The thyroid gland is dependent on iodine for production of the thyroid hormones thyroxine (T_4) and triiodothyronine (T_3), through which the thyroid gland governs our body function and development. In the thyroid, iodine can be enriched and stored in the thyroid iodine pool. The individual size of the iodine pool is dependent on many factors such as the availability of iodine in the food. Knowledge of the iodine pool is most valuable since it can contribute to the understanding of thyroidal diseases and possibly predict treatment outcome. This information can be obtained with the method X-ray fluorescence analysis (XRF).

The XRF technique is applicable *in vitro* as well as *in vivo* and due to the low radiation dose analysis can be performed even in pregnant women. The method has proven useful in several situations but to obtain accurate results there are a number of method features to consider. The primary limitations of *in vivo* XRF analysis of the iodine pool are low iodine concentration and impairment of the detected signal due to attenuation in overlying tissue. The challenge is therefore to optimise the system with purpose of obtaining a large iodine signal and a low background.

This thesis includes an *in vivo* study of 37 euthyroid individuals. During that study, questions concerning the method arose that lead to a methodological study, including comparisons of different irradiation sources, analysed volumes, and scattering effects on the detected signal. The last two points were further investigated with Monte Carlo (MC) simulations, which were also used for system optimisation and method evaluation. Also important was the use of MC simulations for development of an alternative individual calibration method. Scattering in the tissue overlying the thyroid but also in the whole neck region, was shown to influence the detected signal. Through a relevant choice of analysed volume though, that effect could be controlled and minimised. Most important is to be aware of and to have knowledge about the different factors changing the detected signal. By knowing that it was possible to perform individually adjusted calibrations. Moreover, iodine content and distribution in benign and malignant thyroid tissue together with tissue from thyroid healthy subjects was analysed with XRF and secondary ion mass spectrometry (SIMS) as complementary methods. The XRF and SIMS analysis presented similar results showing a significant difference in iodine content between benign and malignant thyroid tissue.

In conclusion it is our opinion that XRF investigations offer a unique possibility to study the thyroidal iodine pool in thyroid sickness as in health. Apart from clinical applications in subjects with thyroid disease it would be of outmost interest to apply the method in situations of iodine deficiency or iodine overload to improve the knowledge of how our body handles uptake and storage of the rare element iodine.

Key words: thyroid, iodine, x-ray fluorescence analysis, XRF, secondary ion mass spectrometry,