THE CONSISTENTLY SUPERIOR QUALITY OF CARROTS FROM ONE ORGANIC FARM IN AUSTRIA COMPARED WITH CONVENTIONAL FARMS.

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Key Words: Organic Farming, product quality, carrots, food preference test, decomposition test, sensory evaluation, P-value

Abstract

The aim of this 5 year investigation was to compare quality parameters of differently cultivated carrots of the same cultivar grown in the same region as well as to compare the relevance of different methods of analysis to differentiate between these products.
The following quality tests were applied:

- Sensory tests (all harvests)
- Food preference tests with laboratory rats (all harvests)
- Decomposition tests (all harvests)
- P-value determination (all harvests)
- Single-Photon-Counting (1999)
- Chemical analysis of the main components (1998 and 1999)

It could be shown that carrots (var. Tarvil) grown using an organic farming method were significantly preferred by humans and laboratory rats, lost significantly less dry matter during decomposition, had lower P-values, indicating better bioelectrical properties, revealed a significantly better capacity to store biophotons, but showed no conclusive differentiation concerning their main components. Holistic methods were well qualified to distinguish organic from conventional carrots on significant levels.

Introduction/Problem

Ever since organically produced food has reached the markets, gaining higher prices for environmentally friendly production, the dispute about possible quality advantages has been going on. In the last 10 years a number of comprehensive revisions of relevant scientific investigations have been published with the aim to come to a final conclusion about “organic quality” (Woese *et al.* 1995; Alföldi *et al.* 1998; Worthington 1998; Heaton for the Soil Association 2001; Bordeleau *et al*. 2002; Bourn & Prescott 2002; Tauscher *et al*. 2003; AFSSA 2003; Velimirov & Müller 2003b). In short, the data on nutritional quality of organic in comparison to conventional produce are inconclusive, whereas the results of holistic methods seem to be more promising to reflect quality differences. In other words, there is enough cumulative evidence to indicate better quality in organic food for anyone who wishes to be convinced, such as lower levels of pesticide residues and nitrate, higher contents of minerals and secondary metabolites, better flavour and so on. But there are also enough conflicting results for anyone who is not a fan of organic to reach the conclusion that the reported differences don´t justify any claims to a superior quality of organic food.

Methodology

The purpose of the studies presented here was yet again to investigate quality differences induced by production methods. Organic and conventional carrots (cultivar *Tarvil*) from 5 harvests (1998, 1999, 2001-2003) have been compared in relation to different quality aspects. They were grown in the same region near Vienna (Marchfeld), thus assuring comparable sites and climatic conditions. The production methods were monitored each year, soil samples were compared in the first 2 years to ascertain the comparability of soil type and physical soil properties.
All carrots were of good commercial quality according to the Austrian market regulations and are sold in Viennese supermarkets.

In the first 2 years the test carrots were also routinely analysed for their main components: nitrate, carbohydrates (glucose, fructose, saccharose), K, P, Fe, organic acids (malic and citric acids), carotinoides, dry matter and ash.
A more global understanding of biological systems and interactions has led to the thesis, that life is more than the sum of all parts. Therefore the comparison has been focussed on holistic methods:

- Sensory evaluation

The applied difference test was the Extended Triangle Test with the following procedures: three samples of grated carrots are presented, two are alike, one is different. The different sample has to be defined and characterised. The third task is to state any preferences. Thus objective – differentiation – and subjective – preference – aspects can be tested in one test. 20-70 test persons (untrained consumers) have participated. For the preference evaluation only the choices of the participants who could identify the aberrant sample in the Triangle Test have been used.

- Food preference tests with laboratory rats

The food preference tests are carried out with 20 - 40 adult male laboratory rats (Long Evans strain), kept separately in Macrolon cages size III, under air conditioning at 22°C and 55% rel. humidity. The basic diet for all test animals (conventionally feed mixture T 779 by Tagger Co.) is supplied in the cages, in order to prevent any deficiency symptoms. A partition, containing the water bottle, divides the feeding rack into a right and left section, into which a defined amount of the two test products is apportioned simultaneously. The remainders of the feed are weighed 24 hours later in order to determine the quantity consumed. At this time, new feed is also supplied. Differences in the rate of evaporation of the examined feeds are quantified with control samples used in every test run. The sides are changed with every meal in order to prevent the effect of "position preference". Each test run is conducted over a period of one week.

- Decomposition test

The samples are washed, dried and shredded with a coarse household shredder. 20 g each are weighed into petri dishes. At the beginning the dry matter content of the shredded material is determined. After a defined period of incubation (at 20° C, 50 rel. humidity, in darkness), the samples are dried at 85°C and weighed to determine the loss of dry matter.

- P-Value determination

(The measurement of the electrochemical parameters have been carried out at the Institute of Fruit Growing and Horticulture, University of Agricultural Sciences in Vienna with the help of R. Krautgartner, B. Meltsch and R. Kappert)
The juice of washed plant material is extracted from the plants using a customary household juicer, homogenised and immediately measured by usual electrodes connected to compatible meters. In terms of the calculation of temperature-compensated values the temperature of the samples is noted. The data for pH-value and conductivity are noted after the electrodes have come to their level. For the redox potential there is a continuous data collection during a certain period of time. From these three measured parameters the so called P-value (Hoffmann 1991) is calculated.

- Single-Photon-Counting

(M. Lenzenweger conducted this investigation at the Atomic Institute of the Technical University of Vienna, with the help of Prof. Dr. H. Klima).
Carrot slices of the same size were put under a 100 Watt light bulb for 2 minutes. After 30 seconds the biophoton emission was measured for 10 minutes.

Results and brief discussion

The organic carrots were certified according to the regulations of the farmers´ association “Ernte”, the conventional method used was customary in the Marchfeld. Main differences were the use of mineral fertilisers and biocides in the conventional cultivation as well as the use of treated seeds (Thiram / Iprodione Metalaxyl). In the first two years soil samples and carrots were routinely analysed. There was more NO_3-Nitrogen, potassium, and lead in the conventional soil, the other values were similar. The analytical values corresponded with the soil contents as far as potassium was concerned. Accordingly there was also more malic acid in the conventional carrots. The sugar and dry matter contents were higher in the organic variant, whereas the contents of phosphorous, ash and carotinoides were lower. The contents of nitrate, iron, and citric acid showed hardly any differences.

The taste of products is a very important determinant of consumer choices. Published sensory tests with carrots resulted in either no difference (Minnaar 1996), a preference of the conventional variant (Kopp 1993) or a preference of organic carrots resp. products from low input systems (Abele 1987).
The results of the here presented sensory tests showed, that in all cases significantly more testers were able to differentiate between the test samples and in four out of the five tests the organic carrots were significantly preferred by mixed groups of consumers, no expert tasters (Fig. 1). According to the participants the organic carrots excelled in their carrot-typical taste and intense flavour as well as in juiciness and sweetness.
These results correspond with the significant preferences of the organic carrots by laboratory rats. It has been well documented, that animals are able to select a diet appropriate to their metabolic needs. So far it has been postulated, that for animals to be able to choose, at least one of the offered foods has to be nutritionally unbalanced, otherwise there would be no benefit in choosing (Sclafani 1995). But food preference tests with laboratory rats have shown, that even in cases of no apparent imbalance sigificant preferences take place (Fig. 2).

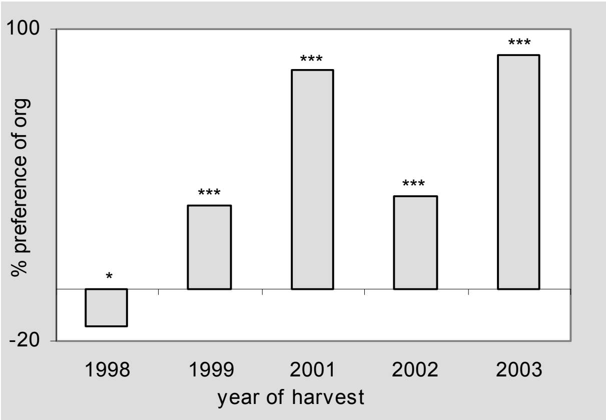

Fig. 1: Sensory tests (p = 0, 215)
(* p=0,05; ** p=0,01; *** p=0,001)

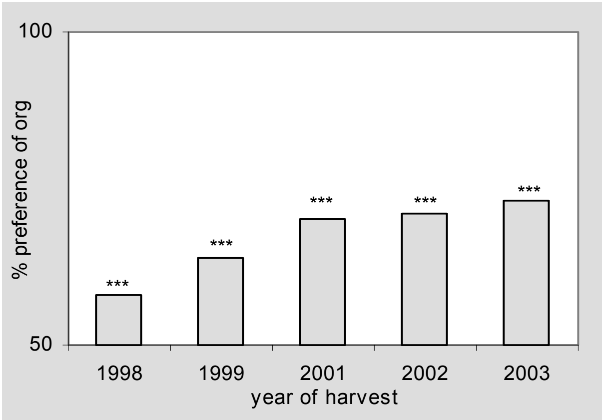

Fig. 2: Food preference tests (p = 0,003)

Different after-harvest-behaviour in connection with growing methods has often been observed (e.g. Samaras 1978, Abele 1987, Peschke 1994, Raupp 1997). The dry matter loss during decomposition indicating better storage quality was significantly higher in conventional carrots (Fig. 3).
Previous results demonstrating the effect of production methods on bioelctrical properties (Walz 1996, Hoffmann 1997) could also be corroborated in this five year comparison: the organic carrots exhibited significantly lower P-values (p = 0,000), indicating better quality (Fig. 4).

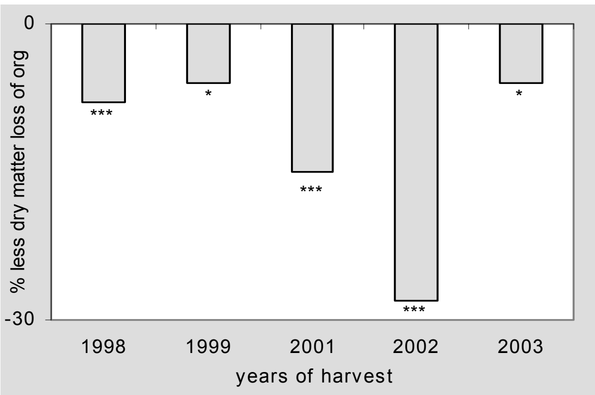

Fig. 3: Dry matter loss (p = 0, 027)
(* p=0,05; ** p=0,01; *** p=0,001)

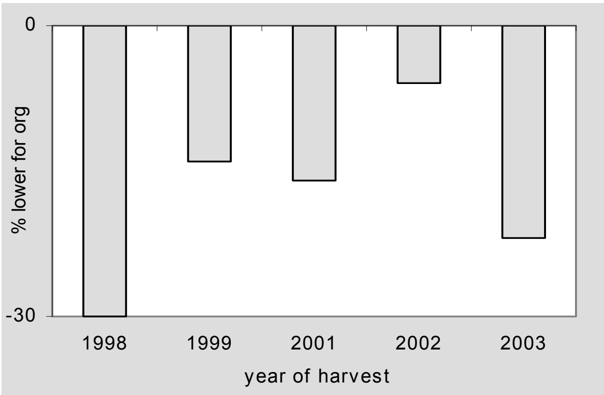

Fig. 4: P-values (p = 0,000)

The statistical evaluation of the results over the 5 year test period showed significant differences in favour of the organic variant concerning P-value determination, food preference tests and dry matter loss during decomposition and a tendency in the differentiation test. Since in the first year the test persons preferred the conventional variant, there was no significant result over the 5 years.
Although the method of single photon counting has only been applied with carrots of 1999 the results are mentioned here, since the significantly better capacity to store biophotons in organic carrots further confirms their superior quality from a different angle (Lenzenweger 2000).

Conclusions

It could be demostrated that carrots (var. *Tarvil*) grown in the Marchfeld (agricultural region near Vienna) revealed superior quality properties when grown on an organic farm as compared to conventional cultivation methods and that holistic methods are well qualified to differentiate between differently cultivated carrots on a significant level.

References

Abele, U. (1987): Produktqualität und Düngung - mineralisch, organisch, biologisch-dynamisch. Angewandte Wissenschaft, Heft 345, Landwirtschaftsverlag Münster Hiltrup

AFSSA (Agence Française de Securite Sanitaire des Aliments) 2003: Evaluation nutritionelle et sanitaire des aliments issus de l´agriculture biologique. www.afssa.fr

Alföldi, T., Bickel, R., Weibel, F. (1998): Vergleichende Qualitätsuntersuchungen zwischen biologisch und konventionell angebauten Produkten: Eine kritische Betrachtung der Forschungsarbeiten zwischen 1993 und 1998. Forschungsinstitut für biologischen Landbau, Frick, Ackerstrasse, Schweiz. pp. 32

Bordeleau, G., Myers-Smith, I., Midak, M., Szeremeta, A. (2002): Food Quality: A comparison of organic and conventional fruits and vegetables. Ecological Agriculture; Den Kongelige veterinœr-og Landbohøjskole, pp. 81

Bourn, D., Prescott, J. (2002): A Comparison of the Nutritional Value, Sensory Qualitites and Food Safety of Organically and Conventionally Produced Foods. Critical Reviews in Food Science and Nutrition, 42 (1); pp. 1-34

Heaton for Soil association (2001): Organic farming, food quality and human health. A review of the evidence. www.soilassociation.org

Hoffmann, M. (1997): Vom pH-Wert zum Pyhysiogramm. In: M. Hoffmann (Hrsg.): Vom Lebendigen in Lebensmitteln. Alternative Konzepte 92, pp.62-69, Deukalion Verlag, Holm.

Kopp, H. J. (1993) : Untersuchung an ökologisch und konventionell erzeugtem Gemüse mittels Hochleistungs-analysemethoden. Dissertation. Universität Hohenheim

Lenzenweger, M. (2000): Singel-Photon-Counting in der Lebensmittelqualität. Ein Vergleich von Weizenkeimlingen und Karotten aus zwei verschiedenen Anbauformen. Diplomarbeit an der Univ. Wien

Minnaar, Ch. (1996): Etude comparative des qualités de produits issus de l`agriculture biologique et de l`agriculture conventionnelle. Example de la carotte (1994-1995). Groupe de Réchérches en Agriculture Biologique, Avignon

Peschke, J. (1994): Inhaltsstoffe und Anfälligkeit von Möhren (*Daucus carota L.*) im Nacherntestadium unter dem Einfluß von Sorte, Herkunft und Anbaubedingung. Dissertation, Universität Giessen

Raupp, J. (1997): Vergleichende Bewertung mikrobiologisch-biochemischer Parameter zur Qualitätsbestimmung pflanzlicher Produkte anhand von Untersuchungen zu einem langjährigen Düngungsversuch. Beiträge zur 4. Wissenschaftstagung zum Ökologischen Landbau, Bonn. Hrs.: Köpke, U. und Eisele, J.-A., pp.217-223

Samaras, I. (1978): Nachernteverhalten unterschiedlich gedüngter Gemüsearten mit besonderer Berücksichtigung physiologischer und mikrobiologischer Parameter. Dissertation, Universität Gießen

Sclafani, A. (1995): How food preferences are learned: Laboratory animal models. Proceedings of the Nutrition Society 1995/54; pp. 419-427

Tauscher, B., Brack, G., Flachowsky, G.,Henning, M., Köpke, U., Meier-Ploeger, A., Münzing, K., Niggli, U., Pabst, K., Rahmann, G., Willhöft, C., Mayer-Miebach, E. (2003): Bewertung von Lebensmitteln verschiedeneer Produktionsverfahren. Statusbericht 2003. Senat der Bundesforschungsanstalten im BMVEL. (http://www. bmvel-forschung.de/themen/download/tdm200306_bericht_030515.pdf)

Velimirov, A. (2003a): Biogram and Quality Count as Suitable Indicators of Product Quality. In: B. Freyer (Hrsg.) Beiträge zur 7. Wissenschaftstagung zum Ökologischen Landbau: Ökologischer Landbau der Zukunft, pp.233-236

Velimirov, A. und Müller, W. (2003b): Die Qualität biologisch erzeugter Lebensmittel. Ist bio wirklich besser? www.bioernte.at

Walz, V. (1996): The P-value as a holistic quality parameter for food experiments with organically and non-organically grown carrots (daucus carota ssp. sativus cv. „Bolero“). In: N.H. Kristensen und H. Hogh-Jensen (ed) Proceedings of the 11th IFOAM International Scientific Conference, Copenhagen, pp. 265-272

Woese, K., Lange, D., Boess, C., Bögl, K.W. (1995a): Ökologisch und konventionell erzeugte Lebensmittel im Vergleich. Eine Literaturstudie, Teil 1 (BgVV-Hefte 4/1995) & Teil2 (BgVV-Hefte 5/1995). Hrsg.: Bundesinstitut für gesundheitlichen Verbraucherschutz und Veterinärmedizin. Berlin

Worthington, V. (1998): Effect of agricultural methods on nutritional quality: a comparison of organic with conventional crops. Alternative Therapies, VOL. 4 NO.1, pp.58-69