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# The Use of Colorimetry for the Identification of Fusarium-Infested Wheat Grains

*With regard to food- and feed hygiene (EU directive 178/2002), the detection of fusarium infestation is gaining in importance. Attempts to distinguish fusarium-infested from non-infested wheat kernels based on colourimetry have shown that the differences in colour between these kernels which can be detected by the human eye cannot easily be quantified technically. In contrast to non-infested kernels, infested kernels tendentially show smaller chromaticity coordinates x, y and greater luminosity values Y. Based on the present results, a clear differentiation between fusarium-infested and healthy wheat kernels is not possible*

Kernel colourimetry for the detection of fusarium infestation was carried out in wheat grains of the variety Certo (C wheat) from the 2003 harvest. The kernels were sorted based on the visible symptoms which are typical of an infestation and divided into a group of fusarium-infested and non-infested kernels. Eleven 20 g samples of wheat kernels were put together which contained 0%, 10%, ..., 100% of fusarium-infested kernels in relation to the sample weight. These were mixed thoroughly.

The measuring instrument used was a Minolta Chroma-Meter CR-310 with a sample container CR-A 50 for granular material. The colourimetric measurements were carried out using the standard illuminant D65 (which approximately corresponds to daylight) and the XYZ standard colour space since dealing with this basic colour space is relatively easy. The chromaticity coordinates x and y as well as luminosity Y were determined (*Fig. 1*). These dimensionless numerical values allow all non-fluorescent colours to be described [2, 3, 5]. According to the instructions of use, the instrument was calibrated against the white standard Minolta CR-A44. After each series of measurements, this calibration was repeated.

One series of measurements consisted of 25 colourimetric measurements of one of the eleven samples each. For this purpose, the sample was poured into the sample container and mixed thoroughly after each individual measurement. It was ensured that the measurements were not able to be corrupted by scattered light, such as light from room lighting or falling-in daylight.

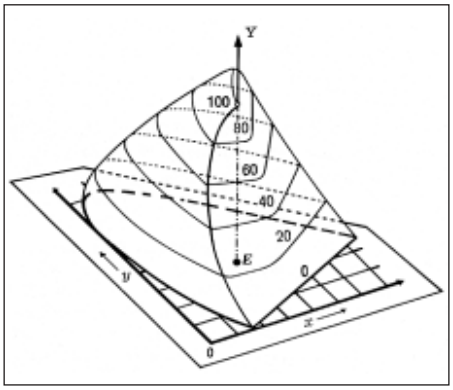


*Fig. 1: CIE-colour-body (Loos, 1989) x, y: chromaticity coordinates; Y: luminosity; E: illuminant*

The measuring field of the instrument has a diameter of 50 mm. Thus, the values measured by the instrument are the average colour values of the measurement surface. Hence, these values are colourimetric measurements without local resolution. Locally resolved measurements (of an individual kernel), however, can be carried out at a significantly higher resolution (up to ~ 7,700 measuring points per kernel) [1].

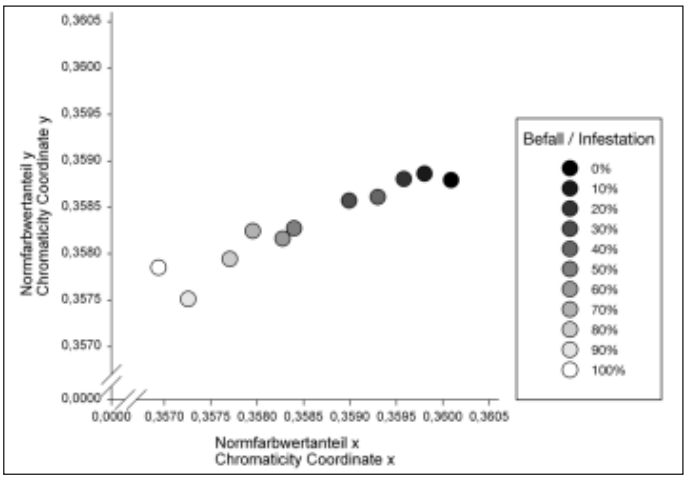


*Fig. 2: Determined chromaticity coordinates*

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**Keywords**
Fusarium spp., colourimetry, quality

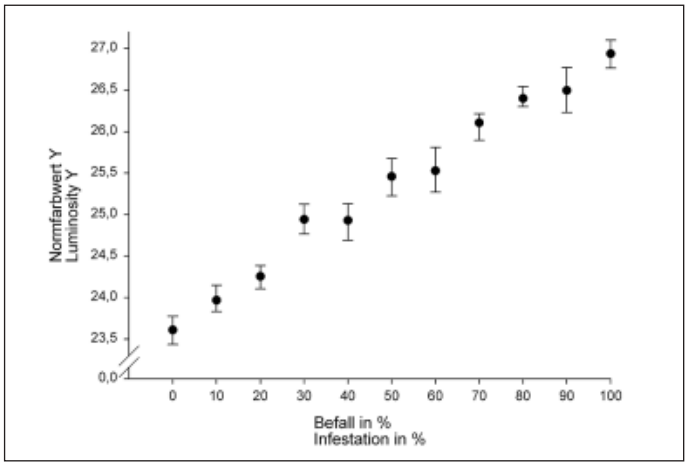


*Fig. 3: Change of luminosity Y depending on fraction of infested kernels (the error bars indicate the upper and lower quartiles)*

### Results

The results of the colourimetric measurements with the Minolta Chroma-Meter CR 331 are shown in *Figures 2 and 3*. It can be discerned that the chromaticity coordinates x and y decrease slightly with a growing percentage of infested wheat kernels in the sample (*Fig. 2*). They approach the illuminant E. In the standard illuminant D65 used for the measurement, the coordinates of this illuminant are x = 0.3127; y = 0.3290. Luminosity Y (the lightness value), however, increases with growing infestation (*Fig. 3*). In other words: the saturation of the colour diminishes, and the visual impression of infested kernels having a lighter appearance than non-infested ones is confirmed. One must take into consideration that the measurement values change only very slightly. The reproducibility of the chromaticity coordinates x, y by the Minolta Chroma-Meter is ± 0.0002 [4].

The differences between the average values of the individual samples characterized by different degrees of infestation within the groups chromaticity coordinate x, chromaticity coordinate y, and luminosity Y are very small, though significant in some cases. Luminosity Y shows the most significant differences.

### Discussion

The reddish glimmer of infested samples, which is caused by the mycelium, was not reflected by the measurement values as had been expected beforehand. Since the values measured by the Chroma-Meter describe the average colour value of the measurement surface, which has a size of ~ 20 $cm^2$, the assumption suggests itself that the reddish spots on the kernels are just simply too small to cause a shift of the measurement values into the reddish range. Other possible explanations are shadows cast by overlapping kernels or dark hollow spaces between the kernels which influence the colour measurements.

The statistical evaluation of the measurement data (SAS system for Windows 8.1) shows significant differences between the average values of the samples characterized by different degrees of infestation within the groups chromaticity coordinate x, chromaticity coordinate y, and luminosity Y. These differences are most significant in luminosity Y. However, no excessive importance may be attributed to these results because the differences are extremely small. The measuring conditions were ideal because the samples were free of impurities and homogeneous with regard to the visual appearance of the infested and non-infested kernels. The results may be more difficult to reproduce with heterogeneous material, which might contain dust or straw residues. Only the fact that fusarium-infested wheat kernels are tendentially lighter in appearance than non-infested kernels can be confirmed by the measurement results.

In further studies, measurements with greater local resolution provided results which were able to be differentiated far more easily because disturbing factors, such as the above-mentioned hollow spaces between the kernels, no longer influenced the measurements, and significant characteristics of the kernels, such as reddish mycelium, were able to be detected better [1]. Since, however, reddish mycelium is not always produced by the fungus, but only under certain weather conditions, distinction based on the lighter colour of the infested kernels is difficult or even impossible. An additional impeding factor is the natural heterogeneity of the colour of wheat kernels, which was not given in the material used for the trials because very homogeneous material of one variety was used.

Therefore, auxiliary characteristics, such as texture analyses of the "shrivelled" or damaged surface structure of fusarium-infested kernels should be considered in addition to the colour of wheat kernels.

### Future Prospects

The idea of sorting out kernels which contain toxin as early as possible in the process chain in order to minimize possible contamination by the fusarium toxin is a prospect for the future.

The first possible chain link is the combine, where the analysis of a grain flow of up to 40 tonnes per hour would have to be carried out in real time. This would without doubt be an enormous technical challenge.

In addition, fusarium toxins are also contained in kernels which do not show any external symptoms. It remains to be examined to what extent toxin contamination can be reduced if only wheat kernels with fusarium symptoms are sorted out.

Given quick general technological development, in particular in areas such as the gaining of digital image material and its evaluation, it will likely only be a question of time until the above-described techniques are employed in practice. Therefore, further research regarding the detection of fusaria in grain will be required in any case.

## Literature

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