

Plum cultivars grown in Norway

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Cover picture: The Norwegian plum cultivar 'Edda' in full flowering. Photo: Mekjell Meland

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Preface

The overall goal of the research project NORWEGIAN FRUIT GENETIC RESOURCES; HEALTHY, TASTE & NO WASTE was to evaluate fruit genetic resources of traditional apple, plum and raspberry cultivars in Norway, to promote sustainable and innovative use of these resources by plant breeding programs, Norwegian fruit industry, Norwegian food processing industry, and finally by consumers.

From different ex-situ sites located at different regions in total 243 cultivars (139 apple, 64 plum and 40 raspberry cultivars) was tested for agronomic traits and chemical characteristics of the fruits during the years 2018-2021. The composition of individual sugars, acids, the polyphenolic profile was determined in fruits, while content of fatty acids, carotenoids and tocopherols was analysed in kernels/seeds.

This will raise consumer awareness of the need for consumption of food rich in beneficial health compounds and will help with the selection of raw material for the food processing industries for making fresh juices, ciders, jams, and jellies. Oil obtained from kernels/seeds will give an opportunity to the Norwegian industry to develop new products aimed for different purposes (food, cosmetic, fuel).

This NIBIO Book presents data of pomological, agronomical, and chemical traits of total 64 heritage and along with some commercial plum cultivars identifying the most important quality parameters, and selecting cultivars with desirable traits giving valuable information for future breeding programs, the fruit industry, processing industry and public awareness.

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Lofthus, 07.01.2025
Mekjell Meland
Project leader

Summary

This report presents results of plum cultivars and selections studies, performed during 2018-2021 at NIBIO Ullensvang, Njøs Fruit and Berry Centre and Norwegian University of Life Sciences (NMBU) in the frame of FRUIT-N-QUALITY (Evaluation of traditional Norwegian apple, plum and raspberry cultivars) project.

The aim of this study was to evaluate Norwegian heritage plum cultivars from pomological, agronomical, and biochemical point of view, identify the most important quality parameters, and select cultivars with desirable traits for modern markets and breeding purposes.

In total 64 heritage plum cultivars were evaluated. Along with some commercial cultivars and new selections, heritage cultivars Edwards, Prosser 84, Yakima, Belle de Louvain and Thames Cross have all very big fruits (71 – 90 g).

Cultivars Experimentalfältets Sviske, Reine Claude Grøn and Italiensk Sviske accumulated the highest soluble solid content.

Cultivars Sinikka, Grand Duke, Italiensk Sviske, Sviske frå Tveit and Vinterplomme had the most acid fruits.

Cultivars Bleue de Belgique, Reine Claude Grøn, Vinterplomme, and Mount Royal accumulated the highest fruit phenol content.

Cultivars Jefferson, Mallard and Mount Royal had the most aromatic fruits.

13 cultivars and selections received very high overall sensor evaluation (taste, attractiveness, aroma) score, among them heritage cultivars Helgøypomme, Reine Claude d'Althanns and Mallard.

In addition, the chemical contents of the fruits and the kernels are listed for 60 cultivars.

Content

1	Introduction.....	6
2	Materials and Methods	7
3	Results and Discussions	10
4	Description of cultivars and selections	31
5	Conclusions.....	62
6	Acknowledgments	63
7	References.....	64
	Appendix 1.Chemical contents in the flesh of 60 plum cultivars	67
	Appendix 2.Chemical contents in the kernels of 60 plum cultivars	79

1 Introduction

Plums include a group of closely related *Prunus* species of the Rosaceae family (*P. domestica*, *P. cerasifera* Ehrh., *P. insititia* L., *P. spinosa* L., *P. salicina*), and present a wide range of variation in terms of fruit size and shape, flavour, aroma, texture, and colour, greater than in any other fruit crop (Faust, Suranyi, 1999). Despite of this variation commercially cultivated plum cultivars have limited genetic variability (Zhebentyayeva et al., 2019).

Two main *Prunus* species *P. domestica* and *P. salicina* have been cultivated for 4000–6000 years in Europe and Asia. Plum growing in Norway started around the ninth century. First plum trees were planted in the monastery gardens. Yellow plums, known as ‘Gulplomme’ may date from this period (Nilsson, 1989). In Norway 51 plum cultivars have status of heirloom cultivars. Some of them have Norwegian or Scandinavian origin, but most of them are long time ago introduced cultivars and cultivated in Norway for many decades or centuries (Sehic et al., 2015).

Plum genetic resources are preserved in national, regional or local plum collections (Hjalmarsson, 2019). Many of these collections are focused to preserve unique plum genotypes to enlarge genetic diversity and to sustain cultural heritage (Gaši et al., 2020; Nybom et al., 2020). Knowledge of the diversity of morphological and pomological characteristics are very useful for conservation, management, and optimal use of plum cultivars, however, only a few studies have been carried out recently (Šebek, 2016; Butac et al., 2017; Mirheidari et al., 2020; Drogoudi and Pandelidis, 2022). Heritage plum cultivars can be used for breeding purposes, exploiting their adaptation to local climate, disease resistance and various fruit quality aspects (Okie and Ramming, 1999; Sotile et al., 2015; 2022).

The scientific project FRUIT-N-QUALITY (Evaluation of traditional Norwegian apple, plum and raspberry cultivars) was started in 2018. To develop results for a robust, efficient use of genetic resources and to maintain a database of valuable agronomic and commercial traits of apple, plum and raspberry to meet consumer and industry needs, it is aimed to:

- Develop the database of agronomic traits within genotypes suitable for breeding programs, fruit industry, processing industry, and innovation partners.
- Evaluate and document sensory and chemical characteristics of fruits, important for the fruit and food processing industry to develop new products.
- Analyse bioactive compounds with high biological importance in seeds/kernels of apple, plum and raspberry to develop significant health and/or economic benefits of possible new products.

The aim of this study is to evaluate Norwegian heritage plum cultivars from pomological, agronomical, and biochemical point of view, identify the most important quality parameters, and select cultivars with desirable traits for modern markets and breeding purposes.

2 Materials and Methods

Sixty-four plum cultivars and selections were tested at NIBIO Ullensvang, Njøs Fruit and Berry Centre and Norwegian University of Life Sciences (NMBU) in 2018 – 2021. At Ullensvang trees were propagated on Sant Julien A rootstock and planted in 2008 at the distances 4.5 x 2 m. At Njøs trees were propagated on Sant Julien A rootstock and planted during 2009 – 2017 at the distances 4 x 1.5 m. At NMBU trees were propagated on St. Julien A rootstock and planted during 2010.

Each cultivar was replicated from 2 till 3 times with one-four trees per plot.

Plum tree vigour was assessed visually in 1-3 scale, where 1 - weak, 2 - medium, 3 – strong.

The growth pattern of annual shoots was assessed in 1-4 scale, where 1 – upright, 2 - partially upright, 3 – horizontal, and 4 - hanging.

The phenological stages of flowering (Table 1) and harvest dates and maturity (1. Extremely early, 2. Very early, 3. Early, 4. Early/mid-season, 5. Mid-season, 6. Mid-season/late, 7. Late, 8. Very late, 9. Extremely late) were assessed every year.

Table 1. Flowering stages and BBCH scale (Meier et al., 1994)

Code	Description
60	First flowers open
61	Beginning of flowering: about 10% of flowers open
62	About 20% of flowers open
63	About 30% of flowers open
64	About 40% of flowers open
65	Full flowering: at least 50% of flowers open, first petals falling
67	Flowers fading: majority of petals fallen
69	End of flowering: all petals fallen

Flowering abundance was evaluated visually in 1-9 scale, where 1 – no flowers, 9 – the highest possible number of flowers.

Flower diameter (mm) was measured and expressed in 1-3 scale, where 1 - small, 2 - medium, 3 – large.

Fruit setting was evaluated visually in 1-9 scale, where 1 – no crop, 9 – overcropping.

Average fruit weight (g), fruit length and width (mm) were calculated based on 50 fruit sample per cultivar and year.

Fruit shape was determined and expressed in 1-6 scale (Fig.1).

Depth of stem cavity was assessed in 9 scale score, 1-no cavity, 3-shallow, 5-moderate, 7-deep, 9-very deep.

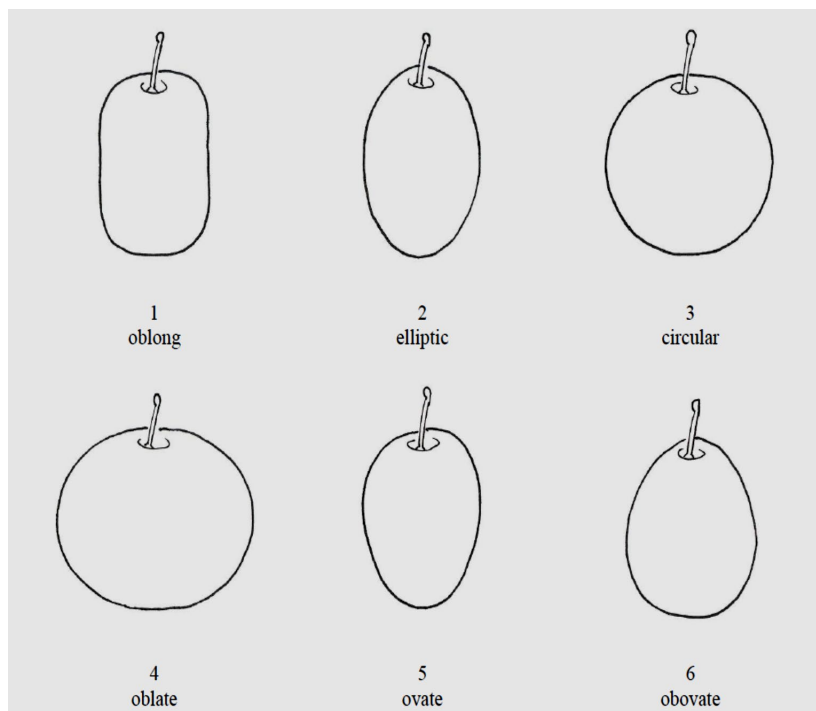


Fig.1. Fruit shape description.

Average stone weight (g), stone length, width and thickness (mm) were calculated based on 10 fruit sample per cultivar and year.

Stone shape was determined and expressed in 1-3 scale (Fig.2).

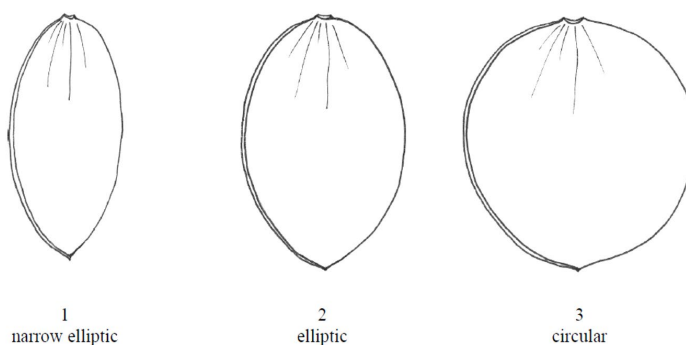


Fig.2. Stone shape description.

Leaf blade length (cm) and width (cm) was measured using the sample of 10 leaves. Leaf blade length/width ratio and leaf area (cm²) was calculated.

Incisions of leaf blade margin was evaluated in upper half of the leaf. Two types of incisions were determined using the sample of 10 leaves: crenate or serrate (Fig. 2).

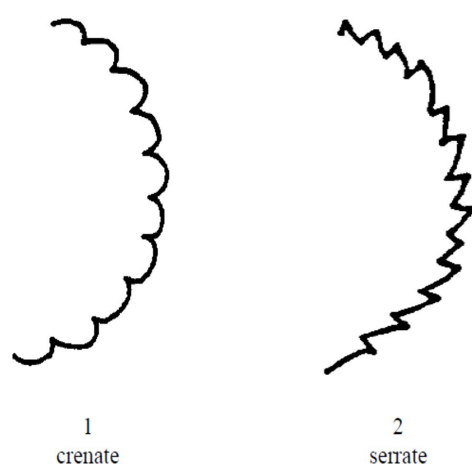


Fig.3. Leaf margin incision

Fruit quality characteristics were determined on samples of 10 randomly collected fruits per tree.

Area of over colour (blush) was evaluated visually in 1-9 point scale, where 1 – 0% of blush, 9 – 100% of fruit surface is covered by blush.

Fruit colour was described using following colour scale, 1- green white, 2- green, 3- yellow green, 4- yellow, 5- orange yellow, 6-red, 7-light violet, 8-pink violet, 9-dark violet, 10-blue violet, 11-dark blue.

Bloom of skin was assessed in 1-3 scale score, where 1 – little bloom, 2 – moderate bloom, and 3 – strong bloom.

Fruit flesh colour was described using following colour scale, 1- whitish, 2- yellow green, 3- yellow, 4- orange, 5-red.

Freestone or clingstone traits depends on fruit ripening stage. Evaluation on this character is given for well ripe fruits and assessed in 3 scale score, where 1 – fruits are freestone, 2 – semi cling, 3 –fruits are clingstone.

Soluble solid content (%) was measured by Atago® Pallete Digital refractometer PR-101 (Atago®, Tokyo, Japan).

Dry matter content was determined gravimetrically by drying apple samples to a constant weight at 105°C.

The total phenol content (TPC) in plum fruits was evaluated by using the Folin–Ciocalteu method. The TPC was expressed as gallic acid equivalents (GAE) in mg/100 g. Antioxidant activity (FRAP-method) was analysed according to Benzie and Strain (1996) and expressed in $\mu\text{mol/g}$.

Fruit taste (0-6 points, where 0 - extremely poor, 3 – intermediate, 6 - excellent), attractiveness (0-6 points, where 0 - extremely poor, 3 – intermediate, 6 - extremely attractive), aroma (0-4 points) firmness (1-3 points, where 1 – soft, 2 – moderate, 3 – firm), and juiciness (1-3 points, where 1 – low, 2 – moderate, 3 – high) was evaluated by trained panellists.

Data was analysed by general analysis of variance (ANOVA) for randomised complete block designs using the statistical program Minitab® 16 statistical software (Minitab Ltd., UK). All main data is presented as an average of 3 years.

3 Results and Discussions

Tree vigour and habitus

Tree vigour and growth habitus are important characteristics for the management of plum tree orchards, especially for the choice of planting distances and adoption of pruning and tree training. Plum trees of some commercial cultivars like Opal, Victoria, Jubileum and Reeves and of some old cultivars like Admiral Rigny, Sanctus Hubertus and River's Early Prolific were weak growing (Table 2). 28% of cultivars were strong growing, and moderate tree vigour was recorded for 60% of tested cultivars.

Tree crown shape or tree habitus was evaluated by the growth pattern of annual shoots. Almost all cultivars (95%) had upright or partially upright shoot growth and only two cultivars Diana and Victoria 'NMBU' had more horizontal shoot growth pattern. No one of tested cultivars had hanging shoots.

Flowering and flower size

The beginning of plum flowering greatly depended on the year conditions and varied from one trial site to another. Therefore, recorded dates of flowering time were transformed using the reference cultivar Victoria and rated from very early to very late flowering time (Table 2). Only Avalon and Grand Duke were very early flowering two cultivars. 15% of cultivars belong to the early flowering group, and 24% to the late flowering group. Flowering time of the largest group of tested cultivars was rated as moderate. Overlapping of flowering time is very important for optimal pollination and fruit set. Very early and early flowering cultivars can demonstrate low productivity. One reason for this could be absence of compatible pollen from plum trees flowering simultaneously in close proximity.

Difference of full flowering dates between the earliest and the latest cultivars in 2020 was 11 days at NIBIO, 14 days at NMBU and 21 days at Njøs, where the highest number of cultivars were tested. Difference of full flowering dates between the earliest and the latest cultivars in 2021 was much less due to weather conditions during the flowering and equalled 8-10 days.

Flower size of 56% of tested plums cultivars was medium and 33% of cultivars had large flowers. Variation of flower diameter was low, and no correlations were found with other plum tree or fruit characters.

Harvest time and productivity

The same as flowering time, fruit harvest time was rated from very early to very late to eliminate differences between years and three different trial sites (Table 2). The harvest time of two cultivars Herman and Ruth Gerstetter was very early, while the harvest time of other two cultivars Haganta and Vinterplomme was very late. Latter two cultivars are far too late for cultivation at Norwegian climate conditions. Around 20% of cultivars belong to each early or late ripening groups.

Harvest window of the earliest and the latest cultivars depended on the growing site and the season weather conditions and varied up two months.

Plum fruit yield depended mainly on cultivar, but the trial site, different age of trees, different tree training and pruning technologies, or orchard management practice had also significant impact on tree bearing and yield. To avoid impact of different factors, the tree productivity was evaluated visually in 9 point scale, where the higher number the more productive cultivars are (Table 2). Tree productivity was one of the most variable characters (CV% 38.6) (Table 8). The highest productivity was recorded of most commercially grown cultivars as Victoria, Reeves, Cacanska lepotica, Opal, Valor and Jubileum. Among old cultivars higher than moderate productivity was recorded for Edda, Haganta, Ive, Thames Cross and Vinterplomme.

Table 2. Tree vigour, habitus, productivity and phenology, average 2019-2021

Cultivar	Trial site	Tree vigour	Annual shoots (1-4)*	Flower size	Flower-ing time	Harvest time	Productivity (1-9) **
Admiral Rigny	Njøs	weak	1	medium	moderate	moderate	5
Anita	Njøs	moderate	2	large	moderate	early	5
Avalon	Njøs	strong	1	large	very early	moderate	5
Bleue de Belgique	Njøs	moderate	2	medium	moderate	moderate	4
Blue Rock	NMBU				early	moderate	2
Cacanska Lepotica	NIBIO	moderate	1	small	moderate	early	8
Czar	Njøs	moderate	1	small	moderate	early	5
Diamond	NMBU		-		early	late	6
Diana	Njøs	moderate	3	medium	moderate	early	3
Edda	Njøs	moderate	2	medium	early	early	6
Edwards	Njøs	strong	2	large	late	moderate	4
Emil	NMBU				moderate	moderate	2
Excalibur	Njøs	strong	2	large	moderate	moderate	4
Experimentalfältets Sviske	NMBU					moderate	2
Frostaplomme	Njøs	moderate	2	medium	moderate	early	4
Grand Duke	Njøs	moderate	1	large	very early	late	5
Haganta	Njøs	moderate	2	large	early	very late	6
Helgøypomme	Njøs	strong	1	large	late	moderate	1
Herman	Njøs	moderate	2	small	moderate	very early	4
Italiensk Sviske	NMBU				moderate	late	1
Ive	NMBU	strong			moderate	late	6
Jefferson	Njøs	moderate	2	medium	moderate	late	5
Jubileum	NIBIO	weak	2	large	moderate	moderate	7
Kirkes	Njøs	moderate	1	medium	moderate	moderate	3
Mallard	NIBIO	strong	1	large	early	moderate	5
Mount Royal	Njøs	moderate	2	medium	late	late	5
Njøs II	Njøs	moderate	2	medium	moderate	moderate	3
NPr 152	Njøs	strong	2	large	early	early	3
NPr 3403	Njøs	strong	2	medium	late	early	3
NPr 3541	Njøs	strong	1	medium	early	early	5
NPr 458	Njøs	strong		medium	late	late	5
NPr 696	Njøs	moderate		medium	moderate	moderate	5
NPr 878	Njøs	strong		medium	early	moderate	5
Ontario	Njøs	moderate	2	medium	moderate	moderate	4
Opal	NIBIO	weak	2	large	moderate	moderate	8
Oullins 'Henjum'	Njøs	strong	1	large	moderate	moderate	2
Prosser 84	Njøs	moderate		large	late	late	4
R5	Njøs	strong	1	medium	moderate	moderate	4
Raud eplevik	Njøs	moderate	2	medium	moderate	moderate	3
Raud Victoria	Njøs	moderate		medium	early	early	7
Reeves	NIBIO	weak	1	medium	moderate	moderate	7
Reine Cl. d'Althanns	Njøs	strong	2	large	late	late	5
Reine Cl. d'Oullins	NMBU	strong			late	moderate	2
Reine Claude grøn	NMBU	moderate			late	moderate	4
Reine Claude Noir	Njøs	moderate	2	small	late	moderate	5
Reine Claude Souffriau	Njøs	moderate	2	large	moderate	moderate	3
River's Early Prolific	Njøs	weak	2	medium	moderate	early	5
Ruth Gerstetter	Njøs	moderate	2	medium	moderate	very early	4
Sanctus Hubertus	Njøs	weak	2	medium	late	early	5
Sinikka	NMBU				early	early	5
Søgneplomme	NMBU				moderate	early	4
Sviske frå Tveit	Njøs	moderate	1	medium	moderate	moderate	3
Thames Cross	Njøs	moderate	2	medium	moderate	late	6
Trâneplomme	NMBU				late	late	2

Cultivar	Trial site	Tree vigour	Annual shoots (1-4)*	Flower size	Flower-ing time	Harvest time	Productivity (1-9) **
Valor	NIBIO	moderate	1	medium	late	late	8
Victoria	NIBIO	weak	2	small	moderate	moderate	7
Victoria 'NMBU'	Njøs	moderate	3	medium	moderate	moderate	4
Vinterplomme	Njøs	moderate	1	small	late	very late	6
Washington	Njøs	strong	2	medium	moderate	moderate	2
Yakima	Njøs	moderate	1	large	moderate	moderate	3

*Tree habitus - annual shoots (1-upright, 2-partially upright, 3-horizontal, 4-hanging)

**Productivity (1-no crop, 9-overcropping)

Plum leaf characters

The average leaf length (Ll) of tested cultivars was 8.97 cm, and varied between low 7.4 and high 14.2 cm (Table 3). The leaf length of cultivars Anita, Excalibur, Reine Claude Souffriau, Ontario and Washington was 12 and more cm, while leaf length of cultivars R5 and Mount Royal was less than 8 cm. Variation of leaf length was very low (CV% 14.6) (Table 8).

Leaf length was closely correlated with leaf width (Lw) ($r = 0.77$) (Table 9). This character also has low variation coefficient (CV% 14.9) and varied between low 5.0 and high 10.7 cm. The same cultivars that had the longest leaves, except Excalibur, also had the widest ones, and cultivars with the shortest leaves had leaves with the smallest width.

Due to close relationship between leaf length and width, very strong correlation of these characters with leaf area was established ($r=0.93$ with Ll and $r=0.94$ with Lw). Average of leaf area was 77.5 cm², but differently from leaf length and leaf width, this character was more variable (CV% 27.9) and varied more than 3-fold from low 37.0 cm² till high 134 cm². The leaf area of cultivars Washington, Anita, and Reine Claude Souffriau exceeded 120 cm², while leaf area of R5 and Mount Royal was less than 50 cm².

The average of leaf length and width ratio was 1.43 what indicate that most of cultivars had prolonged leaves. Only three cultivars Washington, Diana and River's Early Prolific had almost round leaves and their leaf length/width ratio was 1.2. Cultivars Anita and Victoria distinguished by prolonged leaf shape (leaf length/width =1.7).

Serrate leaf blade margin was inherent for the majority of tested cultivars. Only 27% of cultivars had leaves with crenate incisions of leaf margin.

Table 3. Leaf blade characters, average 2019-2021

Cultivar	Length (cm)	Width (cm)	Length/ width ratio	Leaf area, cm ²	Incisions of margin (1-serrate. 2-crenate)
Admiral Rigny	10.4	7.7	1.3	80	1
Anita	14.2	8.5	1.7	121	1
Avalon	11.5	8.2	1.4	94	1-2
Cacanska Lepotica	8.8	6.6	1.3	58	1
Czar	9.3	6.5	1.4	60	1
Diana	9.4	7.7	1.2	72	1
Edda	9.2	6.0	1.5	55	1
Excalibur	13.1	8.0	1.6	105	1
Grand Duke	11.1	6.9	1.6	77	2
Haganta	9.3	6.6	1.4	61	2
Herman	11.7	8.6	1.4	101	1
Jefferson	10.4	8.0	1.3	83	2
Jubileum	11.0	7.3	1.5	77	1
Kirkes	10.1	6.9	1.5	70	1
Mallard	8.9	6.6	1.3	59	1
Mount Royal	7.4	5.0	1.5	37	2
Njøs II	11.3	7.0	1.6	79	2
NPr 152	11.8	9.6	1.2	113	1
NPr 3403	10.5	7.4	1.4	78	2
NPr 3541	10.0	6.4	1.6	64	1
NPr 458	10.1	7.8	1.3	79	1
NPr 696	9.5	7.1	1.3	67	1
NPr 878	11.3	8.5	1.3	96	1
Ontario	12.8	8.8	1.5	113	1
Opal	9.2	6.0	1.5	55	1
Oullins 'Henjum'	11.6	8.0	1.5	93	1
Prosser 84	10.8	6.7	1.6	72	1
R5	7.8	5.6	1.4	44	2
Raud Victoria	9.8	6.7	1.5	66	1
Reeves	8.8	6.1	1.4	54	1
Reine Claude d'Althanns	8.8	6.9	1.3	61	1
Reine Claude Noir	9.9	6.4	1.6	63	1
Reine Claude Souffriau	13.9	8.6	1.6	120	1
River's Early Prolific	9.0	7.5	1.2	68	2
Ruth Gerstetter	10.7	7.3	1.5	78	2
Sanctus Hubertus	10.1	7.7	1.3	78	1
Thames Cross	9.2	6.8	1.4	63	2
Valor	9.0	6.4	1.4	58	1-2
Victoria	11.4	6.7	1.7	76	1
Victoria 'NMBU'	11.3	7.8	1.5	88	2
Washington	12.5	10.7	1.2	134	1
Yakima	11.4	8.1	1.4	92	1

Plum fruit stone

All plum fruit stone characters were closely correlated with each other. Stone weight depended on stone length ($r=0.74$), stone width ($r=0.60$) and thickness ($r=0.73$) (Table 9). Stone length and width had moderate correlation ($r=0.44$).

Stone weight was one of the most variable characters among all tested fruit, leaf and tree traits in this study. That is confirmed by a very high coefficient of variation (CV% 41.6) (Table 8). River's Early Prolific had the smallest stone (0.4 g), which was 5-6 times smaller than the stone weight of Valor (2.5 g) or Reeves (2.3 g) (Table 4). Cultivars Italiensk Sviske, Victoria and Jubileum had heavy stones too (2 g), while the stone weight of Blue Rock, Frostapomme and Reine Claude Noir reached only 0.5 g.

Differently to the stone weight, variability of stone length, width and thickness was low, and established CV% ranked 17.2, 14.4 and 11.9 respectively.

Double differences were recorded between low and high scores of stone length, stone width and thickness. Valor, Jubileum, Grand Duke and Thames Cross had the longest fruit stones around 30 and more millimetres. The highest stone width was recorded for Vinterpomme, and highest thickness for Reeves. River's Early Prolific plums had the least stone length and width, and together with Reine Claude Noir least stone thickness.

Almost 70% of tested cultivars had elliptic fruit stones, and almost 20% of cultivars had narrow elliptic stones. Circular shape of the fruit stone was specific only for cultivars Anita and Mount Royal.

Table 4. Plum stone characters, average 2019-2021

Cultivar	Weight, g	Length (mm)	Width, (mm)	Thickness, (mm)	Shape in lateral view *
Admiral Rigny	1.1	21.1	14.5	9.4	2
Anita	1.1	20.1	15.9	11.2	3
Avalon	1.2	23.1	15.8	10.6	2
Bleue de Belgique	0.7	20.0	12.5	8.5	2
Blue Rock	0.5				
Cacanska Lepotica	1.6	24.7	13.9	9.1	1
Czar	0.6	18.3	11.8	8.0	2
Diamond	1.8				
Diana	1.0	25.1	15.3	9.1	2
Edda	1.4	23.4	15.3	10.1	2
Edwards	1.5	28.4	17.7	10.2	2
Emil	1.2				
Excalibur	1.1	24.0	14.5	9.8	2
Experimentalfältets Sviske	0.7				
Frostapomme	0.5	25.4	10.4	7.3	1
Grand Duke	1.8	29.2	15.2	10.2	1
Helgøypomme	1.4	22.1	15.8	10.4	2
Herman	0.6	21.6	12.0	8.5	2
Italiensk Sviske	2.0				
Ive	1.1				
Jefferson	1.6	26.6	16.3	10.1	2
Jubileum	2.0	31.6	15.2	9.1	1
Kirkes	1.1	23.5	15.6	8.6	2
Mallard	1.2	24.3	13.5	9.0	1
Mount Royal	0.8	16.6	13.3	8.3	3
NPr 152	1.0	22.1	14.0	9.5	2
Ontario	1.2	21.1	15.1	9.6	2
Opal	0.8	19.9	12.7	8.7	1 2
Oullins 'Henjum'	1.2	20.7	14.4	9.7	2
R5	1.3	25.6	15.7	10.0	2
Raud eplevik	0.6	17.2	11.4	7.4	2
Reeves	2.3	23.2	17.9	12.3	1 2
Reine Claude d'Althanns	1.1	19.5	14.5	9.6	2
Reine Claude grøn	0.9				
Reine Claude Noir	0.5	17.8	11.6	6.9	2
Reine Claude Souffriau	1.1	20.2	14.3	9.6	2
River's Early Prolific	0.4	16.0	10.2	7.2	2
Ruth Gerstetter	0.8	22.4	13.5	9.1	2
Sanctus Hubertus	0.9	22.9	14.6	9.2	2
Sinikka	1.0				
Søgneplomme	1.0				
Sviske frå Tveit	1.0	25.6	13.1	9.9	2
Thames Cross	1.5	29.2	15.9	9.8	2
Trâneplomme	1.3				
Valor	2.5	32.8	17.5	10.3	1
Victoria	2.0	28.4	16.6	9.4	1
Victoria 'NMBU'	0.7	24.1	15.2	8.5	2
Vinterplomme	0.6	19.4	20.9	7.8	2
Washington	1.1	23.4	15.1	9.5	2
Yakima	1.2	27.2	14.5	9.7	1

*1-narrow elliptic, 2-elliptic, 3-circular

Fruit size and shape

The average fruit weight of tested group of cultivars was relatively high – 47.9 g, though very large difference was recorded between the smallest Gul sukkerplomme fruits (13.5 g) and the biggest Edwards fruits (90 g) (Table 5, Fig.4). It was a reason why fruit weight was one of the most variable traits (CV% 40.9) (Table 8). The same high variation of fruit weight is reported from other cultivar studies (Drogoudi and Pandelidis, 2022). Seventeen percent of cultivars had fruits with average weight more than 70 g, 43% of cultivars – more than 50 g. Besides Edwards, cultivars Prosser 84, Anita, Yakima, Belle de Louvain, Thames Cross and other have very large fruits, but cultivars Vinterplomme, Frostapomme, Raud eplevik, Sinikka and River's Early Prolific were small fruited (less than 20 g).

Fruit weight was closely correlated both with fruit length and fruit width ($r=0.93$) (Table 9). Thus, cultivars with the biggest or with the smallest fruit weight had highest or lowest scores of fruit length or width. Differently from fruit weight variation coefficient of these characters was low (CV% fruit length 17.7 and CV% fruit width 16.3).

Fruit weight and width correlated with many other fruit, stone or tree characters. Very strong positive correlations were established with stone weight and stone width. Weak positive correlations ($Fw\ r=0.43$ and $Fw\ r=0.49$) was established with fruit sell appearance. All fruit size characters negatively correlated with flesh structure, though correlation coefficient was weak ($r=0.36 - 0.49$). Larger fruits determined softer fruits, lower content of soluble solids, dry mater and total phenols. Interesting that these correlations were established with fruit weight and width, but not with fruit length.

Fruit shape was the most variable character among all tested traits (CV% 46.7) (Table 8), what is also confirmed by Drogoudi and Pandelidis (2022). All possible fruit shapes were established in the tested group. Shape of 39% of tested cultivars fruits was elliptic, 27% of cultivars had circular, and 20% of cultivars had ovate fruits. The only one cultivar with obovate fruits was Prosser 84, and only Reine Claude d'Althanns had ovate shape of fruits. Cultivars Bleue de Belgique, Excalibur, Raud Victoria and River's Early Prolific distinguished by oblong fruit shape.

Table 5. Plum fruit characters, average 2019-2021

Cultivar	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Shape*	Depth of stem cavity**
Admiral Rigny	38.1	42.2	38.7	36.5	5	3
Anita	79.6	52.5	54.4	49	3	7
Avalon	55.4	47.6	43.2	44	3	3
Belle de Louvain	72.9	58.9	47.2	44.1	2	
Bleue de Belgique	35.8	41.5	37.5	37.1	1	7
Blue Rock	25.1		33			
Cacanska Lepotica	47.0	49.0	40.0	40.5	2	5
Czar	35	43	38	39	3	5
Diamond	40.0		38			
Diana	56	47.6	46.1	43.8		7
Edda	47.6	46.3	41.0	40.5	5	5
Edwards	90	63.9	52	47.7	5	5
Emil	38.8		40			
Engelsk sviske	20.5	41.4	30.4	28.2	5	3
Excalibur	63.9	51.1	45.6	45.3	1	
Experimentalfältets Sviske	21.0		30			
Frostapomme	17.2	38.8	28.9	26.8	5	3
Grand Duke	57.5	55.5	42.7	41.9	5	3
Gul sukkerplomme	13.5	29.8	26.9	25.5	3	3
Gulplomme Hallan	28	41.3	35.5	33.2	2	3
Haganta	61	59	42	43	5	5
Helgøypomme	58.9	47.7	45.2	43.8	5	5
Herman	30.8	43.6	36.7	33.6		5
Italiensk Sviske	29.8		34			
Ive	42.4		41			
Jefferson	58	49.8	42.9	42.2	2	3
Jubileum	75.4	54.8	42.4	44.4	2	5
Kirkes	46.2	44.7	41.9	39.4	3	3
Mallard	44.9	48.0	38.8	40.0	2	5
Mount Royal	28.4	35	35.7	33.9	3	3.8
Njøs II	52	45	44	44	3	7
NPr 152	44.1	43.8	40.6	39.7	3	
NPr 3403	54	49	44	42	2	5
NPr 3541	71	53	48	47	2	7
NPr 458	60	49	45	47	3	7
NPr 696	81	56	52	46	6	5
NPr 878	75	59	48	45	2	2
Ontario	52	46.7	44.6	41.1	3	5
Opal	30.7	39.2	35.0	35.7	2	5
Oullins 'Henjum'	54.4	46.3	43.8	43	5	3.8
Prosser 84	85	62	49	50	6	3
R5	57.5	49.6	44.1	40.8	2	5
Raud eplevik	16.6	30.4	30.2	28.2	3	3
Raud Victoria	61	58	44	42	1	7
Reeves	65.3	49.1	46.9	49.0	2	6
Reine Claude d'Althanns	50	43	45	42	4	5
Reine Claude d'Oullins	47.9		40			
Reine Claude grøn	25.4		35			
Reine Claude Noir	26.7	37.1	35	33.3	3	3
Reine Claude Souffriau	45.3	41.3	42	40.8	3	7
River's Early Prolific	14.9	31.1	29	26.5	1	5
Ruth Gerstetter	40.5	44.7	40	37.3		7
Sanctus Hubertus	38.7	43.5	40	36.7		4.5
Sinikka	16.6		21			
Søgneplomme	37.4		35			

Cultivar	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Shape*	Depth of stem cavity**
Sviske frå Tveit	49.3	46.5	33.7	32.1	2	3
Thames Cross	71.1	61.8	46.9	43.9	2	3
Trâneplomme	47.6		43			
Valor	80.0	65.2	46.9	46.2	2	7
Victoria		49.5	37.9	39.4	2	5
Victoria 'NMBU'	52.5	46.3	42.5	40.8	2	5
Vinterplomme	18.1	34.2	30.5	27.5	2	
Washington	60.8	49.4	45	44.5	5	3
Yakima	77	59	47.5	46.1	2	5

*Shape, 1-oblong, 2-elliptic, 3-circular, 4-oblate, 5-ovate, 6-obovate

**Depth of stem cavity, 1-no cavity, 3-shallow, 5-moderate, 7-deep.

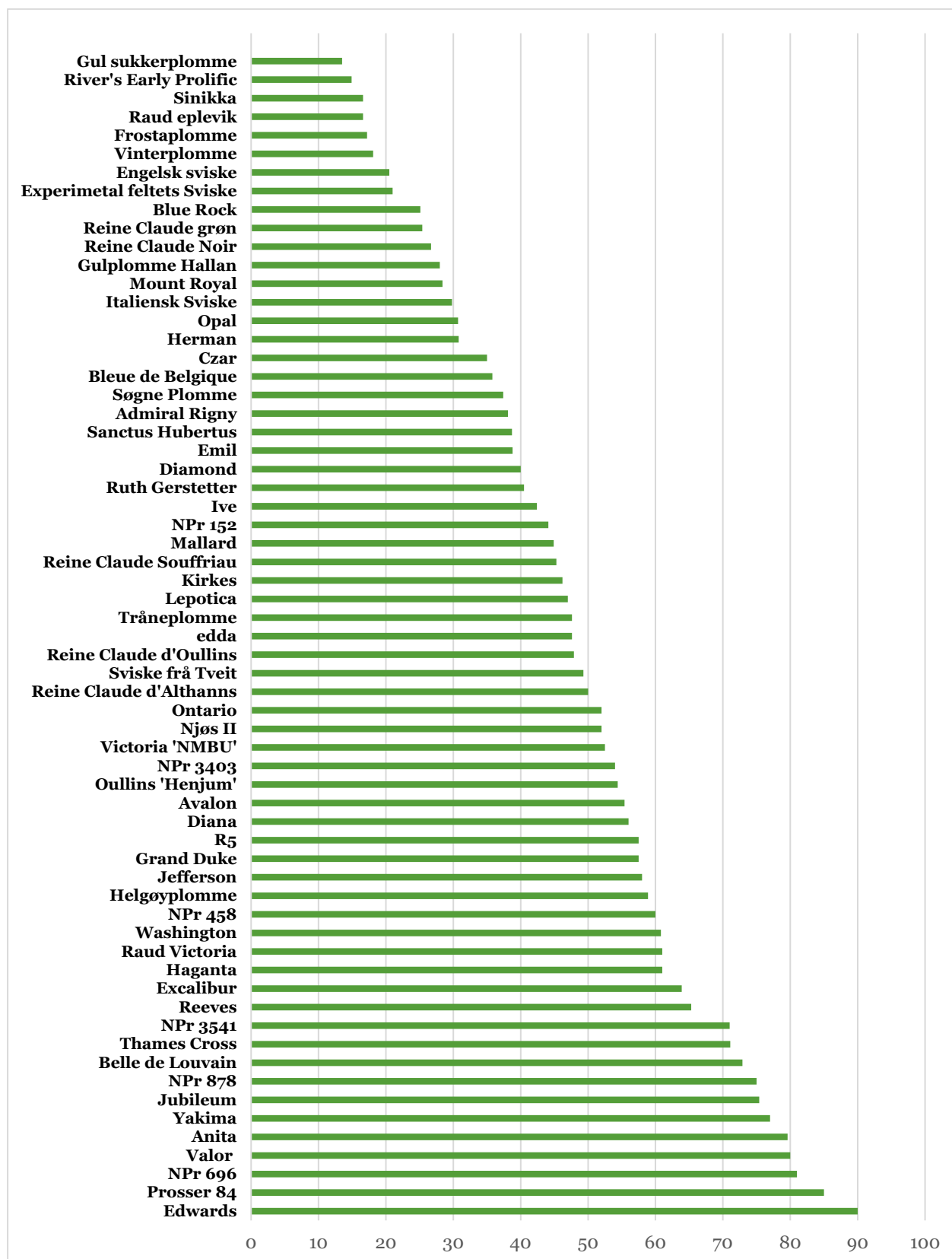


Fig.4. Fruit weight of tested plum cultivars, average 2019-2021.

Fruit colour and flesh

Highly coloured fruits are more attractive and such cultivars were chosen naturally during the selection process. 55% of tested cultivars had fruits with more than 70% of surface covered by overcolour (Table 6). Among them, almost half had a full blush. Only ten of tested cultivars bear fruits without blush, among them heritage cultivars Admiral Rigny, Oullins 'Henjum', Reine Claude d'Oullins and Vinterplomme.

Dark fruit colours were dominating overcolours. More than half of studied cultivars had dark violet, dark blue or violet blue fruits. 27% of cultivars had green, yellow green, yellow or orange yellow fruit colour. Only three cultivars and selections Reeves, NPr 3403, and Njøs II were red-fruited.

Almost half of cultivars had a moderate bloom on the fruits and 29% of cultivars had a strong bloom. Both of characters, fruit colour and bloom, were strong positively correlated with each other ($r=0.71$), meaning the darker fruit colour the stronger bloom is on the fruit surface.

Half of studied cultivars (53%) had fruits with yellow flesh. 23% of cultivars had orange flesh and 24% yellow green or whitish fruit flesh.

Fruit firmness is an important fruit quality parameter closely related with fruit storage and consumer preference. Most of cultivars had moderate fruit flesh firmness, 32% of cultivars were rated having soft flesh, and only 13% had firm fruits.

Moderate juiciness of fruit flesh was established even for 68% of cultivars, while higher than moderate fruit juiciness had 19% of cultivars, and low juiciness had 13% of cultivars.

Adherence of stone to the fruit flesh was categorized as cling, semi cling and free stone types. Among the different cultivars under investigation, only four cultivars (Frostaplomme, Grand Duke, NPr 696 and Ontario) were cling stone type. Free stone was characteristic to 34% of cultivars, and the rest of tested cultivars had fruits with semi cling stone.

Area of overcolour or part of fruit covered by blush was one of two most variable characters. Coefficient of fruit blush variation reached 44.6 (Table 8). Variation of fruit and flesh colour, and flesh firmness was moderate and CV% was between 29.3 and 33.6. Bloom on the fruits was highly variable (CV% 37.0) character, while variation of fruit juiciness was low (CV% 19.7).

Only some positive or negative correlations of these characters were found with other studied traits, but all of them were weak and in most cases difficult to explain. The only area of overcolour was highly correlated with over colour and fruit bloom – the more blush the darker over colour ($r=0.85$) and the more bloom is recorded on fruits ($r=0.75$) (Table 9).

Table 6. Plum fruit colour and flesh characters, average 2019-2021

Cultivar	Area, over-colour*	Over colour	Fruit bloom**	Flesh colour	Firmness**'	Juiciness****	Adherence, stone to the flesh
Admiral Rigny	1	green	2	yellow	3	5	semi cling
Anita	9	light violet	2	yellow	5	5	free stone
Avalon	7	pink violet	2	whitish	3	7	free stone
Belle de Louvain		pink violet	2	whitish	3	7	
Bleue de Belgique	9	dark violet	3	yellow	5	5	semi cling
Blue Rock	9						
Cacanska Lepotica	9.0	dark violet	3	yellow green	6	5	free stone
Czar	8.5	pink violet	2	yellow	5	5	free stone
Diamond	9						
Diana	7	pink violet	2	yellow	7	5	semi cling
Edda	8	blue violet	2	yellow green	5	5	semi cling
Edwards	7.5	pink violet	2	yellow	7	3	semi cling
Emil	7						
Engelsk sviske	6	dark violet	3	yellow	3	5	
Excalibur	6	light violet	2	orange	5	5	free stone
Experimetal feltets Sviske	6						
Frostaplomme	7	pink violet	2	yellow	3	5	cling
Grand Duke	9	pink violet	3	orange	5	5	cling
Gul sukkerplomme	2	yellow green	2	yellow green	3	5	
Gulplomme Hallan	1	yellow	1	yellow	5	3	
Haganta	9	light violet	3	yellow	7	5	free stone
Helgøypomme	5	light violet	1	yellow	3	5	semi cling
Herman	9	pink violet	3	yellow	5	5	free stone
Italiensk Sviske	9						
Ive	8.5	pink violet					
Jefferson	3	yellow green	1	orange	5	5	semi cling
Jubileum	8.1	dark violet	2	orange	5	6	semi cling
Kirkes	8.8	dark violet	3	yellow green	6	5	free stone
Mallard	6.3	orange yellow/	2	yellow green	6	6	semi cling
Mount Royal	8.5	dark violet	3	orange	5	3	semi cling
Njøs II	5	red	2	yellow	6	5	semi cling
NPr 152	7	orange yellow	1	orange	5	5	free stone
NPr 3403	3	red	2	orange	5	5	free stone
NPr 3541	9	dark violet	3	yellow	5	5	free stone
NPr 458	3	orange yellow	1	yellow	7	3	free stone
NPr 696	9	pink violet	2	yellow	7	5	cling
NPr 878	1	yellow/ yellow green	1	yellow / orange	3	5	semi cling
Ontario	1	yellow green	1	yellow	3	7	cling
Opal	6.9	varying	2	orange	6	5	semi cling
Oullins 'Henjum'	1	yellow green	1	yellow	3	7	semi cling
Prosser 84	9	dark violet	3	yellow	7	3	semi cling
R5	7	light violet	2	yellow	5	7	semi cling
Raud eplevik	2	green	1	yellow	3	5	semi cling
Raud Victoria	5	light violet	2	yellow	7	5	free stone
Reeves	6.5	red/orange yellow	2	orange / yellow green	5	7	semi cling

Cultivar	Area, over-colour*	Over colour	Fruit bloom**	Flesh colour	Firm-ness**'	Juici-ness****	Adher-ence, stone to the flesh
Reine Claude d'Althanns	5	light violet	1	orange	4	6	semi cling
Reine Claude d'Oullins	1	yellow green		yellow			semi cling
Reine Claude grøn	3.5	green		green			
Reine Claude Noir	7.5	dark violet	2	yellow	3	5	semi cling
Reine Claude Souffriau	8	dark violet	3	yellow	3	7	semi cling
River's Early Prolific	9	dark violet	3	yellow	5	5	free stone
Ruth Gerstetter	8.5	pink violet	2	yellow green	5	5	free stone
Sanctus Hubertus	7	pink violet	3	yellow	5	5	semi cling
Sinikka	9						
Søgneplomme	8						
Sviske frå Tveit	8.5	dark violet	3	whitish	5	5	semi cling
Thames Cross	1	yellow	1	whitish	5	5	semi cling
Trâneplomme	6						
Valor	9.0	dark violet	3	yellow green	6	5	semi cling
Victoria	6.4	varying	1/2	orange / yellow green	3	7	semi cling
Victoria 'NMBU'	5	orange yellow	2	whitish	5	5	semi cling
Vinterplomme	1	green	1	yellow green	3	5	semi cling
Washington	4	light violet	1	yellow	3	5	free stone
Yakima	5	pink violet	2	orange	3	5	free stone

*1-9; **1-little, 2-moderate, 3-strong; ***1-very soft, 5-moderate, 7-firm; ****1-low, 5-moderate, 7-high

Fruit chemical content

The inner quality of fruits is described by fruit chemical content. Different studies revealed that soluble solid content (SSC), titratable acidity (TA), the ratio of SSC and TA, and dry matter content (DM) are closely related to the taste of plum fruits (Butac et al., 2012). Total phenol content (TPC) and antioxidant activity (FRAP) are very important fruit quality characters determining health benefits (Donovan et al., 1998; Nakatani et al., 2000; Kim et al., 2003; Kazim, Onur, 2012).

Most of these characters had high or very high variability. Only for SSC and DM there was established low coefficients of variation, 17.7 and 16.5 respectively (Table 8). Lower variation of SSC was also reported in the study of European plum collection in Greece (Drogoudi and Pandelidis, 2022).

The average content of SSC was 15.5 in the tested group of cultivars, and varied from low 10.2 up to very high 23.4 (Table 7). This is a much broader range than what was reported in some other studies (Sundouri et al., 2018), but very similar to Italian autochthonous cultivars (Sottile et al., 2015). Three cultivars Experimentalfältets Sviske, Reine Claude grøn and Italiensk Sviske accumulated more than 22% of SSC. On the other hand, SSC of Lepotica, Ruth Gerstetter, Thames Cross, NPR 458 and Diana was lower than 12%. European plums with SSC of more than 16°Brix are considered as sweet and suitable for fresh consumption (Butac et al., 2012).

A very high correlation ($r=0.95$) was established between SSC and DM (Table 9). Therefore, cultivars having high SSC, Experimentalfältets Sviske and Reine Claude grøn also had a very high content of dry matter (more than 21%). Very low DM content was detected in fruits of Cacanska Lepotica and Diana. The average content of DM in tested group of cultivars was 15.0% and it is comparable to the averages of other studies (Bohačenko, 2010; Dimkova et al., 2018).

Very distinctive differences up to 4.5 among tested selections were recorded for the acid content. Fruit titratable acidity varied from very low 0.69 till high 3.09%. Eight cultivars had TA higher than 2%. Less than 1% of TA was detected in fruits of seven cultivars.

Fruits rich in SSC, DM and TA also have higher phenol content and antioxidant activity (FRAP). Positive correlations were established between all these characters and phenol content and FRAP. Fruit phenol content as well as their antioxidant activity were dependent on the cultivar and varied to a great extent, CV% 38.1 and 42.0 respectively. Average content of total phenols was 190 mgGAE/100g. Very high TPC (more than 300 mgGAE/100g) was recorded in fruits of Bleue de Belgique, Reine Claude grøn and Vinterplomme, but especially high of Mount Royal and Haganta (around 370 mgGAE/100g). Similar variation of TPC was found in other studies too (Kim et al., 2003; Rupasinghe et al., 2006; Hallmann et al., 2017; Liaudanskas et al., 2020). Weak negative correlation was established between TPC and fruit taste. This was one of the reasons that some cultivars (Jefferson, Reeves, Prosser 84) having very high taste score accumulated the lowest amounts of TPC.

Fruit antioxidant activity directly depended on TPC ($r=0.98$). It was the highest correlation from all analysed characters. Besides of mentioned cultivars with the highest TPC, high FRAP was established for Cacanska Lepotica, Sinikka and Blue Rock. Very low FRAP (less than 0.90 mmol/100 g), besides mentioned cultivars with lowest amount of TPC, was recorded in fruits of cultivars Raud eplevik, Anita and Thames Cross.

Table 7. Chemical content of plum fruits, average 2019-2021

Cultivar	SSC	pH	TA	DM	FRAP	TPC
Admiral Rigny	18.7	3.23	1.58	19.7	2.05	246
Anita	13.3	3.06	1.65	12.7	0.85	116
Avalon	17.3	3.01	2.11	16.9	1.19	138
Bleue de Belgique	17.1	3.29	1.26	18.5	2.88	318
Blue Rock	17.9	3.21	1.47	16.8	2.83	295
Cacanska Lepotica	11.9	3.17	1.33	10.9	2.92	285
Czar	12.9	3.10	1.48	13.3	2.25	242
Diamond	14.0	2.72	3.09	12.3	1.64	168
Diana	10.2	3.26	1.08	10.1	0.45	66
Edda	13.8	3.29	1.09	14.0	1.66	180
Edwards	15.4	2.94	2.00	14.8	2.54	270
Emil	14.3	3.37	0.98	14.7	1.56	177
Excalibur	14.6	3.15	1.17	14.0	1.41	173
Experimentalfältets Sviske	23.4	3.26	1.96	21.8	2.34	255
Frostaplomme	17.6	3.24	1.86	16.5	1.30	151
Grand Duke	14.7	2.89	2.35	15.1	2.28	277
Haganta	15.8	2.99	1.91	17.3	3.09	368
Herman	12.7	3.36	1.08	12.7	1.33	143
Italiensk Sviske	22.1	3.23	2.30			
Ive	19.8	3.62	0.82	17.3	1.33	159
Jefferson	18.5	3.60	0.77	16.8	0.74	103
Jubileum	14.7	3.07	1.30	14.4	1.34	154
Kirkes	17.6	3.28	1.32	16.7	1.22	146

Cultivar	SSC	pH	TA	DM	FRAP	TPC
Mallard	17.0	3.48	0.90	15.3	0.97	122
Mount Royal	19.2	3.30	1.07	18.4	3.55	370
Njøs II	14.0	2.97	1.81	13.2	1.21	147
NPr 152	14.5	3.33	1.16	14.0	1.36	169
NPr 3403	13.7	3.30	1.12	13.0	0.93	113
NPr 3541	12.2	3.20	1.10	11.7	1.32	164
NPr 458	11.2	3.11	1.18	11.5	1.15	122
NPr 696	16.0	3.34	1.09	14.5	1.72	201
NPr 878	15.7	2.99	1.83	14.7	1.12	139
Ontario	15.5	3.32	1.12	15.7	2.21	263
Opal	13.8	3.31	1.09	13.0	1.31	150
Oullins 'Henjum'	14.2	3.15	1.12	13.9	1.45	166
Prosser 84	13.9	3.14	1.22	14.0	1.02	110
R5	14.4	3.16	1.27	13.9	0.91	110
Raud eplevik	16.8	3.49	1.07	16.2	0.88	117
Raud Victoria	13.8	3.07	1.41	13.7	1.25	145
Reeves	12.9	3.27	0.98	12.5	0.86	109
Reine Claude d'Althanns	18.2	3.63	0.69	17.4	1.32	167
Reine Claude d'Oullins	16.5	3.20	1.34	16.2	1.96	236
Reine Claude grøn	23.2	3.42	1.24	23.3	2.58	317
Reine Claude Noir	14.0	3.41	0.75	13.4	1.48	163
Reine Claude Souffriau	16.3	3.30	1.15	15.7	1.03	110
River's Early Prolific	15.9	3.14	1.74	15.3	2.18	235
Ruth Gerstetter	11.9	3.23	1.24	11.4	0.92	107
Sanctus Hubertus	14.4	3.16	1.48	14.6	1.76	203
Sinikka	18.0	3.10	2.40	17.3	2.90	297
Søgneplomme	16.6	3.29	1.28	16.0	1.91	215
Sviske frå Tveit	14.8	2.95	2.30	14.8	1.46	163
Thames Cross	11.4	3.21	1.02	12.6	0.82	102
Trâneplomme	16.4	3.17	1.75	16.4	2.48	258
Valor	16.4	3.11	1.66	15.4	2.20	235
Victoria	13.3	2.99	1.62	13.4	1.67	195
Vinterplomme	13.5	3.03	2.29	14.1	2.54	304
Washington	18.1	3.17	1.57	15.6	1.54	197
Yakima	16.1	3.30	1.10	15.9	1.67	195

*SSC – soluble solid content, TA – titratable acidity, DM – dry matter content, FRAP – antioxidant activity, TPC – total phenol content

Plum fruit sensory qualities

Test panel evaluation indicated cultivars with the best tasting fruits (Table 8). Taste of 72% of cultivars was rated as very good or good. Only 15 cultivars were evaluated having moderate and lower taste, and cultivars Edwards and Gul sukkerplomme were rated as not edible. Fruit taste was correlated with fruit aroma, and weak negative correlation was established with TA and FRAP.

43% of cultivars had very high or high attractiveness, and attractiveness of 24% of cultivars was rated as less than moderate. Cultivars Avalon and Jubileum received the highest possible score of

attractiveness. Fruit attractiveness was correlated with fruit weight and width, but the correlations were weak ($r=0.43$ and 0.49) (Table 9).

Cultivars Edda, Jefferson, Mallard and Mount Royal had the most aromatic fruits. No aroma was detected in fruits of Diana, Sanctus Hubertus and Vinterplomme.

Relatively low variation between cultivars was established for fruit taste (CV% 22.2) and sell appearance (CV% 21.5), while aroma component was more variable (CV% 28.6) (Table 8).

13 cultivars received 13-14 points of overall score from 16 available, and 13 cultivars received less than 10 (7-9). Cultivars Edda, Avalon and NPr 3541 received the highest total sensory evaluation score.

Table 8. Sensory analysis of plum fruits, average 2019-2021

Cultivar	Taste (0-6)	Attractiveness (0-6)	Aroma (0-4)	Total (0-16)
Admiral Rigny	4	3	3	10
Anita	3	5	2	10
Avalon	5	6	3	14
Belle de Louvain	4	4	2	10
Bleue de Belgique	3	3	3	9
Cacanska Lepotica	3	4	2	9
Czar	3	4	2	9
Diana	3	4	1	8
Edda	5	5	4	14
Edwards	2	5	2	9
Engelsk sviske	3	2	3	8
Excalibur	5	5	3	13
Frostapomme	3	3	2	8
Grand Duke	3	4	3	10
Gul sukkerpomme	2	3	2	7
Gulplomme Hallan	3	3	2	8
Haganta	4	3	3	10
Helgøypomme	5	5	3	13
Herman	4	4	2	10
Jefferson	5	3	4	12
Jubileum	4	6	3	13
Kirkes	4	4	3	11
Mallard	4	5	4	13
Mount Royal	4	3	4	11
Njøs II	5	5	3	13
NPr 152	5	4	2	11
NPr 3403	5	5	3	13
NPr 3541	6	5	3	14
NPr 458	4	5	2	11
NPr 696	4	5	2	11
NPr 878	4	3	2	9
Ontario	4	4	2	10
Opal	5	5	3	13
Oullins 'Henjum'	5	4	3	12
Prosser 84	5	3	2	10
R5	4	5	2	11
Raud eplevik	4	4	2	10
Raud Victoria	5	4	3	12
Reeves	5	5	3	13
Reine Claude d'Althanns	5	5	3	13
Reine Claude Noir	4	4	3	11
Reine Claude Souffriau	4	5	3	12
River's Early Prolific	4	4	2	10
Ruth Gerstetter	4	4	2	10
Sanctus Hubertus	3	5	1	9
Sviske frå Tveit	3	3	2	8
Thames Cross	4	5	2	11
Valor	3	5	2	10
Victoria	5	5	3	13
Victoria 'NMBU'	5	5	2	12
Vinterplomme	4	3	1	8
Washington	5	4	3	12
Yakima	3	4	3	10

Variation of plum fruit, tree and leaf characters

Coefficients of variation (CV%) indicate variability of certain characters. Relatively low variation (CV%<20) was established for some chemical traits as SSC, DM and juiciness (Table 9). The highest coefficient of variation was established for fruit shape (CV% 46.7) and fruit blush (CV% 44.6) and very high for tree productivity (CV% 38.6), TPC (CV% 38.1) and FRAP (CV% 42.0).

It is interesting that the length and width of leaf, stone and fruit had a low variability, while leaf area (CV% 27.9) and especially, fruit and stone weight, characters that are directly related to the length and width, had very high variability (CV%>40).

Table 9. Average, minimum (Min), maximum (Max), standard deviation (StDev) and variation (CV%) of different characters of 64 plum cultivars

Characters	Average	Min	Max	StDev	CV%
Leaf length	8.97	7.4	14.2	1.52	14.6
Leaf width	6.34	5.0	10.7	1.09	14.9
Leaf area	77.5	37.0	134	21.7	27.9
Fruit weight	47.9	13.5	90.0	19.58	40.9
Fruit length	47.6	29.8	65.2	8.41	17.7
Fruit width	40.7	21.4	54.4	6.57	16.3
Fruit shape	3	1	6	1.40	46.7
Stone weight	1.15	0.40	2.50	0.48	41.6
Stone length	23.2	16.0	32.8	3.97	17.2
Stone width	14.6	10.2	20.9	2.11	14.4
Stone thickness	9.28	6.90	12.3	1.10	11.9
Soluble solid content (SSC)	15.5	10.2	23.4	2.75	17.7
Titrateable acidity (TA)	1.43	0.69	3.09	0.49	34.0
SSC/TA	11.9	4.53	26.2	4.37	36.6
Dry matter content	15.0	10.1	23.3	2.47	16.5
pH	3.21	2.72	3.63	0.18	33.0
Total phenol content (TPC)	190	65.9	370	72.6	38.1
Antioxidant activity (FRAP)	1.66	0.45	3.55	0.70	42.0
Taste	4.04	2	6	0.90	22.2
Attractiveness	4.21	2	6	0.91	21.5
Aroma	2.53	1	4	0.72	28.6
Fruit blush	6.21	1	8.8	2.77	44.6
Colour pattern	6.72	2	10	2.26	33.6
Bloom	2.02	1	3	0.75	37.0
Flesh colour	2.83	1	4	0.87	30.8
Flesh structure	4.51	1	7	1.49	33.0
Flesh firmness	4.68	3	7	1.38	29.6
Juiciness	5.09	3	7	1.01	19.7
Tree productivity	4.40	1	8	1.70	38.6
Tree habitus	1.68	1	3	0.56	33.4

Table 10. Pearson correlation analysis of 27 plum fruit, stone, and leaf parameters.

Character	Taste	Attractiveness	Aroma	Flesh structure	SSC*	pH	TA	SSC/TA	DM	FRAP	TPC	F weight	F length	F width
Taste	1													
Attractiveness	0.35	1												
Aroma	0.44	ns	1											
Flesh structure	ns	ns	ns	1										
SSC	ns	ns	0.44	ns	1									
pH	ns	ns	ns	ns	ns	1								
TA	-0.36	ns	ns	ns	ns	-0.79	1							
SSC/TA	ns	ns	0.51	ns	0.41	0.90	-0.75	1						
DM	ns	-0.35	0.39	ns	0.95	ns	ns	0.38	1					
FRAP	-0.36	ns	ns	ns	0.38	ns	0.36	ns	0.48	1				
TPC	-0.33	-0.37	ns	ns	0.42	ns	0.34	ns	0.53	0.98	1			
F weight	ns	0.43	ns	-0.46	-0.35	ns	ns	ns	-0.35	ns	ns	1		
F length	ns	ns	ns	-0.49	ns	ns	ns	ns	ns	ns	ns	0.93	1	
F width	ns	0.49	ns	-0.36	-0.37	ns	ns	ns	-0.37	-0.38	ns	0.93	0.81	1
L area	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
L length	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
L width	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
St weight	ns	0.44	ns	-0.49	ns	ns	ns	ns	ns	ns	ns	0.64	0.74	0.48
St length	ns	ns	ns	-0.56	ns	ns	ns	ns	ns	ns	ns	0.71	0.84	0.45
St width	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.58	0.51	0.55
Colour type	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
F bloom	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.35	ns	ns	ns	ns
Flesh colour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Flesh firmness	ns	ns	ns	ns	-0.36	ns	ns	ns	ns	ns	ns	0.39	0.41	ns
Flesh juiciness	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Area of overcolour	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Flower diameter	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

	L area	L length	L width	St weight	St length	St width	Colour type	F bloom	Flesh colour	Flesh firmness	Flesh juiciness	Area of overcolour
L area	1											
L length	0.93	1										
L width	0.94	0.77	1									
St weight	ns	ns	ns	1								
St length	ns	ns	ns	0.74	1							
St width	ns	ns	ns	0.60	0.44	1						
Colour type	ns	ns	ns	ns	ns	ns	1					
F bloom	ns	ns	-0.38	ns	ns	ns	0.71	1				
Flesh colour	ns	ns	ns	ns	ns	ns	ns	ns	1			
Firmness	-0.36	ns	-0.35	ns	0.39	ns	ns	ns	ns	1		
Juiciness	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	1	
Area of overcolour	ns	ns	ns	ns	ns	ns	0.85	0.75	ns	0.42	ns	1
Flower diameter	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

*SSC – soluble solid content, TA – titratable acidity, DM – dry matter content, FRAP – antioxidant activity, TPC – total phenol content, F – fruit, L – leaf, St – stone. Weak correlations 0.35-0.50, moderate correlations 0.50-0.70, strong correlations over 0.70. $p < 0.05$

Pearson correlation analysis was applied for 27 fruit internal and external quality parameters, fruit sensory traits, stone, and leaf parameters (Table 10). Obviously, that strong significant correlations were found between total phenol content and antioxidant activity, dry matter, and soluble solid content, or among all leaf size, all fruit size and among stone size traits. Gunduz and Saracoglu (2012) also found that size variables (fruit width, length and weight) were all correlated to each other. Kim et al. (2003), Rupasinghe et al. (2006) and Rop et al. (2009) also established very strong correlation between TPC and FRAP.

The biggest number of significant correlations was found analysing fruit chemical content. DM, SSC, FRAP were correlated with 7-8 fruit parameters and sensory traits. Even 10 different parameters were significantly correlated with fruit weight and width. Fruit colour type, area of over colour, bloom and pH correlated with only 1 or two other traits, while fruit flesh colour, fruit juiciness and size of the flowers were not correlated with any other trait. Drogoudi and Pandelidis (2022) found that plum cultivars with more blue- and red- coloured peel contain higher antioxidant contents, but our study did not confirm their findings.

In some studies (Mirheidari et al., 2020; Drogoudi and Pandelidis, 2022) positive correlation between plum leaf area and fruit weight was found. No such correlation was established in our trial. Leaf characters as length, width and leaf area were strongly correlated only with each other.

Study performed in Turkey stated that fruit size characters were not correlated to soluble solids, pH and total acidity (Gunduz and Saracoglu, 2012). In our study weak negative correlations were established between fruit size variables and SSC and DM.

Cluster analysis revealed the similarities and dissimilarities among the tested characters. Fruit taste and aroma formed cluster together with some of fruit chemical traits as SSC, DM, SSC/TA and pH (Fig. 5). Sell appearance was clustered with fruit and stone size traits. Leaf characters formed separate cluster as well as TPC with FRAP and TA. Fruit colour characters as area of overcolour and colour pattern were clustered with fruit bloom. The last cluster was linked to TPC cluster, revealing correlations between these external and internal fruit characters. Flesh structure and flesh colour were the only not clustered characters.

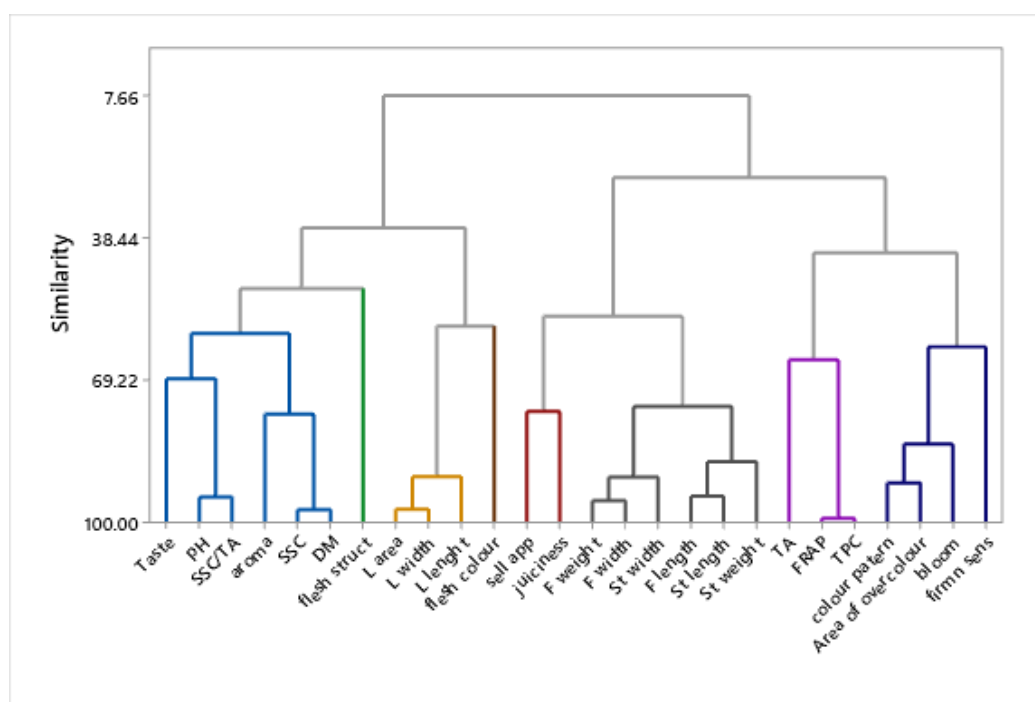


Fig.5. Cluster analysis of plum fruit, stone, and leaf parameters

4 Description of cultivars and selections

Admiral Rigny



Origin: England. Known since 1884.

Ripening time: moderate.

Flowering time: moderate.

Yield: medium productive

Fruit quality: medium size, ovate shaped fruits. Green fruits with moderate bloom. Yellow, soft, moderate juicy and aromatic fruit flesh. Medium large, semi cling stone. High total phenol content and high antioxidant activity. Moderate attractive fruits.

Taste: Good. High soluble solid content and medium acidity. High dry matter content.

Tree vigour / habit / leaf: weak growing trees with upright shoots and large roundish leaves.

Anita



Origin: Sweden, 1994. Cross Laxton's Early x Ruth Gerstetter

Ripening time: early.

Flowering time: moderate.

Yield: medium productive

Fruit quality: very big, circular shaped fruits. Light violet colour with moderate bloom covers 90-100 % of surface. Yellow, moderate firm and moderate juicy fruit flesh. Medium sized, free stone. Low total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. Low soluble solid content and medium acidity. Low dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and very large very long leaves.

Avalon



Origin: England.

Ripening time: moderate.

Flowering time: very early.

Yield: medium productive

Fruit quality: big, circular shaped fruits. Pink violet over colour with moderate bloom covers 70-80 % of surface. Whitish, moderate soft, very juicy and aromatic fruit flesh. Medium sized, free stone. Moderate total phenol content and antioxidant activity. Very attractive fruits.

Taste: very good. Moderate soluble solid content and high acidity. High dry matter content.

Tree vigour / habit / leaf: strong growing trees with upright shoots and large normal shaped leaves.

Belle de Louvain



Origin: Belgium. Known since 1886.

Ripening time: moderate.

Flowering time: moderate.

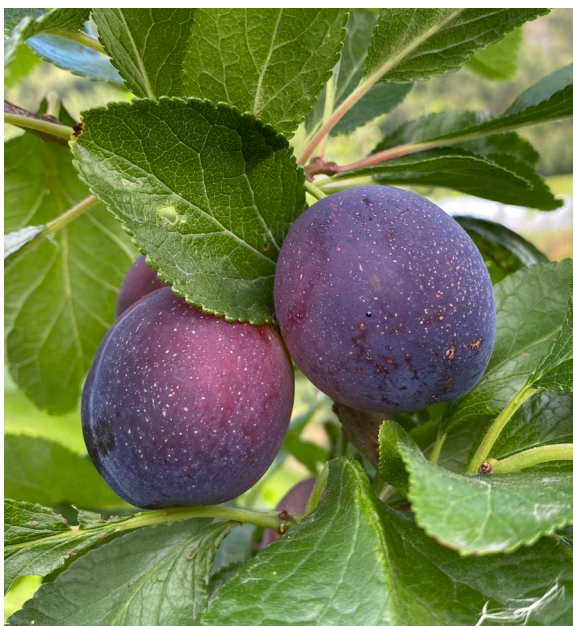
Yield: medium productive

Fruit quality: Very big, elliptic fruits. Pink violet over colour with moderate bloom covers 70 % of surface. Whitish, moderate soft, very juicy and low aromatic fruit flesh. Small, free stone. Very high total phenol content and high antioxidant activity. Attractive fruits.

Taste: Good. Moderate soluble solid content and medium acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots.

Bleue de Belgique



Origin: Belgium. Known since 1850.

Ripening time: moderate.

Flowering time: moderate.

Yield: medium productive

Fruit quality: medium size, oblong shaped fruits. Dark violet over colour with strong bloom covers 100 % of surface. Yellow, moderate firm, moderate juicy and aromatic fruit flesh. Small, semi cling stone. Very high total phenol content and high antioxidant activity. Moderate attractive fruits.

Taste: Average. Moderate soluble solid content and medium acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots.

Blue Rock



Origin: England. Known since 1891.

Ripening time: moderate.

Flowering time: very early.

Yield: low productive. Need for pollen variety with the same flowering time

Fruit quality: small size. Dark violet over colour with moderate bloom covers 100 % of surface. Very small, semi cling stone. High total phenol content and antioxidant activity.

Taste: Good. Moderate soluble solid content and medium acidity. High dry matter content.

Czar



Origin: England. Known since 1874.

Ripening time: early.

Flowering time: moderate. Self-fertile

Yield: medium productive

Fruit quality: medium size, circular shaped fruits. Pink violet over colour with moderate bloom covers 80-90 % of surface. Yellow, moderate firm and moderate juicy fruit flesh. Small, free stone. High total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. Low soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Diana



Origin: Romania.

Ripening time: early.

Flowering time: moderate.

Yield: low productive

Fruit quality: big, oblong fruits. Pink violet over colour with moderate bloom covers 70 % of surface. Yellow, very firm and moderate juicy, not aromatic fruit flesh. Medium, semi cling stone. Very low total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. Very low soluble solid content and low acidity. Very low dry matter content.

Tree vigour / habit / leaf: moderate growing trees with horizontal shoots and medium sized, round leaves.

Edda



Origin: Norway. 1971.

Ripening time: early.

Flowering time: early

Yield: higher than average productivity

Fruit quality: Big, ovate fruits. Blue violet over colour with moderate bloom covers 80-90 % of surface. Yellow green, moderate firm, moderate juicy and very aromatic fruit flesh. Medium, semi cling stone. Moderate total phenol content and antioxidant activity. Very attractive fruits.

Taste: Very good. Low soluble solid content and low acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and small, normal shaped leaves.

Edwards



Origin/breeder: USA, chance seedling, 1930.

Ripening time: moderate.

Flowering time: late

Yield: lower than average productivity

Fruit quality: extremely big, ovate fruits. Pink violet over colour with moderate bloom covers 80-90 % of surface. Yellow, very firm, not juicy and low aromatic fruit flesh. Large, semi cling stone. High total phenol content and antioxidant activity. Very attractive fruits.

Taste: Not tasty. Medium soluble solid content and high acidity. Medium dry matter content.

Tree vigour / habit / leaf: strong growing trees with partially upright shoots.

Emil



Origin/breeder: Sweden, 1978. Cross Jefferson x Rein Claude d'Althanns

Ripening time: moderate.

Flowering time: moderate.

Yield: lower than average productivity

Fruit quality: medium size, oval fruits. Red over colour covers 70 % of surface. Yellow and juicy fruit flesh. Medium sized, semi cling stone. Moderate total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Good. Medium soluble solid content and very low acidity. Medium dry matter content.

Tree vigour / habit / leaf:

Engelsk sviske



Origin/breeder: England. Known since 1874.

Ripening time: early.

Flowering time: moderate. Self-fertile

Yield: medium productive

Fruit quality: Small, ovate fruits. Dark violet over colour with strong bloom covers 50-60 % of surface. Yellow, moderate soft and moderate juicy, aromatic fruit flesh. Small, free stone. High total phenol content and antioxidant activity. Not attractive fruits.

Taste: Average. Low soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Excalibur



Origin/breeder: England, 1989.

Ripening time: moderate.

Flowering time: moderate.

Yield: lower than average productivity

Fruit quality: big, oblong fruits. Light violet over colour with moderate bloom covers 60 % of surface. Orange, moderate firm and moderate juicy, aromatic fruit flesh. Medium sized, free stone. Moderate total phenol content and antioxidant activity. Very attractive fruits.

Taste: Very good. Medium soluble solid content and low acidity. Medium dry matter content.

Tree vigour / habit / leaf: strong growing trees with partially upright shoots and very large, prolonged leaves.

Experimentalfältets Sviske



Origin/breeder: Sweden. Known since 1865.

Ripening time: moderate.

Flowering time: moderate.

Yield: medium productive

Fruit quality: Small, circular shaped fruits. Pink violet over colour with moderate bloom covers 80-90 % of surface. Yellow, moderate firm and moderate juicy fruit flesh. Small, free stone. High total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. Very high soluble solid content and high acidity. Very high dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Frostapomme



Origin/breeder: Norway.

Ripening time: early.

Flowering time: moderate.

Yield: lower than average productivity

Fruit quality: very small, ovate fruits. Pink violet over colour with moderate bloom covers 70-80 % of surface. Yellow, moderate soft and moderate juicy fruit flesh. Very small, cling stone. Medium total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. Medium soluble solid content and high acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and very small leaves.

Grand Duke



Origin/breeder: England. Known since 1876.

Ripening time: very late.

Flowering time: late.

Yield: medium productive

Fruit quality: big, ovate fruits. Pink violet over colour with strong bloom covers 90-100 % of surface. Orange, moderate firm and moderate juicy, aromatic fruit flesh. Large, cling stone. High total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. Medium soluble solid content and high acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, prolonged leaves.

Gul sukkerplomme



Origin/breeder: Norway. Known since 1874.

Ripening time: early.

Flowering time: moderate.

Yield: medium productive

Fruit quality: very small, circular shaped fruits. Yellow green over colour with moderate bloom covers 20 % of surface. Yellow green, moderate soft and moderate juicy, low aromatic fruit flesh. Small, free stone. High total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: lower than average. Low soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Gulplomme Hallan



Origin/breeder: Norway. Known since 1874.

Ripening time: early.

Flowering time: moderate.

Yield: medium productive

Fruit quality: small, elliptic fruits. Yellow over colour with moderate bloom covers 10 % of surface. Yellow, moderate firm and not juicy, low aromatic fruit flesh. Small, free stone. High total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: average. Low soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Haganta



Origin/breeder: Germany, 2005.

Ripening time: very late.

Flowering time: early.

Yield: higher than average productivity

Fruit quality: Big, ovate fruits. Light violet over colour with strong bloom covers 100 % of surface. Yellow, moderate firm and low juicy, aromatic fruit flesh. Medium size, free stone. Very high total phenol content and very high antioxidant activity. Moderate attractive fruits.

Taste: Average. Medium soluble solid content and high acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and medium sized, normal shaped leaves.

Helgøyplomme



Origin/breeder: Norway. Known since 1960.

Ripening time: moderate.

Flowering time: late

Yield: very low productivity

Fruit quality: Big, ovate fruits. Light violet over colour with little bloom covers 40-50 % of surface. Yellow, moderate soft and moderate juicy aromatic fruit flesh. Medium, semi cling stone. High total phenol content and antioxidant activity. Very attractive fruits.

Taste: very good. Low soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: strong growing trees with upright shoots and medium sized, normal shaped leaves.

Herman



Origin/breeder: Sweden, 1974. Cross Czar x Ruth Gerstetter

Ripening time: very early.

Flowering time: moderate.

Yield: lower than average productivity

Fruit quality: medium size, oval fruits. Pink violet over colour with strong bloom covers 100 % of surface. Yellow, moderate firm and moderate juicy, low aromatic fruit flesh. Small, free stone. Moderate total phenol content and antioxidant activity. Attractive fruits.

Taste: Good. Low soluble solid content and low acidity. Low dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and very large, normal shaped leaves.

Ive



Origin/breeder: Sweden, 1977. Seedling Reine Claude d'Althanns.

Ripening time: late

Flowering time: moderate

Yield: higher than average productivity

Fruit quality: medium size, circular shaped fruits. Pink violet over colour with moderate bloom covers 80-90 % of surface. Yellow, moderate firm and moderate juicy fruit flesh. Medium size, free stone. Moderate total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. High soluble solid content and very low acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Jefferson



Origin/breeder: USA. Known since 1825.

Ripening time: late.

Flowering time: moderate.

Yield: medium productive

Fruit quality: big, elliptic shaped fruits. Yellow green over colour with little bloom covers 30 % of surface. Orange, moderate firm and moderate juicy, very aromatic fruit flesh. Large, semi cling stone. Low total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Very good. High soluble solid content and very low acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and large, roundish leaves.

Jubileum



Origin/breeder: Sweden, 1988. Cross Giant x Yakima.

Ripening time: moderate.

Flowering time: moderate.

Yield: very productive

Fruit quality: very big, elliptic fruits. Dark violet over colour with moderate bloom covers 80-90 % of surface. Orange, moderate firm and very juicy fruit flesh. Large, semi cling stone. Medium total phenol content and antioxidant activity. Excellent fruit appearance.

Taste: Good. Medium soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: weak growing trees with partially upright shoots and medium sized, normal shaped leaves.

Kirke



Origin/breeder: England. Known since 1830.

Ripening time: moderate.

Flowering time: moderate.

Yield: Low productivity

Fruit quality: big, circular shaped fruits. Dark violet over colour with strong bloom covers 80-90 % of surface. Yellow green, firm and moderate juicy, aromatic fruit flesh. Medium size, free stone. Medium total phenol content and antioxidant activity. Attractive fruits.

Taste: Good. Moderate soluble solid content and medium acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Cacanska Lepotica



Origin/breeder: Serbia, 1961.

Ripening time: early.

Flowering time: moderate.

Yield: very productive

Fruit quality: big, elliptic fruits. Dark violet over colour with strong bloom covers 100 % of surface. Yellow green, firm and moderate juicy, low aromatic fruit flesh. Large, free stone. High total phenol content and antioxidant activity. Attractive fruits.

Taste: Average. Very low soluble solid content and medium acidity. Very low dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and small, roundish leaves.

Mallard



Origin/breeder: England. Known since 1885.

Ripening time: early.

Flowering time: moderate.

Yield: medium productive

Fruit quality: medium size, elliptic fruits. Orange yellow over colour with moderate bloom covers 60 % of surface. Yellow green, moderate firm, juicy and very aromatic fruit flesh. Medium size, semi cling stone. Low total phenol content and antioxidant activity. Very attractive fruits.

Taste: Good. Medium soluble solid content and very low acidity. Medium dry matter content.

Tree vigour / habit / leaf: strong growing trees with upright shoots and small, roundish leaves.

Mount Royal



Origin/breeder: Canada. Known since 1830.

Ripening time: late.

Flowering time: late

Yield: medium productive

Fruit quality: Small size, circular shaped fruits. Dark violet over colour with strong bloom covers 90 % of surface. Orange, moderate firm and not juicy, very aromatic fruit flesh. Small, semi cling stone. Very high total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Good. High soluble solid content and low acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and very small, normal shaped leaves.

Njøs II



Origin: Norway. Selection number.

Ripening time: moderate.

Flowering time: moderate.

Yield: not productive

Fruit quality: big, circular shaped fruits. Red over colour with moderate bloom covers 50 % of surface. Yellow, firm, moderate juicy and aromatic fruit flesh. Semi cling stone. Moderate total phenol content and antioxidant activity. Very attractive fruits.

Taste: Very good. Medium soluble solid content and high acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and medium sized, prolonged leaves.

NPr 152



Origin: Norway. Selection number.

Ripening time: early.

Flowering time: early

Yield: low productive

Fruit quality: medium size, circular shaped fruits. Orange yellow over colour with little bloom covers 60-70 % of surface. Orange, moderate firm and moderate juicy, low aromatic fruit flesh. Medium size, free stone. Moderate total phenol content and antioxidant activity. Attractive fruits.

Taste: Very good. Medium soluble solid content and low acidity. Medium dry matter content.

Tree vigour / habit / leaf: strong growing trees with partially upright shoots and very large, round leaves.

NPr 3403



Origin: Norway. Selection number.

Ripening time: early.

Flowering time: late

Yield: low productive

Fruit quality: big, elliptic fruits. Red over colour with moderate bloom covers 30 % of surface. Orange, moderate firm and moderate juicy, aromatic fruit flesh. Free stone. Low total phenol content and antioxidant activity. Very attractive fruits.

Taste: Very good. Low soluble solid content and low acidity. Low dry matter content.

Tree vigour / habit / leaf: strong growing trees with partially upright shoots and medium sized, normal shaped leaves.

NPr 3541



Origin: Norway. Selection number.

Ripening time: early.

Flowering time: early

Yield: medium productive

Fruit quality: Very big, elliptic fruits. Dark violet over colour with moderate bloom covers 100 % of surface. Yellow, moderate firm and moderate juicy, aromatic fruit flesh. Free stone. Medium total phenol content and antioxidant activity. Very attractive fruits.

Taste: Excellent. Low soluble solid content and low acidity. Low dry matter content.

Tree vigour / habit / leaf: strong growing trees with upright shoots and medium sized, prolonged leaves.

NPr 878



Origin: Norway. Selection number.

Ripening time: moderate.

Flowering time: early.

Yield: medium productive

Fruit quality: very big, elliptic fruits. Yellow, yellow green over colour with little bloom covers 10 % of surface. Yellow orange, soft and moderate juicy, low aromatic fruit flesh. Semi cling stone. Moderate total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Good. Medium soluble solid content and high acidity. Medium dry matter content.

Tree vigour / habit / leaf: strong growing trees and large, roundish leaves.

NPr 458



Origin: Norway. Selection number.

Ripening time: late.

Flowering time: late.

Yield: medium productive

Fruit quality: big, circular shaped fruits. Orange yellow over colour with little bloom covers 30 % of surface. Yellow, very firm and low juicy, low aromatic fruit flesh. Free stone. Low total phenol content and moderate antioxidant activity. Very attractive fruits.

Taste: Good. Very low soluble solid content and low acidity. Low dry matter content.

Tree vigour / habit / leaf: strong growing trees with medium sized, roundish leaves.

NPr 696



Origin: Norway. Selection number.

Ripening time: moderate.

Flowering time: moderate.

Yield: medium productive

Fruit quality: very big, obovate fruits. Pink violet over colour with moderate bloom covers 100 % of surface. Yellow, very firm and moderate juicy, low aromatic fruit flesh. Cling stone. High total phenol content and moderate antioxidant activity. Very attractive fruits.

Taste: Good. Medium soluble solid content and low acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees.

Ontario



Origin: USA. Known since 1874.

Ripening time: moderate.

Flowering time: moderate.

Yield: medium productive

Fruit quality: Big, circular shaped fruits. Yellow green colour with little bloom. Yellow, soft and very juicy, low aromatic fruit flesh. Medium size, cling stone. High total phenol content and antioxidant activity. Attractive fruits.

Taste: Good. Medium soluble solid content and low acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and very large, normal shaped leaves.

Opal



Origin: Sweden, 1948. Cross Reine Claude d'Oullins x Early Favourite.

Ripening time: moderate.

Flowering time: moderate.

Yield: very productive

Fruit quality: medium size, ovate fruits. Varying over colour with moderate bloom covers 70-80 % of surface. Orange, firm and moderate juicy, low aromatic fruit flesh. Small, semi cling stone. Moderate total phenol content and antioxidant activity. Attractive fruits.

Taste: Good. Low soluble solid content and low acidity. Low dry matter content.

Tree vigour / habit / leaf: weak growing trees with partially upright shoots and small, normal shaped leaves.

Oullins 'Henjum'



Origin: Norway.

Ripening time: moderate.

Flowering time: moderate.

Yield: low productive

Fruit quality: Big, ovate fruits. Yellow green colour with little bloom. Yellow, moderate soft and very juicy, aromatic fruit flesh. Medium size, semi cling stone. Moderate total phenol content and antioxidant activity. Attractive fruits.

Taste: Very good. Medium soluble solid content and low acidity. Medium dry matter content.

Tree vigour / habit / leaf: strong growing trees with upright shoots and large, normal shaped leaves.

Prosser 84



Origin: USA.

Ripening time: late.

Flowering time: late.

Yield: lower than average productivity

Fruit quality: Very big, obovate fruits. Dark violet over colour with strong bloom covers 100 % of surface. Yellow, very firm and low juicy, low aromatic fruit flesh. Semi cling stone. Low total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: very good. Low soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and medium sized, prolonged leaves.

R 5



Origin: Norway.

Ripening time: moderate.

Flowering time: moderate.

Yield: lower than average productivity

Fruit quality: Big, ovate fruits. Light violet over colour with moderate bloom covers 70 % of surface. Yellow, moderate firm and very juicy, low aromatic fruit flesh. Medium size, semi cling stone. Low total phenol content and antioxidant activity. Very attractive fruits.

Taste: Good. Medium soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: strong growing trees with upright shoots and small, normal shaped leaves.

Raud eplevik



Origin: Norway.

Ripening time: moderate.

Flowering time: moderate.

Yield: low productivity

Fruit quality: Very small, circular shaped fruits. Green over colour with little bloom covers 10-20 % of surface. Yellow, soft and moderate juicy, low aromatic fruit flesh. Small, semi cling stone. Low total phenol content and antioxidant activity. Attractive fruits.

Taste: Good. Medium soluble solid content and low acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots.

Raud Victoria



Origin: Norway.

Ripening time: early.

Flowering time: early.

Yield: higher than average productivity

Fruit quality: Big, oblong fruits. Light violet over colour with moderate bloom covers 50 % of surface. Yellow, very firm and moderate juicy, aromatic fruit flesh. Small, free stone. Medium total phenol content and antioxidant activity. Attractive fruits.

Taste: Very good. Low soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees and medium sized, normal shaped leaves.

Reeves



Origin: Canada, 1940.

Ripening time: moderate.

Flowering time: moderate.

Yield: higher than average productivity

Fruit quality: Big, elliptic fruits. Red, orange / yellow over colour with moderate bloom covers 60-70 % of surface. Orange, yellow, moderate firm and very juicy, aromatic fruit flesh. Very large, semi cling stone. Low total phenol content and antioxidant activity. Very attractive fruits.

Taste: Very good. Low soluble solid content and very low acidity. Low dry matter content.

Tree vigour / habit / leaf: weak growing trees with upright shoots and small, normal shaped leaves.

Reine Claude d'Althanns



Origin: Bohemia (Czech). Known since 1850.

Ripening time: late.

Flowering time: late.

Yield: medium productive

Fruit quality: Big, oblate fruits. Light violet over colour with little bloom covers 50 % of surface. Orange, moderate firm, juicy and aromatic fruit flesh. Medium sized, semi cling stone. Medium total phenol content and antioxidant activity. Very attractive fruits.

Taste: Very good. High soluble solid content and very low acidity. High dry matter content.

Tree vigour / habit / leaf: strong growing trees with partially upright shoots and medium sized, roundish leaves.

Reine Claude d'Oullins



Origin: France. Known since 1800.

Ripening time: late.

Flowering time: moderate.

Yield: not productive

Fruit quality: Big, circular shaped fruits. Green over colour with moderate bloom covers 80-90 % of surface. Yellow, moderate firm and moderate juicy fruit flesh. Small, free stone. High total phenol content and moderate antioxidant activity. Moderate attractive fruits.

Taste: Average. Medium soluble solid content and medium acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Reine Claude grøn



Origin: France. Known since 1525.

Ripening time: late.

Flowering time: moderate.

Yield: medium productive

Fruit quality: Small, circular shaped fruits. Pink violet over colour with moderate bloom covers 80-90 % of surface. Greenish yellow, moderate firm and very juicy, aromatic fruit flesh. Small, semi cling stone. Very high total phenol content and high antioxidant activity. Moderate attractive fruits.

Taste: Average. Very high soluble solid content and medium acidity. Very high dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Reine Claude Noir



Origin: England.

Ripening time: moderate.

Flowering time: late.

Yield: medium productive

Fruit quality: Small, circular shaped fruits. Dark violet over colour with moderate bloom covers 70-80 % of surface. Yellow, moderate soft and moderate juicy, aromatic fruit flesh. Very small, semi cling stone. Moderate total phenol content and antioxidant activity. Attractive fruits.

Taste: Good. Medium soluble solid content and very low acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and medium sized, prolonged leaves.

Reine Claude Souffriau



Origin: Belgium.

Ripening time: moderate.

Flowering time: moderate.

Yield: lower than average productivity

Fruit quality: big, circular shaped fruits. Dark violet over colour with strong bloom covers 80-90 % of surface. Yellow, moderate soft and very juicy, aromatic fruit flesh. Medium, semi cling stone. Low total phenol content and moderate antioxidant activity. Very attractive fruits.

Taste: Good. Medium soluble solid content and low acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and very large, prolonged leaves.

River's Early Prolific



Origin: England. Known since 1830.

Ripening time: early.

Flowering time: moderate.

Yield: medium productive

Fruit quality: very small, oblong fruits. Dark violet over colour with moderate bloom covers 100 % of surface. Yellow, moderate firm and moderate juicy, low aromatic fruit flesh. Very small, free stone. High total phenol content and antioxidant activity. Attractive fruits.

Taste: Good. Medium soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: weak growing trees with partially upright shoots and medium sized, round leaves.

Ruth Gerstetter



Origin: Germany. Known since 1932.

Ripening time: very early.

Flowering time: moderate.

Yield: medium productive

Fruit quality: medium size, **circular shaped** fruits. Pink violet over colour with moderate bloom covers 80-90 % of surface. Yellow green, moderate firm and moderate juicy, low aromatic fruit flesh. Small, free stone. Low total phenol content and antioxidant activity. Attractive fruits.

Taste: Good. Very low soluble solid content and medium acidity. Low dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and medium sized, normal shaped leaves.

Sanctus Hubertus



Origin: Belgium.

Ripening time: early.

Flowering time: late.

Yield: medium productive

Fruit quality: medium size, circular shaped fruits. Pink violet over colour with strong bloom covers 70 % of surface. Yellow, moderate firm and moderate juicy, not aromatic fruit flesh. Small, semi cling stone. High total phenol content and moderate antioxidant activity. Very attractive fruits.

Taste: Average. Medium soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: weak growing trees with partially upright shoots and medium sized, roundish leaves.

Sinikka



Origin: Finland.

Ripening time: early.

Flowering time: early.

Yield: medium productive

Fruit quality: very small, circular shaped fruits. Pink violet over colour with moderate bloom covers 80-90 % of surface. Yellow, moderate firm and moderate juicy fruit flesh. Medium size, free stone. High total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. High soluble solid content and very high acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Søgneplomme



Origin: Norway.

Ripening time: early.

Flowering time: moderate.

Yield: medium productive

Fruit quality: medium size, circular shaped fruits. Pink violet over colour with moderate bloom covers 80-90 % of surface. Yellow, moderate firm and moderate juicy fruit flesh. Medium size, free stone. High total phenol content and moderate antioxidant activity. Moderate attractive fruits.

Taste: Average. Medium soluble solid content and medium acidity. High dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and medium sized, normal shaped leaves.

Sviske frå Tveit



Origin: England. Known since 1874.

Ripening time: moderate.

Flowering time: moderate.

Yield: lower than average productivity

Fruit quality: big, elliptic fruits. Dark violet over colour with strong bloom covers 90 % of surface. Whitish, moderate firm and moderate juicy, low aromatic fruit flesh. Medium size, semi cling stone. Moderate total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. Medium soluble solid content and high acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots.

Thames Cross



Origin: England. Known since 1938.

Ripening time: late.

Flowering time: moderate.

Yield: higher than average productivity

Fruit quality: very big, elliptic fruits. Yellow over colour with little bloom. Whitish, moderate firm and moderate juicy, low aromatic fruit flesh. Large, semi cling stone. Low total phenol content and antioxidant activity. Very attractive fruits.

Taste: Good. Very low soluble solid content and low acidity. Low dry matter content.

Tree vigour / habit / leaf: moderate growing trees with partially upright shoots and medium sized, normal shaped leaves.

Trâneplomme



Origin: Norway. Known since 1800.

Ripening time: late.

Flowering time: late.

Yield: low productive

Fruit quality: Medium size, circular shaped fruits. Brownish red over colour with moderate bloom covers 80-90 % of surface. Yellow, firm and moderate juicy fruit flesh. Medium size, free stone. High total phenol content and antioxidant activity. Moderate attractive fruits.

Taste: Average. Medium soluble solid content and medium acidity. High dry matter content.

Tree vigour / habit / leaf: strong growing trees with upright shoots.

Valor



Origin: Canada, 1967. Cross Imperial Épineuse x Grand Duke.

Ripening time: late.

Flowering time: late.

Yield: very productive

Fruit quality: very big, elliptic fruits. Dark violet over colour with strong bloom covers 100 % of surface. Yellow green, firm and moderate juicy, low aromatic fruit flesh. Very large, semi cling stone. High total phenol content and antioxidant activity. Very attractive fruits.

Taste: Average. medium soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and small, normal shaped leaves.

Victoria



Origin: England. Known since 1840.

Ripening time: moderate.

Flowering time: moderate.

Yield: higher than average productivity

Fruit quality: big, elliptic fruits. Varying pink red over colour with little/moderate bloom covers 60-70 % of surface. Yellow green, moderate soft and very juicy, aromatic fruit flesh. Large, semi cling stone. Medium total phenol content and antioxidant activity. Very attractive fruits.

Taste: very good. Low soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: weak growing trees with partially upright shoots and medium sized, very long leaves.

Victoria NMBU (Ås)



Origin: Norway.

Ripening time: moderate.

Flowering time: moderate.

Yield: lower than average productivity

Fruit quality: Big, elliptic fruits. Orange yellow over colour with moderate bloom covers 50 % of surface. Whitish, moderate firm and moderate juicy, low aromatic fruit flesh. Small, semi cling stone. High total phenol content and antioxidant activity. Very attractive fruits.

Taste: very good. Low soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with horizontal shoots and large, normal shaped leaves.

Vinterplomme



Origin: Norway.

Ripening time: very late.

Flowering time: late.

Yield: higher than average productivity

Fruit quality: very small, elliptic fruits. Green over colour with little bloom. Yellow green, moderate soft and moderate juicy, not aromatic fruit flesh. Small, semi cling stone. Very high total phenol content and high antioxidant activity. Moderate attractive fruits.

Taste: Good. Low soluble solid content and high acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots.

Washington



Origin: USA. Known since 1790.

Ripening time: moderate.

Flowering time: moderate.

Yield: low productive

Fruit quality: big, ovate fruits. Light violet over colour with little bloom covers 40 % of surface. Yellow, moderate soft and moderate juicy, aromatic fruit flesh. Medium size, free stone. Moderate total phenol content and antioxidant activity. Attractive fruits.

Taste: Very good. High soluble solid content and medium acidity. Medium dry matter content.

Tree vigour / habit / leaf: strong growing trees with partially upright shoots and very large, round leaves.

Yakima



Origin: USA. Known since 1902.

Ripening time: moderate.

Flowering time: moderate.

Yield: low productive

Fruit quality: very big, elliptic fruits. Pink violet over colour with moderate bloom covers 50 % of surface. Orange, moderate soft and moderate juicy, aromatic fruit flesh. Medium size, free stone. Medium total phenol content and antioxidant activity. Attractive fruits.

Taste: Average. Medium soluble solid content and low acidity. Medium dry matter content.

Tree vigour / habit / leaf: moderate growing trees with upright shoots and large, normal shaped leaves.

5 Conclusions

Comprehensive phenological, pomological, agronomical, and biochemical studies of sixty-four plum cultivars and selections were performed in 2018 – 2021.

55% of tested cultivars had fruits with more than 70% of surface covered by overcolour. Among them, almost half had a full blush. Dark fruit colours were dominating overcolours. More than half of studied cultivars had dark violet, dark blue or violet blue fruits.

Soluble solid and dry matter contents, and fruit juiciness were the most stable plum characters ($CV\% < 20$), while fruit shape and fruit blush, tree productivity, phenol content and antioxidant activity had highest variability ($CV\% 38.1 - 46.7$).

Along with some commercial cultivars and new selections, heritage cultivars Edwards, Prosser 84, Yakima, Belle de Louvain, Thames Cross have very big fruits (71 – 90 g).

The average content of soluble solid content was 15.5% and varied from low 10.2% up to very high 23.4%. Cultivars Experimental feltets Sviske, Reine Claude grøn and Italiensk Sviske accumulated the highest soluble solid content.

Titrateable acidity varied from very low 0.69% till high 3.09%, and cultivars Sinikka, Grand Duke, Italiensk Sviske, Sviske frå Tveit and Vinterplomme had the most acid fruits.

Total phenol content varied from 65.9 mgGAE/100g till 370 mgGAE/100g, and cultivars Bleue de Belgique, Reine Claude grøn, Vinterplomme, and Mount Royal accumulated the highest fruit phenol content.

Cultivars Jefferson, Mallard and Mount Royal had the most aromatic fruits.

13 cultivars and selections received very high overall sensor evaluation (taste, attractiveness, aroma) score, among them heritage cultivars Helgøyplomme, Reine Claude d'Althanns and Mallard.

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Photoes: The cultivars Admiral Rigny, Belle de Louvain, Bleue de Belgique, Engelsk sviske, Grand Duke, Jefferson, Kirkes, Njøs II, NPr 152, NPr 3541, Oullins 'Henjum', Raud eplevik, Sviske frå Tveit, Thames Cross - Stein Harald Hjeltne. The cultivars Jubileum, Lepotica, Prosser 84, R5, Søgneplomme, Valor - Oddmund Frøynes. The cultivar Emil - Kari Grønnerød. The cultivar Sinikka – Finn Måge. The cultivars Tråneplomme, Yakima - <https://www.nibio.no/tema/mat/plantegenetiske-ressurser/nytteplanter-i-norge/hagebruksplanter/fruktsorter/plomme> . Rest of photos - www.fruktsorter.no.

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Appendix 1.

Chemical contents in the flesh of 60 plum cultivars

No	Plum cultivar	Location	No	Plum cultivar	Location
1	Admiral Rigny	Njøs	31	NPr 458	Njøs
2	Anita	Njøs	32	NPr 696	Njøs
3	Avalon	Njøs	33	NPr 878	Njøs
4	Bleue de Belgique	Njøs	34	Ontario	Njøs
5	Blue Rock	NMBU	35	Opal	NIBIO
6	Czar	Njøs	36	Reine Claude d'Oullins 'Henjum'	Njøs
7	Diamond	NMBU	37	Prosser 84	Njøs
8	Diana	Njøs	38	R5	Njøs
9	Edda	Njøs	39	Raud eplevik	Njøs
10	Edwards	Njøs	40	Raud Victoria	Njøs
11	Emil	NMBU	41	Reeves	NIBIO
12	Excalibur	Njøs	42	Reine Claude d'Althanns	Njøs
13	Sviske	NMBU	43	Reine Claude d'Oullins	NMBU
14	Frostapomme	Njøs	44	Reine Claude grøn	NMBU
15	Grand Duke	Njøs	45	Reine Claude Noir	Njøs
16	Haganta	Njøs	46	Reine Claude Souffriau	Njøs
17	Helgøypomme	Njøs	47	River's Early Prolific	Njøs
18	Herman	Njøs	48	Ruth Gerstetter	Njøs
19	Italiensk Sviske	NMBU	49	Sanctus Hubertus	Njøs
20	Ive	NMBU	50	Sinikka	NMBU
21	Jefferson	Njøs	51	Søgneplomme	NMBU
22	Jubileum	NIBIO	52	Sviske frå Tveit	Njøs
23	Kirkes	Njøs	53	Thames Cross	Njøs
24	Cacaska Lepotica	NIBIO	54	Trâneplomme	NMBU
25	Mallard	NIBIO	55	Valor	NIBIO
26	Mount Royal	Njøs	56	Victoria	NIBIO
27	Njøs II	Njøs	57	Victoria 'NMBU'	Njøs
28	NPr 152	Njøs	58	Vinterplomme	Njøs
29	NPr 3403	Njøs	59	Washington	Njøs
30	NPr 3541	Njøs	60	Yakima	Njøs

Methods and instrumentations

Inductively coupled plasma with optic emission spectrometry (ICP-OES) was used for determination of elements in sample extracts (Fotirić Akšić, 2022a,b). The instrument consisted of Thermo Scientific iCAP 6500 Duo ICP (Thermo Fisher Scientific, Cambridge, United Kingdom) spectrometer equipped with RACID86 Charge Injector Device (CID) detector. High-performance anion-exchange chromatography with pulsed amperometric detection (HPAEC-PAD) was used for sugars and organic acids determination, by using ICS 3000 DP liquid chromatograph (Dionex, Sunnyvale, California, USA) and analytical columns Carbo Pac PA100 (4×250 mm) and IonPac AS15, 4x250 mm, respectively (Dionex, Sunnyvale, California, USA) (Fotirić Akšić, 2022 a,b). Ultra-high-performance liquid chromatography system with diode array detection and mass spectrometry (UHPLC-DAD MS/MS) was used for quantification of phenolic compounds in sample extract by using equipment Dionex Ultimate 3000 UHPLC, TSQ Quantum Access Max triple quadruple (QqQ) mass spectrometer (Thermo Fisher Scientific, Bremen, Germany) (Fotirić Akšić, 2022a,b). Ultraviolet-visible spectrophotometry was used for measurement of antioxidant activity of sample extracts. Antioxidant activity was observed through the total phenolic content (TPC) and relative scavenging activity (RSA) by using UV-Vis spectrophotometer (Thermo Scientific Evolution 600; Thermo Fisher Scientific Inc.). Procedures of method's measurements for each instrumental technique were previously described in our recent studies (Fotirić Akšić, 2022 a,b).

Table 1. Concentration (g/kg) of sugars in plum cultivars.

Plum cultivar	Sor- bitol	Tre- halose	Ara- binose	Glu- kose	Fruc- tose	Suc- rose	Tura- nose	Gly- cerol	Galac- titol	Galac- tose	Ribose	Isomal- tose	Isomal- totriose	Mal- tose	Malto- triose	Manni- -tol	Xylose	Melibi- ose	Panos- e	Ramn- ose	Raffin- ose	Stachy- ose
Admiral	101.27	1.02	1.57	245.65	211.27	219.33	17.96	0.63	1.79	21.40	2.01	1.65	1.99	4.13	0.74	1.88	2.86	8.11	4.33	5.89	1.03	1.41
Rigny																						
Anita	4.16	0.63	0.32	183.62	179.73	155.03	2.31	7.20	0.75	31.22	3.94	2.34	0.68	1.62	1.59	3.34	0.24	8.48	3.06	0.93	0.72	0.96
Avalon	84.26	1.00	1.57	226.33	178.65	199.65	10.66	1.00	1.99	35.66	3.26	4.66	2.14	2.89	0.86	1.90	2.65	5.21	6.33	8.57	0.89	0.98
Bleue de Belgique	119.15	2.84	1.65	245.12	213.56	140.97	14.43	0.89	2.63	16.17	1.98	0.57	4.48	1.56	0.30	0.34	12.23	7.14	6.00	2.27	2.80	3.01
Blue rock	94.47	2.17	1.24	211.27	195.99	67.43	11.38	0.62	2.02	12.70	1.48	0.36	3.38	1.12	0.14	0.17	9.71	5.60	4.70	1.70	5.32	5.71
Czar	92.34	1.84	0.66	256.28	193.86	156.97	15.57	0.96	3.93	29.35	7.27	1.88	1.48	11.95	0.61	3.26	5.22	4.82	4.27	6.38	1.47	0.77
Diamond	112.46	4.37	1.94	319.13	204.78	96.51	7.14	0.71	7.62	31.86	7.98	0.70	2.81	2.42	0.30	0.29	7.35	5.79	4.32	1.44	4.08	4.34
Diana	100.45	4.11	1.94	244.94	183.54	102.50	6.81	0.77	6.85	28.57	7.21	0.75	2.61	2.25	0.38	0.41	7.01	5.58	4.14	1.47	0.96	1.61
Edda	69.06	0.17	0.24	326.42	158.68	170.06	10.50	0.87	4.32	34.78	8.69	2.02	1.76	24.40	0.68	2.18	7.08	4.90	0.88	2.57	2.40	0.86
Edwards	85.19	2.36	1.02	241.02	171.01	83.11	8.66	1.06	5.14	33.67	1.59	4.51	3.03	13.74	0.19	7.68	3.39	7.60	1.88	1.71	1.37	1.76
Emil	120.33	0.61	0.96	170.31	142.18	227.09	12.33	1.64	2.24	14.95	3.31	1.74	0.96	3.61	0.33	1.69	4.56	8.17	4.09	5.74	2.17	3.11
Excalibur	114.53	0.82	0.89	211.44	178.17	227.29	15.38	0.45	1.36	16.49	1.78	1.29	1.35	4.08	0.28	2.10	5.41	9.48	4.47	6.63	0.93	1.36
Experimental	109.06	2.03	1.23	286.11	270.94	78.37	9.28	0.25	1.43	27.74	0.97	1.28	3.42	6.39	0.25	0.19	13.36	6.75	5.12	2.11	6.55	1.07
fältets Sviske																						
Frosta-	133.85	0.14	0.36	205.75	141.50	114.10	7.38	2.29	2.39	21.61	4.63	1.92	1.41	4.07	0.57	2.17	6.00	10.46	5.27	8.40	2.75	4.55
plomme																						
Grand Duke	91.65	0.99	1.15	235.69	201.33	225.33	16.99	0.59	1.33	19.89	1.94	1.55	1.66	3.79	0.66	1.53	2.33	7.86	4.13	6.13	0.99	1.89
Haganta	103.54	0.52	0.47	308.74	151.66	106.14	4.88	1.01	4.00	32.03	6.66	2.30	2.41	17.08	0.59	1.78	5.95	4.93	0.56	3.53	2.73	1.07
Helgøy-	71.65	0.91	2.33	175.33	145.67	112.26	8.32	0.57	1.88	21.33	3.26	0.87	3.26	14.26	0.72	2.00	4.65	3.53	1.99	4.33	1.10	1.96
plomme																						
Herman	164.54	1.35	1.00	210.19	275.64	127.16	20.57	1.03	3.21	33.29	2.74	0.26	0.23	5.86	0.17	0.07	6.48	3.05	4.04	1.48	2.99	2.52
Ive	64.64	0.74	1.04	221.99	189.58	185.07	19.54	0.34	1.31	24.93	2.21	3.04	2.55	3.63	0.24	6.28	2.83	2.33	15.57	14.68	2.46	1.18
Jefferson	84.65	1.26	0.90	194.65	175.65	135.65	18.65	0.36	2.45	24.65	4.65	0.95	3.60	14.67	0.48	1.99	6.65	4.33	1.02	4.65	3.14	2.65
Jubileum	104.84	0.29	0.61	231.39	150.04	269.02	16.24	2.15	1.70	31.13	4.91	2.40	2.87	6.87	0.42	1.49	5.00	5.67	3.97	5.59	1.94	1.58
Kirkes	82.33	5.32	1.65	258.66	171.56	152.33	5.23	1.00	2.33	32.36	5.63	0.92	1.99	4.33	0.33	0.59	4.33	4.37	2.15	5.67	1.25	2.14
Canska	114.32	34.66	1.10	248.94	244.51	97.03	22.67	0.22	9.80	40.28	5.67	3.68	2.08	16.94	1.33	3.70	11.56	7.11	1.71	2.71	2.97	1.13
Lepotica																						
Mallard	91.11	10.49	0.39	247.11	186.28	168.41	6.75	1.67	2.85	34.57	11.84	1.44	0.62	32.29	0.74	2.92	8.88	5.59	1.33	2.24	2.33	0.87

Plum cultivar	Sor-bitol	Tre-halose	Ara-binose	Glu-kose	Fruc-tose	Suc-rose	Tura-nose	Gly-cerol	Galac-titol	Galac-tose	Ribose	Isomal-tose	Isomal-totriose	Mal-tose	Malto-triose	Manni-tol	Xylose	Melibi-ose	Panos-e	Ramn-ose	Raffin-ose	Stachy-ose
Mount Royal	118.28	2.84	1.89	221.39	196.93	180.54	15.95	0.30	1.88	21.68	7.81	4.21	2.72	23.08	0.55	7.81	4.63	6.38	20.56	18.51	0.53	1.31
Njøs II	61.54	0.51	0.42	294.95	160.89	127.51	4.37	1.54	1.91	34.80	5.76	2.24	2.95	16.76	0.35	1.02	3.58	4.09	0.10	4.00	2.32	1.10
NPr 152	72.26	0.28	0.25	225.89	150.31	193.99	4.00	1.57	2.14	20.38	3.06	1.83	1.41	3.17	0.55	1.85	4.81	8.03	4.65	7.06	1.28	1.03
NPr 3403	53.22	0.19	0.39	200.09	75.68	128.33	2.70	2.09	1.61	20.19	4.13	1.31	1.31	2.98	0.56	1.70	4.86	8.56	3.69	5.87	2.21	2.76
NPr 3451	51.09	0.47	0.21	366.47	135.78	133.54	6.02	1.63	1.23	19.37	3.48	1.05	1.36	2.85	0.51	1.70	4.86	8.46	3.68	6.35	2.28	2.89
NPr 458	27.39	0.36	0.28	94.81	196.10	110.64	1.10	0.95	3.15	24.52	1.44	2.84	1.83	3.21	0.68	2.18	4.49	6.87	6.63	8.76	2.34	6.10
NPr 696	49.36	0.26	0.08	265.66	160.39	136.99	4.13	1.31	2.74	19.99	2.43	2.34	1.40	3.48	0.52	1.89	4.90	7.64	4.89	7.41	2.28	4.66
NPr 878	110.26	0.11	0.30	202.43	83.61	110.46	6.08	1.89	1.97	17.80	3.81	1.58	1.16	3.35	0.47	1.78	4.94	8.62	4.34	6.92	2.26	3.75
Ontario	88.65	1.25	1.79	204.67	198.37	201.33	13.66	0.73	1.70	22.33	2.26	1.77	2.01	4.33	0.25	1.63	2.57	9.00	5.32	5.66	1.15	1.65
Opal	76.03	4.18	0.37	230.89	168.50	198.71	10.06	1.75	4.38	26.58	9.45	2.51	3.55	13.41	0.74	2.17	7.22	6.98	0.59	5.93	3.08	1.82
Oullins 'Henjum'	91.66	0.86	1.05	201.67	155.66	145.62	9.66	0.37	3.53	25.62	5.63	1.00	4.13	19.82	0.65	2.65	7.89	5.62	1.66	5.62	4.33	3.00
Prosser 84	102.71	0.32	0.30	166.51	60.95	135.74	3.84	0.78	2.18	32.12	4.25	1.67	2.45	6.70	0.30	1.34	4.25	5.77	1.34	4.88	1.97	1.76
R5	61.03	0.42	0.32	167.38	182.10	115.31	11.26	1.09	3.58	27.78	1.64	3.23	2.08	3.64	0.79	2.48	5.10	7.80	7.52	9.93	2.66	1.92
Raud Eplevik	85.33	0.95	0.93	223.26	192.36	214.66	15.27	0.53	1.54	18.33	1.85	1.36	1.48	3.26	0.52	1.14	1.26	6.76	3.85	6.33	0.96	1.63
Raud Victoria	28.33	0.22	0.48	349.79	136.61	139.12	6.75	0.97	1.16	16.43	2.42	1.01	1.23	3.11	0.33	1.68	4.63	8.03	3.67	5.66	2.32	2.71
Reeves	67.79	1.00	0.73	223.43	182.09	279.02	29.76	1.47	2.28	39.61	13.12	2.04	3.87	37.54	0.54	1.21	4.01	4.58	0.17	4.39	3.38	1.29
Reine Claude d'Althanns	42.05	1.01	0.08	222.74	173.23	169.68	20.92	1.38	4.37	39.07	4.58	0.73	0.59	24.59	0.85	3.23	5.25	6.30	1.50	2.45	2.59	0.92
Reine Claude d'Oullins	102.10	0.32	0.30	165.52	160.59	134.93	3.82	0.78	2.16	31.92	4.23	1.66	2.44	6.66	0.30	1.34	4.23	5.74	1.33	4.85	1.96	1.75
Reine Claude Grøn	88.99	2.24	1.48	182.69	239.72	189.62	21.05	0.32	3.51	29.20	4.55	2.19	2.51	3.38	0.60	1.10	7.28	5.76	4.82	5.12	3.76	6.92
Reine Claude Noire	73.35	2.00	0.65	220.33	188.63	207.80	29.45	0.60	1.28	20.09	6.16	0.33	1.26	5.16	0.30	0.19	6.81	2.90	3.88	1.42	2.83	0.33
Reine Claude Souffriau	97.54	0.75	1.00	238.79	193.77	226.27	15.17	0.70	4.02	32.08	0.60	3.83	2.47	3.38	1.02	2.37	5.63	7.00	5.99	10.00	0.67	0.70
River's Early Prolific	77.52	1.02	0.68	200.83	172.88	151.28	16.19	0.75	1.88	26.93	4.60	0.78	2.14	13.20	0.61	0.54	5.77	6.29	2.54	2.36	1.96	1.01
Ruth Gerstetter	48.96	3.26	0.84	205.65	163.66	131.33	11.26	1.65	1.96	31.26	5.62	1.00	2.33	9.65	0.37	2.02	5.03	3.21	1.53	4.65	2.05	0.56
Sanctus Hubertus	47.74	1.00	0.66	156.69	206.32	131.11	14.35	1.10	2.90	35.52	7.20	2.72	2.77	19.75	0.71	2.25	5.04	7.22	4.49	6.73	2.42	4.02

Plum cultivar	Sor-bitol	Tre-halose	Ara-binose	Glu-kose	Fruc-tose	Suc-rose	Tura-nose	Gly-cerol	Galac-titol	Galac-tose	Ribose	Isomal-tose	Isomal-totriose	Mal-tose	Malto-triose	Manni-tol	Xylose	Melibi-ose	Panos-e	Ramn-ose	Raffin-ose	Stachy-ose
Sinikka	104.63	2.29	1.25	225.62	180.75	75.83	4.72	2.01	1.12	20.01	4.01	0.97	1.30	2.31	0.61	1.53	4.50	7.84	3.27	6.02	1.98	2.74
Søgne-plomme	98.54	1.03	0.83	194.78	189.89	191.67	1.47	1.22	0.48	37.62	1.03	1.46	3.11	4.39	0.28	0.13	2.11	7.67	3.06	1.07	6.16	1.00
Sviska Frå Tveit	54.64	5.29	3.34	257.68	225.38	76.78	17.71	0.32	2.82	30.67	2.57	1.01	1.49	8.36	0.31	6.16	3.62	1.96	16.53	14.63	4.34	10.37
Thames Cross	89.66	1.12	1.87	215.33	155.37	102.36	11.02	0.43	2.33	18.66	4.70	1.02	2.15	25.33	0.33	1.86	5.90	4.22	1.57	3.25	2.02	1.74
Tråne-plomme	134.36	4.82	1.68	253.67	221.58	73.33	17.93	2.18	2.31	28.98	7.14	1.04	1.71	8.53	0.53	0.35	7.33	6.19	4.37	1.36	4.22	4.21
Valor	109.45	1.28	0.95	278.16	205.84	219.73	25.75	0.53	3.68	45.58	10.80	1.17	3.58	2.86	0.52	1.79	6.07	6.80	0.31	6.60	2.64	1.89
Victoria	87.65	2.24	1.51	263.24	206.28	195.91	29.90	1.08	1.54	32.16	2.44	2.73	4.65	7.95	0.33	2.74	2.50	4.75	6.66	9.51	2.42	3.98
Victoria 'NMBU'	66.98	2.72	1.58	275.54	163.07	125.60	33.14	1.68	2.48	39.00	2.36	3.05	3.35	14.06	0.40	0.95	3.29	3.79	0.12	3.69	1.39	1.02
Vinter-plomme	54.96	0.21	0.42	186.60	178.15	112.51	2.80	2.17	1.67	20.86	4.27	1.37	1.37	3.09	0.59	1.76	5.03	8.85	3.82	6.08	2.30	2.86
Washington	68.95	2.36	0.79	235.63	165.66	178.65	7.32	1.12	4.33	21.66	4.33	0.89	1.24	12.66	1.09	0.69	2.22	6.54	3.37	2.27	2.04	1.12
Yakima	75.65	0.83	0.57	204.33	168.95	175.66	11.74	2.99	1.43	24.52	4.11	2.98	3.01	6.52	0.37	1.70	5.69	6.35	0.59	4.22	1.89	1.64

Table 2. Concentration (g/kg) of organic acids in plum cultivars

Plum cultivar	Citric	Maleic	Malic	Pyruvic	Schimik	Lactic	Propionic	Butiric	Quinic	Oxalic	Fumaric
Admiral Rigny	0.87	1.33	27.30	0.90	0.18	0.14	0.0020	0.36	8.74	0.13	0.24
Anita	2.06	1.06	15.40	0.67	0.14	0.09	0.0090	0.07	2.80	1.18	0.40
Avalon	1.13	1.52	26.90	1.53	0.12	0.13	0.0030	0.10	2.90	1.11	0.65
Bleue de Belgique	1.78	1.16	29.63	1.16	0.15	0.10	0.0010	0.09	4.51	0.05	0.38
Blue rock	1.62	1.03	26.44	1.03	0.13	0.08	0.0006	0.08	3.98	0.04	0.33
Czar	0.40	0.86	21.93	0.86	0.09	0.08	0.0012	0.08	3.81	0.25	0.05
Diamond	1.21	0.88	22.53	0.88	0.15	0.08	0.0013	0.07	3.70	0.08	0.46
Diana	1.12	1.09	28.00	1.09	0.16	0.10	0.0010	0.10	3.74	0.83	0.41
Edda	0.76	0.68	17.45	0.68	0.08	0.08	0.0014	0.07	3.13	0.18	0.06
Edwards	1.30	1.14	29.15	1.14	0.13	0.09	0.0020	0.09	4.72	0.81	0.26
Emil	0.50	0.68	17.40	0.68	0.13	0.09	0.0011	0.08	5.89	0.12	0.27
Excalibur	0.70	0.92	23.52	0.92	0.16	0.12	0.0020	0.11	7.77	0.06	0.27
Experimentalfältets Sviske	1.47	1.16	29.80	1.16	0.12	0.08	0.0009	0.07	4.32	0.07	0.29
Frostapomme	0.78	0.56	7.26	0.56	0.13	0.13	0.0030	0.12	8.55	9.69	1.10
Grand Duke	0.95	1.03	26.63	0.99	0.18	0.13	0.0040	0.24	9.06	0.11	0.30
Haganta	1.04	0.65	16.68	0.65	0.09	0.08	0.0015	0.07	3.15	0.16	0.11
Helgøypomme	1.03	2.33	31.59	1.99	0.37	0.24	0.0040	0.26	5.33	1.65	0.25
Herman	0.13	1.64	14.06	1.64	0.14	0.10	0.0010	0.10	2.35	5.25	2.25
Ive	1.21	1.00	25.81	1.00	0.13	0.08	0.0005	0.08	1.64	0.07	0.27
Jefferson	0.79	1.13	23.65	1.86	0.24	0.19	0.0030	0.15	4.26	1.15	0.27
Jubileum	1.37	0.74	18.55	0.73	0.12	0.11	0.0025	0.10	4.11	0.11	0.14
Kirkes	1.36	1.63	31.26	1.11	0.20	0.14	0.0020	0.14	4.22	1.11	0.65
Cacanska Lepotica	1.05	2.23	32.52	2.18	0.16	0.11	0.0015	0.10	5.50	0.41	0.30
Mallard	0.24	0.89	23.69	0.92	0.30	0.08	0.0022	0.08	3.38	0.17	0.07
Mount Royal	1.19	0.94	24.17	0.94	0.17	0.10	0.0010	0.10	4.31	0.12	0.44
Njøs II	1.27	0.69	17.70	0.69	0.09	0.08	0.0020	0.08	2.62	0.09	0.10
NPr 152	0.80	0.63	16.26	0.63	0.12	0.11	0.0030	0.11	7.62	0.20	0.10
NPr 3403	0.56	0.32	8.32	0.32	0.09	0.08	0.0024	0.08	5.48	0.15	0.09

Plum cultivar	Citric	Maleic	Malic	Pyruvic	Schimik	Lactic	Propionic	Butiric	Quinic	Oxalic	Fumaric
NPr 3451	0.59	0.58	14.94	0.58	0.08	0.08	0.0020	0.08	5.41	0.14	0.05
NPr 458	0.79	0.84	21.57	0.84	0.08	0.08	0.0015	0.07	4.40	0.18	0.07
NPr 696	0.60	0.69	17.64	0.69	0.08	0.08	0.0018	0.08	4.89	0.14	0.02
NPr 878	0.50	0.36	9.20	0.36	0.09	0.08	0.0023	0.08	5.51	0.13	0.07
Ontario	1.07	1.65	28.96	1.03	0.19	0.22	0.0010	0.42	8.96	0.14	0.27
Opal	0.16	0.83	23.78	0.85	0.11	0.09	0.0011	0.08	4.00	0.28	0.12
Oullins 'Henjum'	1.00	1.56	26.90	2.63	0.26	0.22	0.0020	0.17	5.00	1.13	0.13
Prosser 84	1.05	0.26	6.70	0.26	0.09	0.08	0.0014	0.07	3.69	0.08	0.07
R5	0.71	0.41	10.41	0.41	0.11	0.10	0.0030	0.10	6.85	10.19	1.16
Raud Eplevik	0.73	0.96	25.63	0.94	0.17	0.13	0.0030	0.22	7.21	0.07	0.29
Raud Victoria	0.53	0.59	15.03	0.59	0.09	0.08	0.0015	0.07	5.14	0.09	0.11
Reeves	1.46	0.69	17.68	0.69	0.10	0.09	0.0023	0.08	2.59	0.11	0.13
Reine Claude d'Althanns	0.27	1.05	16.90	1.05	0.10	0.11	0.0030	0.10	4.41	4.25	1.75
Reine Claude d'Oullins	0.98	0.24	19.67	0.24	0.08	0.07	0.0000	0.07	3.45	0.08	0.07
Reine Claude Grøn	1.25	1.21	30.90	1.21	0.15	0.07	0.0004	0.07	3.53	0.11	0.51
Reine Claude Noire	0.62	1.06	27.23	1.06	0.12	0.10	0.0010	0.10	2.28	1.06	0.17
Reine Claude Souffriau	2.56	1.32	19.18	0.83	0.17	0.12	0.0110	0.08	3.48	1.47	0.50
River's Early Prolific	1.25	1.16	24.22	1.21	0.13	0.11	0.0005	0.09	5.36	0.21	0.20
Ruth Gerstetter	0.97	1.36	29.65	1.36	0.25	0.09	0.0020	0.10	3.65	1.36	0.45
Sanctus Hubertus	0.86	1.01	27.11	1.06	0.16	0.10	0.0010	0.09	4.09	0.88	0.34
Sinikka	0.68	0.94	24.16	0.94	0.14	0.09	0.0013	0.08	6.17	0.20	0.37
Søgneplomme	1.64	1.00	25.55	1.00	0.12	0.09	0.0009	0.08	6.02	0.09	0.25
Sviska Frå Tveit	0.89	1.44	18.95	1.44	0.27	0.10	0.0010	0.10	6.93	0.11	1.07
Thames Cross	1.33	1.79	23.85	1.45	0.24	0.27	0.0020	0.31	4.22	2.26	1.09
Trâneplomme	0.74	0.95	24.37	0.95	0.14	0.08	0.0025	0.08	3.96	0.14	0.40
Valor	1.54	0.98	25.38	0.98	0.12	0.09	0.0010	0.09	4.14	0.71	0.20
Victoria	1.78	1.03	24.90	1.10	0.14	0.11	0.0019	0.10	4.60	1.92	0.32
Victoria 'NMBU'	0.94	0.77	25.87	0.97	0.11	0.12	0.0000	0.11	7.17	0.21	0.03
Vinterplomme	0.73	0.73	9.67	0.73	0.10	0.10	0.0030	0.09	6.77	10.17	0.63
Washington	0.85	1.59	19.54	1.24	0.24	0.22	0.0010	0.10	5.24	1.00	0.54
Yakima	0.84	0.80	21.33	0.85	0.23	0.12	0.0030	0.13	4.52	0.13	0.16

Table 3. Concentration (mg/kg) of elements in plum cultivars.

Plum cultivar	Al	B	Ca	Cu	Fe	K	Mg	Mn	Na	P	S	Zn	N (%)
Admiral Rigny	11.27	2.05	312.65	2.54	8.65	5123.33	158.92	4.03	45.70	8523.65	345.70	4.90	3.09
Anita	28.65	1.55	63.33	2.86	2.89	2114.12	105.65	1.00	38.99	5421.26	187.54	5.65	2.87
Avalon	6.59	1.65	198.26	2.99	5.62	3147.66	92.65	2.15	15.65	8523.62	189.65	8.66	3.06
Bleue de Belgique	8.13	6.79	142.70	3.67	5.88	2568.04	154.21	1.38	31.89	7930.17	246.96	24.60	3.12
Blue rock	7.28	7.14	132.40	2.31	5.27	1860.78	110.13	1.07	23.45	8416.16	170.04	23.99	3.15
Czar	7.14	7.38	159.01	2.98	6.41	2496.32	126.12	0.98	9.75	7493.81	227.78	6.89	3.03
Diamond	31.98	6.50	172.91	1.28	4.64	2489.74	122.37	1.36	29.02	6398.91	190.01	6.99	3.29
Diana	7.22	3.66	63.59	4.22	7.05	3874.27	123.54	2.52	52.65	6536.66	1953.56	6.86	3.22
Edda	4.51	13.24	116.84	2.56	5.71	1902.43	165.90	1.48	13.15	6333.46	187.57	6.04	2.96
Edwards	8.90	5.53	61.08	2.24	5.29	3291.22	76.76	0.99	31.19	6294.38	171.64	5.32	3.11
Emil	11.91	12.25	117.08	2.33	8.00	2680.04	100.89	0.87	36.14	12198.01	187.64	8.33	2.98
Excalibur	7.09	9.13	82.71	2.01	6.97	2598.22	96.95	1.56	18.80	5253.15	201.62	6.74	3.26
Experimentalfältets Sviske	17.67	6.34	164.64	2.36	2.98	2206.17	90.77	1.43	37.55	6808.62	187.87	10.89	3.01
Frostapomme	7.65	3.26	108.98	3.26	8.96	2562.69	110.53	1.32	9.65	8112.65	256.33	8.65	3.42
Grand Duke	4.65	1.02	263.13	1.89	7.89	4256.33	135.66	3.16	41.37	7856.63	325.27	4.66	3.02
Haganta	4.88	9.76	102.63	2.82	3.53	1830.21	108.32	0.86	46.12	5972.07	192.67	8.79	2.90
Helgøypomme	2.65	1.66	283.33	2.66	41.26	8536.99	278.65	8.96	101.24	5985.62	365.33	10.25	2.98
Herman	10.29	5.65	115.44	2.70	5.70	2578.84	118.91	1.30	15.88	7550.90	367.56	11.26	3.17
Ive	7.22	10.50	76.96	2.61	8.31	1840.81	76.34	0.92	26.30	10397.93	202.13	8.74	3.03
Jefferson	11.26	2.65	285.37	4.66	29.62	8523.62	245.62	6.33	85.33	4965.32	301.27	8.26	3.24
Jubileum	9.13	3.87	263.83	2.37	14.64	5723.61	292.51	3.79	66.45	4928.48	186.23	4.32	3.15
Kirkes	8.01	4.26	71.99	5.21	8.24	4125.65	153.65	3.05	64.56	8321.51	2325.66	7.13	3.12
Cacanska Lepotica	11.22	3.43	365.27	3.73	23.74	8180.19	367.17	5.04	67.77	5848.60	93.18	4.38	3.16
Mallard	24.38	3211.26	500.89	3.97	27.53	11696.62	529.53	9.48	88.75	7864.60	333.32	8.90	2.95
Mount Royal	7.99	6.62	127.52	2.85	8.27	3340.60	106.08	1.03	40.96	8844.27	258.83	8.00	3.38
Njøs II	6.64	8.55	280.36	2.11	3.35	2261.36	111.49	0.75	29.53	7079.04	124.00	12.07	3.00
NPr 152	6.41	3.26	205.65	3.66	9.85	4452.66	87.99	2.01	65.33	7468.95	301.36	6.33	3.07
NPr 3403	6.24	14.73	90.70	3.77	5.90	2652.01	178.30	1.30	32.00	7294.46	235.95	15.02	3.26
NPr 3451	3.80	10.59	103.83	1.90	2.20	2212.46	110.67	0.99	3.42	5396.63	215.98	7.74	3.18
NPr 458	5.04	10.49	70.37	2.04	2.61	1380.88	95.01	0.36	20.86	6962.66	160.61	5.35	3.00

Plum cultivar	Al	B	Ca	Cu	Fe	K	Mg	Mn	Na	P	S	Zn	N (%)
NPr 696	4.37	9.52	54.26	3.22	4.96	2681.52	135.80	1.31	34.60	6727.81	245.77	11.93	3.13
NPr 878	2.83	13.49	74.32	2.86	8.75	2179.09	123.57	1.00	47.71	6744.74	219.66	9.29	3.22
Ontario	18.65	3.65	257.99	3.65	7.99	4889.32	201.51	6.66	85.33	9001.65	365.26	5.93	2.89
Opal	4.73	0.56	120.27	1.44	3.17	2745.22	121.49	1.79	37.23	3312.55	74.26	2.56	3.15
Oullins 'Henjum'	6.99	3.26	326.33	3.89	36.66	9652.32	268.95	7.22	95.33	5213.32	352.65	9.13	3.05
Prosser 84	5.38	5.72	101.29	1.70	2.58	1884.16	110.74	0.69	0.50	8230.53	163.45	5.55	2.68
R5	6.11	3.85	103.33	3.12	6.85	2456.62	99.65	1.00	7.65	7412.36	301.24	6.25	3.14
Raud Eplevik	12.66	2.65	185.66	2.65	8.96	3658.66	105.65	2.66	32.65	6985.65	305.67	7.41	3.08
Raud Victoria	5.43	15.56	106.26	3.57	32.29	1972.94	148.09	1.42	34.77	6235.81	252.27	22.60	3.25
Reeves	20.45	1.00	348.76	5.81	54.72	11456.59	470.71	8.61	101.33	7965.93	300.57	11.70	3.21
Reine Claude d'Althanns	5.24	12.68	52.10	2.78	3.50	1574.34	99.37	0.94	15.14	10225.25	218.89	8.91	2.98
Reine Claude d'Oullins	42.77	9.09	93.32	2.26	9.80	1562.42	72.26	0.64	21.00	7893.83	130.50	4.90	2.96
Reine Claude Grøn	8.73	8.50	92.48	2.64	6.60	2095.21	107.53	1.06	21.74	8107.30	235.50	7.36	2.98
Reine Claude Noire	7.15	7.34	58.18	3.27	3.56	2438.93	124.44	0.69	36.46	7227.61	309.69	10.94	3.07
Reine Claude Souffriau	5.38	6.99	88.96	2.14	7.22	2031.30	112.49	1.41	24.70	5581.37	201.47	7.37	3.23
River's Early Prolific	16.92	6.30	180.60	4.14	10.06	2865.71	142.26	2.43	38.48	8190.41	327.09	8.53	2.94
Ruth Gerstetter	10.26	3.26	209.66	6.23	21.66	9259.33	326.33	8.65	91.26	4563.32	257.65	9.99	3.42
Sanctus Hubertus	14.72	5.04	147.83	4.64	19.56	5111.60	248.67	4.60	49.60	6098.21	256.24	7.69	3.17
Sinikka	17.58	4.15	81.06	1.49	9.53	2359.34	93.99	1.33	15.35	6060.25	177.30	8.26	3.09
Søgneplomme	8.79	4.88	76.27	1.70	5.48	1612.86	89.90	0.94	21.89	6355.70	148.00	5.82	2.97
Sviska Frå Tveit	35.52	4.87	42.70	1.50	5.19	2779.32	78.27	0.72	75.42	6850.72	229.06	7.78	3.24
Thames Cross	5.02	12.66	97.27	2.84	4.05	2432.24	144.49	1.15	17.71	6345.55	225.97	11.38	3.08
Trâneplomme	14.20	6.33	73.67	2.85	6.58	2052.23	126.99	1.37	50.10	6559.98	282.97	9.49	3.13
Valor	9.49	0.69	369.20	4.02	29.88	6827.79	343.46	4.88	62.85	4985.72	316.59	7.64	2.99
Victoria	14.53	6.58	339.60	3.82	14.88	6240.41	265.89	4.10	61.50	8540.89	227.98	6.49	3.16
Victoria 'NMBU'	17.32	10.88	105.78	1.91	7.00	1378.30	70.25	1.19	29.81	11970.70	131.87	4.36	3.12
Vinterplomme	8.26	4.67	125.65	4.02	7.65	2896.33	121.65	1.04	10.26	8014.55	288.65	9.65	3.65
Washington	9.82	3.42	58.62	3.89	6.02	4128.66	92.33	1.82	45.62	7124.26	185.26	6.33	3.01
Yakima	7.85	2.33	296.33	1.99	18.65	6853.21	301.26	2.86	71.26	4896.33	198.65	4.96	3.04

Table 4. Concentration (mg/kg) of polyphenols in plum cultivars.

Plum cultivar	Protocatechuic_acid	5-O-Caffeoylquinic_acid	p-Hydroxybenzoic_acid	Caffeic_acid	Rutin	p-Coumaric_acid	Quercetin_3-O-glucoside	Isorhamnetin_3-O-rutinoside	Ferulic_acid	Isorhamnetin_3-O-glucoside	Quercetin_3-O-rhamnoside	Kaempferol_7-O-glucoside	Phlorizin	Quercetin	Phloretin	Acacetin	Syringic acid	Aesculetin	Kaempferol_3-O-glucoside
Admiral Rigny	NF	8.87	NF	2.98	18.15	NF	7.66	NF	NF	NF	NF	NF	NF	6.50	NF	NF	NF	1.38	0.84
Anita	NF	2.22	NF	5.79	2.40	NF	3.09	NF	NF	NF	NF	NF	NF	6.67	NF	NF	NF	0.45	0.22
Avalon	NF	0.57	NF	4.90	1.52	NF	0.86	NF	NF	NF	NF	NF	NF	7.22	NF	NF	NF	1.52	0.02
Bleue de Belgique	NF	15.08	NF	7.67	19.51	NF	7.61	NF	NF	NF	NF	NF	NF	8.64	NF	NF	NF	5.28	0.79
Blue rock	6.67	84.75	6.81	7.68	82.73	2.99	15.26	11.02	2.74	0.74	NF	0.70	0.46	3.56	NF	NF	9.40	6.16	NF
Czar	2.28	43.28	3.51	3.92	35.21	1.43	7.76	35.92	3.30	4.93	1.20	1.14	0.54	6.82	NF	0.25	NF	1.12	0.46
Diamond	3.92	137.53	10.47	8.01	132.82	12.35	15.31	28.94	4.06	1.29	0.19	0.62	0.87	26.01	0.20	0.53	NF	NF	NF
Diana	NF	0.55	NF	NF	1.54	NF	0.91	NF	NF	NF	NF	NF	NF	7.66	NF	NF	NF	0.76	0.14
Edda	2.07	118.94	2.85	3.52	122.38	0.24	20.02	3.75	2.72	0.13	NF	1.04	0.96	3.10	0.30	0.15	NF	0.00	0.00
Edwards	NF	2.42	NF	1.65	4.76	NF	2.57	NF	NF	NF	NF	NF	NF	8.04	NF	NF	NF	0.55	0.45
Emil	6.61	74.23	5.09	3.93	27.18	2.96	2.89	0.80	3.23	NF	0.23	0.33	2.42	3.11	0.23	0.27	6.32	2.89	0.00
Excalibur	NF	1.11	NF	1.19	3.31	NF	4.77	NF	NF	NF	NF	NF	NF	5.70	NF	NF	NF	0.88	0.30
Experimentalfältets Sviske	2.06	18.33	14.29	1.21	34.62	0.22	12.08	4.30	1.82	0.51	NF	0.46	0.29	3.38	0.19	0.25	NF	NF	NF
Frostapomme	NF	0.19	NF	0.30	0.62	NF	2.52	NF	NF	NF	NF	NF	NF	7.15	NF	NF	NF	0.21	0.18
Grand Duke	NF	NF	NF	0.69	0.66	NF	0.94	NF	NF	NF	NF	NF	NF	6.62	NF	NF	NF	0.48	0.21
Haganta	1.67	90.94	4.18	6.62	60.48	2.18	13.81	3.83	2.67	0.31	0.21	0.91	0.90	2.66	0.23	NF	NF	NF	NF
Helgøypomme	NF	3.48	NF	2.45	9.76	NF	5.41	NF	NF	NF	NF	NF	NF	9.30	NF	NF	NF	1.68	1.21
Herman	NF	0.56	NF	0.81	0.83	NF	1.49	NF	NF	NF	NF	NF	NF	9.32	NF	NF	NF	0.20	0.33
Ive	2.80	56.65	4.60	5.37	28.98	2.34	6.34	11.03	4.30	2.43	NF	1.02	1.06	3.17	0.19	0.45	5.97	2.73	NF
Jefferson	NF	NF	NF	1.24	2.41	0.00	0.62	NF	NF	NF	NF	NF	NF	7.36	NF	NF	NF	0.32	0.09

Plum cultivar	Protocatechuic_acid	5-O-Caffeoylquinic_acid	p-Hydroxybenzoic_acid	Caffeic_acid	Rutin	p-Coumaric_acid	Quercetin_3-O-glucoside	Isorhamnetin_3-O-rutinoside	Ferulic_acid	Isorhamnetin_3-O-glucoside	Quercetin_3-O-rhamnoside	Kaempferol_7-O-glucoside	Phlorizin	Quercetin	Phloretin	Acacetin	Syringic acid	Aesculetin	Kaempferol_3-O-glucoside
Jubileum	2.75	22.49	3.05	1.65	14.89	4.72	1.13	27.68	NF	1.13	0.75	0.98	1.05	5.30	0.25	0.71	NF	0.65	0.03
Kirkes	NF	NF	NF	1.10	2.91	NF	1.13	NF	NF	NF	NF	NF	NF	8.11	NF	NF	NF	0.35	0.07
Cacanska Lepotica	26.69	16.35	3.17	1.24	18.77	4.03	3.23	11.84	NF	0.47	0.28	1.73	1.03	5.51	0.22	0.14	NF	0.41	0.14
Mallard	8.46	13.50	5.47	1.07	7.37	1.10	0.58	1.08	NF	NF	0.14	0.16	0.75	4.59	0.25	0.29	NF	0.58	0.04
Mount Royal	NF	1.89	NF	2.40	4.15	NF	5.22	NF	NF	NF	NF	NF	NF	5.83	NF	NF	NF	1.29	0.35
Njøs II	1.27	129.12	2.67	3.73	42.95	1.21	3.89	2.04	1.60	0.16	0.16	0.43	0.59	2.12	0.47	0.91	NF	NF	NF
NPr 152	NF	2.24	NF	3.81	1.95	NF	0.5	NF	NF	NF	NF	NF	NF	6.89	NF	NF	NF	0.21	0.08
NPr 3403	1.01	49.71	1.58	1.21	31.88	0.21	2.10	1.46	0.79	0.08	0.52	0.21	0.62	1.97	0.36	0.39	NF	NF	NF
NPr 3451	1.68	89.47	2.27	1.89	123.56	1.88	18.18	6.96	1.88	0.81	0.99	0.56	6.76	3.73	0.45	0.41	NF	NF	NF
NPr 458	0.50	38.25	0.98	0.75	22.47	0.66	1.60	1.94	0.48	0.26	0.18	0.16	0.37	0.79	0.20	0.14	NF	NF	NF
NPr 696	5.89	96.52	4.99	6.00	104.39	1.17	11.01	25.47	2.81	0.58	1.39	0.82	1.51	3.01	3.31	0.38	NF	NF	NF
NPr 878	0.62	77.64	3.27	3.95	8.16	1.18	0.56	6.17	2.10	0.22	NF	0.24	0.38	1.72	NF	0.41	NF	NF	NF
Ontario	NF	0.18	NF	0.77	0.80	NF	0.54	NF	NF	NF	NF	NF	NF	5.90	NF	NF	NF	0.74	0.21
Opal	173.61	16.08	11.49	1.04	9.03	4.09	3.33	6.24	NF	0.35	0.26	0.71	0.74	6.50	NF	NF	NF	0.50	0.43
Oullins 'Henjum'	NF	0.74	NF	2.04	3.02	0.00	1.45	NF	NF	NF	NF	NF	NF	6.66	NF	NF	NF	0.67	0.29
Prosser 84	1.83	95.60	5.30	5.43	99.42	1.57	9.55	10.37	3.05	0.38	NF	0.58	1.13	2.65	NF	NF	NF	NF	NF
R5	NF	0.18	NF	1.12	1.94	NF	1.98	NF	NF	NF	NF	NF	NF	7.98	NF	NF	NF	0.32	0.15
Raud Eplevik	NF	2.61	NF	0.46	6.50	NF	2.45	NF	NF	NF	NF	NF	NF	6.71	NF	NF	NF	0.60	0.26
Raud Victoria	2.63	69.76	3.55	4.46	95.17	0.83	9.40	2.30	2.19	0.12	NF	0.48	0.38	2.10	0.21	0.24	NF	NF	NF
Reeves	36.62	54.89	2.96	0.93	27.86	1.50	3.32	9.79	NF	0.32	0.47	0.64	1.25	4.54	0.24	NF	NF	0.30	0.06
Reine Claude d'Althanns	NF	1.59	NF	1.13	0.96	0.00	0.73	NF	NF	NF	NF	NF	NF	6.08	NF	NF	NF	0.80	0.17

Plum cultivar	Protocatech uic_acid	5-O- Caffeoyl quinic_a cid	p- Hydroxy benzoic_ acid	Caffeic_ acid	Rutin	p- Coumari c_acid	Querceti n_3-O- glucosid e	Isorham netin_3- O- rutosid e	Ferulic_a cid	Isorham netin_3- O- glucosid e	Querceti n_3-O- rhamnos ide	Kaempfe rol_7-O- glucosid e	Phlorizin	Querceti n	Phloretin	Acacetin	Syringic acid	Aesculet in	Kaempfe rol 3-O- glucosid e
Reine Claude d'Oullins	7.99	46.83	NF	6.84	19.2	2.34	2.11	NF	NF	NF	NF	NF	NF	1.97	NF	NF	8.07	2.54	NF
Reine Claude Grøn	4.13	71.66	5.84	1.88	45.33	1.76	5.42	13.20	2.65	0.42	NF	0.89	0.78	2.30	NF	NF	5.47	1.21	NF
Reine Claude Noire	NF	0.81	NF	1.38	10.50	NF	7.12	NF	NF	NF	NF	NF	NF	7.83	NF	NF	NF	0.77	0.50
Reine Claude Souffriau	NF	0.78	NF	2.29	1.90	NF	2.17	NF	NF	NF	NF	NF	NF	7.31	NF	NF	NF	NF	0.09
River's Early Prolific	12.82	44.16	NF	4.14	77.65	1.50	22.35	NF	NF	NF	NF	NF	NF	5.86	NF	NF	9.46	2.06	0.34
Ruth Gerstetter	0.00	0.00	NF	0.48	0.57	0.00	1.08	NF	NF	NF	NF	NF	NF	6.84	NF	NF	NF	0.22	0.28
Sanctus Hubertus	7.15	82.85	NF	4.45	59.73	0.54	8.93	NF	NF	NF	NF	NF	NF	6.09	NF	NF	6.23	2.16	0.26
Sinikka	7.72	77.38	6.75	13.13	79.10	17.56	11.89	9.71	4.89	3.27	7.62	0.71	1.53	13.71	0.19	0.55	11.20	7.48	NF
Søgneplomme	7.28	112.14	3.78	10.06	44.72	1.80	8.36	4.67	1.71	0.38	NF	0.61	0.52	2.92	0.21	NF	14.00	7.34	NF
Sviska Frå Tveit	NF	1.16	NF	1.09	2.92	NF	3.90	NF	NF	NF	NF	NF	NF	6.88	NF	NF	NF	1.34	0.33
Thames Cross	NF	NF	NF	1.03	2.05	NF	0.73	NF	NF	NF	NF	NF	NF	7.14	NF	NF	NF	0.89	0.13
Tråneplomme	4.61	49.17	16.27	5.33	76.34	2.63	14.25	16.32	4.04	1.11	19.06	3.98	102.16	5.53	0.83	10.02	NF	NF	NF
Valor	1.40	14.15	2.13	1.36	9.25	1.13	2.02	1.97	NF	NF	0.18	0.36	0.72	5.98	0.22	0.61	NF	0.61	0.05
Victoria	7.57	31.25	8.74	3.58	33.75	3.43	2.02	7.14	2.41	0.24	0.35	0.69	0.57	5.14	0.22	0.31	11.03	1.72	0.13
Victoria 'NMBU'	11.00	66.42	NF	13.56	63.21	6.52	2.5	NF	NF	NF	NF	NF	NF	2.67	NF	NF	11.03	5.32	NF
Vinterplomme	NF	7.98	NF	3.68	7.17	NF	5.44	NF	NF	NF	NF	NF	NF	16.47	NF	NF	NF	1.99	1.05
Washington	NF	1.00	NF	1.50	0.88	NF	0.24	NF	NF	NF	NF	NF	NF	5.76	NF	NF	NF	0.47	0.14
Yakima	NF	NF	NF	0.64	0.78	NF	0.33	NF	NF	NF	NF	NF	NF	6.00	NF	NF	NF	0.37	0.12

Table 5. Total phenolic content, TPC (g GAE/kg) and radical scavenging activity, RSA (mmol TE/kg) in plum cultivars

Plum cultivar	Trial site	TPC (g GAE/kg dw)	RSA (mmol TE/kg dw)
Admiral Rigny	Njøs	12.79	75.29
Anita	Njøs	8.25	78.48
Avalon	Njøs	11.82	48.15
Bleue de Belgique	Njøs	5.76	34.97
Blue rock	NMBU	7.89	39.08
Czar	Njøs	10.79	40.18
Diamond	NMBU	6.46	47.61
Diana	Njøs	8.81	32.78
Edda	Njøs	8.70	40.61
Edwards	Njøs	3.47	12.14
Emil	NMBU	13.84	58.48
Excalibur	Njøs	5.83	71.87
Experimentalfältets Sviske	NMBU	4.62	28.99
Frostapomme	Njøs	6.91	82.06
Grand Duke	Njøs	6.16	21.15
Haganta	Njøs	7.92	30.53
Helgøypomme	Njøs	6.06	16.27
Herman	Njøs	6.77	27.13
Ive	NMBU	4.86	42.70
Jefferson	Njøs	10.36	72.97
Jubileum	NIBIO	20.59	36.66
Kirkes	Njøs	8.60	30.52
Cacanska Lepotica	NIBIO	6.49	18.11
Mallard	NIBIO	10.89	39.13
Mount Royal	Njøs	11.75	23.88
Njøs II	Njøs	7.65	24.02
NPr 152	Njøs	7.39	30.46
NPr 3403	Njøs	1.92	94.16
NPr 3451	Njøs	7.29	35.47
NPr 458	Njøs	1.79	69.70
NPr 696	Njøs	10.33	49.40
NPr 878	Njøs	3.79	61.58
Ontario	Njøs	9.16	35.98
Opal	NIBIO	10.39	36.40
Oullins 'Henjum'	Njøs	16.08	32.80
Prosser 84	Njøs	14.35	45.31
R5	Njøs	8.81	27.01
Raud Eplevik	Njøs	8.48	44.44
Raud Victoria	Njøs	2.485	67.194
Reeves	NIBIO	6.49	25.49
Reine Claude d'Althanns	Njøs	3.90	58.18
Reine Claude d'Oullins	NMBU	5.04	40.38
Reine Claude Grøn	NMBU	8.53	32.50
Reine Claude Noire	Njøs	10.55	35.39
Reine Claude Souffriau	Njøs	7.96	47.36
River's Early Prolific	Njøs	10.28	25.66
Ruth Gerstetter	Njøs	6.99	57.39
Sanctus Hubertus	Njøs	5.81	31.93
Sinikka	NMBU	8.26	25.54
Søgneplomme	NMBU	12.36	33.28
Sviska Frå Tveit	Njøs	6.36	30.11
Thames Cross	Njøs	9.55	41.57
Trâneplomme	NMBU	5.52	23.81
Valor	NIBIO	4.77	36.39
Victoria	NIBIO	8.65	26.65
Victoria 'NMBU'	Njøs	6.96	52.23
Vinterplomme	Njøs	7.84	24.01
Washington	Njøs	17.09	45.98
Yakima	Njøs	6.76	43.09

Appendix 2.

Chemical contents in the kernels of 60 plum cultivars

No	Plum cultivar	Location	No	Plum cultivar	Location
1	Admiral Rigny	Njøs	31	NPr 458	Njøs
2	Anita	Njøs	32	NPr 696	Njøs
3	Avalon	Njøs	33	NPr 878	Njøs
4	Bleue de Belgique	Njøs	34	Ontario	Njøs
5	Blue Rock	NMBU	35	Opal	NIBIO
6	Czar	Njøs	36	Reine Claude d'Oullins 'Henjum'	Njøs
7	Diamond	NMBU	37	Prosser 84	Njøs
8	Diana	Njøs	38	R5	Njøs
9	Edda	Njøs	39	Raud eplevik	Njøs
10	Edwards	Njøs	40	Raud Victoria	Njøs
11	Emil	NMBU	41	Reeves	NIBIO
12	Excalibur	Njøs	42	Reine Claude d'Althanns	Njøs
13	Sviske	NMBU	43	Reine Claude d'Oullins	NMBU
14	Frostapomme	Njøs	44	Reine Claude grøn	NMBU
15	Grand Duke	Njøs	45	Reine Claude Noir	Njøs
16	Haganta	Njøs	46	Reine Claude Souffriau	Njøs
17	Helgøypomme	Njøs	47	River's Early Prolific	Njøs
18	Herman	Njøs	48	Ruth Gerstetter	Njøs
19	Italiensk Sviske	NMBU	49	Sanctus Hubertus	Njøs
20	Ive	NMBU	50	Sinikka	NMBU
21	Jefferson	Njøs	51	Søgneplomme	NMBU
22	Jubileum	NIBIO	52	Sviske frå Tveit	Njøs
23	Kirkes	Njøs	53	Thames Cross	Njøs
24	Cacaska Lepotica	NIBIO	54	Trâneplomme	NMBU
25	Mallard	NIBIO	55	Valor	NIBIO
26	Mount Royal	Njøs	56	Victoria	NIBIO
27	Njøs II	Njøs	57	Victoria 'NMBU'	Njøs
28	NPr 152	Njøs	58	Vinterplomme	Njøs
29	NPr 3403	Njøs	59	Washington	Njøs
30	NPr 3541	Njøs	60	Yakima	Njøs

Oil extraction

The oil was extracted from the dry, cleaned and milled kernels by *n*-hexane at room temperature for 24 hours. The mixture then was filtered and the solvent was removed from the oil on a rotary vacuum evaporator. The obtained oil was drained under a nitrogen steam and stored at –18 °C prior to analysis.

Fatty acid composition

The preparation of fatty acid methyl esters was performed according to the standard method (SRPS EN ISO12966-2: 2017). Methyl esters were separated and detected, according to the standard method (SRPS EN ISO 12966-1: 2015). A gas chromatograph (Agilent Technologies 6890, USA) with split-splitless injector, flame ionization detector (FID) and capillary column Supelco SP-2560 (100 m length x 0.25 mm inner diameter x 0.20 µm film thickness, Supelco, Bellefonte, USA) with helium as the mobile phase and a flow rate of 5 ml/min was used. The injector and detector temperatures were 250 °C and 260 °C, respectively. The injected volume was 1 µl, and the injector distribution ratio was set to 20:1. The column temperature was programmed from an initial 50 °C (maintained for 5 minutes) to 240 °C (maintained for 20 minutes), with a linear temperature change of 4 °C/min. Chromatographic peaks in the sample were identified by comparing the relative retention times of fatty acid methyl esters from the samples with a standard Supelco 37 Component methyl ester mixture (Supelco, Bellefonte, USA).

Carotenoids and Tocopherol Analysis

The extraction was performed by ultrasonication of seeds of each apple variety separately with solvents of different polarity. To improve the efficacy of total carotenoids extraction, solvents of different polarity were used. Hexane and acetone were used for extraction of less polar carotenoids (lycopene, β -carotene, β -cryptoxanthin, canthaxanthin), while ethanol was used for extraction of other more polar carotenoids (lutein, zeaxanthin, apocarotenal, physalene). An Agilent 1200 HPLC system (Agilent, Santa Clara, CA, USA) equipped with a Quat Pump (G1311B), Injector (G1329B) 1260 ALS, TCC 1260 (G1316A), Detector 1260 DAD VL+ (G1315C), and thermostated column compartment was used. Chromatographic separation was performed on octadecyl silica as a stationary phase (Nucleosil C18 analytical column, 4 mm $\times$ 150 mm, 5 μ m) using a mobile phase consisting of deionized water (A), acetonitrile (B), and methanol (C). The optimized HPLC method was developed to allow appropriate separation of individual carotenoids and tocopherols. UV–vis diode array detection was set at 450 nm for carotenoids and at 280 nm for tocopherols. Carotenoids and tocopherols were identified by comparing their retention times and spectral data with those of the authentic standards. Quantification was performed by comparing peak area with standard reference curves.

Table 6. Concentration (%) of fatty acids in kernels of plum cultivars.

Plum cultivar	Butyric acid (C4:0)	Caproic acid (C6:0)	Caprylic acid (C8:0)	Capric acid (C10:0)	Undecanoic acid (C11:0)	Lauric acid (C12:0)	Tridecanoic acid (C13:0)	Myristic acid (C14:0)	Myristoleic acid (C14:1)	Pentadecanoic acid (C15:0)	Pentadecenoic acid (C15:1)	Palmitic acid (C16:0)	Palmitoleic acid (C16:1)	Heptadecanoic acid (C17:0)	Heptadecenoic acid (C17:1)	Stearic acid (C18:0)	Oleic acid (C18:1) and its isomers
Anita	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	5.97	0.78	<0.02	0.02	0.97	53.40
Avalon	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.02	<0.02	4.99	0.97	0.1	0.03	0.77	59.36
Bleue de Belgique	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.49	0.52	<0.02	<0.02	1.02	65.05
Blue rock	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	4.6	0.23	0.03	0.05	0.75	71.21
Czar	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	<0.02	<0.02	5.9	0.32	<0.02	0.04	0.49	51.15
Diamond	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	5.06	0.42	<0.02	0.05	0.51	57.02
Diana	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	6.11	0.59	0.04	<0.02	0.89	54.68
Edda	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.03	<0.02	4.98	0.61	<0.02	<0.02	1.12	63.08
Edwards	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	5.36	0.44	<0.02	0.05	0.85	58.48
Emil	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.44	0.26	0.02	0.05	0.85	67.63
Excalibur	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	4.87	0.29	<0.02	0.05	0.73	64.5
Experimetal feltets Sviske	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.26	0.22	<0.02	0.04	0.68	70.28
Frostaplomme	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02	<0.02	4.13	0.52	0.06	<0.02	0.81	76.72
Grand Duke	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.61	0.69	<0.02	<0.02	0.93	70.43
Helgøypomme	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02	<0.02	5.07	0.51	<0.02	<0.02	0.83	63.36
Herman	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	0.02	0.03	7.18	0.31	<0.02	0.06	0.87	46.45
Italiensk Sviske	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	3.91	0.21	<0.02	0.05	0.99	73.20
Ive	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.87	0.3	<0.02	0.04	0.76	72.51
Jefferson	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	3.91	0.59	<0.02	0.02	0.93	72.11

Plum cultivar	Butyric acid (C4:0)	Caproic acid (C6:0)	Caprylic acid (C8:0)	Capric acid (C10:0)	Undecanoic acid (C11:0)	Lauric acid (C12:0)	Tridecanoic acid (C13:0)	Myristic acid (C14:0)	Myristoleic acid (C14:1)	Pentadecanoic acid (C15:0)	Pentadecenoic acid (C15:1)	Palmitic acid (C16:0)	Palmitoleic acid (C16:1)	Heptadecanoic acid (C17:0)	Heptadecenoic acid (C17:1)	Stearic acid (C18:0)	Oleic acid (C18:1) and its isomers
Jubileum	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	5.26	0.83	0.07	0.04	0.75	58.26
Kirkes	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.34	0.61	0.08	0.02	1.13	70.54
Lepotica	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.97	0.59	0.12	0.02	0.81	65.52
Mallard	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	<0.02	0.02	<0.02	<0.02	0.04	4.72	0.75	0.14	0.12	0.87	71.51
Mount Royal	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	3.88	0.24	<0.02	0.03	0.9	75.74
Njøs II	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.02	<0.02	5.79	0.78	<0.02	0.10	0.61	48.51
NPr 152	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	5.30	0.72	0.05	<0.02	0.95	67.22
NPr 3403	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	<0.02	0.03	<0.02	6.94	0.80	<0.02	0.10	0.89	49.29
NPr 3451	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.02	<0.02	5.96	0.71	<0.02	0.09	1.25	52.49
NPr 458	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.02	<0.02	5.53	0.74	<0.02	0.10	0.72	57.68
NPr 696	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02	<0.02	4.70	0.69	0.02	0.10	0.75	71.98
NPr 878	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02	<0.02	4.93	0.53	<0.02	0.10	0.62	61.99
Ontario	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.38	0.60	0.06	0.02	0.88	67.64
Opal	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.02	<0.02	<0.02	5.34	0.78	0.12	0.06	0.72	62.21
Oullins 'Henjum'	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02	<0.02	5.15	0.54	<0.02	0.08	0.87	63.32
Prosser 84	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	5.73	0.68	<0.02	0.11	0.76	51.10
R5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.65	0.69	0.09	0.02	0.95	65.61
Raud Eplevik	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.03	0.44	<0.02	0.08	1.19	69.35
Reeves	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.69	0.62	0.08	0.02	0.63	62.47
Reine Claude d'Althanns	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.24	0.54	<0.02	<0.02	0.76	69.67

Plum cultivar	Butyric acid (C4:0)	Caproic acid (C6:0)	Caprylic acid (C8:0)	Capric acid (C10:0)	Undecanoic acid (C11:0)	Lauric acid (C12:0)	Tridecanoic acid (C13:0)	Myristic acid (C14:0)	Myristoleic acid (C14:1)	Pentadecanoic acid (C15:0)	Pentadecenoic acid (C15:1)	Palmitic acid (C16:0)	Palmitoleic acid (C16:1)	Heptadecanoic acid (C17:0)	Heptadecenoic acid (C17:1)	Stearic acid (C18:0)	Oleic acid (C18:1) and its isomers
Reine Claude Grøn	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.23	0.18	<0.02	0.04	0.81	68.61
Reine Claude Noire	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.71	0.23	<0.02	0.05	0.73	66.73
Reine Claude Souffriau	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.02	<0.02	5.35	0.27	0.06	0.02	0.54	62.43
River's Early Prolific	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	6.01	0.32	<0.02	0.06	0.88	59.1
Ruth Gerstetter	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.04	<0.02	6.64	0.59	0.05	<0.02	1.19	50.07
Sanctus Hubertus	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	0.02	<0.02	6.51	0.77	<0.02	0.02	0.75	53.12
Sinikka	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02	<0.02	4.41	0.23	<0.02	0.09	0.55	68.12
Søgneplomme	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	5.48	0.36	<0.02	0.06	0.48	59.21
Sviska Frå Tveit	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	5.49	0.37	<0.02	0.05	0.86	62.25
Thames Cross	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.64	0.71	<0.02	0.10	1.00	65.47
Tråne-plomme	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	3.89	0.19	<0.02	0.06	1.09	72.28
Valor	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	5.53	0.88	0.09	0.04	0.84	49.23
Victoria	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.82	0.6	<0.02	0.07	0.51	57.62
Vinter-plomme	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.21	0.47	<0.02	0.02	0.74	64.11
Washington	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	<0.02	0.03	<0.02	7.03	0.19	0.03	0.03	0.85	56.79
Yakima	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	4.94	0.66	<0.02	0.02	0.87	62.82

Table 7. Concentration (%) of fatty acids in kernels of plum cultivars (continued)

Plum cultivar	Linoleic acid (C18:2) and its isomers	γ - Linolenic acid (C18:3)	Linolenic acid (C18:3)	Arachidic acid (C20:0)	Gondolic acid (C20:1)	Eicosadienoic acid (C20:2)	Eicosatrienoic acid (C20:3) and its isomers	Arachidonic acid (C20:4)	Eicosapentaenoic acid (C20:5)	Heneicosanoic acid (C21:0)	Behenic acid (C22:0)	Erucic acid (C22:1)	Docosadienoic acid (C22:2)	Docosahexaenoic acid (C22:6)	Tricosanoic acid (C23:0)	Lignoceric acid (C24:0)	Nervonic acid (C24:1)	Oil content
Anita	38.65	<0.02	0.07	0.07	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Avalon	33.49	<0.02	0.12	0.06	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	18.06
Bleue de Belgique	28.73	<0.02	0.06	0.07	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Blue rock	22.78	<0.02	0.09	0.05	0.02	0.06	0.02	0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	12.06
Czar	41.81	<0.02	0.13	0.05	0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	10.09
Diamond	36.69	<0.02	0.09	0.06	0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	13.91
Diana	37.34	<0.02	0.16	0.09	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Edda	29.9	<0.02	0.12	0.09	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	17.87
Edwards	34.54	<0.02	0.1	0.08	0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	13.89
Emil	26.38	<0.02	0.1	0.03	0.02	0.07	0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05	<0.02	<0.02	<0.02	14.79
Excalibur	29.28	<0.02	0.1	0.06	0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	14.27
Experimetal feltets Sviske	24.28	<0.02	0.10	0.07	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	12.18
Frostaplomme	17.53	<0.02	0.08	0.07	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Grand Duk	23.18	<0.02	0.05	0.05	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Helgøypomme	29.95	<0.02	0.09	0.07	0.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Herman	44.53	<0.02	0.28	0.11	0.04	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	0.02	8.46
Italiensk Sviske	21.45	<0.02	0.04	0.06	0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	22.62
Ive	21.29	<0.02	0.07	0.07	0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	15.06
Jefferson	22.27	<0.02	0.05	0.04	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	

Plum cultivar	Linoleic acid (C18:2) and its isomers	γ - Linolenic acid (C18:3)	Linolenic acid (C18:3)	Arachidic acid (C20:0)	Gondolic acid (C20:1)	Eicosadienoic acid (C20:2)	Eicosatrienoic acid (C20:3) and its isomers	Arachidonic acid (C20:4)	Eicosapentaenoic acid (C20:5)	Heneicosanoic acid (C21:0)	Behenic acid (C22:0)	Erucic acid (C22:1)	Docosadienoic acid (C22:2)	Docosahexaenoic acid (C22:6)	Tricosanoic acid (C23:0)	Lignoceric acid (C24:0)	Nervonic acid (C24:1)	Oil content
Jubileum	34,58	<0,02	0,08	0,05	0,04	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	18,97
Kirkes	23,08	<0,02	0,07	0,07	0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
Lepotica	27,74	<0,02	0,06	0,09	0,04	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	16,42
Mallard	21,59	<0,02	0,1	0,08	0,13	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	19,88
Mount Royal	19,03	<0,02	0,07	0,05	0,02	0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	13,08
Njøs II	43,96	<0,02	0,10	0,05	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
NPr 152	25,51	<0,02	0,10	0,07	0,04	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	25,51
NPr 3403	41,55	<0,02	0,19	0,10	0,04	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
NPr 3451	39,17	<0,02	0,12	0,11	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
NPr 458	34,99	<0,02	0,08	0,06	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
NPr 696	21,56	<0,02	0,07	0,04	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
NPr 878	31,62	<0,02	0,08	0,04	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
Ontario	26,22	<0,02	0,07	0,07	0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
Opal	30,47	<0,02	0,1	0,07	0,07	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	25,2
Oullins	29,79	<0,02	0,09	0,07	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
'Henjum' Prosser 84	41,36	<0,02	0,12	0,06	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
R5	27,83	<0,02	0,07	0,03	0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
Raud Eplevik	24,72	<0,02	0,07	0,06	0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	
Reeves	31,31	<0,02	0,06	0,05	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	20,21
Reine Claude Grøn	25,88	<0,02	0,08	0,09	0,04	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	17,95

Plum cultivar	Linoleic acid (C18:2) and its isomers	γ - Linolenic acid (C18:3)	Linolenic acid (C18:3)	Arachidic acid (C20:0)	Gondolic acid (C20:1)	Eicosadienoic acid (C20:2)	Eicosatrienoic acid (C20:3) and its isomers	Arachidonic acid (C20:4)	Eicosapentaenoic acid (C20:5)	Heneicosanoic acid (C21:0)	Behenic acid (C22:0)	Erucic acid (C22:1)	Docosadienoic acid (C22:2)	Docosahexaenoic acid (C22:6)	Tricosanoic acid (C23:0)	Lignoceric acid (C24:0)	Nervonic acid (C24:1)	Oil content
Reine Claude Noire	27,33	<0.02	0,06	0,07	0,03	0,02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	11,9
Reine Claude Souffriau	31,06	<0.02	0,08	0,07	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	0,02	<0,02	<0,02	<0,02	<0,02	16,64
River's Early Prolific	33,25	<0.02	0,13	0,11	0,03	0,04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0,02	15,28
Ruth Gerstetter	40.93	<0.02	0.28	0.14	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Sanctus Hubertus	38.49	<0.02	0.14	0.09	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Sinikka	26,27	<0.02	0,11	0,06	0,06	0,02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0,02	12,33
Søgneplomme	34,12	<0.02	0,11	0,07	0,04	0,02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	13,31
Sviska Frå Tveit	30,67	<0.02	0,08	0,12	0,04	0,02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	13,41
Thames Cross	27.93	<0.02	0.03	0.06	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Trâneplomme	22.23	<0.02	0.08	0.09	0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	15.16
Valor	42,75	<0,02	0,26	0,15	0,19	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	10,26
Victoria	36,14	<0.02	0,1	0,05	0,03	0,02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	12,02
Vinterplomme	30.32	<0.02	0.03	0.04	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Washington	34,6	<0,02	0,17	0,09	0,05	0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	0,03	<0,02	<0,02	<0,02	<0,02	26,86
Yakima	30.50	<0.02	0.07	0.05	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	

Table 8. Concentration (g/kg) of sugars in plum kernels

Plum cultivar	Sorbitol	Trehalose	Arabinose	Glucose	Fructose	Sucrose	Turanose	Glycerol	Galactitol	Galactose	Ribose	Isomaltose	Isomaltotriose
Avalon	54.363	0.452	0.659	139.652	133.322	214.325	1.542	0.752	1.98	11.352	1.983	0.986	1.125
Blue rock	77.724	1.265	0.896	147.632	120.665	198.652	1.844	0.785	1.186	11.322	1.562	0.452	1.563
Czar	79.917	0.865	0.897	144.458	137.249	238.373	1.952	0.863	1.112	11.623	2.325	1.142	1.563
Edda	63.302	1.025	0.856	168.921	133.253	241.256	1.256	0.658	1.332	11.332	1.562	0.365	1.689
Edwards	41.234	2.023	0.562	178.652	145.632	204.652	7.254	1.325	3.363	14.622	2.652	0.985	1.023
Emil	57.968	0.543	0.332	135.625	124.332	156.985	10.325	4.323	2.652	10.652	2.325	0.896	1.325
Excalibur	32.266	1.332	0.906	156.325	142.332	234.325	1.752	0.398	1.221	12.452	1.331	0.568	1.256
Herman	47.722	0.852	0.895	145.632	138.665	208.933	5.102	1.142	2.365	18.652	2.332	1.356	1.112
Ive	45.985	0.862	0.442	133.256	127.652	176.325	23.322	1.985	0.996	12.632	2.633	0.856	1.553
Jubileum	59.131	0.356	0.569	147.652	128.652	201.325	2.145	0.638	1.896	13.256	2.325	0.869	1.489
Lepotica	63.954	1.203	0.853	168.325	144.322	226.653	3.256	0.589	1.985	14.325	1.632	0.653	1.896
Mallard	40.079	0.965	0.898	175.855	142.325	203.652	1.774	0.986	1.365	10.365	1.652	0.447	1.856
Mount Royal	53.256	0.568	0.331	165.325	142.326	196.355	8.652	3.652	1.025	15.652	2.896	0.885	1.112
Opal	52.439	1.652	0.456	129.652	114.326	201.321	21.023	3.145	1.887	15.698	4.112	1.896	1.863
Reeves	25.084	1.985	0.856	122.332	119.623	222.332	18.963	3.652	1.632	19.652	5.325	1.996	1.663
Reine Claude Grøn	72.325	0.558	0.658	164.325	133.252	214.332	8.652	1.224	1.865	16.852	1.985	1.117	1.325
Reine Claude Noire	71.015	0.968	0.785	133.256	124.362	225.632	2.856	1.685	1.236	12.332	1.458	1.325	1.586
Reine Claude Souffriau	39.359	0.625	0.744	146.355	132.653	206.325	4.688	1.447	2.689	14.326	1.243	1.998	1.563
River's Early Prolific	41.758	0.632	0.342	123.563	114.332	224.362	23.652	1.625	1.422	15.641	4.225	2.653	2.331

Plum cultivar	Sorbitol	Trehalose	Arabinose	Glucose	Fructose	Sucrose	Turanose	Glycerol	Galactitol	Galactose	Ribose	Isomaltose	Isomalto triose
Sinikka	45.3256	0.269	0.221	131.256	112.322	157.652	18.652	3.633	0.896	14.631	4.025	1.653	1.896
Søgneplomme	46.883	1.023	0.334	126.853	122.332	201.325	11.263	2.653	0.398	17.652	3.114	0.774	1.236
Sviska Frå Tveit	53.188	1.428	0.896	143.256	132.332	198.365	3.225	1.236	2.742	13.332	1.365	1.256	1.663
Valor	65.053	0.993	0.693	150.831	134.26	235.14	4.653	0.665	1.142	16.325	1.953	0.563	1.963
Victoria	33.599	1.036	1.986	147.652	123.653	196.896	33.241	2.856	1.523	14.652	3.02	2.412	1.784
Washington	58.632	0.655	0.358	188.325	139.652	197.325	7.141	2.856	1.322	17.652	3.086	0.986	1.442

Table 9. Concentration (g/kg) of sugars in plum kernels

Plum cultivar	Maltose	Malto- triose	Mannitol	Xylose	Melibiose	Panose	Rhamnose	Raffinose	Stachyose	Malto- tetrase	Malto- pentase	Malto- hexase	Malto- heptase
Avalon	0.866	0.356	0.852	1.147	0.834	0.425	0.685	0.896	0.256	0.662	0.144	0.165	0.033
Blue rock	0.995	0.236	1.063	4.633	0.992	1.653	1.712	1.653	0.963	0.528	0.173	0.11	0.052
Czar	1.365	0.334	1.147	2.652	0.889	1.145	2.653	1.425	0.985	0.367	0.166	0.184	0.036
Edda	0.963	0.425	1.035	4.632	0.996	1.325	1.325	1.633	0.896	0.388	0.147	0.17	0.047
Edwards	14.652	0.389	1.063	1.297	2.552	0.456	3.562	2.785	0.356	0.507	0.062	0.078	0.037
Emil	13.652	0.321	0.856	4.653	2.699	0.337	4.965	2.685	0.452	0.741	0.003	0.036	0.006
Excalibur	0.956	0.332	1.065	4.638	0.985	1.885	1.654	1.523	0.852	0.424	0.151	0.161	0.046
Herman	5.632	0.741	1.568	3.226	3.985	0.652	4.887	2.116	0.653	1.483	0.204	0.417	0.019
Ive	22.452	0.332	0.863	4.663	2.985	0.264	4.652	3.222	0.332	1.23	0.077	0.183	0.152
Jubileum	0.933	0.325	0.996	1.658	1.124	0.896	0.632	0.895	0.663	0.711	0.134	0.114	0.038

Plum cultivar	Maltose	Malto- triose	Mannitol	Xylose	Melibiose	Panose	Rhamnose	Raffinose	Stachyose	Malto- tetrase	Malto- pentase	Malto- hexase	Malto- heptase
Lepotica	0.832	0.523	1.362	3.652	0.898	0.994	0.921	1.123	0.741	0.622	0.188	0.163	0.044
Mallard	0.986	0.647	1.125	4.652	0.856	1.112	1.426	1.332	0.705	0.513	0.233	0.142	0.062
Mount Royal	12.653	0.426	1.022	3.655	2.452	0.552	5.114	2.632	0.452	0.787	0.819	0.047	0.026
Opal	15.632	0.332	0.974	6.895	5.625	0.158	3.526	2.999	0.975	1.014	0.221	0.028	0.182
Reeves	18.665	0.241	1.012	4.995	3.114	0.331	4.652	3.526	1.234	1.525	0.088	0.058	0.166
Reine Claude Grøn	8.953	0.881	1.334	2.998	3.114	0.752	6.012	1.985	0.633	0.469	0.093	0.517	0.071
Reine Claude Noire	2.852	0.522	1.068	4.221	0.983	1.024	2.325	1.114	0.856	0.421	0.184	0.128	0.071
Reine Claude Souffriau	2.046	0.685	1.523	3.058	3.114	0.782	3.332	1.862	0.604	0.516	0.155	0.146	0.067
River's Early Prolific	20.321	0.295	0.991	4.332	3.214	0.145	3.653	2.322	0.665	1.423	0.219	1.087	0.14
Sinikka	11.363	0.23	0.889	4.326	2.663	1.563	3.221	1.425	1.33	1.282	0.763	0.02	0.002
Søgne-plomme	18.523	0.214	1.023	2.856	3.221	0.256	3.426	2.253	0.326	0.823	0.064	0.041	0.001
Sviska Frå Tveit	2.536	0.485	1.332	3.056	1.245	0.833	4.112	1.658	0.985	0.484	0.192	0.13	0.68
Valor	0.884	0.456	1.253	4.002	0.863	1.103	0.953	1.098	0.883	0.633	0.211	0.152	0.064
Victoria	19.652	0.235	0.874	5.623	2.895	0.124	5.123	2.114	0.889	0.103	0.22	0.151	0.179
Washington	10.332	0.688	1.256	3.895	2.885	0.687	5.885	2.356	0.526	0.95	0.671	0.929	0.172

Table 10. Concentration (mg/100g) of tocopherols in plum kernels

Plum cultivar	δ	γ	β	α
Avalon	2.77	11.12	21.32	35.63
Blue rock	3.47	12.33	17.96	41.85
Czar	2.44	10.97	18.74	48.96
Edda	1.89	16.68	20.98	33.55
Edwards	4.32	13.69	20.89	69.75
Emil	8.21	12.58	22.36	64.85
Excalibur	2.89	14.52	21.33	42.66
Herman	3.56	15.52	21.63	64.44
Ive	7.98	11.22	21.26	62.68
Jubileum	2.56	12.42	16.74	29.85
Lepotica	6.01	11.85	17.2	41.39
Mallard	4.65	17.33	22.32	41.89
Mount Royal	5.11	11.75	22.77	71.35
Opal	7.65	11.25	21.32	51.36
Reeves	9.12	9.85	29.56	40.85
Reine Claude Grøn	2.98	15.09	24.56	61.52
Reine Claude Noire	3.89	11.52	23.56	59.85
Reine Claude Souffriau	5.01	15.85	20.15	67.89
River`s Early Prolific	6.26	11.24	24.34	39.65
Sinikka	5.42	12.98	22.52	53.67
Søgneplomme	8.63	10.89	26.32	61.33
Sviska Frå Tveit	4.75	17.23	19.75	62.33
Valor	5.32	18.36	23.89	50.32
Victoria	8.63	10.9	26.41	46.32
Washington	3.08	14.56	23.65	72.98

Table 11. Concentration (mg/100g) of carotenoids in plum kernels

Plum cultivar	Lutein	Zea-xanthin	Crypto-xanthin	Asta-xanthin	Apocarot enal	Canta-xantin	Physa lein	Beta-carotene	Lycopene
Avalon	19.53	3.25	3.25	1.55	1.68	1.33	1.87	21.22	1.18
Blue rock	12.63	6.04	4.98	1.68	2.07	1.66	1.26	14.63	0.95
Czar	12.63	4.52	3.42	0.94	1.06	1.14	1.65	16.63	0.82
Edda	15.33	2.68	6.01	1.52	2.32	1.05	0.95	14.33	1.97
Edwards	10.66	4.72	2.13	0.96	0.83	1.52	1.13	14.35	1.11
Emil	14.89	6.14	2.36	1.05	0.97	2.33	1.45	17.63	0.69
Excalibur	11.45	2.33	5.63	1.18	2.03	1.86	1.66	18.05	1.66
Herman	16.99	6.55	3.85	1.65	2.14	2.03	0.97	19.86	2.01
Ive	12.74	5.39	2.14	0.85	1.33	2.06	2.68	14.33	0.73
Jubileum	16.33	4.12	4.85	0.98	2.15	1.22	2.07	15.98	1.12
Lepotica	14.63	4.98	5.96	1.09	1.99	1.63	1.87	17.22	0.93
Mallard	13.54	1.85	4.33	1.42	2.11	1.36	1.14	17.33	1.27
Mount Royal	17.66	5.69	1.55	1.05	0.87	1.33	0.86	18.96	2.04
Opal	12.74	4.85	5.32	1.98	0.73	1.08	0.88	13.65	1.57
Reeves	15.65	3.42	4.36	1.16	1.02	1.35	0.76	14.33	1.22
Reine Claude Grøn	18.33	6.32	2.33	1.56	1.22	0.94	1.04	21.25	2.23
Reine Claude Noire	16.55	7.32	4.32	1.08	0.83	0.77	1.33	18.63	1.28
Reine Claude Souffriau	17.98	5.11	2.69	1.23	1.05	1.06	1.25	22.55	1.75
River's Early Prolific	12.89	6.88	5.65	1.52	1.33	1.04	0.96	11.87	0.83
Sinikka	14.96	4.65	3.22	1.89	0.98	1.16	1.22	16.85	1.03
Søgneplomme	16.88	4.85	4.59	2.03	1.56	1.98	2.35	18.33	0.86
Sviska Frå Tveit	16.75	6.85	3.11	2.04	1.93	1.18	2.04	18.84	1.96
Valor	16.88	3.87	5.06	0.94	1.43	1.42	2.09	15.89	1.68
Victoria	10.68	3.12	4.32	1.6	0.65	0.98	1.33	12.45	1.42
Washington	19.52	3.22	2.08	1.26	1.04	1.55	0.93	17.52	1.14

