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First Results with the Gas Discharge Visualisation (GDV) Method (Kirlian Photography) to assess the Inner Quality of Apples

What is the GDV or Kirlian Photography Method?

Kirlian Photography is a physical treatment where intact tissue of a sample is exposed to a high voltage and high frequency electrical field which causes the emission of electrons and photons accompanied by light emission. This light emission can be photographed or digitally recorded. The method is therefore also called Gas Discharge Visualisation (GDV). The shape of the resulting light "corona" can differ according to the composition of the tissue and is thus a potential indicator of the inner quality of the fruit. Because the tissue examined is fresh and not manipulated before the measuring process the method is suited to give a complementary or "holistic" information of the tissues inner quality.
The advantages of the GDV method are that it is cheap, many measurements can be made per day (around 100 apples per day, including standard quality assessments in parallel with two persons occupied), and the picture analysis process is completely digital, thus objective.

Goals of our Research?

The goal of our studies, supported by Coop and starting in 2002 is to find out the possibilities and limits of the GDV method for complementary quality assessment.

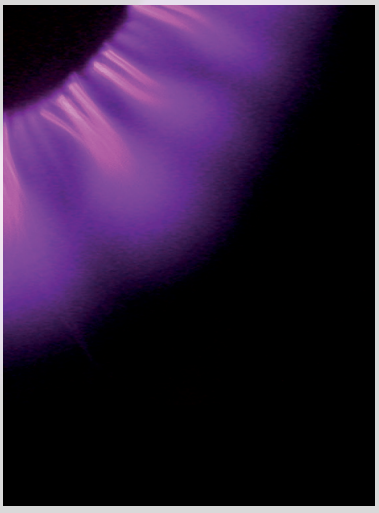
Questions are:
1) Reproducibility of the measurements
2) Variation studies (within different parts of a fruit; within batches of 15-30 fruit)
3) Correlation of GDV data with standard quality parameters (e.g. sugar, firmness, taste)
4) Potential to differentiate the growing system (organic and conventional)
5) Correlation to other complementary methods such as e.g. fluorescence emission spectroscopy
6) Suitability of different algorithms for statistical analyse of the data

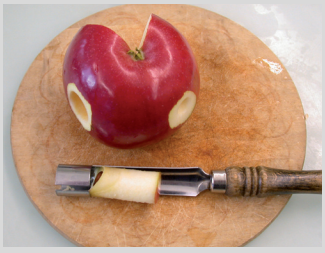
Preliminary Studies and Results

In several studies we recorded GDV coronas of apple tree leaves and fruits in order to verify and compare their vitality under different conditions. We used GDV Assistant Software for pre-processing and for numerical parameterization of corona pictures and then various machine learning algorithms for analyzing the data (Sadikov et al. 2004)
For six measuring series results with calculated with different machine learning methods are presented in Tab. 1. Last column shows how good a default classifier would be. Positive scenarios (values better than a default classifier) are highlighted. It can be seen that "See5" algorithm is very robust. Thus, for further study we use the See5 algorithm.

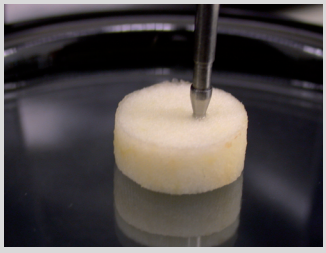
Table 1. Classification accuracy (%) of different machine learning methods in 9 studies

Algorithm / Study	see5	core. reliefF	core.CI	HINT	default cl.
variety s41 vs s50	**68**	**69**	**70**	**75**	**50**
sick vs healthy tree	**84**	**81**	**81**	**84**	**50**
cultivars: Resi vs Arriwa	50	54	54	50	50
rootstocks: M7 vs J-TE-G	32	48	50	0	50
conventional vs organic	36	46	37	24	51
rootstocks: M7 vs Sup2	43	49	54	0	50
variety Rajka vs Rosana	**75**	**77**	**82**	**79**	**57**
aphid-stressed vs healthy trees (fruitlets)	**72**	**74**	**68**	**76**	**50**
aphid-stressed vs healthy trees (leaves)	48	50	56	0	50

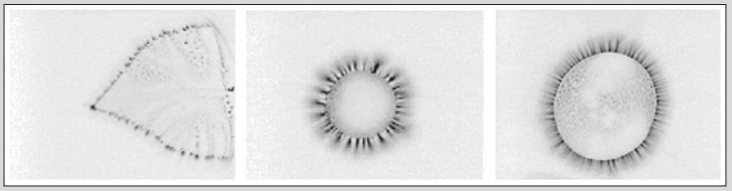




Extraction of fruit flesh for GDV-measurements and standard quality assessment.



The sample in position for GDV recording.



GDV pictures of a leaf (left), ripe apple (center) and apple fruitlet (right).

Conclusions

GDV technology can provide useful information for distinguishing healthy and stressed plants and, in some cases, it can provide useful information for distinguishing different varieties and rootstocks. It can also provide information for distinguishing fruits grown using different fertilization treatments. However, in our cases with fruit of very similar standard quality, we were not able to find complementary information to distinguish organically from conventionally grown apple fruit. Currently we are carrying out two larger and refined studies on just that topic with 5 conventional/organic comparison pairs from harvests of two years.

Sadikov A, Kononenko I and Weibel F P 2004 Analyzing Coronas of Fruits and Leaves. In Measuring Energy Fields: State of the Science, Ed K Korotkov. Backbone Publishing.