7 Summary

In this study, essential oils, acid fractions, and pyrolysates of *Boswellia carterii*, *B. serrata*, *B. frereana*, *B. neglecta* and *B. rivae* were investigated. In addition, antibacterial and antioxidative activities of these samples were tested.

Investigations on the essential oils, which were carried out by GC, GC-MS, and TLC, led to the identification of the diagnostic markers for each species. During these investigations, a diterpenoic constituent of *B. carterii*, verticilla-4(20),7,11-triene (**1**), was isolated and identified for the first time from a natural source. In addition, 5,5-dimethyl-1-vinylbicyclo-[2.1.1]hexane (**3**), m-camphorene (**4**), p-camphorene (**5**) from *B. serrata*, and a dimer of α-phellandrene (**7**) from *B. frereana* were isolated and identified in *Boswellia* for the first time (**Fig. 6.1**).

SPME investigations, performed on the essential oils and resin samples, showed that the major constituents are predominantly responsible for the fragrance of olibanum.

The acid fractions of olibanum were investigated by GC or GC-MS after derivatisation. The stability of these fractions was checked by the application of "*stress tests*" by 1- or 2-D TLC. Acid fractions were prepared using various published methods and compared with own investigations. The results allowed the identification of artifacts in these extracts and -moreover- the reaction step in the procedure causing the formation of these artifacts, especially when HCl was used even in small amounts. These results were considered as decisive facts in quality control of the phytopharmaceuticals involving boswellic acids.

The investigations on acid fractions of olibanum by GC and GC-MS also showed that only *B. carterii* and *B. serrata* contain derivatives of pharmacologically active boswellic acids and tirucallic acids, whereas in *B. frereana* lupeol and *epi*-lupeol were detected. Derivatives of α- and β-amyrin were formed in *B. neglecta* and *B. rivae*. Among these three species, *B. rivae* was the only one that also contained small amounts of α- and β-BA.

In order to obtain toxicologically relevant data, pyrolysates of olibanum originating from incensing were collected by a newly designed solid phase adsorption set-up where the pyrolysates were adsorbed on Super Q® phases. The investigations were performed by GC and GC-MS. The formation of nortriterpenoic constituents was observed as a result of dehydration, deacetylation reactions accompanied by decarboxylation of boswellic acids in *B. carterii* and *B. serrata*. The isolation of 24-norursa-3,12-diene (**8**) directly from the pyrolysate was achieved by CC and TLC at different temperatures. In addition, 24-norursa-3,12-dien-11-one (**13**) (**Fig. 6.3**) was isolated and identified for the first time in this study. Moreover, the stability of the diterpenoic constituents of these species even at high temperatures were surprising. The results were compared with *Curie*-point (670 °C) pyrolysis-GC-MS and found consistent.

The antibacterial activity of olibanum was tested for *Bacillus subtilis* by using a Biodip test-kit. Among the essential oils, only that of *B. carterii* showed antibacterial activity for verticilla-4(20),7,11-triene (**1**) and incensyl acetate (**2**).

The acid fractions of *B. carterii* and *B. serrata* showed high antibacterial effects for AKBA, α- and β-BA and 3-oxo-8,9,24,25-tetradehydro-TA whereas KBA exhibited a moderate activity (**Fig. 6.2**).

Both *B. carterii* and *B. serrata* pyrolysates, showed inhibition zones for 24-norursa-3,12-diene (**8**) and cembrene A. In addition, incensyl acetate (**2**), present in the pyrolysate of *B. carterii* had showed an antibacterial activity. In contrast, the pyrolysates of *B. frereana* and *B. neglecta* were found to be inactive. These results could support the successful use of certain *Boswellia* resins as a desinfectant in traditional ceremonies.

Antioxidative activities were tested with DPPH. Both essential oils and pyrolysates of olibanum species showed no relevant effects for *B. serrata*, *B. frereana* and *B. neglecta*. The acid fractions of olibanum resins were found to be inactive under the conditions tested.