STUDIES ON THE PECTIN QUALITY OF DIFFERENT VARIETIES OF APPLE

M.A. KHAN* AND A. ASGHAR.*

The pectin characteristics of three varieties of apples grown in Pakistan namely Kulu, Amri and Mashadi were studied with the aim of their possible utilization in jam making. It was found that the water-soluble pectin in different varieties ranged between 0.538 to 0.75% (as per cent AGA). The Kulu variety contained the highest amount followed by Amri and Mashadi. The Ca-pectinate varied from 0.375 to 0.50% (as per cent AGA) and Kulu variety contained the highest amount followed by Amri and Mashadi. The protopectin varied between 0.327 to 0.331% (as per cent AGA), however, the difference between varieties was not significant. The overall amount of pectin was highest in Kulu variety (1.58%) followed by Amri (1.36%) and Mashadi (1.24%).

The Methoxyl content of the pectin was highest in Amri (14.6%) followed by Mashadi (8.6%) and Kulu (7.9). However, the difference between the latter two varieties was not significant. The amount of alpha-cellulose varied between 0.98 to 1.14% in different varieties. The Kulu variety contained the highest amount followed by Amri and Mashadi, whereas the amount of beta-cellulose fraction ranged between 0.049 to 0.057% in different varieties and the varieties fall in same order as for alpha-fraction. The alpha-cellulose fraction constituted the major portion of cellulose in apple. Keeping in view the pectin content Kulu variety appeared to be more appropriate for jam making as compared to the remaining varieties.

INTRODUCTION

Apple (*Pyrus malus* Linn or *Malus sylvestris*), besides being a very nutritious fruit, has a high theraputic value for the treatment of diarrhoea and dysentery (Kertesz, 1951; Smock and Neubert, 1950), especially for infants and children. The active curative ingredient in apple is believed to be pectin or more precisely the various pectic consituents which occur in the middle lamella of the cell wall in association with cellulose and hemi-cellulose. It is thought that the detoxication effect of galacturonic acid is responsible for curing these diseases.

Apart from this, pectin also carries a significant importance in the

*Department of Food Technology, University of Agriculture, Lyallpur.

technology of some food products: viz., jam, jellies, dessert. For this purpose apple is considered a very good source of high grade pectin (Rooker and Daughters, 1928; Bluementhal, 1947; Smock and Neubert, 1950; Kertesz, 1951; Rauch, 1952). However, the quantity and quality of the pectin in apple may vary with the variety, soil condition, environmental and agronomical factors (Rooker and Daughters, 1928). Smock and Neubert (1950) reported about 1.2% pectin in apple. Hills *et. al.* (1945) observed the methoxyl content of apple pectinic acid as 12.0% but repeating the analysis by improved method showed only 9.0% methoxyl content and 4.5% ethoxyl (or 3.1% calculated as methoxyl). Baker and Murray (1947) observed 1.16 to 1.93% of pectin and 4.6 to 6.8% of methoxyl content in different varieties of apple.

According to Kertesz (1951), the apple pectin contains the highest methoxyl content during the period of early development of fruit, while it drops gradually as the fruit matures. The maximum methoxyl content reported by him was 14.9%. Wilkinson and Perring (1964) studied the changes in chemical composition of apples during development and near the picking time. Although the changes in total pectin were small, they observed that apples from later picks contained less pectin than those from earlier picks.

Although a number of varieties of apple are grown in Pakistan, (Ali, 1970), the following varieties are produced extensively viz., Kulu, Amri and Mashadi. Ali (1970) has described the eating quality characteristics of these varieties in detail. It is, however, not known whether the pectic material of these varieties have the same quantitative characteristics. The present study, therefore, was designed to explore this aspect.

MATERIALS AND METHODS

The three varieties of apple namely Kulu, Amri and Mashadi were analysed for pectin characteristics. The chemical characteristics involved were total pectin, soluble-pectin, Ca-pectinate, protopectin, methoxyl content of the pectin, total cellulose, alpha–cellulose and beta–cellulose.

The different fractions of pectin were separated and determined according to the method of Rouse and Atkins (1955). The various steps of the procedure are summarised in Figure 1. The methoxyl content of pectin was estimated by Hinton's method (1940). The Doree's method (1950) was used for the separation and determination of alpha- and beta-cellulose. The experimental data were subjected to one-way analysis of variance model (Snedecor, 1966), to determine the level of significance of the varietal effect, whereas the

significance of difference between means was tested by Duncan Multiple Range Test.

RESULTS AND DISCUSSION

The experimental data on different fractions of pectin and cellulose from Kulu, Amri and Mashadi apples are presented in table I. The result of the statistical analysis are shown in the sub-tables I-A to I-F and have been discussed in a sequence as below :

1. Total Pectin

i. *Water-soluble fraction :* The mean values of the data on water-soluble pectin fraction (expressed as per cent anhydro-galacturonic acid-AGA) in different varieties of apple are presented in table I. It shows that the values ranged from 0.538 to 0.750%. The analysis of variance of the data revealed a highly significant difference ($P<0.01$) between the varieties (Table I-A), while testing the mean by Duncan Multiple Range Test indicated that Kulu variety contained the highest amount of water-soluble pectin followed by Amri and Mashadi ($P<0.05$).

ii. *Ammonium oxalate-soluble fraction :* The ammonium oxalate-soluble pectin fraction (as per cent AGA) in different varieties of apple varied from 0.375 to 0.501% (Table I). The statistical analysis (Table I-B) of the data indicated a highly significant difference between the varieties ($P<0.01$). The comparison of mean values of varieties revealed a similar picture as was found in the case of water-soluble pectin.

iii. *Sodium hydroxide-soluble fraction :* Although the amount of sodium hydroxide-soluble pectin in different apples varied from 0.327 to 0.331% (Table I), the statistical analysis of the data (Table I-C) showed no significant difference between varieties ($P>0.05$).

The sum of the values of different fractions showed that the Kulu apples contained 1.58% total pectin, followed by Amri (1.36%) and Mashadi (1.24%). These results fall within the range 1.16 to 1.93% as reported by Baker and Murray (1947) but slightly higher than those of Smock and Neubert (1950).

2. Methoxyl Content of the Pectin

Table I presents the per cent methoxyl content of different varieties of apples which varied between 7.99 to 14.61% (based on pectin content). The statistical analysis of the data (Table I-D) indicated a highly significant difference between the varieties ($P<0.01$). Comparison of the means by Duncan Multiple Range Test indicated that the pectin from Amri variety contained the highest amount of methoxyl content (14.61%), however, the difference between Mashadi (8.61%) and Kulu (7.99%) was not significant ($P>0.05$).

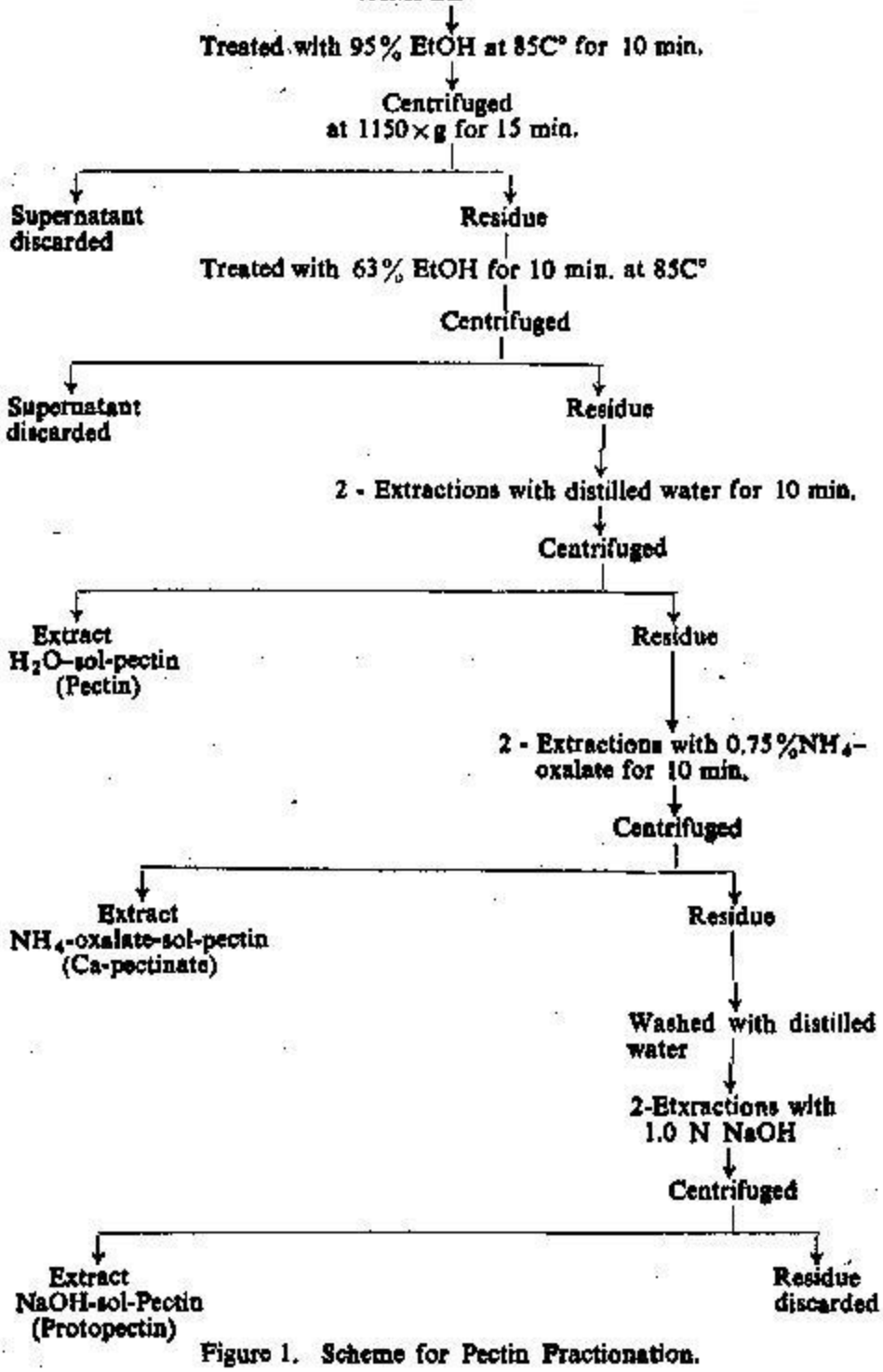

Figure 1. Scheme for Pectin Fractionation.

TABLE I: *Average Value for Different Varieties of Apple*

Components	Kulu (V_1)	Amri (V_2)	Mashadi (V_3)
Total Pectin (% AGA)	1.58	1.36	1.24
i) Water-solube pectin fraction (% AGA)	0.750	0.563	0.538
ii) Ammonium oxalate-soluble pectin fraction (% AGA)	0.501	0.470	0.375
iii) Sodium hydroxide-soluble pectin fraction (% AGA)	0.327	0.331	0.331
Methoxyl Content of the Pectin (% of total pectin)	7.99	14.61	8.61
Total Cellulose (% fresh weight basis)	1.19	1.15	1.03
i) Alpha-cellulose fraction (% fresh weight basis)	1.14	1.09	0.98
ii) Beta-cellulose fraction (% fresh weight basis)	0.057	0.055	0.049

TABLE I—A *Analysis of Variance for Water-Soluble Pectin Fraction of different Varieties of Apple*

Source of Variation	D.F.	S.S.	M.S.	F.R.
Varieties	2	0.053692	0.026846	1491.44**
Error	3	0.000054	0.000018	
Total	5	0.053746		

S. E. for varieties = 0.003

Varieties	V_1	V_2	V_3
Mean Values	0.750	0.563	0.568

TABLE I—B *Analysis of Variance for Ammonium Oxalate-Soluble Pectin Fraction of different Varieties of Apple*

Source of Variation	D.F.	S.S.	M.S.	F.R.
Varieties	2	0.017346	0.008673	1084.12**
Error	3	0.000025	0.000008	
Total	5	0.017371		

S. E. for varieties = 0.002 **Highly Significant

Varieties	V_1	V_2	V_3
Mean Values	0.501	0.470	0.375

TABLE I—C *Analysis of Variance for Sodium Hydroxide-Soluble Pectin Fraction of different Varieties of Apple*

Source of Variation	D.F.	S.S.	M.S.	F.R.
Varieties	2	0.000022	0.000011	0.73 N.S
Error	3	0.000044	0.000015	
Total	5	0.000066		

TABLE I—D *Analysis of Variance for Methoxyl Content of the Pectin Fraction of different Varieties of Apple*

Source of Variation	D.F.	S.S.	M.S.	F.R
Varieties	2	53.5289	26.7644	636.76**
Error	3	0.1260	0.0420	
Total	5	53.6549		

N.S. Non-significant
** Highly Significant

S.E. for varieties = 0.145

Varieties	V_2	V_3	V_1
Mean Values	14.614	8.608	7.993

The maximum methoxyl content in apple reported to be 14.9% by Schlubach and Hoffmann (1949). The Amri apple seemed to fall in this range while the other varieties had fairly low amount of methoxyl content which was, however, higher than those reported by Baker and Murray (1947).

3. Total Cellulose

i. *Alpha-fraction* : The average amount of alpha-cellulose in different varieties of apples is presented in table I, which shows that the values ranged from 0.98 to 1.14% on fresh weight basis. The statistical analysis of the data in table I-E reveals a highly significant difference between varieties ($P < 0.01$) while testing of the means suggested that Kulu variety contained the highest amount of alpha-cellulose followed by Amri and Mashadi ($P < 0.05$).

ii. *Beta-fraction* : The beta-cellulose fraction (Table I) in different varieties varied from 0.0492 to 0.572%. The statistical analysis of the data

is given in table I-F, which discloses a highly significant difference between varieties ($P < 0.01$). The testing of means indicated a similar picture as for alpha–fraction i.e. Kulu variety contained the highest amount of beta-cellulose fraction followed by Amri and Mashadi ($P < 0.05$).

The total cellulose in these varieties ranged between 1.03 to 1.19% which was slightly higher than the amount found by Smock and Neubert (1950) in apple. Generally speaking the alpha-fraction (consisting of 500—2000 glucose units/molecule) constituted the mojor portion of cellulose in apple, whereas the beta-fraction of low molecular weight (consisting of 10—50 glucose untits/ molecules) composed only minor fraction of the total cellulose.

TABLE I—E *Analysis of Variance for Alpha-Cellulose Fraction of different Varieties of Apple*

Source of Variation	D.F.	S.S.	M.S.	F.R.
Varieties	2	0.024867	0.012433	654.36**
Error	3	0.000057	0.000019	
Total	5	0.024924		

S.E. for varieties = 0.0031

Varieties	V_1	V_2	V_3
Mean Values	1.136	1.094	0.994

TABLE I—F *Analysis of Variance for Beta-Cellulose Fraction of different Varieties of Apple*

Source of Variation	D.F.	S.S.	M.S.	F.R.
Varieties	2	0.00006934	0.00003467	577.83**
Error	3	0.00000018	0.00000006	
Total	5	0.00006952		

**Highly Significant

S.E. for Varieties = 0.00017

Varieties	V_1	V_2	V_3
Mean Values	0.0572	0.0552	0.0492

LITERATURE CITED

Ali, N. 1970. Apple growing in West Pakistan. pp. 1-3, 23, 24, WPAU Press, Lyallpur

Baker, G.L., and W.G. Murray, 1947. Pectinic acids as related to texture and quality of dehydrated fruit products. Fd Res., 12: 129.

Bluementhal, S. 1947. Food Products. pp. 737, 743, 728-795. Chemical Publishing Co. Inc. London.

Dorse, C. 1950. The methods of cellulose chemistry. pp. 261, 334, 363, 465. Chapman and Hall Ltd., London.

Hills, C.H., C.L. Ogg, and R. Speiser, 1945. Commercial Production of pectin from apple. Ind. Engg. Chem. Analyt. Edn. 17: 507.

Hinton, C.L. 1940. Fruit pectins, their chemical behaviour and jellying properties. Chemical Publishing Co. New York.

Kertesz, Z. I. 1951. The Pectic Substances. Interscience Publishers Inc., New York.

Rauch, G.H. 1952. Jam Manufacture. Leonard Hill, Ltd., London.

Rooker, W. A., and M.R. Daughters. 1928. Fruit Pectin. pp. 3-7. Avi Publishing Co. Inc. New York.

Rouse, A. H., and C. D. Atkins, 1955. Pectinesterase and pectin in commercial citrus juices. Citrus Expt. Sta. Univ. Florida, Agri. Sta. Bull. 570.

Smock, R.M., and A. M. Neubert, 1950. Apple and apple products. Interscience Publishers Inc., New York.

Snedecor, G. W. 1966. Statistical Methods, applied to experiments in Agriculture and Biology. The Iowa Sta. Univ. Press, Iowa.

Wilkinson, B.G., and M.A. Perring, 1964. Changes in chemical composition of apples during development and picking time. J. Sci. Fd Agri. 15 (3) : 146.