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. Retio 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
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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 (μSv/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.

SO_3^{2-} 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 (SO4 2-), mg/l	Sulfite (SO3 2-), mg/l	Nitrate (NO3 -), mg/l	Nitrite (NO2 -), mg/l	Mn, mg/l	Zn, mg/l	Pb, mg/l	As, mg/l	Dissolved, O2, 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 Mutsuna**	13.30	>33.3	2.52	886	592	430
55	**Pasific 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

Table 3 Sensory testing of the juices and purees

№	Juice parameters / Apple varieties	Colour	Turbidity	Aroma	Taste	Tasete of the Dried fuit
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	tastele ss	sweed
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	unide ntifie d	tastele ss	sweet
10	**Defloga**	brown	high	dried fruit	sweet -acid	acid-sweet
11	**Democrat**	brown	hign	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	hign	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	hign	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 Smoothee**	brown	puree	dried fruit	sweet -acid	sweet-acid
25	**Golden Winter Pearmain**	brown	high	dried fruit	sweet -acid	sweet-acid
26	**Gorana**	yellow	hign	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**	grenn-brown	high	dried fruit	acid-sweet	sweet-acid
45	**Kadunka**	brown	hign	dried fruit	sweet-acid	sweet-acid
46	**Karastoyanka**	brown	hign	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	hign	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	**Pasific Rose**	yellow	hign	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	hign	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	hign	dried fruit	sweet	sweet
67	**Rubinola**	yellow	hign	fresh fruit	sweet	sweet
68	**Sansa**	yellow	hign	fresh fruit	acid-sweet	sweet
69	**Sekai Ichi**	brown	hign	dried fruit	sweet	sweet
70	**Siyana**	yellow	puree	fresh fruit	sweet	sweet
71	**Skrinyanka**	brown	hign	dried fruit	acid-sweet	sweet-acid
72	**Super Chief**	brown	hign	dried fruit	sweet-acid	sweet-acid
73	**Teser T219**	yellow	hign	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	hign	fresh fruit	acid	acid
78	**White Kandile**	brown	hign	dried fruit	sweet	sweet
79	**White Winter Calville**	brown	hign	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	hign	dried fruit	acid-sweet	sweet-acid

Table 4 Ratios between Electroconductivity (EC), Total Dissolved Solids (TDS) and Salt.

№	Juice parameters / Apple varieties	Juice Yield, %	Ratio Brix/pH	Ratio EC/Salt	Ratio EC/TDS	Ratio TDS/Salt
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	**Pasific 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

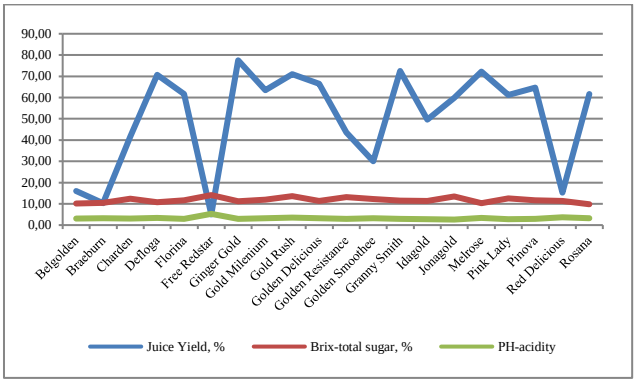

Fig. 1 Diagram of the measured technological parameters of the juices and purees, according to the variety

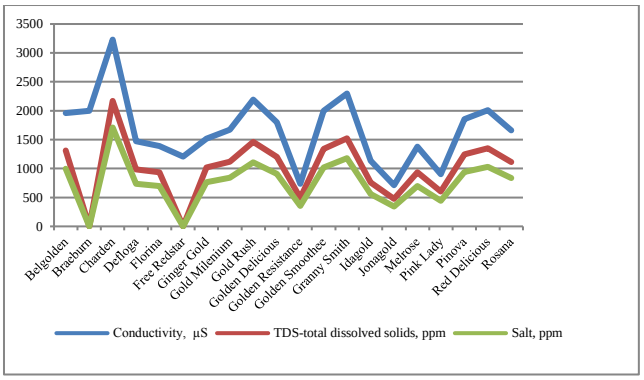

Fig. 2 Diagram of the measured technological parameters of the juices and purees, according to the variety

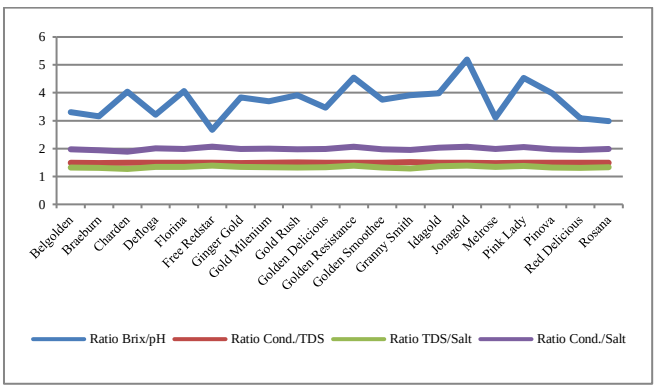

Fig. 3 Diagram of the ratios between total sugar content (Brix), total acidity (pH), Conductivity

(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 μSv/h (as it fluctuates from 0,10 to 0,18 μSv / 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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