Noninvasive methods for hydration monitoring of biological samples

Brendtke R [1,2] | Schachtner F [1] | Wiehl M [1] | Walles H [2]| Hansmann J [2]
[1] senetics healthcare group GmbH & Co.KG | Henkestraße 91 | 91052 Erlangen | Germany
[2] Tissue Engineering and Regenerative Medicine | University Hospital Würzburg | Röntgenring 11 | 97070 Würzburg | Germany

Objective

Water plays a crucial role in biological tissues. Every biochemical process is performed in water. Hence, the water balance is a highly complex issue and once disturbed serious problems may occur. If biological tissues lack water they will get dehydrated, biochemical processes can only be performed in an impaired way.

The continuous progress in the area of noninvasive monitoring technologies such as quality controls in the field of bioreactor based test systems is right now not able to measure the hydration of biological samples reliably. As to overcome this we aim to develop a hydration monitoring system that can work as a quality control during the maturation and testing of biological samples.

Materials & Methods

The projects objective is to develop a monitoring system, capable of measuring the dehydration of a sample.

For this reason we try to combine noninvasive monitoring techniques together in order to be able to state the contemporary condition of biological samples without the need of having to halt an experiment.

However, to get authorization, it is necessary to validate the new concept. With the experiments we want to demonstrate how noninvasive measurement methods can help to perform hydration monitoring of a test system. In order to check whether an epidermal layer influences measurements, an impedance analysis has been carried out. Moreover, we aimed to control the quality of the samples investigated, without destroying them. Therefore we accomplished Raman-spectroscopy.

Results

Bioimpedance analysis (BIA) of different samples: the analysis shows the shift of amplitude and phase, caused by the trans-epidermal electric resistance (TEER) over the epithelial layer of porcine skin samples compared to hydrogels or dermal equivalents without an epithelial layer.

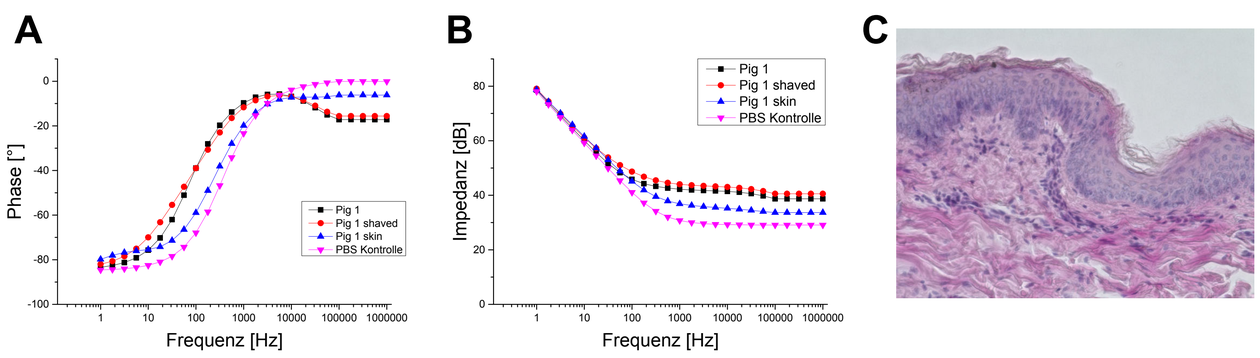

Figure 1: BIA of porcine skin; shift of the phase **(A)** and amplitude **(B)** caused by TEER of the epidermal layer, visualized with HE staining **(C)**

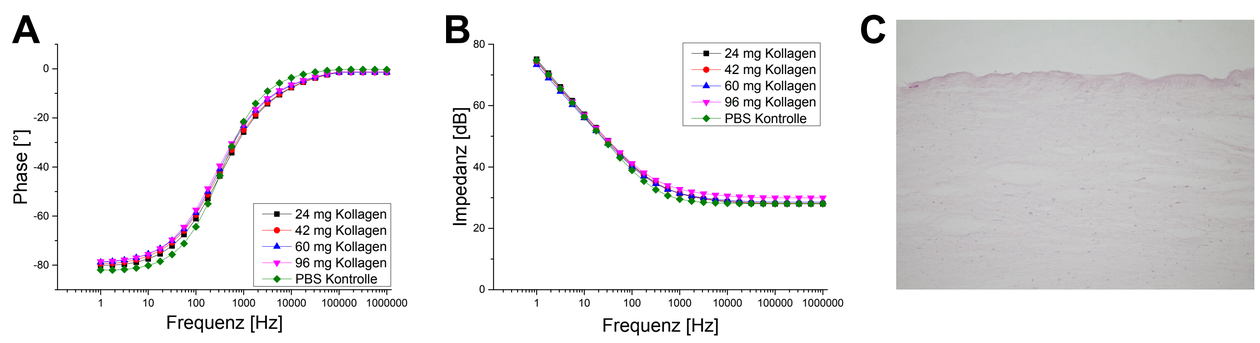

Figure 2: BIA of collagen hydrogels; phase **(A)** and amplitude **(B)** underlie no shifting as there is no epidermal layer, visualized with HE staining **(C)**

Raman-spectroscopy: analyzing the primary components can help to distinguish between different concentrations of each hydrogel.

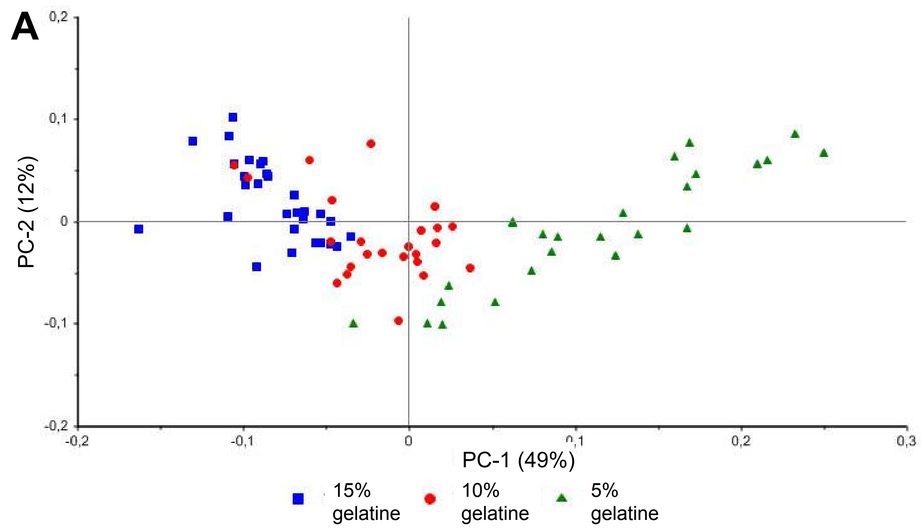

Figure 3: primary component analysis of hydrogels **(B)** gelatine hydrogels with a concentration range from 5-15% **(C)** collagen hydrogels compared to a dermal skin equivalent using 45 mg collagen

Summary

Bioimpedance analyses can be used for noninvasive quality control of the epidermal constitution via the TEER. Hence, the method might be used to gain supportive information about complex models or tissues regarding the epithelial barrier function as well as the samples composition.

Raman-spectroscopy is a method that is capable to perform a noninvasive quality control of samples regarding their concentration. Moreover cell vitality measurements can be done. Nevertheless the method might not be suitable for the analyzing more complex models or tissues.

Outlook

The experiments demonstrate how both examined noninvasive methods are capable to support the maturation of biological samples by giving quantitative information on samples that have to be monitored.

References

Brauchle, E., et al. (2014). "Cell death stages in single apoptotic and necrotic cells monitored by Raman microspectroscopy." Sci. Rep. **4**.
Groeber, F., et al. (2014). "Impedance Spectroscopy for the Non-Destructive Evaluation of In Vitro Epidermal Models." Pharmaceutical research: 1-10.
Popkin, B. M., et al. (2010). "Water, hydration, and health." Nutrition reviews **68**(8): 439-458.

Contact

Rico Brendtke
senetics healthcare group GmbH & Co.KG | Henkestraße 91 | 91052 Erlangen | Germany
phone +49 9131 9 201 201 | fax +49 9131 9 201202 | rico.brendtke@senetics.de