Cultivation and analysis of anthocyanin containing types of potatoes in organic farming regarding cultivability and additional health benefits

Hüsing, B.[1], Herrmann, M.-E., Hillebrand, S.[2] ,Winterhalter, P[2], U. Schliephake[1] Trautz, D.[1]

Key words: anthocyanin content, blue potatoes, additional health benefits, organic farming

Abstract

In a two year research project a representative spectrum of blue potato varieties were cultivated and tested in detail regarding disease infestation, yield potential and the influence of production systems (organic). Cultivation recommendations for blue potatoes could be deduced from this. Furthermore the varying anthocyanin content as well as the antioxidant capacity of the varieties used was analysed. Varieties with a particularly high content will undergo further tests to show the influence of the manner of preparation (boiling, steaming, frying) and determine their use for the processing industry. The combination of ecologically produced potatoes with „additional health benefits" arouses the customers interest. The cultivation of high yield blue types can be an alternative to the cultivation of yellow fleshed high yield varieties in organic operating companies.

Introduction

Anthocyanin, the phytochemical which appears in various useful plants such as potatoes and cereal, known especially for its health promoting effects in red wine, have a health promoting effect with their antioxidant properties (KATSUBE et al. 2003, KÄHKÖNEN 2003, MURCOVIC 2002, WATZL et al. 2002). The health promoting properties of anthocyanin are determined by its antioxidant capacity. The health promoting features are for example protection against DNA damage, degenerative illnesses and boosting the immune system (WEISEL 2006). As the potato with a consumption of 60 kg/person/year (ANONYMOUS 2007) still has an important position as a basic food, it is increasingly in the interest of the consumer, nutritional medicine and the food processing industry (e.g. potato crisps production). The goal of the interdisciplinary AGIP research project is the compiling and evaluation of the influence of the organic cultivation system with various intensities (fertilisation/no fertilisation).

Materials and methods

Within the project a field test was carried out in Germany at the Waldhof experimental station at the FH [University of Applied Sciences] Osnabrück (organic farmed) in terms of a randomized block design with four repetitions. In the test a compilation and evaluation of the influence of various cultivation parameters on technically more favourable type features with the varieties: Blauer Schwede, Blauer Schwede, Blauer

[1] University of Applied Sciences Osnabrück, Oldenburger Landstrasse 24,49090 Osnabrück, Germany, E-Mail B.Huesing[a]fh-osnabrueck.de, Internet www.fh-osnabrueck.de
[2] TU-Braunschweig, Institute of Food Chemistry, Schleinitzstrasse 20, 38106 Braunschweig, Germany, E-Mail S.Hillebrand[a]tu-bs.de, Internet www.tu-braunschweig.de/ilc

Schwede, Herrmanns Blaue, Blue Salad Potato, Olivia, Red Cardinal (2006), Highland Burgundy Red (2007), Blaue St. Galler, Vitelotte, Norika 4251 – 4254 (breeding strains) took place. The variety Blauer Schwede was tested with different nutrient levels of 70 kg N/ha and 105 kg N/ha to determine a positive or negative effect on anthocyanin content, all other varieties got no fertilization. The harvest took place at 2006-07-27 and 2007-07-25. The manner of storage has an influence on the anthocyane content and antioxidant capacity on the ready to consume end product, which will be analysed in the course of the project. To document the effect of storage, there are various time frames for analysis: a) after 4 weeks of storage: investigations into raw harvest crop = analysis of original content b) after 8 weeks of storage: investigation of raw harvest crops = determination of storage losses (raw); c) after 16 weeks of storage: investigations on raw harvest crop = determination of storage losses (raw). During the complete storage period the potatoes were kept dark and cool (8°C). For the determination of the anthocyanin potatoes were washed with water und cut in small slices (incl. potato peel). A mixture of water/acetonitrile/formic acid (87/3/10, v/v/v) was added and the suspension was stirred at room temperature overnight. After the potato pieces were separated from the extract by filtration, the clear filtrate was cleaned-up on Amberlite XAD-7 in order to remove sugars and organic acids. The quantitative determination of anthocyanins was performed by HPLC monitoring at 520 nm using a calibration curve obtained for standard cyanidin-3-glucoside. The determination of the antioxidant capacity was carried out using the Trolox Equivalent Antioxidant Capacity (TEAC) – Test at the FH Osnabrück (HILLEBRAND 2004). Statistical data concerning yield have been determined by ANOVA 2.3 using the LSD test.

Results

The selected varieties of potato display significant differences in yield in cultivation year 2006 and 2007, in organic cultivation procedures (Tab. 1). Vitelotte, Red Cardinal (2006) and Highland Burgundy Red (2007) only showed a very small yield in both cultivation years. Other varieties such as Blue Salad Potato or Olivia had higher yields in 2007 than in 2006.

Tab. 1: Yields of selected varieties of blue potatoes in the years 2006 and 2007 in organic farming

	Total yield (t ha^{-1}) (organic cultivation) 2006	Total yield (t ha^{-1}) (organic cultivation) 2007
Vitelotte	2,0 (a)	2,9 (a)
Red Cardinal (2006)/Highland Burgundy Red (2007)	2,9 (ad)	4,0 (ad)
Olivia	7,3 (b)	18,4 (b)
Blue Salad Potato	4,4 (c)	11,79 (c)
Test used: ANOVA 2.3; 2006 SD 5 % = LSD 2,29; 2007 SD 5 % = LSD 9,53 (significant differences between varieties). Different letters in brackets indicates statistical significant differences between the varieties.		

Fig. 1 shows the anthocyanin content of selected varieties of blue potatoes after four, eight and sixteen weeks of storage: the anthocyanin content of Red Cardinals is partly increasing, but in Olivias and Blue Salad Potatoes it is decreasing.

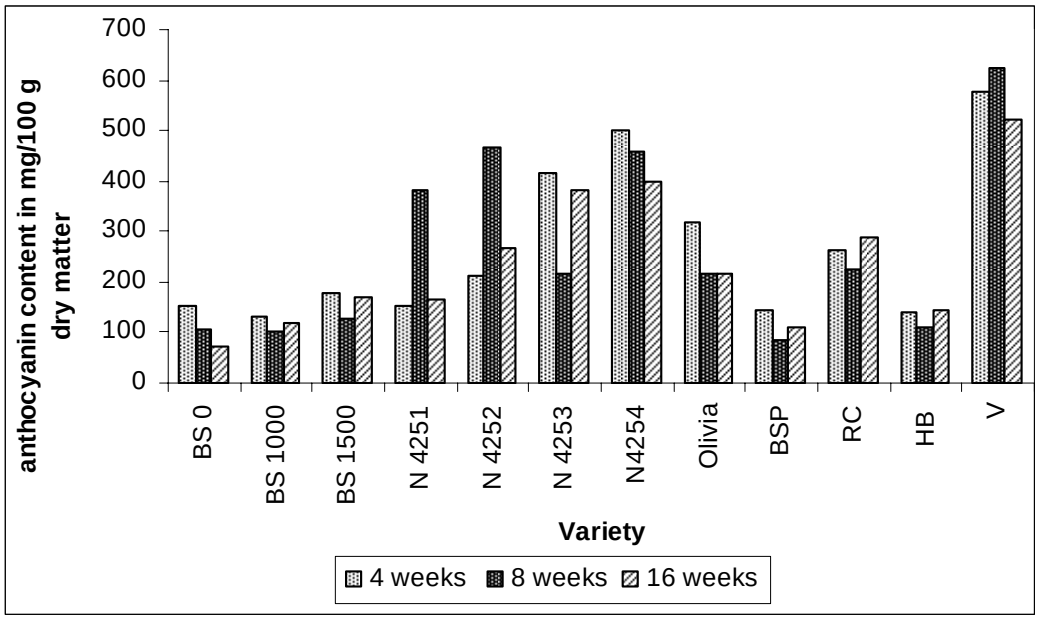

Fig. 1: Anthocyanin content in mg/100g dry matter of different potato varieties after 4, 8 and 16 weeks of storage in 2006 (organic cultivation)

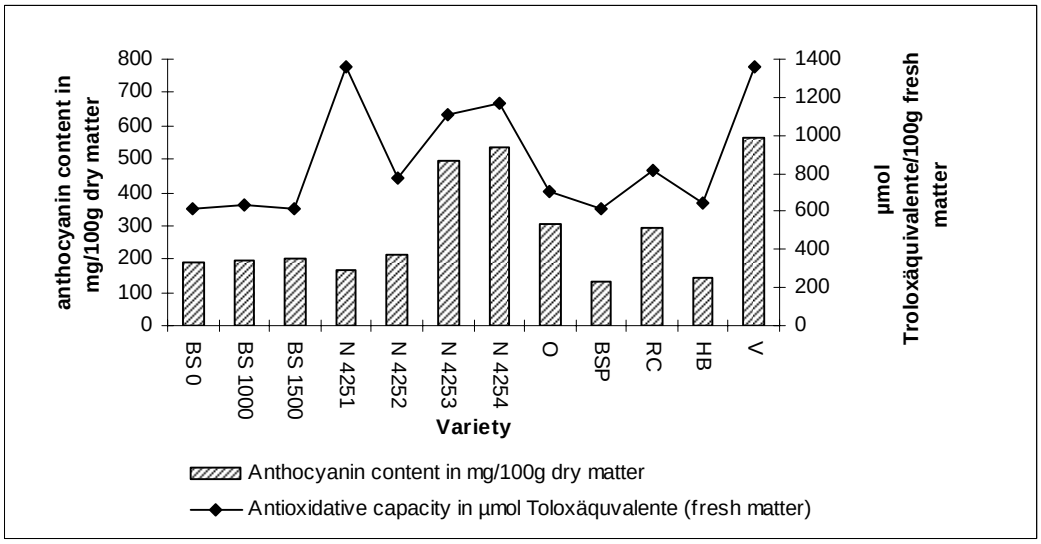

Fig. 2: Relation between anthocyanin content and antioxidative capacity at different blue potato varieties 2006 (organic cultivation) Abbreviations: BS 0 = Blauer Schwede, without fertilization; BS 1000 = Blauer Schwede, 70 kg/N/ha; BS 1500 = 105 kg/N/ha; N4251 – N 4254 = Norika breeding strains; O = Olivia; BSP = Blue Salad Potato; RC = Red Cardinal; HB = Herrmanns Blaue; V = Vitelotte

Fig. 2 illustrates the antioxidant capacity of the cultivated varieties in relation to the anthocyanin content. The investigations in 2006 showed that the level of anthocyanin influenced the antioxidant capacity and therefore the health promoting effects.

Discussion

The high temperatures and missing rainfall in June 2006 had a negative effect on the tuber growth. Layers and second shoots formed. As a result the exterior and interior quality of the potatoes was often not satisfactory (infestation with potato scurf (*Streptomyces scabies*)). The yields achieved could not be regarded as representative. In the investigations of 2007 it could be recognised that some of the old blue types preferred a relatively high nitrogen content (105 kg ha^{-1}). Vitelotte and Highland Burgundy Red as well as Red Cardinal could not achieve an adequate yield in organic cultivation, other varieties showed good harvest crop yields up to a total yield of e.g. 30.22 t ha^{-1} with the Olivia variety. The investigations in 2006 showed that the anthocyanin content has an influence on the antioxidant capacity and therefore on the health promoting effects. Anthocyanin content and antioxidant capacity are dependent on the variety and according to the results from 2006 are not influenced by the use of a nitrogen fertiliser.

Conclusions

The results of the research project show that sometimes it is possible to cultivate a particular variety e.g. old anthocyanin containing varieties of potatoes in organic farming, however a breeding process must take place for some types of potatoes concerning the needs of the user today regarding skin texture, shape or taste. Investigations in 2007 have not yet been completed at this point, but will be integrated into the contribution for the conference. This also applies to the investigations into the antioxidant capacity according to various methods of preparation.

Acknowledgments

Special thanks go to AGIP [work group innovative projects, ministry for economy and culture in Lower Saxony] as well as to DIL [German Institute for food technology], for their financial support in carrying out this project.

References

Anonymus 2007: http://www.agrarheute.com, (accessed 2007-12-21).

Bundesministerium für Bildung und Forschung (2007) : Biosicherheit Genetik – Umwelt – Pflanzen. http://www.biosicherheit.de/de/kartoffel/26.doku.html, (accessed 2007-10-11).

Busch-Stockfisch, M. (2004): Praxishandbuch Sensorik in der Produktentwicklung und Qualitätssicherung. Behrs Verlag, Hamburg, 2004.

Hillebrand, S. (2004): Analytic von Polyphenolen in Buntsäften im Hinblick auf Saftqualität, Farbe und Antioxidative Aktivität, Dissertation, Cuvillier Verlag, Göttingen 2004, 214 p.

Kähkönen, M., Heinonen, M. (2003): Journal of Agricultural Food Chemistry 51: 628-633.

Katsube, N., Iwashita,K., Tsushida, T., Yamaki, K., and Kobori, M. (2003): Journal of Agricultural Food Chemistry 51: 68-75.

Murcovic, M. (2002): Ernährung & Mensch 17: 167-172.

Watzl, B., Briviba, K., Rechkemmer, G. (2002): Ernährungsumschau 49: 148-150.

Weisel, T. (2006): Untersuchungen zur antioxidativen Wirkung von flavonoid-/polyphenolreichen Mischfrchtsäften bei Probanden. Ph.D. Thesis, Technische Universität Kaiserslautern, Germany.