

## Phenolic compounds and disease resistance of 5 blackcurrant varieties in an organic growing system

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### Abstract

The field resistance and the concentration of phenolic compounds of five black currant varieties grown under organic conditions were compared. Significant differences between varieties were seen for all of seven quantified hydroxycinnamic acid derivatives. The variety 'Intercontinental' clearly contained the highest level of hydroxycinnamic acid esters and at the same time was the most resistant variety. There seems to be a connection between the content of a caffeoyl-di-quinic acid ester and coumaryl-quinic acid ester and disease resistance under field conditions. The effect of four different growing conditions was much less evident. Analysis of the content of these phenolic acids might be a tool to help choosing the disease resistant varieties that are suitable for organic growing.

### Introduction

25 years ago a study of the relationship between phenolics in blackcurrant leaves and resistance to mildew was performed (Trajkovski 1974). It was concluded that the species which had resistant leaves clearly differed from the susceptible ones by having a higher content of hydroxycinnamic acid derivatives, especially chlorogenic acids. The aim of our study was to compare the levels of phenolic compounds in the leaves of five blackcurrant varieties with different field resistance and different content of phenolic compounds, when grown in an organic system with different cover crops.

### Materials and Methods

Black currant *Ribes nigrum* cv. 'Ben Alder', 'Ben Lomond', 'Intercontinental', 'Farleigh' and 'Titania' were planted autumn 1996 and grown under unsprayed organic conditions. Planting distance was 3,50 x 0,60 m. The design was a split plot where each variety was planted in single rows, the four treatments were randomized in four blocks. Each plot consisted of 25 bushes per variety. The bush rows were cleaned mechanically for weed, and cover crops were established in the alleyways (treatment 1-4). 1: Annual cover crop sown every year in July. Vetch (*Vicia sativa*) and rye (*Secale cereale*). Mulched down in April. Mechanical weed cleaning from April to July. 2: Perennial white clover (*Trifolium repens*) and rye grass (*Lolium perenne*) mulched. 3: Perennial white clover and rye grass, 50-kg total nitrogen added in spring using slurry. 4: Permanent white clover and rye grass. Infection of diseases were assessed on a scale 1= no attack to 10 = severe attack on 5 bushes of each variety in each plot. The following diseases were assessed: American gooseberry mildew (*Sphaerotheca mors-uvæ*) white pine blister rust (*Cronartium ribicola*) and leaf spot (*Gloeosporidiella ribis*).

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The main hydroxycinnamic acid esters and flavonols were quantified by use of HPLC. Some of the compounds were isolated and identified by use of ES-MS, UV-spektra and in some cases also H-NMR.

## Results

The major diseases in blackcurrant cultures in Denmark are American gooseberry mildew (*Sphaerotheca mors-uvae*) white pine blister rust (*Cronartium ribicola*) and leaf spot (*Gloeosporidiella ribis*). Mildew attacks the young newly developed leaves starting in May. The first signs of pine rust and leaf spot can be seen in the end of June; leaf spot attacks the oldest leaves first.

**Table 1:** Mildew infection (scale 1-9) in 5 blackcurrant varieties grown with different cover crops assessed 28.7.1998.

	Annual	Clover-mulching	Clover-manure	Clover
Ben Alder	3,05a	2,95a	2,95a	2,95a
Ben Lomond	4,80b	5,30ab	5,60a	4,87b
Intercontinental	2,27a	2,00a	2,07a	2,27a
Farleigh	2,33a	2,13a	2,27a	2,20a
Titania	1,90a	1,80a	1,95a	1,90a
Total soil nitrogen in april (percent)	5,61a	7,25a	6,50a	6,76a

For each variety treatments are compared. Values followed by different letters are statistically different at  $p > 0.05$ .

For 'Ben Lomond' a tendency towards a lower disease incidence for the annual and clover treatments was found, but the general picture shows no effect of growing conditions (table 1). In Table 2 all four soil treatments are put together. The seven major hydroxycinnamic acid esters and the five major flavonols were quantified. Table 2 displays the three main hydroxycinnamic acid esters.

**Table 2:** Disease incidence (1998) and the content of the three main hydroxycinnamic esters in the leaves (27.6.1998). Varieties are compared statistically.

	Mildew	Pine rust	Leaf spot	Caffeoyl-di-quinic acid	coumaryl quinic acid	Caffeoyl-3-quinic acid
Ben Alder	3,0 c	-	9,0 d	320 d	144 c	510 d
Ben Lomond	5,1 d	1,3 b	8,6 c	518 c	181 c	1969 a
Intercontinental	2,2 b	1,0 a	7,6 a	2436 a	1157 a	1526 b
Farleigh	2,2 b	4,0 c	8,4 c	206 c	83 c	277 e
Titania	1,9 a	1,1 a	8,2 b	1240 b	433 b	1041 c

For each variety disease level and compound concentrations are compared. Values followed by different letters are statistically different at  $p > 0.05$ . Concentrations in

absorbance units at 320 nm.

In 1998 leaf spot was the dominating disease. In 1994-1996 disease incidence data was collected in an unsprayed culture of blackcurrant (Lindhard Pedersen, 1998), during this period pine rust was the dominating disease. Registrations of diseases from 1994-96 and in 1998 at Aarslev research station shows that 'Intercontinental' and 'Titania' are clearly the most healthy varieties, both varieties are in most cases far below the average for all of the assessed diseases. 'Ben Lomond', 'Ben Alder' and 'Farleigh' falls in a group with high disease susceptibility, 'Ben Lomond' is susceptible to mildew and all three varieties are susceptible to pine rust.

'Intercontinental' had the lowest disease score when both 1994-96 and 1998 data are taken into account; and at the same time 'Intercontinental' had by far the highest content of caffeoyl-di-quinic and coumaryl quinic acid esters.

'Titania' has the second highest level of caffeoyl-di-quinic and coumaryl quinic acid esters and it was field resistant to mildew and only slightly harmed by leaf spot and pine rust (Lindhard Pedersen 1998).

'Ben Alder' and 'Farleigh' were both highly susceptible to diseases and they clearly contains much lower levels of caffeoyl-di-quinic and coumaryl quinic acid esters compared to the two resistant varieties 'Intercontinental' and 'Titania'.

'Ben Lomond' seems to show a slightly different pattern. From Table 2 it appears that for 'Ben Lomond' a serious attack of mildew is seen. 'Ben Lomond' is also low in the content of caffeoyl-di-quinic and coumaryl quinic acid esters, but it has a very high content of caffeoyl-3-quinic acid. The severe early mildew attack for 'Ben Lomond' may induce formation of chlorogenic acid and this could be an explanation for the extremely high level of this compound (Table 2) but apparently this does not lead to mildew resistance.

Regression analysis was performed to examine the correlation between diseases and the content of the individual phenolic compounds in 1998. It was shown that Leaf spot was inversely correlated to coumaryl quinic acid ( $P = 9,7 \cdot 10^{-6}$ ) and to caffeoyl-di-quinic acid ( $P = 2,6 \cdot 10^{-6}$ ).

In Trajkovskis study it was concluded that the mildew susceptible Nordic and Continental varieties all contained only small amounts of caffeoyl quinic acids (Trajkovski 1974). The mildew resistant russian varieties, however, was characterized by a large accumulation of caffeoyl quinic acids as well as coumaric and gallic acid esters. These hydroxycinnamic acid derivatives were present right from the start of the growing season. This is in good agreement with our study where caffeoyl-di-quinic acid and coumaryl quinic acid were found in higher quantities in the disease resistant varieties.

## Conclusion

Significant differences in the content of hydroxycinnamic acid derivatives were seen when five black currant varieties were grown under organic conditions. High levels of caffeoyl-di-quinic acid and coumaroyl-quinic acid early in the growing season seemed to be related to disease resistance in a blackcurrant culture under organic growing conditions. Analysis of the content of hydroxycinnamic acids could be an important tool to help choosing the disease resistant varieties that are suitable for organic growing.

## Literatur

- Lindhard Pedersen, H. (1998). Field resistance of black currants (*Ribes nigrum* L.) to diseases and pests. *Fruit Varieties Journal* 52: 6-10.
- Trajkovski, V. (1974). Resistance to *Sphaerotheca mors-uevea* (schw.) Berk. in *Ribes nigrum* L. (4) Developmental changes in phenolic compounds in leaves of *Ribes nigrum*. *Swedish J. agric. Res.* 4: 143-150.