DESSERT-TYPE CULTIVARS of BLACKCURRANT
NEW BREEDING AIM at the RIPF, POLAND

Edward ŻURAWICZ and Stanisław PLUTA

RIBES SEMINAR - Drammen, Norway - 24 March, 2010
SHORT INFORMATION ABOUT POLAND
GENERAL INFORMATION ABOUT POLAND

- An area - 313 000 km²
- Population - almost 39 million inhabitants
- Mean yearly temperature ranges from 6,0 °C to 8,5 °C
- Warmest month is July, the temp. reaches + 30 °C more
- Coldest month is January, the temp. drops below - 30 °C
- Late spring frosts in May are quite frequent
- Average yearly precipitation is 500 - 600 mm
- About 60 % of the agric. land are rather poor podsolic soils
- Soils consisting of clayey sand and boulder clay
ADMINISTRATIVE DIVISION OF POLAND
SHORT INFORMATION ABOUT SKIERNIEWICE AND THE RESEARCH INSTITUTE OF POMOLOGY AND FLORICULTURE
SKIERNIEWICE – HISTORICAL CITY

- **1136** - the oldest mentions about Skierniewice as rural settlement belonging to the vast estates of Gniezno archbishops
- **1457** - official foundation of the town;
- **50,000** – recent population
The RIPF was established in 1951 under the patronage of the Ministry of Agriculture and Food Economy.

RIPF concentrates on research in fruit growing, ornamental plants and beekeeping.
ORGANIZATION OF RIPF

MAIN OFFICE
SKIERNIEWICE

DIVISION
OF POMOLOGY
SKIERNIEWICE

DIVISION
OF FLORICULTURE
SKIERNIEWICE

DIVISION
OF APICULTURE
PULAWY
Research Institute of Pomology and Floriculture

Baltic Sea

O

Gdańsk

O

Warszawa

O

Pulawy

O

SKIERNIEWICE

Poznan

Berlin

Leipzig

Dresden

Praha

Krakow

Kosice

Ivano Frankovsk

200 km

Linz

Regensburg

Brno
STAFF OF RIPF – 01.01.2009
(total 387 persons)

- Scientific Personel: 155
- Other staff: 232
STRUCTURE OF SCIENTIFIC PERSONNEL OF RIPF – 01.01.2009

- Professor: 56
- Ass. Professor: 64
- Doctor: 16
- M. Sc.: 19

Professor: 56
Ass. Professor: 64
Doctor: 16
M. Sc.: 19
MINISTRY OF EDUCATION AND SCIENCE (STATUTORY MONEY)

OTHER SOURCES

FUNDING OF RIPF (%)
BRIEF HISTORY OF THE POLISH BLACKCURRANT BREEDING PROGRAM

1954 – 1967 – Dr. Kazimierz Somorowski – 6 cultivars
1968 – 1985 – Dr. Józef Gwozdecki – 2 cultivars
From 1986 – Dr. Stanisław Pluta – 6 cultivars
ACHIEVEMENTS OF THE POLISH BLACKCURRANT BREEDING PROGRAM
STRUCTURE OF BLACKCURRANT CULTIVARS PLANTED IN POLAND (2007-2009)

- Ben Lomond: 28%
- Titania: 10%
- Ben Alder: 10%
- Ben Tirran: 10%
- Ben Hope: 10%
- Tiben: 5%
- Tisel: 5%
- New Polish: 5%

27%
**WHY DESSERT-TYPE CULTIVARS OF BLACKCURRANT?**

- **Blackcurrant** is one of the small fruit crops commonly grown in Poland.
- **Blackcurrant fruits** are regarded as very healthy fruits, due to the high content of vit. C, mineral compounds, polyphenols including flavonoids such as anthocyanins and other compounds. Till now they have been consumed as processed.
- **Cultivation of dessert-type blackcurrants** in Great Britain, Germany, Switzerland, Belgium and Netherlands has been under development for many years.
- In Poland there is also a growing interest in production of dessert-type blackcurrant cultivars.
- Breeding technology and genetic resources allow to receive new blackcurrant cultivars producing high quality fruits for fresh consumption.
- We believe that dessert-type blackcurrant fruits will become soon „the fruit of tomorrow” suitable for fresh consumption.
<table>
<thead>
<tr>
<th>Fruit</th>
<th>Vitamin C Content (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>4.6</td>
</tr>
<tr>
<td>Pear</td>
<td>4.2</td>
</tr>
<tr>
<td>Peach</td>
<td>6.6</td>
</tr>
<tr>
<td>Sweet cherry</td>
<td>7.0</td>
</tr>
<tr>
<td>Bananas</td>
<td>8.7</td>
</tr>
<tr>
<td>Plum</td>
<td>9.5</td>
</tr>
<tr>
<td>Sour cherry</td>
<td>10.0</td>
</tr>
<tr>
<td>Apricot</td>
<td>10.0</td>
</tr>
<tr>
<td>Grapes</td>
<td>10.8</td>
</tr>
<tr>
<td>Blackberry</td>
<td>21.0</td>
</tr>
<tr>
<td>Raspberry</td>
<td>26.2</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>34.4</td>
</tr>
<tr>
<td>Lemon</td>
<td>53.0</td>
</tr>
<tr>
<td>Orange</td>
<td>53.2</td>
</tr>
<tr>
<td>Strawberry</td>
<td>58.8</td>
</tr>
<tr>
<td>Blackcurrant</td>
<td>181.0</td>
</tr>
</tbody>
</table>
# ANTIOXIDANT PROPERTIES OF DIFFERENT FRUITS

(umol TEAC/gram - Trolox Equivalent Antioxidant Capacity)

<table>
<thead>
<tr>
<th>Fruit</th>
<th>Antioxidant Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackcurrants</td>
<td>14.0 – 50.0</td>
</tr>
<tr>
<td>Highbush blueberries</td>
<td>20.0 – 45.0</td>
</tr>
<tr>
<td>Raspberries</td>
<td>13.0 – 22.0</td>
</tr>
<tr>
<td>Strawberries</td>
<td>9.0 – 18.0</td>
</tr>
<tr>
<td>Plums</td>
<td>9.5</td>
</tr>
<tr>
<td>Oranges</td>
<td>7.5</td>
</tr>
<tr>
<td>Grapes</td>
<td>7.4 – 18.0</td>
</tr>
<tr>
<td>Apples</td>
<td>2.2</td>
</tr>
<tr>
<td>Red wine</td>
<td>10.0 – 18.0</td>
</tr>
<tr>
<td>White wine</td>
<td>2.0 – 5.0</td>
</tr>
</tbody>
</table>

Source: Deighton D. *et al.* - 2002)
FRUIT QUALITY PARAMETERS

- **Ascorbic acid** (vit. C)
- **Anthocyanins and other phenolics**
- **Sensory components** (appearance, size/weight, taste, flavor, aroma, smell, etc.)

High content of anthocyanins and other phenolics as well as ascorbic acid in fresh blackcurrant fruit = HIGH ANTIOXIDANT CAPACITY
GREENMARKET IN NEW YORK
- AUGUST, 2008

- A variety of fruits and vegetables are displayed at a market stand.
- Signs indicate prices for different types of fruits, such as blackberries and gooseberries.
- The market appears to be well-stocked with fresh produce.
ADVENTAGES OF BLACKCURRANT FRESH FRUITS PRODUCTION

CONSUMERS

➢ Enhance the fresh fruit market

➢ Enrich the human diet in a very healthy fresh fruit

FRUIT GROWERS

➢ Increase profitability of blackcurrant production

➢ Allow the growers to introduce innovative technology of blackcurrant production (open field, protected cultivation, out of season production)
ADVENTAGES OF BLACKCURRANT FRESH FRUITS PRODUCTION

POTENTIALLY VERY GOOD FRUIT FOR ORGANIC PRODUCTION
We believe it is possible!

As a good example of blackcurrant cultivars fulfilling partly the requirements of dessert fruits can be Scottish - 'Ben Sarek'; Polish - 'Bona' as well as few Ukrainian cultivars such as 'Chereshnieva', 'Sjuta Kyevskaja' or 'Sanjuta'
BREEDING STRATEGY

First step
Exploring the existing genetic resources of blackurrant

Fruit of some cultivars - 'Bona' (PL), Big Ben' (UK), 'Chereshnieva', 'Sjuta Kyevskaja', 'Sanjuta' (UA) and 'Storklas' (S) have a good taste and are attractive in appearance.

Second step
Studies on suitability of above mentioned genotypes for breeding of new desser-type cultivars

Estimation of breeding value (GCA-General Combining Ability and SCA-Specific Combining Ability)
REQUIREMENTS FOR BLACKCURRANT FRESH FRUITS

- Big fruit (1.5 g and more)
- Good fruit taste and aroma
- High fruit quality (vit. C and anthocyanins)
- Fruit appearance and firmness
- Long strigs
- Uniform ripening
- Green strigs preferred
- Hand picking (all strigs)
BREEDING STUDIES

EXPERIMENT I
Seedlings resulting from 6 x 6 half-diallel complete design Griffing’s method 4, (15 F₁ full-sib families — 720 seedlings)

<table>
<thead>
<tr>
<th></th>
<th>BONA</th>
<th>BEN SAREK</th>
<th>LENTAJ</th>
<th>STORKLAS</th>
<th>BIG BEN</th>
<th>CHERESHNIEVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>BONA</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>BEN SAREK</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>LENTAJ</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>BIG BEN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>CHERESHNIEVA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GENOTYPES CROSSED
(Six cultivars were crossed)

1. BONA (PL)
2. BEN SAREK (U.K.)
16. LENTAJ (RUS)
GENOTYPES CROSSED
(Six cultivars were crossed)

4. STORKLAS (S)

5. ‘BIG BEN’ (UK)

6. CHERESHNIEVA (UA)
CROSSING PROGRAM - PLASTIC TUNNEL
(SPRING - 1996)
CROSSING OF PARENTAL FORMS

♀ BONA

X

♂ BIG BEN
PRODUCTION OF SEEDLINGS IN GLASHOUSE

(January 15 - May 30, 1997)
COLLECTING RESULTS – FRUIT HARVESTING

15 July, 2001
INVESTIGATED TRAITS – 2000 - 2003

• Fruit yield \([\text{kg/plant}]\)
• Fruit size \([\text{weight of 100 berries in g}]\)
• Field resistance to American powdery mildew \((\text{Sphareotheca mors-uvae})\) [\text{ranking scale 1-5}]
• Field resistance to leaf spot \((\text{Drapenopezizia ribis})\) [\text{ranking scale 1-5}]
• Field resistance to white pine blister rust \((\text{Cronatrium ribicola})\) [\text{ranking scale 1-5}]

**Ranking scale** 1-5; 1 – no symptoms, 5 – very severe symptoms

Taste and aroma (only on the selected clones with good productive value) – evaluated by 5 persons
SENSORY EVALUATION of BLACKCURRANT FRUIT of the BEST DESSETRT CLONES
**ANALYSIS OF VARIANCE OF COMBINING ABILITY OF SELECTED TRAITS IN BLACKCURRANT DIALLEL-CROSS DESIGN (averaged 2000-2003)**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>df</th>
<th>Fruit yield</th>
<th>Fruit size</th>
<th>Mean squares (S²)</th>
<th>Field resistance to fungal diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Powdery mildew</td>
</tr>
<tr>
<td>GCA</td>
<td>5</td>
<td>0,368**</td>
<td>449,9**</td>
<td>0,058**</td>
<td>0,320**</td>
</tr>
<tr>
<td>SCA</td>
<td>9</td>
<td>0,298**</td>
<td>181,6**</td>
<td>0,076**</td>
<td>0,128**</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td>0,080</td>
<td>42,8</td>
<td>0,006</td>
<td>0,024</td>
</tr>
<tr>
<td>( \frac{S_{GCA}^2}{S_{SCA}^2} )</td>
<td></td>
<td>0,55</td>
<td>0,71</td>
<td>0,43</td>
<td>0,71</td>
</tr>
</tbody>
</table>

** - significant at the level \( \alpha=0,05 \)
ESTIMATES of GCA EFFECTS of SIX BLACKCURRANT CULTIVARS for SELECTED TRAITS
(averaged 2000-2003)

Legend: FY - Fruit Yield, FS - Fruit Size, PM - Powdery mildew, LS - Leaf Spot, WPBR - White Pine Blister Rust
**ESTIMATES of GCA EFFECTS for SIX BLACKCURRANT CULTIVARS for SELECTED TRAITS**  
(averaged 2000-2003)

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Fruit yield</th>
<th>Fruit size</th>
<th>Field resistance to fungal diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Powdery mildew</strong></td>
</tr>
<tr>
<td>Bona</td>
<td>-0.24*</td>
<td>-4.92*</td>
<td>0.05*</td>
</tr>
<tr>
<td>Ben Sarek</td>
<td>-0.06</td>
<td>-6.68*</td>
<td>0.03</td>
</tr>
<tr>
<td>Lentaj</td>
<td>0.02</td>
<td>2.70</td>
<td>0.02</td>
</tr>
<tr>
<td>Storklas</td>
<td>0.23*</td>
<td>3.45*</td>
<td>-0.12*</td>
</tr>
<tr>
<td>Big Ben</td>
<td>0.01</td>
<td>7.74*</td>
<td>-0.01</td>
</tr>
<tr>
<td>Chereshnieva</td>
<td>0.05</td>
<td>-2.30</td>
<td>0.02</td>
</tr>
<tr>
<td>$SE(\hat{g}_i) \times 2.77$</td>
<td>0.17</td>
<td>5.01</td>
<td>0.06</td>
</tr>
<tr>
<td>$SE(\hat{g}_i, g_j) \times 3.11$</td>
<td>0.31</td>
<td>8.74</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>General mean</strong></td>
<td><strong>0.75</strong></td>
<td><strong>97.4</strong></td>
<td><strong>1.32</strong></td>
</tr>
</tbody>
</table>
PRACTICAL RESULTS OF EXPERIMENT I
FIRST RESULTS of BREEDING PROGRAM

Best desert advanced selectiones (average 2008-2009):

D 4A/10 (Bona x Lentaj)
D 7C/3 (Storklas x Bona)
D 9B/5 (Storklas x Lentaj)
D 13A/9 (Big Ben x Lentaj)
D 13B/11 (Big Ben x Lentaj)
D 13C/6 (Big Ben x Lentaj)
D 14D/10 (Big Ben x Storklas)
D 20D/3 (Chereshnieva x Big Ben)

CHERESHNIEVA 1,4 g
BONA 1,8 g
D 13B/11 2,3 g
0,75-1,0 g
(OJEBYN, TIBEN)

1,5-2,5 g
(BONA, TINES, BIG BEN)

0,5-0,75 g
(CONSORT)

1,0-1,5 g
(BEN LOMOND, TISEL, RUBEN)

2,5-3,5 g
(D 13B/11)
CONCLUSIONS (Experiment I)

Of the tested six genotypes the highest significantly positive GCA effects posses the following cultivars (based on the averaged values for 2000-2003):

- ‘Storklas’ – fruit yield
- ‘Big Ben’ (SCRI C2/15/40) and ‘Storklas’ – fruit size
- ‘Storklas’ – resistance to American powdery mildew
- ‘Lentaj’ and ‘Storklas’ – resistance to leaf spot
- ‘Big Ben’, ‘Bona’ and ‘Ben Sarek’ – resistance to WPBR

For the practical breeding oriented on the studied traits ‘Big Ben’, ‘Storklas’ and ‘Lentaj’ are the best parental forms.
EXPERIMENT II
### NEW CROSSING PROGRAM – 2008
(factorial crossing design)

<table>
<thead>
<tr>
<th>PARENTAL FORMS</th>
<th>1. CERES</th>
<th>2. FOXENDOWN</th>
<th>3. SANJUTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BONA (PL)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2. BIG BEN (UK)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3. CZERESZNIEWA (UA)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4. KUPLINIAI (LT)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5. GOFERT (PL)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>6. DLINNOKISTNAJA (RUS)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7. LENTAJ (LT)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>8. TINES (PL)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>9. TISEL (PL)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>10. SOFIJEWSKAJA (UA)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>11. PC-425 (PL)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>12. D 13B/11 (PL)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>13. ORES (PL)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>14. RUBEN (PL)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>15. TITANIA (S)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
DESSERT TYPE CULTIVARS

KUPOLINIAI

VYCIAI

LENTAJ
DESSERT TYPE CULTIVARS
(new Polish cultivars)

TISEL
TINES
GOFERT
FURTHER SELECTION WORKS

STAGE I.  (2008-2013)

• Selection of the best individuals with large fruits and good productive value

STAGE II.  (2012-2013)

• Sensory evaluation and chemical analysis of fruit of the best breeding clones selected in the stage I.
THANK YOU
DESIRED TRAITS OF BLACKCURRANTS
FOR FRESH MARKET

• **Cultural practices:**
  open field and protected cultivation on wires etc.

• **Desired fruit traits:**
  - Large berries preferred (1.5 g or more) on long strings,
  - Green strings preferred
  - High fruit quality (ascorbic acid, anthocyanins, others)
  - Uniform fruit ripening
  - Easy hand picked on string
Obtain information on breeding value based on General Combing Ability (GCA) effects of six genotypes which could be used in the efficient breeding program aimed at developing dessert type of blackcurrant cultivars.