

# USE OF APPLE EXTRACTS AS JAM-SETTING AGENTS

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## SUMMARY

The comparative gelling strengths of extracts prepared from Queensland apples were determined. A factor F was calculated to indicate the number of times the maximum legal limit of apple juice (or pulp) must be exceeded in preparing strawberry jam with a gelometer reading of 400 mm. Average F values from 5 to 10 indicated that this type of extract was unsuitable.

The quality of apple extract required to obtain a gel results in much higher production costs than when powdered pectin is used.

## I. INTRODUCTION

Queensland apples which are unsuitable for the fresh fruit market on account of hail damage or other blemishes are consigned to factories but there is usually a surplus over the quantity required for the production of apple jelly. In 1956 a request was received from the Deciduous Sectional Group Committee to investigate the possibility of using a pectinous extract of factory apples as a jam-setting agent instead of imported powdered pectin. This pectin is normally prepared from citrus and apple wastes as described by Cruess (1948), Kertesz (1951) and von Loesecke (1949). Kertesz (1951) also described a home preparation method for extracting pectin from whole apples but pointed out that their gelling ability varies.

Experiments were designed to prepare aqueous extracts from the main varieties of apples, determine their gel strengths and use them in the manufacture of jam.

## II. EVALUATION OF GEL STRENGTH OF APPLE EXTRACTS

### (a) Procedure

A modified Tarr Baker type gelometer similar to that described by Kobenhavns Pektinfabrik (1952) was constructed and calibrated as follows. Standard gels were prepared using various concentrations of 200 grade powdered pectin to give gelometer readings from 100 to 1200 mm of water pressure. The pH was kept at 3.0 by means of a calcium citrate/potassium citrate/citric acid buffer and the total soluble solids was maintained at 65 per cent. by boiling the gels to constant weight before pouring into standard rings and allowing them to set for 18 hr. By examining commercial jam and jelly samples it was found that a gelometer reading of 400 mm was the optimum for best quality.

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Weekly samples of the three main varieties, namely Granny Smith, Jonathan and Delicious, were drawn from the Stanthorpe district. Extracts were prepared in a manner similar to the first stages of jelly manufacture: 1300 g of fruit were sliced and boiled vigorously with 1000 g of water until the combined weight was reduced to 1950 g. (Prolonged boiling resulted in undesirable flavours, as pointed out by von Loesecke (1949).) While still hot, the mixture was strained through good quality calico. The extract then contained a solution of pectin at a concentration approximately equal to two-thirds of its strength in the apple. The pH was then adjusted to 3.0 by the addition of a citric acid solution to the clear extract, in which pH meter electrodes were immersed. The total soluble solids varied from 8.0 to 11.6 per cent. A known weight of extract (between 200 and 300 g) was boiled with 25 ml of the abovementioned buffer and 210 g of cane sugar until a constant weight of 360 g was obtained, which was equivalent to a total soluble solids content of approximately 66 per cent. The mixture was then immediately poured into standard rings (35 mm dia and 27 mm high) and allowed to stand for 18 hr. The breaking strength (G) of the jelly was determined in terms of millimetres of water, using the modified Tarr Baker gelometer.

From the calibrations it was possible to determine the weight of 200 grade pectin (P) equivalent to 200 g of the sample of juice taken. Since 0.56 g of 200 grade pectin when made up to a standard gel with 183–184 g of sugar and the required amount of water produce the desired gel strength of 400 mm (according to standard nomograms of Kobenhavns Pektinfabrik), the number of g (E) of each extract required to give a 400 mm gelometer reading was then calculated by multiplying by the factor  $P/0.56$  of 200. The values for each sample are set out in Table 1.

### (b) Results and Discussion

As the Queensland Food and Drug Regulations do not permit the addition of apple juice to jam, except in the case of apple jam, to a greater extent than 5 per cent., the strengths of the apple extracts were related to the maximum permissible addition to a jam. When a gel is prepared from 200 g of fruit, 210 g of sugar and 25 ml of buffer by boiling and evaporating to 360 g at 65° Brix as described above, the maximum legal apple juice addition would be 18 g of pure apple or 27 g of apple extract. By dividing 27 g into E, a factor (f) was obtained which indicated the number of times the legal limit would have to be exceeded to obtain a satisfactory gel with each extract. However, this factor made no allowance for pectin naturally present in fruit. Strawberry jam was selected as the test product and by preparing several samples of jam with both 200 grade powdered pectin and apple extracts of known gel strength it was found that the strawberry itself provided about 12½ per cent. of the pectin required for setting. The factor f was therefore multiplied by 0.875 to give a new factor (F) which was defined as the number of times the maximum legal limit of apple juice (or pulp) must be exceeded to obtain a strawberry jam equal in gel strength

TABLE 1  
PROPERTIES OF APPLE EXTRACTS, 1956

Variety*	J	J	J	J	J	D	D	J	J	D	GS	C	C	C	D	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS
Date .. ..	9/2	15/2	23/2	28/2	7/3	28/2	15/3	5/3	12/3	12/3	12/3	19/3	19/3	20/3	21/3	26/3	2/4	3/4	9/4	9/4	16/4	16/4	23/4	23/4	30/4	30/4	14/4
Brix of extract ..	9.8	10.8	11.5	10.3	10.8	9.6	9.0	9.3	11.6	11.6	11.0	8.6	8.0	7.9	9.1	7.3	8.9	8.4	8.5	8.0	9.7	7.9	8.8	8.3	8.4	7.9	8.4
Weight of extract used (g) .. ..	300	300	250	225	250	250	250	250	250	250	250	350	250	250	250	250	250	250	200	200	200	200	200	200	200	200	200
Brix of gel .. ..	65.3	65.4	65.6	62.7	66.8	66.4	65.4	65.5	67.0	67.5	66.5	65.3	67.1	66.2	66.7	66.6	66.4	66.8	66.2	66.1	65.7	66.5	68.5	68.8	65.6	66.0	66.0
pH of gel .. ..	2.9	2.9	2.8	3.0	3.0	3.0	3.0	3.0	3.0	2.9	3.0	3.0	3.0	3.0	3.1	3.0	3.0	3.0	2.9	2.9	3.0	3.0	2.9	3.0	3.0	3.0	3.0
Average gel strength (G) .. ..	453	962	479	597	594	232	381	210	499	394	942	1,169	366	544	301	472	729	1,190	618	605	505	437	360	198	423	404	510
Pectin equivalent (P)	0.40	0.54	0.49	0.59	0.53	0.35	0.44	0.33	0.50	0.45	0.64	0.52	0.43	0.51	0.40	0.48	0.57	0.74	0.67	0.66	0.62	0.59	0.54	0.41	0.57	0.56	0.72
Grams extract (E) ..	284	208	230	191	212	318	254	226	217	250	175	222	258	218	280	234	195	158	164	170	180	190	208	272	192	200	220
Factor F .. ..	9.2	6.7	7.4	6.2	6.8	10.2	8.2	7.4	7.0	8.1	5.7	7.2	8.4	7.1	9.0	7.6	6.3	5.2	5.3	5.5	5.9	6.1	6.7	8.8	6.2	6.5	7.2

Average values for Factor F :=Jonathan 7.3; Delicious 8.5; Granny Smith 6.1; Composite samples 7.6.

\* J=Jonathan ; D=Delicious ; GS=Granny Smith ; C=Composite sample prepared from 3 varieties direct from factory samples.

( $G = 400$ ) to that prepared from a standard formula using powdered pectin. It will be noted from Table 1 that the Granny Smith variety of apple had the highest proportion of pectin, with an average factor  $F$  of 6.1, while Jonathan had an average of 7.3 and Delicious 8.5; composite samples comprising mainly these three varieties had an average factor  $F$  of 7.6.

### III. PREPARATION OF STRAWBERRY JAM USING APPLE EXTRACTS

#### (a) Procedure

Some of the apple extracts prepared as described above were blended and their factor  $F$  determined. The extracts were quick-frozen and stored at  $-5^{\circ}\text{F}$  until the strawberry season.

The following batches of strawberry jam were prepared to a standard commercial formula but on a laboratory scale:—

- (a) Normal commercial procedure using powdered pectin.
- (b) Powdered pectin replaced by Granny Smith extract to the extent of giving a similar strength gel as (a). In this case it amounted to five times the legal limit, that is 25 per cent. apple juice.
- (c) Powdered pectin replaced by a mixture of Jonathan and Delicious extracts to the extent of giving a similar gel as (a). In this case it amounted to seven times the legal limit, that is 35 per cent. apple juice.
- (d) Powdered pectin replaced by the maximum legal limit of Granny Smith apple extract equivalent to 5 per cent. juice.
- (e) Normal commercial procedure but without the addition of pectin.

#### (b) Results and Discussion

The samples of jam were examined seven days later. The Brix and pH values are shown in Table 2. The apple extracts had the pH adjusted to 3.0 during the initial testing and this lowered the pH of the jam to slightly less than the desired value.

TABLE 2  
ANALYSES OF JAM SAMPLES

Sample No.	Brix	pH
a .. ..	69.1	3.3
b .. ..	71.0	3.2
c .. ..	69.1	3.2
d .. ..	67.5	3.3
e .. ..	68.1	3.4

The colour was normal in all batches, there being no significant difference to the eye.

The two batches without apple extract had normal rich strawberry flavours. It was difficult to detect any difference between these two and the batch containing 5 per cent. apple extract. The remaining two batches containing 25 and 35 per cent. apple extract had strong apple flavours which masked the strawberry flavour.

The jam containing powdered pectin was slightly stiffer than necessary but those batches containing 25 and 35 per cent. of apple extract had an ideal consistency. Jam prepared with 5 per cent. apple extract and that prepared without pectin or apple extract were quite unsatisfactory.

There was no significant difference in fruit suspension between samples containing pectin, 25 and 35 per cent. apple juice, but those containing 5 per cent. apple juice and no pectin were unsatisfactory.

### (c) Discussion

Since jam production is small during the apple season, it was considered that if an apple extract was to be used, it would require pasteurization and storage in cans. Although the colour of the jam was not affected on a laboratory scale, it was expected that on a commercial scale some darkening would occur, firstly due to possible further evaporation because of extra dilution needed during preparation of the extract, and secondly due to the heat required to pasteurize in 4 gal cans. This was later confirmed commercially. Pasteurization and storage in 4 gal cans was responsible also for some loss in gelling power. This supports the statement by von Loesecke (1949) that prolonged boiling of jams or jellies caused the product to darken and hydrolyses the pectin, thus possibly causing failure to set.

The material cost of producing apple extract was considered by allowing £16 1s. per ton for factory apples and 4s. each for 77 cans required to store the extract from 1 ton. Allowance was made for the double use of each can. The total cost per ton of fruit was then £24. After allowing for a 93.5 per cent. recovery of extract (possibly not allowable on a commercial scale), the cost of apple extracts, calculated on the basis of 100 per cent. fruit content, was 2.7d. per lb.

In considering a batch of jam weighing 120 lb, the maximum legal limit of apple juice would be 6 lb. The material cost of adding apple extract to strawberry jam could then be expressed as follows:—

Granny Smith	..	6 x 6.1 x 2.75 = 101d.
Jonathan	.. ..	6 x 7.3 x 2.75 = 120d.
Delicious	.. . . .	6 x 8.5 x 2.75 = 140d.

These apple extracts would replace  $3\frac{3}{4}$  oz of 200 grade pectin, which cost only 45d. Therefore the material cost of using apple extract as a jam-setting agent instead of powdered pectin would be 2·2–3·2 times as much. In other words, the cost per can of jam would rise by 0·7–1·2d. plus the labour cost of preparing the extract and the increased labour costs of producing the jam due to decreased production rates caused by the greater time required for evaporation.

#### IV. GENERAL CONCLUSIONS

Apple extracts prepared from Stanthorpe district apples are considered unsuitable for jam setting agent because:—

- (a) The quantity and quality of the pectin in the extract are excessively variable.
- (b) A darker colour is likely to be produced in the jam due to longer processing times of the jam.
- (c) The quantity of extract required varies from 5 to 10 times the maximum legal limit of apple juice (5 per cent.) which may be added to a jam. Such a jam would therefore have to be a mixed jam such as "Strawberry and Apple" or more likely "Apple and Strawberry."
- (d) The material cost to the manufacturer for the mixed jam would be 0·7–1·2d. per can more than the single-fruit jam such as strawberry. To this must be added labour charges, overhead selling expenses, retail margins, etc., so the likely increase in price to the consumer would be at least 2d. per can.
- (e) It is considered extremely unlikely that anyone would be prepared to pay 2d. more per can for a mixed jam when apple jelly is one of the cheapest jams.
- (f) To utilize culled apples they would have to be much cheaper and large quantities would have to be available to warrant the installation of expensive extraction and concentration plant to produce powdered pectin.

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