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## **TECHNOLOGICAL AND COMMODITY SCIENCE RELATED ASPECTS OF CIDER PRODUCTION**

*Remarkable changes in terms of alcohol consumption have taken place in Poland in the recent years. These changes refer not only to the amount of the alcohol consumed but also to the structure of the alcohol beverages. Cider is one of beverages whose production and consumption has increased remarkably.*

*The objective of this study is to present some selected aspects of manufacturing as well as the factors determining the quality of cider. Attention has been drawn to the economic conditions of cider production in Poland. The present studies have shown that the further increase of cider production depends on the development of orchards of apple trees suitable for cider production and on the legal regulations. Reduction of excise tax on cider as a drink made of apple juice of 5% alcohol content, general community action supporting the consumption of Polish apples in 2014 as well as the change in Polish people's preferences and choosing weaker alcohols, have caused a rise in interest among cider manufacturers and consumers.*

**Key words:** *cider, technology, commodity scientific aspects, quality*

### **INTRODUCTION**

Cider is popular especially in the UK, northern France, Belgium, Ireland and Lithuania [2]. According to Polish law, cider is a low alcohol drink of the factual alcohol content from 1.2% to 8.5% vol., obtained in the process of alcohol fermentation of the prepared cider liquor [23].

This study presents the issues related to the technological and commodity science aspects of cider production. The presentation of Polish and foreign cider markets in Poland was an additional objective of this study.

Already the Romans manufactured cider of apples and Pearmain, an old English apple variety, was popular in 13th century as a desserts fruit and it was used for cider production [21]. The first records about cider in North America come from 1635 when Mr. Wolcott of Connecticut wrote that he had succeeded to obtain five hundred barrels of apple cider, 240l each, from the apples picked up in his orchard [32]. Cider was known in Poland already in 17th century and it was called "apple cider" [Pol. "jabłecznik"]. A light beverage was much liked by women who were not expected to drink stronger alcohols. It was also a cheaper

beverage for common people. The best cider is obtained in the process of long-term fermentation. Unless its production is artificially accelerated, 3 months or even 6 months should be waited. The more cloudy the real cider is, the better. If produced by traditional methods, cider is stronger and it contains 6–8.5% alcohol. In large scale cider production, manufacturers often interrupt the fermentation process by diluting the fruit juice and adding preservatives. Thus cider of 3–4% vol. is obtained [16].

## PRODUCTION OF CIDER

The raw material for cider production is a fermented apple juice, called apple must [10, 14]. It is the must what gives cider a characteristic apple and sour taste and light straw to dark yellow colour. Adding sugar, apple juice or apple juice concentrate is allowed, however, it is not allowed to add any other alcohol to cider [2, 10, 14, 20]. Polish Classification of Products and Services qualifies cider as “other wine products” which include, but are not limited to: cider, perry, mead and other beverages containing alcohol [23]. The legal act divides cider into 4 categories: dry, with sugar (invert sugar) content up to 15 g/dm<sup>3</sup>, semi-dry (15–30 g/dm<sup>3</sup>), semi-sweet (30–60 g/dm<sup>3</sup>) and sweet – containing above 60 g/dm<sup>3</sup> of sugar. Mainly semi-sweet and semi-dry ciders are imported to Poland, which may result from Polish preferences for moderately sweet beverages. Generally, sugar content corresponds to the level of sweetness indicated by the manufacturer or importer on the label. There are ciders with a dominating rate of fructose, glucose and saccharose on Polish market. Glucose dominates in English ciders and there was almost no saccharose in the beverages imported from France and fructose was more common than glucose [27].

In order to obtain a high quality product the raw material for cider must be selected in a proper way. The production of cider is started by the preparation of preferment/natural yeast culture and of a portion of apple must at the same time. It is assumed that the juice for cider production should contain about 15% of sugars, 0.2% of tannins and 0.3–0.5% of acids. Different varieties of apples with various contents of acids, sugars and tannin are used for blending. In the post-Soviet Union republics high sugar rate apples such as Antonówka, Słowianka and Reneta are used for cider production. In Switzerland home grown apples such as Weinapfel, Bohnapfel, Sauergrauch, Tobiassler [6, 12] are used. The prepared apple must is pressed through to fermentation tanks where the specific fermentation process takes place. Alcohol and heat are generated in the process. The heat must be removed by cooling process in order to obtain a stable temperature range between 12–18°C (1–3 months of fermentation) or 20–25°C (1–4 weeks of fermentation). The speed of fermentation is controlled by temperature level whereas lower temperature upgrades the sensory value of cider [11, 28].

Fermentation process is going on in the fermentation tank. It lasts from 1 week up to 3 months depending on the type of the used apple must, level of dilution and desired final alcohol contents. After a certain time the yeast deposit is centrifuged (whirled) off the apple stock. Sometimes, fermentation is stopped, still before the whole sugar has been fermented. Then, cider of lower alcohol content is obtained.

The pure cider without any yeast deposits is transported to the seasoning tank. After several days cider undergoes blending (coupage) process and it is upgraded with additions such as sugar and acidity regulator. Next, the prepared cider blend is subjected to filtration. This process can be performed by means of diatomaceous earth, powdered gelatin (E441), tannin (E181), bentonites (E558), silicic acid sol, Potassium ferrocyanide (Potassium ferrocyanide (II)) (E536), active carbon filter or filtration plates.

Enzymatic preparations constitute a special group of clarifying agents. Enzymatic preparations can also be used in filtration process. The best results are achieved, however, through natural filtration, that is natural sedimentation process. Sometimes, filtration is carried out twice, the second time just before pouring into bottles. Cider is pasteurized and subjected to CO<sub>2</sub> satiation, often with the tank method. Next, the product is transferred to the pouring line where it is bottled. So prepared cider is poured into bottles which, after labelling, excise tax banding and packing into boxes [11, 28], are transported to the storage place. The whole technological process has been shown in Fig. 1.

### **Factors determining the quality of cider**

Cider should have from 1.2 to 8.5% vol. alcohol content and should reflect the acidity understood as the number of grams of apple acid per dm<sup>3</sup> of cider which is in the range from 3.5 to 9.0 [22, 27, 30]. Fruits of the selected apple varieties are required for this process [1]. More acid apples often with unrepresentative look are good for production of apple cider [9, 11]. The characteristic acid-bitter taste of good ciders is obtained due to the high content of tannin. The content of tannin in the popular apple tree varieties grown in Poland is quite low and it is 100–120 mg/100 g of the apple sauce. However, for obtaining a tasteful apple cider the apples containing 200–400 mg, or even more tannin in 100 g of apple squash, are required. Varieties used for production of apple cider are totally inedible, sour and sometimes even bitter [5, 9].

The apple cider is usually prepared from a number of apple varieties at the same time [5]. Farming of apple trees was started thanks to the cooperation with a British company. Two experimental orchards were planted over a dozen years ago.

After many years of research it has been confirmed that the best varieties for apple must in Polish climatic conditions are: Dabinett, Yarlinton Mill, Michelin, Major and Chisel Jersey [7]. The varieties are mixed in order to obtain the most appropriate combination of acidity, sweetness and tannin [29, 33]. The best fruits for cider production are the apples in the early ripeness stage due to their excellent aroma whereas overripe fruit are less suitable [8, 33].

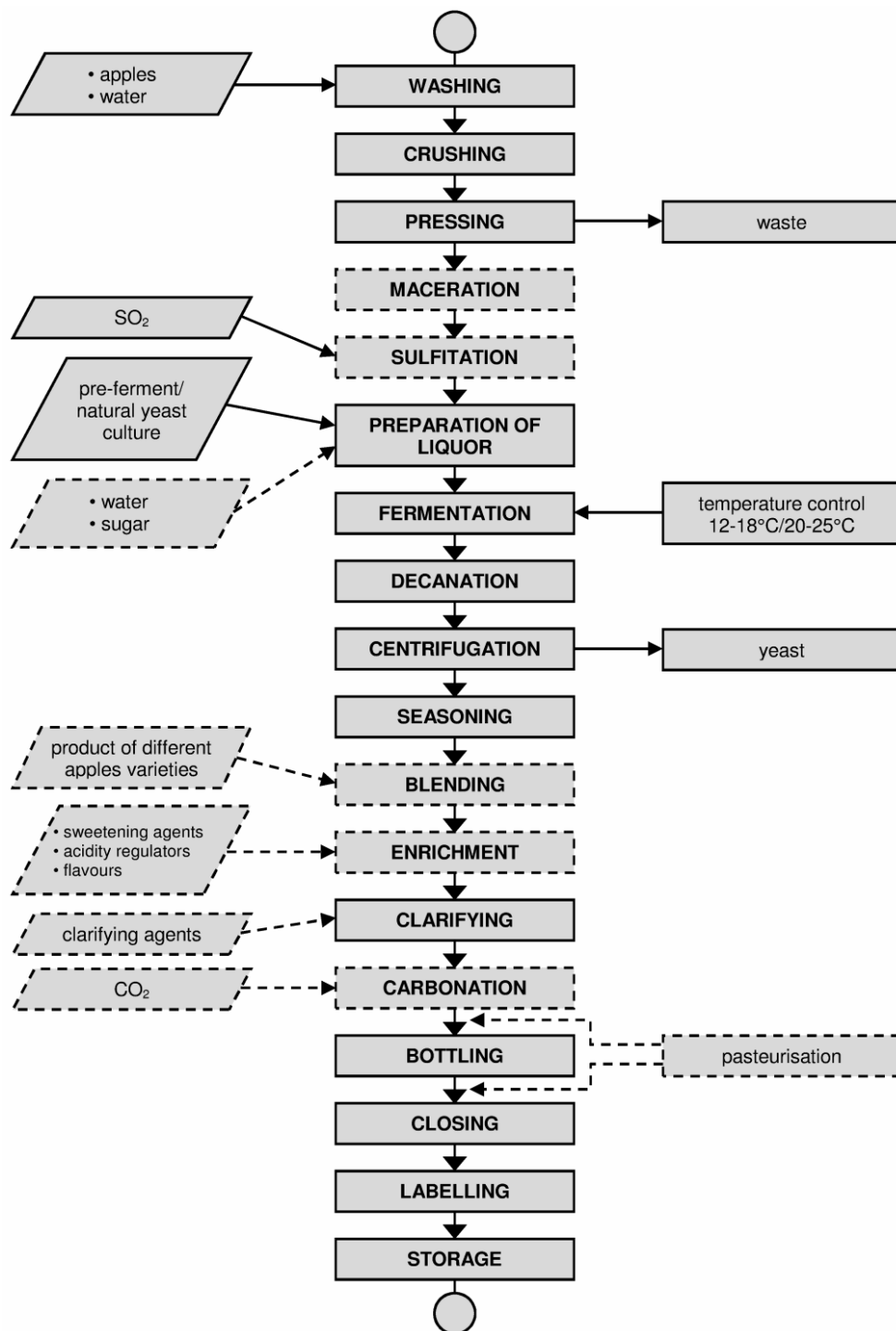


Fig. 1. Technical process diagram of cider [5]

Crab apple (*Malus pumila* of Rosaceae family) is excellent for cider production, according to traditional recipes. Nowadays, it is mainly an addition to the varieties grown for cider. Crab apple trees used to grow high, as pigs were usually grazed under their spreading branches. Crab apples have accompanied man already since prehistoric times and it is certain that cider had been produced in those times, too. Apples for cider are left on the trees as long as possible in order to produce more sugar and to soften. Any fruit fallen from the trees and any apples bruised while tree shaking must be immediately squashed in the press and they should not be stored in heaps. The obtained cider can be clear or cloudy, contain gas or not. It can differ by sweetness and colour, from yellow to greenish [5].

Very important ingredients of fermented beverages which shape their sensory values are sugars. They also influence the energetic value of the final product. The quantity and quality composition of sugars in ciders depend on many factors connected with the quality of the apples used, their variety, degree of ripeness, storing conditions and climatic conditions in which they ripened. Fructose is the dominating sugar in apples. It constitutes 57% of total sugars, next there are glucose, saccharose and sugar alcohol. It has been proved that while storing the amount of sorbitol increases and the amount of saccharose reduces. One of the most important factors determining the cider sugar rate is fermentation [27].

### The characteristics of ciders available on Polish market

The ciders available on Polish market possess very different taste values. According to Witt and Śmiechowska the leading ciders are the tasty semi-dry, refreshing, acrid ciders of pleasant, pure, distinctive, and apple flavour. At the other end there are beverages which are more like carbonated flavour drink than a real cider – they are very sweet, with caramel or artificial “green apple” flavour [33]. Studies on selected properties ciders available on the Polish market are presented in Table 1. The apple varieties used in the production of the examined ciders are unknown, because the producers do not put such information on the label.

**Table 1**

Polish ciders properties [33]

Product number	pH	Extract sugar [%]	Price [PLN/l]	Factor colour *L	Factor colour a*	Factor colour b*
1	3,49	9,67	9,99	56,00	-1,65	5,09
2	3,94	9,37	11,97	56,17	-3,00	16,51
3	3,48	9,72	12	58,24	-2,82	10,68
4	3,97	7,70	12,69	57,80	-2,04	7,25
5	3,97	7,85	14,98	53,28	-2,39	29,21
6	3,56	9,22	15,12	55,95	-2,38	18,26
7	3,73	7,20	16	55,30	-2,52	19,97
8	4,01	7,25	21,3	57,23	-2,81	12,66

A mature analysis of the cider market status, where such chain stores like Carrefour, Auchan, Real, Biedronka, Lidl, Kaufland, Inter Marche, E. Leclerc, Piotr i Paweł, Polo Market and Alma have been taken into account, has shown that most of the examined stores were selling ciders on permanent basis and only two were selling it as a seasonal product. Light sparkling and sparkling ciders are available on Polish market, they are artificially CO<sub>2</sub> carbonated and mostly pasteurized [33].

All examined beverages contained 4.5% vol. alcohol. The price of examined ciders ranged from 9.99 to 21.30 PLN/liter. For the purpose of this study the beverages were sorted according to ascending price and labelled consecutively by numbers from 1 to 8 [33].

The sugar extract was determined according to the PN-66/A-79120 norm, using an areometer with Brix scale and an Abbe refractometer. As the final result of the extract an arithmetic mean of both instruments readouts was taken [33].

Cider colour parameters were determined by a Konica Minolta CR-400 colorimeter in the CIE Lab system, by measuring trichromatic components L\*, a\*, and b\*.

The most popular ciders in Poland are semi-sweet ciders. Dry ciders are not liked very much [33]. Only ciders from organic production do not contain additions of sulphates. According to the research these beverages showed acid reaction, pH varied between 3.48 to 4.0. The ciders available on Polish market differ from each other so much that it is a proof of artificial colouring [33].

The authors conducted (in April 2015) the organoleptic analysis performed on 10 respondents using 5 point Tilgner's scale (1 point means disqualification and 5 means very good) of 18 Polish ciders bought on Polish market showed the average score of 3.03, and the cider which was graded best received 3.82 points while the worst one 2.15. The examined ciders came from 18 Polish and international industrial manufacturers and were purchased in the territory of Pomeranian voivodeship. The performed analysis leads to a conclusion that Polish consumers prefer semi-dry ciders characterized with high sweetness, while dry ciders are considered as not tasty.

### **Economic presumptions for the development of cider production in Poland**

A dynamic growth of the export volume and value in Polish trade of foreign apples was observed in the years 2004–2013. The export of apples grew at that time from 434 thousand ton to 1 230 thousand ton. The main foreign sales markets for Polish apples were the countries of the Commonwealth of Independent States and, first of all, Russia. In 2013 the export of apples to this country constituted 55% of the total export of these fruits [25, 29]. The farming area of apple trees has been decreasing in Europe and it has been spreading in Poland [15, 19]. Our country is famous for apple production which has been growing constantly [4]. However, the situation on Polish orchard market was very hard in the previous

season, mainly due to the introduction of embargo [15, 17]. According to prof. Makosz the apple crops in 2014 were about 3.7 million ton, including over 2.1 million ton of fruit of industrial value only. The difficulties to sell apples and low purchase prices were caused significantly by the general apple overproduction in EU countries. The overproduction was about 2 million ton whereas minimum 500 thousand ton was in Poland [13, 15].

The export of apples from Poland to Russia in two previous seasons was adequately 738 and 550 thousand ton. It is estimated that the direct export of Polish apples to Russian market in 2013 was over 700 thousand ton, and 300 thousand ton were exported through the adjacent countries. Poland lost a sale market for 1 million ton of apples [26] and manufacturers suffered the highest loss in EU in the amount of PLN 1.3 billion [15]. 55–60% of the general export of apples was directed to Russia [9, 13, 15]. The purchase price drop in 2014 was severe. As compared to the prices from 2013, prices dropped as much as by 43%, and in other EU countries – by 20–30% [15, 17, 26]. One of the reasons of such low purchase prices was Polish home competition [15]. It was necessary to find new ways to boost up consumption of apples so that it could reach 18 kg/ per person/ yearly [15], and finding new sales markets for Polish fruit [4, 17, 24]. Fortunately, apples consumption in Poland, as opposed to EU countries, is maintained at the same level and it is even slightly growing. Due to embargo, apples became to be more valued in public opinion and started to be bought by Poles more frequently [15].

An interest in the production of cider, that is of the fermented apple juice, in Poland has been observed in the last few years [7]. A revolution in Polish cider production took place when excise tax rate for beverages with alcohol content lower than 5% was reduced in 2013, from PLN 158 to PLN 97 per hectoliter [9, 16]. This could be named a progress, however, if compared to English law where anybody can manufacture 7 thousand liters of cider per year without any excise taxes or licenses, it seems to be a poor comfort [16]. Paradoxically, the interest grew also due to the consequences of the embargo imposed on Polish apples on 1st August 2014 after the reservations reported by Russian party against the fitosanitary quality of our fruit and of the second embargo imposed on the whole EU [9, 26].

Cider market is growing in Poland at 400% rate. We drank 400 thousand liters of cider in 2012 [31], 2 million liters of cider in 2013 and 9–10 million liters of cider in 2014 [4, 18]. Nevertheless, this is only 2% of beer consumed in Poland and still not much, as compared to the Lithuanians who drink 5.7 liters or the British who drink 15.4 liters of cider yearly. A statistic Pole drinks only 0.25 l of cider yearly [31]. The prognoses say that Polish cider market can achieve the level of 8–15% of beer market within 5 years, that is 30–50 million of ton yearly [18].

Lublin Festival of Young Cider could be deemed an evidence of the cider production boom in Poland. A huge number of people could taste various beverages, both classic ones: natural, wild, premature, dry or crab apple ciders, also with additions of exotic fruits [16].

## CONCLUSION

This study has discussed the aspects of technology and commodity science of ciders production. Its additional aim was to present markets of cider, both Polish and foreign.

Cider is an alcohol drink obtained from apple must. The value of the cider is determined by the contents of vitamins, mainly A and C, organic acids, mineral salts, simple saccharides (glucose, fructose), polysaccharides (pectin, fibre) and substances of polyphenol nature. Creating the quality of cider is started from obtaining the right quality apples appropriate for cider production, which is connected with cider orchards farming development. Not all apple varieties are appropriate for cider production. A drop of Polish apples export to Russia following the imposed embargo caused that a surplus of these fruit occurred in Poland. Economic analyses have indicated that, on one hand, apple consumption is possible to grow and, on the other, cider production can grow too.

A statistic Pole eats 17 kg of apples and drinks only 0.25 l of cider yearly. It is predicted that apple consumption in Poland can reach 18 kg per person yearly. Studies on consumption show that the Polish prefer semi-dry, refreshing, acrid ciders of pleasant, pure, distinctive and apple flavour.

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