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Malt and Wort Characteristics of 42 Cereal Rice Varieties Cultivated in Thailand

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ABSTRACT

The objective of this research was to investigate physical and chemical properties of cereals cultivated in Thailand. Forty-two local varieties, sticky types, non sticky types, japonica types wheat and barley grains were malted using a micro-malting method. Their malt characteristics were studied and compared to those of a commercial barley malt. The optimal germination time at 30°C to produce a good malt of high diastatic power and extract of these varieties was 2-5 days. The hot-water extracts of Thai rice malts were different due to varieties and lower than the commercial barley malt. Malt and wort quality evaluated followed European Brewery Convention method in order to come up with product profile suitable for the future new product development from rice malt. The collected data will be used for a further related study and applied for domestic food and beverage industry as sources of raw materials.

Key words: malted rice, germination, malting, wort extract, diastatic power

INTRODUCTION

Barley and malt imported volume tended to increase every year. Data on importing malt products in Thailand for 2001 to 2005 was increased from 536,464 ton, cost 244,244,156 million baht to 1,532,660 ton, cost 389,387,7832 million baht. Most of them is used in beer industry, food manufacturing industry and several brands of beverages and chemicals as they are element of microorganism feeding of the laboratory.From the feasibility study of Thai rice in preparation as malt, there are only the reports of a few rice cultivars planted in Thailand which are suitable for the beverage manufacturing as beer and whisky but they do not cover other widely grown varieties. The research is to compile characteristics of those malt which are important and can lead to the utilization of rice that have lot of quantity, cheap and easily find within the country for optimal benefit. Promotion and expansion of plantation area can reduce raw materials imported from abroad in the future. The objective of this research is to find out the suitable time to soak the paddy rice and the suitable period of malt growth including quality of malt and wort of each breed of rice. The condition of malt preparation must be adjustable for actual use, practical to use in research and does not need high investment.

MATERIAL AND METHODS

Materials

The 16 varieties of each of sticky and non-sticky indica rice, 4 Japonica rice, 4 wheat and 2 barley varieties selected to use in malt

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cultivation were derived from Phrae Rice Research Center, San Patong Rice Research Center, Pathum Thani Rice Research Center, Samerng Cold Plant Experimental Station, Bangkhen Rice Testing Station. Barley from Chiang Mai Malting Co., Ltd., Chiang Mai province was used as control.

Sixteen varieties of sticky rice: Dowprao, R-258, Niawprae1, Luang sanpahtong, Pi-e-nuemu, San pah tawng1, Mueynawng 62 M, Praedaeng, Kam1, Kam2, RD6, RD8, RD10 , Khao pong kri, Niaw U-bon2, Haodaw.

Sixteen varieties of non-sticky rice: KDML105, Pathum thani1, Howm Klong Luang1, Namru, Jaopukud, Tipdaeng, Jao haw, Jao khao, Luang Pratahn, RD7, RD21, Leuang Pratew123, Suphanburi1, Khaochip, Phitsanulok2, Chainat1

Ten varieties of temperate crops: 4 varieties of japonica rice: Khao yipun DOA1, Khao yipun DOA2, Koshihikari, Hiyuku . 4 Wheat varieties: Samerng1, Samerng2, Fahng60, Phrae60. 2 Barley varieties: Samerng2, Samerng1

Methods

Phase 1 Test: The study of suitable time for malting of paddy rice.

Grains were cleaned and weighted for approx. 5 kg., the paddy were soaked in water at 30°C for 5 minutes to sort out the floating seeds, changed water and soaked again every 12 hours and then air dry for 1 hour. After completion of 1 hour air drying, changed water and repeated the processes. Random sampling was at 12, 24, 36, 48 and 60 hours; 5 grams each for the analysis. Moisture content according to EBC (1987) method and random again 100 grains for 10 repeatedly times, placed in petri dish plate lining with whatman No. 1 of 90 mm diameter by the method of BRF, cultivated in dark cabinet at 30°C for 72 hours and then took out to count the sprouting grains, reported sprouting efficiency as % germinative energy.

After soaking the paddy at the suitable time for each variety, the paddy seeds were divided and weighed at approx. 100 grams and evenly spread on plastic perforated basket 26 cm. wide x 36 cm. long for the total of 50 baskets per 1 variety. The seeds then were germinated in dark cabinet at controlled temperature 30°C, relative humidity at 90% for 120 hours. Fresh malt was sampled by gradual gathering from 5 basket every 12 hours to count their sprouts and % germinative energy. The counted fresh malts were partially weighed and 50 grams for each variety were kept to analyze the value of activity of Diastatic enzyme (WK units) according to EBC (1987). The remaining malts were kilned by tray dryer at 55°C for 24 hours and derooted to keep for analysing the quality of dried malt and wort in phase 2 test.

Remark : The temperature for steeping and germination of control malt was 20°C.

Phase 2 Test: The study of malts and wort quality

Maximum Diastatic Power of each fresh malt was measured and stopped its enzyme activity by drying process to analyse moisture, amylose, protein content and grinded and then boiled and extracted by adjusting the temperature to prepare congress wort. The value of enzyme activity of DP, free amino nitrogen (FAN), specific gravity, pH, color and extract substances were analyzed according to EBC (1987) method.

RESULTS AND DISCUSSION

Suitable condition for malting

The relationship between suitable time for soaking and moisture content of the most efficient sprouting for each variety during 60 hours at 30°C are shown in Table 1. It was shown that the paddy was well sprouted at 18-40% moisture or between 12-60 hours depending on variety. However, it was found that as the soaking time was increased, the moisture in the grain increased to the maximum level and stable. For sticky rice malt, the hard and thick cover required longer

Table 1 Suitable conditions for malting in 42 fresh malts.

Varieties	Suitable conditions for malting				
	Steeping hours	Germination hours	%Moisture content	% Germinative energy	DP (WK units)
Sticky rice					
Dawprao	24	84	27.69±0.99	96.35±1.11	62.65±15.0
R-258	60	48	30.36±0.59	95.35±1.88	284.21±6.3
Niawprae1	24	96	17.77±0.22	95.32±3.30	103.12±10.1
Luangsanpahtawng	24	72	25.25±0.68	94.57±1.24	58.19±12.4
Pi-e-nuemu	60	60	28.01±0.62	94.59±0.50	273.85±7.3
Sanpahtawng1	12	84	18.78±0.83	98.70±1.38	157.76±20.0
Mueynawng 62 M	12	84	20.94±0.85	97.34±2.05	297.23±6.0
Praedaeng	48	60	25.62±0.36	63.53±6.71	50.86±15.7
Kam 1	36	24	22.24±0.38	97.14±1.16	137.40±17.4
Kam 2	24	24	17.92±0.45	96.75±1.55	125.76±12.6
RD 6	24	72	19.27±0.45	95.00±1.00	105.22±13.5
RD 8	24	72	18.32±0.32	98.96±0.04	109.59±14.4
RD 10	36	60	19.11±0.29	98.51±0.70	105.92±17.3
Khaopongkri	60	84	30.28±0.34	94.56±3.50	59.80±15.1
U-bon 2	60	72	28.63±0.58	64.98±4.21	97.72±14.6
Haodaw	48	72	26.97±0.41	86.46±1.68	40.35±16.1
Non-sticky rice					
KDML 105	48	60	21.45±0.11	96.77±1.98	55.92±10.4
Pathumthani1	48	60	22.45±0.27	81.29±2.45	52.59±11.5
Hawmklongluang1	36	60	23.89±0.35	97.16±1.11	50.13±10.7
Namru	24	84	26.62±0.12	95.40±2.34	46.63±11.2
Jaopukud	36	60	20.41±0.24	95.05±1.57	63.57±18.5
Tipdaeng	60	96	22.92±0.45	98.43±0.40	52.05±12.6
Jaohaw	12	72	20.64±0.30	98.50±0.34	82.93±17.9
Jaokhao	48	60	25.96±0.25	96.49±0.72	60.83±10.8
Luangpratahn	12	60	20.34±0.14	98.43±1.21	159.81±12.7
RD 7	12	72	24.00±0.50	95.00±2.00	105.85±10.0
RD 21	12	72	23.65±0.41	97.44±2.15	49.42±10.0
Leuangpratew123	48	120	24.03±0.36	97.02±2.38	176.35±10.1
Suphanburi 1	24	72	22.25±0.61	96.11±3.50	64.98±11.4
Khao chip	60	120	24.98±0.23	97.02±0.21	144.06±11.5
Phitsanulok2	60	72	18.07±0.67	82.32±2.85	52.17±10.5
Chainat1	60	60	27.89±0.12	82.80±2.55	211.35±7.5
Other cereals					
Khaoyipun DOA1	24	96	25.14±0.41	91.98±2.51	74.20±18.2
Khaoyipun DOA 2	36	96	28.24±0.45	93.78±2.45	64.98±17.6
Koshihikari	24	96	26.09±0.32	91.81±2.35	94.08±15.5
Hiyuku	24	96	26.42±0.35	90.43±2.61	93.20±17.3
Wheat Samerng1	48	72	34.26±0.10	75.64±3.43	182.06±16.4
Wheat Samerng2	48	72	41.98±0.11	74.16±3.51	174.67±17.3
Wheat Fahng60	36	72	38.98±0.25	78.05±3.50	184.33±15.2
Wheat Phrae60	36	72	38.17±0.22	77.34±3.45	166.54±16.5
Barley Samerng2	60	84	38.26±0.24	34.62±2.89	181.24±17.5
Barley Samerng1	60	84	39.93±0.25	33.67±3.11	178.05±18.9
Control	48	60	39.60±0.16	95.73±2.55	290.70±5.0

Values represent mean± standard deviation of means

soaking time such as R-258, Pi-e-nuemu, Khaopongkri and U-bon2, that required 60 hours soaking until the moisture was increased to 18-30% while the moisture of malt in non-sticky rice required lesser time to raise up the moisture content to 18-28%. Malt of temperate crops such as malt wheat and barley, required maximum moisture of 35-40% except japonica rice that required lower moisture at approximately 25%. Activity value of of DP enzymes for each variety is also shown in Table 1

It was found that the DP activity of fresh malt in indica rice and japonica rice was between 52-159 WK-units, lower than wheat malt and barley which was between 166-184 WK-units. While malt in 3 sticky rice groups, namely R-258, Pi-e-nuemu and Mueynawng 62 M and in 1 non-sticky rice, Chainat 1 where its DP enzyme activity was 211-297 WK-units, as compared to the same standard of controlled malt (290 WK units). The maximum sprouting efficiency of sticky rice was at the beginning of germination period in the 48th hour while malt in non-sticky rice was slower or the maximum sprout efficiency was at latter period of the 48th hours. However, it was noticeable that DP activity of malt of temperate crop group was slower than controlled malt and Thai rice malt. Sprouting was at 72nd hour for wheat malt, 84th hours for barley malt and 96th hour for japonica malt.

Percent amylose, moisture content, protein and diastatic power are presented in Table 2. All values are means±standard deviation of means.

The suitable moisture level for sprouting to prepare malt for indica rice; sticky rice, non-sticky rice and japonica rice was similar value at 20-30% while wheat malt and barley malt would required higher moisture level at 35-40%. However, each variety required different sprouting period due to chemical and physical properties of each kind of rice that had different absorption rate (Wolfgang, 1999). The suitable sprouting period of 42 varieties calculated by mean of Diastatic Power in all malt every 12 hours was 2-5days depending on variety. It was found that most of Thai rice had lower sprouting efficiency than standard quality malt. The varieties having DP value similar to good grade standard malt were 3 varieties from sticky rice group, namely; R-258, Pi-e-nuemu and Mueynawng 62 M and one variety in non-sticky rice, namely Chainat 1. The efficiency of malting of temperate crops, wheat and barley was lower than the standard. This may be due to the improper germinated temperature as described by Aisien (1982) and Demuyakor and Ohta (1992). However, japonica malt had its high efficiency in sprouting similar to indica malt but higher than wheat and barley.

Malt and wort quality

As compared to the extracted substance from good standard malt for beer manufacturing which was between 75-85% (Taylor and Boyd, 1986) 3 varieties from malt in sticky rice group, namely, R-258, Pi-e-nuemu and Mueynawng 62 M and only one variety in non-sticky rice group, namely Chainat 1 were found to be up to the standard (Table2). For malt of temperate crops, japonica malt had lower extracted substance than standard malt while wheat and barley were similar to standard controlled malt. The volume of extracted substance and specific gravity of all varieties were varied according to the DP enzyme and FAN. However, pH of wort was up to the standard, moisture content was lower than 5% and pH was between 5.6-6.0. These indicated the good preparation of wort except in temperate group malt. FAN value in indica malt was lower than standard value (120-190 mg/l), which was varied according to the protein depending on each breed as described by Briggs (1998). For color of wort, it was noticeable that malt from indica rice in almost all varieties of sticky and non-sticky rice was more paler than pale malt standard as prescribed at 4.0-6.5 degree EBC except malt from

Table 2 Malt and wort quality of 42 cereals.

Varieties	Malt and wort quality								
	Malt analysis					Wort analysis			
	% amylose	% moisture content	% protein	Diastatic power (WK units)	FAN (mg/L)	pH	Specific gravity	Colour (∞EBC)	% extract
Sticky rice									
Dawprao	8.3±0.8	4.47±0.11	10.2±0.6	145±21	119±7	6.08±0.01	1.0526±0.00	3.25±0.18	66.35±0.3
R-258	8.4±0.7	4.57±0.11	10.5±0.5	290±24	130±5	5.69±0.01	1.0775±0.00	6.41±0.15	81.55±0.2
Niawprae1	8.8±0.7	4.95±0.12	6.3±0.8	139±21	95±4	5.92±0.01	1.0476±0.00	1.75±0.08	58.15±0.3
Luangsanpa	8.8±0.7	5.02±0.10	7.9±0.3	142±16	97±5	6.00±0.01	1.0503±0.00	2.40±0.15	63.74±0.3
Pi-e-nuemu	8.9±0.8	4.24±0.13	10.4±0.2	282±23	124±5	5.90±0.01	1.0762±0.00	7.50±0.15	80.46±0.2
Sanpahtaw1	9.1±0.8	5.01±0.15	7.6±0.3	147±49	102±4	5.78±0.01	1.0501±0.00	2.24±0.10	63.51±0.3
Muey62M	9.2±0.9	3.57±0.10	12.2±0.7	289±26	138±6	5.86±0.01	1.0798±0.00	4.12±0.10	82.15±0.2
Praedaeng	9.2±0.9	1.85±0.10	8.2±1.0	134±38	121±10	5.44±0.01	1.0452±0.00	1.95±0.15	57.90±0.3
Kam 1	9.4±0.8	1.76±0.11	9.3±1.1	252±34	125±10	5.92±0.01	1.0539±0.00	1.40±0.05	66.47±0.2
Kam 2	9.5±0.8	2.01±0.10	9.7±1.3	208±36	127±11	5.41±0.01	1.0462±0.00	2.17±0.05	65.32±0.3
RD 6	9.6±0.8	4.78±0.10	7.8±0.2	167±38	108±5	5.74±0.01	1.0511±0.00	2.05±0.05	65.85±0.3
RD 8	9.8±0.8	4.00±0.10	8.4±0.3	160±48	108±5	5.96±0.01	1.0593±0.00	2.22±0.05	63.23±0.2
RD 10	9.8±0.8	4.19±0.10	9.6±0.4	164±45	110±5	5.09±0.01	1.0542±0.00	2.18±0.05	67.02±0.3
Khaopongkri	10.0±0.8	4.82±0.10	6.7±1.1	151±21	105±5	5.57±0.01	1.0498±0.00	2.66±0.05	62.97±0.3
U-bon2	10.2±0.7	2.41±0.10	7.7±1.2	151±13	109±5	5.86±0.01	1.0490±0.00	1.09±0.05	62.63±0.3
Haodaw	13.2±0.9	2.35±0.10	8.1±0.1	161±26	105±5	4.98±0.01	1.0338±0.00	1.74±0.05	61.02±0.3
Non -sticky rice									
KDML105	17.9±0.8	4.54±0.10	7.7±0.2	121±14	102±8	5.69±0.01	1.0402±0.00	2.72±0.17	52.39±0.5
Pathumtha1	18.1±0.8	3.45±0.10	7.6±0.1	119±23	101±8	6.01±0.01	1.0401±0.00	2.93±0.15	52.14±0.5
Hawmklon1	19.1±0.7	3.78±0.10	7.8±0.1	116±13	107±8	5.84±0.01	1.0399±0.00	2.59±0.13	51.46±0.5
Namru	22.4±1.0	3.83±0.10	7.3±1.9	91±24	100±6	5.87±0.01	1.0368±0.00	1.73±0.02	51.06±0.5
Jaopukud	23.2±1.2	2.14±0.10	6.9±1.4	57±15	95±5	5.45±0.01	1.0235±0.00	1.76±0.05	32.06±0.2
Tipdaeng	24.3±1.3	1.87±0.10	8.4±1.1	57±18	115±7	5.50±0.01	1.0273±0.00	2.14±0.12	35.45±0.3
Jaohaw	26.9±1.1	3.21±0.10	7.0±0.9	72±18	103±8	5.43±0.01	1.0335±0.00	2.22±0.18	41.37±0.3
Jaokhao	27.0±1.0	2.29±0.10	7.7±0.5	58±14	112±8	5.85±0.01	1.0287±0.00	2.66±0.12	39.87±0.3
Luangpratah	27.4±0.9	4.44±0.10	7.3±0.4	61±16	99±5	6.08±0.01	1.0356±0.00	1.77±0.18	50.71±0.5
RD 7	28.2±0.9	2.35±0.10	7.4±0.3	124±16	97±6	5.12±0.01	1.0481±0.00	1.96±0.11	54.50±0.4
RD 21	28.5±0.9	5.40±0.10	6.4±0.3	164±45	97±5	6.03±0.01	1.0395±0.00	2.50±0.20	55.45±0.3
LPT123	28.6±1.0	5.17±0.10	8.3±1.1	142±10	111±6	6.00±0.01	1.0491±0.00	2.61±0.20	62.77±0.3
SPT 1	29.1±1.0	5.87±0.10	7.3±0.5	119±11	100±6	5.87±0.01	1.0342±0.00	1.73±0.09	50.21±0.4
Khaochip	29.9±1.0	2.29±0.10	6.9±0.2	57±14	97±8	5.42±0.01	1.0269±0.00	2.07±0.15	34.49±0.3
Pisanulok 2	30.1±1.0	2.50±0.10	7.5±0.3	139±11	98±7	6.07±0.01	1.0498±0.00	1.85±0.06	57.23±0.4
Chainat1	31.0±1.1	6.08±0.10	8.8±0.8	260±19	121±6	6.08±0.01	1.0755±0.00	2.16±0.05	78.37±0.5
Other cereals									
DOA 1	17.3±0.9	2.13±0.10	7.2±1.1	151±28	105±9	4.85±0.01	1.0481±0.00	3.30±0.05	54.60±0.5
DOA 2	18.2±0.9	2.40±0.10	7.4±1.0	155±27	115±9	4.97±0.01	1.0496±0.00	3.15±0.05	56.48±0.5
Koshihikari	18.4±0.9	2.28±0.10	7.1±1.1	154±26	102±9	5.25±0.01	1.0499±0.00	4.02±0.05	59.11±0.5
Hiyuku	19.9±0.9	2.26±0.10	6.9±1.0	152±14	102±9	5.12±0.01	1.0498±0.00	4.27±0.05	59.11±0.5
WSamern1	28.2±0. 8	3.52±0.10	9.7±0.8	272±45	161±5	5.21±0.01	1.0809±0.00	5.65±0.05	83.47±0.6
WSamern2	29.4±0.7	3.61±0.10	9.9±0.8	268±29	158±4	4.95±0.01	1.0800±0.00	5.62±0.05	81.89±0.6
WFahng60	30.9±0.6	3.55±0.10	9.2±0.8	256±53	152±4	4.90±0.01	1.0803±0.00	5.26±0.05	80.89±0.6
WPhrae60	31.1±0.8	3.48±0.10	9.8±0.8	281±58	160±4	4.78±0.01	1.0801±0.00	5.34±0.05	84.28±0.6
BSamerng2	38.9±1.1	3.19±0.10	11.5±2.2	259±16	120±3	6.01±0.01	1.0782±0.00	5.91±0.05	77.45±0.4
Bsamerng1	40.1±1.2	3.13±0.10	10.8±2.4	252±36	118±3	5.83±0.01	1.0755±0.00	5.83±0.05	76.85±0.4
Control	37.2±0.1	5.81±0.19	10.8±0.3	397±24	158±6	6.01±0.01	1.0793±0.00	5.05±0.50	81.46±0.6

Values represent mean± standard deviation of means

3 high protein sticky rice which their color value was similar to the controlled malt. These were resulted from maillard reaction from the source substance having higher amino acid and sugar and from permanent characteristic of variety that had darker color of seed covering than other varieties.

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