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On Amylose Content of Cultivated Rice Collected in Madagascar, 1988

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Introduction

During the period from June 1 to June 28 in 1988, the writers took a trip to Madagascar 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 Madagascar, there have been quite few reports. In this trip, various types of cultivated rice, distributed and under cultivation, were collected in Madagascar.

In the present report, only the amylose content of brown rice of the cultivated rice collected in Madagascar was 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 thirty strains of 99 seed samples 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 100 μl iodine solution (0.2% I_2·2 % KI) was used for colorimetric analysis of the amylose content of endosperm starches of brown rice.

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 were given, too.

Amylose contents of 130 strains of 99 seed samples collected in Madagascar were listed in Table 1. A wide variation was found in amylose contents among them. The amylose contents of endosperm starches in brown rice ranged from 29.1 % to 12.4 %. The highest amylose content was obtained in No.3-2. The lowest was obtained in No.79. Average value was found to be 24.1 %.

Frequency-distribution of amylose content in endosperm starches of cultivated rice collected in Madagascar was shown in Fig. 2. Based on the amylose content, brown rices collected in Madagascar were classified according to the respective amount of amylose as low (12 % to 18 % amylose), intermediate (18 % to 24 % amylose) and high (above 24 % amylose) types, respectively. Seventy five strains, about two thirds of seed samples collected in Madagascar, were observed to be of high amylose type. Fifty one strains were found to be of intermediate amylose type. Only 4 strains were found to be of low amylose type.

Geographical differences in amylose content of endosperm starches of cultivated rice in Madagascar were shown in Fig. 3A to Fig. 3D.

In the Northern Area (strain Nos.1 to 32), *i.e.*, Mahajanga, Marovoay, Maevatanana, Mampikony, Antsohihy and Bealanana districts, the amylose content of endosperm starches in brown rice ranged from 29.1 % to 20.7 %, with a mean of 24.9 %. The highest amylose content was observed in No.3-2. The lowest was found in No.7. Frequencies of strains belonging to low, intermediate and high amylose types were 0, 10 and 22, respectively (Fig. 3A). About two thirds of seed samples collected in this area belonged to the high amylose type and remains belonged to the intermediate type. No low amylose type was found in the collected samples (Fig. 3A).

In the Central Area (strain Nos.33 to 53), *i.e.*, Moramanga and Lac Alaotra districts, the amylose contents of endosperm starches of brown rice ranged from 28.3 % to 19.5 %, with a mean of 24.7 %. The highest amylose content was observed in No.37. The lowest was observed in No.48. The frequency of strain belonging to each type of amylose content was observed to be 8 in 'intermediate' and 20 in 'high' (Fig. 3B).

In the Eastern Area (strain Nos.54 to 80), *i.e.*, Brickaville, Anosibe and Fenerive

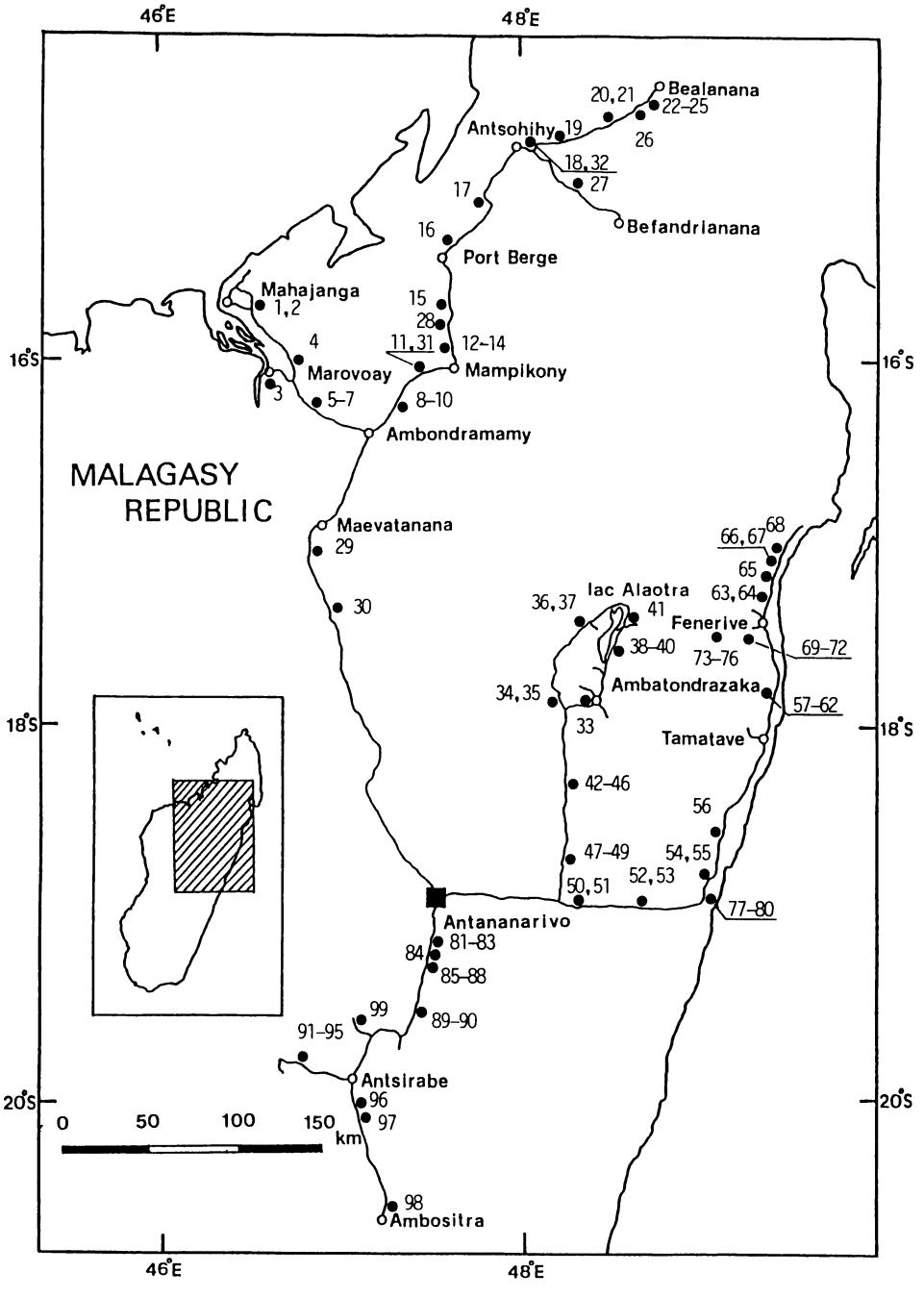

Fig. 1. Map showing several localities where the cultivated rices were collected in Madagascar. Solid line; routes of observations, filled circles; collection areas, open circles; main towns. Code-numbers used in the figure are corresponding to the strain number used in the table.

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

Strain No.	Local name	Blue value* (A600)	λ max (nm)	Amylose content(%)
1	Avia Mizaha	0.481	581.6	25.0
2	Sanabody	0.388	581.4	24.9
3-1	Andramonta	0.429	584.0	26.1
3-2	〃	0.418	590.8	29.1
3-3	〃	0.405	584.6	26.4
4-1	Tsipala	0.429	584.0	26.1
4-2	〃	0.394	583.8	26.0
5	Tsipala	0.408	586.4	27.2
6	Andramonta	0.405	586.2	27.1
7	-Unknown-	0.371	572.6	20.7
8	-Unknown-	0.364	582.8	25.5
9	Tsipala	0.375	583.6	25.9
10	Masokibobo	0.424	584.8	26.5
11	Vary Vatosoa	0.401	578.2	23.3
12	Vary Vato	0.410	583.0	25.6
13	Tsipala	0.403	576.6	22.6
14-1	Naoromidina	0.395	584.4	26.3
14-2	〃	0.373	580.2	24.3
15	Tsipala	0.380	587.8	27.9
16	Makalioka	0.381	578.0	23.2
17	Bemarijy & Andramonta	0.367	581.6	25.0
18	Mamoriake	0.363	575.6	22.1
19-1	Tsitaitra	0.390	576.2	22.4
19-2	〃	0.406	581.8	25.0
20	Tsivimbina	0.334	575.2	21.9
21	Tahosy	0.405	584.8	26.5
22-1	Makalioka	0.355	581.8	25.0
22-2	〃	0.230	578.4	23.4
23	Rakaraka	0.328	581.4	24.9
24-1	Komojy	0.350	578.6	23.5
24-2	〃	0.322	580.6	24.5
25	Rojo	0.308	577.0	22.8
26**	Tsara Voa Banga	0.353	580.6	24.5
27	Makalioka	0.355	584.2	26.2
28-1	Vary Patsa	0.389	583.8	26.0
28-2	〃	0.320	576.2	22.4
28-3	〃	0.396	580.0	24.2
28-4	〃	0.367	578.6	23.5
29	Bekimondro	0.398	582.0	25.1
30-1	-Unknown-	0.372	586.6	27.3
30-2	〃	0.355	583.0	25.6
31	-Unknown-	0.422	582.2	25.2
32	-Unknown-	0.342	575.6	22.1
33	Makalioka	0.398	585.2	26.7
34-1	Makalioka	0.393	580.2	24.3
34-2	〃	0.388	588.0	28.0
35	-Unknown-	0.405	580.6	24.5

36-1	Makalioka	0.362	578.0	23.2
36-2	〃	0.294	581.8	25.0
37	Vary Malady	0.519	588.6	28.3
38	〃	0.386	581.2	24.8
39	-Unknown-	0.362	579.6	24.0
40	Rojomena Rojofotsy	0.388	580.8	24.6
41-1	Makalioka	0.370	579.2	23.8
41-2	〃	0.362	580.6	24.5
42	Vonjy	0.292	583.2	25.7
43	Bestileo	0.322	580.6	24.5
44-1	Makalioka	0.385	585.2	26.7
44-2	〃	0.353	582.8	25.5
45	Rojhofosty	0.381	579.2	23.8
46	Vary Be	0.356	576.8	22.7
47	Makalioka	0.380	582.2	25.2
48	Telovolana	0.260	570.0	19.5
49	Rojofotsy	0.381	578.4	23.4
50-1**	Langakafotsy	0.322	581.0	24.7
50-2**	〃	0.312	580.6	24.5
50-3**	〃	0.305	584.6	26.4
51**	Somotra	0.311	583.6	25.9
52**	〃	0.303	578.0	23.3
53-1	Vanjakohnandiana	0.320	579.0	23.7
53-2	〃	0.301	581.2	24.8
54**	Mena Vazana	0.306	580.4	24.4
55**	〃	0.326	583.2	25.7
56	Ramaditra	0.387	584.4	26.3
57**	Vimboahangy	0.290	575.6	22.1
58**	Mintimalady	0.311	573.2	21.0
59**	Telovorana	0.285	578.4	23.4
60	Diara	0.311	575.8	22.2
61	Makalioka	0.351	583.2	25.7
62-1**	Vary Be	0.288	575.8	22.2
62-2**	〃	0.273	571.4	20.1
63-1	Vary Gonibe	0.328	579.4	23.9
63-2	〃	0.311	573.4	21.1
64**	Vary Be Malady	0.300	577.8	23.2
65-1	Marotia	0.315	577.4	23.0
65-2	〃	0.320	578.8	23.6
66	Kirimy	0.388	581.8	25.0
67	Lohambitro	0.288	574.0	21.3
68-1	Lohambitro (Menamongo)	0.273	575.6	22.1
68-2	〃	0.285	572.0	20.4
69**	Bemahasoa	0.300	578.0	23.2
70**	Lohambirtobe	0.261	575.6	22.1
71**	Rambompiso	0.292	576.2	22.4
72-1	Tsipala	0.324	582.4	25.3
72-2	〃	0.328	582.8	25.5
73-1	Vary Gony	0.312	579.0	23.7
73-2	〃	0.331	583.6	25.9
74**	Telovorana	0.258	576.6	22.6
75	Vary Botrika	0.239	580.2	24.3

76	Vary Kitrana	0.343	582.8	25.5
77	〃	0.359	580.4	24.4
78**	Vary Somotra	0.331	577.8	23.2
79	Kirotsaka	0.216	555.2	12.4
80	Ramilona	0.387	584.2	26.2
81	Rojomena	0.357	581.2	24.8
82-1	Botry-Tsindrilahy	0.347	578.4	23.4
82-2	〃	0.342	580.8	24.6
83-1	Botry	0.388	584.4	26.3
83-2	〃	0.343	581.4	24.9
84	Ambolavava	0.356	584.8	26.5
85	Botry	0.332	577.6	23.1
86-1	Rojo	0.374	581.4	24.9
86-2	〃	0.367	576.8	22.7
87	Japone (Unknown)	0.315	558.8	14.1
88	Botry	0.227	560.2	14.8
89	Telorirana	0.358	587.2	27.6
90-1	Rojomena	0.383	577.6	23.1
90-2	〃	0.339	581.2	24.8
91	Rijakely	0.268	566.6	17.8
92	〃	0.378	578.8	23.6
93	Mangakely	0.357	575.8	22.2
94	Tsipala	0.373	585.0	26.6
95-1	Mavokely	0.361	582.6	25.4
95-2	〃	0.343	578.8	23.6
96-1	Manfe	0.352	576.4	22.5
96-2	〃	0.336	578.4	23.4
97-1	Mangatovo	0.371	582.2	25.2
97-2	〃	0.362	581.4	24.9
98	Kalafohindrazaha	0.400	580.0	24.2
99	Latsika	0.294	577.6	23.1

* Absorbency at 600 nm when 20 mg of rice powder are stained by I_2·KI solution.
** Upland rice.

districts, the amylose contents of endosperm starches of brown rice ranged from 26.3 % to 12.4 %, with a mean of 23.1 %. The highest amylose content was observed in No. 56. The lowest was found in No.79. The frequency of strains belonging to the respective amylose type was found to be 1 in 'low', 20 in 'intermediate' and 12 in 'high' (Fig. 3C), respectively.

In the South Mountain Area (strain Nos.81 to 99), *i.e.*, Antsirabe and Ambositra districts, the amylose contents of endosperm starches of brown rices ranged from 27.6 % to 14.1 %, with a mean of 23.4 %. The highest amylose content was observed in No. 89. The lowest was found in No.87. The frequency of strains belonging to the each type of amylose content was found to be 3 in the low amylose type, 10 in the intermediate amylose type and 13 in the high amylose type (Fig. 3D).

Nineteen upland-rice strains were also collected in Madagascar. The amylose con-

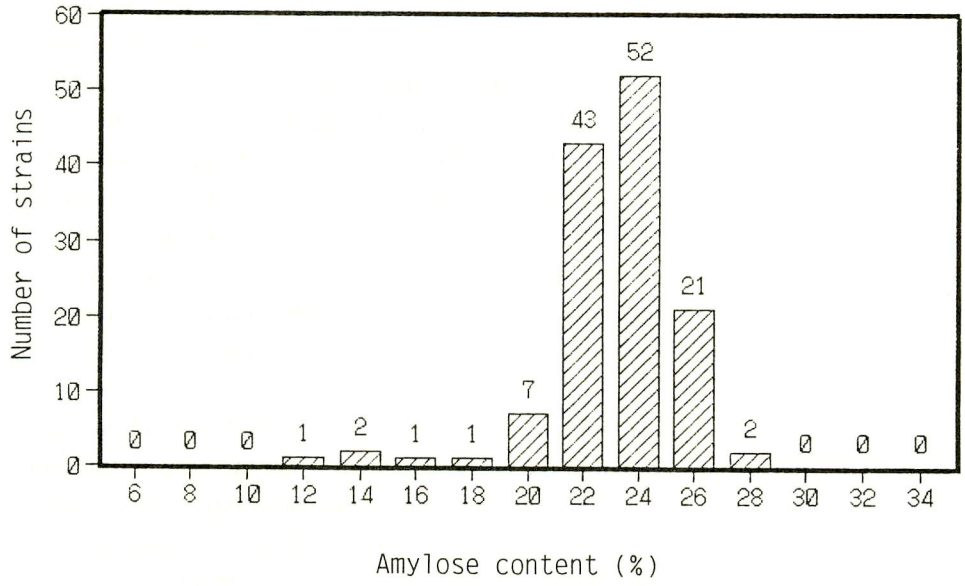

Fig. 2. Distribution of amylose content of brown rice in cultivated rice collected in Madagascar in 1988.

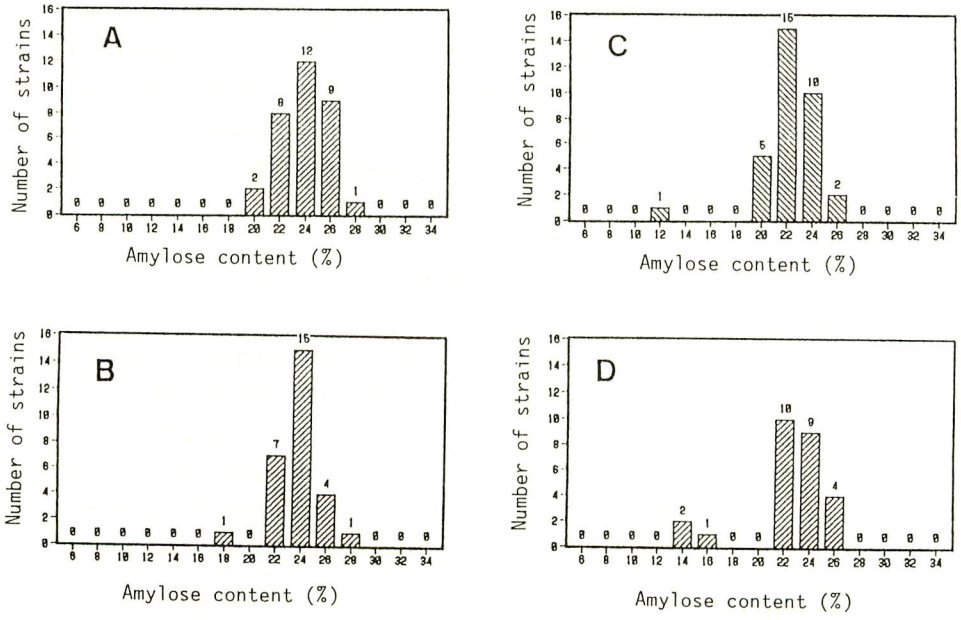

Fig. 3. Geographical distribution of cultivated rice for the amylose content of brown rice in Madagascar.
A: Northern Area, B: Central Area, C: Eastern Area, D: South Mountain Area

tents of endosperm starches of them ranged from 26.4 % to 20.1 %, with a mean of 23.6 %. The highest amylose content was found in No.50-3. The lowest was found in No.62-2. The frequency of strains belonging to the each type of amylose content was found to be 12 in the intermediate amylose type and 7 in the high amylose type.

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). 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 is calculated on the basis of grain weight.

In this analysis of amylose content, cultivated rices collected in Madagascar were classified into three groups, based on the amylose content. On the basis of this criteria, high or intermediate amylose type is dominant and low amylose type is less frequent in Madagascar. No waxy rice was found in the seed samples collected in Madagascar.

There were some differences in the pattern of geographical distribution of rice with varying contents of amylose among localities in Madagascar.

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 varying contents of amylose was different among localities. A wide variation was found in amylose contents for the endosperm starches of rice collected in Madagascar (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 1 to June 28 in 1988, 99 seed samples of cultivatred rice, *Oryza sativa* L., were collected. Those were classified into 130 according to the morphological observations. Their amylose contents were reported (Table 1).

Amylose contents of endosperm starches of brown rice collected in Madagascar ranged from 29.1 % to 12.4 %, with a mean of 24.1 %. The highest amylose content was found in a variety collected in the Northern Area. The lowest was found in a variety collected in the South Mountain Area.

Based on the amylose content of endosperm starches, cultivated rices collected in Madagascar were classified into 'low' (12 % to 18 % amylose), 'intermediate' (18% to 24% amylose) and 'high' (above 24% amylose) types. Of 130 strains of cultivated rice, 75 strains belonged to the high amylose type, 51 strains to the intermediate amylose type and only 4 strains to the low amylose type. No waxy rice was found in the cultivated rices collected in Madagascar.

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

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