STUDIES IN THE DEHYDRATION OF GUAVA FOR THE SUBSEQUENT RECOVERY OF PECTIN DURING OFF-SEASON

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ABSTRACT

The conditions of dehydration of guava for subsequent recovery of pectin from the dehydrated guava during off-season have been studied. The results of a systematic study on the determination of the critical temperature of dehydration of guava, by following up the recovery and stability of pectin during dehydration at different temperatures have been presented and discussed. Besides the losses in the yield and quality of pectin recovered from the dehydrated guava slices during storage at different temperatures have also been studied.

Introduction

During the course of our studies on the recovery of pectin from guava, it was noticed that the refrigerated storage of guava fruit[1] as such and the storage of preserved guava pulp[2] were not very satisfactory, as in the long run, the quality of pectin deteriorated. It was, therefore, considered desirable to study the long range preservation of guava by dehydration.

There are several factors which affect the quality of the dehydrated product. Of these, the temperature of drying of the product is the most important. The temperature of drying, i.e., the temperature of the air used in dehydration, greatly affects not only the time required for drying, but also the quality of the dehydrated product. In order to secure large capacity and minimum operating costs, it is very essential to use the highest temperature that will not materially injure the product[3]. The optimum drying temperature and also the critical temperature of a product varies with the nature of the product and its moisture content, etc. [3,4]. *Critical Temperature* is defined[3,4] as 'the temperature at which a nearly dry product is seriously injured when exposed for a certain period of time'. At temperatures above critical temperature, the dry product is likely to scorch, the sugars contained therein are likely to caramelize and the colour, flavour and aroma of the product are likely to be adversely affected[5]. To determine the critical temperature of a product, the stability of its most desirable character is followed up during heating at different temperatures. Little scientific evidence is available in literature on the precise critical temperature of guava from the view point of recovery and stability of pectin, though some general statements regarding the temperature for guava dehydration have been given[6,7]. A systematic study was, therefore, undertaken to determine the critical temperature of guava by following up the stability and recovery of the pectin during dehydration at different temperatures of dehydration and also during the storage of dehydrated guava at three different temperatures. The important results of this study are presented in this paper.

Experimental

(*i*) *Determination of optimum temperature of dehydration of guava fruit for future recovery of pectin*

Five lots (12 lbs. each) of fully developed green guavas were taken for the present study. The guavas were washed, their calyces and stem-ends were removed and then sliced into 1/4″ thick slices. The slices were blanched in boiling water for 4 minutes [6], loaded in stainless steel trays (16″×32″) at the rate of 5 lbs./tray and dehydrated separately in a Cabinet (Cross-flow) Drier at air-temperatures of 130, 140, 150, 160 and 170°F, the velocity of air being constant (not variable) in each case. The product temperatures were measured by employing a Cambridge Recording thermometer. In most cases, the product during the last [1,2] hours of dehydration, acquired nearly the same temperature as that of air over it. The lots took 11·5 to 8 hours for dehydration, upto 4 per cent moisture in the final products, their respective times of dehydration for the lots dehydrated at 130, 140, 150, 160 and 170°F being 11·5, 11, 9, 8·5 and 8 hours respectively. During dehydration, in all the cases, the weights of the trays were recorded every two hours in order to find out the respective losses in weight and when there was no further loss in weight, dehydration was stopped. The weight of moisture per lb. of dry matter in the product at different stages during dehydration at different temperatures were then calculated in each case.

From the guava slices dehydrated at different temperatures (130—170°F) the yield of pectin[8] (alcohol precipitate), methoxyl content[9] (MeO per cent) equivalent weight[9] and anhydrouronic acid[10] (A.U.A. per cent) of the pectin were determined. The results are presented in Table 1.

TABLE 1

Determination of critical Temperature for Dehydration of Guava (Recovery and Quality of pectin obtained from guavas dehydrated at different temperatures)

Physico-Chemical Characteristics	Dehydration Temperature (°F)				
	130	140	150	160	170
(A) *Pectin Extract:*					
°Brix	6·0	6·0	6·0	6·0	6·0
pH	2·8	2·8	2·8	2·9	3·0
*Viscosity (Secs.) ..	107	105	100	88	80
Jelmeter reading ..	1	1	1	3/4	3/4
Pectin % (w/w) ..	3·91	4·50	4·55	4·24	3·10
Pectin % (M.F.B.) ..	4·1	4·7	4·9	4·5	3·3
(B) *Pectin:*					
Moisture %	4·9	4·6	4·9	4·8	4·9
Eq. Wt.	962	968	970	962	970
MeO%	9·6	9·6	9·9	8·7	8·9
A.U.A. %	89·3	89·0	87·0	70·6	69·7

* Time of efflux (Seconds) as determined by Ostwald Viscometer No. 2 at 20°C. The mean efflux time for water at 20°C. was 13 secs.

M.F.B.—Moisture free basis. A.U.A.—Anhydrouronic acid.

(ii) Effect of blanching of guava slices prior to their dehydration

With a view to study the effect of blanching of guava slices prior to dehydration, one lot of guava slices was blanched in boiling water for 4 minutes and then subjected to dehydration along with a control lot (unblanched) of guava slices.

(iii) Effect of addition of Polyphosphates

Polyphosphates are known to increase the yield of pectin when used during pectin extraction [11] but no published information is available on their effect on both the recovery and quality of pectin from either fresh or dehydrated guavas.

With a view to study the effect of addition of polyphosphates (Calgon) on the recovery and quality of pectin, to one lot of dehydrated guavas, sodium-hexa-metaphosphate was added at the rate of 2·5 per cent *w/w* on the basis of fruit[2] prior to the extraction of pectin, while one lot (without any added calgon) served as control. The results of a typical experiment are presented in Table 1-A.

TABLE 1-A

Effect of Addition of Polyphosphates on the Recovery and Quality of Pectin from Dehydrated Guava

Physico-Chemical Characteristics	Control (No polyphosphate added)	With polyphosphate added
Pectin Recovery %	4·58	6·12
Methoxyl content %	10·50	10·40
Equivalent weight	970	970
Anhydrouronic acid %	89·0	89·0

(iv) Determination of Rehydration Ratio

Eight lots of 30 g each of dehydrated guavas were taken in a beaker containing 500 ml. water and slowly simmered for different periods (from 5 to 40 minutes) separately. At stipulated periods, the drained weights of the slices were noted. The experiment was conducted in duplicate. The average results on the rate of rehydration and rehydration ratio are presented in Table 2.

TABLE 2

Data on the Rate of Rehydration of Dehydrated Guava Slices

Time of simmering (Minutes)	Weight of Slices (g)	Rehydration Ratio
0	30	1·00
5	58	1·93
10	72	2·40
15	84	2·80
20	92	3·00
25	99	3·30
30	103	3·43
35	104	3·47
40	103	3·43

It can be seen from Table 2, that the progressive absorption of water took place upto 35 minutes, after which the slices started disintegrating. Thus the optimum *Rehydration Ratio* of dehydrated guava was found to be 3·47. This ratio was employed in future experiments for the recovery of pectin. In an earlier study[2] on the effect of solid: extractant ratio on the recovery of pectin from fresh guava, an optimum ratio, of 1 : 2 was determined. Keeping in view this ratio and the optimum rehydration ratio of about 3·47, a solid (dehydrated guava slices): water ratio of 1 : 9 was employed. To the water, were added 0·75 per cent citric acid and calculated quantity of calgon (0·25 per cent) prior to the usual extraction of pectin.

(*v*) *Storage of dehydrated guavas*

Three lots of guava slices dehydrated at 150°F for 9 hours, were packed separately in 3 tin-containers and one container each was stored at 5—7°C, room temperature (20—28°C) and at 37°C. The pectin recovery and its quality were studied every month at each of the above storage temperatures as usual. The results are presented in Table 3 (page 110).

Discussions

(*i*) *Critical Temperature of Dehydration of guava*

Deterioration of a food material during dehydration depends to a considerable extent on the temperature attained by the material and the period for which the material remains at that temperature. In our studies on the dehydration of guava slices in a cross-draught drier, the product temperature, as measured by a Cambridge recording thermometer, was always lower than the air temperatue except during the last one to two hours when it was very near the air-temperature. Further, in these studies, all other factors like method of preparation, density of tray-load, method of dehydration and air-velocity being the same, it is quite reasonable to assume that the product temperature would be a function of the air-temperature employed during dehydration and as such we have attempted to discuss the comparative effects of different air-temperatures employed during dehydration of guava on the recovery and quality of pectin as follows:—

The pectin recovery from guavas dehydrated at 130, 140, 150, 160 and 170°F was 3·91, 4·50, 4·55, 4·24 and 3·10% respectively, the corresponding MeO% and A.U.A. % being 9·6, 9·6, 9·9. 8·7, 8·9% and 89·3, 89·0, 87·6, 70·6, 69·7 % respectively (Table 1). It will be seen that the recovery of pectin was comparatively low both at 130° and 170°F, perhaps because of the longer time of heating at the former and higher heat damage at the latter. The yield, MeO% and A.U.A.% were best at 150°F (Table 1) and thus this temperature could be recommended as the optimum temperature of dehydration of guavas for pectin extraction. It may also be inferred that the critical temperature of guava dehydration was 160°F, when the pectin content started deteriorating.

(*ii*) *Effect of Blanching and addition of polyphosphates*

The results of a preliminary study indicated that blanching of guava slices prior to dehydration had a beneficial effect on the quality of pectin probably because of the leaching away of impurities during blanching. Further, the addition of sodium-hexa metaphosphate increased the yield of pectin, without materially affecting the quality of pectin as judged from the methoxyl and A.U.A. content (Table 1-A).

(iii) Storage studies on Dehydrated Guavas

Dehydrated guava slices kept at 5-7°C had undergone very little changes in pectin recovery (4·8 to 4·6%), MeO% and A.U.A.% (9·2 to 7·8% and 96·1 to 90·0% respectively) after 4 months' storage. The corresponding lot kept at 37° C had undergone slightly more losses in the recovery of pectin, but it had undergone a marked loss in MeO% and A.U.A.% to the changes being from 9·5 to 7·0 and 96·3 to 69% respectively. Upto 7 months' storage at 5-7°C, dehydrated guava slices could be kept without much loss in the recovery and quality of pectin. At room temperature, the losses were slightly more, but at 37°C, considerable deterioration took place (Table 3).

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TABLE 3

Effect of time and temperature of storage on the recovery and quality of pectin from dehydrated Guava

Physico-Chemical Characteristics	Initial	Storage Temperatures (°C)												
		37°C				Room Temperature (20—28°C)				5—7°C.				
		Storage Period (Months)				Storage Period (Months)				Storage Period (Months)				
		1	2	3	4	1	2	3	4	1	2	3	4	5
Extract.														
Volume (ml)	400	400	405	400	400	400	400	400	400	405	400	405	405	405
Weight (*g*)	410	410	413	411	410	409	408	410	410	410	410	415	415	412
°Brix	6	6	6	6	6	6	6	6	6	6	6	6	6	6
pH	2·0	1·9	2·0	2·0	2·0	2·0	2·0	2·0	2·0	2·0	2·0	2·0	2·0	2·0
Viscosity*	125	121	120	120	120	121	120	120	120	121	120	120	120	119
Pectin % (w/w)	4·53	4·45	4·30	4·30	4·25	4·50	4·45	4·41	4·30	4·50	4·40	4·40	4·40	4·3
Pectin % (MFB)	4·8	4·7	4·5	4·5	4·4	4·7	4·7	4·7	4·5	4·8	4·7	4·7	4·7	4·6
Pectin:														
Moisture %	5·0	4·9	4·9	5·0	4·7	4·9	4·8	4·2	4·3	4·8	4·5	4·5	4·5	4·4
Eq. Wt.	759	768	780	785	790	805	796	799	759	763	780	778	789	785
MeO%	9·5	7·9	7·7	7·5	7·0	8·0	7·8	7·4	7·3	9·1	8·7	8·2	7·8	7·6
A.U.A. %	96·5	78	72	70	69	83·0	80·0	76·5	76·3	90·1	90·0	90·0	90·0	89·4

*Time of efflux (seconds) as determined in Ostwald Viscometer No. 2 at 20°C. The mean time of efflux for water at 20°C was 13 seconds.
MFB—Moisture free basis. A.U.A.—Anydrouronic acid.