

Apple cultivars for manufacturing of stewed apples

Æblesorter til fremstilling af æblegrød

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Summary

Apple cultivars which were supposed to be suitable for manufacturing of stewed apples were evaluated in 1989/90 and 1990/91.

The main quality demand for processing of stewed apple is that no browning occur and that the surface colour should be bright and slightly greenish or white. To obtain satisfactory surface colour the HunterLab values of L and a should be above 55 and below -3, respectively.

To obtain high quality fruit for processing of stewed apples from cold stored raw apples a

number of cultivars can be used. The remaining part of the year, frozen apple cubes must be available.

Only the cultivars 'Elstar', 'Nørup' and 'Sønderskov' complied with the requirements for processing of frozen apple cubes.

The cultivar 'Elstar' is grown in commercial orchards in Denmark. Due to low yield and liability for biennial bearing the cultivars 'Nørup' and 'Sønderskov' are not of interest for commercial orchards.

Key words: *Malus domestica*, stewed apples, surface colour, soluble solids, titratable acid, firmness.

Resumé

Der er i 1989-91 blevet udført forsøg med fremstilling af frosne æbleterninger til brug ved forarbejdning af æblegrød.

For at være velegnet til fremstilling af dybfrosne æbleterninger må der ikke ske brunfarvning. Hvis HunterLab-værdierne for L og a er henholdsvis over 55 og under -3, har æblegrøden en tilfredsstillende farve.

I nogle måneder efter høst kan anvendes kølelagrede æbler til fremstilling af æblegrød.

Den resterende del af året kan der anvendes frosne æbleterninger.

Kun sorterne 'Elstar', 'Nørup' og 'Sønderskov' kunne anvendes til fremstilling af æblegrød ud fra frosne æbleterninger.

Da 'Elstar' i vid udstrækning dyrkes som almindeligt spiseæble, er det på nuværende tidspunkt forholdsvis let at fremskaffe råvarer. På grund af lavt udbytte for 'Nørup' og vekselbæring hos 'Sønderskov' kan disse sorter ikke anbefales til kommercielle plantager.

Nøgleord: *Malus domestica*, æblegrød, overfladefarve, opløseligt tørstof, titrerbar syre, fasthed.

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Introduction

In Denmark, most of the apples grown are sold on the fresh fruit market. Apples of secondary quality including apples sorted out after storage are applied for processing of apple juice.

Compared to the amounts of apples used for processing of apple juice only minor quantities are applied for manufacturing of other apple products such as stewed apples.

One of the main quality demands for processing of stewed apples is that no browning occur and that the surface colour of the final product should be bright and slightly greenish to white.

To obtain superior quality of stewed apples an industrial process must be based on use of high quality uniform raw material. One possibility for this is processing of stewed apples from frozen apple cubes which are processed after harvest.

The aim of this paper is to determine the suitability of some new apple cultivars for manufacture of stewed apples from cold stored apples and from frozen apple cubes.

Materials and methods

Cultivars

In 1989 experiments with twenty cultivars expected to be suitable for industrial processing were carried out.

By use of quality characteristics determined by analyses in 1989-90 only three cultivars were found to be suitable for manufacture of stewed apples from frozen apple cubes. The determination of quality characteristics for these cultivars was continued in 1990-91.

Field experiment

The trees were grown in the experimental orchard of the Department of Pomology. Fruits of most cultivars were taken from the ordinary screening program for new cultivars (3), comprising eight trees per cultivar planted during the period 1982-86. The trees were grown as spindles at a spacing of 4x2 m.

Harvesting and storage

Each cultivar was picked at optimum stage of maturity and stored in a cold storage room at 3°C.

Processing

Processing of stewed apples were carried out immediately after picking, after cold storage of the apples and after frozen storage at -18°C of apple cubes processed at harvest.

After removal of the cores and peeling ten apples were cut into cubes of about 1 cm edges. Frozen or fresh cubes was cooked for five minutes and then cooled to 20°C.

Analyses

The shape of the apples were evaluated by use of xerox copies of transverse and longitudinal cuts of ten apples.

After harvest and after storage the firmness of the apples was determined by use of an Instron apparatus equipped with a 12 mm cylindrical rod with a convex tip. After removal of the apple skin the tip was forced 8 mm into the flesh with a velocity of 200 mm/min. The maximum force was registered and applied as a measure of firmness of the apple.

For each cultivar the firmness of ten apples measured at two diagonal positions perpendicular to the core was determined.

The content of soluble solids and titratable acid was measured immediately after harvest and after storage. Ten apples were treated with water (1:0.5) in a Waring blender and the content of soluble solids and titratable acid was measured by refractometry (Bausch & Lomb refractometer) and titration to pH 8.1 with 0.1 N NaOH by use of a Mettler DL automatic titrator, respectively. Ascorbic acid content was determined by use of a titration method modified after Pongracz (8).

The HunterLab-values L, a and b were measured by use of a HunterLab colorimeter.

Results

Surface colour

Stewed apples with HunterLab L- and a-values above 55 and below -3 had the most satisfactory surface colour. By use of 'Elstar', 'Nørup' and 'Sønderskov' these values were almost equal for stewed apples processed after harvest (h), cold storage (c) or by use of frozen (f) apple cubes (Table 1). For all the other cultivars an increase in the a-values and a decrease of the L-values resulted in a less white and a more red to brown stewed product.

Table 1. Harvest time and storage days on cold storage in 1989-90. Soluble solids (RT), titratable acid as malic acid (acid) and HunterLab colorimeter values (L lightness 0=black, 100=white; a green/yellow < 0=green, > 0=red; b yellowness, high = most yellow) of stewed apples processed after harvest (h), after cool storage (c) and after frozen storage of apple cubes at -18°C for 6 months.

Høsttidspunkt og lagringstid på kølelager i 1989-90. Opløseligt tørstof (RT), titrerbar syre som æblesyre (Syre) og HunterLab kolorimeterværdier (L lyshed, 0 = sort, 100 = hvid; a grøn/rød, < 0 = grøn, > 0 = rød; b gulhed, høj = mest gul) for æblegrød fremslillet efter høst (h), efter kølelagring (c) og efter lagring af dybfrosne i 6 måneder ved -18°C.

Cultivar	Harvest date	Storage days		RT	Acid	L	a	b
Sort	Høst dato	Lagring dage		RT g/100 g	Syre g/kg			
'Aroma'	09.29	41	h	15.0	6.6	63	-3	25
			c	15.5	6.9	65	-2	26
			f			60	0	27
'Blauacher'	09.29	41	h	12.2	6.7	66	-2	30
			c	11.2	6.2	64	-2	29
			f			54	4	28
'Bountiful'	09.14	41	h	13.1	5.9	60	-4	22
			c	13.1	6.2	64	-3	28
			f			51	5	25
'Bramley'	09.28	54	h	12.1	9.0	62	-5	25
			c	12.9	8.4	62	-6	25
			f			58	0	28
'Charlottenlund'	09.29	53	h	13.7	9.4	63	-6	24
			c	14.0	8.7	65	-6	26
			f			62	-3	28
'Elstar'	09.18	64	h	13.9	6.4	65	-7	28
			c	16.0	6.1	69	-7	35
			f			66	-6	27
'Freedom'	10.02	50	h	13.1	4.7	65	-5	26
			c	14.3	4.1	66	-6	26
			f			57	1	28
'Hauxapfel'	09.29	74	h	11.4	8.4	60	-5	25
			c	12.6	7.9	59	-3	26
			f			53	-1	28
'Hilde'	10.10	63	h	11.8	7.1	65	-5	29
			c	12.0	7.6	66	-5	33
			f			59	-1	31
'Horneburger'	09.28	75	h	11.0	8.3	63	-5	21
			c	12.1	7.8	61	-6	20
			f			56	-1	23
'Ingol'	10.02	71	h	12.2	6.2	64	-7	26
			c	13.7	5.5	64	-6	27
			f			59	-2	25
'Jonafree'	10.11	62	h	12.0	5.8	62	-2	31
			c	12.2	5.2	65	-5	33
			f			56	3	30
'Liberty'	09.22	64	h	13.4	4.7	62	-1	24
			c	14.0	4.4	63	-3	23
			f			51	6	28
'Nittany'	09.25	57	h	13.1	3.8	63	-5	36
			c	13.9	3.3	61	-6	32
			f			58	-2	32
'Nørup'	09.29	39	h	13.7	12.0	65	-6	20
			c	13.8	11.4	66	-6	20
			f			64	-4	22
'Priam'	09.12	43	h	13.4	6.5	61	-2	31
			c	13.2	6.0	65	-4	27
			f			56	2	30
'Prima'	10.25	50	h	13.1	6.6	62	-2	31
			c	12.9	6.0	63	-3	30
			f			53	4	29
'Sønderskov'	09.18	37	h	12.2	8.3	68	-5	22
			c	13.1	7.9	67	-6	20
			f			63	-6	18
'Undine'	10.04	69	h	12.4	6.3	62	-4	27
			c	13.1	5.7	64	-6	27
			f			57	-1	27
'Virumgaard'	09.18	37	h	11.3	8.5	66	-3	24
			c	11.4	8.1	65	-5	25
			f			58	3	26
LSD				0.1	0.2	2	2	2

Table 2. Harvest date and storage time on cold storage in 1990. Soluble solids (RT), titratable acid as malic acid (Acid) and HunterLab colorimeter values (see Table 1)
*Høsttidspunkt og lagringstid på kølelager i 1990. Opløseligt tørstof (RT), titrerbar syre som æblesyre (syre) og HunterLab kolori-
 meterværdier (se tabel 1).*

Culivar	Harvest date	Storage days		RT	Acid	L	a	b
Sort	Høst dato	Lagring dage		RT g/100 g	Syre g/kg			
'Bramley'	09.19		h	11.0	7.5	53	-6	18
			c	10.9	6.5	50	-6	16
			c	10.7	6.0	60	-6	25
			f			59	-3	25
'Elstar'	09.20		h	15.1	5.4	56	-7	20
			c	15.0	5.0	54	-7	23
			c	14.9	4.5	62	-7	31
			f			59	-6	24
'Nørup'	10.03		h	13.4	12.7	60	-5	20
			c	13.9	12.7	62	-4	22
			c			68	-4	25
			f			59	-5	15
'Sønderskov'	09.10		h	13.1	8.0	59	-5	15
			c	12.0	7.1	57	-5	13
			c	12.8	6.2	67	-3	24
			f			62	-5	18
LSD				0.5	0.4	3	2	2

By use of the apple cultivars 'Elstar', 'Nørup' or 'Sønderskov' stewed apples can be processed from fresh fruit immediately after harvest or after cold storage for 3-4 months. Another possibility is use of frozen apple cubes processed immediately after harvest and stored for several months.

Stewed apples can be processed from cultivars 'Bountiful', 'Bramley', 'Charlottenlund', 'Freedom', 'Hilde', 'Horneburger', 'Ingol', 'Nittany' and 'Undine' after harvest and cold storage, but not by use of frozen cubes. The main reason is browning during frozen storage.

As shown in table 2 stewed apples with L- and a-values above 55 and below -3 could be processed from 'Elstar', 'Nørup' and 'Sønderskov' harvested in 1990.

Soluble solids and titratable acid

Table 1 shows that the content of soluble solids increases slightly during cold storage and that the content of titratable acid decreases.

In 1990 the content of soluble solids in the cultivars 'Elstar', 'Nørup' and 'Sønderskov' was between 12.0 and 15.0 g/100 g. A greater variation from 4.5 to 12.7 g/kg titratable acid was found. This means that the ratio between soluble solids and titratable acid and therefore the sweetness of the products increases from 'Nørup', to 'Sønderskov' and 'Elstar'.

Within the variety no decrease in soluble

solids occurred during cold storage, but the content of titratable acid decreased.

Fruit shape

Fig. 1 shows transverse and longitudinal cuts through apples of 'Elstar', 'Nørup' and 'Sønderskov'. The relationship between the height and the diameter of 'Elstar', 'Nørup' and 'Sønderskov' was 0.86, 0.75 and 0.88 respectively.

Firmness and ascorbic acid

Figures 2 and 3 show that the firmness and the content of ascorbic acid decrease during cold storage.

Fruit yield

Tables 3 and 4 show the yields and fruit sizes for the three cultivars suitable for processing of stewed apples.

Discussion

Surface colour

As found earlier by *Sapers* and *Douglas* (9) the Hunter values L and a were suitable to measure the surface colour of apples or apple products. To obtain stewed fruit with bright, slightly greenish to white surface colour the HunterLab values of L and a should be above 55 and below -3 respectively (Table 1 and 2).

Christensen (2) found that the varieties 'Elstar', 'Freiherr von Berlepsch', 'Ingol', 'Peder-

Fig. 1.

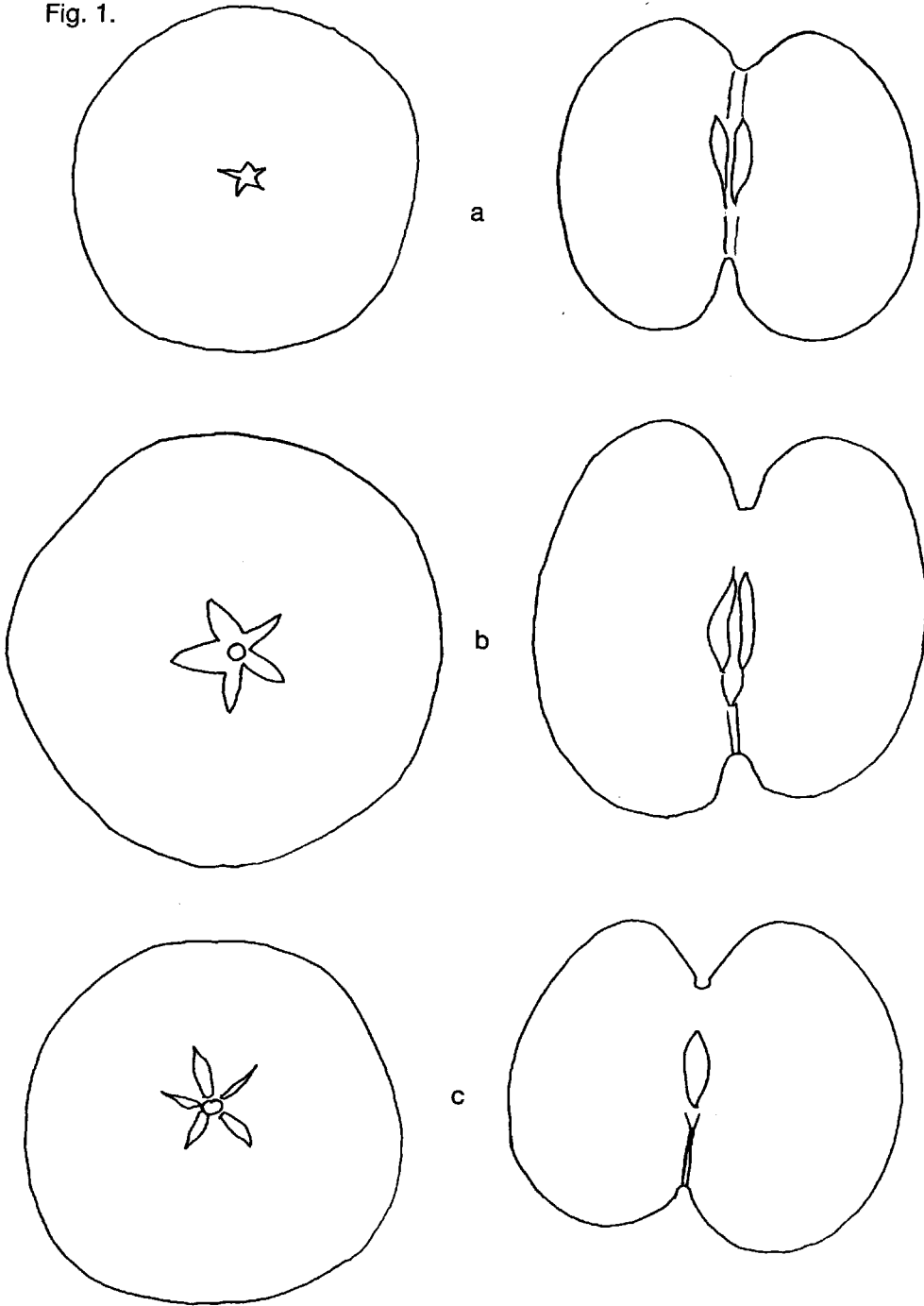


Fig. 1. Transverse and longitudinal cuts through fruits of 'Elstar' (a), 'Sønderskov' (b) and 'Nørup' (c).
Længde- og tværsnit gennem æbler af 'Elstar' (a), 'Sønderskov' (b) og 'Nørup' (c).

Fig. 2

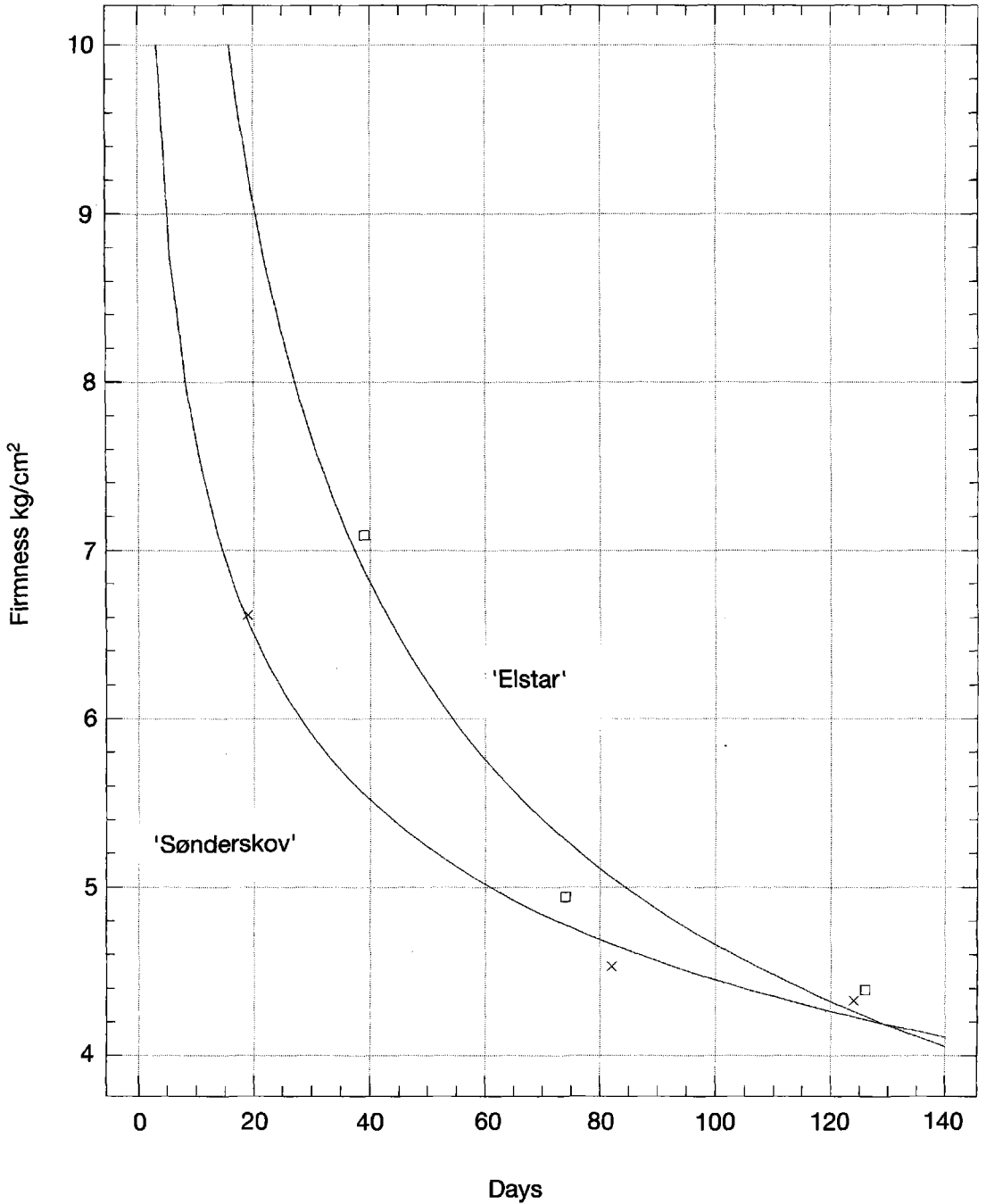


Fig. 2. Firmness of two cultivars measured during cold storage at 3°C in 1990-91.
Fasthed hos to sorter under kølelagring 1990-91 ved 3°C.

Fig. 3

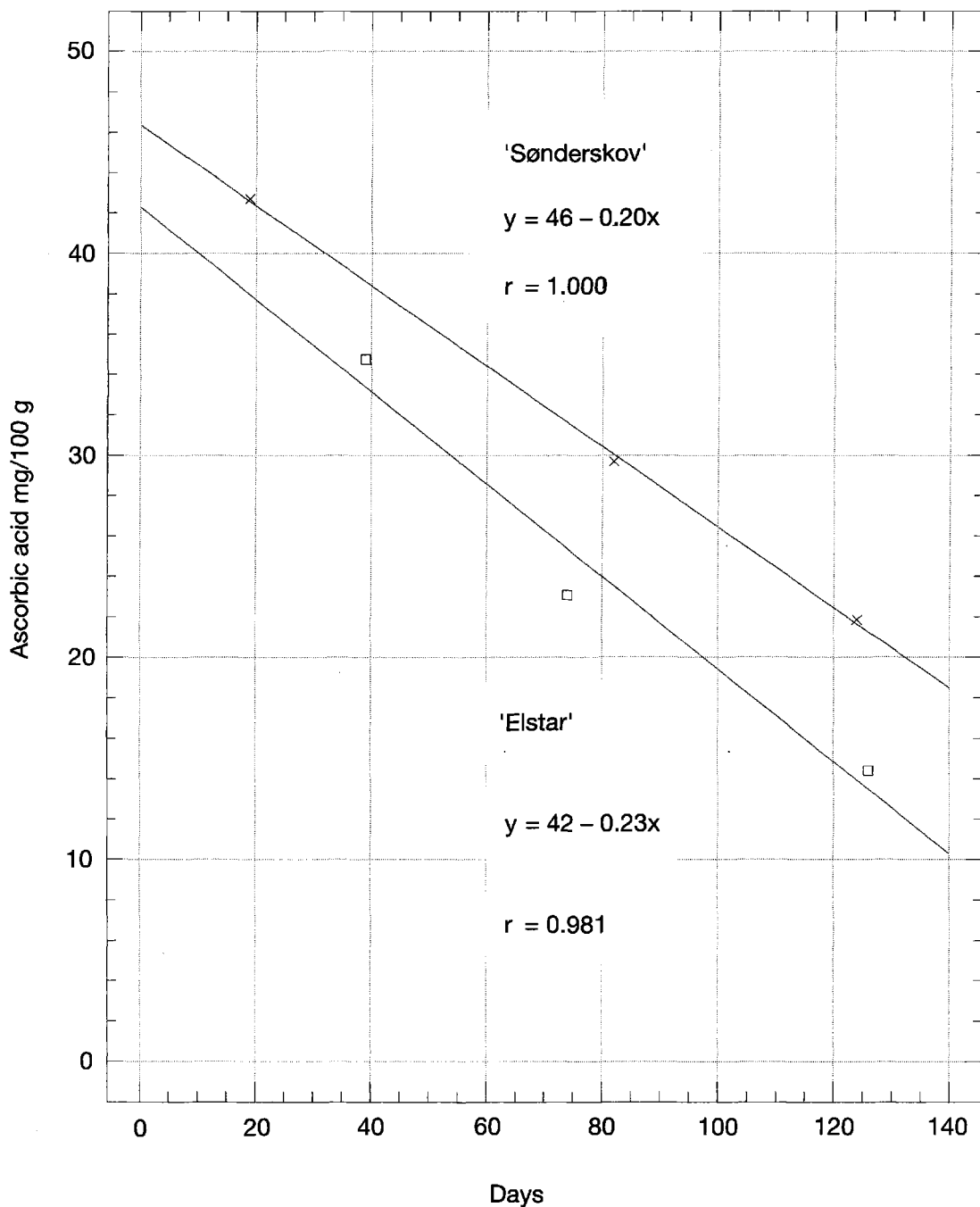


Fig. 3. Content of ascorbic acid in two cultivars measured during cold storage at 3°C in 1990-91.
Indhold af askorbinsyre hos to sorter opbevaret på kølelager ved 3°C i 1990-91.

Table 3. Accumulated fruit yield and average fruit size of 'Elstar' and 'Nørup' in the first three fruiting years 1988-90 after planting autumn 1986.

Akkumuleret frugtudbytte og gennemsnit for frugtvægt i de første tre år med bæring 1988-90 efter plantering i 1986.

Cultivar Sort	kg fruits/tree kg frugt/træ	g/fruit g/frugt
'Elstar'	43	153
'Nørup'	13	215

strup' and 'Undine' were suitable for processing of frozen apple cubes, but his experiment did not include frozen storage of the processed apple slices.

Earlier *Christensen* (1) has found that the varieties 'Ingøl' and 'Elstar' were suitable for processing of apple slices, but the applied process comprised treatment of the cut slices with a 0.2% solution of ascorbic acid.

Processing

By use of frozen apple cubes it is possible to manufacture stewed apples all the year round with almost constant raw product quality. Frozen apple cubes can be processed immediately after harvest or after a short period on cold storage.

Only machinery for mechanical peeling, coring, cutting and a freezer are necessary. Blanching is not necessary.

Because of great uniformity (Fig. 1) 'Elstar' is very suitable for mechanical peeling and coring.

Table 4. Fruit yield and fruit size of 'Sønderskov' during the years 1985-90 after planting in 1982.

Frugtudbytte og frugtvægt for 'Sønderskov' i 1985-90 efter plantering i 1982.

Year År	kg fruits/tree kg frugt/træ	g/fruit g/frugt
1985	17	167
1986	8	213
1987	28	129
1988	0	-
1989	42	248
1990	13	270

Soluble solids, titratable acid and ascorbic acid

A slight increase in soluble solids and a decrease in titratable acid during cold storage of apples as shown in this experiment has been found earlier (4,5). In fresh stored fruits a decrease of ascorbic acid content occurs with time (10).

Field performance

'Elstar' is a well known and high-yielding cultivar with vigorous growth. Average picking date during 1988-90 was 20 September.

'Nørup' originated in a private garden in Denmark (*Arne Nørup*, Aalborg). The trees are healthy, of medium vigour and have a spreading growth habit, but yield of young trees was low compared to 'Elstar' (Table 3). The fruits of 'Nørup' are large with a dark red covercolour and some russeting. Average picking date in this experiment was 1 October. The apples can be kept in cold storage for 3-4 months.

Because of its very acidic taste this cultivar is not suitable for growing as an eating apple.

'Sønderskov' is an old Danish cultivar, mentioned by *Christensen* (2) as suitable for some processing purposes. The trees are strong growing with a spreading habit and the fruits are more or less covered with a rather dark red colour. The apples are usually large, but the fruits were small 1987, probably because of unusually cold weather. Average picking date during 1985-90 was 19 September. This cultivar has capacity for high yields, but is very liable to biennial bearing (Table 3). A detailed description of 'Sønderskov' is found in *Pedersen* (7).

Conclusion

The cultivar 'Elstar' is very suitable for processing of frozen apple cubes which probably can be applied all year around for processing of stewed apples with bright, greenish to white surface colour.

Further research is necessary in order to optimize the processing of stewed apples or other apple products.

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