Grain Quality of Paw San Varieties from Pathein, Pyapon and Shwebo Townships

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Abstract

Aromatic rice has become popular and gets the higher price than non-aromatic rice in the local and international markets. Paw San rice is one of the famous aromatic rice variety in Myanmar. The aim of this study was to compare the grain quality of the Paw San varieties from U To village (Pathein), Let Pan village (Pyapon) and Thee Lone village (Shwebo). A total of 13kg (10 pyis) of Paw San rice seeds were collected for each Paw San group (early, medium, late and Taung Pyan) from the farmers in each Township and seed moisture content were kept at 13%. Gain quality tests such as head rice percentage, milled grain length and grain length-width ratio, kernel elongation after cooking and grain aroma were carried out at Yezin Agricultural University (YAU). Amylose content, gelatinization temperature and gel consistency were analyzed at Department of Agricultural Research (DAR). Four groups of Paw San varieties such as Paw San Yin (PSY), Paw San That Latt (PSTL), Paw San Gyi (PSG) and Paw San Taung Pyan (PSTP) were cultivated in the study areas. Among the collected Paw San varieties, most consumer preference characters were found in Paw San Yin (Pyapon) such as medium length and length-width ratio of milled grain, strong aroma and slow harden on cooling. Moreover, most consumer acceptance characters such as the higher head rice percentage, sticky and less time required for cooking were also found in Paw San Gyi (Shwebo). Generally, all of the Paw San varieties from Pathein and Pyapon except PSTP (Pyapon) had aroma scores which were higher than that of varieties from Shwebo.

Key words: Paw San rice, grain quality, aroma

Introduction

Rice (*Oryza sativa* L.) is the major food of most Asian countries and aromatic rice varieties are playing a vital role in global rice trading. Aromatic rice varieties are popular all over Asia, and have also gained wider acceptance in Europe, Middle East, Australia and the United States of America (Sakthivel et al. 2009). While the supply of aromatic rice does not meet its demand, consumers appreciate it from paying the premium (Napasintuwong 2012). Major feature of these aromatic rice varieties is aroma which is being appreciated by many people and represents a high value added (Cruz and Khush 2000).

Paw San Yin (low photoperiod sensitive), Paw San Bae Gyar and Paw San Hmwe (high photoperiod sensitive) are the most famous aromatic rice varieties and widely grown in the districts of Pathein, Pyapone and Myaungmya of Ayeyarwaddy Delta region (Nwe and Myint 2004). Shwebo Township is one of the most rice growing areas in Sagaing Region and Shwebo Paw San variety is famous for quality rice variety with high price (Cho Cho Win 2013).

The fragrance of Paw San rice in Pathein and Pyapon is famous in the past and current situation. However, among Paw San varieties, Shwebo Paw San gets the highest price in the local market (The Agri-Business News 2016). However, the information on grain quality of Paw San rice from different regions of Myanmar is less documented. Therefore, this study was carried out to compare the grain quality of the Paw San varieties from Pathein, Pyapon and Shwebo Townships.

Materials and Methods

Seed sample collection and soil analysis

A total of 13 kg (10 pyis) of Paw San rice

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seeds were collected for each Paw San group (early, medium, late and Taung Pyan) (Table 1) from the farmers in each Township and seed moisture content were kept at 13%. Seeds were packed by polyethylene bag and placed in tin box and stored at ambient condition in the laboratory of Department of Agronomy, YAU till all the samples were completely collected. The soil samples were collected randomly at 0-15 cm depth from seed sample collected areas and analyzed at DAR (Table 2).

Grain Quality Test

Gain quality tests such as head rice percentage, milled grain length and grain length-width ratio, kernel elongation after cooking and grain aroma were carried out at YAU. Amylose content, gelatinization temperature and gel consistency were analyzed at DAR.

Head rice percentage

Rough rice samples are dehulled by using rice mill (LH-5001M LEEHWA).Whole grains (head rice) and broken rice were separated from the total milled rice by hand. The separated head rice and broken rice were weighted and calculated by the following formulae;

$$\text{Head rice } (\%) = \frac{\text{Weight of head rice (g)}}{\text{Weight of rough rice(g)}} \times 100$$

(Cruz and Khush 2000)

Based on the head rice percent, grades were classified as premium (>57%), grade 1 (>48.0 - <56.9 %), grade 2 (>39.0 - <47.9%) and grade 3 (>30.0 - <38.9) (Rice Technical Working Group 1997).

Milled grain length and length - width ratio

The grain length and width were measured with the help of a micro-scale Venier Caliper. Twenty grains of each sample were randomly selected from the respective samples and measured to determine their length and width (Rickman et al. 2006). Based on the length of the grains, the milled rice grains (size) were classified into four classes; very long (>7.5mm), long (>6.61 -<7.5mm), medium or intermediate (> 5.51- <6.6) and short (5.5mm or less) (Cruz and Khush 2000).

Ten randomly selected whole kernels of rice were taken, and length and width of each grain was measured by placing on a micro-scale of Venier Caliper. The average of 10 such observations was taken for final reading of length and breadth of rice kernels in millimeter (mm). The milled rice grains were again classified into four classes considering their length to width ratio as slender (>3), medium (2.1- 3), bold (1.1 - 2) and round (<1.1) (IRRI 1996).

Kernel elongation

The elongation test consisted of measuring 25 whole milled kernels which were soaked in 20 ml of distilled water for 30 minutes. The samples were placed in a water bath and the temperature was maintained at 98°C for 10 minutes. The cooked rice was transferred to a petri dish lined with filter pa-

Table 1. Paw San rice varieties collected from Pathein, Pyapon and Shwebo Townships

No.	Variety	Flowering time	Days to harvest*
1	Paw San Yin (Pathein)	October	135
2	Paw San Gyi (Pathein)	November	150
3	Paw San Yin (Pyapon)	October	135
4	Paw San Taung Pyan (Pyapon)	October	135
5	Paw San Gyi (Pyapon)	November	150
6	Paw San Yin (Shwebo)	October	120
7	Paw San Thet Latt (Shwebo)	November	150
8	Paw San Gyi (Shwebo)	November	165

* Although Paw San is photoperiod sensitive varieties, it could be harvested at the mentioned growth periods depending on the sowing time and probably photoperiod sensitivity of the Paw San varieties.
Source: Department of Agriculture

Table 2. The physicochemical properties of soil samples from Pathein, Pyapon and Shwebo Townships

Characteristics	Units	Pathein		Pyapon		Shwebo	
		Result	Rating	Result	Rating	Result	Rating
Soil pH		5.2	Moderately acid	5.9	Moderately acid	6.5	Slightly acid
Available N	mg kg^{-1}	73	Medium	64	Medium	39	Low
Available P	mg kg^{-1}	4	Low	12	Medium	11	Medium
Available K	mg kg^{-1}	196	Medium	492	High	265	High
Cation Exchange	$cmolkg^{-1}$	32	High	34	High	48	Very High
Organic Matter	%	2.9	Medium	2.2	Medium	2.0	Low
Soil Texture Class		**Loamy Sand**		**Loamy Sand**		**Sandy Loam**	
Sand	%	86		87		75	
Silt	%	2		1		10	
Clay	%	12		12		15	

per. Ten cooked whole grains were selected and measured in a photographic enlarger. The proportionate elongation is the ratio of the average length of cooked rice grains to the average length of raw rice grains (Cruz and Khush 2000).

Amylose_content

Amylose content was determined by using the simplified iodine colorimetric procedure by the method of Juliano (1971). Samples were categorized into waxy (0-7%), low (8-20%), intermediate (21-25%) and high (>25) based on the standard curve method of Williams et al. (1985).

Gel consistency

The gel consistency test was performed by the method of Cagampang et al. (1973) and classified into soft (100 mm), medium (41-60 mm) and hard (25-40 mm).

Gelatinization temperature

It was measured using alkali-spreading value. The alkali digestibility test was done by the method of Juliano (1971). Based on the alkali spreading value, gelatinization temperature was categorized into low, intermediate and high.

Sensory test

Aroma was evaluated with potassium hydroxide (KOH) according to a technique developed by Faruq et al. (2011). Ten members of post-graduate students from Yezin, Agricultural University were invited to score the aroma of each variety.

Statistical Analysis

Completely randomized design with three replications was used for testing the grain qualities of Paw San varieties. Rice quality data were analyzed with the analysis of variance (ANOVA) by using Statistix Program (Version 8.0) and means comparisons were done by Least Significant Difference (LSD) at 5% level.

Results and Discussion

Head rice percentage

In this study, different Paw San varieties showed different head rice percentages (Figure 1). The highest value of head rice percentage was found in PSG (Shwebo) and the lowest value was observed from PSG (Pyapon). The results detected that except PSG (Pyapon), all of the varieties in this research obtained premium grade. Although moisture content was controlled at 13% in this study, head rice percentage of PSG (Pyapon) was the lowest among the Paw San varieties. It may be related to longer stacking period of this variety. During stacking period, fissures may be formed due to internal stress that can cause breakage during milling. As stated by Lan and Kunze (1996), fissures were formed due to internal stresses in the rice grains

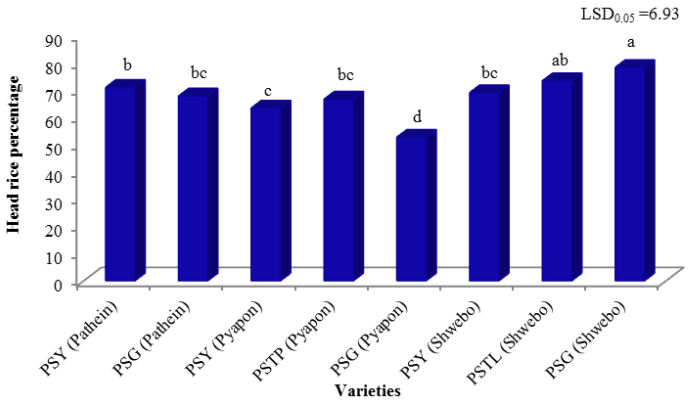

Figure 1. Head rice percentage of different Paw San varieties from Pathein, Pyapon and Shwebo Townships

(PSY= Paw San Yin, PSG = Paw San Gyi, PSTP = Paw San Taung Pyan, PSTL = Paw San That Latt)

during moisture re-adsorption from the surrounding environment. This practice may cause relatively lower head rice yield for Paw San varieties from Pyapon.

Milled Grain Length (mm) and Length-Width Ratio

Grain length was significantly different among different Paw San varieties collected from Pathein, Pyapon and Shwebo (Table 3). The longest grain length (5.65 mm) was found in Paw San Yin (Shwebo) which was not significantly different from Paw San Yin (Pyapon) (5.53 mm), and the shortest grain length (5.23mm) was observed in Paw San Gyi (Shwebo). Paw San Yin (Shwebo) and Paw San Yin (Pyapon) were included in medium group and the other six Paw San varieties were included in short group. In general, long grains are preferred in the Indian subcontinent, but in Southeast Asia the demand is for medium to medium long rice (Cruz and Khush 2000).

Significant differences in length-width ratio were observed among the different Paw San varieties (Table 3). Length-width ratios of Paw San Gyi (Shwebo) (1.73) and Paw San That Latt (Shwebo)

Table 3. Milled grain length and length-width ratio of Paw San varieties collected from Pathein, Pyapon and Shwebo Townships

Varieties	Length (mm)	Group	Length-width ratio	Group
PSY (Pathein)	5.40 bc	short	2.00 a	bold
PSG (Pathein)	5.35 cd	short	2.00 a	bold
PSY (Pyapon)	5.53 ab	medium	2.11 a	medium
PSTP (Pyapon)	5.33 cd	short	2.02 a	bold
PSG (Pyapon)	5.43 bc	short	2.03 a	bold
PSY (Shwebo)	5.65 a	medium	2.08 a	medium
PSTL (Shwebo)	5.37 cd	short	1.83 b	bold
PSG (Shwebo)	5.23 d	short	1.73 b	bold
LSD 0.05	0.15		0.14	
Pr>F	**		**	
CV%	1.58		4.00	

PSY= Paw San Yin, PSTP = Paw San Taung Pyan, PSTL = Paw San That Latt, PSG = Paw San Gyi

** means statically different at 1% level

(1.83) were smaller than the other varieties. Paw San Yin (Shwebo) and Paw San Yin (Pyapon) with medium grain length were included in medium group and the other varieties with short grain length were included in bold group.

Elongation ratio

Elongation ratio was significantly different among the different Paw San varieties collected from Pathein, Pyapon and Shwebo (Figure 2). The maximum elongation ratio (2.43) was observed in PSY (Shwebo), which was followed by PSTL (Shwebo), PSY (Pyapon) and PSG (Pyapon). The minimum value (2.01) was observed in PSG (Pathein). Sood et al. reported that linear elongation of the kernel on cooking is characteristic of the highly priced rice.

Amylose content

Amylose content was not significantly different among the different Paw San varieties (Figure 3). However, the highest amylose content was found in PSTP (Pyapon) (22.60) and the lowest value of amylose content was observed in PSG (Shwebo) (21.17). Therefore the coo ked rice of PSG (Shwebo) was tender and more sticky than PSTP (Pyapon) variety. In this study, all of the Paw San varieties were included in intermediate amylose content group. The majority of Myanmar people prefer intermediate amylose rice (23-24%) (Feder et al. 1985).

Gel consistency

In this study, all of the varieties fell into the group of hard gel consistency (below 40 mm). Cooked rices with hard gel consistency harden faster than those with a soft one (Julino 1979). Although gel consistency was not significantly different among different Paw San varieties (Figure 4), the highest value of gel consistency was found in PSY (Pyapon) (31.00**),** and the lowest gel consistency value was observed from PSG (Pyapon) (27.50). The cooked rice of PSG (Pyapon) can be slow hardened on cooling than the other Paw San varieties.

Gelatinization Temperature

The gelatinization temperature of almost Paw San varieties in this study were 75°C except PSG (Shwebo) with relatively lower gelatinization temperature (74˚C), as PSG (Shwebo) was the intermediate gelatinization temperature (Figure 5). In many rice growing countries there is a distinct preference for rice with intermediate gelatinization temperature (IRRI 2004). All varieties that have an intermediate gelatinization temperature are either intermediate or high in amylose content. In this experiment, PSG (Shwebo) have intermediate amylose content and intermediate gelatinization temperature. Thus, PSG (Shwebo) was tendered and the time required for cooking was less than other than the other Paw San varieties.

Grain Aroma

In this study, significant difference in grain aroma score was observed among different Paw San varieties (Figure 6). Manawthukha (non aromatic rice) was used as a check variety in this experiment. The highest aroma score (3.00) was found in PSY (Pyapon) followed by PSG (Pyapon) (2.67) and PSY (Pathein) (2.67). Among the different Paw San varieties in this experiment the lowest grain aroma score was observed in PSTP (Pyapon) (1.00) which was similar to the non-aromatic check variety. According to the results of this study, except PSTP (Pyapon), all of the Paw San varieties from Pathein and Pyapon Townships have higher aroma than Paw San varieties from Shwebo.

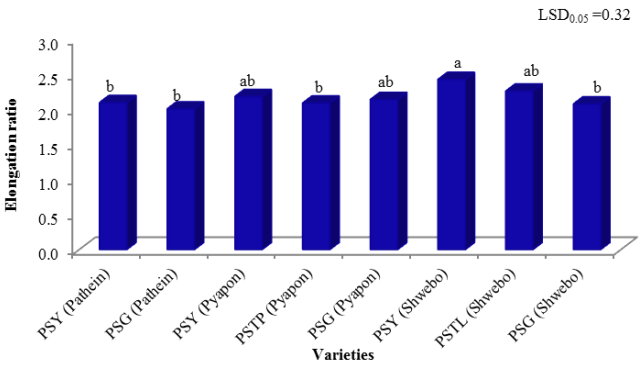

Figure 2. Elongation ratio of different Paw San varieties from Pathein, Pyapon and Shwebo Townships
(PSY= Paw San Yin, PSG = Paw San Gyi, PSTP = Paw San Taung Pyan, PSTL = Paw San That Latt)

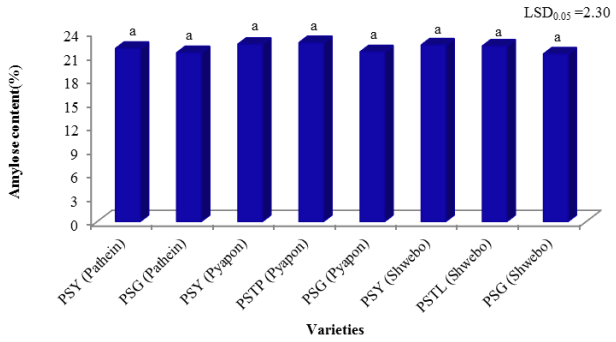

Figure 3. Amylose content of different Paw San varieties from Pathein, Pyapon and Shwebo Townships
(PSY= Paw San Yin, PSG = Paw San Gyi, PSTP = Paw San Taung Pyan, PSTL = Paw San That Latt)

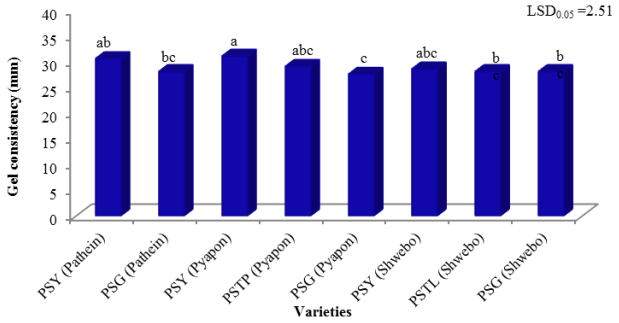

Figure 4. Gel consistency values of different Paw San varieties from Pathein, Pyapon and Shwebo Townships
(PSY= Paw San Yin, PSG = Paw San Gyi, PSTP = Paw San Taung Pyan, PSTL = Paw San That Latt)

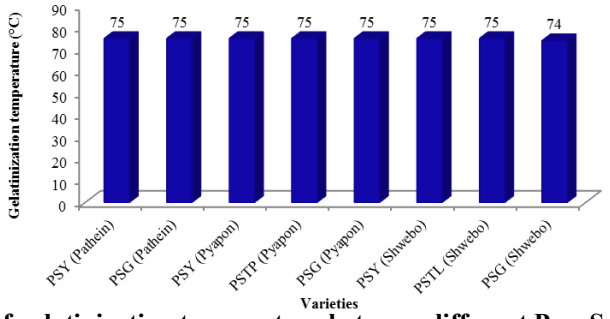

Figure 5. Mean values of gelatinization temperature between different Paw San varieties
(PSY= Paw San Yin, PSG = Paw San Gyi, PSTP = Paw San Taung Pyan, PSTL = Paw San That Latt)

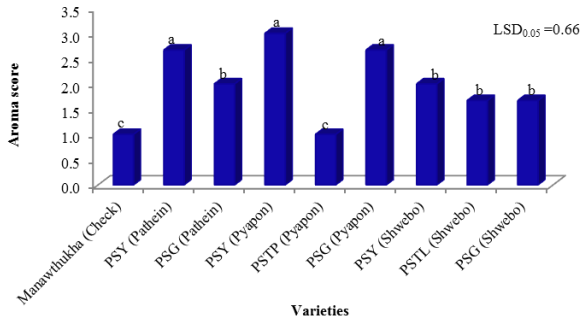

Figure 6. Aroma scores of different Paw San varieties from Pathein, Pyapon and Shwebo Townships
(PSY= paw san yin, PSG = paw san gyi, PSTP = paw san taungpyan, PSTL = paw san that latt)

Although BADH2 (Niu et al. 2008) has been identified as gene responsible for the synthesis of the aroma compound 2AP (Bradbury et al. 2005), other factors such as soil texture and soil pH seem to influence the aroma score of Paw San varieties (Bocchi et al. 1997; Itani et al. 2004). Itani et al. (2004) found that the 2AP concentration was higher in brown rice ripened at a low temperature (day: 25° C/night: 20°C) than that ripened at a high temperature (day: 35°C/night: 30°C) in both a short-grain cultivar 'Hieri' and a long-grain cultivar 'Sari Queen'. This finding showed that low temperature increased aroma. However in the present study, higher aroma was detected in Paw San varieties from the region with higher temperature. The maximum and minimum temperature during grain ripening in Pathein (32°C and 24°C) and Pyapon (33°C and 23°C) Townships during grain ripening were higher than that of Shwebo (29°C and 15°C) Township (DOA 2016).

Among Pathein, Pyapon and Shwebo Townships, loamy sand type was found in Pathein and Pyapon Townships whereas sandy loam type was observed in Shwebo Township (Table 2). Bocchi et al. (1997) also investigated the effect of soil characteristics on aromatic quality of rice in a field trial at Pavia, Italy. In this study, Paw San rice having relatively higher aroma score were produced from Pathein and Pyapon where the soil is sandy loam. This finding agreed with Bochhi et al. (1997).

Soil pH vales play an important role in aroma of rice. Saetung and Treloges (2017) also pointed out that the very fragrant of jasmine rice was found in range pH 4.7-4.8. Also in this study, soil pH vales of Pathein (5.2) and Pyapon (5.9) were relatively lower than Shwebo (6.5) Township (Table 2). Accordingly with these soil pH values, the aroma score of Paw San rice from Pathein and Pyapon except Paw San Taung Pyan were generally higher than that from Shwebo.

The findings from the present study highlight the needs to observe more about the relationship between rice aroma and other factors such as soil pH, soil texture and temperature of Paw San rice cultivation region.

Conclusion

Four groups of Paw San varieties (Paw San Yin, Paw San That Latt, Paw San Gyi and Paw San Taung Pyan) were cultivated in the study areas. Among the collected Paw San varieties, most consumer preference characters were found in Paw San Yin (Pyapon) and Paw San Gyi (Shwebo). Generally, all of the Paw San varieties from Pathein and Pyapon except Paw San Taung Pyan (Pyapon) had aroma score which was higher than that of varieties from Shwebo. In the present study, aroma score difference between Paw San varieties may be related to a different environmental condition such as temperature during grain ripening, and soil condition such as soil texture and soil pH of Paw San rice cultivation.

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