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THE EFFECT OF FRAGMENTATION AND PACKAGING OF DRIED PARSLEY LEAVES ON SELECTED CHEMICAL AND MICROBIOLOGICAL PARAMETERS

Short communication

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ABSTRACT

Parsley leaves (*Petroselinum crispum*) have long been known for their organoleptic properties. They are widely used in cuisine all over the world in fresh and dried form and also as pharmaceutical raw material. The presented work assessed if the storage of parsley leaves (as whole leaves or leave pieces) and packaging with PE or Xtend® foils influence the content of selected chemical compounds and the microbiological quality of the product. For this purpose, the leaves were dried, packaged and analyzed after 3 weeks' storage under room temperature. Neither the degree of fragmentation nor the type of packaging foil affected the content of vit. C and total sugars. Higher content of reducing sugars was obtained in the samples packed in PE foil. Number of detected bacteria did not exceed the safety border. Less bacterial colonies were detected in the material packed as fragmented in the PE foil. No fungal colonies were detected in the leaves packed in the Xtend® foil.

Keywords: parsley leaves, drying, microbial analysis, chemical parameters, storage

INTRODUCTION

Parsley leaves (*Petroselinum crispum*) have long been known for their organoleptic properties. The richness in many valuable ingredients causes its widespread use in the kitchen and medicine (Linde et al. 2016; Snoussi et al. 2016; Ajebli & Eddouks 2019). Presence of essential oils (e.g., 1,3,8-p-menthatriene, phenylacetaldehyde, γ-elemene, α-terpineol, α-pinene, camphene), resinoid, oleoresin, linoleic and petroselinic acids, microelements (e.g., Ca, Fe), flavonoids (e.g., apigenin, luteolin, quercetin) but also vitamin C and carotene make it very valuable plant (Farzaei et al. 2013; Ouzounidou et al. 2013; Snoussi et al. 2016). The plant affects the human body by causing diuretic effect, acts against hypertension and also as a potent cancer chemoprotective agent. Recently, researchers pointed out the antibacterial abilities of parsley (Ouzounidou et al. 2013; Snoussi et al. 2016; Ajebli & Eddouks 2019).

Therefore, it is important to maintain an accessibility to parsley leaves for all year usage. Most useful method of storage is drying. The dried leaves are known as parsley flakes. The most frequently used process (except sun drying) is conventional air drying (at 40, 50, 80 °C), but nowadays, microwaves also are used for this purpose (Soysal 2004; Doymaz et al. 2006). The point that needs to be taken under consideration is that high temperature is harmful for a variety of whole range of active compounds (Stępień 2008). That may decrease the quality (flavor, odor) and content of functional compounds (e.g., vitamins level). Therefore, it is important to precisely chose the most favorable temperature for the process. Parker (1999) pointed 40 °C as most appropriate temperature for drying parsley leaves.

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Parsley leaves are stored fragmented in pieces, which influences the drying process and may shape the chemical composition of the final product, since greater fragmentation is connected with greater tissues interruption (Stępień & Michalski 2006; Slave et al. 2014). This causes greater leakage of cell fluids and starts a chain of biochemical reactions that result in the loss of many valuable compounds.

Another process that may result in the losses of compounds is storage time (Azeez & Parthasarathy 2008; Santos et al. 2014).

To minimize the phenomena of biological compounds' losses, trials are conducted with different packaging materials (Ouzounidou et al. 2013). Parsley leaves (dried) are mostly sold in PE bags of different sizes but paper packaging is also used (inside lined with foil), and nowadays, in carton-paper tubes (lined inside with aluminum foil). An access to the market is based largely on the price of the product, which is the sum of the cost of manufacturing and packaging, considering a quality, which may change during storage.

Important issue is microbiological safety of the product, which is crucial in the case of a dry spices – thus stored at room temperature (Slave et al. 2014). Microbial analysis of dried herbs pointed towards a generally high degree of contamination by bacteria and/or fungi (Brużewicz & Malicki 2007; Wójcik-Stopczyńska et al. 2010).

In this work, the effectiveness of the proposed technology of preparation of parsley leaves for market is verified by chemical analyzes, which may indicate how the technological processes influence the product quality – contents of chemical compounds and microbiological purity.

MATERIALS AND METHODS

Fresh parsley leaves 'Fest' were bought in a local market, cleaned manually from dirt and damages, stalks were removed, and leaves divided into 2 groups: whole leaves and leave pieces. The leaves were dried in an air-drier at 40 °C for 3 consecutive days, then packed into Xtend® and PE bags and stored for three weeks in a dark at room temperature. After storage, the contents of vitamin C and sugars as well as the level of microbiological contaminations were estimated. The content of vitamin C was evaluated using the Tillman's method and total and reducing sugars was evaluated using the Bertrand's method. Water content was obtained by the oven-drying method. Also, the total number of cultivable bacteria, and mold and yeast-like fungi were determined. For this analysis, one gram of leave sample and 9 ml of sterile TSB (Triptic Soya Broth) medium (Oxoid) were mixed and shaken for 30 min at room temperature (300 rpm·min^{-1}). Then, the washes were serially diluted from 10^{-2} to 10^{-6} in TSB medium. The number of microorganisms was counted using spreading 0.1 ml of a given dilution onto triptic soya agar medium (Oxoid) in Petri plates, to determine number of bacterial cells. To determine the number of fungal cells Sabouraud Dextrose Agar with chloramphenicol and gentamicin was used (Oxoid). The bacteria were counted after 48 h of incubation at 37 °C and fungi after an incubation of 5 days at 25 °C. On the basis of the number of grown colonies, the microbial concentration per gram of the dried sample was expressed as colony forming units (CFU·ml^{-1}). Each sample was analyzed in triplicate.

Samples were also tested for the presence of coliform bacteria and bacteria from the genus *Staphylococcus* using a pre-enrichment step. 10 ml samples in dilution (10^{-1}) were incubated at 37 °C for 24 h and after spread of 0.1 ml on a plate with appropriate diagnostic-selective medium. Coliform bacteria was assayed on MacConkey agar medium (Oxoid), and *Staphylococcus* spp. on Baird-Parker agar medium (Oxoid). Plates were incubated for 24 h at 37 °C for the detection of both the microorganisms (counted purple and black colonies with white halo, respectively for coliform and *Staphylococcus*).

Statistical analysis over chemical parameters were performed with Duncan's test ($p = 0.05$) and microbial with Kruskal-Wallis test with Dunn's post-hoc test ($p \leq 0.05$).

RESULTS

After drying and storage, the whole parsley leaves had a higher vitamin C and total sugar concentrations than those fragmented, regardless of the packaging material used, although differences were not statistically different (Table 1). Contrary to this, the reducing sugars content was influenced more by the type of foil used, than by leaf fragmentation. Reducing sugars concentration was by 22% higher in parsley leaves stored in PE foil, compared to Xtend foil. There was

non-significantly higher content of total sugars in the whole leaves compared with the leave pieces (differences of 8–13% for PE and Xtend, respectively).

In the examined material, no fungi were detected on parsley leaves stored in Xtend foil (Table 2). In the case of PE packaging, a higher number of fungi was detected in the whole leaves samples. The least number of bacterial colonies were detected in the samples of crushed leaves packed in PE (not statistically different). Generally, less bacterial colonies were detected in the crushed leave samples and those packed in Xtend. No coliform bacteria nor bacteria from the genus *Staphylococcus* were detected in the examined samples.

Table 1. Vitamin C and sugars content in dried parsley leaves

Type of foil	Degree of fragmentation	Vitamin C content (mg 100 g^{-1} DW)	Reducing sugar content (% DW)	Total sugars content (% DW)
PE	whole leaves	1.65 a ± 0.40	3.47 a ± 0.00	6.23 a ± 0.00
PE	leaves pieces	0.94 a ± 0.17	3.47 a ± 0.00	5.71 a ± 0.73
Xtend	whole leaves	1.14 a ± 0.12	2.91 b ± 0.59	6.75 a ± 0.73
Xtend	leaves pieces	1.06 a ± 0.44	2.49 b ± 0.00	5.71 a ± 1.47

Means ± SD in columns followed by the same letters are not significantly different at $p \leq 0.05$ according to Duncan's test

Table 2. Bacteria and fungi number in dried parsley leaves

Type of foil	Degree of fragmentation	Bacteria	Fungi
		cfu ml^{-1}	
PE	whole leaves	$7.15 \pm 1.50 \times 10^3$ ab	$5.10 \pm 0.95 \times 10^2$ a
PE	leaves pieces	$1.57 \pm 3.10 \times 10^4$ a	$3.00 \pm 0.60 \times 10^2$ a
Xtend	whole leaves	$9.60 \pm 1{,}81 \times 10^3$ ab	0 b
Xtend	leaves pieces	$5.65 \pm 1.22 \times 10^3$ bc	0 b

Means in columns followed by the same letters are not significantly different at $p \leq 0.05$ according to Kruskal–Wallis test with Dunn's post-hoc test

DISCUSSION

According to the scientific literature, drying and storage process decreases level of vitamin C and causes decomposition of sugars (Śledź & Witrowa-Rajchert 2012). Haleam (2016) observed loss of vitamin C content, depending on the temperature, from 16 to 98%. In our experiment, after 3 weeks of storage, a tendency was observed that, independently from packaging material, a higher content of vitamin C was detected in the samples of whole leaves. The losses of vitamin C may be due also by other factors – e.g., oxygen availability, ions, time (Kuźma et al. 2014).

Atta-Aly (1999) and Karklelienė et al. (2014) pointed that sugars levels, as well as ascorbic acid, are strongly dependent on the cultivation conditions. In our 1-year study, the highest total sugar content was determined in the whole parsley leaves stored in the Xtend foil (6.75% DW). Higher level of reducing sugars were observed in the PE foils (3.47% DW, for fragmented and whole leaves), which means that the higher vitamin C and total sugar contents were connected with the larger size of leaves, while reducing sugar content with the type of packaging.

Conducted microbial analysis evidenced the lowest bacteria number on parsley leaves pieces and packed in PE. Also, less fungal colonies were detected in the samples from fragmented leaves. No fungus colonies were found in the samples stored in Xtend. According to Snoussi et al. (2016), fungi are sensitive to essential oils present in parsley leaves and Xtend foils may protect better against their escaping. Important is the fact of possibility to decrease the microbial community on parsley dry leaves by basic cleaning before drying (Correa-Filho et al. 2018a). Nevertheless, all the determined microorganism numbers were below the safety border: 10^5 cfu·g^{-1} and 10^3 cfu·g^{-1} for contamination with both oxygen microflora and saprophytic fungi respectively (Brużewicz & Malicki 2007). In all the examined samples, no presumptive coliform bacteria or bacteria from the genus *Staphylococcus* were isolated.

CONCLUSIONS

Reducing sugars were better protected under storage in the PE foil. Less bacterial cells survived on the fragmented leaves. No fungi survived on the leaves packed in the Xtend® foil.

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