85 ± 0,23	$5,04^{c}$ ± 0,01	$6,65^{c}$ ± 0,45	2,34 ± 0,18
significance	**	ns	*	***	ns
Mint^{F}	7,15 ± 0,23	$5,71^{a}$ ± 0,19	$6,30^{a}$ ± 0,09	$5,32^{a}$ ± 0,17	$3,16^{a}$ ± 0,31
Mint^{TD}	7,31 ± 0,41	$6,05^{b}$ ± 0,24	$5,57^{b}$ ± 0,45	$4,43^{b}$ ± 0,06	$2,87^{ab}$ ± 0,28
Mint^{CD}	7,31 ± 0,31	$5,90^{ab}$ ± 0,23	$5,58^{b}$ ± 0,34	$5,52^{a}$ ± 0,45	$2,69^{b}$ ± 0,21
significance	ns	*	*	**	*
Savory^{F}	6,50 ± 0,38	4,45 ± 1,44	6,15 ± 0,67	3,68 ± 0,33	$1,20^{a}$ ± 0,25
Savory^{TD}	7,21 ± 0,65	6,34 ± 0,13	4,36 ± 1,54	5,20 ± 0,98	$2,24^{b}$ ± 0,16
Savor ^{CD}	5,93 ± 1,44	4,70 ± 0,01	4,33 ± 0,38	3,36 ± 1,5	$2,05^{b}$ ± 0,36
significance	ns	ns	ns	ns	*

[1]Selective cultural media as reported in Materials and Methods paragraph.
F-fresh samples; TD-traditionally dried samples; CD-cold dried samples
Means followed by different letters are significantly different at $p<0.05$ – Significance: *** $p<0.001$ **$p<0.01$ *$p<0.05$ ns-not significant
Data are expressed as mean value ± standard deviation (SD) of three analysis

Regarding to sensory analysis, cold drying did not affect the overall quality of savory, mallow, lemon balm, either negatively or positively, compared to traditional drying. On the contrary, duo-trio test highlighted significant differences between mint samples submitted to the two drying treatments.

4. Conclusions

On the basis of the data obtained, cold drying did not lead to a strong change and/or improvement of the overall quality of the herbs analysed, compared to the herbs traditionally dried. Nevertheless, this technique deserves attention for the possibility of recovering of vegetation water containing a fair amount of aromas. In addition, further evaluations will be made on the possible preservation of essential oils with cold drying. These results will be further enriched with new analysis planned in summer-autumn 2019.

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