

Agro-ecological and technological quality of some apples

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Abstract: - The aim of the study is to investigate cloudy apple juices, produced from 83 apple varieties, grown by the Institute of Agriculture in town of Kyustendil, Bulgaria for their main ecological and technological parameters, in view of their safety for the population and the possibilities for their use as raw material in the food industry. The study found, that the apples are environmentally friendly for the studied parameters. Technologically, there are varieties with the highest juice yields (over 70%) - Defloga, Ginger Gold, Gold Rush, Granny Smith, and Melrose. The most tasty and colored juices of fresh fruit and fruit flour are separated from the Florina, Free Redstar, Ginger Gold, Gold Rush, Golden Delicious, and Granny Smith. Some practically do not give juice and material for fruit flour with the applied method 100% cold-pressed apple juice, but they produce puree with high quality as the Belgolden, Braeburn, Charden, and Red Delicious. There were observed very stable approximate ratios between Conductivity, Total Dissolved Solids, and Salt content in the juices as follows: Cond./TDS=1.5, TDS/Salt=1.3, Cond./Salt=2. Ratio between Total Sugar Content and Total Acidity - Brix/pH = 3-5, as the most tasty and with good color juices have ratio Brix/pH=4.

Key-Words: - agroecology, technology, apples, juices, chemical, quality

1 Introduction

Apple (*Malus domestica* Borkh.) is the main raw material for the food industry and cooking in terms of fruit. It is the main raw material in a wide range of productions in the food industry. It is used for producing of cloudy and clear juice, syrups, concentrates, nectars, purees, wine, vinegar, cider, malic acid, pectin, fruit flours, dried fruits, compotes, marmalades and more. It is an indispensable fruit for direct consumption, canning, as well as in cooking and confectionery for various dishes.

The aim of the study is to be analyzed 83 of the popular apples, grown by the Institute of Agriculture in town of Kyustendil, Bulgaria for their main agro-environmental and technological parameters, in view of their safety for the population and the possibilities for their use as raw material for the production of cold-pressed juices in the canning industry.

2 Methods

2.1 Agro-ecological parameters

The total radiation background, the radioactivity of the fruit and the juice obtained from them were measured with a Geiger counter "Radex" RD1503 in the microsievert per hour ($\mu\text{Sv/h}$). Four consecutive measurements of radioactivity were

performed of each apple variety and their juices, without separation of the individual types of radiation, followed by averaging of the value, performed automatically.

Nitrate NO_3 mg/l and nitrite NO_2 mg/l contents in the obtained juice were determined by semi-quantitative colorimetric analysis with test strips with a range of 0-10-25-50-100-250-500 mg/l.

The arsenic As content was measured by semi-quantitative colorimetric analysis with a set of test strips with a range of 0,000-0,005-0,010-0,025-0,05-0,1-0,25-0,5 mg/l and malonic acid reagent.

For determination of the zinc Zn content, a semi-quantitative colorimetric analysis was applied with a set of test strips with a range of 0-4-10-20-50 mg/l and sodium hydroxide reagent.

Manganese Mn was also determined by semi-quantitative colorimetric analysis with a set of test strips in the range 0-2-5-20-50-100 mg/l and sodium hydroxide reagent.

The content of lead Pb was established by semi-quantitative colorimetric analysis - Blei-Test, with a set of test strips with a range of 0-20-40-100-200-500 mg/l and reagent rhodic acid.

Sulfates SO_4^{2-} were measured by semi-quantitative colorimetric analysis with test strips with a range of 0-200-400-800-1200-1600 mg/l.

SO₃²⁻ sulfites were also measured by semi-quantitative colorimetric analysis with test strips in the range 0-10-40-80-180-400 mg/l.

2.2 Technological parameters

Portable digital instruments were used as follow: Brix refractometer MA871 ” to measure the total sugar content by Brix (%), "SensoDirect 150" apparatus and "Waterproof IP57" tester for determination of total acidity (pH), electrical conductivity (µS), total dissolved solids (ppm), total salt content (ppm). The glucose content in the apples was measured with a CodeFree titration glucometer (range 0,6-33,3 mmol/l).

The yield (%) was calculated, ie. the ability of apples to release juice during cold pressing of the fruit, as the measurements of the weight of the apples and the juice released during pressing were performed with a laboratory analytical balance.

Sensory testing was performed also, such as taste, aroma, color and turbidity of the juice and the separated fruit puree.

Apple juice (100%) is obtained by the method of cold pressing with a single-shaft juicer Star Light SJB-150 R, unpasteurized, without additives.

The topic is developed in different ways in the scientific literature, as [1,2,3] present research related to the protection of apples from radiation during their storage. Information about possible sources of radioactive contamination is given by [4]. Data on the old apple in Kyustendil region, Bulgaria give [5,6]. Extensive analysis of apples as a fruit is presented [7], and [8,9] make a description and classification of apple juices. Other authors perform a qualitative analysis of apple juices [10,11]. Regarding the chemical composition of apples and their juices, the topic is well developed, for example, such data give [12,13,14,15,16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26] and others.

3 Results

Table 1 Measured almost constant agro-ecological parameters for all juices and purees of different apple varieties

Radioactivity, µSv/h	Sulfate (SO ₄ ²⁻), mg/l	Sulfite (SO ₃ ²⁻), mg/l	Nitrate (NO ₃ ⁻), mg/l	Nitrite (NO ₂ ⁻), mg/l	Mn, mg/l	Zn, mg/l	Pb, mg/l	As, mg/l	Dissolved, O ₂ , mg/l
0.10-0.18	200-300	0	0	0	1-2	0-1	0	0	0.4-0.6

Table 2 Measured technological parameters of the juices and purees of different apple varieties

№	Juice parameters						
	Apple varieties	Brix-total sugar, %	Glucose, mmol/l	PH-acidity	Conductivity, µS	TDS-total dissolved solids, ppm	Salt, ppm
1	Aivanija	12.10	>33.3	5.37	1726	1154	866
2	Winter Banana	18.50	>33.3	3.45	2180	1450	1110
3	Belgolden	10.10	>33.3	3.06	1962	1313	995
4	Berner Rosenapfel	7.60	>33.3	3.31	4180	2800	226
5	Besapara	11.40	>33.3	3.39	187	138	98
6	Braeburn	10.40	>33.3	3.30	2000	1350	1030
7	Buhavitsa	11.20	>33.3	2.65	1780	1191	897
8	Charden	12.40	>33.3	3.07	3230	2170	1710
9	COOP 10	9.90	>33.3	3.66	763	509	371
10	Defloga	10.70	>33.3	3.33	1472	986	734
11	Democrat	13.20	>33.3	3.68	2070	105	1380
12	Elegia	13.30	>33.3	3.31	751	629	335
13	Erwin Bauer	14.30	>33.3	2.97	1462	978	729
14	Florina	11.70	26.9	2.9	1391	935	699
15	Free Redstar	14.10	>33.3	5.28	1208	808	584
16	Freedom	11.80	>33.3	2.85	2190	1460	1120
17	Gala Mondial	10.10	>33.3	3.53	2680	1790	1380
18	Ginger Gold	11.20	>33.3	2.92	1515	1020	763
19	Gloster 69	11.30	>33.3	3.91	1912	1277	967
20	Gold Milenium	12.00	>33.3	3.25	1671	1116	839
21	Gold Rush	13.60	>33.3	3.48	2190	1460	1110
22	Golden Delicious	11.30	>33.3	3.26	1799	1204	908
23	Golden Resistance	13.10	>33.3	2.88	738	495	357

24	Golden Smoothee	12.20	>33.3	3.25	2000	1340	1016
25	Golden Winter Pearmain	11.50	>33.3	2.92	1806	1211	914
26	Gorana	15.30	>33.3	3.33	4040	2180	2700
27	Granny Smith	11.50	>33.3	2.94	1250	685	374
28	Green Knyajevska	11.20	>33.3	2.78	1973	1323	1004
29	Hybrid 1/3	15.90	>33.3	4.02	1413	942	702
30	Hybrid 1/37	10.90	>33.3	3.87	1972	1321	1003
31	Hybrid 2/14	11.60	>33.3	2.72	1992	1323	1004
32	Hybrid 2/28	11.10	26.7	3.00	1908	1277	969
33	Hybrid 2/30	13.00	27.1	3.81	507	765	370
34	Hybrid 2/4	13.00	>33.3	3.00	3760	2520	2020
35	Hybrid 2/8	11.70	>33.3	3.15	1459	979	724
36	Hybrid 6	12.00	>33.3	3.70	3820	2560	2040
37	Hybrid 7	10.30	>33.3	2.97	1911	1281	971
38	Hybrid 8/22	13.10	>33.3	3.11	1901	1276	968
39	Hybrid 8/35	13.80	>33.3	2.84	1460	982	730
40	Hybrid 9	14.10	>33.3	3.30	1833	1226	925
41	Hybrid 9/36	12.50	25.3	3.47	3770	2520	2010
42	Hybrid Pinova x Fuji	14.00	>33.3	3.97	1914	1282	971
43	Idagold	11.30	>33.3	2.84	1135	761	558
44	Jonagold	13.50	>33.3	2.60	712	477	345
45	Kadunka	13.10	>33.3	3.45	3850	2580	2070
46	Karastoyanka	11.50	>33.3	3.07	1120	741	548
47	Landsberger Renette	13.90	>33.3	2.90	2830	1890	1470
48	Liberty	15.00	>33.3	3.43	4450	2980	2000
49	Marlena	11.60	>33.3	3.50	2000	1340	1020
50	Martinika	13.90	>33.3	3.20	2120	1410	1070

51	Melrose	10.30	>33.3	3.31	1379	933	695
52	Mollie's Delicious	11.00	>33.3	2.59	2620	1740	1340
53	Mutsu	10.60	>33.3	2.91	555	373	271
54	Ovcha Mutsuma	13.30	>33.3	2.52	886	592	430
55	Pacific Rose	12.90	>33.3	3.60	1106	743	546
56	Pink Lady	12.60	>33.3	2.78	905	605	441
57	Pinova	11.60	>33.3	2.91	1857	1244	941
58	Priam	10.50	>33.3	5.30	1893	1260	965
59	Prima	10.50	>33.3	3.1	727	664	478
60	Reandra	11.10	>33.3	2.77	1427	964	710
61	Red Chief	13.22	>33.3	5.34	1628	1090	816
62	Red Delicios	11.40	>33.3	3.70	2010	1350	1030
63	Reinette du Canada	12.20	>33.3	3.25	3690	2470	1970
64	Renora	12.60	>33.3	2.84	2820	1880	1470
65	Rosana	9.80	>33.3	3.28	1661	1112	836
66	Rosemary	11.70	>33.3	3.62	2140	1430	1090
67	Rubinola	14.60	>33.3	3.90	1160	778	574
68	Sansa	12.80	>33.3	3.81	1415	950	707
69	Sekai Ichi	13.00	>33.3	3.42	3850	2570	2000
70	Siyana	13.90	>33.3	3.38	410	272	195
71	Skrinyanka	11.90	>33.3	3.02	2160	1400	1090
72	Super Chief	10.30	>33.3	3.98	2090	1390	1050
73	Teser T219	12.30	>33.3	3.49	4030	2790	2180
74	Tetovka	9.64	>33.3	2.85	1595	1069	799
75	Topaz	16.50	>33.3	4.01	2010	1350	1030
76	Tsiganka	12.90	>33.3	2.87	1795	1202	904
77	Wellington	10.20	>33.3	2.72	461	287	189
78	White Kandile	13.31	>33.3	3.64	4400	2940	2380
79	White Winter Calville	13.70	>33.3	3.22	3990	2670	2150
80	Wild apple plant	13.20	>33.3	2.98	1530	1058	789
81	Winter Lemon	9.80	>33.3	3.34	4170	2790	2250
82	Wiygik	9.70	>33.3	2.77	1476	988	736

83	Yellow Bellefleur	10.30	>33.3	2.74	4300	2800	2330
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Table 3 Sensory testing of the juices and purees

No	Juice parameters Apple varieties	Colour	Turbidity	Aroma	Taste	Taste of the Dried fruit
1	Aivanija	brown	puree	dried fruit	sweet	sweet
2	Winter Banana	yellow	puree	fresh fruit	sweet -acid	sweet-acid
3	Belgolden	brown	puree	dried fruit	sweet -acid	sweet
4	Berner Rosenapfel	yellow	puree	fresh fruit	tasteless	sweet
5	Besapara	brown	puree	dried fruit	sweet -acid	sweet-acid
6	Braeburn	brown	puree	dried fruit	sweet -acid	sweet-acid
7	Buhavitsa	dark-green	high	dried fruit	acid-sweet	sweet-acid
8	Charden	brown	puree	dried fruit	sweet	sweet-acid
9	COOP 10	yellow	puree	undefined	tasteless	sweet
10	Defloga	brown	high	dried fruit	sweet -acid	acid-sweet
11	Democrat	brown	high	dried fruit	sweet -acid	sweet-acid
12	Elegia	yellow	puree	fresh fruit	sweet	sweet
13	Erwin Bauer	yellow-green	high	fresh fruit	acid-sweet	sweet-acid
14	Florina	yellow brown	high	fresh fruit	sweet -acid	sweet-acid
15	Free Redstar	yellow	high	fresh fruit	sweet	sweet
16	Freedom	brown	high	dried fruit	sweet -acid	sweet
17	Gala Mondial	brown-green	high	dried fruit	sweet -acid	acid-sweet

18	Ginger Gold	yellow-green	high	fresh fruit	sweet -acid	sweet-acid
19	Gloster 69	brown	high	dried fruit	sweet	sweet
20	Gold Milenium	brown	high	dried fruit	sweet	sweet
21	Gold Rush	yellow-brown	high	fresh fruit	sweet -acid	sweet-acid
22	Golden Delicious	yellow	high	fresh fruit	sweet -acid	sweet-acid
23	Golden Resistance	brown	puree	dried fruit	sweet -acid	sweet
24	Golden Smoothie	brown	puree	dried fruit	sweet -acid	sweet-acid
25	Golden Winter Pearmain	brown	high	dried fruit	sweet -acid	sweet-acid
26	Gorana	yellow	high	fresh fruit	sweet	sweet
27	Granny Smith	yellow-green	high	fresh fruit	acid-sweet	acid-sweet
28	Green Knyajevska	green-brown	high	dried fruit	acid-sweet	sweet-acid
29	Hybrid 1/3	yellow-brown	high	dried fruit	sweet -acid	sweet
30	Hybrid 1/37	brown	high	dried fruit	sweet	sweet-acid
31	Hybrid 2/14	yellow-brown	high	fresh fruit	sweet -acid	sweet-acid
32	Hybrid 2/28	yellow-brown	puree	dried fruit	sweet -acid	sweet-acid
33	Hybrid 2/30	brown	high	dried fruit	sweet -acid	sweet
34	Hybrid 2/4	brown	puree	dried fruit	sweet -acid	sweet
35	Hybrid 2/8	brown	puree	dried fruit	sweet -acid	sweet-acid
36	Hybrid 6	brown	puree	dried fruit	sweet -acid	sweet
37	Hybrid 7	yellow-brown	puree	dried fruit	sweet -acid	sweet-acid
38	Hybrid 8/22	brown	puree	dried fruit	sweet -acid	sweet-acid

39	Hybrid 8/35	yellow-brown	high	fresh fruit	sweet -acid	sweet-acid
40	Hybrid 9	brown	puree	dried fruit	sweet -acid	sweet
41	Hybrid 9/36	brown	high	dried fruit	sweet -acid	sweet-acid
42	Hybrid Pinova x Fuji	yellow	high	fresh fruit	sweet -acid	acid-sweet
43	Idagold	brown	high	dried fruit	sweet -acid	sweet-acid
44	Jonagold	green-brown	high	dried fruit	acid-sweet	sweet-acid
45	Kadunka	brown	high	dried fruit	sweet -acid	sweet-acid
46	Karastoyanka	brown	high	dried fruit	acid-sweet	acid-sweet
47	Landsberger Renette	yellow	high	fresh fruit	sweet -acid	sweet-acid
48	Liberty	brown	puree	dried fruit	sweet -acid	sweet-acid
49	Marlena	brown	puree	dried fruit	sweet -acid	sweet-acid
50	Martinika	yellow	high	fresh fruit	sweet -acid	sweet-acid
51	Melrose	brown	high	dried fruit	sweet -acid	acid-sweet
52	Mollie's Delicious	brown	high	dried fruit	sweet -acid	sweet-acid
53	Mutsu	green-brown	high	dried fruit	sweet -acid	sweet
54	Ovcha Mutsuna	yellow-green	high	fresh fruit	sweet -acid	sweet-acid
55	Pacific Rose	yellow	high	fresh fruit	sweet	sweet
56	Pink Lady	brown	high	dried fruit	acid-sweet	sweet-acid
57	Pinova	brown	high	dried fruit	sweet -acid	sweet-acid
58	Priam	brown	high	dried fruit	sweet	sweet
59	Prima	brown	puree	dried fruit	sweet -acid	sweet-acid

60	Reandra	brown	high	dried fruit	sweet -acid	acid-sweet
61	Red Chief	brown	puree	dried fruit	sweet	sweet
62	Red Delicios	brown	puree	dried fruit	sweet	sweet
63	Reinette du Canada	brown	puree	dried fruit	acid-sweet	acid-sweet
64	Renora	yellow	high	fresh fruit	sweet -acid	sweet-acid
65	Rosana	brown-green	high	dried fruit	sweet -acid	sweet
66	Rosemary	brown	high	dried fruit	sweet	sweet
67	Rubinola	yellow	high	fresh fruit	sweet	sweet
68	Sansa	yellow	high	fresh fruit	acid-sweet	sweet
69	Sekai Ichi	brown	high	dried fruit	sweet	sweet
70	Siyana	yellow	puree	fresh fruit	sweet	sweet
71	Skrinyanka	brown	high	dried fruit	acid-sweet	sweet-acid
72	Super Chief	brown	high	dried fruit	sweet -acid	sweet-acid
73	Teser T219	yellow	high	fresh fruit	sweet -acid	sweet
74	Tetovka	brown	high	dried fruit	sweet -acid	acid-sweet
75	Topaz	brown	puree	dried fruit	sweet	sweet
76	Tsiganka	brown	puree	dried fruit	acid-sweet	sweet-acid
77	Wellington	light green	high	fresh fruit	acid	acid
78	White Kandile	brown	high	dried fruit	sweet	sweet
79	White Winter Calville	brown	high	dried fruit	sweet -acid	sweet-acid
80	Wild apple plant	yellow	high	fresh fruit	acid	acid
81	Winter Lemon	brown	puree	dried fruit	sweet -acid	sweet-acid
82	Wiygik	brown-green	high	dried fruit	sweet -acid	acid

83	Yellow Bellefleur	green-brown	high	dried fruit	acid-sweet	sweet-acid
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Table 4 Ratios between Electroconductivity (EC), Total Dissolved Solids (TDS) and Salt.

№	Juice parameters	Juice Yield, %	Ratio Brix/pH	Ratio EC/Salt	Ratio EC/TDS	Ratio TDS/Salt
	Apple varieties					
1	Aivanija	4.00	2.25	1.99	1.50	1.33
2	Winter Banana	3.00	5.36	1.96	1.50	1.31
3	Belgolden	16.00	3.30	1.97	1.49	1.32
4	Berner Rosenapfel	3.00	2.30	1.85	1.49	1.23
5	Besapara	13.70	3.36	1.91	1.36	1.41
6	Braeburn	10.26	3.15	1.94	1.48	1.31
7	Buhavitsa	53.00	4.23	1.98	1.49	1.33
8	Charden	41.66	4.04	1.89	1.49	1.27
9	COOP 10	3.00	2.70	2.06	1.50	1.37
10	Defloga	70.73	3.21	2.01	1.49	1.34
11	Democrat	56.32	3.59	1.50	1.97	1.08
12	Elegia	5.00	4.02	1.19	2.24	1.88
13	Erwin Bauer	60.00	4.81	2.01	1.49	1.34
14	Florina	61.61	4.06	1.99	1.49	1.34
15	Free Redstar	5.00	2.67	2.07	1.50	1.38
16	Freedom	61.02	4.14	1.96	1.50	1.30
17	Gala Mondial	51.60	2.86	1.94	1.50	1.30
18	Ginger Gold	77.50	3.84	1.99	1.49	1.34
19	Gloster 69	38.50	2.89	1.98	1.50	1.32
20	Gold Milenium	63.44	3.69	1.99	1.50	1.33
21	Gold Rush	71.00	3.91	1.97	1.50	1.32
22	Golden Delicious	66.51	3.47	1.98	1.49	1.33

23	Golden Resistance	43.60	4.55	2.07	1.49	1.39
24	Golden Smoothee	30.00	3.75	1.97	1.49	1.32
25	Golden Winter Pearmain	76.50	3.94	1.98	1.49	1.32
26	Gorana	30.82	4.59	1.50	1.85	0.81
27	Granny Smith	72.50	3.91	3.34	1.82	1.83
28	Green Knyajevska	56.50	4.03	1.97	1.49	1.32
29	Hybrid 1/3	51.76	3.96	2.01	1.50	1.34
30	Hybrid 1/37	54.67	2.82	1.97	1.49	1.32
31	Hybrid 2/14	70.00	4.26	1.98	1.51	1.32
32	Hybrid 2/28	7.26	3.70	1.97	1.49	1.32
33	Hybrid 2/30	23.00	3.41	1.37	0.66	2.07
34	Hybrid 2/4	42.00	4.33	1.86	1.49	1.25
35	Hybrid 2/8	20.00	3.71	2.02	1.49	1.35
36	Hybrid 6	34.17	3.24	1.87	1.49	1.25
37	Hybrid 7	21.28	3.47	1.97	1.49	1.32
38	Hybrid 8/22	18.93	4.21	1.96	1.49	1.32
39	Hybrid 8/35	61.99	4.86	2.00	1.49	1.35
40	Hybrid 9	19.82	4.27	1.98	1.50	1.33
41	Hybrid 9/36	42.98	3.60	1.88	1.50	1.25
42	Hybrid Pinova x Fuji	49.50	3.53	1.97	1.49	1.32
43	Idagold	49.57	3.98	2.03	1.49	1.36
44	Jonagold	59.90	5.19	2.06	1.49	1.38
45	Kadunka	43.72	3.80	1.86	1.49	1.25
46	Karastoyanka	67.00	3.75	2.04	1.51	1.35
47	Landsberger Renette	63.87	4.79	1.93	1.50	1.29
48	Liberty	17.67	4.37	2.23	1.49	1.49
49	Marlena	16.34	3.31	1.96	1.49	1.31

50	Martinika	55.94	4.34	1.98	1.50	1.32
51	Melrose	72.22	3.11	1.98	1.48	1.34
52	Mollie's Delicious	75.51	4.25	1.96	1.51	1.30
53	Mutsu	70.00	3.64	2.05	1.49	1.38
54	Ovcha Mutsuna	63.00	5.28	2.06	1.50	1.38
55	Pacific Rose	58.34	3.58	2.03	1.49	1.36
56	Pink Lady	61.20	4.53	2.05	1.50	1.37
57	Pinova	64.65	3.99	1.97	1.49	1.32
58	Priam	38.92	1.98	1.96	1.50	1.31
59	Prima	20.00	3.44	1.52	1.09	1.39
60	Reandra	69.77	4.01	2.01	1.48	1.36
61	Red Chief	13.22	2.48	2.00	1.49	1.34
62	Red Delicios	15.30	3.08	1.95	1.49	1.31
63	Reinette du Canada	9.39	3.75	1.87	1.49	1.25
64	Renora	75.68	4.44	1.92	1.50	1.28
65	Rosana	61.68	2.99	1.99	1.49	1.33
66	Rosemary	33.00	3.23	1.96	1.50	1.31
67	Rubinola	46.22	3.74	2.02	1.49	1.36
68	Sansa	32.00	3.36	2.00	1.49	1.34
69	Sekai Ichi	54.00	3.80	1.93	1.50	1.29
70	Siyana	9.80	4.11	2.10	1.51	1.39
71	Skrinyanka	27.30	3.94	1.98	1.54	1.28
72	Super Chief	30.00	2.59	1.99	1.50	1.32
73	Teser T219	76.57	3.52	1.85	1.44	1.28
74	Tetovka	59.00	3.38	2.00	1.49	1.34
75	Topaz	15.92	4.11	1.95	1.49	1.31
76	Tsiganka	29.73	4.49	1.99	1.49	1.33
77	Wellington	64.00	3.75	2.44	1.61	1.52
78	White Kandile	42.52	3.66	1.85	1.50	1.24
79	White Winter Calville	41.95	4.25	1.86	1.49	1.24
80	Wild apple plant	66.66	4.43	1.94	1.45	1.34
80	Winter Lemon	5.00	2.93	1.85	1.49	1.24

81	Wiygik	65.00	3.50	2.01	1.49	1.34
82	Yellow Bellefleur	61.50	3.76	1.85	1.54	1.20

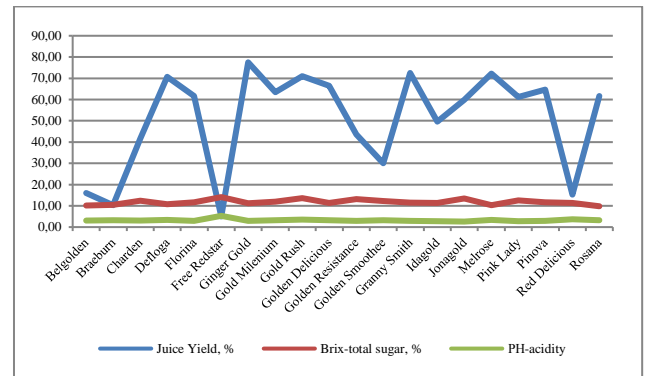


Fig. 1 Diagram of the measured technological parameters of the juices and purees, according to the variety

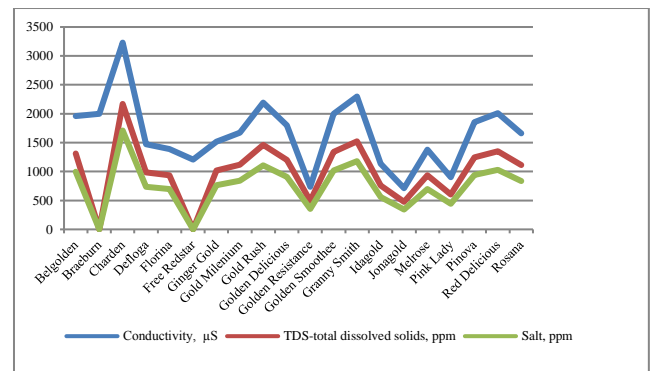


Fig. 2 Diagram of the measured technological parameters of the juices and purees, according to the variety

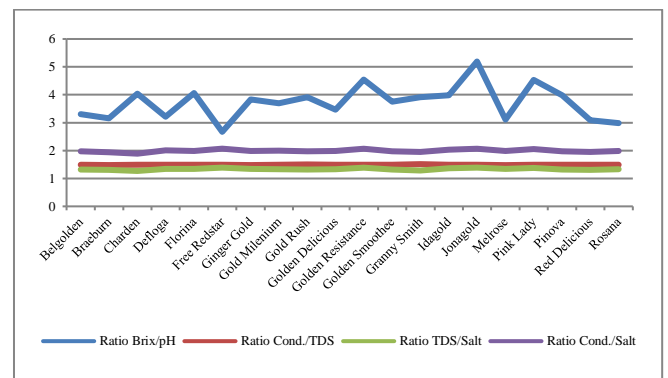


Fig. 3 Diagram of the ratios between total sugar content (Brix), total acidity (pH), Conductivity

(Cond.), total dissolved solids (TDS), and total salt content (Salt).

4 Discussion

Table 1 presents the results of the measurements of the ecological parameters of apples and their juices. All tested apple varieties and their juices have low radioactivity in accordance with the regulations. The natural common radiation background for the Kyustendil region, Bulgaria, according to the Bulgarian Civil Protection Service, is 0,16 $\mu\text{Sv/h}$ (as it fluctuates from 0,10 to 0,18 $\mu\text{Sv/h}$), and is less often outside these norms. To some extent, there is a relationship between the common radiation background and the radioactivity of the fruit. With few exceptions, the radioactivity of the juices directly depends on the radioactivity of the fruits, with a slight decrease in the values in the juice in most cases.

The sulfates SO_4^{2-} in the juice of all apple varieties, vary between 200 and 400 mg/l or about 300 mg/l average. The measured values are minimal, according to the scope of the applied test, and the sulfates are probably part of the organic and mineral substance of the apples, and it is not a result of plant protection or environmental pollution of the area.

Sulfites SO_3^{2-} , lead Pb, arsenic As, nitrates NO_3^- and nitrites NO_2^- are not detected by the applied test methods.

Manganese (Mn) and zinc (Zn) have constant contents, because of this reason it is assumed that they are also part of the natural chemical composition of apples, and not the result of environmental pollution. Manganese content in apples of 2,37 mg/100 g and zinc 0,88 mg/100 g have been reported by [15], ie. the contents of these two elements measured by in present study (Mn=2 mg/l and Zn=1 mg/l) are part of the nutrition composition of apples and cannot be claimed for ecological pollution.

In conclusion, it can be said that in agro-ecological view, the studied apple varieties are of high quality and ecologically clean.

Tables 2,3,4 show that the highest yields (over 70% juice) separate apples of the varieties Defloga, Ginger Gold, Gold Rush, Granny Smith and Melrose. Juice with color and taste of fresh fruit give the varieties Florina, Free Redstar, Ginger Gold, Gold Rush, Golden Delicious and Granny Smith. Some varieties of apples do not produce juice by the method of cold pressing, as well as fruit pulp for fruit flour, but they produce high

quality fruit puree, such as varieties Belgolden, Breburn, Charden and Red Delicious.

As a result of the study, it was found that there are stable relationships between electrical conductivity, total dissolved solids and total salt content in all tested juices, respectively: Cond./TDS~1,5; TDS/Salt~1,3; Cond./Salt~2.

The ratio between the total sugars (Brix) and the total acidity (pH) varies from 3 to 5. The most tasty, delicious and with the best color (fresh yellow or greenish-yellow) are the juices which Brix/pH ratio is 4.

The glucose content of the tested juices exceeds the maximum range of the apparatus used (> 33,3 mmol/l), with an exception of Florina juice, in which the glucose is 29,6 mmol/l and the juices by some hybrids. It has been found that the ratio of fructose to glucose in several studied varieties varies between 2.1 and 3.4 [14,25]. Therefore, the lower glucose content of this variety also implies a lower fructose content. The fructose/glucose ratio can be used as an indicator of the authenticity of apple juice, as a ratio of 1,6 being the lowest expected and respectively the maximum is of 6,09, with average value of 3,03 for typical apple juice [18]. Therefore, from the studied apples, the Florina variety can be recommended for the production of apple foods for diabetics.

It is assumed that apples with the highest values of electrical conductivity of the juice have the most favorable effect on the human body in terms of its detoxification, due to the high mobility and ability to bind and migrate the electrolyte elements. In this regard, the most useful varieties are Breburn, Charden, Gold Rush, Golden Smoothie, Granny Smith and Red Delicious.

5 Conclusion

The highest yields of juice (over 70%) separate apples from the varieties Defloga, Ginger Gold, Gold Rush, Granny Smith and Melrose. Juice with good color and taste of fresh fruit give the varieties Florina, Free Redstar, Ginger Gold, Gold Rush, Golden Delicious and Granny Smith. Some varieties of apples do not produce juice by the method of cold pressing, as well as fruit pulp for fruit flour, but they produce high quality fruit puree, such as varieties Belgolden, Breburn, Charden and Red Delicious.

Variety for diabetics is Florina and Hybrid 9/36, Hybrid 2/28, and Hybrid 2/30. The lowest glucose content was measured for it, respectively

29,6; 25,3; 26,7; 27,1 mmol/l or it means lower fructose content.

Varieties with the strongest ability to remove toxins from the body are those with the most electrolytes: Braburn, Charden, Gold Rush, Golden Smoothie, Granny Smith and Red Delicious. Based on sensory analysis, it was found that the most delicious and best-colored juices and purees are obtained from the varieties Charden, Florina, Ginger Gold, Gold Millennium, Gold Rush, Golden Smoothie, Granny Smith, Ida Gold and Pinova, where the Brix/pH ratio is 4.

There are stable ratios between electrical conductivity, total dissolved solids and total salts in all tested juices, respectively: Cond./TDS=1,5; TDS/Salt=1,3; Cond./Salt=2.

One of the best varieties for the production of 100% apple juice by the cold pressing method is the Granny Smith variety, which participates in almost all positive indicators of juice quality.

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