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1 **SENSORIAL AND NUTRITIONAL QUALITY OF INTER AND INTRA – SPECIFIC**
2 **STRAWBERRY GENOTYPES SELECTED IN RESILIENT CONDITIONS**

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25 **Declarations of interest: none**

26 **HIGHLIGHTS**

- 27 • The wild species *Fragaria virginiana glauca* is a source of phytochemicals
- 28 • Back-crossing with *Fragaria x ananassa* increased production and sensorial quality
- 29 • Choosing the right parents is fundamental for improving fruit quality
- 30 • Third back-cross generation showed an overall increase in fruit quality parameters

31

32 **ABSTRACT**

33 The strawberry breeding is now aimed to produce new cultivars combining high plant adaptability
34 and yield with high sensorial and nutritional quality of the fruit. The aim of this study is to assess the
35 breeding progress achieved in 3 backcross generations (BC1, BC2, BC3) from F1 *Fragaria x*
36 *ananassa* (Fxa) x *F. virginiana glauca* (FVG) interspecific crosses, in terms of productive parameters
37 (plant commercial yield) and the sensorial quality (Average Fruit Weight, Soluble Solids and
38 Titratable Acidity). Among those genotypes, the most interesting were selected and analyzed for
39 nutritional parameters (Total Antioxidant Capacity, Total Phenolics Content and Total Anthocyanins
40 Content by spectrophotometer; Vitamin C, specific Anthocyanins and specific Phenolic Acids
41 through HPLC). For the sensorial analyses, the BC3 genotypes showed higher Soluble Solids content
42 in respect to BC1 and BC2. Regarding the Titratable Acidity, F1 showed the highest values. Also for
43 the qualitative parameters, BC3 showed a higher value, in particular for the Total Antioxidant
44 Capacity and phenolic acids content. For the Total Phenolics Content and the Total Anthocyanins
45 Content the highest values were registered in F1 and Fxa (aimed to Industry), respectively. Finally,
46 in the case of Vitamin C, the BC1 had fruits rich in this compound. The highest values for
47 anthocyanins content were registered in Fxa (aimed to Industry). The results of the back-crossing
48 program developed at UNIVPM-D3A showed that the BC3 generation possess many improved
49 characters, in respect to Fxa genotype and the F1 generation.

50

51 **Keywords:** back-crossing; HPLC; average fruit weight; polyphenols; vitamin C; plant yield

52 **1. INTRODUCTION**

53 The genetic improvement of fruit since inception, was based on the selection of genotypes that
54 demonstrated better agronomic/commercial and organoleptic attributes compared to their previous
55 generations. Over the years, the market demand has changed in favor of new agricultural systems
56 able to reduce environmental impacts and improve fruit quality and safety. Therefore, breeding
57 programs have now to be oriented towards the release of new cultivars with increased resistance to
58 pests and diseases and fruit sensorial and nutritional quality (Mezzetti et al., 2018). In most species,
59 wild germplasm remains the major source of genes for disease resistance and quality traits. However,
60 breeding programs that use wild germplasm to reach these goals are generally negatively influenced
61 by the difficulties in obtaining the appropriate genetic source and the long-term timeline of the
62 selection (Diamanti et al., 2014).

63 By focusing on fruit quality, the sensorial traits are the primary guide for consumer acceptance. In
64 the evaluation of the sensorial quality, the consumers combine the aspect of the fruit (color, shape,
65 size) with the taste of the fruit (sweetness, acidity), in order to satisfy their personal definition of the
66 ideal fruit. Also, the flavor is one of the main attributes that the consumer appreciates in berries, and
67 that can influence the consumer's acceptance. Among the volatile organic compounds (VOCs)
68 responsible for the aroma of berries, a subset of about 20 volatile compounds have a high impact on
69 the human nose (Ulrich and Olbricht, 2013). For these reasons, most of the actual cultivar breeding
70 programs include sensory quality as an important breeding objective (Ulrich et al., 1997). As a
71 consequence, the new cultivars need to combine high yield standards to the more appreciable and
72 appealing fruit traits.

73 The other basic aspect of fruit quality is the nutritional value. In fact, a careful consumer also seeks
74 fruits with high nutritional value, and strawberry are well known for their many health benefits for
75 the consumers (Battino et al., 2009, 2019; Di Vittori et al., 2018; Forbes-Hernandez et al., 2017;
76 Gasparrini et al., 2018), thanks to their high content of bioactive compounds such as vitamins,
77 minerals, polyphenols, especially anthocyanins and phenolic acids (Battino et al., 2019; Gil et al.,

78 2000; Maatta-Riihinen et al., 2003, 2004; Mazzoni et al., 2016; Rice-Evans et al., 1995; Tian et al.,
79 2017; Wu and Prior, 2005). However, the quantity and quality of bioactive compounds possessed by
80 fruit is closely related to the genotype (Capocasa et al., 2008; Diamanti et al., 2012; Du et al., 2009;
81 Scalzo et al., 2005a; Wu et al., 2006).

82 The aim of this work was to compare productive, fruit sensorial and nutritional quality of F1 inter-
83 specific hybrid and three back-cross generations with Fxa cultivars and selections, all grown in
84 resilient conditions, and to evaluate the progress of the breeding program in ameliorating nutritional
85 quality, maintaining good productive and sensorial parameters.

86

87 **2. MATERIALS AND METHODS**

88 **2.1. Plant growth, fruits harvest and sampling**

89 Strawberry selections derived from interspecific crossing (F1) of *Fragaria x ananassa* with *Fragaria*
90 *virginiana glauca*, three subsequent back-crossings (BC1, BC2, BC3) with *Fragaria x ananassa*,
91 advanced selections and cultivars of *Fragaria x ananassa* (Fxa), and selections of *Fragaria x*
92 *ananassa* adapted to the industrial transformation for their dark red coloration (Fxa Ind) were grown
93 for three production cycles in open field, located at the UNIVPM Didactic-Experimental Farm “P.
94 Rosati” in Agugliano, Italy (43°32'N - 13°22'E) (Table 1).

95 The field was characterized by not fumigated clay-silty heavy soil, pH 7.8, and was subjected to a
96 short rotation (3-4 years) after a previous strawberry cultivation cycle.

97 During the harvesting seasons (spring-summer 2014, 2016 and 2017), productive parameters were
98 analysed. Furthermore, 20 full red ripe fruits from the third, fourth and fifth harvest (the main
99 harvesting periods) were sampled from each genotype and frozen at -20°C, then analysed for the
100 sensorial traits.

101 From the sensorial data and the in-field evaluations, the more interesting genotypes were selected for
102 fruit nutritional quality study (Table 1). Following the same harvesting and sampling procedure,
103 another batch of 20 ripe fruits were frozen at -20°C, then extracted and analysed for nutritional

104 quality. Spectrophotometric parameters were evaluated for fruits harvested in the years 2014, 2016
105 and 2017, while HPLC analyses were performed only in fruits harvested during the year 2016.

106

Type	N° genotypes analyzed for productive and sensorial parameters	N° Genotypes analyzed for nutritional analyses
F1	16	16
BC1	3	3
BC2	10	10
BC3	10	10
Fxa	55	8
Fxa (Ind)	4	4

107 **Table 1: Strawberry genotypes analyzed in this study.**

108

109 **2.2. Productive parameters**

110 On the genotypes listed in Table 1, plant yield was measured considering only the fruits with
111 homogeneous shape, colour, with a diameter bigger than 22 mm, and free of any physical or
112 pathological damage. Results were expressed as grams/plant.

113 **2.3. Fruit sensorial Analysis**

114 Fruit sensorial quality of strawberry genotypes was analysed taking into account the following
115 parameters:

116 a) Average Fruit Weight (AFW): determined by weighing 20 fruits per genotype at each commercial
117 harvest, results were expressed as grams/fruit.

118 b) Solid Soluble (SS): determined using a hand-held refractometer (ATAGO, Tokio, Japan), results
119 were expressed as °Brix.

120 c) Titratable Acidity (TA): determined from 10 mL of juice diluted with distilled water (1/2 v/v) and
121 titrated with 0.1N NaOH solution, until pH 8.2, and expressed as mEQ of NaOH per 100g Fresh
122 Weight (FW).

123 **2.4. Spectrophotometric Nutritional Analysis**

124 a) Extraction method

125 For each sample of whole raw fruit stored at -20°C, ten fruits were selected and cut in two specular
126 slices, then chopped into small pieces, weighed (10g) and placed in a Falcon tube containing methanol
127 (1:4, fruit: methanol, w/v) for initiation of extraction. This methanolic solution was homogenized by
128 Ultraturrax T25 homogenizer (Janke and Kunkel, IKA Labortechnik, Staufen, Germany). The
129 suspension was placed in continuous agitation for 30 minutes, in the dark. The suspension was
130 centrifuged at 4.000 rpm for 10 min (Centrifuge Rotofix32, Hettich Zentrifugen, Tuttlingen,
131 Germany) and the supernatant collected and stored in three amber vials. To complete the extraction,
132 the procedure was repeated as above on the residual pellet. The supernatant was collected and
133 combined with the previous ones in the same amber vials and stored at -20°C.

134 b) Total Antioxidant Capacity (TAC)

135 TAC was evaluated by the ABTS assay, according to a previously validated procedure (Miller et al.,
136 1993). Every sample was analysed three times. The results are expressed as mM of Trolox equivalent
137 per kilogram of fresh weight (mM Trolox eq/Kg fruit).

138 c) Total Phenol Content (TPH)

139 TPH was evaluated by the Folin-Ciocalteu's reagent method (Slinkard and Singleton, 1977). Results
140 were calculated and expressed as mg of gallic acid per kilogram of fresh weight (mg GA/Kg fruit).

141 d) Total Anthocyanin Content (ACY)

142 ACY assay was performed by the pH differential shift method (Giusti and Wrolstad, 2001), using the
143 anthocyanins' characteristic to change intensity of hue depending on pH shifting. The results were
144 expressed as mg of pelargonidin-3-glucoside (the compounds more representative for anthocyanins
145 in strawberry) per kilogram of fresh weight (mg PEL-3-GLU/Kg fruit).

146 **2.5. HPLC Nutritional Analysis**

147 a) Anthocyanins and phenolic acids extraction

148 The extraction method for the HPLC analysis of anthocyanins and phenolic acids is exactly the same
149 as the spectrophotometric analyses. In this case, however, before the HPLC measurement, the samples
150 were filtered with 0.45 µm hydrophobic PTFE (polytetrafluoroethylene) syringe filters.

151 b) Vitamin C extraction

152 For each strawberry genotype, 5 fruits were picked from the bulk samples stored at -20°C, and cut in
153 small pieces; then, 1g was weighed and 4 mL of extracting solution added. The extracting solution
154 consisted of MilliQ water containing 5% meta-phosphoric acid and 1 mM ethylenediaminetetraacetic
155 acid (EDTA). Vitamin C was extracted by sonication of the strawberry-extracting solution
156 suspension, during 5 min, after a previous homogenization using an Ultraturrax T25 homogenizer
157 (Janke & Kunkel, IKA Labortechnik, Germany) at medium-high speed for 2 min. After the ultra-
158 sound assisted extraction, the cell walls and proteins were precipitated by centrifugation at 2500 rpm
159 for 10 min at 4°C, the supernatant was then filtered through a 0.45 µm nylon (NY) filter into 1.8 mL
160 HPLC vials, and stored at -20°C until the analysis through HPLC.

161 c) Anthocyanins analysis

162 The HPLC program was performed as described in Terefe et al. (2013), with some modifications as
163 suggested in Fredericks et al. (2013). The three most abundant anthocyanins in strawberries
164 (pelargonidin-3-glucoside, pelargonidin-3-rutinoside and cyanidin-3-glucoside) were used as
165 standards. The final values were expressed as the sum of the three main anthocyanins, as milligrams
166 per 100 grams of fresh weight (mg/100g FW).

167 d) Phenolic acids analysis

168 Phenolic acids were analyzed according to Fredericks et al. (2013). The identification and
169 quantification of phenolic acids was performed using chlorogenic acid, caffeic acid, ellagic acid and
170 p-coumaric acid as standards for creating a calibration curve. The final values were expressed as the
171 sum of the four main phenolic acids, as milligrams per 100 grams of fresh weight (mg/100g FW).

172 e) Vitamin C analysis

173 Vit C was measured as described by Helsen et al. (2003). Results were expressed as milligrams of
174 vitamin C per 100 grams of fresh weight (mg vit C/100 g FW).

175 **2.6. Statistical analysis**

176 Results for strawberry fruit sensorial and nutritional parameters of all genotypes included in this study
177 were obtained and analyzed in triplicate. However, data are presented as mean \pm standard error (SE)
178 for each crossing type, considering all the years of study together. One-way analysis of variance was
179 used to test the differences among crossing types. Statistically significant differences ($p \leq 0.05$) were
180 determined with SNK test. Statistical processing was carried out using STATISTICA software
181 (Statsoft, Tulsa, OK, USA).

182

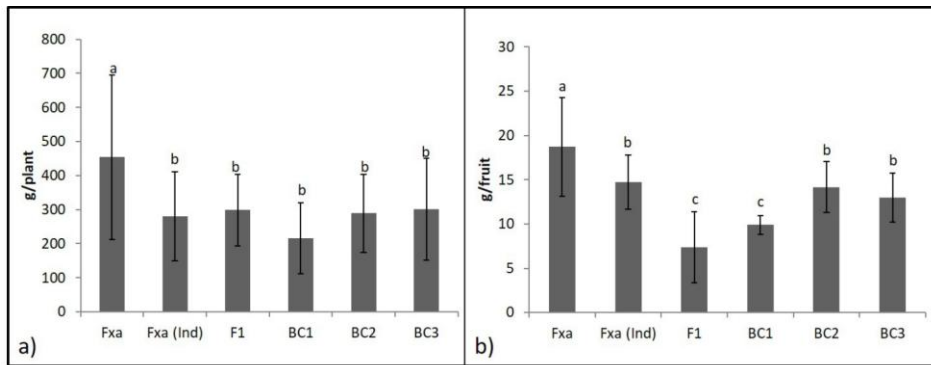
183 **3. RESULTS**

184 **3.1. Plant yield and Average Fruit Weight**

185 Regarding Plant yield, Fxa was the crossing type with the statistically higher value, followed by BC3
186 (Figure 1a). The result was expected considering that Fxa group contains the selections and
187 commercial varieties that satisfy the productive standards required by the market. By crossing Fxa
188 with the wild genotype, productivity has been clearly lost. However, through sequential back-
189 crossings with Fxa parental, some productive capacity was recovered moving from BC1 towards BC3
190 (Figure 1a). Similarly, also the higher Average Fruit Weight was registered for the Fxa group,
191 followed by Fxa (Ind) and BC2. The BC3 group was statistically similar to Fxa (Ind) and BC2, while
192 BC1 and F1 revealed the lowest values for Average Fruit Weight (Figure 1b).

193

194



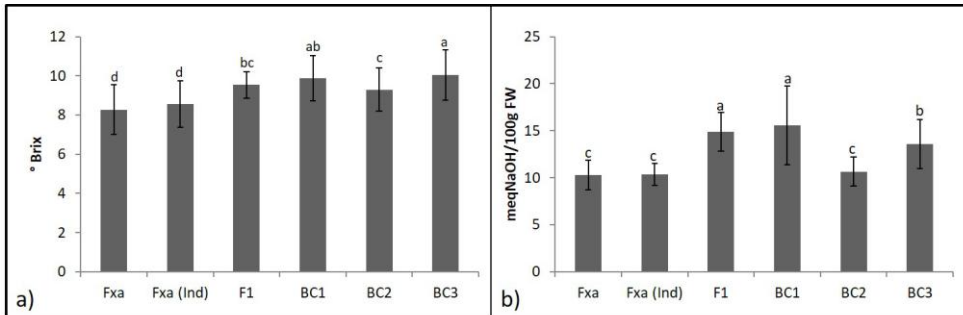
195 **Figure 1: a) Plant Yield and b) Average Fruit Weight (AFW) for different types of crossing.**
 196 **Data are expressed as three-years means \pm standard errors. Different letters indicate significant**
 197 **differences at $p < 0.05$ (SNK test).**

198

199 3.2. Soluble Solids Content and Titratable Acidity

200 BC3 selections yielded fruits with the highest average values of fruit Soluble Solids (SS); BC1
 201 showed lower average value, but statistically similar to BC3. This result is evidence on how
 202 successive backcrossing generations can promote the stabilization of high amount of fruit SS (Figure
 203 2a) together with other agronomic and sensorial traits, mainly fruit yield and size, as previously
 204 showed. Fruit SS mean values in BC3 (10.05°Brix) were higher in comparison to what was detected
 205 in Fxa selections and cultivars (Figure 2a). On the contrary, the highest mean values of Titratable
 206 Acidity (TA) obtained in BC1 fruits were statistically similar to those obtained in F1 fruit (Figure
 207 2b). There was reduced TA from fruit of subsequent backcrossing generation (BC2), but this
 208 increased again in BC3 fruit, it is therefore evident that, the parent used in any backcross generation
 209 influences fruit TA of the progeny, even increasing it to higher levels in comparison with TA values
 210 detected from Fxa selections and cultivars. In fact, consumers do not accept higher acidity levels but
 211 generally prefers balanced SS and TA values (Capocasa et al., 2016).

212



213 **Figure 2: a) Soluble Solids (SS) and b) Titratable Acidity (TA) for different types of crossing.**
 214 **Data are expressed as three-years means \pm standard errors. Different letters indicate significant**
 215 **differences at $p < 0.05$ (SNK test).**

216

217 3.3. Fruit nutritional spectrophotometric parameters

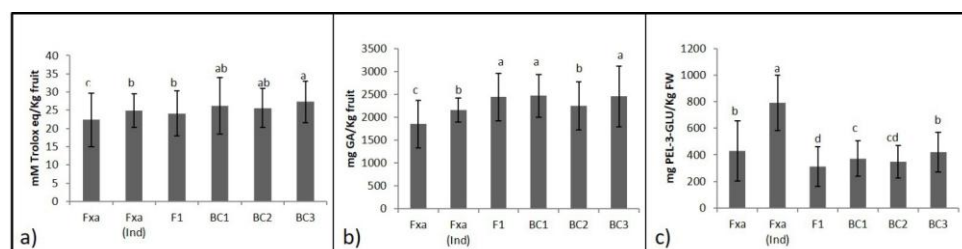
218 Regarding the fruit nutritional parameters, fruit Total Antioxidant Capacity (TAC) detected for BC3
 219 fruit was interesting as it had the highest mean value, even if it was not statistically different from
 220 values obtained from BC1 and BC2 selections. Unexpectedly, F1 fruit TAC mean values were lower
 221 and similar to TAC values obtained in Fxa genotypes currently used by processing industry (Ind),
 222 while the lowest TAC mean value was obtained in Fxa advanced selections and cultivars used for the
 223 fresh market (Figure 3a).

224 A similar behavior was observed in the results obtained on fruit Total Phenolic Content (TPH); BC1
 225 fruits recorded the highest mean value of TPH, statistically similar to values registered in F1, BC3
 226 and Fxa (Ind), all these were higher than values obtained in Fxa genotypes (Figure 3b).

227 The highest mean value of fruit total anthocyanins content was detected from Fxa breeding selections
 228 adopted from the processing industry (Ind) (Figure 3c). These results indicate that the red dark color
 229 requested for strawberry fruit processing and pasteurization is strictly correlated to high ACY
 230 contents. High ACY content positively affects the color stability, turning towards a pleasing violet
 231 rather than towards the unattractive brown color after processing (Diamanti et al., 2016). The mean
 232 values of fruit ACY contents of F1 and 3 backcrossing generations were lower than what obtained in

233 Fxa (Ind) fruit selections, with the lowest values obtained in fruits from F1 population which then
 234 increased in BC1 and BC3 fruit selections; in this last group, the mean value of ACY content were
 235 statistically similar to those of Fxa genotypes.

236



237 **Figure 3: a) Total Antioxidant Capacity (TAC), b) Total Phenolic Content (TPH) and c) Total**
 238 **Anthocyanin Content (ACY) for different types of crossing. Data are expressed as three-years**
 239 **means ± standard errors. Different letters indicate significant differences at p<0.05 (SNK test).**

240

241 3.4. Fruit nutritional HPLC parameters

242 The high ACY content from Fxa (Ind) selections was confirmed by HPLC analyses of total
 243 anthocyanins (sum of Cyanidin-3-O-glucoside, Pelargonidin-3-O-glucoside, Pelargonidin-3-O-
 244 rutinoside, the second one representing about 90% of the strawberry anthocyanins). In fact, fruit of
 245 Fxa (Ind) selections showed almost double the content of anthocyanins in comparison to all the other
 246 crossing types. These strawberry genotypes were specifically selected for the processing industry and
 247 showed dark red color, an absolute index of the abundant presence of anthocyanins. All fruits from
 248 the other cross-typologies presented statistically similar quantities of total anthocyanins and
 249 confirmed the increasing trend of content from F1 fruits towards BC3 populations, with the latter
 250 being higher than Fxa genotypes for the fresh market (Table 2).

251 Data on total Phenolic Acids content of fruit, confirmed a significant wide variability among different
 252 cross-typologies (Table 2). BC3 selections showed the highest content of phenolic acids whereas, F1
 253 generation contained less phenolic acids; this was evidence of the lower capacity of FVG in

254 increasing phenolic acids content in the first-generation fruits (Table 2). While, subsequent back
 255 crossing generations with Fxa parents produced new selections with a statistically increased value of
 256 phenolic acids, in particular fruit of BC3 population. This improvement during the back-crossing
 257 program was probably due to the positive effect of Fxa genotype used as parents, which showed quite
 258 high values of total Phenolic Acids.

259 HPLC analyses on fruit Vitamin C content showed very limited differences and almost always not
 260 statistically different (Table 2). The highest content of Vitamin C was detected in fruit of BC1
 261 population, even if not statistically different from Fxa, F1, and BC3 (Table 2). For this compound, it
 262 is not possible to note a trend linked to the type of crossing combination.

263

Type	Anthocyanins (mg/100g FW)	Phenolic Acids (mg/100g FW)	Vitamin C (mg/100g FW)
Fxa (Ind)	60.37 ± 13.25 ^a	62.9 ± 6.46 ^{bc}	54.49 ± 8.92 ^b
Fxa	33.98 ± 24.90 ^b	67.15 ± 18.47 ^b	66.45 ± 17.23 ^a
F1	32.71 ± 13.61 ^b	49.47 ± 16.74 ^d	62.26 ± 13.72 ^{ab}
BC1	32.86 ± 11.88 ^b	53.36 ± 17.94 ^{cd}	66.92 ± 13.59 ^a
BC2	34.18 ± 7.89 ^b	72.84 ± 14.42 ^b	52.72 ± 7.69 ^b
BC3	35.68 ± 9.45 ^b	84.09 ± 19.76 ^a	60.08 ± 7.69 ^{ab}

264 **Table 2: Anthocyanins, Phenolic Acids and Vitamin C content measured by HPLC for different**
 265 **type of crossing in the year 2016. Data are expressed as means ± standard errors. Different**
 266 **letters indicate significant differences at p<0.05 (SNK test).**

267

268 4. DISCUSSION

269 Productive results are in agreement with other studies published by our group, where the mean total
 270 yield among BC1 and BC2 were similar , but lower than the mean values of Fxa genotypes (Diamanti

271 et al., 2012). The presence of wild germplasm in the crossing types significantly reduced the Average
272 Fruit Weight, but back-crossings with Fxa genotypes seem to be able to restore good levels of
273 Average Fruit Weight from the BC2 generation onwards. AFW results confirmed what we have
274 previously published, with fruits deriving from BC1 and BC2 plants being clearly smaller than fruits
275 obtained from Fxa plants (Diamanti et al., 2012).

276 The FVG genotype seemed to increase fruit SS and TA, with both the parameters tending to be higher
277 in wild germplasm than in Fxa genotype (Diamanti et al., 2012, 2014; Mezzetti et al., 2016);
278 furthermore, when used in inter-specific breeding programs, the use of proper parents have an effect
279 in reducing fruit TA but keeping higher SS fruit content. In fact, differently from all the other studies
280 previously mentioned, in BC3 we obtained fruits with increased SS mean values combined with not
281 too high TA, therefore maintaining an optimal sugar/acid ratio but with an increased sensorial
282 perception for the consumer.

283 The low TAC mean values detected, in this study, in F1 generation fruit, still possessing 50% of wild
284 FVG germplasm, has been probably determined by the genetic background of the *F. virginiana*
285 *glauca* accession. Usually, the wild germplasm is believed to possess strong antioxidant activity,
286 higher than the cultivated germplasm (Halvorsen et al, 2002; Scalzo et al., 2005b), but Wang and
287 Lewers (2007) showed a larger variability in fruit TAC values of different wild octoploid *Fragaria*
288 accessions. Therefore, even when starting a long-term interspecific crossing program, it is very
289 important to choose the wild parent with the most appropriate genetic background to improve fruit
290 TAC values. However, also the choice of high-quality recurrent Fxa parents used in the different
291 backcross generations is important, and this aspect can explain the good levels of TAC obtained in
292 the following generations of the inter-specific breeding program. Similar results were obtained in
293 Diamanti et al. (2012), where BC2 and BC1 populations presented statistically higher values of TAC
294 than Fxa selections.

295 The association between high amount of TPH and high TAC value has already been demonstrated in
296 many studies (Halvorsen et al., 2002; Milivojevic et al., 2011; Prolegente et al., 2002; Scalzo et al.,

Commentato [LC(1): It is either high or low but not 'not too'

297 2005b). Therefore, the best crossing-types for TAC (BC3 and BC1) also showed the best crossing
298 types for TPH. In Diamanti et al. (2014), BC2 selections presented values clearly higher than BC3
299 selections, which in turn presented higher values than the Fxa cultivar analyzed. In this study, all the
300 back-crossings presented statistically higher TPH values than Fxa genotypes but, differently from the
301 other studies in literature, BC3 selections mean value was statistically similar to the mean value of
302 F1 and BC1 selections. In Mezzetti et al. (2016), BC1 selections showed higher TPH values than BC2
303 selections, which in turn showed slightly higher values than Fxa commercial varieties. These
304 differences can be determined by the parents used and clearly also by the climatic conditions that
305 affect the different production cycles.

306 The fruit content of anthocyanins is important for the contribution to the color of fresh fruit, a valuable
307 quality attribute for the consumer appreciation, and for color stability in processed fruit (Diamanti et
308 al., 2016). In addition, high content of ACY contributes to an increase in antioxidant capacity of the
309 fruits and therefore their nutritional value. This study showed that strawberry genotypes selected for
310 the processing industry are a very important genetic source for increasing the ACY content,
311 overcoming the values of the genotypes for fresh consumption and the selections directly deriving
312 from the wild germplasm (F1).

313

314 5. CONCLUSION

315 The results of the back-crossing program developed at UNIVPM-D3A showed that the BC3
316 generation, which are actually the most recent generation of this program, possessed many improved
317 characters in respect to the Fxa genotype and the F1 generation. In particular, SS content was very
318 high in BC3, but this value was counteracted by the high level of acidity. The yield in this group is
319 not far from commercial requirements; with further crossings with an Fxa parent, also the fruit weight
320 could be ameliorated. Regarding the nutritional parameters, BC3 showed the highest TAC values and,
321 consequently, one of the highest values of TPH, demonstrating the efficiency of the breeding program
322 to increase the nutritional value of strawberries in BC3. The ACY level was also very interesting, but

323 far from the Fxa (Ind). This was expected, given that Fxa (Ind) genotypes were elected for their
324 intense red coloration. Finally, HPLC data confirmed the excellent nutritional value of BC3
325 generation, presenting good amount of Anthocyanins and the highest amount of Phenolic Acids.
326 Regarding vitamin C, the value was statistically similar to the commercial Fxa genotypes and to the
327 F1 generation (which presented 50% of wild germplasm).

328

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332

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