Yields and raw material quality of *Hypericum perforatum* L. and *Solidago virga aurea* L. from one-year and two-year plantations

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Summary

Yields of herbs of both compared species were significantly higher in the second year (St. John's-wort by 47%, and goldenrod by 20%). The share of the most valuable parts (leaves and flowers) in the raw material was similar in the first and second year (St. John's-wort: 68% and 69%, goldenrod: 73% and 68%, respectively). As far as the contents of biologically active compounds are concerned, the raw material obtained in the second year was more valuable: hypericine in St John's-wort increased by 0.2% and leiocarposide in goldenrod by 0.15% (flavonoids were at the same level).

Key words: goldenrod, St. John's-wort, culture, hypericine, leiocarposide

Goldenrod (*Solidago virga aurea* L.) and St. John's-wort (*Hypericum perforatum* L.) are perennial species commonly occurring in natural flora of Poland and they are cultivated as well due to large demand for raw material. Leaved shoots with inflorescences harvested at the initial flowering stage are medical materials of both species. The factors determining the quality of raw material include the cultivation method, the harvest date as well as drying and storage conditions [1, 2, 3]. The aim of the research was to compare the yields and quality of raw material from St. John's-wort and goldenrod received from one-year and two-year plantations.

MATERIALS AND METHODS

The studies were carried out in 1999-2000 in Ostrów Lubelski on sandy-loam soil containing 1.19% of humus and characterised with high content of available forms of potassium, nitrogen and phosphorus. White mustard ploughed under as a green fertilizer was a forecrop. The experiment was set by means of sin-

gle classification in four replications on 24-square-meter plots. Stratified seeds of St. John's-wort (Topaz cv.) were sown in spring at 4 kg/ha rate into rows separated by 40-cm space. Goldenrod seedlings produced in a foil tunnel were set at 40 cm × 30 cm spacing at the end of April. Mineral fertilisation was applied at rates recommended for particular species. During vegetation, routine cultivation procedures were applied. The plants were sprayed with 0.1% solution of Biosept preparation against fungal diseases.

Plants were harvested at technological maturity (in July in the first year of vegetation and in June in the second year). Before harvest, the height of plants and stem thickness (at the base) were measured. Besides, in the case of St. John's-wort the number of branchings (total and terminated with inflorescence), while in goldenrod the length of inflorescence were calculated. These features were determined by measurement of ten representative plants per plot.

In the first year of vegetation plants were harvested once, in the second year – twice. The second cut was not subjected to qualitative evaluation, because the majority of plants did not produce inflorescences.

After drying at 35°C, the percentages of leaves, flowers, stems and crumbs in raw material were calculated. In the samples of the raw material, the content of active compounds (hypericine in St. John's-wort, flavonoids and leiocarposide in goldenrod) was determined by HPLC in Phytochemical Laboratory "Herbapol" in Klęka.

The numerical data were worked out statistically and the least significant differences were calculated applying Tukey's test at 5% error margin.

RESULTS AND DISCUSSION

Biennial St. John's-wort and goldenrod plants were much taller as compared to annual ones (Table 1). These values for goldenrod were comparable to the literature data [4, 5, 6, 7], while St. John's-wort plants were shorter in the first year and much taller in the second year of cultivation in comparison to those in literature [8, 9]. St. John's-wort plants were characterised by a lower number of stems in the first year, as compared to two-year-old ones (26 vs. 41), and they produced a smaller number of inflorescences. The length of goldenrod inflorescence was similar in both years (30 and 30.3 cm, on average) (Table 1). As for the stem thickness, both species showed increasing tendencies in the second year (differences statistically insignificant), St. John's-wort stem, however, exceeded slightly the respective standard [2].

Table 1.

Results of plant measurements before harvest.

species	year	height of plants (cm)	number of branchings	number of branchings with inflorescence	length of inflorescence (cm)	thickness of stem (mm)
St. John's-wort	first	48.8	26	18	nd	2.8
	second	102.4	41	36	nd	3.2
	mean	75.6	33	27	nd	3.0
	$LSD_{0.05}$	5.4	5.5	2	nd	ns
goldenrod	first	101.6	17	nd**	30.0	5.0
	second	120.4	17	nd	30.3	6.0
	mean	111.0	17	nd	30.15	5.5
	$LSD_{0.05}$	9.7	ns*	nd	ns	ns

*ns – not significant
**nd – not defined

The percentages of particular components in St. John's-wort herb (leaves, flowers, stems and crumbs) were similar in both years (Table 2). In the case of goldenrod, a slightly smaller percentage of leaves and flowers was recorded in the second year, but the difference appeared to be statistically insignificant (Table 2).

Table 2.

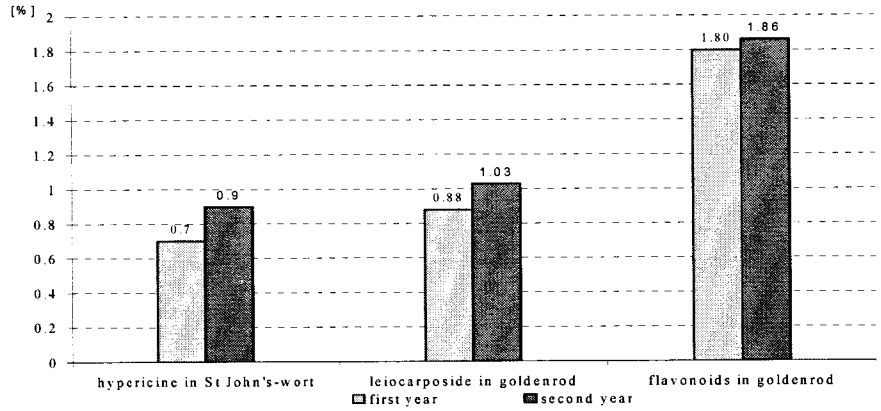
Yields of raw material in the first and second year of vegetation.

species	year	yields of air dry mass of herb		share in raw material (%)	
		per plot (kg)	per ha (t)	leaves & flowers	stems & crumbs
St. John's-wort	first	8.3	3.4	68.0	32.0
	second	12.1	5.0	69.0	31.0
	mean	10.2	4.2	68.5	31.5
	$LSD_{0.05}$	2.2	1.2	ns	ns
goldenrod	first	10.6	4.4	73.0	27.0
	second	12.6	5.3	68.0	32.0
	mean	11.6	4.8	70.5	29.5
	$LSD_{0.05}$	1.1	0.6	ns*	ns

*ns – not significant

The yield of St. John's-wort raw material calculated per hectare was 3.4 tons in the first year and 5.0 tons in the second (increase by 47%). The goldenrod herb yield was 4.4 t/ha and 5.3 t/ha in both years, respectively (increase by 20%) (Table 2). Kordana and Załęcki [10] found a similar dependence in the case of St. John's-wort.

The increase of hypericine content in St. John's-wort raw material in the second year of cultivation (0.9%) as compared to the first one (0.7%), was similar as in the research of Siedler-Łożykowska et al. [3]. In the case of goldenrod, leiocarposide and flavonoid contents in the second year also increased; the flavonoid increase, however, was statistically insignificant – see Fig. 1.



$LSD_{0.05}$ hypericine – 0.15
$LSD_{0.05}$ leiocarposide – 0.1
flavonoids – ns

Fig. 1. Content of biologically active compounds in herbs of 1-year and 2-year plants.

CONCLUSIONS

1. St. John's-wort and goldenrod plants were much smaller in the first year, as compared to the second year of cultivation (St. John's-wort plants formed also a smaller number of branchings). Both species showed increasing tendencies in stem thickness in the second year, which indicates the necessity of cutting the plants higher.
2. The yields of the raw material of both species were significantly higher in the second year of cultivation (St. John's-wort: by 47%, goldenrod: by 20%).
3. The percentages of the most valuable parts (leaves and flowers) in the raw material of St. Jonh's-wort were similar in both years, while in the case of goldenrod decreasing tendencies were recorded in the second year.
4. The content of hypericine in the raw material of St. John's-wort and leiocarposide in goldenrod were higher in the second year of cultivation, while flavonoids (in goldenrod) remained at the same level.

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PLONY I JAKOŚĆ SUROWCA *HYPERICUM PERFORATUM* L. I *SOLIDAGO VIRGA AUREA* L. Z PLANTACJI JEDNOROCZNYCH I DWULETNICH

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Streszczenie

Plony surowca dziurawca i nawłoci w drugim roku uprawy były wyższe odpowiednio o 47% i 20%. Udział najwartościowszych części surowca (liści i kwiatów) w surowcu porównywanych gatunków w pierwszym i w drugim roku był zbliżony (dziurawiec 68% i 69%; nawłoć 73% i 68%). Pod względem zawartości związków czynnych surowiec roślin dwuletnich wykazywał korzystniejsze parametry: zawartość hiperycyny w dziurawcu była o 0,2% wyższa, a lejokarpozydu w nawłoci – o 0,15% (zawartość flawonoidów praktycznie nie różniła się).

Słowa kluczowe: nawłoć pospolita, dziurawiec zwyczajny, uprawa, hiperycyna, lejokarpozyd