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収穫年度別標準米（滋賀産日本晴：1997～2004年）に及ぼすかおり米の添加効果

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Effect of the Addition of Aromatic Rice to Shiga-grown Nihonbare Rice (1997 – 2004) Harvested in Different Years

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Abstract

The odor of old rice which has a great influence on rice quality, however, both odor and flavor can be improved by blending old rice with aromatic rice. The authors examined the improvement of rice that can be achived by blending aromatic Sawakaori rice (harvested in the Kochi Prefecture in 2003), which contains much acetyl pyrroline, a main component of aromatic rice, with the Nihonbare rice (harvested in Shiga Prefecture in 1997 to 2004). Sawakaori rice contains high levels of acetyl pyrroline, a main component of the odor of aromatic rice. The blending contained 5 to 50 % of Sawakaori rice by weight. Baseds with stable improvements in both taste and odor were identified based on sensory evaluations of the cooked rice by panelists. It became clear that blends containing older samples of Nihonbare rice (in particular, those harvested in 1999 and 2001) had the same taste and aroma qualities as new rice if they contained 10 to 30 % Sawakaori rice.

Keyword : Aromatic rice, Acetyl pyrroline, Blending, Sawakaori rice, Nihonbare rice

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1. INTRODUCTION

The use of new information about rice by producers has greatly influenced its taste [1] and consumers are now able to choose freely between several types of rice. However, the deterioration in the quality of any rice depends on its storage conditions (temperature, environmental humidity, gaseous conditions), its form during storage (paddy, brown rice, milled rice, rice flour), and its packaging (punched bag, plastic bag, laminated film). Therefore, the deterioration in quality is not only dependent on the length of the storage period [2-4]. The components of the odor generated during the cooking of new and old rices consist mostly of 5 to 15 carbon alcohols, aldehyde and organic acids [5-11]. The blending of rice prior to its distribution and consumption can play an essential role in the stability of a rice blends taste [12], and blending can provide consumers with an affordable yet good-tasting rice. At the same time, the proper labelinf of all milled rice is required by law [13]. The authors examined the improvement in the taste of cooked rice, and the suppression of the old rice odor (attributable to an aldehyde) that could be achieved by blending the Nihonbare rice harvested between 1997 and 2004 with Sawakaori rice, which was harvested in 2003 and contains high levels of acetyl pyrroline, a main component of new and aromatic rice. The Nihonbare rice and Sawakaori rice samples were obtained from pearl rice plants in the Shiga and Kochi Prefectures, respectively.

2. EXPERIMENTS

2.1. Experimental Materials

Nihonbare rice samples harvested in Shiga prefecture in 1997 to 2004 were obtained from Shiga pearl rice plant. Sawakaori rice sample harvested in Kochi prefecture in 2003 were obtained from Kochi pearl rice plant.

2.2. Preparation Methods of Samples

200 g each of brown rice samples of Nihonbare rice harvested in Shiga prefecture (in 1997 to 2004) and Sawakaori rice harvested in Kochi prefecture (in 2003) were milled by using a test rice milling machine (Satake, MC-250) at five milling yield settings (100-90 %, 90-80 %, 80-70 %, 70-60 %, 60-50 %). 1g each of blended rice samples were ground by using a grinder (Kett, TQ-100) and then sealed in vial containers having a septum.

2.3. Analysis of Aromatic Components (GC and GC-MS Analysis)

Carbonyl compound and acetyl pyrroline contained in the blended rice described in the item 2-2 were confirmed by heating it in an aluminum temperature-controlled oven (Iwaki, MG-2000) at 100 °C for 10 min, having fibers absorb headspace gas by the SPME (Solid Phase Micro Extraction) method for 15 min and then conducting GC analysis (Shimazu, QP-2010, column: DB-WAX, 60 m x 0.25 mm, 35 °C (4 min hold) - 220 °C (4 °C / min), injection: 260 °C, detector: 220 °C) and GC-MS analysis (Shimazu, QP-5000, column: DB-WAX, 60 m x 0.25 mm, 35 °C (4 min hold) - 200 °C (4 °C / min), injection: 260 °C, detector: 220 °C).

2.4. Sensory Evaluations

In order to assess the quality of the blended rice, sensory were undertaken by 5 panelists using the index shown in Table 3. This index was created by reference to the standards of the Japan Grain Inspection Association.

3. RESULTS AND DISCUSSION

The purpose of blending rice of different varieties and origins is to produce a milled rice of stable taste that will meet consumers' quality and price demands throughout the year (14). To this end, the authors compared and blended the Nihonbare rice from the Shiga prefecture with the aromatic rice Sawakaori from the Kochi prefecture.

Table 1 Percentage of Carbonyl Compound at Different Milling Yields.

Rice Variety	Harvest Year	Milling Yield (%) 100－90	90－80	80－70	70－60	60－50
Sawakaori	2003	25.19	21.76	22.02	25.21	26.34
Nihonbare	1997	22.48	29.93	31.64	30.57	27.05
"	1999	24.78	28.76	34.14	29.04	28.72
"	2001	25.44	32.77	29.69	28.03	19.72
"	2003	19.24	20.53	28.19	25.93	17.14
"	2004	23.03	16.22	17.07	16.97	14.02

Firstly, no significant differences were observed in the contents of carbonyl compounds among the old rice samples obtained using different milling yield settings (100-90 % to 60-50 %), as shown in Table 1. The content of carbonyl compounds, which are components of the odor of old rice, was higher in older Nihonbare rice samples at the milling yields of 90-60 %, compared with regularly milled rice (100-90 %). This was due to increases in the percentage of 1-hexanol in these samples.

Table 2 Percentage of Acetyl Pyrroline at Different Milling Yields.

Rice Variety	Harvest Year	Milling Yield (%) 100－90	90－80	80－70	70－60	60－50
Sawakaori	2003	1.14	1.57	1.58	1.09	0.83
Nihonbare	1997	0.19	0.33	0.48	0.46	0.36
"	1999	0.18	0.21	0.29	0.29	0.25
"	2001	0.24	0.49	0.57	0.51	0.49
"	2003	0.25	0.46	0.57	0.44	0.40
"	2004	0.42	0.61	0.69	0.59	0.57

The authors also examined the percentage of acetyl pyrroline in milled rice samples obtained using different milling yield settings (100-90 % to 60-50 %), as shown in Table 2. The results indicated that more acetyl pyrroline was present in rice milled at yields of 90-80 % and 80-70 %. It was also found that the quantity of acetyl pyrroline was 1/2 - 3/4 of the range found in the relatively new

Table 3 Evaluation Index of Functional Group.

Evaluation Degree / Evaluation Item	-3	-2	-1	0	1	2	3
Smell of Stored Rice / Smell of Old Rice	M.W.	W.	S.W.	N.D.	S.B.	B.	M.B.
Aroma Evaluation (Aroma passingthrough from mouth to nose to be sensed)	M.W.	W.	S.W.	N.D.	S.B.	B.	M.B.
Taste Evaluation (Sweetness to be sensed when bit.)	M.W.	W.	S.W.	N.D.	S.B.	B.	M.B.
Stickiness Evaluation (Mouth feeling)	M.W.	W.	S.W.	N.D.	S.B.	B.	M.B.
Total Evaluation	M.W.	W.	S.W.	N.D.	S.B.	B.	M.B.

M.W. : Much worse, W. : Worse, S.W. : Slightly worse, N.D. : No difference,
S.B. : Slightly better, B. : Better, M.B. : Much better
Note: The standards (taste evaluation value) of Japan Grain Inspection Association to be referred.

Table 4 Sensory Evaluation of Cooked Rice (Stored Rice; Smell of Old Rice, Taste and Aroma).

Harvest Year of Nihonbare	Addition Rate of Sawakaori (%)											
	1.0	2.0	3.0	5.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
1997	-15	-15	-10	-8	-5	2	6	8	8	12	14	**15**
1999	-15	-15	-13	-9	-4	2	7	12	**15**	-	-	-
2001	-5	-3	3	7	10	**15**	**15**	-	-	-	-	-
2003	-4	-3	1	4	7	**12**	**12**	**15**	-	-	-	-
2004	-1	5	8	**15**	**15**	-	-	-	-	-	-	-

Sawakaori rice (harvested in 2003), milled at yields of 70-60 % and, 60-50 %.

Deeper layers of rice kernels contain more aldehyde, and this is considered to be an important factor in contributing to the taste of cooked rice.

The conventional blend mixes a kind, the different rice of the production center and finishes rice cleaning in accord with the taste of the consumer (15). The details of the prescription are not clarified.

Based on these results, the authors examined the proportion of Sawakaori rice that should be blended with Nihonbare rice (harvested in 2004), in order to improve the taste of the blend and suppress the old rice odor. Since the acetyl pyrroline content of Sawakaori rice is 1.14 % at milling yields of 100-90 % (see Table 2) these improvements can be accomplished when the blending ratio ranges from 4:6 to 5:5 (Sawakaori rice : Nihonbare rice). An index (with ranges of -3 to 3) for the sensory evaluation of cooked blended rice by five panelists was established by reference to the standards of the Japan Grain Inspection Association (Table 3).

The results of the evaluation of rice blends obtained usingmilling yields of 100-90 % are shown in Table 4. In order to obtain a stable, milled blended rice the proportion of Sawakaori rice should be increased according to harvest year (1997 to 2004) of the Nihonbare rice. In this experiment the proportion of Sawakaori rice ranged from 5 % to 50 %. When the Sawakaori rice was blended at proportions of approx. 40 %, 30 %, 10 % and 5 % with Nihonbare rice harvested in 1997, 1999, 2001 and 2004, respectively,milled rice blends of a

Table 5 Percentage Composition of Acetyl Pyrroline and Aldehyde
(Nihonbare rice blended with Sawakaori rice)

Harvest Year of Nihonbare	Addition Rate of Sawakaori (%)	Percentage composition (%)								
				Compound						
		Acetylpyrroline	Aldehydes (	Pentanal	Hexanal	Heptanal	Octanal	Decanal	Others)
1997	0	0.54	16.45 (	0.98	11.02	0.84	1.66	0.87	1.08)
	50	0.92	18.46 (	0.72	12.68	0.86	1.76	1.27	1.17)
1999	0	0.65	19.95 (	0.77	13.41	1.08	2.39	1.04	1.26)
	30	0.89	21.16 (	1.18	13.99	1.05	2.32	1.20	1.35)
2001	0	0.83	20.90 (	0.98	14.52	1.11	2.41	1.10	0.78)
	10	0.92	11.23 (	0.12	8.02	0.49	1.12	0.57	0.91)
2003	0	0.76	20.02 (	0.69	13.89	0.99	2.31	0.92	0.81)
	20	0.89	21.92 (	0.49	10.22	0.67	1.96	0.77	1.02)
2004	0	0.91	8.39 (	0.17	5.19	0.44	0.78	0.90	0.91)
	5	0.99	7.58 (	0.17	4.91	0.37	0.73	0.74	1.03)

predictable, satisfactory quality were obtained.

Next, the authors examined the relationship between levels of acetyl pyrroline and the aldehydes considered to be responsible for the odor of old rice. The results are shown in Table 5. It was found that the rice blends with a stable taste contained approx. 0.89 % to 0.99 % acetyl pyrroline. This was very similar to the level found in regularly milled (yields of 100-90 %) Sawakaori rice. The quantity of aldehydes in the blends was approx. 3/4 - 1/2 that of regularly milled Nihonbare rice. This indicated that the goal of blending, toreduce the old rice odor, and to improve taste, had been achieved.

Considering the above results, it is expected that the blending of older rice with aromatic rice, at levels dependent on the age of the rice, could become a viable means for providing high quality rice to the consumer year-round.

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