Quality Assessment of integrated, Organic and Biodynamic Wine using Image forming Methods

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Abstract

Nine encoded wine samples from a German long-term field trial on the comparison of different cultivation systems were examined with the image forming methods biocrystallization, capillary dynamolysis and circular chromatography. The images of the encoded samples were i. differentiated into three groups of images with similar form expression, ii. characterised as 'fresh – aged' based on a catalogue of reference images, iii. ranked (according to the quality characterization) and iv. assigned to the different cultivation systems (classified). Images gained with samples from integrated farming showed more structures indicating enhanced aging compared with the samples from organic and especially from biodynamic origin. Based on these observations, a correct assignment of all encoded samples to cultivation systems was possible. These results are interpreted as indicating higher product quality of biodynamic and organic wine compared to wine from integrated farming.

Introduction

The global production area of organic and biodynamic viticulture has almost tripled within the last ten years (Willer 2010). Following this notable interest in organic and biodynamic viticulture expressed by winegrowers and consumers, a long-term field trial was established in Geisenheim, Germany, in order to compare integrated, organic and biodynamic cultivation systems with respect to soil, plant development, pests and diseases as well as the product quality of grapes and wines (Meissner 2010). Wine quality was assessed with extensive chemical analyses and sensory analysis (Meissner et al. 2010), and, as shown in this study, also with the image forming methods biocrystallization, capillary dynamolysis and circular chromatography.

As described in Fritz et al. (2011a), in these methods structural features are formed as a function of the reaction of the food matrix with inorganic salt solutions. Characteristic qualitative traits of the food, e.g. the degree of freshness and the ripening stage, result in typical and reproducible image structures. Hence, samples have been characterized with respect to food quality by linking image structures to physiological processes such as maturation and aging (Balzer-Graf and Balzer 1991, Fritz et al. 2011a).

Material and methods

The wine samples analysed were from harvest year 2010. The Riesling grapes were taken from the cultivation systems integrated, organic and biodynamic farming of a long-term field trial in Geisenheim, Germany (Meissner et al. 2010, Meissner 2010). The samples were mixed together from four field replications for each treatment. Samples were each encoded by co-workers of Geisenheim Research Center and then analysed using the three image forming methods biocrystallization, capillary dynamolysis and circular chromatography in the laboratory of the Institute of Organic Agriculture in Bonn (methods see Fritz et al. 2011a). Nine samples (three repetitions per farming system) were assessed, based on several series with varying concentrations of wine per image, fresh and after 1, 2, 6, 9, 16, 23, 38, 43, 114 days of aging in the open bottle at room temperature.

Analysis

The images of the encoded wine samples were differentiated into three groups of images with similar form expression, and then characterized as 'strong – weak form expression' and 'fresh – aged' based on a catalogue of reference images with i. varying stages of wine amount per plate and ii. different deterioration stages.

Based on these characterizations a qualitative assessment of the generated images was made, where (a1) wine with strong form expression and (b1) fresh wine was ranked higher than (a2) wine with weak form

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expression and (b2) aged wine. Based on experience from earlier investigations, the encoded samples were then assigned to cultivation methods (classification).

Statistical Analysis

The agreement between correct grouping / classification and the grouping / classification based on the results of the image forming methods was tested using Fisher's Exact Test for grouping and the simple Kappa coefficient for classification (Agresti 2002). The test is based on a 3x3 contingency table, comparing a set of given categories to the ones determined in the investigation (see Tab. 1).

Results and Discussion

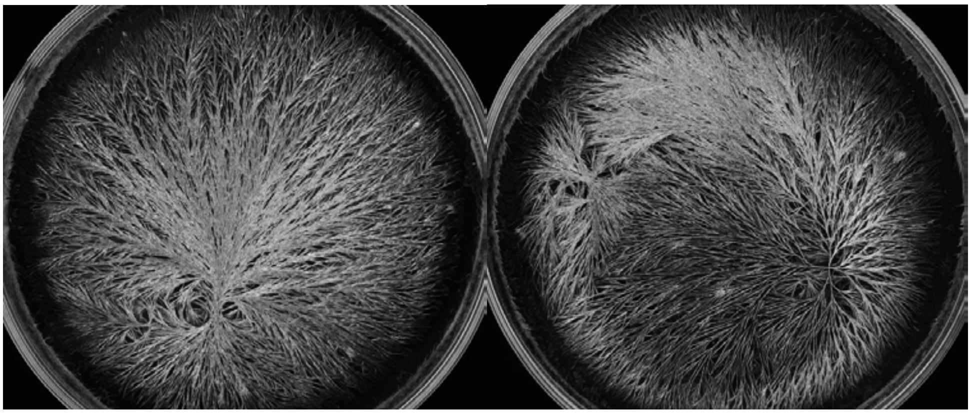

Figure 1: Biocrystallization of wine samples from biodynamic (A) and integrated production (B), aged for two days, 1.4 ml wine and 0.2 g $CuCl_2$ per image.

Based on the experiences gained from earlier investigations on various foods (Athmann 2011, Fritz et al. 2011a) it was known that organic and especially biodynamic products usually show fewer signs of aging and stronger form expression than samples from conventional or integrated production. Figure 1 shows two biocrystallization images of samples from biodynamic and integrated production after two days of aging. The cross-like centre and the more irregular needle structures in the image developed by the integrated sample indicate enhanced aging based on the reference series (not shown). The organic sample was in between the biodynamic and the integrated sample with respect to signs of aging in the image.

Based on these observations, all encoded samples were correctly grouped and assigned to production methods. Grouping and classification of the encoded samples was significant (Table 1). The samples later decoded as originating from the biodynamic production system were ranked highest in the quality assessment, followed by organic and integrated production. These results are interpreted as indicating higher product quality of biodynamic and organic wine compared to wine from integrated farming.

Table 1: Contingency table of Fisher's Exact Test (test for grouping of encoded samples) and Interrater Agreement (classification of encoded samples). From left to right i. samples needed more juice per sample for similar form expression, and ii. samples showed more pronounced structural features that indicate enhanced aging.

		Correct grouping					Correct classification		
		G1	G2	G3			D	O	C
Grouping of encoded samples	G1	3	0	0	Classification of encoded samples	D	3	0	0
	G2	0	3	0		O	0	3	0
	G3	0	0	3		C	0	0	3
Significance		p = 0.004			Significance		p = 0.001		

G1 – G3: sample group 1 to 3. D: biodynamic system, O: organic system,
C: integrated system.

After beetroot (Mäder et al. 1993), apples (Weibel et al. 2000) rocket lettuce (Athmann 2011) wheat (Mäder et al. 2007, Kahl et al. 2008, Fritz et al. 2011a) and grapes (Fritz et al. 2011b) this is the first study discriminating wine from different production systems using image forming methods. On the site under study, the reduction in vegetative growth of the vine by organic and especially biodynamic as compared to integrated production (Meissner, unpublished) was accompanied by higher grape (Fritz et al. 2011b) and wine quality. Further studies with different sites and varieties are necessary to see if these results can be generalized.

References

Agresti, A. (2002): Categorical Data Analysis. John Wiley & Sons Inc: Hoboken, New Jersey.

Athmann, M. (2011): Produktqualität von Salatrauke (Eruca sativa L.) und Weizen (Triticum aestivum L.): Einfluss von Einstrahlungsintensität, Stickstoffangebot, Düngungsart und Hornkieselapplikation auf Wachstum und Differenzierung. PhD Thesis, Bonn University; Bonn, 310 pp.

Balzer-Graf, U. & Balzer, F.M. (1991): Steigbild und Kupferchloridkristallisation - Spiegel der Vitalaktivität von Lebensmitteln. In: A. Meier-Ploeger & H. Vogtmann (eds): Lebensmittelqualität - ganzheitliche Methoden und Konzepte (2nd edn). Verlag CF Müller pp. 163-210.

Fritz, J., Athmann, M., Kautz T. & Köpke, U. (2011a): Grouping and classification of wheat from organic and conventional production systems by combining three image forming methods. Biological Agriculture & Horticulture 27, 320-336.

Fritz, J., Athmann, M. & Köpke U. (2011b): Quality assessment of grape juice from integrated, Organic and biodynamic farming with Image forming methods. First International Conference on Organic Food Quality and Health research, May 18–20, 2011, Prague, Czech Republic

Kahl, J., Busscher, N., Mergardt, G., Mäder, P., Dubois, D. and Ploeger, A. (2008) Authentication of organic wheat samples from a long-term trial using biocrystallization. In: Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research, Modena, Italy. Institute of Organic Agriculture, pp. 742-745.

Mäder, P., Hahn, D., Dubois, D., Gunst, L., Alföldi, T., Bergmann, H., Oehme, M., Amadó, R., Schneider, H., Graf, U., Velimirov, A., Fließbach, A. & Niggli, U. (2007): Wheat quality in organic and conventional farming: results of a 21 year field experiment. Journal of the Science of Food and Agriculture 87, 1826-1835.

Mäder, P., Pfiffner, L., Niggli, U., Balzer, U., Balzer, F.M., Plochberger, A., Velimirov, A. & Besson, J.M. (1993): Effect of three farming systems (bio-dynamic, bio-organic, conventional) on yield and quality of beetroot (Beta Vulgaris L. Var. Sculenta L.) in a seven year crop rotation. Acta Horticulturae 339, 10-31.

Meissner, G. (2010): Biologisch-dynamischer Weinbau, Dynamische Entwicklung für besondere Weine. Ökologie und Landbau 154, 28-29.

Meissner, G., Kauer, R., Stoll, M. & Schulz, H. R. (2010): Evaluation of viticultural farming systems with specific reference to biodynamic viticulture and the use of the biodynamic preparations. Proceedings 14th Australian wine industry technical conference. Adelaide, Australia, pp. 89-90.

Weibel, F., Bickel, R., Leuthold, S., Alföldi, T. & Balzer-Graf, U. (2000): Are organically grown apples tastier and healthier? A comparative study using conventional and alternative methods to measure fruit quality. Acta Horticulturae 517, 417-427.

Willer, H. (2010): Von den Anfängen bis heute, Bioweinbau in Europa auf dem Vormarsch. Ökologie und Landbau 154, 12-14.