



The effect of pulp holding time and pectolytic enzyme treatment on the acid content in apple juice

Leif Poll

Department of Dairy and Food Science, Section of Technology of Plant Food Products,
The Royal Veterinary and Agricultural University, Thorvaldsensvej 40, DK-1871 Copenhagen FC, Denmark

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It is shown that malic acid was enzymatically reduced during the period from pulp production until pressing of the juice (pulp holding time). After 8 and 24 h pulp holding time the malate content was reduced by 50% (70% of the original content). Corresponding figures for titratable acid were 62% and 81%. Pectolytic enzyme treatment resulted in higher malate and titratable acid content than the control due to pectin esterase activity of the added enzymes and probably due to better extraction of the malate from the pulp.

INTRODUCTION

Titratable acid is possibly the most important quality factor of apple juice and other fruit juices. Approximately 90% of the total acid content in apples is malic acid (Hulme, 1971); therefore the titratable acid is often expressed as grams malic acid per litre juice. The titratable acid content is normally considered to be a good indication of the sour taste (Amarine *et al.*, 1965). Nybom (1962) found good correlation between titratable acid and sour taste in apples, but also the pH of the juice gave a good indication of the sour taste. The titratable acid content together with sugar and phenols are important for the taste; with a given sugar content a low acid content gives a flat tasteless juice. Therefore juices with high acid content are in great demand.

In fruit juice production the pulp can be held for shorter or longer periods due to different production methods and due to pectolytic enzyme treatment before pressing. In the time interval between crushing and pressing, there are possibilities for changes of the acid content which can change the organoleptic quality of the juice. In the present work the effect of different holding periods and pectolytic enzyme treatments on the acid content are examined.

MATERIALS AND METHODS

Raw material

Apples from the variety Mutzu were picked from 8-year-old trees in 1988 at the ripe picking stage (late October)

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and stored at 3°C in normal atmosphere until juice production.

Juice production

The apples were ground by a Braun Multipractic kitchen machine and apple pieces of about 0.02–0.1 cm³ were produced. Out of a pulp mass of at least 5 kg, 1 kg pulp was left in closed glass jars for different holding periods (0–24 h) at 20°C. A portion (500 g) of the pulp was pressed in a laboratory model hydraulic press up to a pressure of 50 kg/cm² in 20 min. After pressing, the juice was pasteurized at 90°C in glass bottles. Each sample was made in duplicate.

Pulp treatment

Tests involving different pulp holding periods and pectolytic enzyme treatments were performed, involving apples stored 70 and 110 days at 3°C. The pectolytic enzymes were added to the pulp in concentrations which were recommended by the producing companies: *Pectolase LX* (Grindsted Products) 1 g per kg pulp and *Pectinex Ultra SP-L* (Novo Industri) ½ g per kg pulp. The closed glass jars were shaken every 20 min to be sure that pulp and enzymes were in good contact. Pasteurization of the pulp was also performed: the pulp was pasteurized (90°C), cooled, pressed and the juice pasteurized.

Analysis

Titratable acid: 10 ml juice was titrated with 0.1M NaOH to pH 8, 10, and expressed as g malic acid per litre. Malate (malic acid) was determined by the

Boehringer Mannheim test combination for L-malic acid (Boehringer Mannheim GmbH) Brochemnica Cat. nr. 139068).

RESULTS AND DISCUSSION

Malate and titratable acid content during pulp holding

Figure 1 shows the malate and titratable acid content in the juice from apples stored 70 and 110 days. The acid content from the pulp with no pulp holding time (fresh pressed juice) was, as expected, lowest from apples with the longest storage time. As can be seen, the malate content was higher than the titratable acid from both apple samples, which is mainly a result of the high pH of the juices (pH = 3.86 and 3.89 for no pulp holding time) and the pK value of the malic acid ($pK_2 = 3.40$). The figure shows a fall in titratable acid and malate content during the period of pulp holding from 0 to 8 h. This is probably a result of an enzymatic oxidation (decarboxylation) of malic acid either through the TCA cycle or by the malic enzyme (Hulme, 1971). The metabolic rate during the pulp holding period is faster for apples stored 70 days compared with apples stored 110 days. This could be due to higher enzyme activity in the 70 days stored apples. The oxidation of acid is closely connected to the pulp; when unpasteurized juice was held for the same periods as the pulp, no oxidation was observed.

In the literature only Mehlitz and Mihás (1966) have shown a reduction in the titratable acid from 8.3 g/litre to 6.4 g/litre in 6 h pulp holding time.

Enzyme treatment of the pulp

Figure 2 shows that pectolytic enzyme treatment of the pulp affects the reduction of titratable acid. The Pectolase treatment reduces the reduction rate to about half of control, and the Pectinex treatment totally stopped the reduction of titratable acid during the pulp holding. Table 1 shows both the malate and the titratable acid

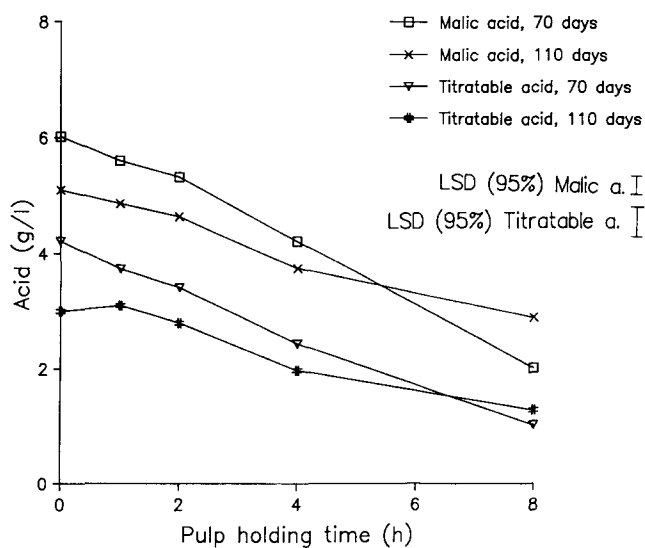


Fig. 1. Titratable acid and malate content in juice from pulp held at different periods before pressing. Apples stored at 70 days and 110 days (average of two tests).

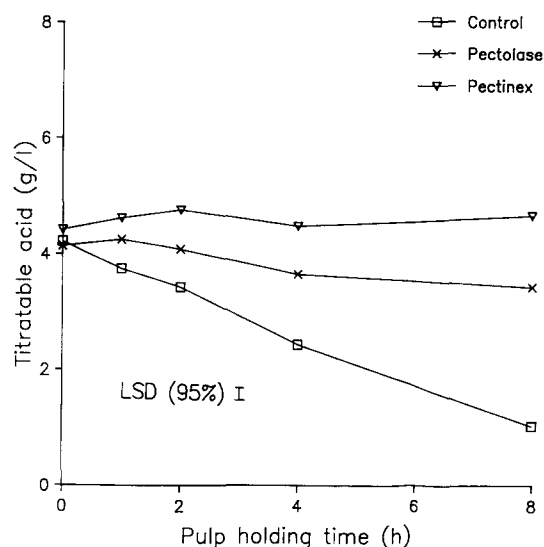


Fig. 2. Titratable acid content in juice from control pulp and pulp treated with Pectolase and Pectinex (average of two tests).

contents from the 0 to 24 h pulp holding tests. The table shows that the enzyme-treated samples are higher in both malate (only Pectinex) and titratable acid content after pulp holding compared with the control treatments. The higher malate content found in the Pectinex-treated juice can be explained by better extraction of malate due to destruction of the cell material. The higher titratable acid content found in the enzyme-treated samples can mainly be explained by a higher galacturonic acid content due to pectin esterase activity of the pectolytic enzymes.

The present results are in agreement with Schobinger *et al.* (1988). They found only small differences in the titratable acid content between enzyme-treated (3 h) and the non-treated samples (fresh pressed juice). Pilnik & Vos (1970), Weiss & Samann (1985) and Schobinger *et al.* (1981) found higher titratable acid content in enzyme-treated samples compared with fresh pressed juice.

Table 1. Changes of malate and the titratable acid content during pulp holding from 0 to 24 h with and without pectolytic enzyme treatment. The relative figures are means from either one, two or four tests

Hours pulp holding	Control	Pectolase	Pectinex
Malate (relative figures)			
0	100	100	100
1	91.0 ^a (4.7)	88.3 ^a (10.8)	92.5 ^b (9.2)
4	71.5 ^a (8.3)	69.0 ^a (6.8)	81.0 ^b (2.8)
8	51.5 ^a (7.6)	61.3 ^a (8.4)	83.5 ^b (2.1)
24	30.6 ^c	31 ^c	71 ^c
Titratable acid (relative figures)			
0	100	100	100
1	93.0 (8.6)	95.8 (6.8)	98.0 (8.4)
4	61.8 (7.6)	82.2 (3.6)	91.5 (4.9)
8	37.7 (10.4)	74.0 (6.2)	103.0 (2.8)
24	19	64	104.0

^a Means from four tests (in parentheses SD).

^b Means from two tests (in parentheses SD).

^c Results from one test (in parenthesis SD).

It should be mentioned that the treatment with pectolytic enzymes, as expected, resulted in higher juice yields. A pulp holding time of 8 h resulted in an increase of the juice yield of 28% for Pectolase and 40% for Pectinex.

The two pectolytic enzymes used in the present work had different effects on both acid reduction and to some extent juice yield. It is believed that these differences are mainly due to differences in the activity and enzyme concentration.

Pulp heating treatments

In pulp heating treatment (90°C in 3 min) the malate and titratable acid concentration in the juice from the heated pulp was higher (no pulp holding) compared to a non-heated pulp (5.58 g/litre malate compared with 4.40 g/litre malate). It is believed that the malate is better released from the heated pulp tissue, the same effect as seen with enzyme treatment of the pulp. As expected, there was no reduction in the acid content when heated pulp was held up to 8 h before pressing. It should be mentioned that the juice yield was 10–15% higher with heated pulp compared with non-heated pulp. When heated and cooled pulp was treated with pectolytic enzyme, it was seen that the titratable acid increased markedly, which must be due to pectin esterase activity. This treatment had no effect on the malate concentration.

Limited sensory evaluations

Sensory evaluations of the juices were performed with a limited taste panel (six tasters). It was observed that a

difference of 0.5 g titratable acid per litre between two samples can significantly be recognized by the tasters. It is therefore obvious that the reduction of titratable acid during pulp holding can result in a sensory change of the juice.

It was also observed that the panel could not distinguish between samples from pectolytic enzyme-treated samples (4 h pulp holding) and non-treated samples (no pulp holding) with approximately the same titratable acid content.

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