ELM FARM RESEARCH CENTRE CONFERENCE

DOES ORGANIC FOOD HAVE AN 'EXTRA QUALITY'?
New Research, New Perspectives and New Insights

A record of the Conference held on
TUESDAY, 23RD NOVEMBER 2004

This Conference was sponsored by Sheepdrove Trust
in collaboration with
FQH (International Network for Food Quality and Health)
Sustain (the alliance for better food and farming)

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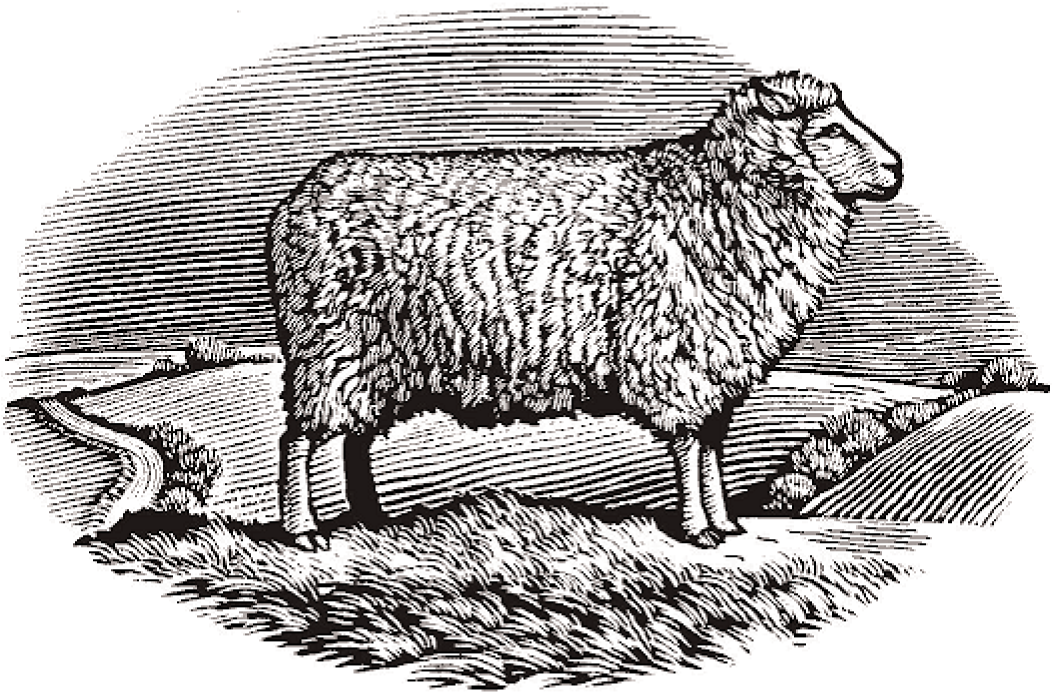

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Acknowledgements

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We also thank the team that organised the event so effectively.

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promar International

"Stressing the importance of differentiating between accepted dogma: "Organic food is better for you" and what is actually "true", i.e. the scientifically proven, Dr Brandt's interesting and balanced paper highlighted the need for a consistent approach and common understanding if claims about organic food are to be accepted.

The science that proves the "extra qualities" of organic food, or equally that demonstrates the detrimental effects of "conventionally-produced" foods, on our health is still developing, as shown by other speakers. But Dr Brandt concluded that organic farming, which has distinct benefits for the environment and food produced, has that "extra quality" that was the Conference's theme.

For consumers, the key benefit of organic produce may simply derive from the fact that positive choices are made in food purchasing that enhance a sense of individual value and well-being".

Alara Wholefoods

"Projects that give statistically robust nutritional differentiation between organic and non-organic food are very welcome by organic food manufacturers".

Duchy Home Farm

"Extra Quality" of Organic Food ? - Results by Fluorescence excitation spectroscopy methodas applied on selected plants

Jürgen Strube and Peter Stolz, KWALIS Qualitätsforschung Fulda GmbH, Fuldaer Str. 21, D-36160 Dipperz, Germany, e-Mail: info@kwalis.de

Abstract: *Purpose of the work was to distinguish food samples with respect to their culture conditions. By the applied method of fluorescence excitation spectroscopy data are gathered from integral parts of a plant sample. In a project funded by the German federal program for ecological farming the method was applied to carrots and wheat. In order to show reliability of data and results, the method was validated according to ISO 17025. For blinded wheat samples it was possible, to separate and identify correctly the organic group from the conventional samples for the two years investigated. Under the blinded conditions it was also possible, to separate and identify the fertilised carrots from the non fertilised ones. The hybrid variants of carrots could be separated from the open pollinating variants. Measured differences can be interpreted in terms of quality.*

Keywords: food quality, organic farming, validation

Overview

During last years the question of influences of the farming method onto the product found increasing interest (Tauscher *et al*. 2003). A special focus is directed to methods which are applicable to a variety of products. Basic idea of the method presented in this paper is to relate farming methods to optical spectral data measured at the whole farming product. Different from the well-known NIR-method the method described here uses the visible part of the optical spectrum and there is a time delay between excitation of sample and measurement of emission (measurement of delayed luminescence). The method was already applied successfully for a number of different samples (Strube 1997; Strube und Stolz 1999; Strube und Stolz 2000; Bloksma, Northolt und Huber 2001a; Bloksma, Northolt und Huber 2001b; Strube und Stolz 2001; Strube und Stolz 2002; Strube und Stolz 2004). The method is presented in short and some elements of validation are mentioned. The application of the method to different kinds of samples is shown and the interpretation of results is given.

The following questions are addressed and answered: 1. Is the method precise and repeatable? 2. Does method separate between a)organic and conventional wheat? b)carrots from different fertilizing levels? c)hybrid and open pollinating carrots? 3. Is it possible to identify organic and conventional samples? 4. What is the meaning of differences? 5. Does organic farming have an "extra quality"? The latter question was taken up due it was the theme of the conference, for which this paper was prepared.

Method

Basic principle of the method is that differences of optical spectra of samples are related to culture conditions. For this the whole sample is put in an instrument. The sample is excited by light and the total light emitted by the sample is measured after the end of excitation. A view into open instrument and a scheme of the instrument are shown in figures 1 and 2.

Fig. 1: View into instrument. Carrot during excitation

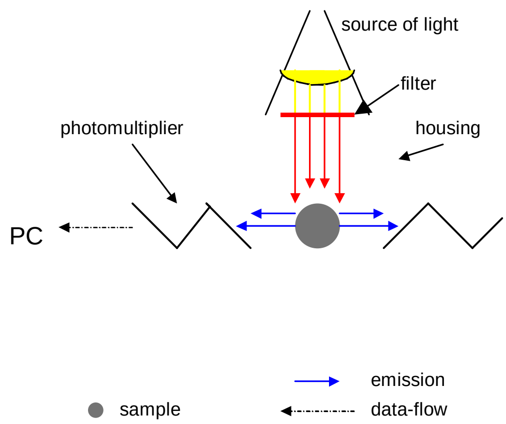

Fig. 2: Scheme of instrument.

The light emitted by the sample (delayed luminescence) decreases by time. A typical course of intensity over time is shown in fig. 3. Some terms used in the following text are also declared in this diagram.

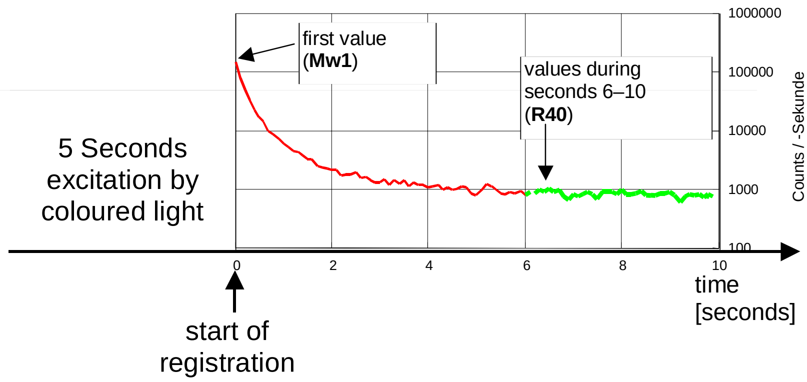

Fig. 3: Typical time dependence of the emission of a sample after an excitation.

The process of excitation and measurement of a sample is repeated eight times in total for eight different excitation colours out of the visible part of spectrum and near UV. The decreasing emission of the sample is different after each of the 8 excitations. For carrots and wheat are set in a common graph (fig. 4) the emissions during seconds 6 - 10 after excitation (named R40, see fig. 3) for each excitation colour. The values at the various colours are related to the values after white excitation as reference (=100%). The excitation spectra are fairly different for these kinds of samples.

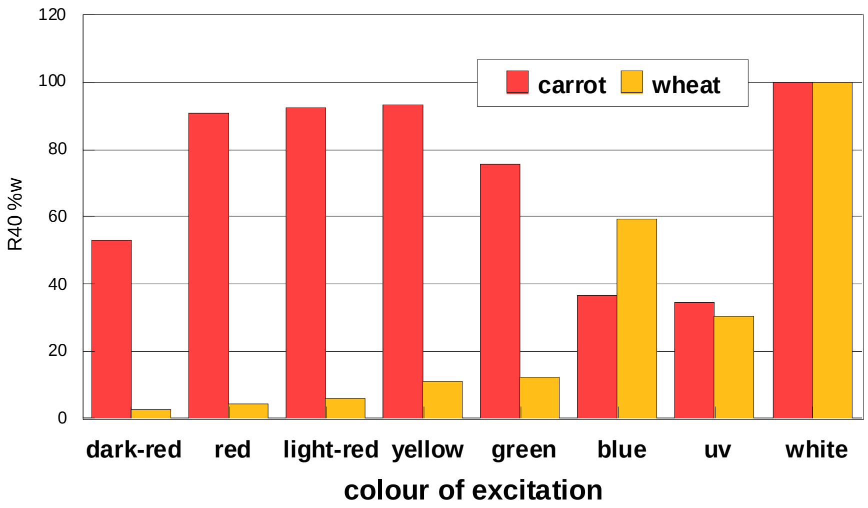

Fig. 4: Excitation spectra of carrots and wheat. Values referred to white=100%.

Validation

Validation means, to show that the method is reliable and suited to answer the question, which sample is grown under which conditions. Validation was performed in three steps. i) validation of the instrument ii) validation of the method applied to wheat and carrots iii) investigation whether method is able to show differences between farming systems.

One part of the validation of the instrument is the repetitive measurement of a inert test sample. A measure for precision and repeatability is the coefficient of variation (cv). The cv for repeated measurements (same day) is about 0.25 %, for long term repeatability (different days) about 3%.

The achievable precision at real samples is influenced by unavoidable changes of the sample. This generally increases the coefficient of variation (cv). For wheat a cv of about 5 % is achieved, for carrots the cv is about 8 %. All of these values depending somewhat on the special value out of spectrum which is investigated.

"Extra Quality" of Organic Food ? - Results by Fluorescence excitation spectroscopy methodas applied on selected plants

Jürgen Strube and Peter Stolz, KWALIS Qualitätsforschung Fulda GmbH, Fuldaer Str. 21, D-36160 Dipperz, Germany, e-Mail: info@kwalis.de

Material

Material for the validation of method was from controlled scientific trials. All samples were coded.

The wheat was out of the DOK-trial of the Research Institute of Organic Agriculture FiBL, Frick (Switzerland) which is well documented (Mäder *et al*. 2002). Wheat samples consisted of the variants organic, bio-dynamic, pure mineral, mineral with manure and neutral.

Two variants of carrots of different fertilization were grown under controlled conditions at the University of Kassel (Michael Fleck). Two different hybrid sorts of carrots (Bolero F1, Nipomo F1) and 2 open pollinating sorts (Samson OP, Tiptop OP) came from Research Institute of Organic Agriculture FiBL, Frick (Switzerland).

Results

Data of the relation of R40yellow/R40blue out of the spectra of wheat from Samples of the harvests of the years 2002 and 2003 are shown in fig. 5.

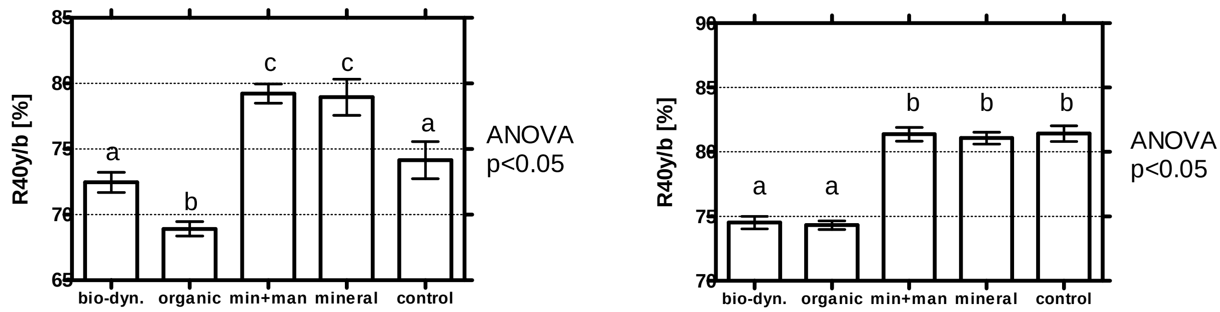

Fig. 5: Results of measurement on wheat of DOK-trial (FiBL) of harvests 2002 (left graph) and 2003 (right graph). Organic variants are depicted in green, conventional in yellow and neutral in grey.

The R40white-data of carrots of different fertilization harvested 2002 and 2003 are shown in fig. 6.

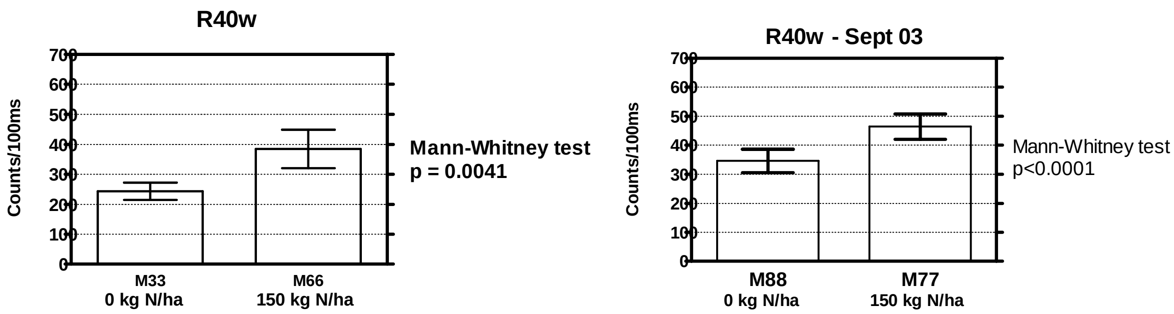

Fig. 6: Results of measurement on carrots of harvests 2002 (left graph) and 2003 (right graph). Unfertilized variants are depicted in blue, fertilized variants marked red.

There were significant differences between the variants at both harvests.
Differences between hybrid and open pollinating carrots were also detected with this method. Results of carrots harvested 2002 and 2003 are shown in fig. 7.

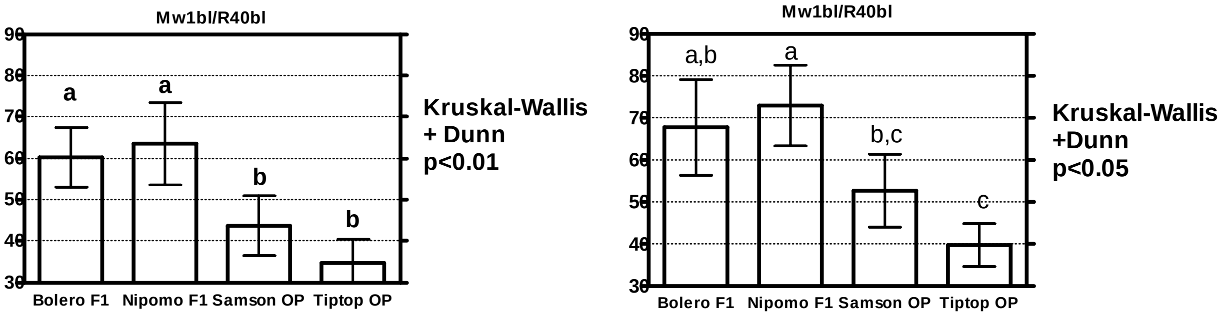

Fig. 7: Results of measurement on carrots of harvests 2002 (left graph) and 2003 (right graph). Hybrid variants are depicted in yellow, open pollinating variants marked green.

The results show significant differences between the hybrid and the open pollinating variants.
Related to the questions above it could be stated: The method is sufficient precise and repeatable. The method is able to discriminate between organic and conventional wheat, between different fertilizing levels of carrots and between hybrid and open pollinating carrots. And furthermore under the controlled conditions it was possible for these cultures to identify the related farming system of the samples.

Discussion

The still open questions are: What is the meaning of the differences measured? And whether organic farming has an extra quality?

On the way to answer these questions an extended look on excitation spectra of different kinds of samples reveals a systematic order.

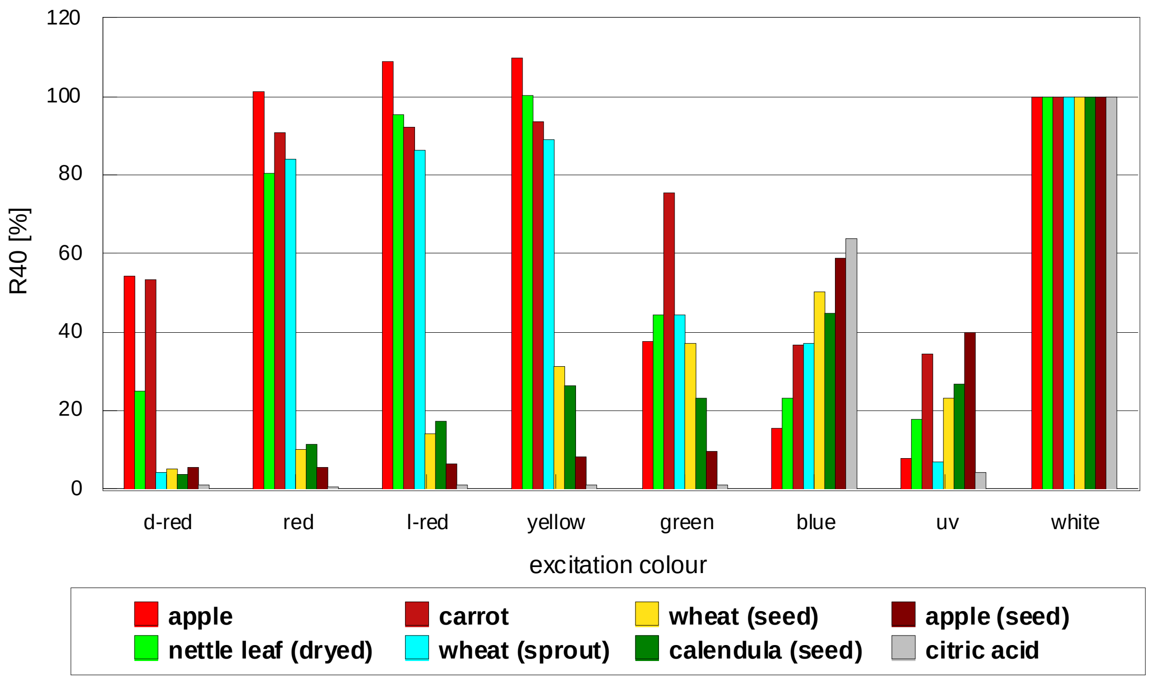

Fig. 8: Excitation spectra of different kinds of samples. Leafs and fruits show high values at red and yellow and lower values at blue. For seeds it is vice versa, seeds show low values at red and yellow but higher values at blue. A chemical (citric acid) is shown for comparison.

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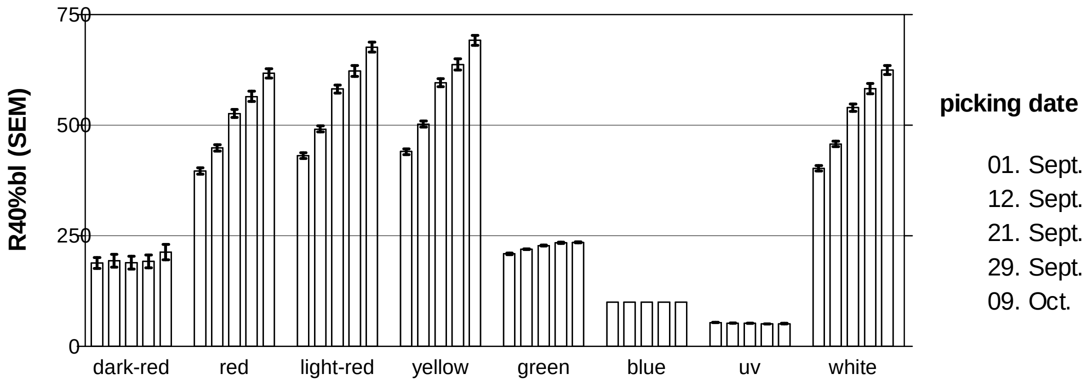
In fig. 8 all emission-values are related to the emission measured after excitation by white light (white = 100 %). By this normalization differences of absolute emission caused by sample type and sample size are cancelled out. Two types of samples can be identified: On one side leafs and fruits which show high values at red and yellow and low values at blue, on the other side seeds which show low values at red and yellow and higher values at blue. Up to now we have not found exceptions from this rule.

This opposite behaviour with respect to light of leaves/fruits and seeds correlates with their different state of life. Active growing is related to leaves/fruits, rest or dormancy is related to seeds. If seeds are germinating their spectrum changes in direction to the type of leafs.

At apples the opposite behaviour was observable exemplarily when the apples were harvested in different states of ripeness (Bloksma, Northolt und Huber 2001a; Strube und Stolz 2002). Spectral values of the fruit-part of apples (outer side) at red/yellow increased with ripeness, the red/yellow values of the kernels of the same apples decreased with ripeness (fig. 9). Out of this data it can be concluded, that lower values at red/yellow are for seeds quite the normal development, indicating deeper dormancy of the seeds.

At apples of same date of harvest but different exposition to light and the variants of treatment by bio-dynamic preparations and no treatment, the exposition levels of light could be differentiated as well as the bio-dynamic treatment. The bio-dynamic treatment showed up in a way in the spectrum, as these apples would have got more light (Strube und Stolz 2002).



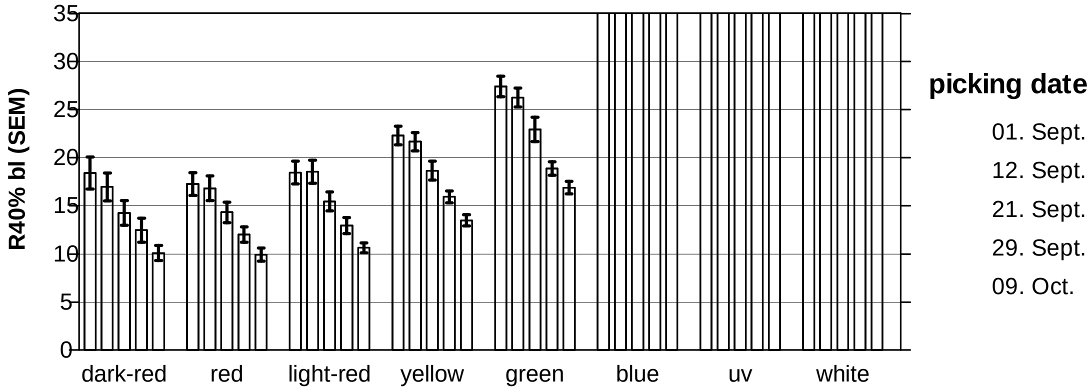


Fig. 9: Change of apple-spectra by ripeness. Spectrum of fruitflesh of apples is shown in upper graph, spectrum of kernels of same apples in lower graph. It can be concluded that ripeness means differentiation in spectrum (as well as morphological).

Seeds of wheat show differences in spectrum when they are fertilized differently. Higher fertilization results in a spectrum that indicates reduced dormancy of this seeds (increased values at red/yellow, reduced at blue). In a simple figure the change in spectrum can be expressed by the ratio of R40yellow/R40blue. This was applied in fig. 5 for the wheat samples from DOK-trial of FiBL. Graphs indicate, that organic farming produced wheat with deeper dormancy of seeds. That can be interpreted as a more species-typical development.

At white beans in a multi-factorial trial it could be shown (blinded conditions), that the beans could be differentiated still after two agricultural periods (two years) when they came from bio-dynamic or conventional farming. Also it was possible to differentiate between beans grown in soil and beans grown in hydroponic culture (Strube und Stolz 2000).

Out of these various experiments we conclude, that data can be interpreted in context of shifts in spectrum related to part of plant and change of conditions. That leads to the interpretation, that there is a clear tendency that organic farming leads to seeds which are more seed-like and fruits which are riper.

The question of an "extra quality" of organic farming could be answered in a summarized way by "organic products are more species-typical".

But it should be kept in mind, that these conclusions probably show a tendency. Under practical circumstances a lot of variation due to sort, geographical area, whether conditions and farmers practice may occur.

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