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Influence of Degree of Milling on Chemical Compositions and Physicochemical Properties of Jasmine Rice

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***Abstract*—This research aimed to verify variations in chemical compositions and physicochemical properties, through a Texture profile analysis (TPA) and pasting properties of Jasmine rice after polishing at six different degrees of milling (DOM). The DOM level significantly affected chemical compositions. The process of polishing induced nutrient contents to decrease further after bran layer was further removed. The physicochemical properties both TPA and pasting properties of rice were also affected by the DOM. The degree of gelatinization value of cooked rice was found to increase with the increase in DOM level.**

Keywords-rice, Jasmine rice, degree of milling, texture profile analysis

I. INTRODUCTION

Rice is one of the most important cereals and the staple food of over half the world's population as the primary dietary source of carbohydrate and energy [1,2]. Generally, rice is consumed as a whole kernel of white rice obtained by milling (dehulling and polishing) rough rice. The degree of milling (DOM) depends on purposes of milling required. Therefore, DOM is one of the key factors affecting several aspects of rice quality such as nutritional, chemical, physicochemical, cooking, and eating quality. DOM brought about variations in nutrient contents [3,4], biological component for example amylase activities, peptidase activities and cooking quality [5]. Jasmine rice is one of the most popular rice types in Thailand and many importing countries as its soft texture, slightly sticky, and aroma. However, the study on effect of DOM on several quality aspects of this rice is still needed to achieve as high as quality and yield. The objective of the study was to investigate the effect of DOM on chemical compositions and physicochemical properties of Jasmine rice.

II. MATERIALS AND METHODS

A. Sample preparation

Rough rice of Jasmine rice samples (*Oryza sativa* cultivar Khao Dok Mali 105) were obtained from the Department of Agricultural Product Technology, Mahasakham University, Mahasarakham, Thailand. Rough rice was dehusked by a dehusker at six levels of polishing including degree of milling at 0% (DOM 0 or brown rice), 1.75% (DOM 1.75), 4.50% (DOM 4.50), 6.50% (DOM 6.50), 8.50% (DOM 8.50), and 10.90% (DOM 10.90). The DOM was monitored by calculate using the weigh of rice before (brown rice) and after polishing. Broken kernels were removed and the polished rice samples were collected and stored until analyzed.

B. Chemical composition analysis

Proximate compositions of all samples were carried out according to [6]. The moisture content was done by drying in an oven at 105°C until constant weight, ash content was determined using a muffle furnace temperature at 550º C, crude fat was determined by Soxhlet extraction method, and protein content was evaluated by the Kjeldahl method, using 5.95 as the conversion factor.

C. Physicochemical properties

1) Texture profile analysis (TPA): Rice (80.0 g) with distilled water of 200.0 g was cooked in an electric rice cooker (KSH-106, Sharp, Japan), until completely gelatinized and edible cooked rice was obtained, prior to measuring the TPA using a Texture analyzer (TA-XT2i, Texture Technologies Corp., Scarsdale, NY/Stable Micro Systems, Godalming, Surrey, UK) by following the method addressed by [7] and [8]. Texture parameters consisting of hardness, cohesiveness, adhesiveness, springiness, and chewiness were derived from the instrument software.

2) Pasting properties: Pasting properties of rice flour from different DOM were measured using a Rapid Visco Analyzer (RVA-4, Newport Scientific, Sydney, Australia) by adopting the method of [9].

3) Degree of gelatinization: Degree of gelatinization was measured by the differential alkaline solubility method [10].

D. Statistics

A one way analysis of variance (ANOVA) and Duncan's multiple range test were performed to test the statistical of differences in the chemical compositions and physicochemical properties between DOM using SPSS statistical software version 16.0 (SPSS, INC., Chicago, USA).The significance was accepted at the 5% confidence level.

III. RESULTS AND DISCUSSION

A. Chemical compositions

The results pertaining to chemical compositions are

presented in Table I. The mean values for the protein, ash, fat, crude fiber were ranged from 6.87% to 8.87%, 0.36%

to 1.42%, 0.63% to 2.92%, 0.35% to 1.12%, respectively. The highest values of protein, ash, fat and crude fiber were observed in DOM 0, whilst the highest mean value of carbohydrate (80.36%) was found in DOM 10.90. These results are confirmed by the earlier studies reported by [11] and [10]. The process of polishing further decreased the nutrient contents after bran removal [12] due to rice bran layer contains several important nutrients [13, 14].

B. Texture Profile Analysis

Hardness, cohesiveness, adhesiveness, springiness, stickiness, and chewiness were evaluated in texture profile analysis of rice (Table II). The hardness values of cooked rice from different DOM level were ranged from 4.99 N to 12.27 N. The hardness of cooked rice was found to decrease with the increasing of DOM level. The present of bran layer added firmness to the cooked grain, which DOM 0 rice was harder than that of DOM 10.90 because of the fibrous bran layer around the kernel. The cohesiveness values were ranged from 0.24 to 0.30, which increased with the increasing in DOM level. The protein, fat, and ash content decrease with the progressive of polishing, as aleurone layer, pericarp and seed coat were removed during milling, thus affected the adhesiveness of the cooked rice. These results were similar to those reported by [12] and [8]. The adhesiveness values were negatively influenced by grain thickness and positively by degree of milling. Moreover, DOM 0 rice had higher springiness and chewiness than that of DOM 10.90%.

C. Rapid Visco Analyzer

The pasting properties were presented in Table III, which the DOM influenced on rice flour pasting properties. Peak viscosity, breakdown, setback and final viscosity of rice flour increased with the increase in DOM level but pasting temperature decreased [15]. Pasting temperature of DOM 0 indicated the highest while its peak viscosity, breakdown, setback and final viscosity were lower than those of other DOM levels.

D. Degree of Gelatinization

The effect of DOM on degree of gelatinization of rice is presented in figure 1. The values were ranged from 59.14% to 96.23% for DOM of 0% to 10.90%, respectively, the degree of gelatinization of cooked rice was found to increase with the increasing in DOM. The DOM significantly affected degree of gelatinization. This probably due to starchy endosperm consisting protein bodies which could restrict water absorbing, swelling, and gelatinization of starch granule. Moreover, minor constituents in rice bran also prevent absorption of water affecting on gelatinization [3, 16].

TABLE I. CHEMICAL COMPOSITIONS OF RICE OBTAINED FROM DIFFERENT DEGREES OF MILLING (g/100g DRY WEIGHT)

DOM (%)	Chemical Compositions					
	Moisture	***Protein***	***Ash***	***Crude Fat***	***Crude fiber***	***Carbohydrate***
0	11.44±0.06[a]	8.87±0.06[a]	1.42±0.08[a]	2.92±0.03[a]	1.12±0.04[a]	74.23±0.02[f]
1.75	11.46±0.04[a]	8.49±0.06[b]	1.16±0.04[b]	2.21±0.04[b]	0.99±0.01[b]	75.69±0.06[e]
4.50	11.48±0.07[a]	7.94±0.04[c]	1.04±0.03[c]	1.71±0.01[c]	0.75±0.04[c]	77.08±0.16[d]
6.50	11.42±0.02[a]	7.63±0.05[d]	0.97±0.02[c]	1.27±0.02[d]	0.66±0.01[d]	78.04±0.03[c]
8.50	11.48±0.02[a]	7.19±0.08[e]	0.60±0.02[d]	0.91±0.05[e]	0.50±0.01[e]	79.31±0.17[b]
10.90	11.45±0.04[a]	6.87±0.14[f]	0.36±0.02[e]	0.63±0.02[f]	0.35±0.01[f]	80.36±0.18[a]

a. Means within columns followed by the same letter are not significant different at $p < 0.05$

TABLE II. DIFFERENCES IN TEXTURAL PARAMETERS AS AFFECTED BY DEGREE OF MILLING

DOM (%)	Texture Profile				
	Hardness	*Cohesiveness*	*Adhesiveness*	*Springiness*	*Chewiness*
0	12.27±1.08^{a}	0.24±0.00^{c}	0.44±0.10^{a}	0.53±0.27^{a}	1.57±0.81^{a}
1.75	9.67±0.39^{b}	0.24±0.10^{c}	0.72±0.06^{b}	0.46±0.07^{ab}	1.07±0.16^{ab}
4.50	8.34±0.39^{c}	0.28±0.00^{b}	1.02±0.02^{c}	0.42±0.43^{ab}	0.97±0.07^{ab}
6.50	6.82±0.80^{d}	0.29±0.01^{ab}	1.23±0.17^{d}	0.38±0.05^{ab}	0.74±0.20^{b}
8.50	6.20±0.59^{de}	0.30±0.00^{a}	1.70±0.12^{e}	0.37±0.04^{ab}	0.68±0.12^{b}
10.90	4.99±0.67^{d}	0.30±0.02^{a}	2.24±0.13^{f}	0.29±0.07^{b}	0.42±0.03^{b}

Values with different letters in a column represent significant difference ($P < 0.05$).

TABLE III. EFFECT OF DOM ON PASTING PROPERTIES OF RICE

DOM (%)	Peak viscosity	Holding strength	Breakdown	Final viscosity	Setback	Peak time	Pasting temperature (ºC)
0	244.22±7.01^{f}	133.72±1.71^{e}	110.50±8.33^{c}	207.03±4.51^{d}	73.31±3.74^{c}	5.51±0.03^{abc}	77.53±0.08^{a}
1.75	303.89±2.72^{e}	159.28±9.62^{d}	144.55±9.71^{b}	240.86±7.43^{c}	76.06±3.88^{bc}	5.38±0.14^{bc}	76.40±3.68^{ab}
4.50	315.42±0.46^{d}	158.78±4.84^{d}	156.64±15.46^{b}	248.53±2.43^{c}	81.58±2.19^{b}	5.31±0.03^{c}	75.88±1.63^{ab}
6.50	364.97±3.55^{c}	184.31±8.13^{c}	180.67±5.68^{a}	272.56±8.07^{b}	88.25±0.76^{a}	5.47±0.14^{abc}	74.85±0.80^{ab}
8.50	385.64±2.34^{b}	210.03±13.43^{b}	175.61±11.43^{a}	303.00±18.05^{a}	89.75±2.42^{a}	5.60±0.23^{ab}	74.60±0.52^{ab}
10.90	428.42±6.11^{a}	236.83±13.88^{a}	191.58±16.93^{a}	312.89±17.75^{a}	92.64±5.10^{a}	5.71±0.14^{a}	73.98±0.46^{b}

Values are averages of triplicates. Values with different letters in a column represent significant difference ($P < 0.05$).

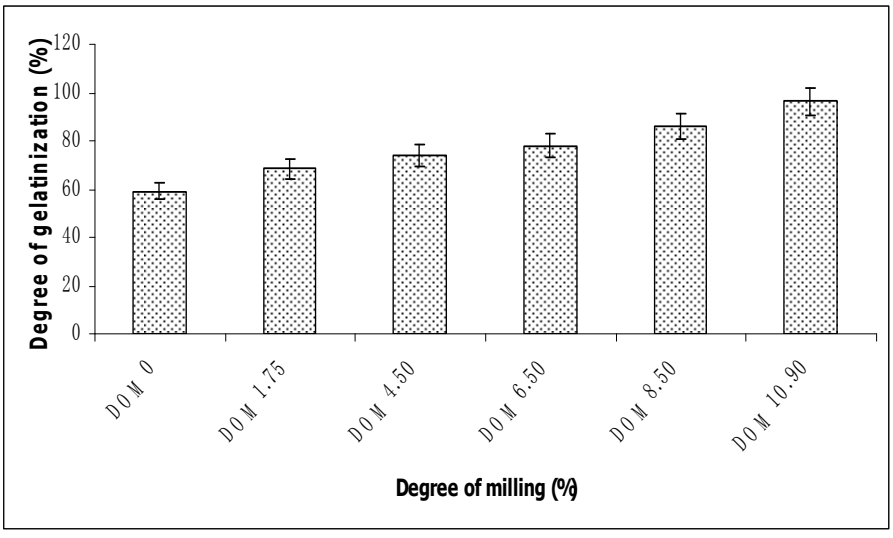

Figure 1. Effect of degree of milling on the degree of gelatinization of cooked rice

IV. Conclusions

The studied showed that the levels of major constituents consisting of protein, ash, fat, and crude fiber of Jasmine rice decrease with the increasing of DOM level. The physicochemical properties namely texture profile analysis and pasting properties, texture profile analysis were also affected by DOM level. This study referred that a lower DOM level could lead to more nutritious rice for better life quality by creating health consciousness to confer consumers to consume rice milled at lower degrees. This research may apply with rice milling business to produce nutritious and functional rice products through a little processing that is suitable DOM level.

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