On Amylose Content of Cultivated Rice Collected in Tanzania, 1988

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Introduction

During the period from June 30 to August 10 in 1988, the writers took a trip to Tanzania for collecting the wild and cultivated rices under the project, "Studies on the Distribution and Ecotypic Differentiation of Wild and Cultivated Rice Species in Africa", supported by a Grant from the Ministry of Education, Science and Culture of the Japanese Government.

Amylose content of endosperm starches in rice greatly influences the eating and the cooking qualities of boiled rice. On the amylose content of cultivated rice in Tanzania, there have been quite few reports. In present trip, various types of cultivated rice, distributed and under cultivation, were collected in Tanzania.

In the present report, only the amylose content of brown rice of the cultivated rice collected in Tanzania were described. Based on the analyses of the data obtained in the further physicochemical characteristics, varietal variations are going to be informed in the following papers.

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Materials and Methods

One hundred and twenty nine strains of 106 seed samples including 127 strains of *O. sativa* cultivars and two strains of *O. glaberrima* were used for colorimetric analysis of amylose content in endosperm starches. The amylose content of endosperm starches of brown rice grain was determined on single grain base, using the colorimetric method with SIMAZU UV 2000 Spectrophotometer. A brown rice of each sample was soaked in 2 ml 1N KOH solution for about 24 hours at room temperature, then added 4 ml 1N CH_2COOH and filled up to 10 ml with distilled water. After homogenization, 0.5 ml of each sample added with 5 ml H_2O and 100μl iodine solution (0.2 % I_2 · 2 % KI) was used for colorimetric analysis of amylose content.

Results and Discussion

Geographical distribution and habitats of the seed samples used in this experiment were briefly illustrated in Fig. 1, in which the trip route and collection site are given, too.

Amylose contents of 129 strains of 106 seed samples collected in Tanzania were listed in Table 1. A wide variation was found in amylose content among them. The amylose contents of endosperm starches in brown rice of *O. sativa* cultivars ranged from 28.1 % to 7.2 %. The highest amylose contents were obtained in strain Nos.109 and 132. The lowest was obtained in No.173. Average value was found to be 21.2 %.

The amylose contents in endosperm starches of two satains of *O. glaberrima* were found to be 25.0 % in No.206-1 and 25.3 % in No.206-2, respectively. The average value was observed to be 25.2 %.

Frequency-distribution of amylose content in endosperm starches of cultivated rice of *O. sativa* collected in Tanzania was shown in Fig. 2. Based on the amylose content, brown rices collected in Tanzania were classified according to the respective amount of amylose as very low (below 12 % amylose), low (12 % to 18 % amylose), intermediate (18 % to 24 % amylose) and high (above 24 %) types, respectively. Forty four strains, about one third of seed samples collected in Tanzania, were observed to be of high amylose type. Forty strains were found to be of intermediate amylose type. Thirty six strains were found to be of low amylose type. Only 7 strains were found to be of very low amylose type.

Geographical differences in amylose content of endosperm starches of cultivated rice in Tanzania were shown in Fig. 3A to Fig. 3E. In Southwestern Area (strain Nos.101 to 126), *i.e.*, Ifakara, Mbeya, Ivuna, Kyela, Mbalari, Iringa districts, the amylose contents of endosperm starches in brown rice ranged from 28.1 % to 10.9 %, with a mean of 19.9 %. The highest amylose content was observed in No.109. The lowest was found in No. 112. Frequencies of strains belonging to very low, low, intermediate and high amylose types were 1, 8, 11 and 6, respectively (Fig. 3A).

In Central and Western Areas (strain Nos.127 to 145), *i.e.*, Dodoma, Singida, Nzega and Ujiji districts, the amylose contents of endosperm starches of brown rice ranged from 28.1 % to 9.8 %, with a mean of 20.9 %. The highest amylose content was observed in No. 132. The lowest was observed in No. 127. The frequency of strain belonging to each type of amylose content was observed to be 1 in 'very low', 5 in

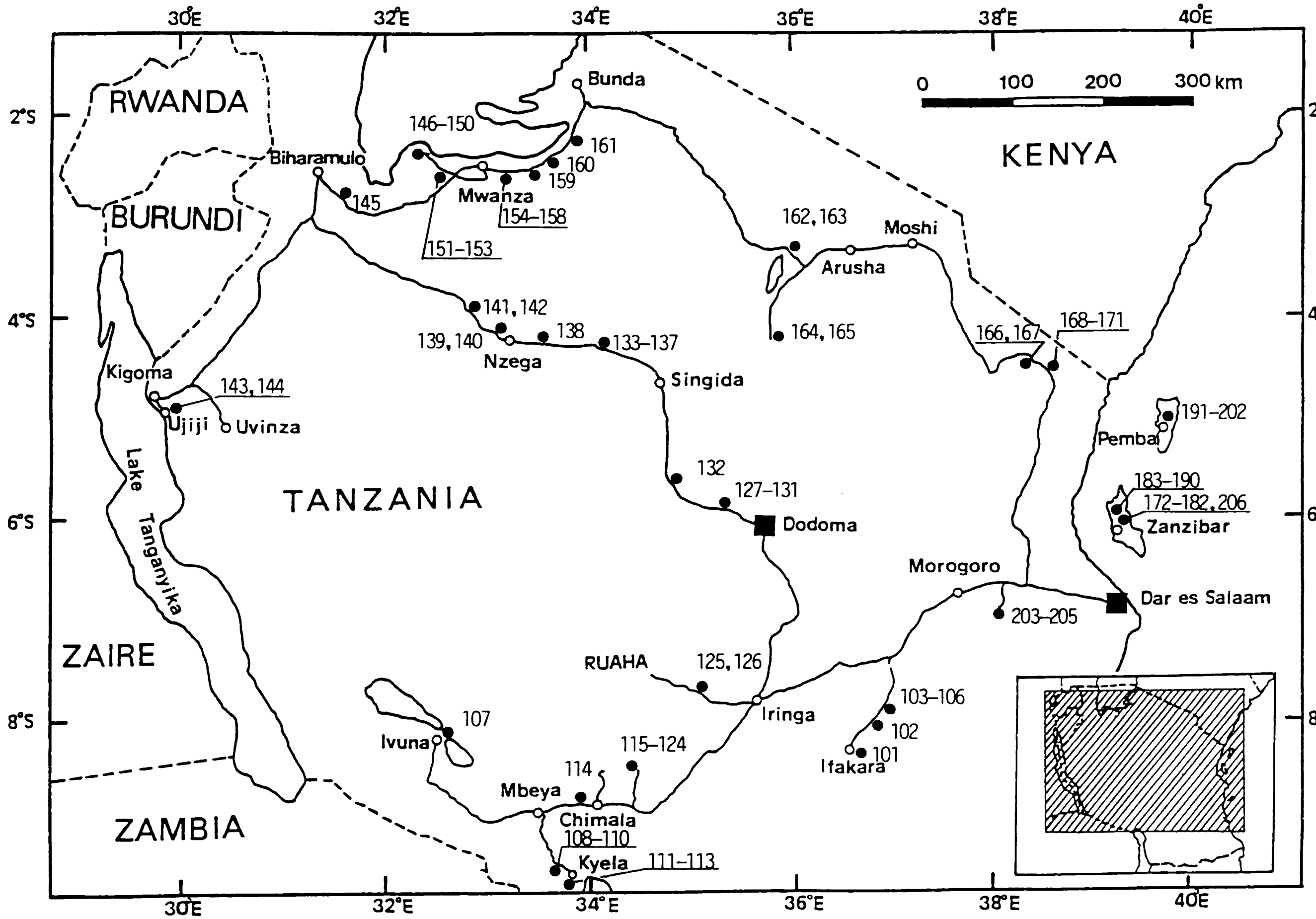

Fig. 1. Map showing several localities where the cultivated rices were collected in Tanzania. Solid line; routes of observations, filled circles; collection areas, open circles; main towns. Code-numbers used in the figure arc corresponding to the strain number used in the table.

Table 1. Amylose content of brown rice collected in Tanzania in 1988

Strain No.	Local name	Blue value* (A600)	λ max (nm)	Amylose content(%)
101	Inda Rangi	0.227	562.6	15.9
102	Limoto	0.226	562.4	15.8
103	India	0.228	562.6	15.9
104	Kisaki	0.372	586.2	27.1
105	Arusha	0.328	576.2	22.4
106	Afaa	0.208	558.2	13.9
107	Kilombero	0.243	568.2	18.6
108	Mwangle	0.318	581.0	24.7
109	Mwasungo	0.367	588.2	28.1
110	Kilombero	0.233	571.6	20.2
111	Supa	0.253	567.2	18.1
112	Kilombero	0.185	552.0	10.9
113	Supa Mwasungo	0.239	562.8	16.0
114	Kilombero	0.259	570.4	19.6
115	Kibibi	0.257	570.2	19.5
116	Kilombero	0.197	565.8	17.5
117	Taiwan	0.359	579.0	23.7
118	Kihogo	0.241	569.0	19.0
119	Afaa Mwanza	0.364	584.4	26.3
120	Selemwa	0.305	580.6	24.5
121	Shindano	0.363	583.8	26.0
122	India	0.242	564.6	16.9
123	Kula Na Bwana	0.341	572.4	20.6
124	Cola (?) (Unknown)	0.195	558.8	14.1
125	Supa	0.223	568.2	18.6
126	Ngohi	0.342	578.6	23.5
127	Supa-1	0.161	549.6	9.8
128	Supa-2	0.353	575.2	21.9
129	Supa-3	0.327	580.6	24.5
130	Kihogo-1	0.355	587.2	27.6
131	Kihogo-2	0.302	576.6	22.6
132	-Unknown (Supa?)-	0.385	588.2	28.1
133	-Unknown-	0.378	576.6	22.6
134	-Unknown-	0.358	581.6	25.0
135	-Unknown-	0.198	554.2	12.0
136	-Unknown-	0.382	582.0	25.1
137	-Unknown-	0.369	578.0	23.2
138	Supa	0.214	560.8	15.1
139	Supa	0.332	578.2	23.3
140	Kihogo	0.226	558.8	14.1
141	Supa	0.351	582.0	25.1
142	Kihogo	0.374	579.2	23.8
143	Supa	0.352	580.6	24.5
144	Supa	0.208	560.6	15.0

145	Horonadi	0.216	558.2	13.9
146-1	-Unknown (Supa?)-	0.337	577.4	23.0
146-2	-Unknown (Supa?)-	0.223	562.2	15.8
147	Moshi	0.371	581.8	25.0
148-1	Supa	0.217	562.4	15.8
148-2	Supa	0.358	579.4	23.9
149	Faya	0.217	557.6	13.6
150	Kihogo	0.362	579.8	24.1
151	Supa	0.226	565.6	17.4
152	Kihogo	0.180	560.2	14.8
153	Shindano	0.322	581.4	24.9
154	Supa	0.235	569.4	19.2
155	-Unknown (Mixture)-	0.200	556.2	12.9
156	Senga Senga	0.365	586.0	27.0
157	Moshi	0.271	570.4	19.6
158	-Unknown-	0.246	567.4	18.2
159	Lukata Kihogo	0.155	550.0	10.0
160	-Unknown-	0.358	578.0	23.2
161	-Mixture-	0.225	560.0	14.7
162	Supa	0.301	574.8	21.7
163	Moshi (Sigara)	0.353	582.4	25.3
164	Moshi (Sigara)	0.254	560.0	14.7
165	Supa	0.186	559.0	14.2
166	Supa	0.416	582.4	25.3
167	-Mixture	0.353	583.0	25.6
168-1	Semanini	0.356	581.6	25.0
168-2	Semanini	0.375	584.0	26.1
169	Kihogo	0.223	561.6	15.5
170	Supa	0.231	565.4	17.3
171	Wahi Wahi	0.356	580.6	24.5
172	-Unknown-	0.355	581.8	25.0
173	Pinlot-330	0.284	544.2	7.2
174	Colombia-5179	0.353	585.2	26.7
175-1	Supa	0.316	578.6	23.5
175-2	〃	0.217	569.8	19.4
176	-Unknown-	0.368	584.4	26.3
177	〃	0.204	554.2	12.0
178	Kijicho	0.227	565.2	17.2
179-1	Moshi	0.236	567.8	18.4
179-2	〃	0.412	584.8	26.5
180-1	Wamba	0.216	562.4	15.8
180-2	〃	0.343	579.4	23.9
181	-Unknown-	0.348	582.2	25.2
182	〃	0.307	578.8	23.6
183-1	-Mixture-	0.358	580.4	24.4
183-2	〃	0.370	583.6	25.9
183-3	〃	0.181	554.6	12.1
184	Supa	0.178	563.6	16.4
185-1	Gamti	0.279	582.8	25.5
185-2	〃	0.232	581.2	24.8
186	Mkia Wa Ngawa	0.329	577.0	22.8

187	Singapuri	0.410	584.6	26.4
188	Ringa	0.403	581.4	24.9
189-1	Tarabizuma	0.228	565.0	17.1
189-2	〃	0.208	562.4	15.8
190-1	Ringa	0.364	580.4	24.4
190-2	〃	0.372	580.8	24.6
191-1	〃	0.317	574.6	21.6
191-2	〃	0.303	569.2	19.1
191-3	〃	0.347	577.4	23.0
192	Afaa	0.220	564.6	16.9
193-1	Kivuli	0.314	574.8	21.7
193-2	〃	0.228	564.6	16.9
194	Riziki	0.331	577.0	22.8
195	Kibawa	0.224	562.8	16.0
196	Ausbin	0.380	582.8	25.5
197-1	Afaa	0.342	580.8	24.6
197-2	〃	0.384	582.0	25.1
198	Tiwani	0.379	577.4	23.0
199-1	Zira	0.256	558.2	13.8
199-2	〃	0.336	574.8	21.7
200-1	Malbora	0.435	578.0	23.2
200-2	〃	0.435	575.6	22.1
201	Kivuli	0.333	553.4	11.6
202	Supa	0.283	579.8	24.1
203-1	Mukia Wa Nyumba	0.272	564.8	17.0
203-2	〃	0.346	581.8	25.0
203-3	〃	0.318	582.0	25.1
203-4	〃	0.343	582.4	25.3
203-5	〃	0.276	574.0	21.3
204-1	Supa	0.208	559.6	14.5
204-2	〃	0.328	580.2	24.3
205	Kula Na Bwana	0.218	566.4	17.7
206-1	*O. glaberrima*	0.313	581.6	25.0
206-2	〃	0.348	582.4	25.3

* Absorbency at 600 nm when 20 mg of rice powder was stained by $I_2 \cdot KI$ solution.

'low', 1 in 'intermediate' and 12 in 'high' (Fig. 3B), respectively.

In Northern Area (strain Nos.146 to 161), *i.e.*, Biharamuro, Mwanza and Bunda districts, the amylose contents of endosperm starches of brown rice ranged from 27.0 % to 10.0 %, with a mean of 19.1 %. The highest amylose content was observed in No.156. The lowest was found in No.159. The frequency of strains belonging to the respective amylose type was found to be 1 in 'very low', 7 in 'low', 6 in 'intermediate' and 4 in 'high' (Fig. 3C), respectively.

In the Eastern Area (strain Nos.162 to 171 and 203-1 to 205), *i.e.*, Arusha, Moshi, Same and Ruvu districts, the amylose contents of endosperm starches of brown rice

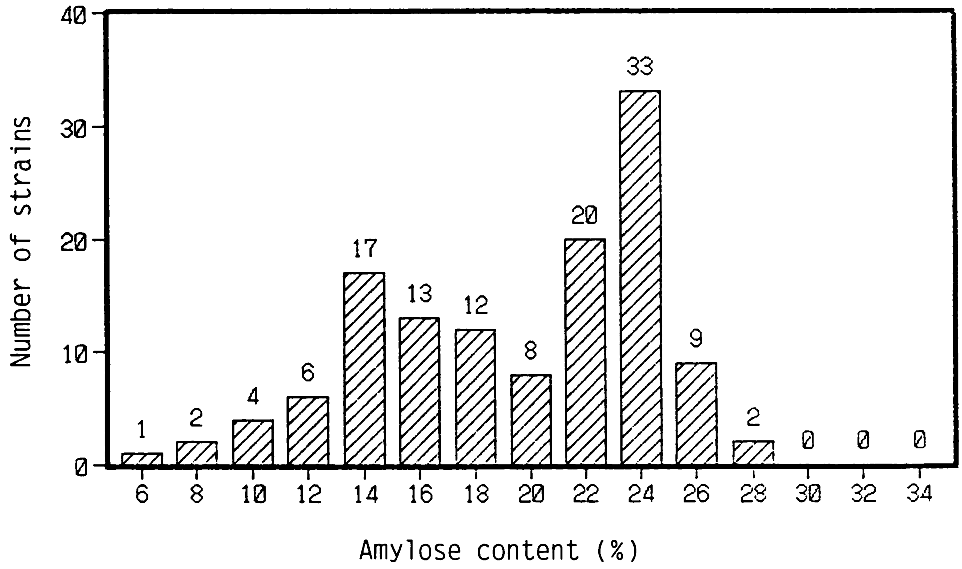

Fig. 2. Distribution of amylose content of brown rice in cultivated rice collected in Tanzania in 1988.

ranged from 26.1 % to 14.2 %, with a mean of 21.7 %. The highest amylose content was observed in No.168-2. The lowest was found in No.165. The frequency of strains belonging to the each type of amylose content was found to be 7 in the low amylose type, 2 in the intermediate amylose type and 10 in the high amylose type (Fig. 3D). No very low amylose type was found in the cultivated rices collected in these districts.

In Zanzibar and Pemba Islands (strain Nos.172 to 202), the amylose contents of endosperm starches of brown rice ranged from 26.7 % to 7.2 %, with a mean of 21.1 %. The highest amylose content was observed in No.174. The lowest was found in No. 173. Of 45 strains examined, 3 strains belonged to very low amylose type, 10 strains to low amylose type, 15 strains to intermediate amylose type and 17 strains to high amylose type (Fig. 3E), respectively.

Based on amylose content, JULIANO [1] classified the milled rice as waxy (1-2 % amylose), or nonwaxy (>2 % amylose); very low (2-9 % amylose); low amylose (9-20 % amylose); intermediate (20-25 % amylose) and high (25-33 % amylose) types. In this experiment, the amylose content was assumed to be under-estimated. This low amylose value might be caused by the analysis of brown rice. The amylose content of the milled rice was higher than that of brown rice when it was calculated on the basis of grain-weight.

In this analysis of amylose content, cultivated rices collected in Tanzania were classified into four groups, based on the amylose content. There was a little differences in the pattern of geographical distributions of rice with varying contents of amylose among localities in Tanzania. No waxy rice was found.

NAKAGAHRA *et al.* [2] reported that a wide variation in amylose content was found in rice cultivars in Asia, but the pattern of geographical distribution of rice cultivars with

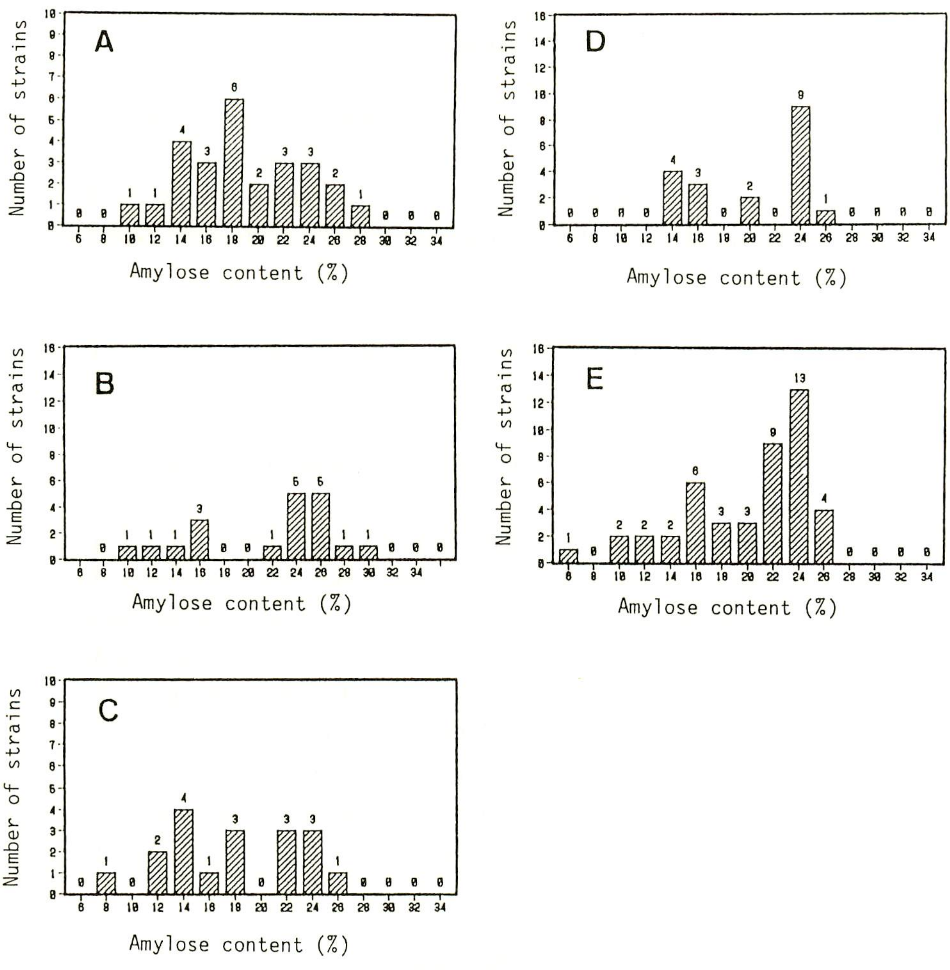

Fig. 3. Geographical distribution of cultivated rice for the amylose content of brown rice in Tanzania. A: Southwestern Area, B: Central and Western Areas, C: Northern Area, D: Eastern Area, E: Zanzibar and Pemba Islands

varying contents of amylose was different among localities. Either in China or in Burma, a wide variation was also found in amylose content for the endosperm starches of rice collected in Tanzania (Table 2 and Fig. 2). Amylose content greatly influences the cooking and the eating qualities of boiled rice. These seed samples are expected to become the useful breeding materials for the improvement of the eating and the cooking qualities of rice.

Summary

During the trip from June 30 to August 10 in 1988, 105 seed samples of cultivated rice, *Oryza sativa* L., and a seed sample of *O. glaberrima* STEUD. were collected. Those were classified into 127 strains in *O. sativa* and 2 strains in *O. glaberrima*, according to the morphological observations. Their amylose contents were reported (Table 1).

Amylose contents of endosperm starches of brown rice of *O. sativa* cultivars collected in Tanzania ranged from 28.1 % to 7.2 %, with a mean of 21.2 %. The highest amylose content was found in varieties collected in Central and Southwestern areas. The lowest was found in the variety collected in Zanzibar Island.

Amylose content of endosperm starches of *O. glaberrima* varied from 25.3 % to 25.0 %, with a mean of 25.2 %.

Based on the amylose contents of endosperm starches, cultivated rices of *O. sativa* collected in Tanzania were classified into 'very low' (below 12 % amylose), 'low' (12 % to 18 % amylose), 'intermediate' (18 % to 24 % amylose) and 'high' (above 24 % amylose) types. Of 127 strains of cultivated rice of *O. sativa*, 44 strains belonged to the high amylose type, 40 strains to the intermediate amylose type, 36 strains belonged to the low amylose type and only 7 strains belonged to the very low amylose type. No waxy rice was found in the cultivated rices collected in Tanzania.

The pattern of geographical distribution of rice with varying contents of amylose was noted to be slightly different among localities.

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