STUDIES ON INDIGENOUS STARCHES OF PAKISTAN

Part V.—Distribution of Amylose and Amylopectin Fractions in the Starches of Red-Skin and White-Skin Varieties of Potatoes

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The change in the size of the starch granules of white-skin and red-skin varieties of potatoes and the distribution of amylose and amylopectin in the structural units of their starches with respect to the growth of the above potatoes have been investigated. It has been observed that with the increase of the size of the potatoes from 1 to 2.5 cm. the average diameter of the starch granules in case of red-skin variety increased from 20.4 to 39.8 μ whereas in case of the white-skin variety this remains within a small range of 20.1 to 24.9 μ. Regarding the distribution of amylose fraction it was also observed that this decreased from 27.74 to 24.68 percent in case of red-skin variety but remains almost constant at the level of 24.32 percent in case of white-skin variety when both are studied with respect to the increase of the size of the potatoes.

Introduction

Extensive researches on starch from different varieties of potatoes have been carried out in various countries to judge their suitability for industrial use and for feeding purpose, *vis-a-vis* the distribution of amylose and amylopectin in their structural units which greatly influence their physical and chemical characteristics.[1–6]

In East Pakistan two varieties of potatoes are generally available—one, the red-skin round shaped variety locally called the 'Darjeeling' variety and the other, the white-skin oval or kidney shaped locally called the 'Nainital' variety. No information is yet available about the physical and chemical characteristics of their starches. Systematic investigations have, therefore, been undertaken in this line and the present communication reports the results of the distribution of amylose and amylopection in the starches of the above two varieties of potatoes. This report also submits data about the effect of growth of the potato on the above distribution of amylose and amylopectin and the ultimate size of the starch granules.

It is known that the amylose and the amylopectin contents of the starch of the plant product of similar botanical origin e.g. of maize[7] sometimes differ and this suggests that the fixed level of amylose is not necessarily a constant property of the starch for any given type of the botanical species. It is so expected that the present investigation may throw new light on the biosynthesis of amylose and amylopectin in the above starches as affected by the generic inheritance factors.

Experimental

White-skin and red-skin potatoes were collected after harvest from two different batches and these were then graded, as shown in Table 1, according to their sizes varying from 1 to 2.5 cm. The starch from each of these grades of both the varieties were then extracted according to the procedure reported in the previous communications from these laboratories.[8–9]

Table 1.—Showing the Grades of the Different Sizes of the Potatoes both White-skin and Red-skin Varieties.

Potato size diameter Red and White-skin)	Grade
From 1 cm. to 1.2 cm.	I
Above 1.2 cm. to 1.5 cm.	II
Above 1.5 cm. to 2 cm.	III
Above 2 cm. to 2.5 cm.	IV

Determination of Amylose Content.—The amylose content of each of the starch was then determined by measurement of Iodine affinity values according to the technique as described previously by Qudrat-i-Khuda, De and Yasin.[8] The method is based on the property of amylose fraction of starch to 'bind' iodine isopotentially with the increase of the E.M.F. in millivolt, which is lacking in amylopectin. A standard Calibration Curve (Fig. 1-A) was first assessed by measurement of the absorption of standard iodine containing 0.1 to 0.2 mg. iodine per c.c. and of the respective E.M.F. in millivolt against each titration value of the iodine. With 0.1 percent purified and neutralised starch solution containning 10 c.c. of

0.05 N-KI per 100 c.c.s olution, similar measurement of iodine absorption values, and the E.M.F. against these values were then made (Fig. 1-B). For each titration curve of Fig. 1-B the free iodine in solution was calculated from the corresponding E.M.F.values of the Reference Calibration Curve (Fig. 1-A) and the quantity of iodine 'bound by the respective starch under different millivolt ranges was then determined by deducting the free

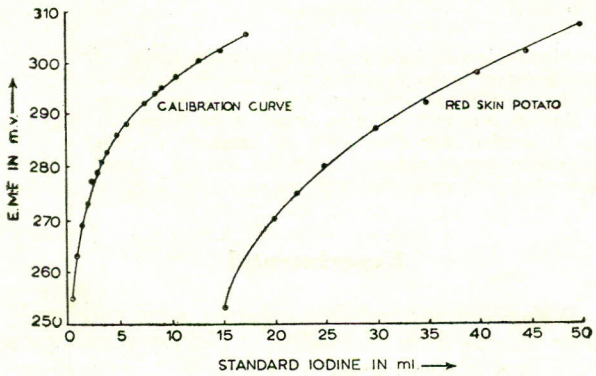

Fig. 1 (A). and Fig. 1 (B).

iodine from the total iodine of Fig. 1-B. The 'bound' iodine values were then plotted against the free iodine values and a curve as in Fig. 2 was obtained, which is characterised by rapid slope at the initial stage indicating the complex formation of amylose with iodine, followed by the

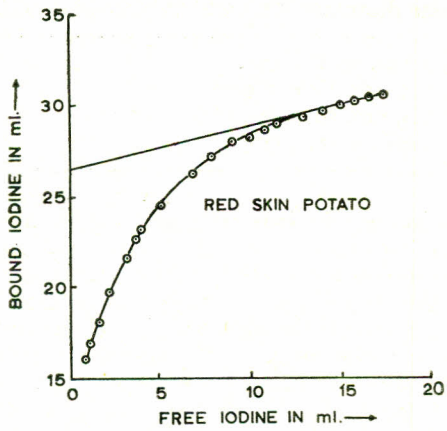

Fig. 2.

upper horizontal portion due to amylopectin fraction. Extrapolation of the horizontal portion to zero axis gave the value of the iodine bound to complete the complex formation with iodine. The quantity of iodine bound by 100 g. of starch was so determined and this was termed as the "Iodine Affinity" and from the values of iodine affinity the amylose content was determined on dry weight basis of the starch by taking into consideration the iodine affinity value of pure amylose as 19. The Fig. 1-B and Fig. 2 represent the curves for the starch of the Red-skin potato of Grade III. Similar curves for other starch were prepared and from the respective iodine affinity values their amylose contents were determined and these are shown in Table 2.

Table 2.—Showing the Amylose and Amylopectin Contents in the Starches of White-skin and Red-skin Potatoes of Different Size Grades

Red potato grade	Iodine affinity	Amylose p.c. on dry wt. basis (A)	Amylopectin p.c. on dry wt. basis (100—A)
I	5.69	29.96	70.04
II	5.41	28.84	71.16
III	5.28	27.74	72.26
IV	4.69	24.68	75.32
White potato grade I,II,III, IV	4.62	24.32	75.68

Photomicrographic Study of the Starch Granules.—The size of the starch granules were determined in microns by measuring the number of scale division in micrometer eyepiece covered by each grain and their photomicrographs were taken with same microscope using Leica camera with a film of 100 ASA. A large number of grains from different areas of the slides were thus measured and these were then grouped according to their sizes varying from 1 to 65μ. The percentage distribution of the starches in the different size groups are shown in Table 3 and the averages of their maximum and minimum sizes are presented in Table 4.

Results and Discussion

From the results presented in Table 2 it is noted that at all stages of growth of the white-skin variety potato the amylose content of their starch fractions almost remained constant at the level of 24.32 percent. But very characteristic results

TABLE 3.—SHOWING THE PERCENTAGE DISTRIBUTION OF STARCHES OF DIFFERENT SIZE OF RED-SKIN AND WHITE-SKIN POTATO ON VARIOUS RANGES VARYING FROM 1 to 65μ.

Size grade of the Photo	Nature of the Potato	Percentage distribution in diameters in μ ranging from						
		1—10	10.01—20	20.01—30	30.01—40	40.01—50	50.01—60	60.0—65
I	Red-skin	18.3	39.7	35.5	6.5	0	0	0
	White-skin	13.5	46.4	33.3	6.8	0	0	0
II	Red-skin	2.5	41.4	39.8	16.3	0	0	0
	White-skin	17.9	55.2	24.9	2.0	0	0	0
III	Red-skin	0	37.2	45.6	15.1	2.1	0	0
	White-skin	24.1	58.6	15.2	2.1	0	0	0
IV	Red-skin	0	35.9	14.4	17.8	10.7	17.7	3.5
	White-skin	27.7	44.7	12.8	8.5	6.3	0	0

TABLE 4.—AVERAGES OF THE MAXIMUM AND MINIMUM DIAMETERS OF THE STARCHES OF RED-SKIN AND WHITE SKIN POTATO OF VARIOUS SIZES.

(The figures indicate the diameter of the starches inμ)

Size	Red-skin Potato			White-skin Potato		
Grade of the potato	Average of maximum diameter	Average of minimum diameter	Average of maximum and minimum diameter	Average of maximum diameter	Average of minimum diameter	Average of maximum and minimum diameters
I	32.4	8.4	20.4	32.0	8.2	20.1
II	38.0	9.4	23.7	33.0	8.0	20.5
III	45.2	15.6	30.5	39.2	8.4	23.8
IV	61.4	18.2	39.8	41.2	8.6	24.9

are noted in case of red-skin variety where the starch fraction, on the contrary, shows diminished amylose content from 29.96 percent to 24.68 percent with increase of the growth of the potato. The work of Kerr and Trubbell [10] and also of other investigators as reviewed by Samec [11] have shown the amylose content of potato starch to the extent of 25.5 to 27 percent. de Willigen *et al.* [12] reported the amylose content of 15 varieties of potato in the range of 23 to 28 percent. Halsall *et al.* [7] in their investigation on the effect of growth on the amylose content of two varieties of potato namely Golden-Wonder and King Edward did not report any change of the amylose content, but careful scrutiny of their data shows decline of the amylose content of the Golden-Wonder variety from 19 to 16 percent with progress of growth.

Starch Granule Size with Respect to Potato Size.— The results as presented in Table 3 show that in Grade I size of both white and red varieties of potatoes, the percentage distribution of starch granules in different ranges of diameters from 1 to 40μ are almost the same. In both cases none of the starch granules were observed in the diameter ranges above 40μ. With the increase of the size of the potato, the distribution of starch of red skin variety potato in the diameter range of 1 to 10μ gradually diminished until it became nil in the sizes of Grade III and IV, whereas in case of white skin variety the above distribution gradually increased from 13.5 to 27.7 percent in the same diameter range with increase of the size of the potato.

It is further noted that the starch granules of red-skin variety of the sizes of grade III and IV showed their distribution in the higher diameter ranges from 50 to 65μ. But the starch granules of the white-skin variety of the similar size grades III and IV did not show any such distribution in the above high diameter ranges. These variable distributions of the above starches clearly indicate that the red-skin variety starch granules increase in diameter upto 65μ with the increase of the size of the potato, whereas the white variety starch does not show such wide increase. This is further explicited from the results of Table 4 in which the average sizes of the starch granules calculated by compilation of their maximum and minimum diameters under different size grades of potato showed an increase of the average size from 20.4 to 39.8 in case of red potato starch, but almost a constancy at the level of 20.1 to 24.9 in case of white potato starch with the increase of the size of the potato.

Photographs of Red-skin and White-skin Patato Starch

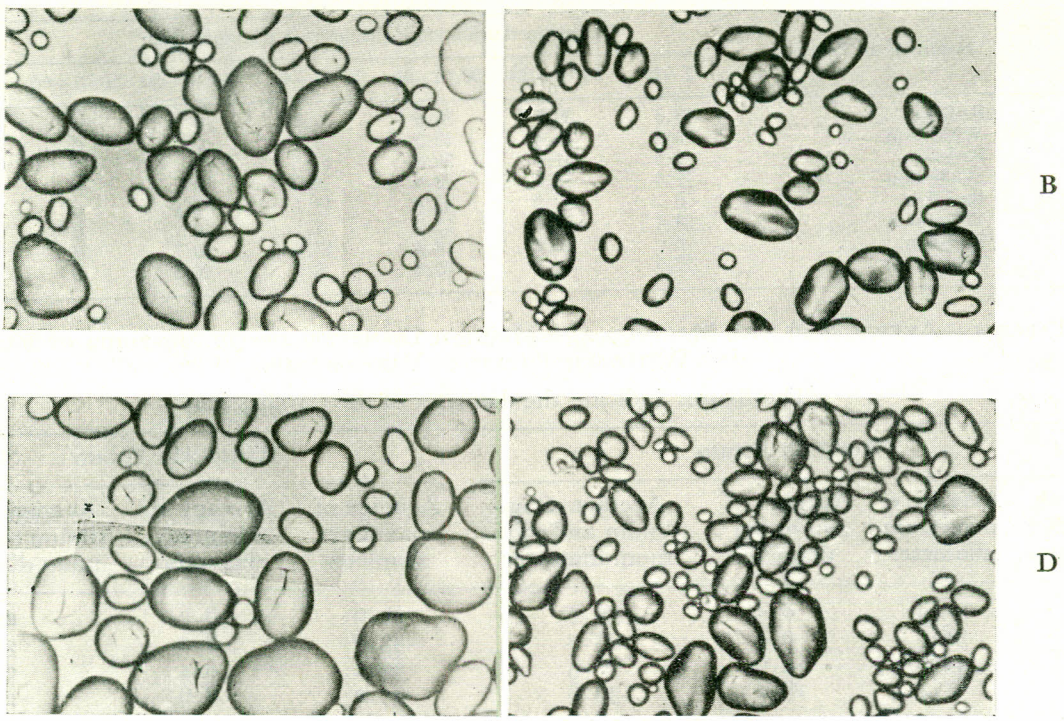

Fig. 3.—A, Starch of red-skin potato, Size grade II, Mag. 200 ×; B, Starch of white-skin patato, size grade II, Mag. 200×; C, Starch of Red-skin patato, Size grade IV, Mag. 200 ×; D, Starch of white-skin patato size grade IV, Mag. 200×.

This is clearly evident from the photomicrographic study of two specimen of starches of grade II and grade IV of the potatoes as represented by the plates in Fig. 3 It is noted from these plates that a large proportion of the starch granules in higher diameter ranges are distributed in case of Grade IV size as compared to those of the Grade II size of the red-skin variety whereas in case of white-skin variety only a few granules of high diameter ranges develop in the starch of the grade IV size of the potato.

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