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ESTIMATION OF BIOLOGICAL VALUE AND SUITABILITY FOR FREEZING OF SOME SPECIES OF SPICE HERBS

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Abstract

The studies were carried out in the years 2003 and 2004 in the Laboratory of Plant Raw Material Processing and Storage and in the Department of Vegetable Crops of Agricultural University in Szczecin. The aim of the experiment was to estimate the biological value, and suitability for freezing and freeze-storage of tarragon (*Artemisia dracunculus* L.), hyssop (*Hyssopus officinalis* L.) and chervil (*Anthriscus cerefolium* L.) were carried out. The chemical analysis were carried out in a raw, frozen and stored material. The determinations included the content of dry matter, total ash, total nitrogen, nitrates, vitamin C as L-ascorbic acid, titratable acidity, total sugars and crude fibre. Among tested in the experiment species the highest amount of dry matter, total nitrogen and nitrates was noted for hyssop. Chervil was characterized by a high content of total ash, total sugars, titrable acidity and L-ascorbic acid. The highest content of crude fibre was found in tarragon. After freezing the level of dry matter, total ash, total nitrogen, crude fibre, total sugars, titrable acidity and L-ascorbic acid decreased. The samples of herbs were frozen and stored at –25 ÷ –27°C for 6 and 12 months. Twelve-month storage had a significant influence on the further decrease of the content of total nitrogen, titrable acidity and L-ascorbic acid. Tested in the experiment spice herb cultivars showed a good ability for freezing and long-period cold storage. The dry matter loss after twelve month storage was on average 1.5%. According to the color, taste and aroma the highest quality after twelve month cold storage was noted for chervil. However, better preservation of L-ascorbic acid was found for hyssop and tarragon.

Key words: tarragon, hyssop, chervil, biological value, freezing, freeze-storage.

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OCENA WARTOŚCI BIOLOGICZNEJ ORAZ PRZYDATNOŚCI DLA ZAMRAŻALNICTWA WYBRANYCH GATUNKÓW ZIÓŁ PRZYPRAWOWYCH

Abstrakt

W latach 2003–2004 oceniano wartość biologiczną świeżego ziela oraz wpływy zamrażania i zamrażalniczego przechowywania na zawartość wybranych składników chemicznych w zielu bylicy estragon (*Artemisia dracunculus* L.), hyzopu lekarskiego (*Hyssopus officinalis* L.) oraz trybuli ogrodowej (*Anthriscus cerefolium* L.). W materiale doświadczalnym (świeże ziele) oznaczono zawartość: suchej masy, popiołu ogólnego, azotu ogólnego, azotanów, kwasu L-askorbinowego, cukrów ogółem, błonnika surowego oraz kwasowość ogólną. Oprócz surowca świeżego ocenie składu chemicznego poddano również surowiec po zamrożeniu oraz po 6 i 12 miesiącach zamrażalniczego składowania. Spośród ocenianych w doświadczeniu gatunków ziół istotnie większą zawartością suchej masy, azotu ogólnego oraz azotanów wyróżniał się hyzop lekarski. W przypadku trybuli ogrodowej wykazano wysoką zawartość popiołu ogólnego, cukrów ogółem, kwasu L-askorbinowego oraz kwasowość ogólną. Najwyższą zawartość błonnika surowego stwierdzono natomiast w przypadku bylicy estragon. Po zamrożeniu surowca odnotowano straty w zawartości: suchej masy, popiołu, azotu, błonnika, cukrów, kwasowości ogólnej oraz kwasu L-askorbinowego. Zamrożony produkt był przechowywany przez 6 i 12 miesięcy w komorze zamrażalniczej, w temp. –25 ÷ –27°C. Po rocznym okresie zamrażalniczego składowania obserwowano dalszy spadek w przypadku zawartości azotu ogólnego, kwasowości ogólnej oraz kwasu L-askorbinowego. Oceniane gatunki ziół przyprawowych wykazały dobrą przydatność do zamrażania i długotrwałego zamrażalniczego przechowywania. W dobrym stopniu zachowały swój charakterystyczny aromat, barwę, a ubytki suchej masy nie przekroczyły 1,5%. Uwzględniając cechy organoleptyczne, najlepszą jakość po 12 miesiącach zamrażalniczego przechowywania miała trybula ogrodowa, natomiast lepiej zachowywały kwas L-askorbinowy hyzop lekarski oraz bylica estragon.

Słowa kluczowe: estragon, hyzop, trybula, wartość biologiczna, zamrażanie, zamrażalnicze przechowywanie.

INTRODUCTION

Spice herbs are very important components of our food as they improve its taste and give a characteristic aroma. The main chemical compounds of spice herbs are essential oils, alkaloids, tannins, glycosides, phytoncides, saccharides (basic component of dry matter), organic acids, vitamins and minerals (SEIDLER-ŁOŻYKOWSKA, KA•MIERCZAK 2002).

The essential oil content in hyssop leaves varies from 0.3 to 1%, while in its inflorescences from 0.9 to 2% (WOLSKI et al. 2006). Tarragon herb contains from 0.6 to 1% of essential oil, depending on the time of harvest (OLSZEWSKA-KACZYŃSKA, SUCHORSKA 1996).

The results of many studies proved that fruits and vegetables are the best sources of antioxidants in our diet. These substances protect the organism by neutralization and disposal of cancerogenic free radicals. Lately, the presence of many efficient antioxidants has been detected in numerous herbs. In marjoram, ginger and pepper there are phenolic diterpenes, phenolic

acids, flavonoids. OSZMIAŃSKI and LAMER-ZARAWSKA (1996) suggest that dietary fibre, folic acid and chlorophylline play a protective role in many cancer illnesses.

Increased environmental contamination has raised levels of chemical impurities in soil, drinking water, agricultural yields and also in herbs. Among such impurities are nitrates and nitrites (WIERZCHOWSKA-RENKE et al. 1994). Many studies have been conducted, both in Poland and abroad, on the influence of the intake of nitrates and nitrites with daily diets on the health of adults, small children and infants. Nevertheless, we still lack enough data on the content of nitrates and nitrites in herbs. The growing interest in herbal medicine or in world cuisine as well as easier transportation have enriched the assortment of herbs available in our country. However, we should remember that except medicated components, herbs may contain nitrates and nitrites, which are easily extracted and passed to water solutions (WIERZCHOWSKA-RENKE et al. 1994).

We use fresh or dried spice herbs. Fresh herbs are more valuable than dried ones because they contain vitamins and high quantities of oils. The latest method of herb storage is freeze-storage (GRZESZCZUK et al. 2005).

The aim of the experiment was to compare the biological value of some spice herb species (tarragon, hyssop, chervil) and to estimate their suitability for freezing and freeze-storage.

MATERIAL AND METHODS

The experiment was conducted in the Laboratory of Processing and Storage of Plant Raw Material of the Agricultural University in Szczecin in 2003-2004.

The research material was produced at the Horticultural Experiment Station in Dołuje, which belongs to the Department of Vegetable Growing of the Agricultural University in Szczecin. The material consisted of three spice herb species: tarragon (*Artemisia dracunculus* L.), hyssop (*Hyssopus officinalis* L.), chervil (*Anthriscus cerefolium* L.).

The chemical analyses of raw, frozen and stored plant material included determination of the content of dry mattter (drying at 105°C to constant weight), total ash (incineration of samples in 500°C), total sugars (by the method of Luff-Schoorl), vitamin C as L-ascorbic acid (by the method of Tillmans), titratable acidity (KREŁOWSKA-KUŁAS 1993), total nitrogen (by the method of Kjeldahl), nitrates (by colorimetric method, ZALEWSKI (1971) and crude fibre (KLEPACKA 1996).

Before freezing, the plant material was fragmented to small pieces (about 1 cm long) with a steel knife. Then the samples were packed in 0.05 mm thick polythene bags, 500 g of herbs each. Frozen samples were stored in a freezing chamber at -25, -27°C for 6 and 12 months.

The results of each year were subjected to an analysis of variance. The means of two years were separated by the Tukey's test at p=0.05.

RESULTS AND DISCUSSION

In the present work significant differences occurred in the chemical composition of the three species. Significantly more dry matter, irrespectively of the processing stage, was noted for chervil (on average 15.07%) and hyssop (on average 14.92%) – Table 1. The content of dry matter in tarragon herb was significantly lower, on average by 1.78% in comparison with chervil and hyssop. The level of dry matter in the raw herbs of the test species was assessed as low. MARTYNIAK-PRZYBYSZEWSKA and WOJCIECHOWSKI (2004) claim that tarragon herb contains 21.9% of dry matter. SÁNCHEZ-CASTILLO et al. (1995) assessed 23.4% of dry matter in mint herb and 27.5%. d.m. in leaves of leafy parsley. JADCZAK (2007) determined 18.85% of dry matter for savory and MARTYNIAK-PRZYBYSZEWSKA and WOJCIECHOWSKI (2004) cited the following shares of dry matter: 12.5 for basil %, 25.6% for oregano, 22.9% for marjoram and 21.0% for thyme.

Among the herb species analysed in the present experiment, tarragon had a significantly lower content of total ash and total nitrogen. The highest amount of total ash was determined for chervil (on average 2.67%), while the highest content of total nitrogen appeared in hyssop (on average 0.95%). Moreover, hyssop was characterized by a significantly higher level of nitrates, on average by 402.59 mg $NaNO_3 \cdot kg^{-1}$ f.m., in comparison with chervil and tarragon, which in turn did not differ significantly in this respect. However, it was noted that the content of nitrates in raw hyssop herb was not high: 1,317.16 mg $NaNO_3 \cdot kg^{-1}$ f.m. (i.e. 961.43 mg $N\text{-}NO_3 \cdot kg^{-1}$ f.m.). According to the Decree of Health Minister of 13 January 2003, the level of nitrates in dill leaves, for example, should not be higher than 1,500, and in frozen spinach must not exceed 2,000 mg $N\text{-}NO_3 \cdot kg^{-1}$ f.m. SEIDLER-ŁOŻYKOWSKA et al. (2007) determined 2,522.80 mg $N\text{-}NO_3$ kg^{-1} f.m in basil herb. WIERZCHOWSKA-RENKE et al. (1995), who analysed dried, packed herbs, found assessed for example: 15,820 mg $KNO_3 \cdot kg^{-1}$ d.m. (i.e. about 1456 mg $N\text{-}NO_3 \cdot kg^{-1}$ f.m.) in mint herb, – 16,919 mg KNO_3 (i.e. 1557 mg $N\text{-}NO_3$) in salvia and and 3,821 mg KNO_3 (i.e. 352 mg $N\text{-}NO_3$) in lemon balm.

Determination of the crude fibre content in the plant material showed the highest crude fibre amount in tarragon, lower – in hyssop and the lowest one – for chervil (Table 2). The content of total sugars was significantly higher for chervil, 0.5% more than in tarragon and 1.15% more than in hyssop. Significantly higher levels of titratable acidity was noted in chervil and tarragon (on average 0.31% citric acid), and lower in hyssop (on average 0.24%).

Table 1

The content of dry matter, total ash, total nitrogen and nitrates in the fresh, frozen and stored frozen plant material (mean in 2003–2004)

Plant species	Stage of processing	Dry matter	Total ash	Total nitrogen	Nitrates (mg $NaNO_3 \cdot kg^{-1}$)
		(%)			
Tarragon	A	13.40	1.41	1.16	688.79
	B	13.07	1.34	1.14	1161.75
	C	13.12	1.34	0.57	650.70
	D	13.27	1.36	0.57	617.29
	mean	13.21	1.36	0.86	779.63
Hyssop	A	15.35	1.84	1.29	1317.16
	B	14.91	1.81	1.25	1275.01
	C	14.59	1.80	0.63	943.57
	D	14.82	1.79	0.63	1121.77
	mean	14.92	1.81	0.95	1164.38
Chervil	A	15.13	2.66	1.20	629.56
	B	14.91	2.58	1.17	604.67
	C	15.14	2.56	0.63	844.03
	D	15.11	2.87	0.61	897.48
	mean	15.07	2.67	0.90	743.94
Mean for processing stage	A	14.62	1.97	1.22	878.50
	B	14.30	1.91	1.19	1013.81
	C	14.28	1.90	0.61	812.77
	D	14.40	2.01	0.60	878.85
$LSD_{\alpha=0.05}$ for:					
species		0.28	0.07	0.02	241.60
processing stage		0.15	0.07	0.01	182.15
interaction		0.27	0.12	0.02	315.50

A – raw material
B – directly after freezing
C – frozen material after 6 month storage
D – frozen material after 12 month storage

Chervil was also characterized by a higher content of L-ascorbic acid, on average by 10.98 mg·100 g^{-1} f.m. in comparison with hyssop and by 28.10 mg·100 g^{-1} compared with tarragon. L-ascorbic acid content in the raw herb of chervil was very high – 104.34 mg·100 g^{-1} f.m. The amounts

Table 2

The content of crude fibre, total sugars, titratable acidity and L-ascorbic acid in the fresh, frozen and stored frozen plant material (mean in 2003-2004)

Plant species	Stage of processing	Crude fibre	Total sugers	Titratable acidity (% citric acid)	L-ascorbic acid (mg 100·g^{-1})
		(%)			
Tarragon	A	1.99	0.89	0.30	35.64
	B	1.95	0.98	0.26	6.60
	C	1.98	1.10	0.34	4.08
	D	2.00	0.99	0.29	3.66
	mean	1.98	0.99	0.30	12.49
Hyssop	A	1.63	0.34	0.21	63.60
	B	1.63	0.37	0.24	22.20
	C	1.77	0.37	0.29	17.72
	D	1.83	0.28	0.23	14.94
	mean	1.72	0.34	0.24	29.61
Chervil	A	1.32	1.70	0.40	104.34
	B	1.23	1.13	0.39	32.22
	C	1.31	1.69	0.26	17.34
	D	1.29	1.44	0.25	8.46
	mean	1.29	1.49	0.32	40.59
Mean for processing stage	A	1.65	0.98	0.31	67.86
	B	1.61	0.83	0.30	20.34
	C	1.69	1.05	0.30	13.05
	D	1.71	0.90	0.26	9.02
LSD $_{\alpha=0.05}$ for:					
species		0.14	0.02	0.05	3.98
processing stage		n.s.	0.01	0.03	3.53
interaction		n.s.	0.02	0.06	6.11

A – raw material
B – directly after freezing
C – frozen material after 6 month storage
D – frozen material after 12 month storage

of L-ascorbic acid determined for hyssop (63.60 mg·100 g^{-1} f.m.) and tarragon (35.64 mg·100 g^{-1} f.m.) were also high. Martyniak-Przybyszewska and Wojciechowski (2004) cited a lower level of vitamin C for tarragon (9.8 mg·100 g^{-1} f.m.). For the other herb species, for example basil, savo-

ry or marjoram, their results varied from 11.9 to 19.9 mg·100 g^{-1} f.m. CAPECKA et al. (2005) reported a higher content of vitamin C for herbs of *Lamiaceae* family – from 23.1 to 53.2 mg·100 g^{-1} f.m.

Among the test spice herb species, chervil was characterized by a high biological value. In comparison with tarragon and hyssop, it contained more dry matter, total ash, total sugars, titratable acidity and L-ascorbic acid.

Freezing and freeze-storage had a significant influence on the changes of chemical composition of the three herb species. There were statistically significant differences in the content of all the compounds determined in the experiment, except crude fibre. Directly after freezing, most chemical parameters decreased, for example: dry matter – by 0.32% on average, total ash – by 0.06% f.m., total nitrogen – by 0.03% f.m., total sugars – by 0.15% f.m. and L-ascorbic acid – by 47.52 mg·100 g^{-1} f.m. Changes in titratable acidity were not statistically significant, while the content of nitrates significantly increased in comparison with the raw material (on average by 13.35%). A similar direction of the changes in nitrates was noted by LISIEWSKA and KMIECIK (1997), who proved that freezing and three-month cold storage of leafy parsley leaves resulted in an increased content of nitrates. However, further storage (6 and 9 months) caused a decrease of the level of nitrates.

In the present study, after 6 months of freeze-storage further decrease in dry matter, total ash, total nitrogen and L-ascorbic acid content was observed. Also, the level of nitrates significantly decreased – on average by 204.04 mg $NaNO_3 \cdot kg^{-1}$ f.m., in comparison with the material analysed directly after freezing.

After 12 months of cold storage, the content of total nitrogen, total sugars, titratable acidity and L-ascorbic acid significantly decreased.

Freeze-storage of the test spice herb species had a pronounced effect on the changes in the content of L-ascorbic acid. Its concentration decreased by 81%, after 6 months and by a further 6% after 12 months. Similar data are given by LISIEWSKA and KMIECIK (1997).

The spice herb species examined in our experiment proved to be suitable for freezing and long-period freeze-storage. They preserved their characteristic aroma and colour very well. The loss of dry matter did not exceed 1.5%. The best colour, aroma, taste after 12 months freeze-storage were noted for chervil. This species was also characterized by good preservation of dry matter, total ash and total nitrogen. However, tarragon and hyssop were better at preserving the content of L-ascorbic acid. Moreover, these two species were characterized by some desirable changes in the content of nitrates. At the beginning of the freezing process, the level of nitrates increased only to gradually decrease later, falling by 10.4% in tarragon and by 14.8% in hyssop herb after 12 months of storage, in comparison with the raw material. In chervil the content of nitrates was constantly increasing, rising by 29.8% after 12 months of freeze-storage.

CONCLUSIONS

1. Among the test spice herb species, the highest biological value of the raw herb was assigned for chervil.

2. Freezing and freeze-storage had a significant effect on changes in the chemical composition of the plant material. In tarragon and hyssop herb, changes in the content of most of the parameters we observed were desirable ones.

3. After 12 months of freeze-storage, chervil's quality improved according to the organoleptic characteristics (colour, aroma, taste).

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