Incidence of the Phenological Stage on the Yield and Quality of Floral Stems of White Genepi (*Artemisia umbelliformis* Lam.)

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Abstract

The floral stems of genepi (*Artemisia umbelliformis* Lam.) are mainly used to produce liquors. Commercial cultures showed great variations in essential oil (aromatic compounds) and costunolide (bitter compound) contents. From 2001 to 2003, the incidence of the phenological stage on the quality of floral trusses of white genepi (*Artemisia umbelliformis* Lam.) was precisely defined. The ideal harvesting period for a maximal content of essential oil and costunolide, is the beginning of flowering. After this stage, the essential oil and costunolide contents dropped of about 50%. Nevertheless the chemical composition of the essential oil remained stable during the whole flowering period of white genepi.

INTRODUCTION

Genepi is the name of five species of alpine plants. All of them are protected in Switzerland and their picking is prohibited. The floral stems are mainly used to produce liquors. At present, commercial cultures are grown in Switzerland, Italy and France.

The culture remains for 3 years, with an annual harvest of floral stems starting the 2nd year. The floral stems of genepi contain bitter compounds from the class of sesquiterpenic lactones, flavonoids and a complex essential oil mainly made of terpenes. (Bicchi et al., 1982; Appendino et al., 1982; Gautheret et al., 1984; Anonyme, 2003; Rey et al., 1997). The phytochemical quality of the harvested material is measured by analysing the volatile substances (essential oil), and determining the bitter compounds (mainly costunolide, representing about 80% of the sesquiterpenic lactones) (Anon, 2003).

Unfortunately commercial crops showed great variations in the quality of floral stems. Their contents of essential oil (aromatic compounds) and of costunolide (bitter compound) were irregular. In order to find out the sources of these variations, a trial on the incidence of the phenological stage on the yield and quality of floral stems of has been conducted during two years in Switzerland. The present paper presents the results obtained.

MATERIALS AND METHODS

Field Evaluation

Two trials were conducted from 2001 to 2003 on an altitude site (1300 m a.s.) in Valais (Switzerland) with the variety RAC 12. The plantlets were issued from a drilling on pressed mould of 3*3 cm (3-5 seeds per clod).

The planting of the first trial (2001-2002) took place on 13 June 2001, in beds of 5 lines, 0.25x0.25x0.70 m i.e. a density of 11.76 plants/m^2. An experimental layout with 3 replications on elementary plots with 45 plants each was retained.

The planting of the 2nd trial (2002-2003) took place in June 2002 in beds of 4 lines, 0.30*0.30*0.75 m, i.e. a density of 8.08 plants/m^2. The layout with 3 replications included 24 plants per elementary plot.

The harvests took place between beginning June and beginning July 2002 and 2003, depending on the phenological stages showed at Table 1. The harvested plants were

dried at 30-35°C. The analyses were done on whole floral trusses.

CHEMICAL ANALYSIS

Determination of the essential oil content was done in a standard hydro-distillator, using o-xylene according to European pharmacopoeia (3rd release). The quality analysis of essential oil was made through GC-MS by the laboratory of HEVs according to their own method (Anonyme, 2003b).

The obtention of sesquiterpenes was made through automatic high pressure extraction (ASE) with a mix of ethanol and water (94%:6%) and the successive quantification of costunolide was done by HPLC-UV at 210 nm, taking into account a recuperation factor of 80% (Anonyme, 2003b).

RESULTS AND DISCUSSION

Essential Oil

A very strong influence of the phenological stage on the essential oil concentration in the floral trusses was highlighted (Table 2). At the beginning of flowering, the essential oil content of the variety RAC 12 exceeded 1.5%. Seven to nine days later, the essential oil content dropped of 30% in 2002 and even 60% in 2003. This variety is characterized by high contents in β-pinene (9-20%), α-myrcene (9-21%), cineol-1.8 (11-16%) and borneol (3-17%) and no significant variation in the chemical composition was observed in relation with the harvesting stages (Table 3). The average value of the components remained similar for the years 2002 and 2003, excepted for borneol (7.3% in 2002 and 15.6% in 2003). β- et α-thujone remained constantly inferior to 2%.

Costunolide

The dynamics of costunolide content is very similar to that of essential oil, with a maximum at the beginning of flowering and a quick drop towards full flowering (Table 2). At their maximal concentration, the costunolide content was very high with nearly 3%.

Floral Stems Yield

The floral stems yield doubled between the beginning and the end of the flowering period, reaching up to 100 g/m_2 (Table 2). Harvesting from the full flowering onwards allows better yields.

The results were similar during the two years of evaluation. A very strong influence of the phenological stage on the concentration of aromatic and bitter compounds was highlighted. Harvesting at the beginning of flowering ensures a maximal content in essential oil and costunolide. The essential oil composition remains comparable whatever the phenological stage. Harvesting at the beginning of flowering is recommended to ensure obtaining a product of quality.

CONCLUSIONS

Harvesting at the beginning of flowering is recommended to ensure obtaining a product of quality. Producers have to be correctly paid for the best quality because the yield at the beginning of flowering is smaller but of higher quality than that at the post flowering stage.

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Tables

Table 1. Definition of the phenological stages retained and harvesting dates for 2002 and 2003.

Harvesting stages			Dates in 2002	Dates in 2003
Stage 1	"butts just before flowering"	(first opened capitulums)	6 June	5 June
Stage 2	"beginning of flowering"	(about 50% opened capitulums)	13 June	11 June
Stage 3	"full flowering"	(first wilted capitulums)	20 June	20 June
Stage 4	"end of flowering"	(about 50% wilted capitulums)	26 June	25 June
Stage 5	"flowering over"	(all capitulums wilted)	8 July	7 July

Table 2. Yields, essential oil content and costunolide in the floral stems of *A. umbelliformis* depending on 5 phenological stages (harvests 2002 and 2003).

Harvesting stages	Floral trusses yield (g DM/m^2)		Essential oil content (ml/100 g DM)		Costunolide content (g/100 g DM)	
	2002	2003	2002	2003	2002	2003
Stage 1	48 ab	43 b	1.31 ab	1.46 b	2.72 a	2.91 a
Stage 2	37 b	45 b	1.53 a	1.76 a	3.00 a	2.76 a
Stage 3	93 ab	64 b	1.08 b	0.71 c	2.78 a	0.93 b
Stage 4	87 ab	73 ab	0.61 c	0.41 c	1.26 b	0.75 b
Stage 5	102 a	94 a	0.43 c	0.41 c	1.16 b	0.56 b
Probability	2.25%	0.40%	0.00%	0.00%	0.00%	0.00%
Significance	S*	HS**	HS*	HS**	HS**	HS**
Variation ratio	31.60%	18.20%	13.53%	13.70%	11.68%	14.70%

DM : dry matter; S*: $p<0.05$; HS**: $p<0.01$

Different letters indicate significant differences between stages ($p<5\%$ (test Newman-Keuls)

Table 3. Chemical composition of essential oil in the floral trusses of *A. umbelliformis* depending on the phenological stage (harvests 2002 and 2003).

Harvesting stages			Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Average
α-pinene	(%)	2002	2.4	2.8	2.4	2.4	2.5	2.5
		2003	1.7	2.0	1.9	1.6	1.4	1.7
camphene	(%)	2002	2.9	2.9	2.6	2.7	2.1	2.6
		2003	1.5	2.0	2.0	1.4	1.4	1.7
β-pinene	(%)	2002	13.4	16.3	13.0	13.7	19.9	15.3
		2003	11.2	11.5	10.2	10.8	8.9	10.5
α-myrcene	(%)	2002	20.7	19.3	19.5	20.3	15.9	19.1
		2003	17.8	19.0	16.6	13.0	8.8	15.0
p-cymene	(%)	2002	0.7	0.9	0.9	0.7	1.0	0.8
		2003	0.8	0.8	1.0	0.9	0.8	0.9
1.8-cineol	(%)	2002	15.2	15.7	16.0	15.2	15.4	15.5
		2003	13.1	14.4	10.9	13.7	11.6	12.7
terpinene	(%)	2002	1.7	1.8	1.9	1.6	2.0	1.8
		2003	1.6	1.6	1.8	1.8	1.7	1.7
α-thujone	(%)	2002	1.7	1.0	1.1	1.0	1.0	1.2
		2003	1.4	1.4	1.4	1.6	1.6	1.5
β-thujone	(%)	2002	0.7	0.5	0.8	1.6	1.6	1.0
		2003	1.8	1.8	1.4	1.7	1.7	1.7
camphor	(%)	2002	1.1	0.7	0.9	0.8	0.5	0.8
		2003	1.8	1.5	2.1	2.4	2.4	2.0
borneol	(%)	2002	9.3	9.1	7.5	3.1	7.5	7.3
		2003	13.9	17.1	14.5	15.5	16.8	15.6
α-terpinenol	(%)	2002	2.7	2.9	4.0	3.6	4.6	3.6
		2003	6.0	5.8	5.2	6.3	6.1	5.9
α-terpinol	(%)	2002	0.6	0.6	0.7	0.8	1.0	0.7
		2003	1.3	1.2	0.7	1.2	1.4	1.2
bornyl-acetate	(%)	2002	4.0	3.1	3.0	1.7	0.8	2.5
		2003	3.6	4.1	3.1	2.0	1.5	2.9
caryophyllene	(%)	2002	1.9	1.7	2.0	1.9	2.3	2.0
		2003	4.8	3.6	4.3	3.4	3.5	3.9