Storage of Sugar Beet Raw Juice

ANDREA HINKOVÁ, ZDENĚK BUBNÍK, HELENA ŠTARHOVÁ, VLADIMÍR POUR and PAVEL KADLEC

Institute of Chemical Technology – Department of Carbohydrate Chemistry and Technology, Prague, Czech Republic

Abstract

HINKOVÁ A., BUBNÍK Z., ŠTARHOVÁ H., POUR V., KADLEC P. (2000): **Storage of sugar beet raw juice**. Czech J. Food Sci., **18**: 00–00.

Big disadvantage in sugar beet processing is the possibility of sugar beet treatment only during a three month period. This paper deals with possibilities of raw juice long term storage without adding any chemical additives. For this purpose sugar beet raw juice concentrates were prepared on the climbing film evaporator during two sugar campaigns 97/98 and 98/99. The final refractometric dry solid content varied from 40 to 72%. Some juices were pre-treated by micro- or ultrafiltration. Concentrates were stored for the period of 5 months (campaign 97/98) and 7 months (campaign 98/99) in a stock-room without any heating. Temperatures in the stock-room were very close to the outdoor average temperatures. It resulted from the analysis that initial dry solid content about 65% seemed to be sufficient for avoiding microbiological decomposition and slight sucrose inversion could be expected but not any other monosaccharide decomposition. Initial dry solid content of juice concentrates at least 70% assured high stability. There was not found any relevant influence of the used methods for raw juice pre-treatment on concentrate durability.

Key words: sugar beet; raw juice storage; bioethanol; microfiltration; climbing film evaporator

Overproduction of foodstuffs and the following agriculture production fall seem to be one of the biggest problems in agriculture in the Czech Republic and other countries. Only in Eastern European countries the sugar production and consumption decreased by 13% in 1989–1993 (ČÍŽ 1995) and sugar beet sowing areas in the Czech Republic dropped by 16 thousand hectares (KUNTEOVÁ 1997a). For these reasons new ways of exploitation of agricultural products out of the food industry are looked for. One of the possible ways could be plant biomass processing to obtain an energy source, for instance bioethanol (ethanol produced by fermentation from different carbon sources) which can be used as an engine fuel.

Sugar beet seems to be one of the most advantageous raw materials from this point of view.

Molasses, the waste product in the sugar industry, is utilized the most for fermentation processes nowadays. But this traditional raw material brings many problems with further treatment of waste products such as distiller's stillages (KUNTEOVÁ 1997b). That is why more optimal intermediates from sugar industry are searched for bioethanol production:

- Beet and beet pulp fermentation is negatively influenced by a slow release of sugars from pulp into the fermented solution. Storage of beet is also problematical and brings sugar loss due to enzyme action (BERGHALL *et al.* 1997).
- Thin juice is very suitable for ethanol production but there is no possibility to store it for a longer period.
- Thick juice is possible to store, on the other hand there are high expenses for its production (KUNTEOVÁ, LOUČKA 1997).

Considering all these facts, raw juice could be used as another intermediate. Raw juice contains all nonsugars which are removed in a traditional technology by purification process. These nonsugars remain in broth after the fermentation process and its composition is very suitable for addition into feeds. Additional advantage in comparison with molasses is a low content of inorganic salts (especially potassium).

Besides fermentation, there is another way of raw juice utilization. It is direct cooling crystallization to obtain sugar. This method might replace defecation and carbonation processes in a traditional sugar beet treatment and reduce energy and technological costs (VACCARI 1997; BUBNÍK *et al.* 1997, 1999).

Cooling crystallization and fermentation are processes which could run for the whole year and could be combined together: first cooling crystallization is carried out and then

mother liquor from crystallization is used for fermentation, which seems to be economically more favourable than direct fermentation of raw juice (BUBNÍK *et al.* 1998a).

For the above-mentioned reasons the problem of raw juice storability has risen and is solved at many research centers.

FIEDLER *et al.* (1993) determined conditions (water activity, pH, temperature) for storability of raw thick juice from sugar beet. Limiting parameters were water activity 0.88 (equivalent to 67% refractometric dry solid), pH 6 and temperature 5°C. Tests with periodic formalin dosing were also carried out. All research is complemented with detailed results from microbiological tests.

In Austria (POLLACH 1992; HEIN *et al.* 1996) they started to deal with raw juice storage in the eighties due to ethanol and "whole sugar" production. Attention was focused on raw juice thickening and problems connected with it, such as scale formation which was prevent by adding Ca-ions to the raw juice and/or using special fluidized bed evaporator for pressed juice thickening. The concentrate was stored under carbon dioxide in a tank with the conical head to restrict the exposed surface.

POLLACH *et al.* (1999) also widely discussed the risk of microbial contamination in sugar factories and mentioned the recent results from storage of thick juice and its protection by spraying of sodium hydroxide solution to the surface.

As it was said before, extension of sugar beet raw juice treatment into the period when sugar campaign does not run was one of the most important aims. First, it was necessary to verify methods for pre-treatment and thickening of raw juice and find suitable conditions under which it is possible to store raw juices without any decay of the main components. Department of Carbohydrate Chemistry and Technology in Prague has been engaged in this problem for more than 5 years. Results from storage of raw juices which were sampled during the sugar campaigns 1997 and 1998 are presented in this paper.

MATERIAL AND METHODS

***Raw Material*:** Samples of sugar beet raw juices were taken from different sugar factories and different extractors during the sugar campaigns 97/98 and 98/99. Tables 1 and 2 show designation and pre-treatment method of raw juices in both sugar campaigns.

Pre-treatment of Raw Juices: After sampling some juices were pre-treated in different ways:

- Alkalization: pH adjustment with 10% NaOH to the range of values 6.7–7.2.
- Microfiltration – ICT: Microfiltration of raw juices was carried out at the Institute of Chemical Technology (BUBNÍK *et al.* 1998b) on a filtration unit made by French firm T.I.A. Bollene equipped by ceramic membranes MEMBRALOX with the filtration area 0.2 m^2, porosity 20 nm. Limiting conditions were: temperature 85°C, pH range 0.15–13.5, maximal pressure on input: 0.6 MPa. During the microfiltration some suspended particles like coloured substances and colloids were eliminated and also juices were partly sterilised because of microorganism removing.
- Ultrafiltration – VUC: Ultrafiltration was carried out at the Sugar Research Institute in Prague on the testing equipment UNION FILTRATION (Denmark) with plate arrangement of membranes (ŠÁRKA *et al.* 1999). Three different membranes with different cuts-off were used: PES/PVP 4 PP (cut-off 4000) – raw juice AF, GR61PP (cut-off 20 000) – raw juice BF, PES 50 H (cut-off 50 000) – raw juice CF. Working conditions were following: medium flow 6–8 l/min, temperature 25–30°C, pressure difference 0.1–0.35 MPa.
- Sucrose inversion was provided by enzyme β-fructosidase action in raw juice with pH 5.5.
- Blanching – raw juice obtained by heating of sliced beet with steam in a kitchen equipment BRAUN with adjustable time of steam operation from 0 to 60 min.
- For comparison some juices were left without any treatment.

Thickening: Before storage juices were thickened on a climbing film evaporator (ARMFIELD, England) (Fig. 1) up to the required refractometric dry solid content. Evapo-

Table 1. Designation of raw juice samples in the campaign 97/98

Designation	Sugar factory	Date of sampling in factory	Method of pre-treatment
D1	Dobrovice	18-11-97	alkalization
D2	Dobrovice	18-11-97	no pre-treatment
D3	Dobrovice	06-10-97	microfiltration-ICT
D4	Dobrovice	04-12-97	no pre-treatment
U5	Úžice	02-12-97	no pre-treatment
B6	Bašnice	25-11-97	no pre-treatment
B7	Bašnice	25-11-97	alkalization
B8	Bašnice	25-11-97	microfiltration-ICT

Table 2. Designation of raw juice samples in the campaign 98/99

Designation	Sugar factory	Date of sampling in factory	Method of pre-treatment
AF	Modřany	30-11-98	ulrafiltration-VUC
B0	Modřany	30-11-98	no pre-treatment
BF	Modřany	30-11-98	ultrafiltration-VUC
B0F	Modřany	30-11-98	microfiltration-ICT
C0	Modřany	30-11-98	no pre-treatment
CF	Modřany	30-11-98	ultrafiltration-VUC
C0F	Modřany	30-11-98	microfiltration-ICT
BL	Modřany	25-11-98	blanched
IS	Modřany	25-11-98	sucrose inversion

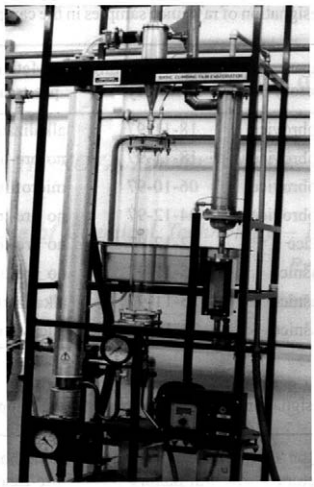

Fig. 1. Climbing film evaporator Armfield

ration run in two stages, under the vacuum and following conditions:

steam pressure:	100–150 kPa
pressure inside the evaporating tube:	60 kPa
input juice temperature:	22°C
output juice temperature in the 1st stage:	72–74°C
output juice temperature in the 2nd stage:	74–77°C
input juice flow rate:	15–17 l/h

Storage: Campaign 97/98 – Juice concentrates were placed into 5 or 10litre barrels and stored in a stock-room without any heating. Temperature in the stock-room was very close to the outdoor average temperature. It is also necessary to notice that no chemical additives (as e.g., formaldehyde) were added to extend the durability because we wanted concentrates to be available for another possible treatment in the food industry.

Campaign 98/99 – Raw juice concentrates were stored almost under the same conditions as in the campaign before (that means: in 5l barrels and 2l polyethylene bottles placed in the stock-room). The observed period was longer and the maximum temperature (30°C – June 1999) was higher in comparison with the previous campaign (Table 3). We also wanted to restrict mould growth on the surface of concentrates and for these reasons bottles and barrels had to be filled up to the cover and minimum of air was left inside.

For evaluation changes during storage samples of concentrated juice taken in one month or two month intervals (Table 4) and juices were analysed for the period of 5 months (campaign 97/98) and 7 months (campaign 98/99).

Analytical Methods

- Refractometric dry solid (RDS) content (= saccharization) – measured directly on digital refractometer ABBEMAT (Dr. Kernchen, Germany).
- Polarization – determined on polarimeter SUCROMAT VIS/NIR (Dr. Kernchen, Germany) at the wave length 589 nm after precipitation of diluted sample (13 g of sample filled with distilled water in 100 ml volumetric flask) with Herles I and II agents and filtration.
- Purity – calculated as a ratio of polarization and RDS multiplied by 100.
- Content of sucrose and of invert (= sum of glucose and fructose) – analysed on HPLC with autosampler AS 54 (Ecom, s. r. o., Czech Republic), column filling: ionex OSTION LG KS 0800 Ca^{2+}, mobile phase: demineralized water with flow rate 0.5 ml/min, detection: refractometer RIDK 101 (Laboratorní přístroje Praha, Czech Republic).
- pH – measurement of diluted sample (13 g of sample filled with distilled water in 100 ml volumetric flask) on apparatus THERM 2290-3 (ALMEMO) with the glass electrode.

RESULTS AND DISSCUSION

Sugar Campaign 97/98: Changes in the composition of stored raw juice concentrates (refractometric dry solid content, polarization, purity, pH, sucrose, glucose and fructose content) were observed in a five months period during the winter and spring months when the temperature in a stock-room did not exceed 20°C (Table 5).

Refractometric Dry Solid (Table 5, Fig. 2): Samples D1 and D2 show very slight variations of values. Gradual saccharization increase (samples D3, D4, U5, B6 – B8) is possible to explain by the way of juice storage. Concentrates were placed in the stock-room where the temperatures were very close to the outdoor temperatures and that is why from the beginning of the experiment sucrose partly crystallized (because of the low temperatures during the winter months) and later it dissolved because of the rising temperature. Another reason could be the way how samples of concentrates have been taken – concentrates were solutions with very high viscosity placed in 10l barrels so it

Table 3. Average, minimum and maximum temperatures in 1998/1999

	Nov-98	Dec-98	Jan-99	Feb-99	March-99	April-99	May-99	June-99
Average temperature	**2.1**	**–0.8**	**3.1**	**–0.3**	**6.1**	**9.7**	**15.2**	**21.0**
Maximum temperature	10.0	7.2	13.5	5.8	10.7	14.5	28.5	30.0
Minimum temperature	–3.0	–8.7	–8.8	–7.3	2.0	3.8	9.5	15.0

Table 4. Dates of analyses of samples from campaign 97/98 and 98/99

Number of analysis	Date of analysis	Designation of analysis
Campaign 97/98		
1	16. 12. 1997	XII-97
2	19. 01. 1998	I-98
3	16. 02. 1998	II-98
4	17. 03. 1998	III-98
5	15. 04. 1998	IV-98
Campaign 98/99		
1	21. 12. 1998	XII-98
2	20. 01. 1999	I-99
3	16. 02. 1999	II-99
4	20. 04. 1999	IV-99
5	30. 06. 1999	VI-99

was not possible to heat them for better sampling otherwise the experiment conditions would have been changed. For these reasons saccharization changes can be considered very small.

Sucrose Content (Table 5, Fig. 3): Both methods for sucrose content determination (polarization measurement and HPLC) show the same trends in all samples. Polarization values are mostly higher. Samples from the sugar refinery Dobrovice had the highest purity and the gradual decrease of sucrose content was confirmed by both methods. Changes of sucrose content in raw juice concentrates with low initial purity (sugar factories Úžice and Bašnice) were not too significant and were lower in comparison with juices from Dobrovice refinery. These values fluctuated around the initial value without any significant trend.

Invert and Total Sugar Content Determined by HPLC (Fig. 4): The increase of invert content (= sum of glucose and fructose) was observed in all concentrates. Samples from refineries Dobrovice and Úžice (D1–D4, U5) had a

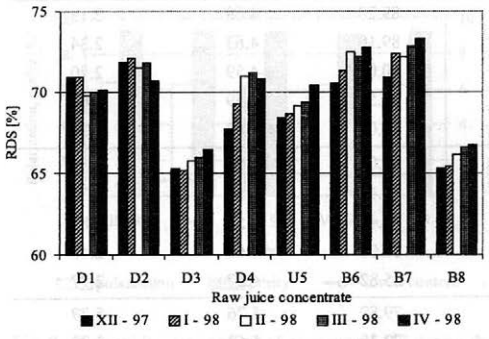

Fig. 2. Changes in refractometric dry solid (RDS) of raw juice concentrates during the campaign 97/98

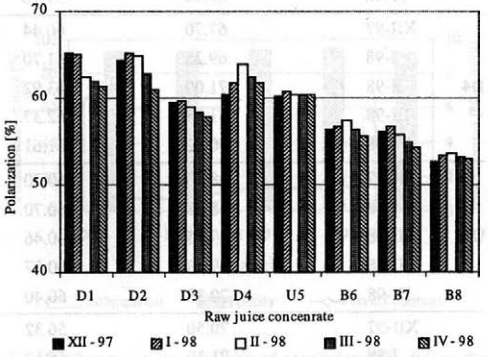

Fig. 3. Changes in polarization of raw juice concentrates during the campaign 97/98

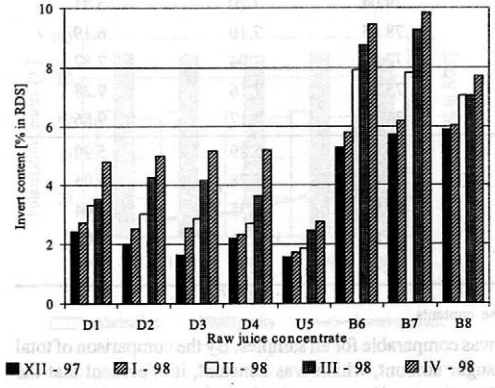

Fig. 4. Changes in invert content of raw juice concentrates during the campaign 97/98

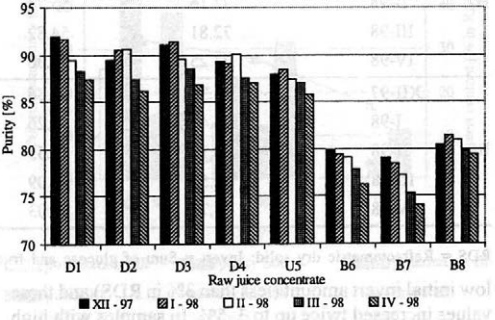

Fig. 5. Changes in purity of raw juice concentrates during the campaign 97/98

Table 5. Analytical values of raw juice concentrate during storage in the sugar campaign 97/98

	Analysis	RDS [%]	Polarization [%]	Purity [1]	pH	Invert [% in RDS]
	XII-97	70.92	65.24	91.99	6.66	2.45
	I-98	70.90	65.00	91.68	6.56	2.72
D1	II-98	69.75	62.40	89.46	6.57	3.33
	III-98	70.00	61.80	88.29	6.71	3.54
	IV-98	70.14	61.30	87.40	6.71	4.80
	XII-97	71.84	64.32	89.53	6.19	1.99
	I-98	72.07	65.26	90.55	6.16	2.53
D2	II-98	71.50	64.81	90.64	6.14	3.03
	III-98	71.77	62.71	87.38	6.24	4.26
	IV-98	70.69	60.90	86.15	6.26	4.97
	XII-97	65.30	59.52	91.15	6.94	1.62
	I-98	65.20	59.60	91.41	6.73	2.55
D3	II-98	65.77	58.93	89.60	6.69	2.87
	III-98	66.00	58.42	88.52	6.83	4.15
	IV-98	66.44	57.70	86.85	6.89	5.18
	XII-97	67.70	60.44	89.28	4.68	2.19
	I-98	69.25	61.70	89.10	4.63	2.34
D4	II-98	71.00	63.92	90.03	4.59	2.70
	III-98	71.23	62.37	87.56	4.59	3.64
	IV-98	70.82	61.61	87.00	4.68	5.21
	XII-97	68.40	60.20	88.01	4.56	1.55
	I-98	68.63	60.70	88.45	4.50	1.70
U5	II-98	69.15	60.46	87.43	4.52	1.87
	III-98	69.39	60.37	87.00	4.60	2.48
	IV-98	70.38	60.40	85.82	4.57	2.77
	XII-97	70.50	56.32	79.89	5.76	5.29
	I-98	71.30	56.60	79.38	5.68	5.79
B6	II-98	72.45	57.36	79.17	5.65	7.94
	III-98	72.20	56.25	77.91	5.75	8.78
	IV-98	72.77	55.50	76.27	5.72	9.44
	XII-97	70.90	56.04	79.04	7.20	5.71
	I-98	72.33	56.74	78.45	7.10	6.19
B7	II-98	72.16	55.74	77.25	7.04	7.82
	III-98	72.81	54.82	75.29	7.16	9.28
	IV-98	73.25	54.30	74.13	7.17	9.86
	XII-97	65.30	52.56	80.49	5.89	5.90
	I-98	65.42	53.26	81.41	5.78	6.05
B8	II-98	66.17	53.55	80.93	5.75	7.04
	III-98	66.53	53.09	79.80	5.81	7.06
	IV-98	66.75	53.03	79.45	5.76	7.72

RDS = Refractometric dry solid; Invert = Sum of glucose and fructose contents

low initial invert amount (less than 3% in RDS) and these values increased twice up to 3–5%. In samples with high initial invert amount (sugar factory Bašnice, B6–B8) these amounts increased up to 7–9%. Absolute invert increase was comparable for all samples. By the comparison of total sugar amount, which was constant, it is evident that the invert created by sucrose hydrolysis was not subsequently decomposed. This assumption is also approved by pH

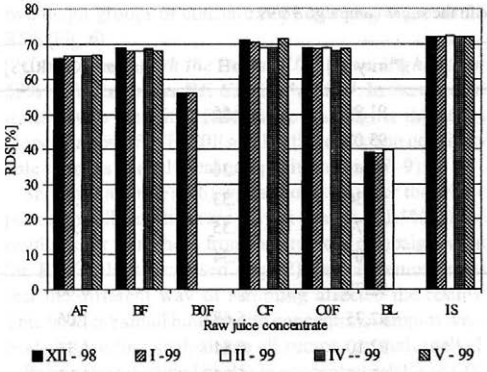

Fig. 6. Changes in refractometric dry solid (RDS) content of raw juice concentrates during the campaign 98/99

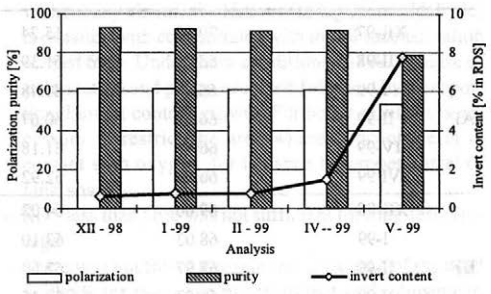

Fig. 7. Changes in composition of concentrate AF during the campaign 98/99

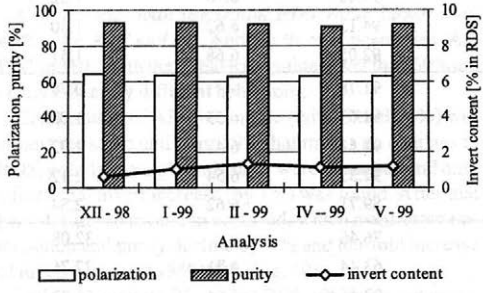

Fig. 8. Changes in composition of concentrate BF during the campaign 98/99

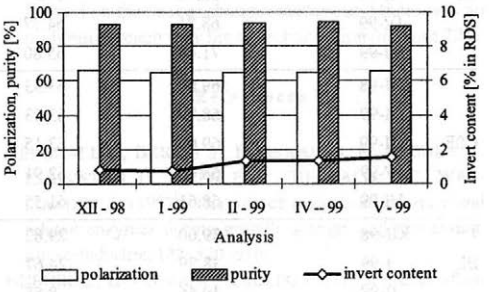

Fig. 9. Changes in composition of concentrate CF during the campaign 98/99

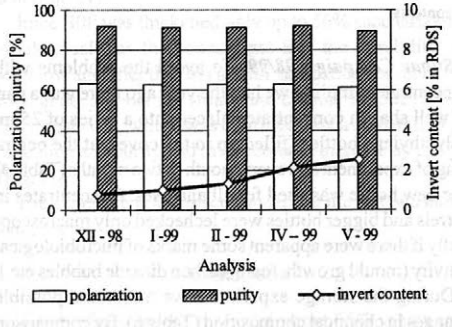

Fig. 10. Changes in composition of concentrate COF during the campaign 98/99

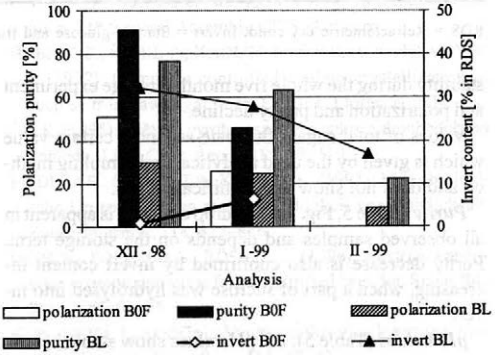

Fig. 11. Changes in composition of concentrates BOF and BL during the campaign 98/99

Table 7. Analytical values of raw juice concentrate during storage in the sugar campaign 98/99

	Analysis	RDS [%]	Polarization [%]	Purity [1]	pH	Invert [% in RDS]
	XII-97	70.92	65.24	91.99	6.66	2.45
	XII-98	66.00	61.39	93.02	–	0.63
	I-99	66.48	61.48	92.48	6.30	0.76
AF	II-99	66.45	60.67	91.30	6.33	0.79
	IV-99	66.69	61.18	91.74	6.35	1.50
	VI-99	66.93	52.92	79.07	6.34	7.79
	XII-98	69.00	64.02	92.78	–	0.66
	I-99	68.03	63.10	92.75	6.68	1.06
BF	II-99	67.97	62.60	92.10	6.84	1.33
	IV-99	68.67	62.45	90.94	6.76	1.15
	VI-99	68.10	62.69	92.06	6.78	1.20
B0F	XII-98	56.00	51.05	91.16	–	0.94
	I-99	56.04	25.47	45.45	5.03	6.50
	XII-98	71.00	65.83	92.72	–	0.78
	I-99	70.39	65.04	92.40	6.43	0.75
CF	II-99	68.90	64.37	93.43	6.76	1.32
	IV-99	68.81	64.77	94.13	6.62	1.30
	VI-99	71.48	65.80	92.05	6.68	1.51
	XII-98	69.00	63.33	91.78	–	0.78
	I-99	68.79	63.03	91.63	6.53	1.02
C0F	II-99	69.01	63.15	91.51	6.45	1.32
	IV-99	68.12	62.91	92.35	6.54	2.12
	VI-99	68.61	61.55	89.71	6.62	2.54
	XII-98	39.00	29.82	76.46	–	32.08
BL	I-99	38.89	24.67	63.44	4.71	27.76
	II-99	39.56	8.88	22.45	4.54	16.83
	XII-98	72.02	–17.24	–	–	90.55
IS	I-99	72.02	–13.02	–	4.64	90.92
	II-99	72.09	–12.94	–	4.60	91.61
	IV-99	72.01	–10.58	–	4.58	89.26
	VI-99	72.00	–11.91	–	4.67	89.77

RDS = Refractometric dry solid; Invert = Sum of glucose and fructose contents

stability during the whole five months storage experiment and polarization and purity decline.

Values of total sugars fluctuate around a certain value which is given by the used analytical and sampling method and does not show any significant trend.

Purity (Table 5, Fig. 5): The drop of purity is apparent in all observed samples and depends on the storage term. Purity decrease is also confirmed by invert content increasing, when a part of sucrose was hydrolysed into invert.

pH Values (Table 5): All pH values show stable behaviour and slight oscillation around the initial value with an aberration ± 0.2. These data indicate that there were no acids created by monosaccharide decomposition.

Sugar Campaign 98/99: To avoid the problems with concentrate sampling we had the year ago there was a part of well shaken concentrates placed into a series of 25 ml polyethylene bottles (filled up to the cover) at the beginning of experiment and every month or two months (Table 4) one new bottle was used for all analyses. Concentrates in barrels and bigger bottles were lechecked only macroscopically if there were apparent some marks of microbiological activity (mould growth, foam, carbon dioxide bubbles etc.).

During the storage experiment we monitored possible changes in chemical composition (Table 6). By comparison of all measured values it is obvious that the concentrate stability is affected the most by the initial saccharization of raw juice concentrate and that is why we will discuss

two major groups of concentrates according to the initial RDS (Fig. 6).

Concentrates with the Initial RDS Value Higher than 69% – Concentrates BF, CF, C0F and IS: In the concentrates where the initial RDS value was higher than 69% (concentrates BF, CF, C0F and IS) there were no considerable changes in analytical composition (Figs 7–9):

Saccharization (Fig. 6) was almost stable for the whole period and all variations are only in a range 1–1.5%. These results differ from those from the previous campaign when the RDS values increased (Fig. 2), which demonstrates that the different way of sampling affected the results. This time, the small bottles with concentrate samples were heated-up before analysis, so all sucrose crystals melted.

Polarization declined by 2% in concentrates BF and C0F (samples with the initial RDS 69%) (Figs 7 and 9). The composition of other samples (with initial RDS 71 and 72%) did not alter too much. These results are confirmed by invert and purity values which follow the polarization trend. The positive issue is that the high initial concentration (more than 70%) enables raw juice storage even when the temperature in the stock-room exceeded 26°C.

Concentrates with the Initial RDS Value Lower then 69% – AF, B0F and BL: Another three concentrates (AF, B0F and BL) with the initial RDS value lower than 69% are characterized by different behaviour:

Composition of AF concentrate (initial RDS 66%) was almost the same until April 99, that means no changes in RDS, polarization, pH and purity were measured and only a fractional invert increase (by 1%) was found. After that period, sucrose inversion occurred, which manifested polarization and purity decline by 8 % and ten-fold increase of invert sugar up to 8% RDS (Fig. 10).

In the concentrate BL (initial RDS 39%) was not possible to reach higher initial saccharization by evaporating because juice had very high viscosity (caused by high pectin content) after blanching. After the first two months of storage moulds were found growing on the surface. This finding was also confirmed by a four-fold decline of polarization and purity and rapid decrease of invert content (Fig. 11).

Juice B0F was thickened only up to 56% saccharization. Analogously, as the concentrate BL, the durability was very low and after the first month indications of microbiological decomposition (foam and carbon dioxide release) were observed, which was confirmed by a 50% fall of polarization and purity and invert content increase up to 6.5% (Fig. 11).

The experiment was discontinued for the last two named samples.

Conclusion

- Initial refractometric dry solid about 65% seems to be sufficient for avoiding microbiological decomposition during spring months with lower temperatures (maximum 20°C). During storage under such conditions slight sucrose inversion could be expected but not any other monosaccharide decomposition.
- Seven month storage with temperature maximum 26°C without any chemical additives (as e.g., formaldehyde) is possible with concentrates with initial saccharization at least 69%. Under these conditions 2–4% decrease of polarization and purity occurred followed by a proportional invert content growth. For better results it is necessary to restrict the area where concentrate is in contact with oxygen, for instance by proper barrel or tank shape.
- RDS less than 56% was not sufficient for long-term storage.
- There was not found any relevant influence of the used methods for raw juice pre-treatment (pH adjustment, microfiltration, ultrafiltration) on a concentrate stability. Most stable were concentrates with the highest initial RDS (concentrate IS).
- On the other hand, microfiltration had a great influence on the evaporating process. All filtered juices were easier to thicken on a climbing film evaporator because of lower viscosity. Evaporation was faster, no singes were formed on the heat exchanger surface and there was no problem to reach very high saccharization of about 70%.

References

BERGHALL S., BRIGGS S., ELSEGOOD S. E., ERONEN L., KUUSISTO J. O., PHILIP E. J., THEOBALD T. C., WALLIANDER P. (1997): The role of sugar beet invertase and related enzymes during growth, storage and processing. Zuckerindustrie, **122**: 520–530.

BUBNÍK Z., HINKOVÁ A., KADLEC P. (1998b): Cross-flow micro- and ultrafiltration applied on ceramic membranes in impure sugar solutions. Czech J. Food Sci., **16**: 33–39.

BUBNÍK Z., HINKOVÁ A., ŠTARHOVÁ H., POUR V. (1998a): Výroba a využití ethanolu ze zemědělských plodin. [Závěrečná zpráva grantového projektu.] Praha.

BUBNÍK Z., KADLEC P., ŠTARHOVÁ H., HINKOVÁ A., POUR V. (1999): Sucrose crystal growth from concentrated raw juice. 21st General Assembly CITS, Antwerp.

BUBNÍK Z., ŠTEKL P., KADLEC P., KADLEC K., HLASIVEC J. (1997): Computer controlled cooling crystallization of sucrose from raw sugar juice. ECCE 1, Florence, Italy.

ČÍŽ K. (1995): Světová výroba a spotřeba cukru z dlouhodobého pohledu. Listy Cukr. Řep., **111**: 117–119.

FIEDLER B., SCHMIDT P., KUNKEL K. (1993): Mikrobiologische Untersuchungen zur Lagerfähigkeit von Rohdicksaft. Zuckerindustrie, **118**: 872–876.

HEIN W., POLLACH G., RÖSNER G. (1996): Austrian experience in producing sugar from unpurified beet. Int. Sugar Jnl., **98**: 52–55, 91–95.

KUNTEOVÁ L. (1997a): Využití cukrovky k výrobě bioethanolu. Listy Cukr. Řep., **113**: 47–49.

KUNTEOVÁ L. (1997b): Co přináší řepa. Listy Cukr. Řep., **113**: 259–262.

KUNTEOVÁ L., LOUČKA Z. (1997): Výroba motorových paliv ze zemědělských plodin. [Výzkumná zpráva.] VUC, Praha.

POLLACH G. (1992): Vollzucker – Technologische Aspekte. Zuckerindustrie, **117**: 711–714.

POLLACH G., HEIN W., RÖSNER G. (1999): New findings to solve microbial problems in sugar factories. 21st General Assembly C.I.T.S., Antwerp.

ŠÁRKA E., SMOLÍK J., GEBLER J., BUBNÍK Z. (1999). Ultrafiltration of raw juice: 21st General Assembly C.I.T.S., Antwerp.

VACCARI G. (1997): Elimination of the traditional purification by raw juice crystallization. L'industria Saccarifera Italiana, **90**: 151–161.

Received for publication October 5, 1999
Accepted for publication December 9, 1999

Souhrn

HINKOVÁ A., BUBNÍK Z., ŠTARHOVÁ H., POUR V., KADLEC P. (1999): **Skladování surové řepné šťávy**. Czech J. Food Sci., **18**: 14–22.

Velkou nevýhodou při zpracování řepy je sezonní charakter možného využití. V poslední době se ovšem objevuje mnoho technologií, které by umožnily využívat cukrovku a z ní vyráběné produkty během celého roku, přičemž by došlo k výraznému snížení jak provozních nákladů, tak i nákladů na technologii. Tato práce zaměřila na možnosti dlouhodobého skladování surové řepné šťávy bez přídavku chemických aditiv. Během kampaní 97/98 a 98/99 byly připraveny koncentráty surové šťávy zahuštěním šťáv na filmové odparce. Konečná sacharizace se pohybovala v rozmezí 40–70 %. Některé šťávy byly před zahuštěním předupraveny mikro- či ultrafiltrací. Koncentráty se skladovaly po dobu pět (kampaň 97/98) nebo sedm měsíců (kampaň 98/99) ve skladu bez vytápění (teploty ve skladu se blížily venkovním teplotám). Z výsledků analýz vyplynulo, že počáteční sacharizace 65 % se zdá být dostačující pro zamezení mikrobiologické aktivity, nicméně s rostoucími venkovními teplotami se dá očekávat mírná inverze sacharosy bez dalšího následného rozkladu monosacharidů. Teprve počáteční sacharizace 70 % zajišťuje dostatečnou stabilitu koncentrátu. Vliv předúpravy surové šťávy na stabilitu koncentrátu nebyl prokázán.

Klíčová slova: cukrová řepa; skladování surové šťávy; bioethanol; mikrofiltrace; filmová odparka se stoupajícím filmem

Corresponding author:

Ing. ANDREA HINKOVÁ, Vysoká škola chemicko-technologická, Ústav chemie a technologie sacharidů, Technická 5, 166 28 Praha 6, Česká republika, tel.: + 420 2 24 35 31 11, fax.: + 420 2 311 99 90, e-mail: hinkovaa@vscht.cz