Integrative methods of product quality assessment in connection with the *P*-value-determination (3 examples: food preference test, sensory evaluation and self-decomposition test)

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ABSTRACT: On the basis of three examples the results of *P*-value determinations are presented in connection with the results of integrative test methods: food preference test with laboratory rats, sensory evaluations with consumers and self-decomposition tests. In all three cases a corresponding evidence regarding the relevant data as well as the differentiating factors fertiliser and/or cultivation systems could be demonstrated. In food preference tests with laboratory rats organically grown carrots (Tarvil cultivar) and beet roots (Formanova cultivar) were significantly preferred to the respective conventionally produced variants. The determination of electro-chemical parameters of these test products was carried out by R. Krautgartner at the Institute of Fruit Growing and Horticulture, University of Agricultural Sciences in Vienna. The *P*-values were lower in the organic products, thus indicating better quality. Sensory tests were applied to investigate the taste of differentlyk fertilised apples (Golden Delicious cultivar). The samples originated from a field trial at the Research Institute for Fruit Growing and Viticulture in Haidegg (Styria). In this case the lower *P*-values (measured by H. Keppel), the preference and the application of the organic fertiliser Agrobiosol, which has a favourable effect on soil microorganisms, were in keeping as well. A series of self-decomposition tests was carried out with spinach samples (Spinnaker F1 cultivar) from a field trial in Gerasdorf near Vienna (R. Krautgartner, Institute of Fruit Growing and Horticulture, University of Agricultural Sciences in Vienna), investigating the influence of 5 different fertilisers on product quality. The ranging of the samples according to the loss of dry matter during self-decomposition corresponded with the electro-chemical ranging: lower *P*-values, lower dry matter loss and a longer shelf life were found in the organically fertilised samples. The here presented concurring data obtained from different integrative quality tests in connection with cultivation methods clearly indicate the advantage and the value of multiperspective research projects.

Keywords: product quality; organic/biological agriculture; *P*-value determination; food preference test; sensory evaluation; self-decomposition test

An interdisciplinary research design enables a multiperspective approach in accordance with the complex concept of product quality. Apart from chemical analyses, integrative test methods provide a valuable basis for a comprehensive quality interpretation. In the present paper the results of integrative quality investigations are presented and compared in regard to quality differences between organically versus conventionally cultivated products as well as to differences between the applied methods.

MATERIAL AND METHODS

Food preference test with laboratory rats (Long Evans)

Test products: carrots (Tarvil cultivar) from Marchfeld and beet root (Formanova cultivar) from Styria

The organic carrots and beet roots were produced according to the guidelines of the Codex Alimentarius Austriacus as well as Regulation (EEC) No. 2092/91 on Organic Production. The conventionally produced test products of the same variety originated from neighbouring farms in each case, providing for equal location and climate, thus accentuating the cultivation effects. The food preference tests were carried out with 40 adult male laboratory rats (Long Evans strain).

The animals were kept separately in Macrolon cages size III, under air conditioning at 22°C and 55% rel. humidity. The basic diet for all test animals (conventional feed mixture T 779 by Tagger Co.) was supplied to the cages in order to prevent any deficiency symptoms.

A partition, containing the water bottle, divided the feeding rack into the right and left section, into which a defined amount (≅ 100 g FW) of the two test products (organic/conventional) was apportioned simultaneously. The remainders of the feed were weighed 24 hours later in order to determine the consumed quantity. At this time, new feed was also supplied. Differences in the rate of evaporation of the examined feeds were quantified with control samples used in every test run. The sides were changed with every meal in order to prevent the effect of "position preference". Each test run was conducted over a period of ten days.

The statistical method used for preference tests was the Multivariate Analysis of Variance for Repeated Measures (MANOVA Programme) and/or Wilcoxon's test for pair differences.

Sensory evaluation with 60 consumers

Test product: apples (cultivar Golden Delicious) from Styria (Research Institute for Fruit Growing and Viticulture Haidegg, Prof. Dr. H. Keppel)

The test apples originated from a field trial in which the influence of mineral fertilisers versus Agrobiosol (a soil optimiser based on fungal mycelium) was compared.

The sensory analyses were performed by untrained consumers (60 persons).

The most widely used difference test is the Extended Triangle Test (JELLINEK 1985) with the following procedures: three samples are presented, two are alike, one is different. The different sample has to be defined and characterised. The second task is to state any preferences. Thus objective (differentiation) and subjective (preference) aspects can be tested in one test.

Self-decomposition test

Test product: spinach (Spinnaker F1 cultivar) from a field trial (University of Agricultural Sciences, Institute of Fruit Growing and Horticulture, DI R. Krautgartner)

The spinach samples originated from a field trial, comparing the influence of the following fertilisers: 2 mineral fertilisers (with and without the application of herbicides), 3 organic fertilisers (blood meal, manure, compost) and 1 unfertilised plot.

The modified method developed by SAMARAS (1977) served as a guideline for the self-decomposition tests. The samples were finely cut and weighed into Petri dishes. At the beginning the dry matter content of the test product was determined. After 7 days of incubation (at 20°C, 50 rel. humidity, in darkness), the samples were dried at 85°C and weighed to determine the loss of dry matter. The course of decay was photographed.

The *P*-value is a calculated value, calculated from the pH-value, the redox potential and the electrical conductivity (KEPPEL 2001; KRAUTGARTNER 2001).

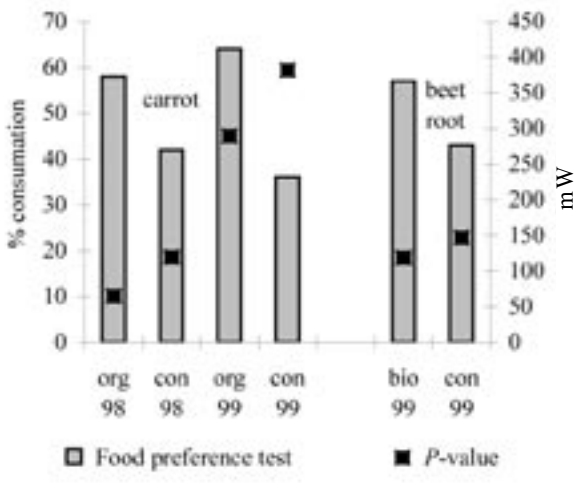

Fig. 1. Comparison of results: *P*-values and food preference tests

RESULTS AND DISCUSSION

Food preference tests with laboratory rats

In three food preference tests with organically and conventionally cultivated carrots (harvest 1998 and 1999) and beet roots (harvest 1999) the organic variant was significantly preferred ($p = 0.000$). In accordance with these results, the preferred samples had lower *P*-values (Fig. 1).

Fig. 1 also shows that the *P*-values of both carrot samples – organically and conventionally grown – were lower in 1998 compared to 1999, which indicates a generally higher quality in the 1st year. This information cannot be obtained from the food preference tests. The self-decomposition tests also were in line with these findings, demonstrating the lower dry matter loss in the organic variants (VELIMIROV et al. 2000).

This example clearly illustrates limits and possibilities of integrative test methods as well as the expedience of interdisciplinary research.

Sensory evaluation

In this investigation the results of the sensory evaluation and the *P*-value determination were also in accordance: the organically fertilised (Agrobiosol) variant was significantly preferred by the test persons and had a lower *P*-value (Fig. 2).

With these test apples a food preference test with 20 male laboratory rats was conducted as well, but after some hesitation the animals decided in favour of the minerally fertilised variant. Previous food preference tests with apples (one exception: VELIMIROV et al. 1995) also resulted in either no clear preference or a decision in favour of the conventional variants (VELIMIROV et al. 2000). In most cases the lower content of malic acid in conventional apples acted as a deciding factor, therefore this method is not suitable for the production-bound differentiation of slightly sour fruit. All rats show a preference to sweeter food (BARNETT 1963), possibly because in free range they have no opportunity to feed on fresh fruit and therefore they have not developed a suitable instinctive behaviour to recognise secure and wholesome quality in fruit contrary to cereals and root vegetables.

This example also shows that the application of different methods to assess product quality is essential.

Self-decomposition test

A clear correspondence between *P*-values and dry matter loss during incubation was shown in a trial with

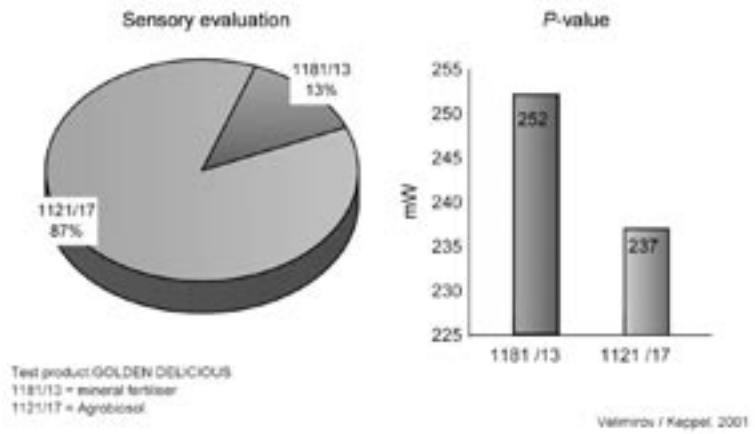

Fig. 2. Comparison of results: *P*-values and sensory evaluation

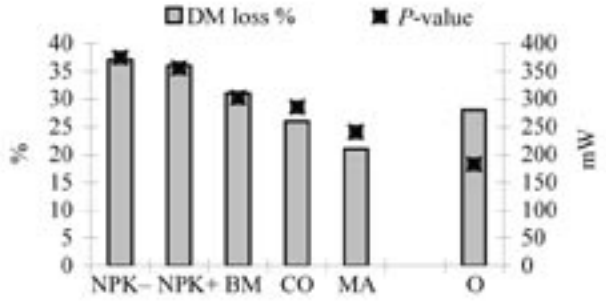

Fig. 3. Comparison of results: *P*-values and dry matter loss in the self-decomposition test
NPK– = mineral fertiliser without herbicide, NPK+ = mineral fertiliser with herbicide, BM = blood meal, CO = compost, MA = manure, O = without fertiliser

spinach from differently fertilised plots. The ranging of the variants according to the *P*-values as well as the dry matter loss was identical with the exception of the unfertilised variant. The highest *P*-value corresponded with the highest dry matter loss in the minerally fertilised variant without the application of herbicide, followed by the minerally fertilised variant with herbicide and the variant with blood meal fertiliser. The samples from the plots where compost and manure had been used demonstrated the best quality as assessed by the determination of *P*-value and dry matter loss in the self-decomposition test (Fig. 3).

The dry matter contents – determined at the beginning of the self-decomposition test in fresh samples

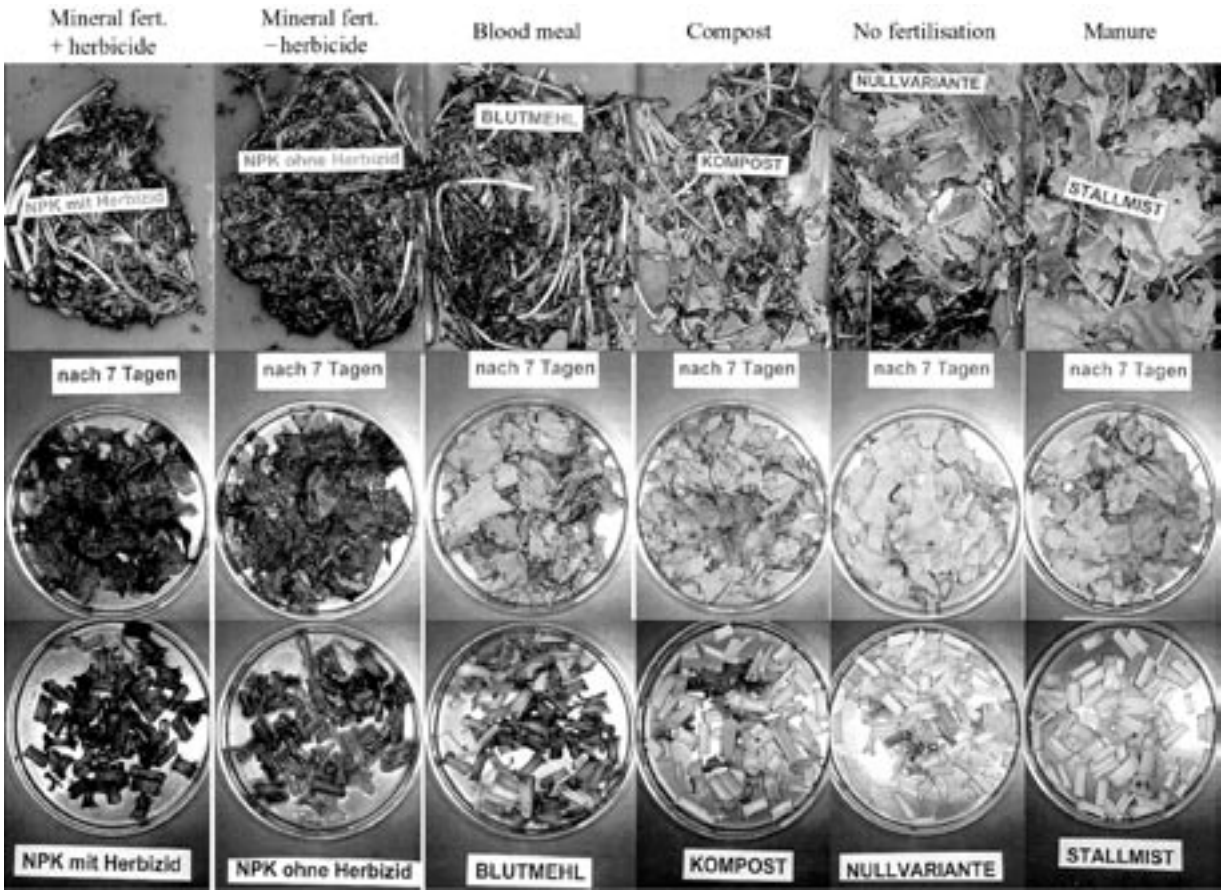

Fig. 4. Self-decomposition tests with differently fertilised spinach after 7 days of incubation
1st row: whole spinach samples; 2nd row: self-decomposition with spinach leaves; 3rd row: self-decomposition with spinach stems

– revealed the same ranging, starting with the lowest dry matter content in the spinach samples from the minerally fertilised plots, followed by the blood meal variant, the composted and the manured variant. The highest dry matter content was found in the unfertilised spinach samples.

In this investigation the favourable influence of organic fertilisers on the keeping quality in connection with bio-electrical properties could be clearly demonstrated. The photographic documentation shows the state of decomposition of spinach samples after 7 days of incubation (Fig. 4).

The minerally fertilised samples show advanced degradation, whereas the organically fertilised samples and the unfertilised sample are withered and dry. The variant fertilised with blood meal lies in between. Accordingly the loss of dry matter was significantly higher in the first 3 variants.

SUMMARY

It could be demonstrated on the three presented examples that the results of the applied integrative test methods
– food preference test with laboratory rats
– sensory evaluation
– self-decomposition test
corresponded with the
– *P*-value determination
and were in favour of organic agricultural methods.

An interdisciplinary research design with a multiperspective approach highlights different quality aspects, agrees with the complex task of comparative quality investigations and enables the assessment of partial results in a wider context.

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Received for publication October 24, 2002
Accepted after corrections December 22, 2003

Integrované metody posuzování kvality produktu ve spojení s určováním *P*-hodnoty (3 příklady: test preference potravy, senzorické hodnocení, test uchovatelnosti)

Na základě tří příkladů jsou uvedeny výsledky určování *P*-hodnoty v souvislosti s výsledky integrovaných metod testování: preferenční testy příjmu potravy laboratorními krysami, senzorická hodnocení spotřebiteli a testy samovolného rozpadu (uchovatelnosti). Ve všech třech případech byly prokázány shodné závěry s ohledem na relevantnost dat a vliv odlišného hnojení, resp. systémů pěstování. V testech příjmu potravy laboratorními krysami byly organicky vypěstované mrkve (odrůda Tarvil) a červené řepy (odrůda Formanova) významně preferovány před variantami vypěstovanými konvenčním způsobem. Určení elektrochemických parametrů těchto testovaných produktů provedl Ing. R. Krautgartner z Ovocnářského a zahradnického ústavu Univerzity zemědělských věd ve Vídni. Zjistil u organických výrobků nižší *P*-hodnoty, což rovněž ukazuje na jejich lepší jakost. Senzorické testy byly aplikovány pro posouzení chuti odlišně hnojených jablek (odrůda Golden Delicious). Vzorky pocházely z polních pokusů založených ve Výzkumném ústavu ovocnářství a vinohradnictví v Haideggu (Štýrsko). I v tomto případě byly naměřeny nízké *P*-hodnoty (měřil je prof. Dr. H. Keppel), což ukazuje na pozitivní vliv používání organického

hnojiva Agrobiosol, které příznivě působí na půdní mikroorganismy. Série testů samovolného rozpadu, která byla provedena se vzorky špenátu (odrůda Spinnaker F1) pocházejícími z polního pokusu v Gerasdorfu u Vídně (Ing. R. Krautgartner, Ovocnářský a zahradnický ústav Univerzity zemědělských věd ve Vídni), zkoumala vliv pěti různých hnojiv na kvalitu tohoto produktu. Pořadí vzorů podle ztráty sušiny během testů samorozpadu se shodovalo s hodnotami jejich elektrochemického hodnocení: nižší *P*-hodnoty, menší úbytky sušiny a delší uchovatelnost byly zjištěny u vzorků hnojených organicky. Uvedená souhlasná data získaná různými integrovanými testy kvality v souvislosti s metodami pěstování zřetelně indikují přednost a hodnotu multidisciplinárních výzkumných projektů.

Klíčová slova: kvalita produktu; organické/biologické zemědělství; určování *P*-hodnoty; test preference potravy; senzorické hodnocení; test uchovatelnosti

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