THE PHYSICO-CHEMICAL STUDIES OF THE STARCH OF SOME UNDER UTILIZED SEED FLOURS

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Abstract

The physico-chemical properties of the starch from gourd seed (*Lagerania vulgaris*), white melon*(Cucumeropsis edulis)*, yellow melon *(Colocynthis citrullus*), benniseed (*Sesamum radiatum*) and bulma cotton seed(*Cochlospermus religiosum*) have been studied with respect to proximate, pasting behaviour using Brabender amylograph, viscosity, retrogradation/setback, swelling and solubility as a function of pH and freeze-thaw stability. The proximate composition of the starch from different sources was as follows: crude protein (0.5% to 0.8%), moisture (7.0% to 10.0%), ash (0.05% to 1.10%) and crude fibre (0.12% to 0.41%) respectively. The pasting behaviour (M_n-M_g) of the samples ranged from 11 min to 16.9 min. The viscosities on cooling to 50 °C (Ve) in the samples studied ranged between 40 B.U and 180 B.U respectively. The trend in solubility is benniseed < bulma cotton < yellow melon < white melon < gourd seed. There is also a remarkable decrease and fair increase in freeze-thaw stability after five different freeze-thaw cycles.

1. Introduction

Food carbohydrates consist of mono-, di-, oligo- and polysaccharides, the latter composed of starch and non-starch polysaccharides (NSP). Starch is the principal dietary carbohydrate of a majority of legume and cereal-based foods. Starch-the only quantitatively important digestible polysaccharide-has long been regarded as nutritionally superior to low-molecular weight carbohydrates or "sugars". This was based on the assumption that starch is more slowly digested and absorbed than sugar. The glycaemic response to both sugar of starch is dependent on the type of sugar, and complex carbohydrate do not necessarily produce slower or lower glycaemic responses than some types of sugars. Carbohydrate not absorbed in the small intestine is fermented extensively by the large intestinal micro flora (Asp, 1996).

In addition to its dietary significance, the primary role of starch, from the technological point of view, is the ability to dictate or modify the texture and consistency of finished food products (Whistler, 1984). Many food industries are greatly dependent on the use of both native and derivatised starch for the manufacturing of varieties of fabricated products. The recommendations to increase the intake of carbohydrate in western diets were originally a consequence of the recommendations to decrease the fat intake and keep the protein intake unchanged, the specific nutritional importance of different food carbohydrates has recently received increasing attention (Anonymous, 1990). Most proposal for increased utilisation of wheat have involved use of the properties of the starch, either separately or as a part of flour (Thewlis, 1964; Naffiziger *et al.,* 1963). Therefore, there is need to search for new sources of starch from grossly available but so far under-utilised foods useful for both food and allied industries.

There are many plants, cultivated or wild growing in tropical countries whose seeds contain highly appreciable amount of oil and protein which find commercial application in industries (Olaofe *et al.*, 1994). There is no communication on some of the physico-chemical properties of starch from these plants. The present studies deal with proximate, isolation and physico-chemical studies of five sources of starch of gourd seed, white melon, yellow melon, benniseed and bulma cotton seed.

2. Materials and Methods

Gourd seed, white melon, yellow melon and benniseed were purchased from Oja Oba market in Akure, Ondo State while bulma cotton seed was obtained from University of Ado-Ekiti, Ekiti State. The seeds were dry milled into fine flours using a blender.

(a) Isolation of starch

Step 1:The seeds were powdered in a Kenwood grinder to pass through 60-mesh sieve.

Step 2: Defatting process: Extraction of the oil was done using the soxhlet extraction apparatus with a mixture of hexane-$CHCl_3$-CH_3OH (1:2:1,V/V/V).

Step 3: Crude starch recovery: The defatted flours were steeped in water containing $HgCl_2$ (100 ppm)

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for 16h at room temperature and then mixed in a Warring blender. Crude starch granules were separated by filtration through 150-200 ¼m mesh sieve and centrifuged 5000 rpm for 10 min.

Step 4: Starch purification: The crude starch granules were successively treated with dil NaOH (0.1M; 5 min at room temperature) and 0.1M NaCl-toluene (10:1, v/v). The treatments were repeated four times and after each treatment the granules were sedimented by centrifugation and the sediment was thoroughly washed with water. The final sediment was washed with methanol (twice) and air dried.

The proximate analysis of the starch samples for moisture, ether extract, total ash, crude protein and crude fibre was carried out using the method of AOAC (1990). The viscosity and pasting behaviour at 8% (W/V) concentration were studied using a Brabender amylograph (PT-100) equipped with 700 cmg sensitivity cartridge. The slurry was heated from 30 °C to 95 °C, held for 3 min and cooled to 50 °C. The holding time was extended to 60 min to observe the viscosity changes due to extended cooking conditions. The speed of the rotor was 75 rpm. The peak viscosity (Vp), viscosity after heating for 30 min at 95 °C (Vr) and cold paste viscosity were recorded and the stability of the starch and set back were calculated and expressed in Bradender units B.U. This was carried out at the International Institute of Tropical Agriculture, Ibadan, (IITA).

Freeze-thaw stability was studied by subjecting 8% (W/V) starch paste to alternate freezing and thawing as described by Rege and Pai (1996) with slight modification. The effect of pH on solubility and swelling power of the starch samples were determined by following the procedure of Leach *et al.* (1959).

3. Results and Discussion

The starch yields by the isolation method described above were between 40 and 50% on the flour basis. The proximate composition of the starch samples is presented in Table 1. Yellow melon has the highest crude protein content while white melon has the highest carbohydrate content. The result indicates that white melon has the lowest moisture content, which indicates good storage potentials of its starch than others studied. Crude fibre varied between 0.12% and 0.41%. The values reported by Rege and Pai (1996) for crude protein (0.5%), moisture (10%), crude fibre (0.5%) for chickpea starch are highly comparable with this present result but the value presently reported for ash, is however lower than the chickpea starch (0.95%) reported by Rege and Pai (1996).

The results in Table 2 showed that the pasting (M_n-M_g) behaviour were gourd (11 min), white melon (16.9 min), yellow melon (14.0 min), benniseed (13.5 min) and bulma cotton seed (12.0 min) which indicate that white melon has the highest cooking time and paste faster than all the samples studied. The viscosities on cooling to 50°C (Ve) were gourd (170 B.U), white melon (100 B.U), yellow melon (70 B.U), benniseed (180 B.U) and bulma cotton seed (40 B.U) respectively. Benniseed has the highest viscosity (170 B.U) while bulma cotton seed has the lowest viscosity (40 B.U). This implies that on cooling benniseed is a good thickening agent especially in soup preparations (Tharanathan *et al.* 1990; Rege and Pai, 1996).

Temperature of initial pasting indicates the temperature at which swelling begins (Medcalf and Gilles, 1965). These data indicate that yellow melon begins to swell at higher temperature (80°C) than those of other samples studied. These values presently reported are higher than that reported for Durum wheat (53°C) by Medcalf and Gilles (1965).

Peak height shows the maximum viscosity obtained and when compared with the 30 min height gives an indication of the relative stability of the starch paste (Medcalf and Gilles 1965). This indicates that at 30 min height, benniseed (v_p-v_r) 35 B.U has relatively high stability compared to other samples under consideration.

The 50 °C height also indicates the relative setback or retrogradation of the cooked paste. Retrogradation affects the texture and acceptability of many starch-containing foods (Ward, 1994). The relative set back or retrogradation (50°C height) of the starch samples as depicted in Fig. 1 are gourd seed (195 B.U), white melon (120 B.U), yellow melon (198 B.U) and bulma cotton seed (48 B.U). The extent of retrogradation is high in benniseed, but bulma cotton seed has the lowest. The high extent of retrogradation recorded for benniseed may be of disadvantage in preservation and acceptability of its products. The low set-back value obtained for bulma cotton seed may enhance its keeping quality and acceptability. Extent of retrogradation and texture of the crystallites formed, may be affected by starch source (Oxford *et al.* 1987); concentration (Zeleznak and Hoseney 1986; Slade & Levine, 1987); storage temperature (Slade & Levine, 1987, Eliasson & Ljunger 1988), sugars (Maxwell & Zobel, 1978; Germani *et al.* 1983).

Figs 2 and 3 depicted the solubility and swelling power of the starch samples with respect to pH. When the solubility of these five starch samples are plotted against pH, the resulting curves (Fig 2 and 3) are similar to their swelling patterns. This observation was similar to that observed for four starch samples from tapioca, white milo (waxy), regular milo and potato reported by Leach *et al* (1959). The order of decrease in solubility as shown in Fig 3 is benniseed < bulma cotton seed < yellow melon < white melon< gourd seed, this indicates that gourd seed is soluble than all other samples studied and with minimum solubility at pH of 4.5. Benniseed starch is much less

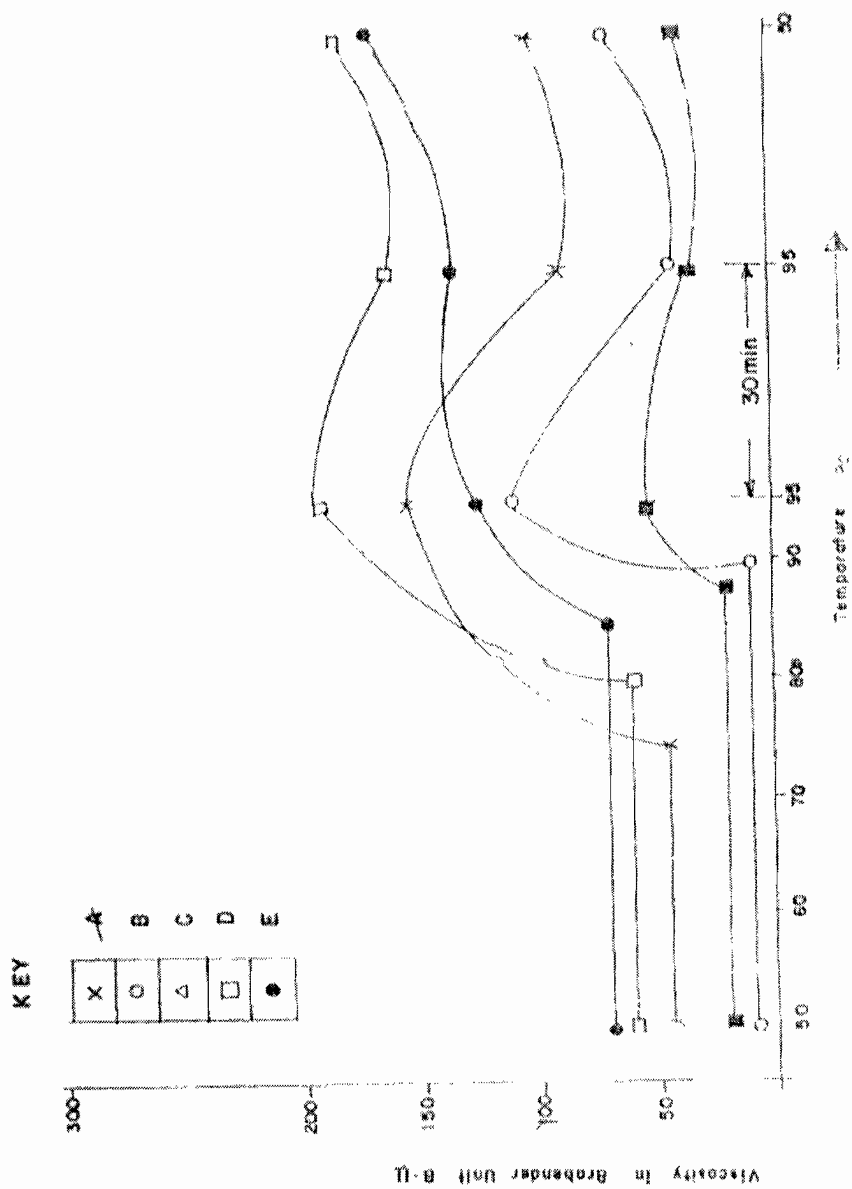

Fig 1 Brabender amylograph of the starches.

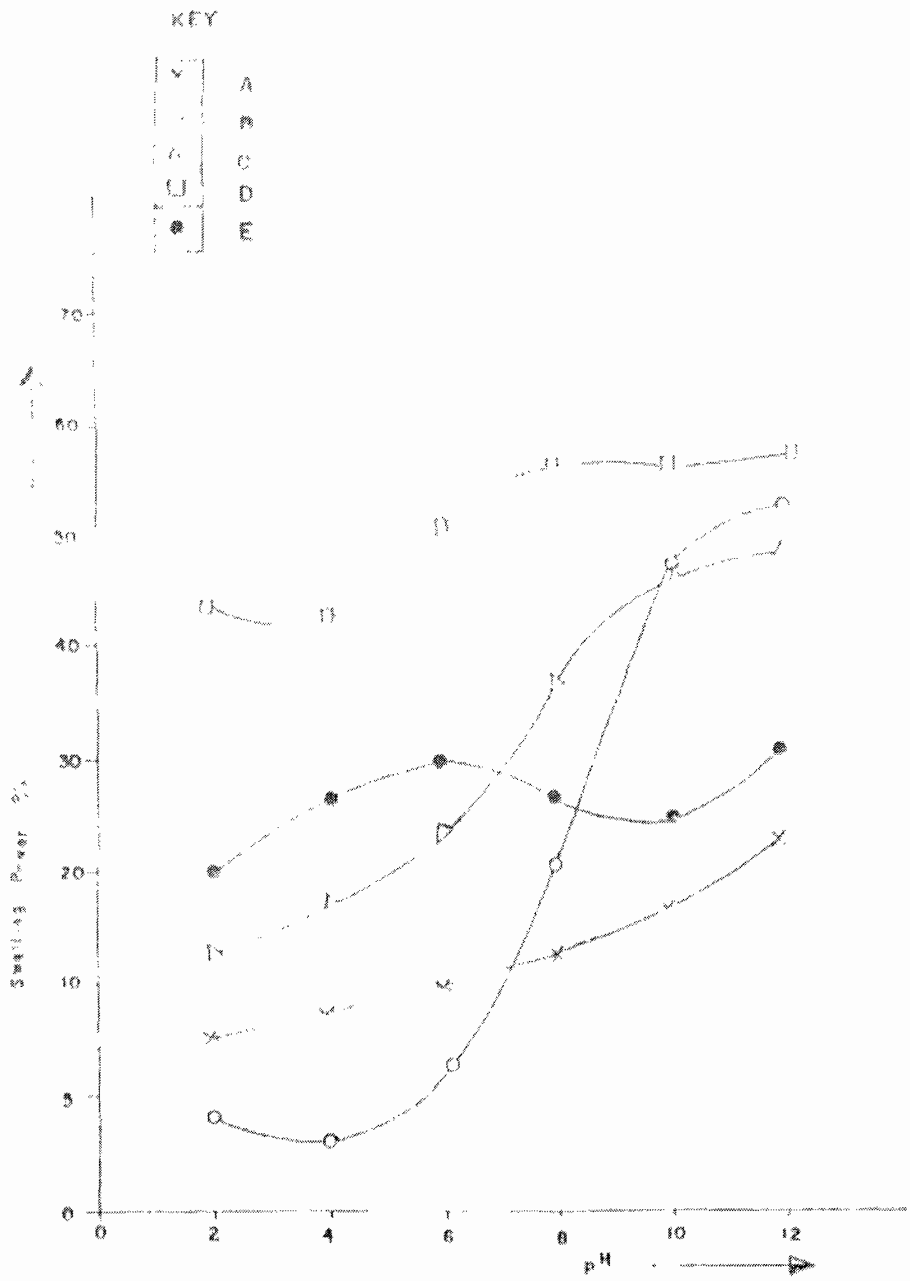

Fig 2 Variation of p^H with swelling power.

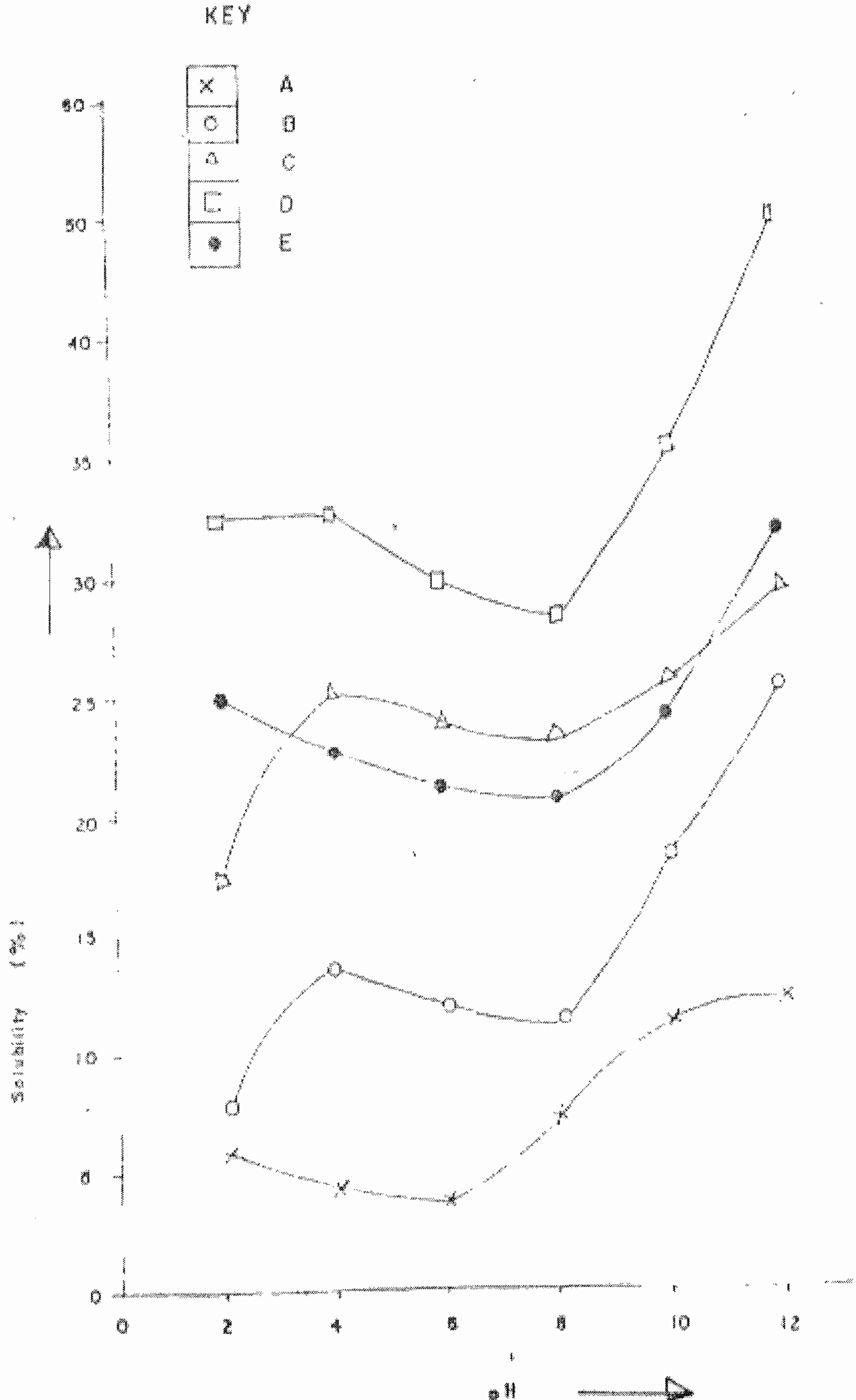

Fig. 3. Variation of pH with solubility.

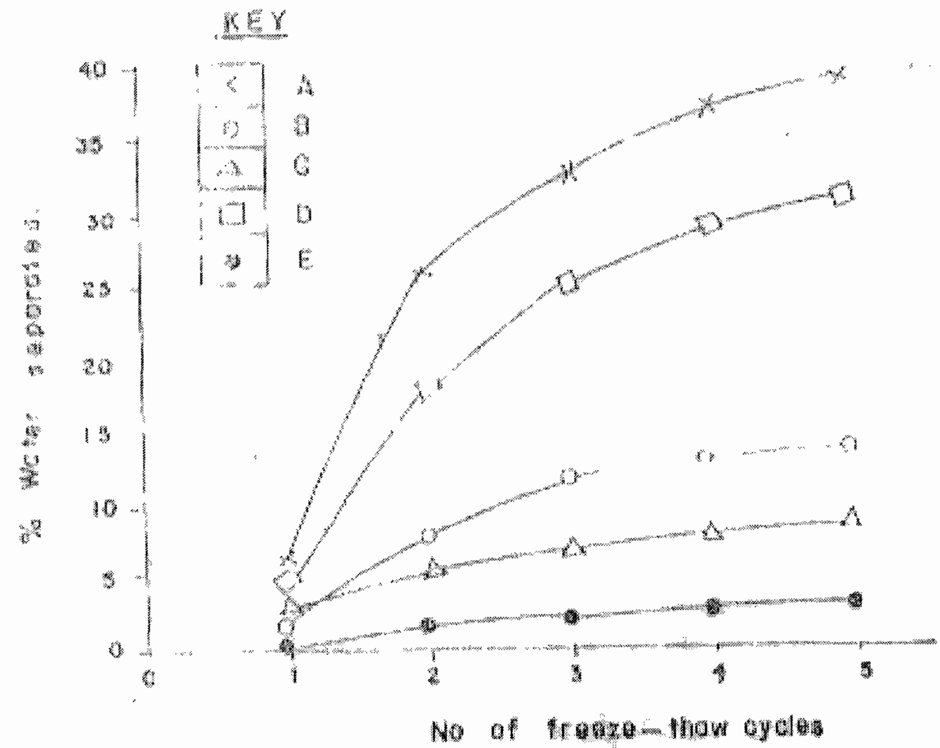

Fig. 4. Freeze – thow cycles.

A = Gourd seed
B = White melon
c = Yellow melon
d = Benniseed
E = Bulma cotton seed

Table 1: Proximate composition of the starch (%)

Starch sample	Moisture	Ash	Crude fibre	Crude protein	Carbohydrate
Gourd	7.50	0.10	0.16	0.75	91.49
White melon	7.00	0.05	0.12	0.08	92.75
Yellow melon	10.0	0.09	0.13	0.70	89.08
Benniseed	9.50	0.06	0.41	0.50	89.53
Bulma cotton seed	9.00	0.10	030	0.65	89.95

Table 2: Amylographic studies of the starch

	Tvp°C	Tp°C	Mg min	Mn min	Mn-Mg min	Vp B.U	Vr B.U	Ve B.U	50°C height	Vp-Vr B.U
Gourd	95	85	28	39	11	125	105	170	195	20
White melon	95	75	20.5	37.4	16.9	155	125	100	120	30
Yellow melon	95	90	21.0	35	14	100	75	70	150	25
Benniseed	95	80	25	38.5	13.5	195	160	180	198	35
ulma cotton seed	95	88	34	46	12	50	35	40	48	15

Tvp = Temp. at peak viscosity °C
Tp = pasting temp°C
Mg = time to reach peak viscosity
Mn – Mg = Pasting time
Vp = Peak height on heating B.U
Ve = Viscosity on cooling to 50°C B.U
Vr = Viscosity after 30 min holding at 95°C BU

soluble at any particular degree of swelling than the other starch samples if comparison of the solubilization of these starch samples at equal levels of swelling is done. Hence, the bonding forces in benniseed starch granule are very weak and tenuous, nevertheless they are comparatively extensive immobilizing the starch substance without granule even at very levels of swellings. There are also remarkable decreases and fair increases in freeze-thaw stabilities after five freeze-thaw cycles which indicate that gourd seed, white melon, yellow melon and benniseed did not tolerate five freeze – thaw cycles. These poor freeze-thaw stabilities make them unsuitable for use in custards and pie-filling which are frozen stored. But bulma cotton seed has fairly good-freeze-thaw stability (Fig. 4) and this compared favourably with the chickpea starch reported by Rege and Pai (1996).

The gelatinization temperature of the present flour starch 75 °C to 90 °C also were significantly higher than those of the starch pastes 70°C to 80°C reported for taro flour (Tharanathan *et al.* 1990) and Waxy White milo or regular milo(67.5°C-74°C) and Waxy maize corn (62 °C-72 °C) reported by Leach *et al.* (1959). The higher gelatinization temperatures obtained for the starches presently considered may indicate a higher degree of association in amorphous areas. The presence of linear molecules interconnecting the micelle does not ordinarily affect the gelatinization temperatures but does restrict subsequent swelling of the granules (Leach *et al.* 1959). This would explain the unlimited swelling of the starch of gourd seed, white melon, yellow melon, benniseed, and bulma cotton seed respectively.

In general, the breakdown of starch molecules became easier and as a result, the viscosity dropped during cooking, which is in agreement with observation for the chickpea starch properties (Rege and Pai 1996).

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