Cropping and Chemical Composition of Black Currant (*Ribes nigrum* L.) Cultivars in Norway

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Abstract

There has been increasing focus on the health benefits of fruits and berries in last years and several chemical components in both fresh and processed berries are believed to have significant effects in reducing chronic diseases. It is commonly known that blackcurrant and other berry species contain the very high content of health related components. The fruit yield and some chemical analyses of black currant fruit (soluble solids, titratable acids and L-ascorbic acid – vitamin C) as well as antioxidant activity (FRAP) are presented in this paper. An experiment with 15 new black currant cultivars and advanced selections from different international breeding programs was carried out for six seasons (2005-2010) at Bioforsk in the South-East of Norway (60°40' N; 10°11' E). Yield and soluble solids of fruits were recorded at harvest all years. The last five seasons berries of selected cultivars were analyzed for several chemical components. The berries were harvested at full maturity which was about the middle of August. Both yield and chemical composition varied significantly both between cultivars and years. Compared to most other species, the average content of vitamin C and antioxidant activity of black currant fruit showed very high values.

INTRODUCTION

Black currants are widely grown in Europe and have become more popular in last years as there has been increasing focus on the high content of health related chemical components as vitamin C and different antioxidants in fruits and berries as important factors in reducing several chronic diseases. Significant differences between cultivars and species were presented (Heiberg et al., 1992; Halvorsen et al., 2002). The high content of minerals and L-ascorbic acid in black currants is well known and earlier investigations have showed high level of antioxidant active components in the fruits of cultivars studied (Heiberg et al., 1992). Great influence of postflowering temperatures in red raspberry cv. Glen Ample has been demonstrated (Remberg et al., 2007). Different cultivation practice like different methods of fertilization and irrigation did not affect the chemical composition of black currant fruits significantly in an earlier investigation (Nes et al., 2008).

This paper presents results of yield and some chemical analyses of fruits of several black currant cultivars conducted in Norwegian conditions during six years (2005-2010).

MATERIAL AND METHODS

A trial with two year old plants of 15 cultivars of black currants was established in a randomised block design with tree replicates and plots of two plants at the Bioforsk Division Kise (60°40' N; 10°11' E) in the South Eastern Norway in early spring 2003. The plants were in single rows 4.0 m apart (2.500 m row/ha) and at a planting distance of 1.5 m (1666 plants/ha) between them. The soil of the experimental field was a morainic loam soil with 6-8% humus and pH in water of 5.6. The plant available P and K were 90 and 250 mg/kg respectively. Before planting the field was applied with 500 kg per ha 15-4-12 NPK complex fertilizer. Irrigation was applied with overhead sprinklers whenever soil moisture deficit exceeded 10 mm. Grass was regularly cut in the alleyways, combined

with a herbicide strip 1.0 m wide in the rows. Fertilization was applied according to leaf analyzes in early spring and at harvest time. The fruits of all cultivars were all years harvested at full stage of ripeness about the middle of August. Yield and soluble solids were recorded at harvest and berry samples were stored at -20°C and analysed later. All chemical analyses were carried out according to Remberg et al. (2010). The antioxidant activity of fruits were done by the FRAP (the Ferric Reducing Ability of Plasma) method. Analysis of variance was applied to test differences between the factors. Fisher's test of comparison was applied to test significant differences at the levels ns = $p>0.05$, * = $p<0.05$, ** = $p<0.01$, and *** = $p<0.001$.

RESULTS AND DISCUSSION

The yield records of the cultivars and advanced selections presented in Table 1 show a similar significant variation between cultivars and years in accordance with Heiberg et al. (1992). The highest cropping cultivars showed little differences in average yield in the period but the variation between years was highly significant for all cultivars but the interaction of the two factors showed no significance. In average the Polish cultivar 'Tiben' yielded most, closely followed by the Norwegian cultivar 'Narve Viking' and the Scottish cultivar 'Ben Tron'. 'Tiben' is a new cultivar in Norway while both 'Narve Viking' and 'Ben Tron' are established cultivars. The latter obtained the highest yield in a single year, but like showed earlier by Nes et al. (2008) 'Ben Tron' showed large variability in yield between years. The reasons for these variations are not easily understood, but both some winter damage as well as unfavourable climatic conditions during flowering may be most possible factors.

The chemical composition of the fruits of selected cultivars tested in the experiment is presented in Table 2. The analyses of fruits show considerable variation between the cultivars. Changes in fruit quality and chemical composition during maturation have been demonstrated (Jeppsson and Johansson, 2000; Wang et al., 2009). Although there was always high focus on avoiding variation in maturation between the berry samples collected and analyzed during the season and in different years, this still could be a reason for some of the variation.

The content of soluble solids and vitamin C were the largest in the Polish cultivar 'Tisel'. This cultivar was, however, not among the most productive. The other Polish cultivar, 'Tiben', had the highest average yield and also high value of titratable acids but lower in vitamin C. Fruits of most cultivars had high antioxidant activity (measured by FRAP). The highest values were found in 'Ben Tron' all years and the level was nearly the same as found in earlier investigation in Norway (Heiberg et al., 1992; Nes et al., 2008).

CONCLUSIONS

Yield showed significant variation both between cultivars and seasons during the six year period of cultivar evaluation. A similar variation was also found in chemical composition of the blackcurrant fruits. No cultivar was found to be the best in all investigated factors.

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Tables

Table 1. Yield (t/ha) of 15 black currant cultivars and advanced selections evaluated.

Cultivars	Years						Average
	2005	2006	2007	2008	2009	2010	
Tiben	6.81	3.99	7.44	9.42	4.44	4.67	6.13
Narve Viking	9.99	3.80	7.84	6.94	3.69	4.32	6.10
Ben Tron	11.83	3.22	8.04	6.00	3.72	3.14	5.99
N 18	9.34	2.15	8.53	6.38	5.12	2.64	5.69
Ben Nare	8.57	4.43	5.89	6.99	3.60	3.90	5.56
PC – 36	7.41	5.10	7.79	5.04	5.37	2.54	5.54
N 16	6.81	2.74	7.58	5.13	6.83	2.16	5.21
2 1A/13	5.24	5.03	6.67	6.20	2.91	2.64	4.78
PC 19	4.18	3.19	7.71	4.66	3.83	4.12	4.62
Kristin*	-	-	5.00	4.06	5.01	3.80	4.47
Polar	6.12	1.86	5.23	5.69	5.65	2.06	4.44
Ben Hope	3.94	4.12	6.17	2.76	4.67	2.88	4.09
Tisel	5.68	3.25	6.05	3.17	2.37	3.24	3.96
Intercontinental	2.21	4.14	9.28	2.05	1.32	1.00	3.33
Ben Gairn	2.28	1.20	3.02	1.68	0.91	1.37	1.74
P>0.05	***	***	***	***	***	***	***

*The plants were established one year later and were not harvested the first year.

Table 2. Content of soluble solids, titratable acids, ascorbic acid and antioxidant activity of eight cultivars of black currant in 2006-2010.

Cultivars	2006				2007			
	Soluble solids (brix)	Titratable acids (%)	Ascorbic acid (mg/100 g FW)	AOX (FRAP)	Soluble solids (brix)	Titratable acids (%)	Ascorbic acid (mg/100 g FW)	AOX (FRAP)
Tiben	16.2	4.767	114	9.11	17.8	4.247	131	9.9
Narve Viking	14.5	3.540	184	9.72	15.3	3.446	165	10.4
Ben Tron	16.7	3.156	176	12.67	14.6	3.138	149	10.7
Ben Nare	15.2	4.020	148	7.92	15.9	3.133	114	6.9
Kristin	-	-	-	-	16.3	3.972	68	9.0
Ben Hope	14.0	4.345	192	9.01	13,6	3.740	180	8.7
Tisel[1]	21.7	4.257	261	12.10	21.4	4.198	212	9.9
Intercontinent[1]	15.9	4.449	111	6.18	14.5	3.926	109	5.8
	***	***	***	***	***	***	***	***
Cultivars	2008				2009			
Tiben	16.0	4.394	189	11.3	-	-	-	-
Narve Viking	15.2	3.288	236	13.3	15.0	3.368	184	11.1
Ben Tron	17.1	3.086	203	14.6	13.6	2.988	158	12.1
Ben Nare	16.0	3.069	168	10.2	15.5	3.926	144	7.9
Kristin	15.0	3.786	120	11.2	15.7	2.683	100	10.3
Ben Hope	14.8	3.459	211	12.6	14.2	4.087	189	9.3
Tisel[1]	22.4	4.009	312	13.6	-	-	-	-
Intercontinent[1]	16.5	3.616	138	7.7	-	-	-	-
	***	***	***	***	***	***	***	***
Cultivars	2010							
Narve Viking	17.9	3.886	194	12.5				
Ben Tron	15.7	3.003	167	13.0				
Ben Nare	16.2	3.937	170	8.2				
Kristin	16.9	2.708	113	11.8				
Ben Hope	18.4	4.526	188	11.5				
	***	***	***	***				

[1]Some missing data.