# ESSENTIAL OILS

## of marjoram *(Origanum majorana L.)* and summer savory *(Satureja hortensis L.)* distilled in pilot plant scale

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***Figure 3:*** *Steam distillation apparatus in pilot plant scale (Herba-Tec, TWE 250-2000)*

## Introduction

Marjoram *(Origanum majorana L.)* and summer savory *(Satureja hortensis L.)* belong to the family of mint plants *(Lamiaceae)*. Marjoram and summer savory are used as spices and condiments. Their essential oils are known to contain high amounts of compounds with antibacterial, sedative and antioxidative properties and are employed in food industry as flavouring and in perfumery for their spicy herbaceous notes. To determine application possibilities of essential oils in new market fields e.g. use in fodder for animals, their chemical compositions and the oil yields have to be examined by distillation in pilot plant scale.

As main components of the essential oil of marjoram monoterpenes with the basic structure of sabinene cis-sabinene hydrate, trans-sabinene hydrate, cis-sabinene hydrate acetate and sabinene were identified in literature. These components are considered to be responsible for the typical odour and flavour of marjoram.[1] It is claimed, that cis- and trans-sabinene hydrate are produced by the same enzyme in an exact ratio of 10:1.[2] Other components found in the oil are mainly artefacts. In acidic solution sabinene hydrate rearranges to terpinen-4-ol and small amounts of α-, γ-terpinene and p-cymene during the distillation process.[3] According to literature data, two main chemotypes of essential oil of marjoram exist. One chemotype consists mainly of monoterpene alcohols and the other of phenols. For the first chemotype terpinen-4-ol, either alone or together with other monoterpene alcohols such as cis- and trans-sabinene hydrate, have been determined as main volatile components.[3] [4] The second chemotype is rich in phenols mainly thymol and/or carvacrol.[5] [6]

Essential oil of the perennial summer savory contains carvacrol (30 to 45%), p-cymene (up to 30%) and γ-terpinene as main compounds. Minor compounds are α-terpinene, thymol, myrcene, α-pinene, linalool, trans-caryophyllene and terpinen-4-ol. Essential oil of summer savory contains only minor amounts of thymol in contrast to thyme. The chemical composition of summer savory is similar to the composition of winter savory *(Satureja montana L.)*. Few data are available in literature regarding the chemical composition of summer savory.[7]

## Methods

Essential oils of marjoram and summer savory distilled in pilot plant scale were analysed to state on their essential oil composition.

Marjoram (sort "Marcelka", CS) was cultivated and harvested in the year 2004, summer savory (sort "Aromata", DE) was harvested in 2005 in one habitat in the southeast of Lower Austria. Distillation of the dried and, for parts of summer savory, wilted plant material was carried out in the autumn of 2005 and the obtained oils were analysed. Plant material was prepared for distillation in case of marjoram with or without stems, in case of summer savory wilted or dried.

Steam distillation was carried out using a hundred litres batch volume distillation plant of the type Herba-Tec 250-2000, which in average processes about 6 to 8 kilograms of dried plant material per batch.

After distillation samples were taken in order to investigate the essential oil composition and the relative amounts of main compounds. Taken samples represent therefore a mixture of the gained essential oil during the whole distillation time. Samples were subjected to capillary gas chromatographic analysis (GC/MS and GC/FID) on an Agilent Technologies 6890N Network GC System instrument with helium as carrier gas. Separation was performed on a HP-5 MS capillary column (30 m length x 0.25 mm i.d. x 0.25 µm film thickness) coated with 5% phenyl and 95% dimethyl polysiloxane. Oven temperature program was started by 50 °C and risen with 7 °C/min to a final temperature of 240 °C (hold: 5 min). The samples were diluted 1:100 with n-hexane and 1 µl of the diluted samples was automatically injected in split mode. Sample compositions were determined by comparing the relative retention times of standards, linear retention indices (Kovats indices) and mass spectra from data library of essential oil components (NIST, WILEY). Relative percentages of the most predominant components (> 0.5%) for both plants were examined by calculating the peak areas. These are important factors for the various applications of essential oils. The results provide the possibility to determine the relative amounts of main compounds of essential oils of marjoram and summer savory distilled in pilot plant scale.

## Results marjoram

20 compounds with relative amounts higher than 0.5% were identified in the essential oil of marjoram. Trans-sabinene hydrate, terpinen-4-ol, trans-sabinene hydrate acetate and γ-terpinene were determined as quantitatively predominant components. Terpinen-4-ol and small amounts of α-, γ-terpinene and p-cymene are results of rearrangements of sabinene hydrate in acidic solutions during steam distillation. Distillation of plant material without stems seems to provide oil with the same chemical composition as distillation of the whole plants. On the other hand a higher oil yield was achieved by distillation of the plant material without stems (in average 1.7–1.9% based on dry substance) in comparison to distillation of plant material with stems (in average 1.0–1.5% based on dry substance).

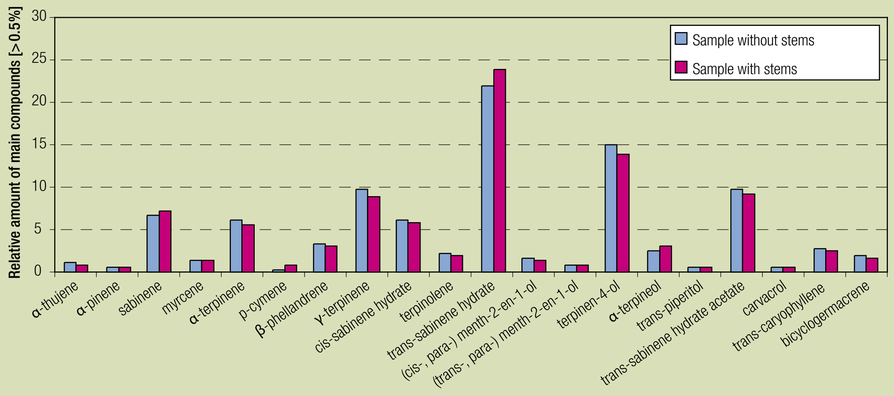


***Figure 1:*** *Relative amounts of main components (>0.5%) of essential oil of two differently prepared sorts of plant material of* ***marjoram*** *(with and without stems) distilled in pilot plant scale*

## Results summer savory

12 compounds with relative amounts higher than 0.5% were identified in the essential oil of summer savory. γ-terpinene, carvacrol and, for distillation of the wilted plant material, additionally p-cymene were the main compounds found in the essential oil. γ-terpinene and p-cymene are known as biosynthetic precursors of thymol and carvacrol. In case of a longer drying time more p-cymene seems to rearrange to carvacrol and thymol.

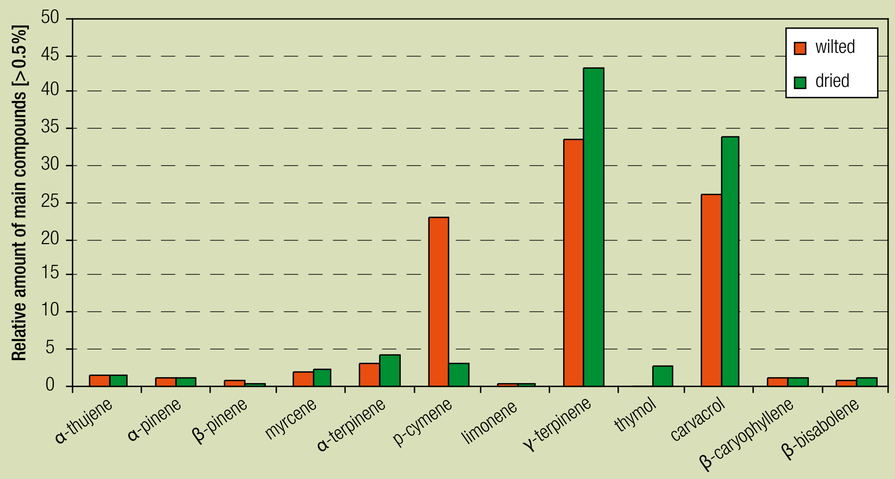


***Figure 2:*** *Relative amounts of main components (>0.5%) of essential oil of dried and wilted* ***summer savory*** *(first cut 2005)*

## Conclusions

As main outcome it can be postulated, that the results of the distillation of marjoram and summer savory in pilot plant scale is comparable to those distillations carried out in lab scale. The marjoram oil obtained by processing of plant material grown in Lower Austria belongs to the sabinene hydrate/terpinen-4-ol chemotype. Minor compounds identified are α-, γ-terpinene and p-cymene which, together with terpinen-4-ol, are known as artefacts of sabinene hydrate and its related compounds and are built during distillation. In contrast to the results of most surveys of essential oil of marjoram, the relative amount of trans-sabinene hydrate is higher than the amount of cis-sabinene hydrate and the ratio is 4:1.

As main compounds of summer savory γ-terpinene, carvacrol and, for the wilted plant material, additionally p-cymene are identified and a difference in the quantitative chemical composition between wilted and totally dried plant material can be observed.

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