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Pectinic Acids and Other Hydrocolloids and Their Gelation

SUMMARY

A study of pectinic acids as related to the texture and quality of dehydrated fruits and vegetables has shown that grade as calculated from viscosity of pectins present in the dehydrated products may be an index to their quality. A straight-line relationship was found in the case of apples and peaches, but not with apricots. Dehydrated carrots, apparently, can be graded in this same manner. The viscosities of solutions of pectins obtained from samples of dehydrated white potatoes, sweet potatoes, beets, raisins, currants, prunes, and pears were too low for correlation with eating quality. A phase report is attached.

BB 10 #5

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RES

Pectinic Acids as Related to Texture and Quality of Dehydrated Products[1]

The acceptance of dehydrated fruits and vegetables depends upon the general appearance, flavor, and eating quality of the rehydrated, cooked food. An index of quality which depends upon some constituent of the dehydrated food products would be desirable. An index of this nature could be used by the processor in improving his methods and it could serve as a guide to the wholesale purchaser. Deterioration or the aging of a product could also be followed. The pectinic acids as one constituent present in fruits or fruit products may offer such an index of quality. Pectinic acids have therefore been extracted from several dehydrated products in order to investigate their possible relationship to quality. The results are recorded herein.

Method of Extracting Pectins

The pectins were extracted from dehydrated fruits and vegetables by the method which produced an extraction liquor of the highest viscosity. It has been found that polyphosphates have a sequestering action for calcium which is advantageous when used in the extraction of pectin (1, 2). Since polyphosphates are valuable in the extraction of pectins above pH 3, sodium hexametaphosphate was used at its optimum concentration in the present experiments following a brief survey of the best conditions of acidity and boiling time for the extraction of pectin from each of several dehydrated products. An example will serve to illustrate the survey procedure as applied to dehydrated apricots, this is as follows:-

Twenty gram samples of dehydrated apricot (blanched, dehydrated apricots, 1945 crop, held in cold storage) were soaked in 180 ml. of water for one hour and then broken down to a fine particle size in a Waring Blender through five minutes of blending action. The finely-divided sample was extracted by boiling for five minutes with various amounts of sodium hexametaphosphate (0 to 5 per cent domestic Calgon) with or without the addition of

1. Problem resulted from an inquiry by Dr. Gertrude Gottschall, Special Assistant in the Office of the Quartermaster General.

acid (0 to 5 ml. N/1 HCL). In the case of this apricot sample the optimum conditions for extraction, as determined from a series of six trials, was the presence of 2.5 per cent polyphosphate based on the weight of the dehydrated fruit without added acid; the pH was 4.12. Under these conditions, an extraction liquor was obtained which had a relative viscosity (Ostwald) of 6.42 at 26°C.

Following the establishment of the optimum conditions of acidity and polyphosphate concentration as determined by optimum viscosity, additional samples were extracted under similar concentrations of extraction ingredients, but the time of extraction was varied from five to 15 minutes. When this was done in the case of this apricot sample, it was found that boiling 10 minutes produced the highest viscosity in an extract.

Since the actual grade of the pectin present in the dehydrated fruit or vegetable product was of primary interest, it was necessary to extract and prepare several grams of pectin from each dehydrated product. This was done by extracting 100 g. of the dehydrated fruit. In the case of the same apricot example discussed in the above paragraphs, 100 g. of the dehydrated apricot was soaked for one hour with 900 ml. of water at 26°C. containing 2.5 g. domestic Calgon and then it was blended in the Waring Blender the same as the earlier, smaller-sized preparations. The blended product was boiled for 10 minutes, then the extract was strained and pressed through coarse muslin. The strained liquor was clarified by passing through a filter pad consisting of coarse filter paper and 60 g. of Johns Manville Standard Super-Cel placed on a 10-inch Buchner funnel. A like amount of filter-aid was mixed with the strained liquor. Suction was applied to aid the clarifying filtration. The pectin in the clarified liquor was precipitated in twice its volume of 90 per cent isopropyl alcohol. Following precipitation the pectin was recovered by filtering using closely woven muslin; it was pressed as dry as possible and then washed, in turn, with 100 ml. of the alcohol and 100 ml. of ethyl ether. The pectin was dried at 60°C. for 20 hours. The yield, methoxyl content, viscosity, and appearance of the pectin were recorded. The grades of the pectins were calculated from the viscosities of 0.5 per cent solutions by the formula-- Grade = 200 (log y - 0.2), where y = the viscosity of a 0.5 per cent solution of pectin.

Results

The pectins extracted from the dehydrated white potatoes, sweet potatoes, beets, raisins, currants, prunes, and pears were all found to have low viscosity values; all except prunes had less than a relative viscosity of "2" for 0.5 per cent solutions at 26°C. One sample of seeded prunes had a relative viscosity of 3.65, but the other two samples had a viscosity of less than "3". These samples were considered worthless for purposes of correlation until further dehydrated products are evaluated.

Pectins extracted from samples of freshly dehydrated and from three-year old dehydrated carrots had relative viscosities in one per cent solution at pH 6.3 of 5.63 and 1.66, respectively. This would indicate grades of 55 and 2 when compared with the grades of pectins of commerce where 100-grade pectin is pectin which will support 100 pounds of sugar per pound of pectin as a 65 per cent soluble solids gel of standard strength at its optimum pH of gelation. Upon giving the freshly-dehydrated carrots a rating of 100 as far as quality and texture were concerned, the three-year old sample would rate about four. These ratings represent a good index of the texture and quality of the dehydrated carrot samples at the time of examination.

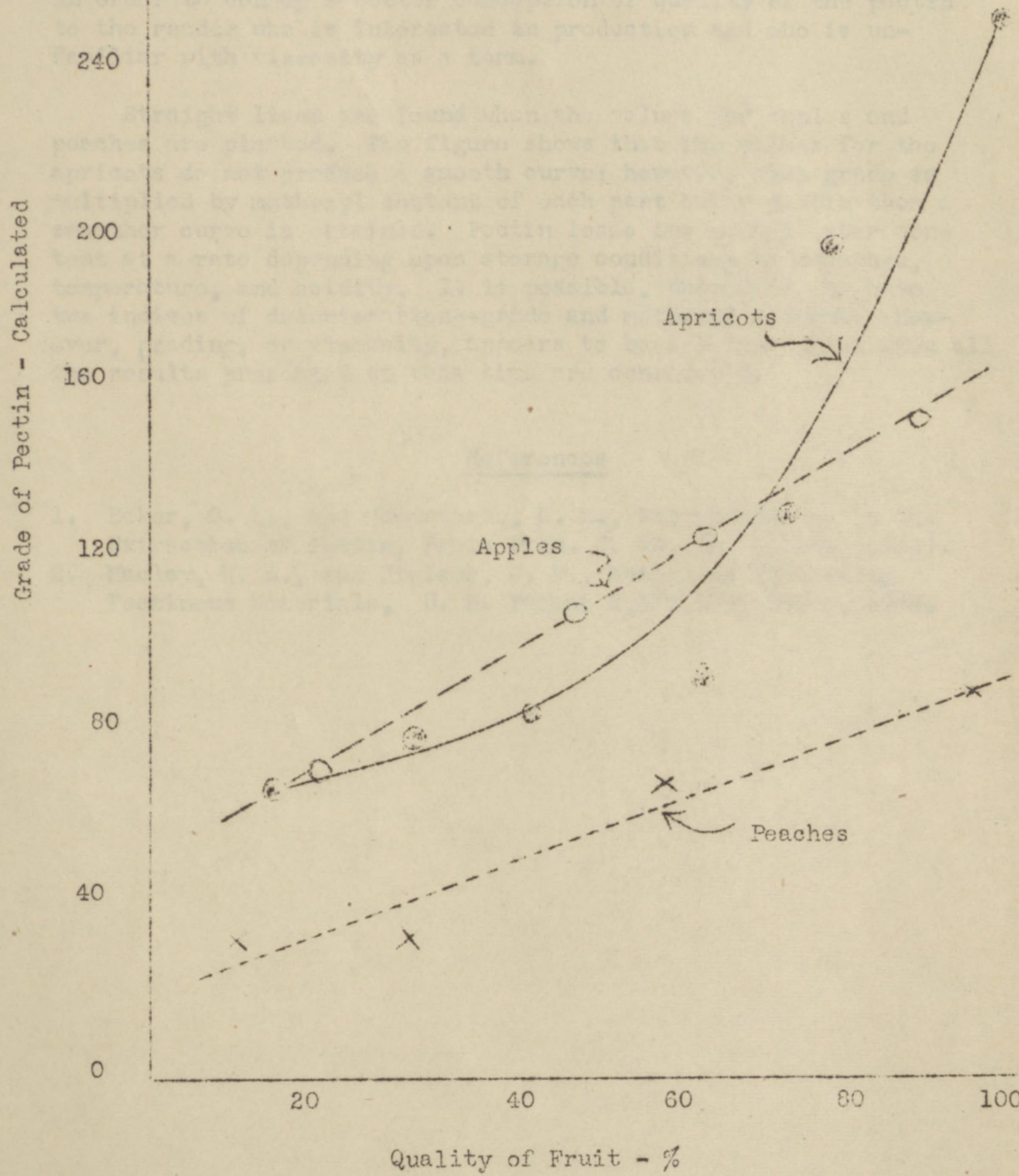
The pectins obtained from the apples, apricot, and peach products were of higher grade and more suitable for correlation with the quality and texture of the prepared, dehydrated products. The results of their examination are given in the table. Correlations between the quality of fruit, which represents the averages of judgement by five individuals, and the grade of the pectin as calculated from viscosity are illustrated by the curves in the figure. A rating of "100" for quality is considered as very good, while "0" is considered to represent a worthless product.

The results show that there are good correlations between pectic quality and product quality for these particular fruits; apples, apricots, and peaches. Some level of acceptability has to be taken for the quality of fruit. In practice this might be "60". Below this level of acceptability the dehydrated products are worthless from the edibility standpoint. It can be assumed that the viscosity of pectin extracted from fruits will be a good index of edibility, This is because the viscosity of pectin solutions of constant concentration, in this case 0.5 per cent, is an index of degree of polymerization of the pectin. The

Table Showing
Quality of Dehydrated Fruit as Related to Grade of Pectin Present in Fruit Tissue

Kind of Fruit	Shelf History	Amt. Pectin Extracted, %	Viscosity 0.5% Soln. 26°C.	Calculated Grade of Pectin	CH_3O %	Quality of Fruit, 100 = Very Good
Apple	1944 Cold Storage	1.74	9.3	154	6.8	90
Apple	1942 Cold Storage	1.65	6.8	126	6.8	65
Apple	? '42 or '43	1.16	5.5	108	4.6	50
Apple	Pacific Theatre	1.93	3.9	72	6.5	20
Apricot	1945 Dehyd. Fruit Assn.	2.31	24.6	248	6.7	100
Apricot	1945 Drum-Dried	3.75	10.9	190	5.9	80
Apricot	1944 Blanched, Cold Storage	3.42	7.2	132	6.8	75
Apricot	1945 Blanched, Cold Storage	2.80	4.7	94	6.4	65
Apricot	1944 Cold Storage	4.44	4.2	84	6.1	45
Apricot	1944 Vacuum Dried	3.17	3.9	78	5.9	30
Apricot	Pacific Theatre	4.37	3.5	68	4.7	15
Peach	1944 Blanched, Cold Storage	3.71	4.8	96	4.7	90
Peach	1944 Cold Storage	4.06	3.5	68	4.3	60
Peach	1944 Cold Storage	4.36	2.3	32	4.6	30
Peach	? Pacific Theatre	4.03	2.3	32	5.4	10

Quality of Fruit as Judged by Grade of Pectins Present in Its Tissues



degree of polymerization of pectin appears to be a good index of the treatment and conditions of storage which the pectin has undergone whether it is still present in vegetative tissues or extracted from such tissues and held in liquid or powdered form. It is unnecessary to convert the viscosity values to grade except in order to convey a better conception of quality of the pectin to the reader who is interested in production and who is unfamiliar with viscosity as a term.

Straight lines are found when the values for apples and peaches are plotted. The figure shows that the values for the apricots do not produce a smooth curve; however, when grade is multiplied by methoxyl content of each particular pectin then a smoother curve is obtained. Pectin loses its methyl ester content at a rate depending upon storage conditions of moisture, temperature, and acidity. It is possible, therefore, to have two indices of deterioration--grade and methoxyl content. However, grading, or viscosity, appears to be a better index when all the results presented at this time are considered.

References

1. Baker, G. L., and Woodmansee, C. W., Polyphosphates in the Extraction of Pectin, Fruit Prod. J. 23, No. 6, 164 (1944).
2. Maclay, W. D., and Nielson, J. P., Method of Extracting Pectinous Materials, U. S. Patent 2,375,376, May 8, 1945.