

M. QUDRAT-I-KHUDA, B.D. MUKHERJEE, M. A. HOSSAIN AND N. A. KHAN

East Regional Laboratories, Pakistan Council of Scientific and Industrial Research, Dacca

(Received May 15, 1960)

The properties and other data of fourteen sources of starch have been described. The starch content and the particle size for each type of the isolated starch have been found to be quite satisfactory for commercial exploitation.

Introduction

Cereals being our staple food, starch for industrial uses, such as sizing materials, production of adhesives, syrups and glucose, must be obtained from other sources of less importance. Such sources have to be so chosen as to contain sufficient quantity of starch which would have properties necessary for commercial purposes. The decision needed numerous analytical experiments on different starchy products. Fourteen varieties such as (a) Mango seed (*Magnifera indica*); (b) Jack fruit seed (*Artocarpus integrus*); (c) Mukhi Kachu (*Colocasia antiquorum*); (d) Man Kachu (*Alcocalasia indica*); (e₁, e₂) Pani Kachu (*Aqua Casia indica*), Narkali Kachu (*Cococalasia indica*); (f) Ol Kachu (*Amorphophallus campanulata*); (g) Cassava (*Manihot utilissima*); (h) Shati (*Zedoary curcam*); (i) Bhet (*Nympheca stellata*); (j) Singhara (*Trapa bispinosa*); (k) Makhna (*Euryale ferox*); (l) Mete Alu (*Dioscorea bulbifera*); (m) Kaon rice (*Setaria italica*) satisfied our requirements, and their properties and other data are recorded in this paper. The starch contents and particle size for each type of isolated starch have been found to be quite favourable for commercial exploitation. As routine, the bye-product of starch was also obtained from (n) defatted ground-nut (*Arachis hypogea*) meal for analysis.

Experimental

Different varieties of the same sample were collected from the local markets. Their ash, protein, fat, fibre, starch and reducing sugar contents were determined by the methods of A.O.A.C.¹ Analysis of sodium and potassium was made gravimetrically,² that of calcium, volumetrically,³ and those of phosphorus and iron, colorimetrically.⁴

Pure starch was isolated from the materials by the following method. The substance was first washed with water to remove the adhering dirt and then rasped mechanically to a pulp, whereby the cells were broken and starch grains exposed. The mass was thoroughly washed with water and

then subjected to sieving through the fine brass-wire sieves which retained the coarser particles of cellulose but allowed the smaller starch granules to pass through. The milky, aqueous suspension, containing practically all the starch and some cellulose, was allowed to stand; the starch settled at the bottom, and the lighter particles of cellulose, etc. were scraped off from the top. The mass was again treated with fresh water and allowed to settle. The supernatant liquid was then decanted off. The starch was centrifuged to remove water and finally dried under vacuum without any heating, and subjected to photomicrographic studies, standardized through several trials with known starch samples from potato, rice and wheat. During the microscopic examination the dimensions of starch particles were also determined.

From Table 1, it is clear that all these food materials except ground-nut are good sources of starch; because their starch content varies from 50 to 91% on dry weight basis. Their ash, protein, fat and fibre content ranges from 0.51 to 5.8%, 2.85 to 12.49%, 0.36 to 2.35% and 1.51 to 12.11%, respectively. These ranges compare favourably with those standard sources like potatoe, rice and wheat. Sodium of all these materials is negligible; and their potassium content is also low, i.e. it varies from 0.0 to 2.9%. They also contain considerable amount of calcium and phosphorus, though their iron content is low.

Table 2 represents some characteristic features of the starch samples and their sources.

The photomicrographic features noted below do suggest grain-sizes, quite suitable for various commercial exploitations.

Photomicrographic features are shown in Figs. 1(a-n).

Generally mango-seed starch (a) is found as a mixture of irregularly oval and round granules. The oval or egg-shaped are usually larger and measure 28 micron; and the smaller are round and measure about 8 micron, the shape of tapering rods. The hilum is distinct and concentric.

Granules of jack-fruit seed starch (b) vary from 18 to 5.5 micron, some are round, some are angular and polyhedral. Hilum is distinct and rings are not visible. Their maximum dimension is 18.7 micron and minimum is 5.5 micron. The granules of Mukhi Kachu starch (c) are very small in size and their range is from 5.5 to 1.4 micron.

They are more angular than rice starch particles. The majority of the particles are polyhedral. Their central hilum is well-developed, fissure is star-shaped and rings are not visible.

The granules of Man Kachu (d) starch have a great resemblance with those of Mukhi Kachu

TABLE 1.—COMPOSITION ANALYSIS OF THE STARCHY PRODUCTS.^a

Local Name	Water ^b g.	Ash. g.	Protein g.	Fat g.	Fibre g.	Reduc- ing sugar g.	Starch g.	Minerals				
								Na ₂ O g.	K ₂ O g.	P g.	Fe g.	Ca g.
Mango seed	10.12	2.91	4.11	8.10	3.22	2.11	70.10	1.21	0.92	0.173	0.005	0.048
Jack fruit seed	62.42	4.13	12.41	1.26	3.12	2.25	75.61	Trace	2.05	0.181	0.016	0.082
Mukhi Kachu	71.24	3.31	8.75	0.36	11.01	1.51	70.23	„	2.12	0.333	0.023	0.106
Man Kachu	83.12	5.80	10.7	2.35	9.50	1.60	68.51	„	2.90	0.138	0.009	0.310
Pani Kachu	84.4	2.38	5.42	0.56	12.11	15.62	50.12	„	1.03	0.125	0.007	0.251
Narkali Kachu	91.12	4.72	6.11	0.61	10.52	22.22	47.70	„	2.40	0.285	0.009	0.259
Ol Kachu ..	71.24	3.31	8.75	0.36	11.01	1.51	70.23	„	1.68	0.153	0.007	0.095
Cassava ..	—	2.63	2.85	0.75	2.81	1.12	91.30	„	1.28	0.212	0.005	0.116
Shati ..	9.83	1.62	1.21	0.52	1.80	1.51	83.24	nil	nil	0.833	0.014	0.077
Bhet ..	80.17	0.72	10.8	1.88	9.25	2.17	71.14	Trace	nil	0.133	0.002	0.047
Singara ..	76.12	3.63	8.62	0.72	4.51	1.61	82.10	„	1.58	0.444	0.412	0.211
Makhna ..	—	0.51	12.49	0.55	1.51	0.91	89.68	„	0.11	0.006	0.003	0.059
Mete Alu ..	81.19	3.69	10.25	1.28	7.05	2.51	71.21	„	2.01	0.210	0.004	0.214
Kaon rice	10.10	1.61	10.51	1.15	1.95	1.21	75.10	„	0.25	0.040	0.021	0.109
Ground-nut (cake)	12.8	5.2	40.6	7.5	9.6	—	15.0	„	Trace	—	—	—

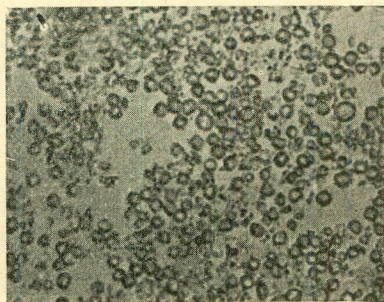
a. Calculated on the basis of dry weight. b. Calculated on the basis of fresh weight.

TABLE 2.—SOME CHARACTERISTIC FEATURES OF STARCH SAMPLES AND THEIR SOURCES.

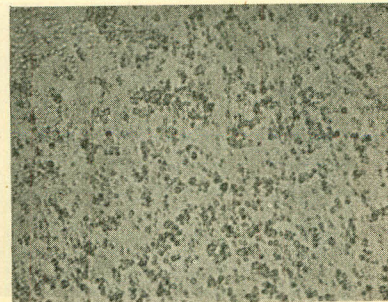
Name of starch source	Feature	No. of sample analysed	Average wt. for each g.	Kernel %	Coat %	Dimension of the starch particles			
						Maximum size Micron	% of total number	Minimum size Micron	% of total number
Mango seed ..	Seed	7	22.5	72.2	27.8	28.1	75	8.3	25
Jack seed ..	Seed	8	7.1	97.5	2.5	24.4	50	7.0	50
Ol Kachu ..	Corn	5	2500	91.9	8.1	18.7	60	5.5	40
Mukhi Kachu ..	Corn	6	15.02	97.1	2.9	5.5	50	1.4	50
Man Kachu ..	Rhizome (root stock)	7	9500	85.2	14.8	4.6	50	1.3	50
Pani Kachu ..	„	7	6512	86.2	13.8	—	—	—	50
Narkali Kachu ..	„	7	6500	86.2	13.8	—	—	—	50
Mete Alu ..	Bulbil	5	950	92.1	7.9	58.2	20	12.5	80
Bhet ..	Seed	8	48.5	60.5	39.5	7.5	50	2.2	50
Singara ..	Fruit	7	10.5	81.9	18.1	39.0	70	15.1	30
Shati ..	Rhizome	8	12.2	97.1	2.9	62.9	25	22.3	75
Cassava ..	Root	8	512.6	94.1	5.9	18.7	50	22.3	50
Kaon rice ..	Seed	7	—	98.1	1.9	17.2	20	6.5	80
Makhna ..	Seed	8	120.1	80.0	20.0	3	50	1	50
Ground-nut ..	Nut	8	7.2	85.1	14.9	13	40	4.4	60



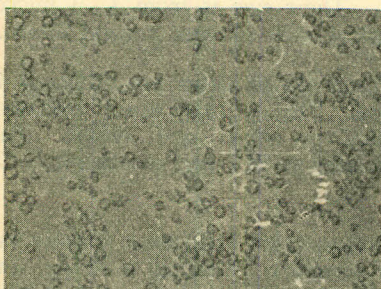
(a) Mango seed



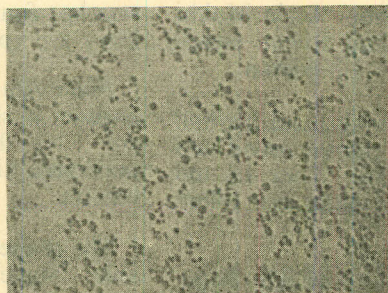
(b) Jack fruit seed



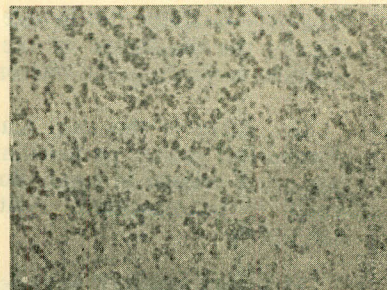
(c) Mukhi Kachu



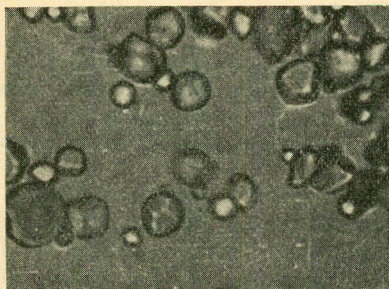
(d) Man Kachu



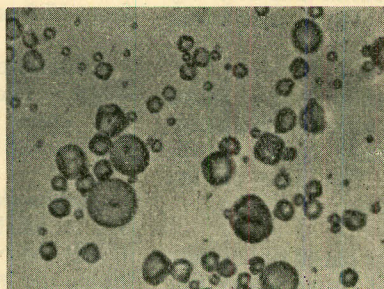
(e₁) Pani Kachu



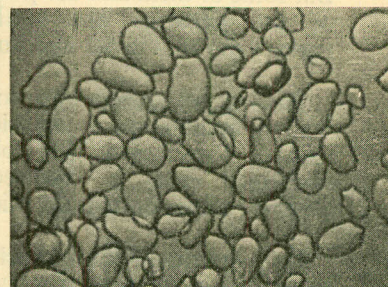
(e₂) Narkali Kachu



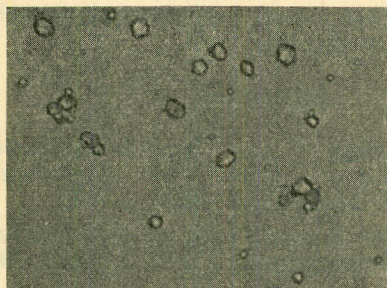
(f) Ol Kachu



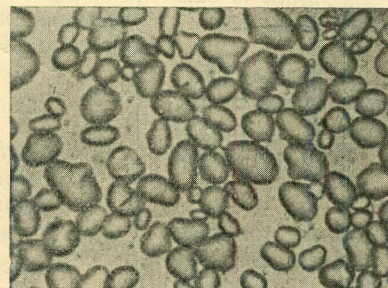
(g) Cassava



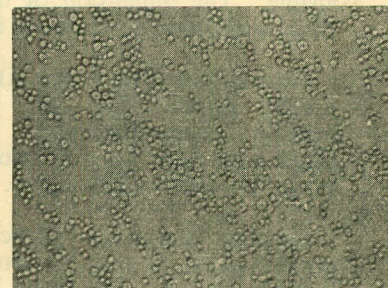
(h) Shati



(i) Bhet

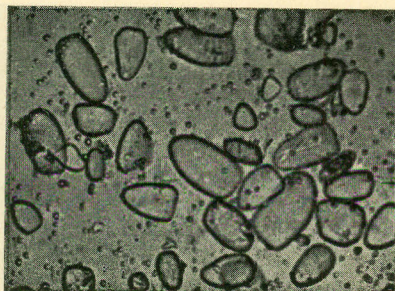


(j) Singhara

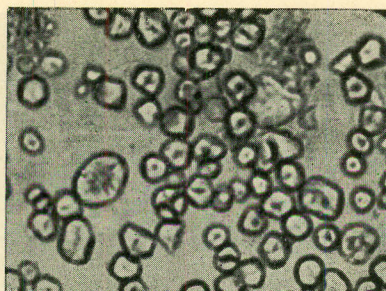


(k) Makhna

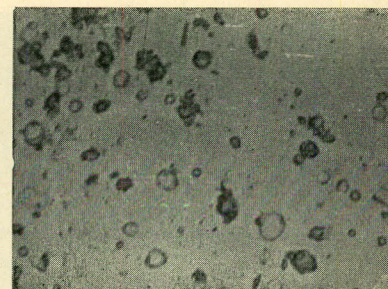
Fig. 1.—Photomicrographs of starch granules of different varieties (continued on next page).



(l) Mete Alu



(m) Kaon rice



(n) Ground-nut

not only in shape but in size also. As in Mukhi Kachu the dimension of the Man Kachu starch particle varies from 4.6 micron to 1.3 micron.

The shape of the Pani Kachu (e_1) and Narkali Kachu (e_2) starch particles are almost round and are often massed in small clustres. They are too small to be measured. Neither rings nor hilum are visible.

O1 Kachu starch (f) granules are varied in shape. Some of them are quite round, some have one end cut-off, leaving a concave or flat surface. But some of them also are polyhedral. The majority of the particles are small. Their dimension varies from 18.7 to 5.5 micron.

Cassava (g) granules are round or oval in shape with an indentation on one side which is characteristic of this starch. In polarized light a well-developed cross is observed. The size of the granules varies from 18-22 micron.

The majority of Shati starch (h) particles are pear or conical in shape with a few of round shape. But almost all of them have angular cones on both sides. The rings are concentric and hilum is not visible. The dimension of the maximum is 62.9 micron and that of minimum size is 22.3 micron.

Granules of Bhet starch (i) are similar to Mukhi Kachu starch. They are quite angular, the majority being polyhedral. There is a central hilum and rings are not visible. Their dimension varies from 7.5 to 2.2 micron.

Singhara starch (j) particles closely resemble potato starch in shape. Most of them are oval having one or two nodule on both sides. Some of them are almost spherical also. No hilum is apparent, rings are not visible. Dimension varies from 39.0 to 15.1 micron.

Makhna starch (k) granules are smallest of the

starches found. Their size is from 1 - 3 micron. They are spherical with distinct central hilum.

Mete Alu starch (l) particles are regularly triangular in shape. The majority are of maximum size. No hilum or rings are visible. Their maximum dimension is 58.2 and minimum is 12.5 micron.

The shape of Kaon rice (m) starch is quite variable. Some of them are spherical in shape, some are angular and polyhedral. Their central hilum is distinct, fissure is star-shaped and rings are not visible. The dimension of the particles varies from 17.2 to 6.5 micron.

Ground-nut (n) starch granules are spherical in shape. Their hilum and rings are not visible. The upper limits of size are usually 13 to 10 micron and lower limits are about 4.4 - 5 micron.

Acknowledgement—The technical assistance of Mr. A. M. M. Ahad for mineral analysis and that of Mr. M.N. Haque and Mr. M. Rahman for taking the photomicrographs of the starch granules is acknowledged. Thanks are also due to Dr. M.M. Qurashi and Mr. A.K.M. Ahsanullah for help in the initial preliminary work at the beginning of 1958 season on photomicrography of certain starch granules.

References

1. *Official Methods of Analysis of the Association of Official and Agricultural Chemists*. Seventh Ed. (1950), p. 342.
2. C.S. Piper, *Soil and Plant Analysis*. (Interscience Publishers, Inc., N.Y., 1950), p. 290.
3. Ref. 1, p. 290.
4. P.B. Hawk, B.L. Oser, W.H. Sumerson, *Practical Physiological Chemistry* (The Blakiston Company, Toronto, 1947), 12th Ed., pp. 579 and 600.