

Antioxidant activities of newly developed day neutral and June bearing strawberry lines

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Abstract

An experiment was carried out to evaluate the antioxidant capacity, phenolic content and composition of known and selected advanced lines from a group of June-bearing (JB) and day-neutral (DN) population using Ferric Reducing/Antioxidant Power (FRAP), Folin-Ciocalteu (FC) and HPLC assay. A significant variation was observed between the genotypes and groups. The highest total phenolic content (2179 µg/g) was found in DN genotype 'FIN0320-47' which also had the highest antioxidant activity (2620 µg/g), based on FRAP method. Meanwhile, mean of total phenolic content and antioxidant capacity in DN strawberries were estimated to be 1341 µg/g and 2062 µg/g, respectively, which were higher than those in JB genotypes (1119 µg/g and 1917 µg/g). There was a positive correlation between the total of phenolic content and antioxidant activity among different genotypes ($r=0.77$). The total phenolics (sum of five groups) was significantly different among the genotypes, ranging from 394.5 to 871 µg/g and the level of anthocyanins, hydroxycinnamic acids, flavonols, ellagic acids and benzoic acids was significantly higher in JB than DN genotypes.



These results revealed the importance of genetic background for the content of total phenolics and the potential use of selected lines as parents in a breeding program to produce new lines with higher levels of antioxidant capacity.

Introduction

In plant organs, oxidative stress is involved in physiological process such as fruit ripening and senescence. Free radicals through the induction of lipid peroxidation play an important role in senescence and ageing. In addition, the oxidative stress can be also induced by abiotic or biological infection causing the oxidative burst. Excess reactive oxygen species (ROS) production results in imbalance between oxidative stress and the detoxification of plant defence system causing damages to biological molecules especially to the DNA, lipids and proteins. All oxygen-consuming organisms are endowed with well-integrated antioxidant system, and there is wide awareness on the importance of antioxidants in cell protection against free radicals and their relationship with shelf life and disease susceptibility (Khanizadeh *et al.*, 2002; Rekika *et al.*, 2005; Hébert *et al.*, 2002). The purpose of this study was to evaluate selected advanced lines and released cultivars for their antioxidant capacity, phenolic content and composition and to examine if there are any differences between DN and JB genotypes.

Materials and Methods

Fruit samples from 17 strawberry (*Fragaria x ananasa* Deuch.) genotypes were collected from a completely randomized design with four replicates established in Agriculture and Agri-Food Canada experimental farm, located at l'Acadie, Quebec. Ten grams of fresh-frozen fruits were used to determine total phenolic content, Ferric Reducing/Antioxidant Power (FRAP) and HPLC assays as described previously (Benzie and Strain, 1996; Tsao *et al.*, 2003; Tsao and Yang, 2003b).

Results and Discussion

A significant variation was observed between the two groups of genotypes (JB and DN) (Table 1). 'St-Jean d'Orléans' a JB genotype showed the lowest total phenolic content and 'FIO966-44' a new advanced lines and a recently released cultivar 'Saint-Laurent d'Orléans' had the highest total phenolics. The highest antioxidant capacity was observed for 'FIO9623-102' and 'Saint-Laurent d'Orléans'. DN type showed a little higher FRAP values than JB type with a greater variation in FRAP assay. The highest FRAP value was observed on DN genotype 'FIN0320-47' and the lowest FRAP value was found for JB bearing type 'La Clé des Champs' and 'St-Jean d'Orléans'.

There was a positive correlation between total phenolic content and FRAP value ($r = 0.77$). This relationship was stronger for DN type ($r = 0.81$). In general the higher total phenolic content resulted in higher antioxidant activity.

Among the five groups, the anthocyanins were the most predominant phenolic compounds in strawberry for JB and DN type and an overall 66% calculated for all genotypes.

'Jewel' a JB type had the highest level of anthocyanins followed by 'Kent' and 'FIO9623-102' with 546 µg/g and 535 µg/g respectively, whereas, the lowest value was found in 'FIO966-44' with 218 µg/g. The variation in DN types was similar to that in JB strawberries and the highest value was found in 'FIN005-50' (552 µg/g) compared to the lowest which observed for 'FIN0016-115', followed by 'FIN005-7' and 'FIN0132-11'.

Benzoic acids were the second group in abundance with 16% of the total phenolics for all genotypes. June bearing Lines had higher benzoic acids composition compared to DN. The highest content of benzoic acid was observed for 'La Clé des Champs' and 'Orléans' followed by 'FIO9623-102' and 'FIO968-1', 'FIO9623-102', 'Jewel' and Saint-Laurent d'Orléans had the lowest concentration. 'FIN0016-115', 'FIN005-7', 'FIN005-55' and 'FIN005-50' DN type had were ranked the highest for their benzoic acids while 'Seascape' and 'FIN008-124' had the lowest composition.

Hydroxycinnamic acids level ranked after benzoic acids and ranged from 145.3 µg/g to 8.3 µg/g for all tested genotypes and the highest level was observed for 'FIN005-55', a DN type. 'FIO966-44' a JB strawberry had the highest hydroxycinnamic acid content, while 'FIO9623-102' and 'Kent' contained the lowest among the JB types. Flavonols and ellagic acids constituted the lowest portion of the total phenolics, with 4% and 3% in abundance respectively.

Results and Discussion (Cont'd)

Table 1. Total phenolic content (TPC) and antioxidant capacity (FRAP) of eight advanced strawberry lines and cultivars

Genotype	Type*	Total phenolic ^b (µg/g)	Antioxidant capacity ^c AAE (µg/g)
Jewel	JB	1129	1975
Kent	JB	1216	1845
FIO9623-102	JB	1067	2167
FIO966-44	JB	1243	1968
FIO968-1	JB	1047	1841
La Clé des Champs	JB	1021	1789
St-Jean d'Orléans	JB	917	1789
Saint-Laurent d'Orléans	JB	1254	2115
Orléans	JB	1152	1859
Mean JB		1119	1917
LSD _{0.05}		245	160
FIN008-124	DN	1276	1921
FIN005-55	DN	1044	1873
FIN005-7	DN	1305	1885
FIN005-50	DN	1205	2002
FIN0016-115	DN	1278	1886
FIN0132-11	DN	991	1719
FIN0320-47	DN	2179	2620
Seascape	DN	1484	2113
Mean DN		1341	2062
LSD _{0.05}		350	280

Values are means of 4 replicates for FRAP analysis and duplicate for total phenols.

* Type: JB=June bearing, DN=day neutral

^b Total phenols expressed as µg gallic acid equivalent (GAE) per gram fresh-frozen weight.

^c FRAP: Ferric-Reducing Antioxidant Power expressed as µg ascorbic acid equivalent (AAE) gram fresh-frozen weight.

LSD_{0.05}: Least significant difference at 0.05 level



Ellagic acids, content varied from 9 to 23.8 µg/g within both group. The highest and lowest content were both found in JB type and generally less variation in ellagic acid was observed in DN. 'Kent', 'FIO96230-102', 'FIO968-1' and 'Orléans' had the highest ellagic acid content of all JB strawberries. All DN tend to have similar ellagic acid concentration except for 'FIN0320-47' that had the highest content.

Total phenolics content based on the sum of the five group analyzed by HPLC ranged from 394.5 µg/g to 871 µg/g. The highest total phenolics was found for JB genotype 'La Clé des Champs' (871 µg/g), and the lowest content was in DN genotype 'FIN0132-11'.

In summary, our results showed a significant variation in antioxidant capacity, total phenolics and phenolic compounds between and among the genotypes of JB and DN strawberries. The major differences between the two types might be mainly to their genetic background (Khanizadeh *et al.*, 2006; Khanizadeh *et al.*, 2007) but also might be due to the flowering and fruiting time and the effect of the environmental factors like day-length and temperature during harvesting.

High variability of antioxidant activity among the different genotypes clearly shows the potential value of certain new cultivars and advanced lines and their possible use in breeding program to develop new strawberry cultivars with higher amount of antioxidant compounds.

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