

6th Conference on Water in Food



Maison des Agriculteurs

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Reims

France

**Rapid moisture measurement with
microwave resonance technology
in infant formulas**

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Water content in infant formula

- physical properties
- technological processes
- microbiological stability and shelf life
- nutritional value
- economic aspects, trade value
- legal issues



Microwave resonance technology

tube sensors and analyzers for laboratory use



Microwave resonance technology

different types of sensors





Microwave resonance technology

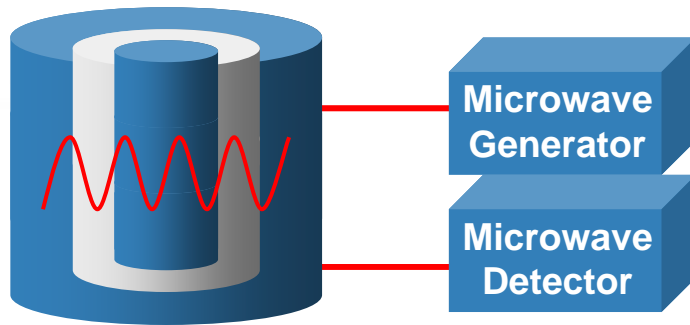
handheld instruments



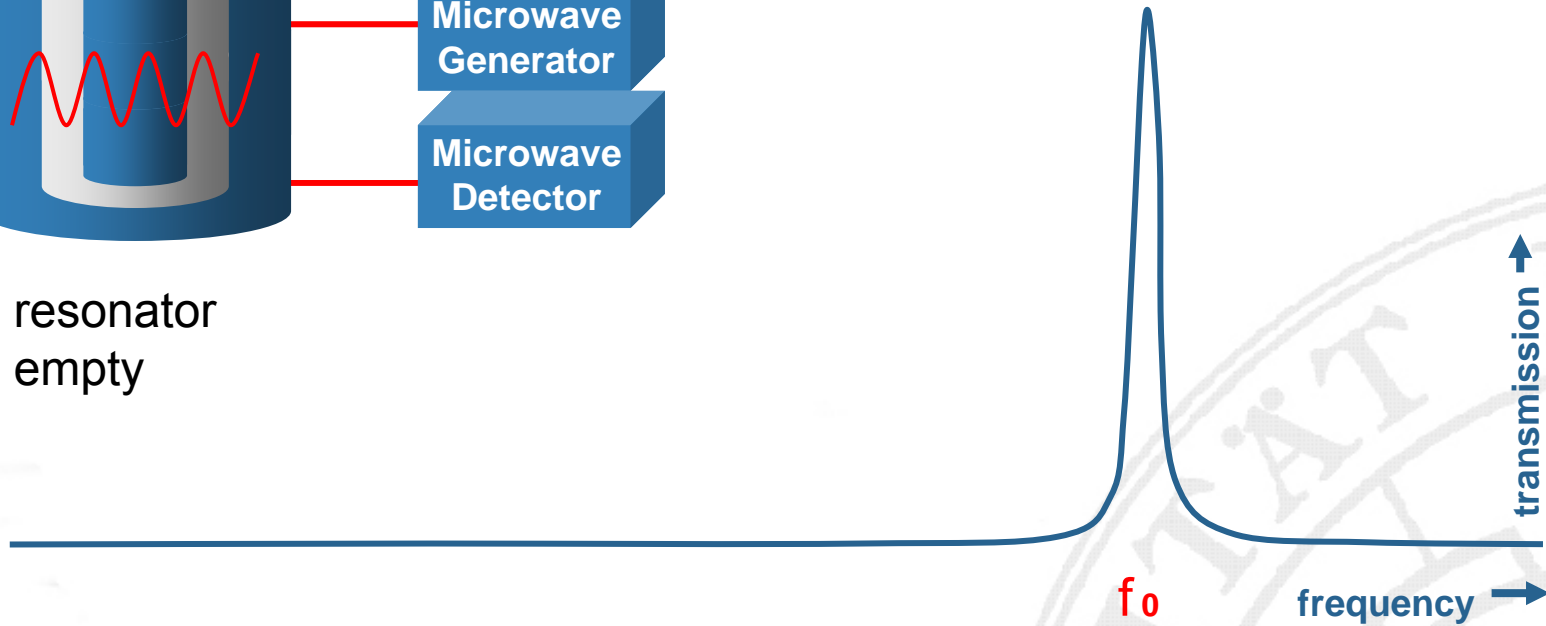


Microwave resonance technology

characteristic microwave resonance of resonator

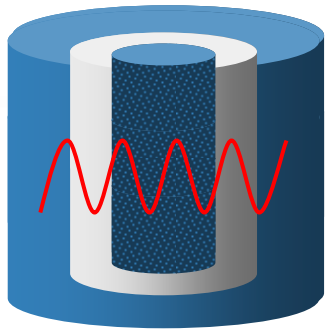


resonator
empty

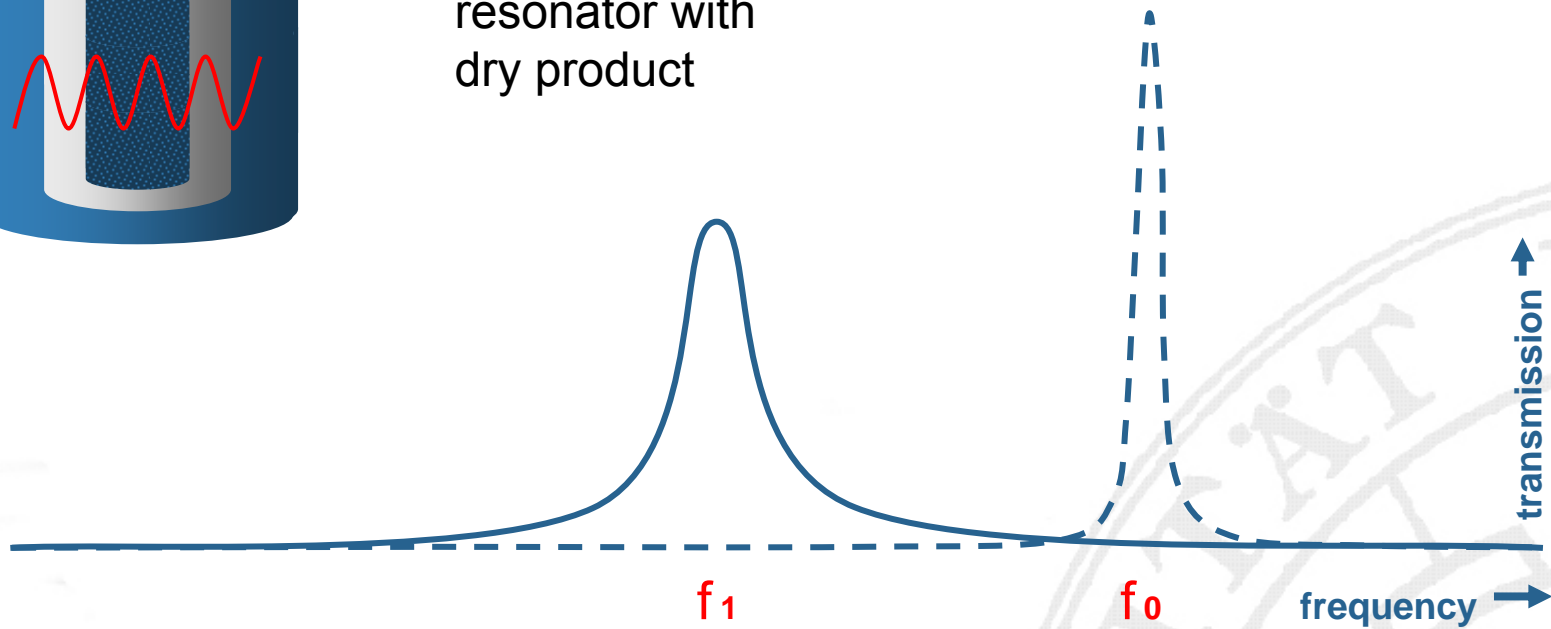


Microwave resonance technology

resonance shift induced by product

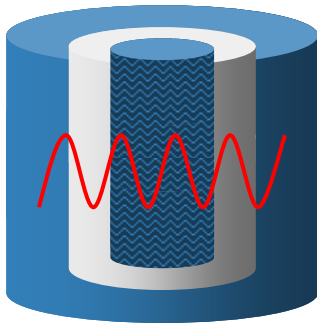


resonator with
dry product

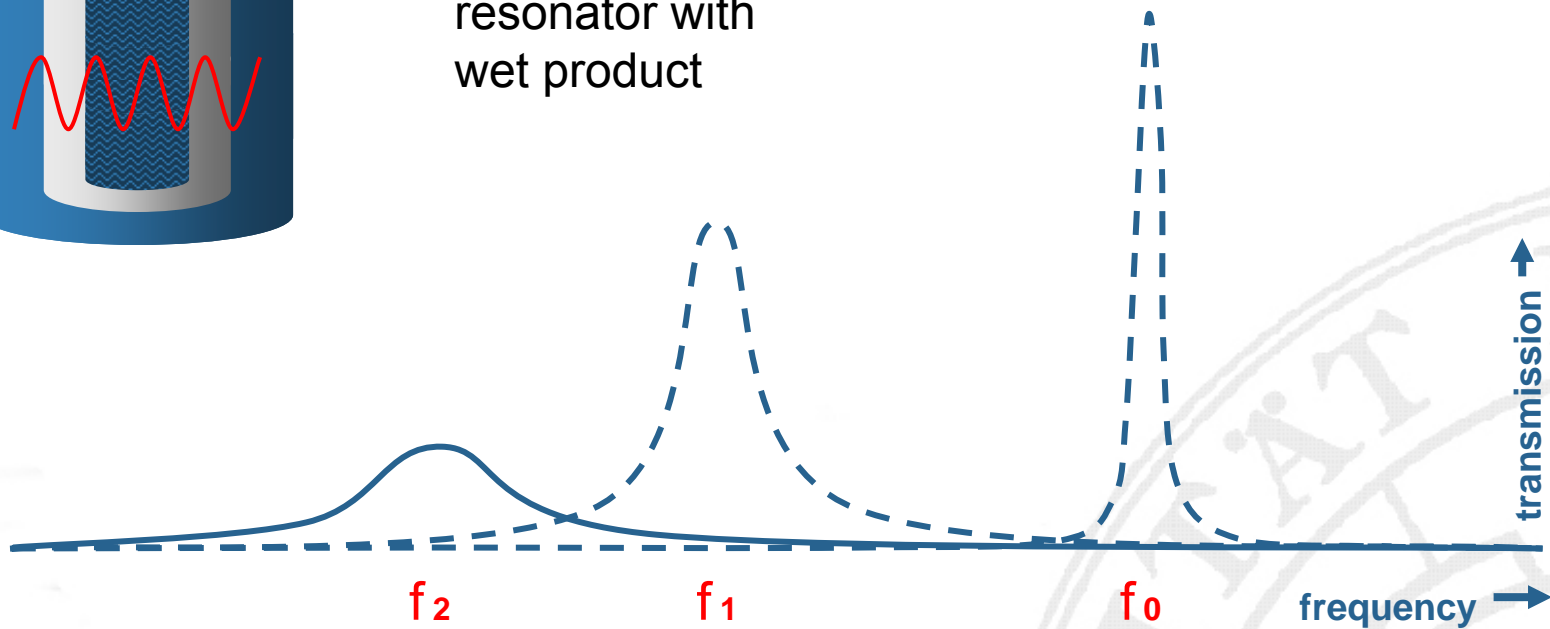


Microwave resonance technology

shift and attenuation induced by moisture



resonator with
wet product





Microwave resonance technology

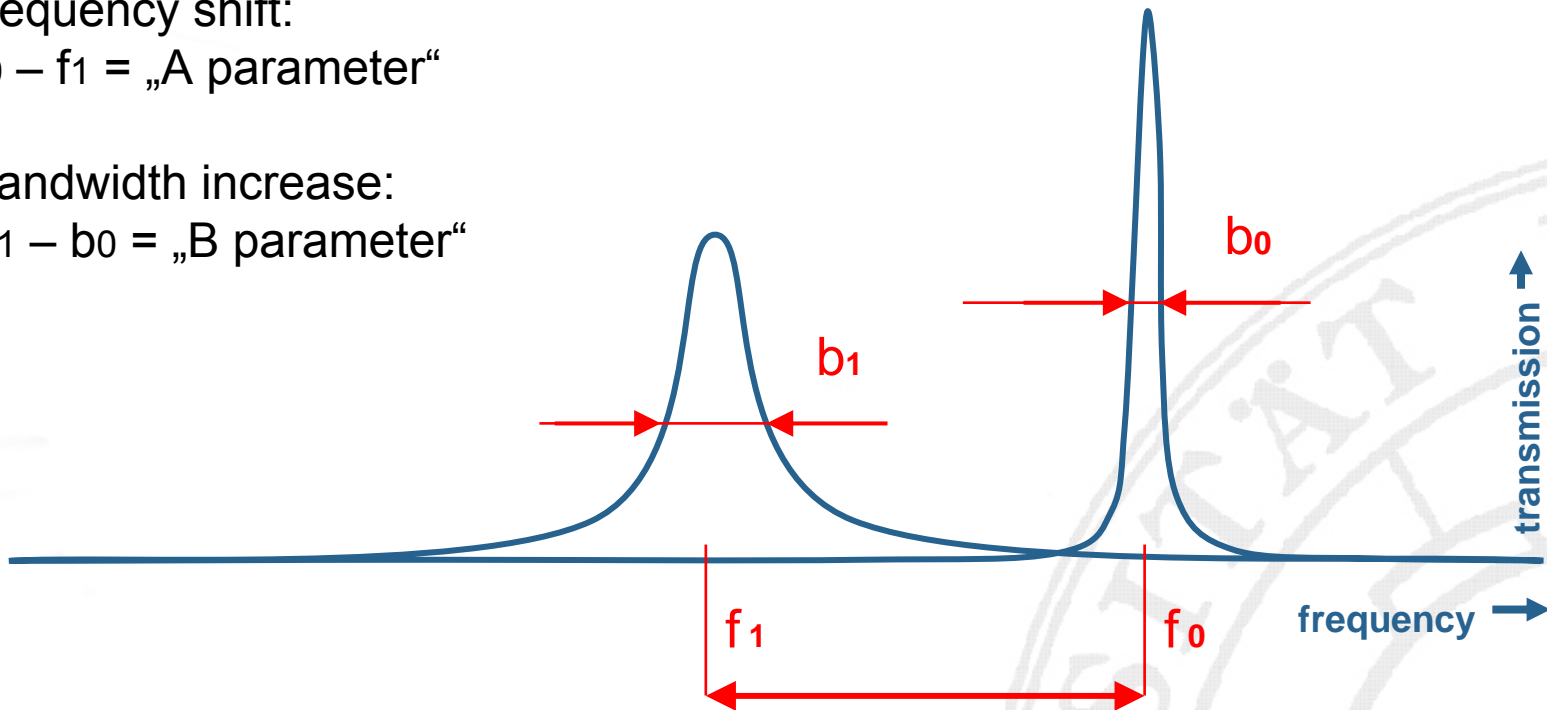
measuring resonance shift and bandwidth

frequency shift:

$f_0 - f_1 =$ „A parameter“

bandwidth increase:

$b_1 - b_0 =$ „B parameter“

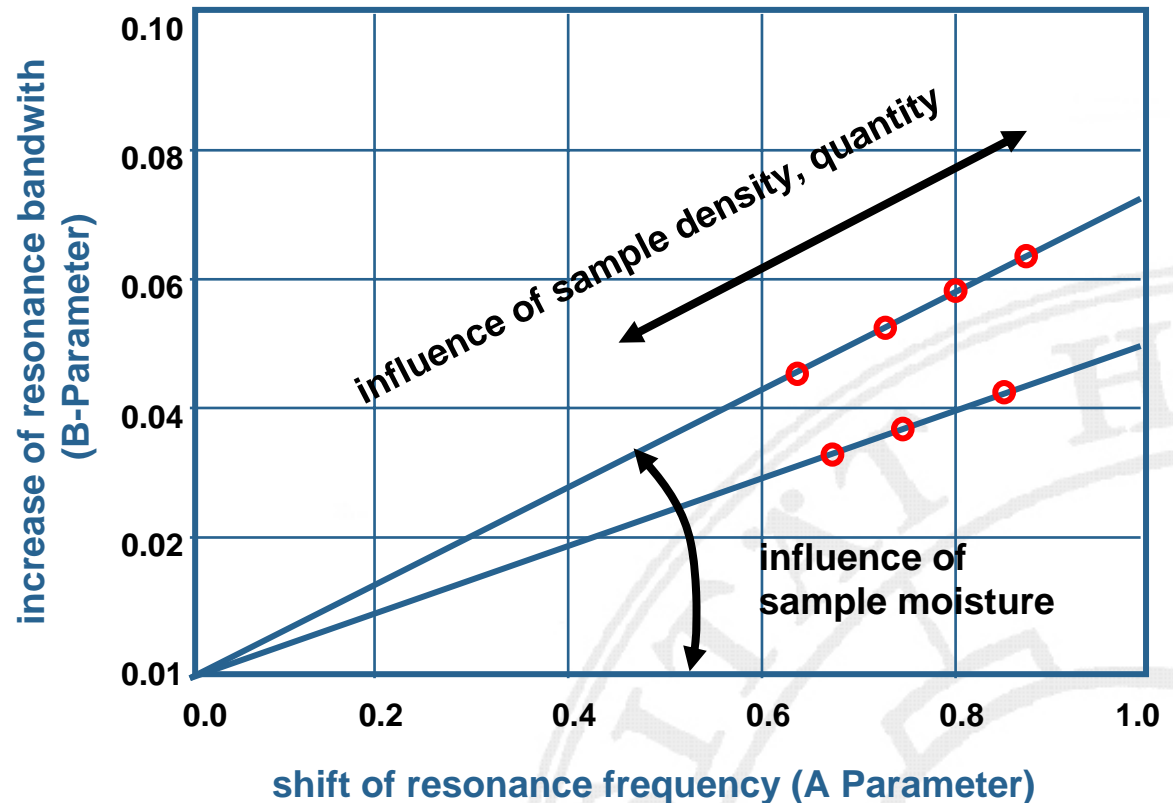




Microwave resonance technology

moisture independent of sample density and quantity

measuring two independent parameters A and B allows calculating a moisture value independent of density and quantity impacts.





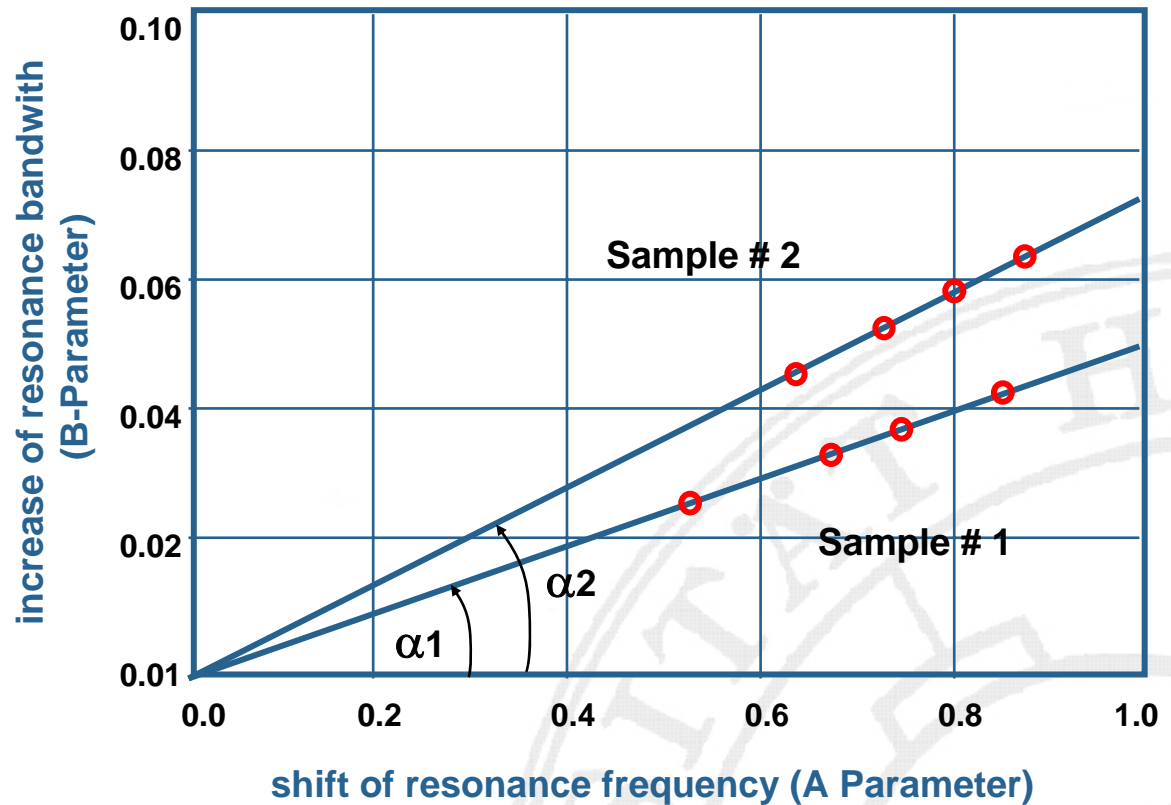
Microwave resonance technology

calculating moisture value

A and B parameters
are measured

$$\alpha = \arctan (B / A)$$

α is proportional
to moisture



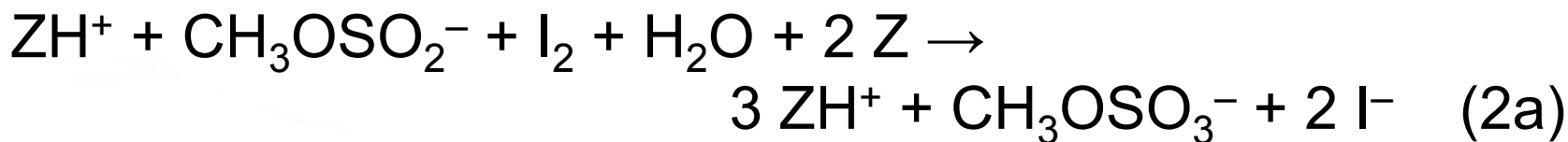
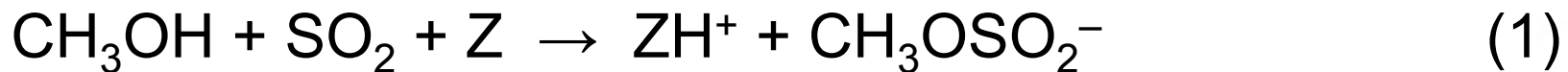


Drying techniques

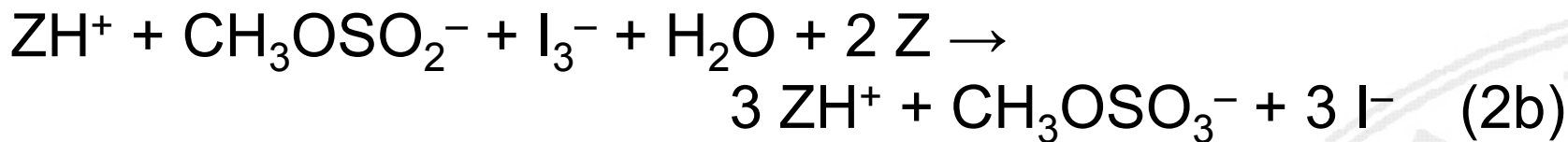
- for the calibration curves different samples were dried in a drying oven at 80 °C, 100 °C and 120 °C, and in a vacuum drying oven at 50 °C.
- after cooling down their loss of mass was measured,
the microwave-moisture-value registered and the water content determined by Karl Fischer titration or gas extraction followed by Karl Fischer titration



Karl Fischer titration:



or



Z = Base, mostly imidazole and no longer the “historic” pyridine

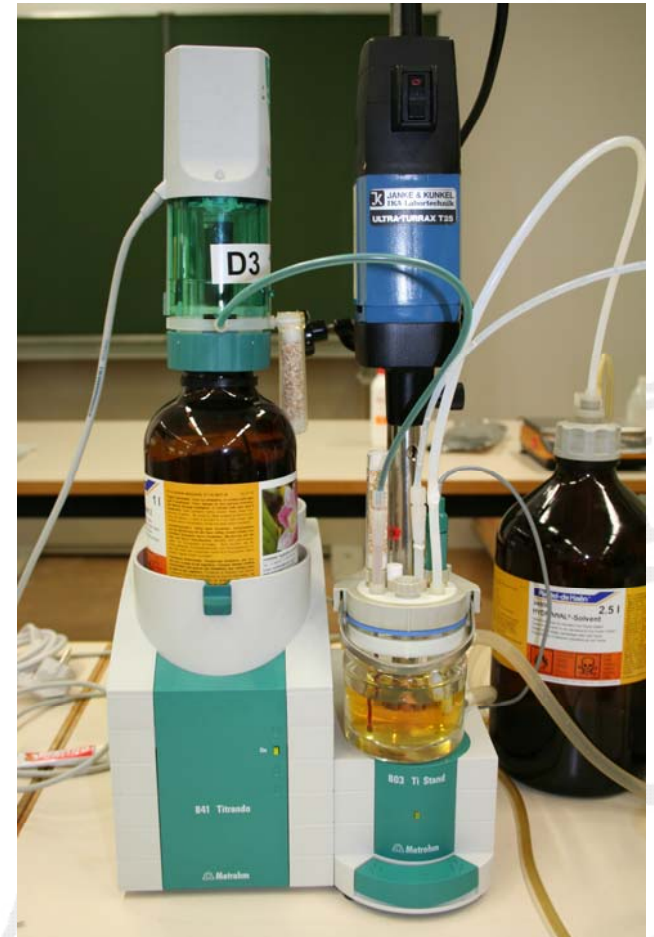


1 mol I_2 indicates 1 mol H_2O .

from the consumption of I_2
the amount or the concentration of H_2O can be calculated.

Karl Fischer titration:

- titration at 40 °C
30 ml Hydranal®-Solvent and
10 ml formamide
- extraction time of 10 min
- 5 replicates





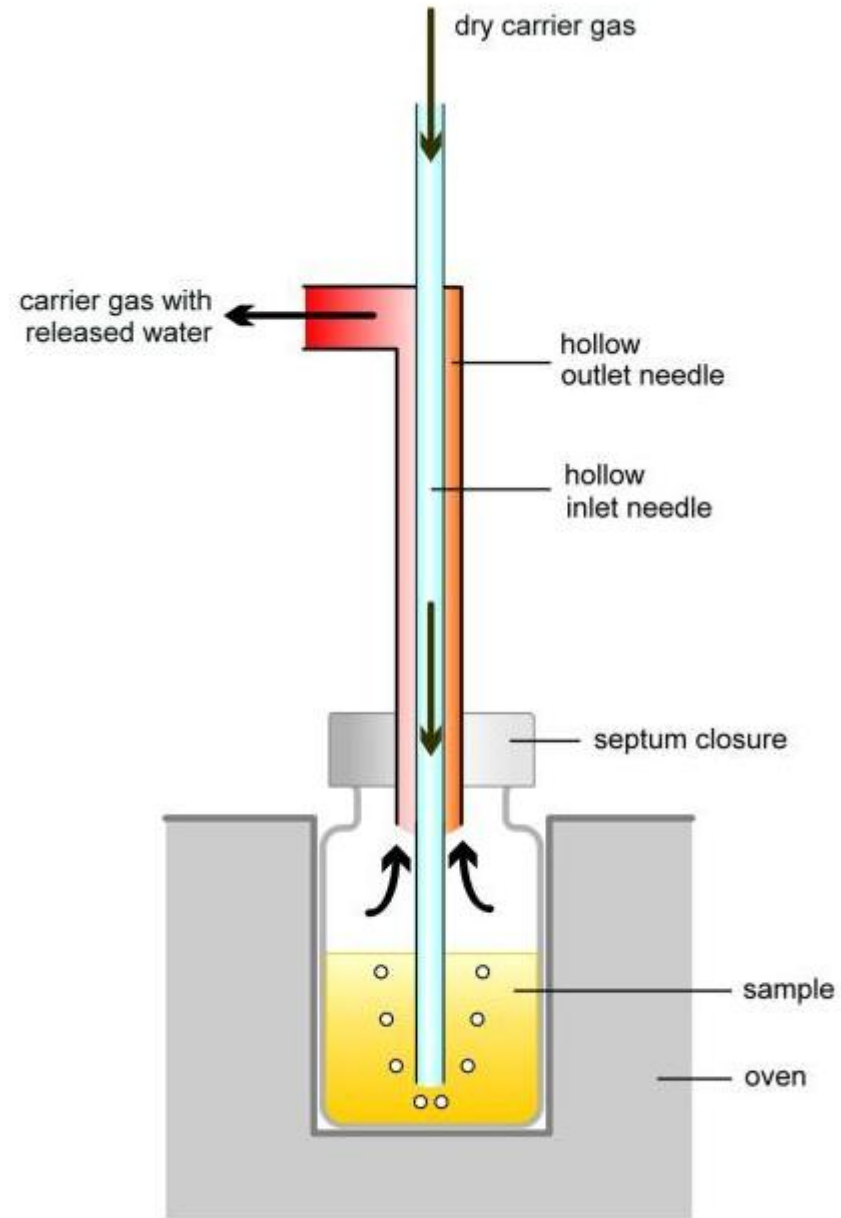
Automated Karl Fischer titration with heating oven

combination of a drying method
and
coulometric Karl Fischer Titration



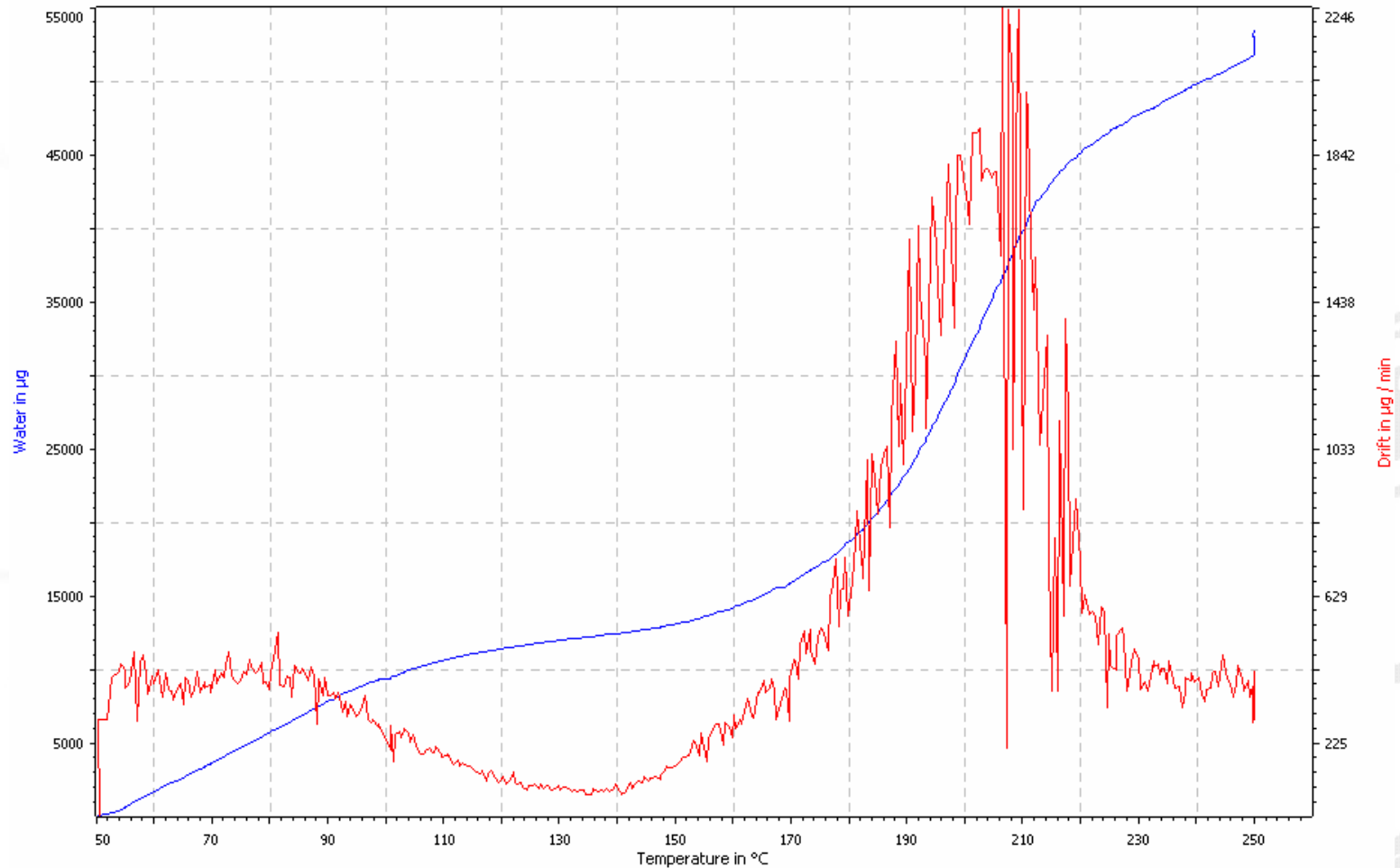
Automated Karl Fischer titrator with heating oven

principle of gas extraction



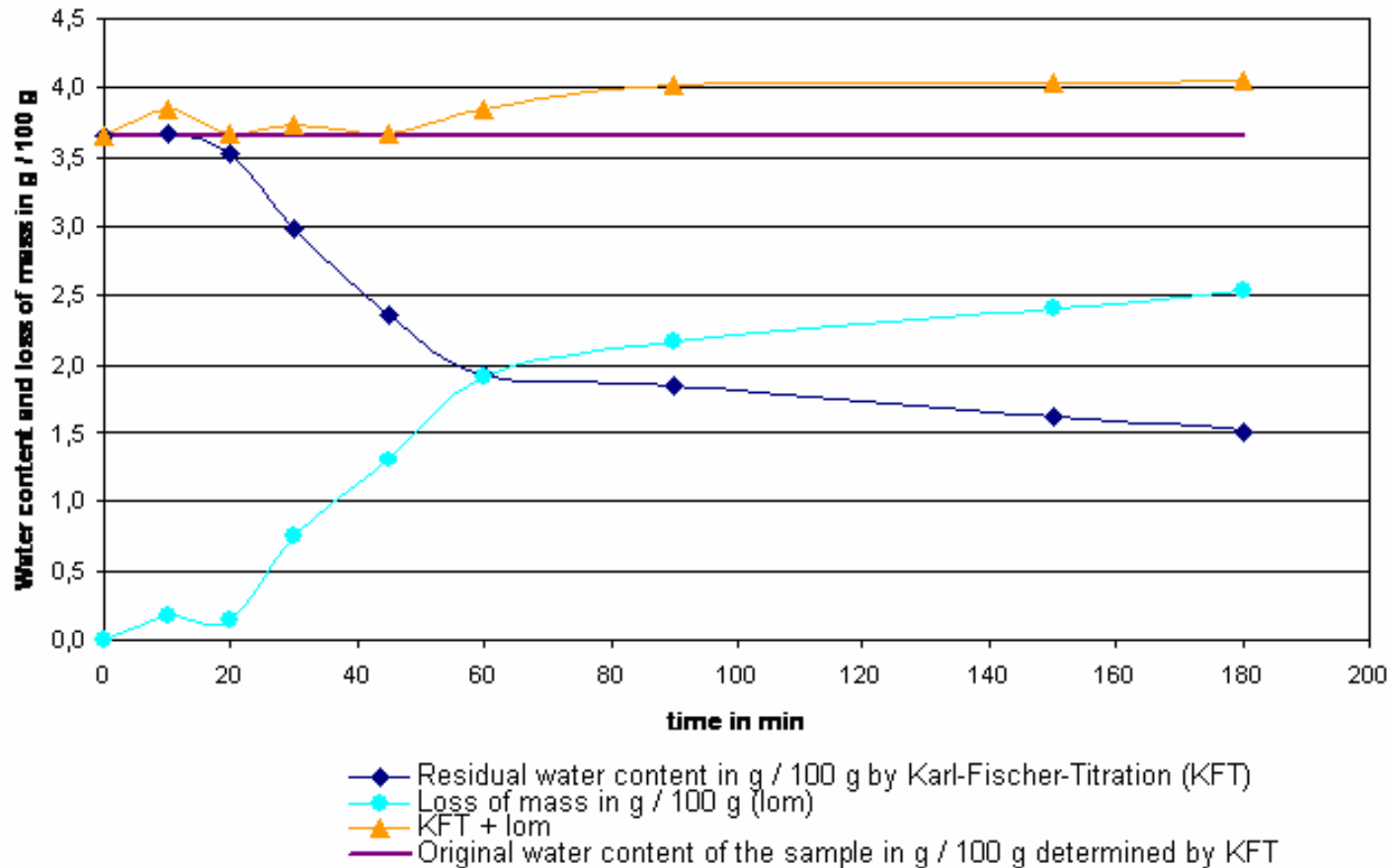


Automated Karl Fischer titration with heating oven



Results and discussion

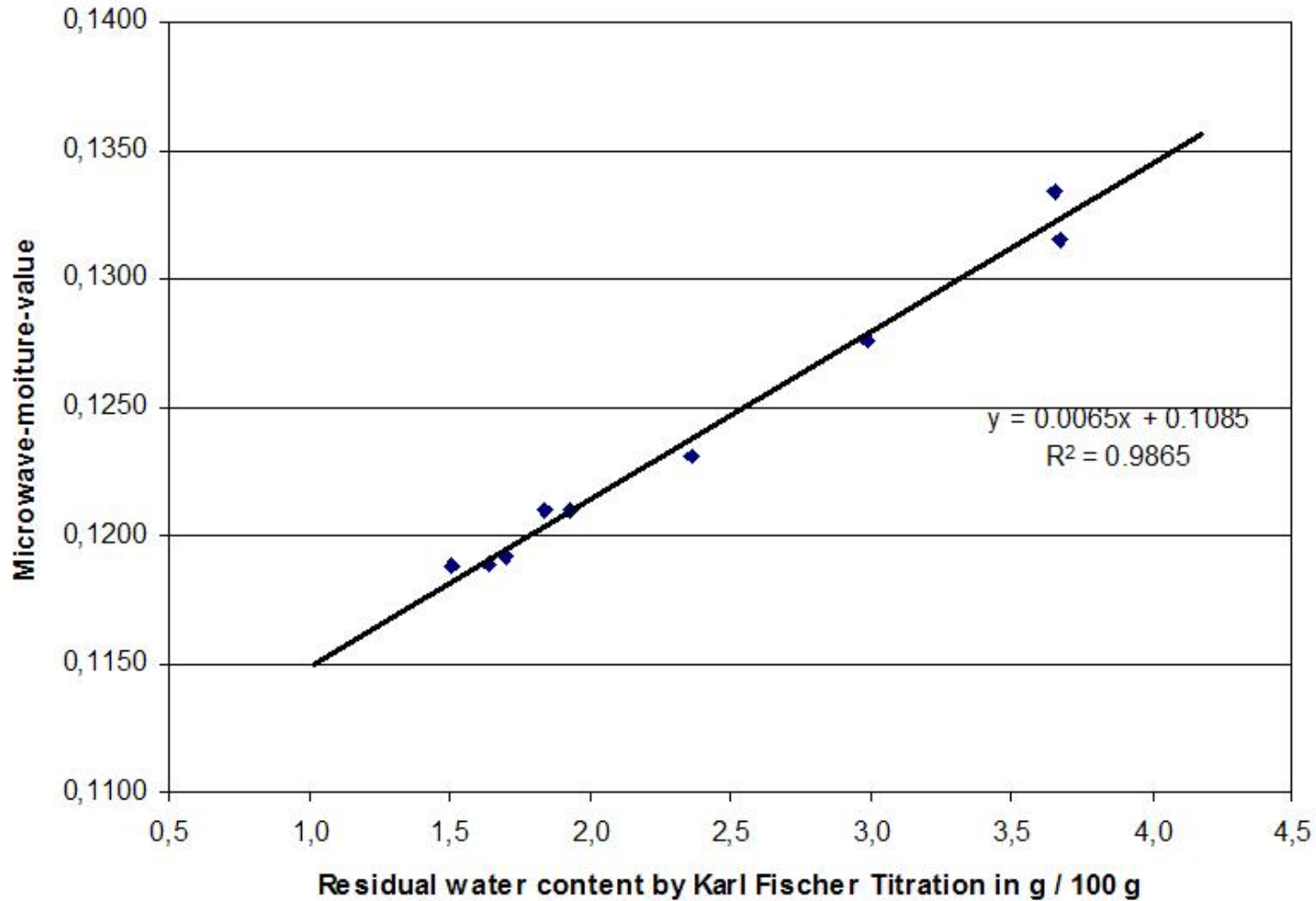
drying curve of Bebivita dried at 80 °C





Results and discussion

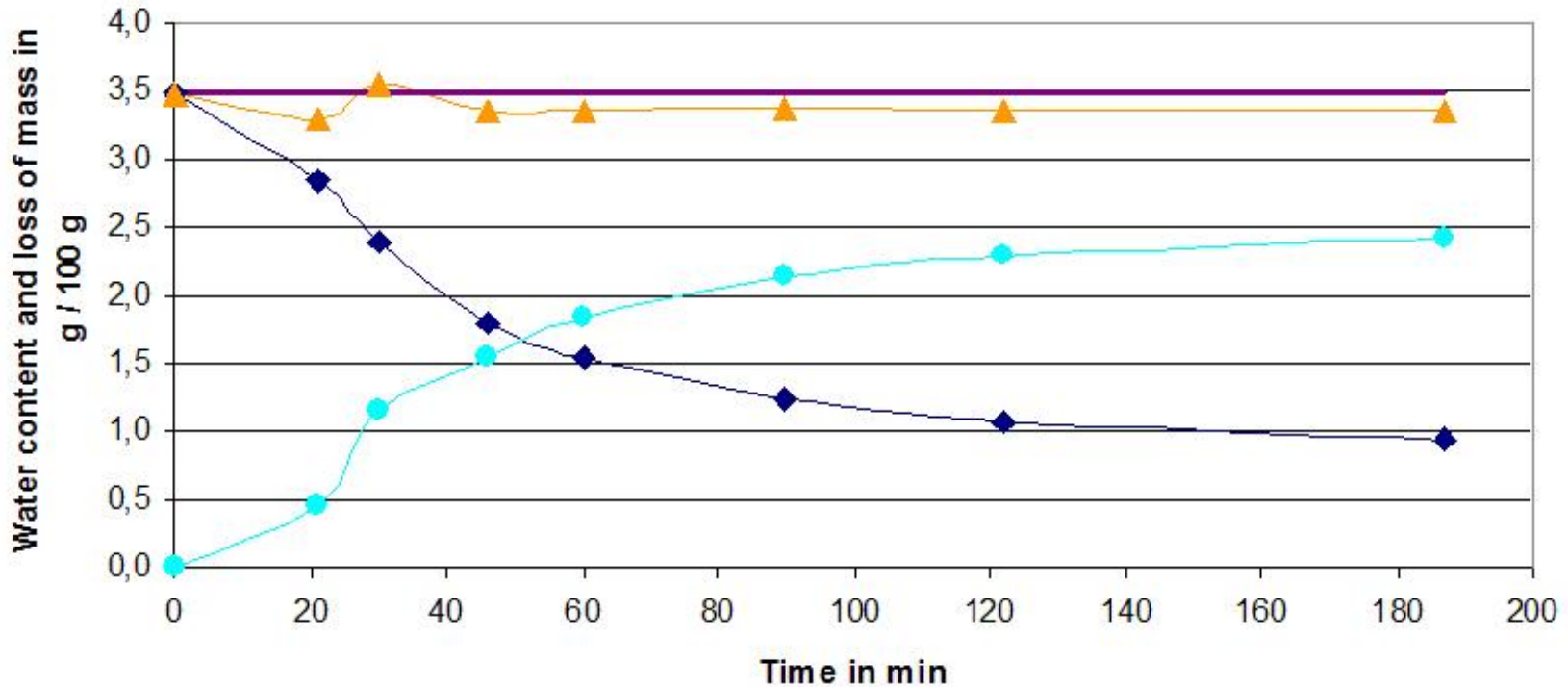
calibration of Bebivita with conventional Karl Fischer titration as reference



Results and discussion

drying curve of Bebivita dried at 80 °C

water contents were measured by KFT-ho

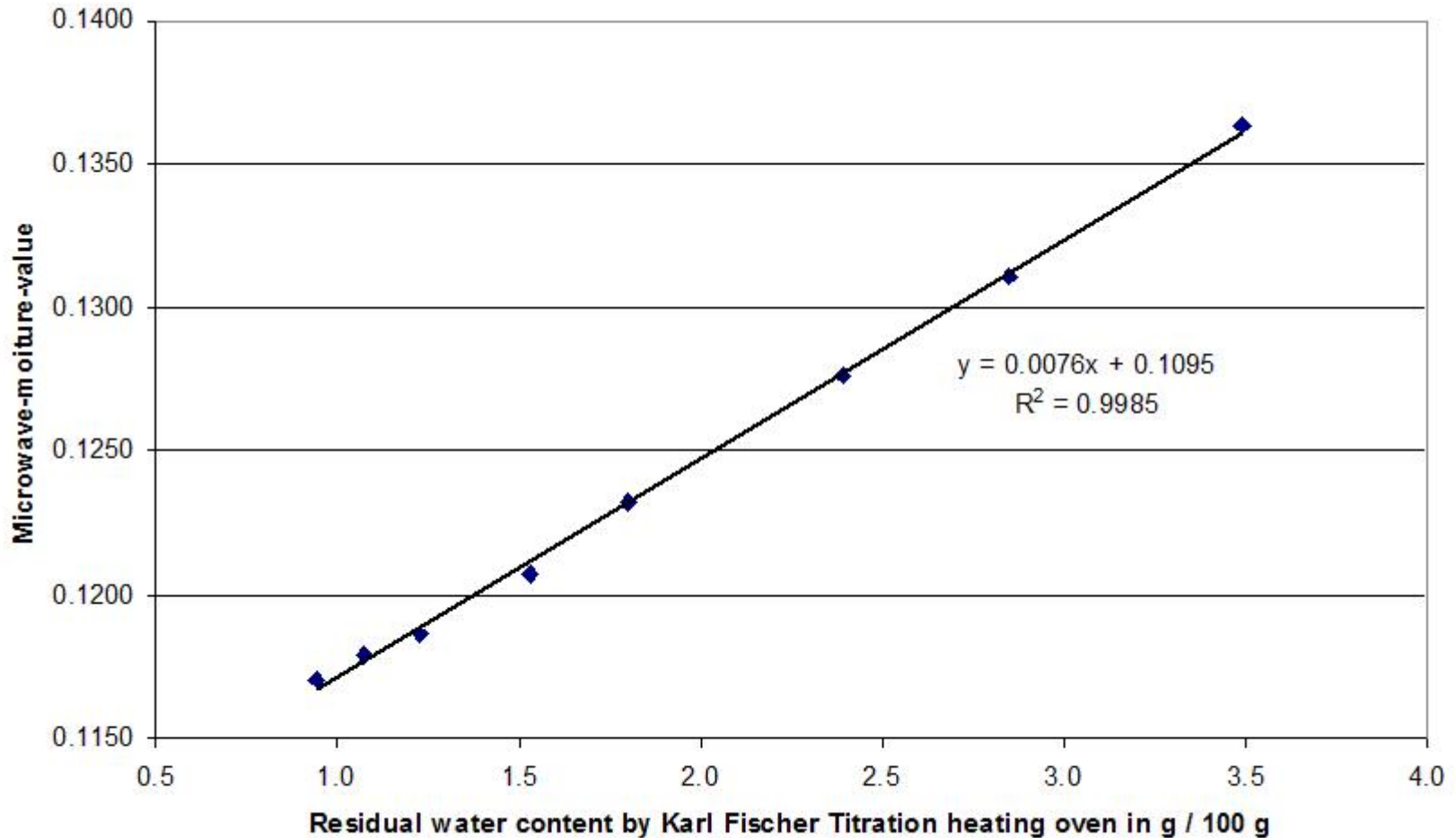


- ◆ Residual water content in g / 100 g by Karl-Fischer-Titration heating oven (KFT-ho)
- Loss of mass in g / 100 g (lom)
- ▲ KFT-ho + lom
- Original water content of the sample in g / 100 g determined by KFT-ho



Results and discussion

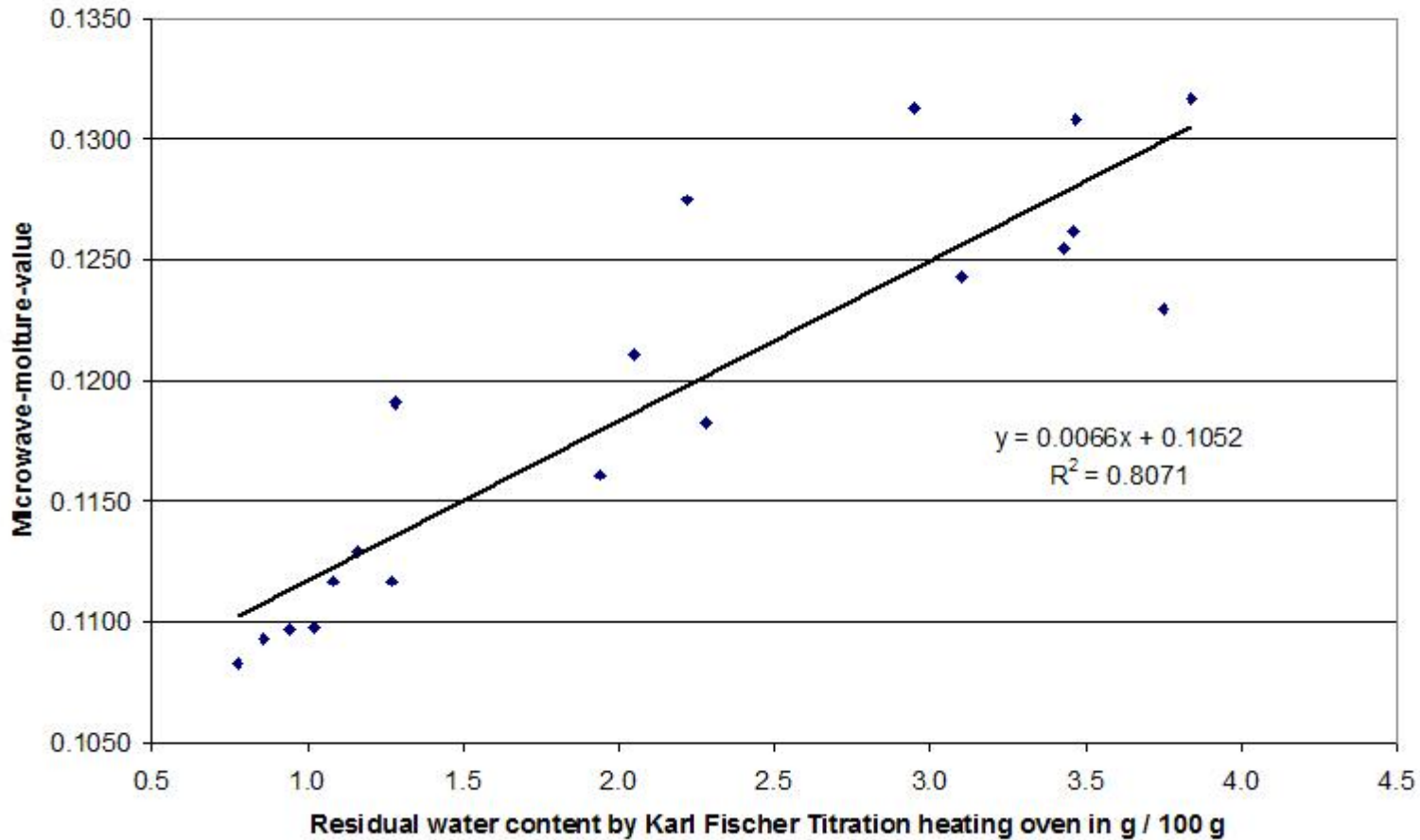
calibration of Bebivita with Karl Fischer titration with heating oven as reference





Results and discussion

calibration of two drying curves at 80 °C of Bebevita with Karl Fischer titration with heating oven as reference





Conclusion

the microwave resonance technology can be used for rapid measurement of the moisture content in infant formulas

the calibrations are highly affected by the production parameters of the product



Conclusion

the Karl Fischer titration with heating oven seems to be a very acceptable reference method

the major benefit of the microwave resonance technique is the very short testing time and the possibility to use it online.



**Thank you very much
for your attention**