# Cooking Properties of Sabah Traditional Rice Germplasm

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## ABSTRACT

*Traditional rice possesses many useful traits that can be used in rice breeding programmes. This study was carried out to determine the cooking properties of Sabah traditional rice. A total of 111 Sabah traditional rice germplasm were collected from local rice farmers in Tuaran and Kota Belud districts during the period of December 2012 to January 2013. The cooking properties studied were elongation, elongation index, width expansion, volume expansion, water uptake and solid loss. A total of 10 whole rice grains per germplasm were selected and measured for length, width, volume and weight. The results revealed that the mean elongation, elongation index, width expansion, volume expansion, water uptake and solid were 1.78 (0.01), 1.28 (0.01), 0.39 (0.01), 326.37% (6.2), 216.86% (2.12) and 0.04 (0.001), respectively. In general, there was significant correlation between the cooking properties, except between solid loss and elongation, elongation index and width expansion; and between elongation index, water uptake and volume expansion. All significant correlation coefficients had positive directional, except width expansion and elongation and elongation index. This means the larger the elongation the smaller the width expansion. This condition can also be observed in basmati. The information obtained from this study will aid in the improvement of crops through breeding programmes.*

**Keywords:** *Cooking properties, Elongation, Water uptake, Volume expansion, Solid loss, Rice*

## INTRODUCTION

Rice (*Oryza sativa* L.) is one of the staple foods for Malaysians. Therefore the Malaysian government aims to be 100% self-sufficient in providing rice to

Malaysians. However, to date, Malaysia has only achieved 60% self-sufficiency. The value is lower in Sabah with only 30% self-sufficiency because 42,496 ha of land planted with rice produced 85422 t $ha^{-1}$ of rice (DOA, 2012). The largest contribution was from Kota Belud district (24.4%), followed by Kota Marudu district (15.2%) then Tenom district (9.4%).

Most of the areas in Kota Belud and Kota Marudu districts are planted with modern varieties. These varieties were produced by Malaysian Agriculture Research and Development Institute (MARDI) and/or Agriculture Research Centre (ARC, Sabah Agriculture Department). Besides high yield, they were designed to suit local preferences such as less amylose content, intermediate gelatinisation temperature, soft gel consistency and greater rice head content (fewer broken) (Unnevehr *et al.*, 1992; Wong *et al.*, 1992). Unnevehr *et al.* (1992) and Wong *et al.* (1992) reported that West Malaysians pay a premium for imported intermediate amylose content from Thailand and longer, slender rice. Wong *et al.* (1992) also reported that price has highly significant correlation with whiteness, chalkiness, rice head, length, shape, damaged grains, amylose content and gel consistency. Despite the above, there have been limited studies on cooking properties, especially for east Malaysians.

This study was carried out to determine the cooking properties preferred by local people. This knowledge will help researchers to tailor new rice varieties to local needs (quality and quantity) besides reducing the poverty among Malaysian farmers.

## MATERIALS AND METHODS

A total of 111 Sabah cultivated rice samples were procured from farmers of Tuaran and Kota Belud districts from December 2012 to January 2013. The grains were air-dried before analysis was carried out. The grains were then de-hulled and polished using rice polishing machine (LTJM-18, China).

The procedure to determine the kernel elongation, water uptake, volume expansion, and solid loss ratios was carried out as suggested by Ge *et al.* (2005), with modifications as stated below. A total of 10 whole milled rice kernels were selected. The selected rice grains were aligned end to end on graph paper with the aid of a ruler to measure their length (UGL) and width (UGW). The length was measured at the longest part and the width was measured at the widest part. The weight (UGWe) of 10 rice grains was recorded with the aid of sensitive, electronic, analytical balance to four decimals (Sartorius, Model BT 224 S). A volume of water was added to a 5 ml cylinder and was recorded as $Y_0$. $Y_1$ was recorded as the volume of water after adding the 10 selected rice grains. The volume (UGV) is denoted by $Y_1 – Y_0$.

Then, the selected rice grains were soaked in 4 ml distilled water for 30 min in a 50 ml test tube. A total 30 min of soaking time was necessary to ensure that the rice kernels absorbed water well before cooking. After that, the test tube mouth was covered with aluminium foil (Dela Cruz and Khush, 2000) and was placed in a water bath (Lab Companion, Model BS-06/31, manufacture by Jeio Tech, Inc.), which temperature was set at 100$^o$C (~98$^o$C; Shahidullah *et al.*, 2009), for 10 min (8 – 9 min; Hossain *et al.*, 2009b). The test tube was then moved from the water bath to an ice bath and cooled for 5 min (Yadav and Jindal, 2007). This is to prevent the rice kernels from continuing to cook outside the boiling water bath.

The cooked rice kernels were then transferred to filter paper before transferred to a petri dish. The rice kernels were blotted gently with a paper towel to remove excessive water on the surface. The cooked rice grains were then measured for length (CGL), width (CGW), weight (CGWe) and volume (CGV) as described above.

The gruel (residue of cooking water) was then poured into a 25 or 50 ml beaker. The test tube was rinsed at least three times and the total volume was made up to 20 ml. Before that, the empty beaker was weighed and the weight was labelled as $Z_0$. The residue was dried in an oven at 100$^o$C overnight or until no weight changed (completely dry; ~28 H). The dried beaker was weighed with the same digital balance and the later weight was labelled $Z_1$. The solid loss was denoted by mean weight of solid per mean weight of dry grain weight (Bello *et al.*, 2004)

## RESULTS AND DISCUSSION

The results of this study showed that elongation of Sabah traditional rice ranged from 1.49 to 2.05 with mean 1.78 (0.01; Table 1). Larger elongation ratio was found in this study as compared to the findings by Singh *et al.* (2005), Hossain *et al.* (2009b) and Shahidullah *et al.* (2009), which reported elongation ranged from 1.29 to 1.50, 1.51 to 1.82, 1.3 to 1.9, respectively. Hossain *et al.* (2009a) reported longer elongation ranging from 1.85 to 2.17. Basmati is well known for its elongation up to 2-fold and minimum elongation ratio accepted by quality standard is 1.73 (Singh *et al.*, 2011). Dela Cruz and Khush (2000) reported that few varieties could elongate up to 100%. The minimum quality standard of elongation ratio accepted in the global trade is 1.70 (Singh *et al.*, 2011). This indicated that some of the Sabah traditional rice could be marketed internationally.

**Table 1** Cooking properties studied in 111 varieties of Sabah Traditional rice

| Cooking properties | N | Minimum | Maximum | Overall Mean | Std. Error | Std. Deviation |
|---|---|---|---|---|---|---|
| **Elongation (1a)** | 111 | 1.49 | 2.05 | 1.78 | 0.01 | 0.10 |
| **Elongation (1b)** | 111 | 0.49 | 1.05 | 0.78 | 0.01 | 0.10 |
| **Elongation (1c) (%)** | 111 | 48.50 | 104.85 | 77.99 | 0.98 | 10.36 |
| **Elongation Index (EI)** | 111 | 1.00 | 1.57 | 1.28 | 0.01 | 0.11 |
| **Width Expansion (WE)** | 111 | 0.19 | 0.58 | 0.39 | 0.01 | 0.06 |
| **Water Uptake (3a)** | 111 | 2.56 | 3.75 | 3.17 | 0.02 | 0.22 |
| **Water Uptake (3b)** | 111 | 1.56 | 2.75 | 2.17 | 0.02 | 0.22 |
| **Water Uptake (3c) (%)** | 111 | 156.11 | 274.73 | 216.86 | 2.12 | 22.36 |
| **Volume Expansion (5a)** | 111 | 2.64 | 6.00 | 4.26 | 0.06 | 0.65 |
| **Volume Expansion (5b) (%)** | 111 | 163.89 | 500.00 | 326.37 | 6.20 | 65.33 |
| **Solid Loss (SL)** | 111 | 0.03 | 0.07 | 0.04 | 0.001 | 0.01 |

The elongation index (1.00 – 1.57) found in this study is lower than the finding (1.52 to 1.89) in Indian varieties by Yadav *et al.* (2007), but higher than the finding (1.13) in Indica/Japonica hybrids by Hossain *et al.* (2009b). Singh *et al.* (2005) and Yadav *et al.* (2007) reported wider and higher ranges of water uptake ratio (2.89 to 4.63, 2.37 to 4.45, respectively) in Indian varieties while Hossain *et al.* (2009a) and Oko *et al.* (2012) reported narrower and lower ranges of water uptake (117% to 248%; 114 to 280%, respectively) in Indica/Japonica hybrids and varieties of Ebonyi State, Nigeria, respectively. Sabah traditional rice germplasm has water uptake ranges (2.56 to 3.75 or 256.1% to 374.7%) that fall between these two groups. The value is fulfilling the minimum required quality standard accepted in the global market (Singh *et al.*, 2011). Hossain *et al.* (2009b) agreed that higher water absorption is observed in short- and medium-grained USA varieties than long grain types.

The volume expansion of Sabah traditional rice germplasm kernel (2.64 – 6.00) is wider than the volume expansion of Bangladesh rice germplasm (3.6 – 4.5) (Shahidullah *et al.*, 2009). Sabah traditional rice germplasm has higher and wider volume expansion (263.9% to 600%) compared to the Indica/Japonica hybrids (Hossain *et al.*, 2009b). The mean volume expansion of Sabah traditional rice germplasm and Bangladesh rice varieties (Hossain *et al.*, 2009b) (426.4%, 430.0%, respectively) are 1.56-fold more than the mean volume expansion (274%) of Indica/Japonica hybrids (Hossain *et al.*, 2009b). Hossain *et al.* (2009a) agreed with Zaman's study that volume expansion ranged ranging between 300 and 570% is valuable for pasty appearance while lower volume expansion (175 – 275%) has good cooking properties. It is observed that Sabahans like to make many kinds of rice paste (Lompuka, Tinapung, Kombos, Sasad, Linobok, Loput-loput, Kuih Wajid, etc.) during festivals such as weddings and Kaamatan (harvest festival).

Solid loss of Sabah traditional rice germplasm, which is between 0.028 and 0.068 (2.81% – 6.76%), is similar to the solid loss of Indian varieties reported by

Yadav *et al.* (2007) (2.51% – 5.20%) but narrower than those studied by Singh *et al.* (2005) (1.88% – 8.53%) and Oko *et al.* (2012) (0.5% – 47.5%), respectively.

In general, there are significant correlation coefficients among the cooking properties of Sabah traditional rice germplasm, except between elongation index (EI) and water uptake and volume expansion; and between solid loss and elongation ratio, elongation index and width expansion (Table 2). The findings are in agreement with those of Thomas *et al.* (2013). All significant correlation coefficients are positive except correlation coefficients between width expansion and elongation ratio and index. The bigger elongation ratio or index the larger water uptake and volume expansion, but narrower width expansion. The finding is in accordance with the results reported by Yadav *et al.* (2007) and Tian *et al.* (2005). Nevertheless, theirs have much higher magnitude.

The solid loss will increase with the higher water uptake and volume expansion ($r=0.386$, $r=0.26$, $p<0.001$, respectively). A similar finding was reported among non-basmati varieties by Yadav *et al.* (2007) who explained that absorbed water causes cell content to leach out easily during cooking and is due to the cell content becoming rather loose. However, they testified in general, there is significant negative correlation between solid loss and water uptake.

**Table 2** Correlation coefficient among cooking properties of Sabah Traditional rice germplasm

| | ER (1a) | ER (1b) | ER (1c) | EI | WE | WU (3a) | WU (3b) | WU (3c) | VE (5a) | VE (5b) | SL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ER (1a)** | 1 | | | | | | | | | | |
| **ER (1b)** | 1.000** | 1 | | | | | | | | | |
| **ER (1c)** | 1.000** | 1.000** | 1 | | | | | | | | |
| **EI** | 0.814** | 0.814** | 0.814** | 1 | | | | | | | |
| **WE** | -0.192* | -0.192* | -0.192* | -0.716** | 1 | | | | | | |
| **WU (3a)** | 0.511** | 0.511** | 0.511** | 0.107 | 0.430** | 1 | | | | | |
| **WU (3b)** | 0.511** | 0.511** | 0.511** | 0.107 | 0.430** | 1.000** | 1 | | | | |
| **WU (3c)** | 0.511** | 0.511** | 0.511** | 0.107 | 0.430** | 1.000** | 1.000** | 1 | | | |
| **VE (5a)** | 0.309** | 0.309** | 0.309** | 0.089 | 0.241* | 0.602** | 0.602** | 0.602** | 1 | | |
| **VE (5b)** | 0.309** | 0.309** | 0.309** | 0.089 | 0.241* | 0.602** | 0.602** | 0.602** | 1.000** | 1 | |
| **SL** | 0.049 | 0.049 | 0.049 | 0.075 | -0.099 | 0.386** | 0.386** | 0.386** | 0.260** | 0.260** | 1 |

*Notes: ER = elongation ratio; EI = elongation index; WE = width expansion; WU = water uptake; VE = volume expansion; SL = solid loss*
*Number in brackets indicates formula used.*
**, ** indicate significant differences at the 0.05 and 0.01 probability levels, respectively.*

## CONCLUSION

Overall, the results showed that there were significant association between the cooking properties and between elongation indexes, water uptake and volume expansion. This may suggest the reason why the locals prefer cooked rice with larger elongation, narrower width expansion, moderate water uptake and larger volume expansion.

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