Quantification of Tocopherols, Tocotrienols and γ -Oryzanol Contents of Local Rice Varieties in Northeastern Thailand

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Summary A total of 101 local rice varieties, composed of 85 glutinous and 16 non-glutinous varieties grown in wet season 2016, were analyzed for tocopherols (TOC), tocotrienols (T3) and γ -oryzanol (Orz). Two popular varieties, RD6 and KDML105, were used as standard checks for glutinous and non-glutinous varieties, respectively. γ -TOC was found in all glutinous varieties (0.47–9.78 mg/kg), which were higher than RD6 (0.16 mg/kg). α -TOC was found in 40 varieties (1.02–6.29 mg/kg), only 6 varieties were higher than RD6 (3.95 mg/kg). δ -T3 was found in 81 varieties (0.57–7.00 mg/kg), mostly varieties were higher than RD6 (0.67 mg/kg). γ -T3 was found in all glutinous varieties (8.00–22.1 mg/kg), while RD6 contained 13.3 mg/kg. For α -T3, it was found in 39 glutinous varieties (1.52–9.94 mg/kg), mostly varieties were higher than RD6 (2.62 mg/kg). Orz was found in all glutinous rice varieties (276–638 mg/kg), while RD6 contained 423 mg/kg. γ -TOC was found in all non-glutinous varieties (0.67–5.21 mg/kg), which were higher than KDML105. α -TOC was found in only 5 varieties (1.92–2.83 mg/kg), while KDML105 contained 2.23 mg/kg. δ -T3 was found in all non-glutinous varieties (1.64–8.87 mg/kg), which were higher than KDML105 (0.71 mg/kg). γ -T3 was also found in all non-glutinous varieties (8.80–17.58 mg/kg), while KDML105 contained 15.8 mg/kg. α -T3 was found in 9 non-glutinous varieties (4.56–8.93 mg/kg), while KDML105 contained only 0.86 mg/kg. Orz was also found in all those non-glutinous varieties (272–469 mg/kg), while KDML105 contained 469 mg/kg. These results indicate that γ -T3 was the highest vitamin E isomer present in all rice samples, while γ -TOC, α -TOC, δ -T3 and α -T3 were present in trace amounts. Orz was found in all local rice varieties.

Key Words tocopherol, tocotrienol, gamma oryzanol, local rice, northeastern Thailand

Nowadays In Thailand, there are many famous local rice varieties which some farmers grow and for consuming and store their own seeds. The local rice is a major food and agricultural resource of the country especially on health concern and environmental conservation trend. The local rice varieties particularly on nutritional value become interesting. The previous research study on nutritional values of local rice varieties found that brown rice is a good source of many nutrients such as iron, zinc, copper, vitamin E and β -carotene (1). Nutritional values depending on the environmental condition, weather, fertilizer, soil, water, and rice genetics (1–2). Vitamin E exists in 8 forms (α -, β -, γ -, and δ -TOC and α -, β -, γ -, and δ -T3). Vitamin E inhibits oxidative processes in living tissues (3) and protects against liver oxidative damage (4). It shows antioxidants properties and will help strengthen the immune system and prevent many diseases; blood pressure, kidney disease, cancer and atherosclerosis. Orz is a natural compound with high nutrition and found only in rice, especially in rice bran. It has the same properties as vitamin E as an antioxidant and can prevent the oxidation of saturated fatty

acids better than tocopherol and tocotrienols. Brunswick Laboratories of the United States found that Orz can prevent oxidative of free radical with up to 6 times higher than vitamin E (5). The order of vitamin E, total TOC, total T3, and Orz contents was rice bran>brown rice>rice husk>polished rice. γ -T3 was the highest vitamin E isomer present in all rice samples, while β -T, β T3, δ -T, and δ -T3 were present in trace amounts (6).

The research project on conservation and utilization of local rice varieties has been conducted with the aims of 1) developing rice varieties with good quality, meet farmers' preferences, and well adapt to local environments, and 2) supporting the utilization of local rice varieties in several aspects. An evaluation of nutritional values of local rice varieties was, therefore, conducted in order to obtain basic information for further utilization of those high nutritional value varieties, especially for health-concerned consumers..

Materials and Methods

Total of 101 local rice varieties, composed of 85 glutinous and 16 non-glutinous varieties grown in wet season 2016 at Sakon Nakorn Rice Research Center, were analyzed for TOC, T3 and Orz using reverse phase high

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Table 1. Tocopherols, tocotrienols and γ -oryzanol of 85 glutinous local rice varieties and RD6.

Variety	TOC (mg/kg)		T3 (mg/kg)		Orz (mg/kg)	
	γ	α	δ	γ	α	
Dang Noi	3.85	0.00	4.27	12.0	0.00	315
Daw Guem	2.70	0.00	1.66	11.0	0.00	352
Daw Hawm	4.56	0.00	1.61	19.7	6.55	450
(G.S. No. 4369)						
Daw Hawm	1.97	0.00	1.53	16.0	0.00	409
(G.S. No. 1115)						
Daw Hawm	4.26	3.23	3.55	10.1	5.83	409
Daw Kruem	2.32	0.00	3.80	11.2	8.04	382
Daw Noi	2.82	0.00	4.22	12.6	0.00	373
(G.S. No. 5609)						
Daw Noi	3.40	2.46	0.63	16.6	3.81	483
(G.S. No. 5629)						
Daw Pla Siew	3.67	2.34	0.57	47.4	4.18	373
Daw Pon	3.98	0.00	0.00	11.7	0.00	500
Daw San Pa Tong	2.93	1.63	3.17	10.9	0.00	385
Daw Tia	2.26	0.00	0.93	11.1	7.99	433
Daw Yuan	3.91	3.21	1.60	20.4	5.33	501
E-Pon	3.57	2.38	4.47	16.9	0.00	434
E-Dam Dang	2.84	0.00	4.09	11.6	4.84	402
E-Leaung	2.53	0.00	1.13	12.9	0.00	401
E-Khao Glang	3.48	0.00	0.77	9.8	0.00	614
E-Nawn Nawi	2.38	0.00	0.90	13.2	0.00	471
E-Tang	2.46	0.00	0.65	12.8	0.00	483
Gra Doog Ngoo	3.85	0.00	2.80	14.1	5.41	367
Hang Yee	4.17	0.00	3.88	11.5	5.80	319
Hawm	4.22	3.06	1.35	18.8	5.54	315
(G.S. No. 245151)						
Hawm	3.61	4.57	1.32	22.1	7.91	421
(G.S. No. 4433)						
Hawm Dang	4.33	3.11	2.15	15.3	6.69	434
Hawm Daw	3.14	0.00	3.54	12.8	0.00	412
Hawm Meaung Lei	2.05	3.35	1.58	13.4	4.40	310
Hawm Nang Nuan	3.08	2.22	0.79	15.3	6.36	343
Hawm Pae Palo	2.79	0.00	1.46	12.9	5.48	290
Hawm Pama	2.10	2.63	1.59	13.7	0.00	342
(G.S. No. 3210)						
Hawm Pama	1.61	0.00	4.36	13.9	4.87	383
(G.S. No. 13739)						
Hawm Tung	2.53	2.43	1.51	15.3	4.61	360
Hawm Sahngem	0.48	4.32	2.48	14.8	7.42	315
Hawm Udom	1.73	2.77	1.72	14.1	4.59	350
Kaset	4.85	2.89	2.44	14.2	0.00	424
Kaset Daw	3.06	0.00	2.00	17.0	5.52	277
Khao Daw	2.23	0.00	0.68	10.3	0.00	479
Khao' Gam	5.19	2.92	2.87	19.5	1.52	439
(G.S. No. 23171)						
Khao' Gam	2.26	1.83	5.28	12.2	0.00	536
(G.S. No. 23175)						
Khao' Hao	4.51	2.95	1.79	12.6	0.00	499
(G.S. No. 23172)						
Khao' Hao	1.11	0.00	2.63	9.1	0.00	408
(G.S. No. 23173)						
Khao' Hao	2.73	0.00	4.41	8.0	0.00	505
(G.S. No. 23174)						
Khao' Hawm	9.78	3.81	1.30	15.3	5.51	297

Table 1. (continued)

Variety	TOC (mg/kg)		T3 (mg/kg)		Orz (mg/kg)	
	γ	α	δ	γ	α	
Khao' Hawm Daw	2.73	4.98	1.29	18.4	0.00	325
Khao Khiew Kway	2.23	0.00	4.57	12.7	0.00	276
Khao Noi	2.70	0.00	4.89	12.3	0.00	506
(G.S. No. 5643)						
Khao Noi	3.61	1.42	4.31	13.1	3.82	320
(G.S. No. 85004)						
Khao Yai	3.77	0.00	0.00	10.6	0.00	638
Leuang Boonma	3.17	0.00	3.42	11.9	0.00	455
Leuang Gaew	2.76	0.00	4.28	11.9	6.88	429
Ma Nam	2.84	1.91	1.70	13.3	0.00	294
Ma Phai	2.23	3.95	4.29	12.7	9.94	407
Ma Prang	2.64	0.00	0.88	14.1	0.00	489
Mhak Yom	5.29	1.02	2.05	16.4	0.00	382
Muay Hin	3.26	3.20	2.16	13.6	0.00	302
Nahng Boon Ma	3.18	3.49	1.84	21.6	0.00	442
(G.S. No. 23217)						
Nahng Boon Ma	2.74	0.00	3.29	12.3	0.00	542
(G.S. No. 87087)						
Nahng Nee	4.56	0.00	1.71	13.6	5.40	281
Nahng Sa-ad	4.13	0.00	0.00	12.8	0.00	435
Nahng Suan	2.66	0.00	4.10	13.3	0.00	419
Niaw Dam	4.02	3.06	1.38	11.6	0.00	597
Niaw Dang	4.25	0.00	2.03	13.7	0.00	534
Niaw E-Noi	3.20	0.00	0.87	9.6	0.00	501
Niaw Hawm	2.83	2.41	1.88	14.1	0.00	398
Niaw Kam Noi	4.26	0.00	2.90	15.6	6.75	357
Niaw Khe' Kway	3.10	0.00	0.79	9.9	0.00	516
Niaw Khiaw Ngoo	3.63	2.98	4.38	12.0	0.00	327
Niaw Mali	0.72	4.68	1.66	19.4	6.69	464
Niaw Som Hong	3.39	0.00	0.00	10.4	0.00	604
Noi Boon Ma	3.28	0.00	4.12	13.1	6.08	488
Pama Hawm	1.99	2.12	1.76	21.6	0.00	421
Pan Poo	2.84	0.00	4.52	12.7	7.03	411
Ped Nam	2.94	5.11	3.71	15.0	5.53	405
Plawng Aew	3.01	2.74	1.01	13.7	5.83	357
Plong Aew	3.63	2.00	2.32	11.6	6.23	403
Pra In	2.59	2.06	2.14	17.4	6.19	412
Pram	3.26	3.06	1.32	18.4	0.00	476
Rak Pai	2.51	0.00	5.00	11.1	0.00	502
Sa-Nai	1.79	0.00	7.00	12.4	5.31	363
Sam Deaun Hang	4.42	3.41	1.66	14.5	0.00	407
Sam Ruang	3.91	2.08	2.79	14.0	6.16	324
San Pa Tong Daw	3.41	0.00	2.19	14.1	0.00	428
Ta Plin	3.09	0.00	2.26	13.6	0.00	450
Ta Prod Lian	3.51	0.00	0.77	10.6	0.00	371
Tan Gon	0.47	6.29	2.12	13.5	8.26	457
RD6 (ck)	0.16	3.95	0.67	13.3	2.62	423

G.S. No.=Genetic Stock Number.

Table 2. Tocopherols, tocotrienols and γ -oryzanol of 16 non-glutinous local rice varieties and KDML 10.

Variety	TOC (mg/kg)			T3 (mg/kg)			Orz (mg/kg)
	γ	α	δ	γ	α		
Choo Chat	2.49	0.00	4.14	15.5	7.35		272
Daw Dang	3.91	0.00	6.18	13.3	0.00		302
Daw Khao	1.92	2.61	4.55	14.2	5.27		436
Hawm Jan	2.28	0.00	1.84	14.8	0.00		349
Jao Dang							
(G.S. No. 5672)	5.21	0.00	2.83	17.6	8.35		376
Jao Dang	4.07	0.00	8.87	15.5	0.00		426
(G.S. No. 14511)							
Jao Dang	2.63	0.00	6.63	11.5	6.19		353
(G.S. No. 13735)							
Khan Nahng	2.20	2.60	2.90	15.7	0.00		367
Khao	2.61	2.83	2.79	13.5	6.58		441
Khao Gaw Diaw	1.78	0.00	2.56	8.8	6.29		307
Khao' Jao Leuang 11	2.03	0.00	6.61	11.6	0.00		324
Kra Dab Tawng	0.67	2.63	2.40	13.5	8.93		292
Nahng Gang	2.34	0.00	2.76	14.5	4.56		469
Pong Aew	5.10	1.92	2.17	15.7	6.74		392
Taw Chaw Daw	1.33	0.00	4.48	10.0	0.00		361
Sam Ruang	2.14	0.00	1.64	12.4	0.00		370
KDML 105 (ck)	0.52	2.23	0.71	15.8	0.86		469

G.S. No.=Genetic Stock Number.

performance liquid chromatography (RP-HPLC) at Ubon Ratchatani Rice Research Center. Two popular varieties, RD6 and KDML105, were used as standard checks for glutinous and non-glutinous varieties, respectively.

Results

The results showed that total of Vitamin E contents of different varieties of brown rice ranged between 0.47 and 47.4 mg/kg. TOC were mostly found in the form of either γ - or α -TOC, while T3 were found in the forms of δ -, γ - and α -T3. Among glutinous varieties, γ -TOC was found in all 85 glutinous varieties with the contents ranging from 0.47–9.78 mg/kg, which were higher than that of the standard check, RD6 (0.16 mg/kg). For α -TOC, it was found in 40 varieties with the contents ranging from 1.02–6.29 mg/kg, while RD6 contained 3.95 mg/kg. For T3, δ -T3 was found in 81 varieties with the contents ranging from 0.57–7.00 mg/kg, while the standard check (RD6) contained 0.67 mg/kg. γ -T3 was found in all glutinous varieties being tested with the contents ranging from 8.00–22.1 mg/kg, while RD6 contained 13.3 mg/kg. For α -T3, it was found in 39 glutinous varieties with the contents ranging from 1.52–9.94 mg/kg, while RD6 contained 2.62 mg/kg. For Orz, it was found in all glutinous rice varieties being tested with the contents ranging from 276–638 mg/kg, while RD6 contained 423 mg/kg (Table 1).

Among 16 non-glutinous varieties being tested, it was found that all those varieties contained γ -TOC with the contents ranging from 0.67–5.21 mg/kg,

which were higher than that of the standard check, KDML 105 (0.52 mg/kg). For α -TOC, it was found in only 5 varieties being tested with the contents ranging from 1.92–2.83 mg/kg, while KDML 105 contained 2.23 mg/kg. For T3, δ -T3 was found in all varieties with the contents ranging from 1.64–8.87 mg/kg, which were higher than that of the standard check, KDML 105 (0.71 mg/kg). γ -T3 was also found in all varieties being tested with the contents ranging from 8.80–17.58 mg/kg, while KDML 105 contained 15.8 mg/kg. For α -T3, it was found in 9 non-glutinous varieties being tested with the contents ranging from 4.56–8.93 mg/kg, which were higher than KDML 105, contained only 0.86 mg/kg. For Orz, it was found in all 16 non-glutinous varieties being tested with the contents ranging from 272–469 mg/kg, while KDML 105 contained 469 mg/kg (Table 2).

Discussion

γ -TOC and γ -T3 were found in all glutinous and non-glutinous local rice varieties, while α -TOC and α -T3 were found in some local rice varieties. Most local rice varieties contain higher γ -TOC, δ -T3 and α -T3 than standard check varieties (RD6 and KDML 105). γ -T3 was the highest vitamin E isomer present in all rice samples, while γ -TOC, α -TOC, δ -T3 and α -T3 were present in trace amounts. As same as Huang SH and Ng LT (2011), which found that γ -T3 was the highest vitamin E isomer present in all 16 commercial rice varieties in Taiwan (6). In japonica rice, α -TOC, α -T3, and γ -T3 were the most abundant homologs, while in indica rice the most abundant were γ -T3, α -TOC, and α -T3 (7). Content of vitamin E isomers varied among local rice varieties both within and between grain color groups. However, no obvious difference in TOC, T3 and γ -oryzanol content was noted between black- and red-colored local rice varieties, while Shammugasamy et al. found that black-pigmented rice had higher contents of TOC and T3 than non-pigmented rice and red-pigmented rice in 58 different varieties of whole rice cultivated in Malaysia (8).

In conclusion, this study provides information on vitamin E and Orz contents of different local rice varieties that would be beneficial for decision making in genetic breeding of bioactive compound-rich rice varieties and for further utilization of those high nutritional value varieties, especially for health-concerned consumers.

Disclosure of State of COI

No conflicts of interest to be declared.

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