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Kernel Ageing: An Analysis in Four Malaysian Rice Varieties

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ABSTRACT

In the present investigations, efforts were made to find out the ageing influence on four popular Malaysian rice varieties i.e. Mahsuri, Mahsuri Mutant, NS 9192 and Putri (Q-50). In Mahsuri, highest proportionate change, actual elongation and elongation was 0.17, 3.2 and 1.73 through natural ageing and in artificial ageing it was 0.23, 4.6 and 1.84, respectively. In Mahsuri Mutant, highest proportionate change, actual elongation and elongation was 0.43, 7.5 and 1.77, respectively through natural ageing and in artificial ageing it was 0.65, 8.5 and 2.15. Highest proportionate change, actual elongation and elongation was 0.27, 3.6 and 1.59, respectively through natural ageing in NS 9192 and in artificial ageing it was 0.60, 6.75, 2.29. Finally, in Putri highest proportionate change, actual elongation and elongation was 0.90, 7.0 and 2.08, respectively through natural ageing and in artificial ageing it was 0.90, 8.1 and 1.85. After considering different factors such as economical and practical limitations and analyzing the obtained results, it can be concluded that to get a good elongation ratio for Mahsuri, Mahsuri Mutant, NS 9192 and Putri, ageing at 110ºC for 3 h is best and convenient.

Key Words: Ageing; Elongation ratio; Proportionate change; Actual elongation

INTRODUCTION

Ageing is a process that can develop rice-cooking quality. Aged rice is popular in many South and South East Asian countries. It helps to increase kernel elongation rate during cooking time. It is very simple to practice, through ageing or storing rough rice for 3-4 month after harvest also affects grain quality. Higher total and head rice yields are obtained from aged rice (Villarial *et al.*, 1976; Perez & Juliono, 1981, 1982). In addition, aged milled rice has higher volume expansion and water absorption and less dissolved solids on cooking, and the cooked grain is flakier (Villarial *et al.*, 1976). Thus aged rice is preferred in testing for milling and cooking properties. The overall changes may depend on the rice variety, storing conditions and further treatment. While it is common knowledge that ageing of rice also affects the eating quality.

Aged rice is preferred over freshly harvested by rice consumers in tropical Asia, but disliked in countries where japonica rice is consumed. Workers in the United States point out that the above methods involve the addition and removal of moisture from the grain and these could cause grain cracking and subsequent reduced yield of head rice. They, therefore, experimented with heat treatment in closed containers and concluded that a temperature of 90ºC to 110ºC for 2-8 h produced rice similar to grain stored for 14 months, though the chemical and physical changes (or both) affected by heat treatment appear different from those changes resulting from natural ageing (Normand *et al.*, 1964). In the present investigation, it was tried to analyze the ageing effect in four popular rice varieties namely Mahsuri, Mahsuri Mutant, NS 9192 and Putri. The objective was to find out the good ageing conditions to improve rice-cooking qualities, as well as to optimize the ageing time, temperature and conditions. So, the consumers use these techniques for their domestic use as well as the traders for their commercial use. The most important issue is Mahsuri is continuously using as a parental materials in crossing block for it's well adaptability in Malaysian agro-climatic conditions. Simultaneously Malaysian fine rice breeders should use Putri to develop further new fine rice variety. Additionally, NS 9191 and Mahsuri Mutant (sister lines) are performing great because of their good yield and linear elongating characters. So our optimized curing technique may be used as breeding tool to screening early generation materials of these four varieties.

MATERIALS AND METHODS

Plant material. Polished white rice grain of the four Malaysia rice namely Mahsuri Mutant, Mahsuri Mutant, NS 9192 and Putri (Q-50) were used.

Artificial ageing. For this purpose seeds were incubated at 90, 100 or 110ºC for 1, 3, 5, 7 or 9 h. Each sample was taken in to Greiner 50 mL airtight and ovenproof test tube. After ageing samples were kept in room temperature for 1 h for cooling and then opened and proceed for further work. A Memmert (Germany) oven was used for these ageing activities.

Natural ageing. For Natural ageing the seeds of the 4 mentioned varieties were kept in airtight container at room temperature (around 28ºC) and every month kernel elongation ratio was measured. These observations were continued for a period of six months. Completely randomized design was followed with three replications and SAS package was used to analyze the data.

Measurement of elongation ratio, proportionate change and actual elongation. Ten measured (length and breath) aged grains of 15 different treatments (3 temperature x 5 different time) were taken into 20 mL glass test tube and soaked for 20 minutes with 5 mL of tap water. After soaking, the test tubes were put into boiling water for around 30 minutes. When the grains cooked properly test tubes were taken out and removed the water inside the test tubes. Thereafter, cooked grains were kept on a glass sheet for few minutes to evaporate extra moisture and then the length and breath of the cooked grains were measured. Measurements were done through a digital slide calipers. Kernel elongation ratio means the proportionate change of rice grain after cooking. But different research group define it in different way, such as Sood and Siddiq (1980) during measuring kernel elongation they want to consider both length and breadth wise expansion of grain after cooking and they proposed the following formula to measure kernel elongation:

$$PC = \frac{L_F / B_F - L_0 / B_0}{L_0 / B_0}$$

Where, L_F, B_F are length and breadth respectively of the kernel after cooking; L_o, B_o are length and breadth before cooking. PC is proportionate change

To measure lengthwise elongation ratio, average length of 10-cooked kernels was divided by 10 precooked kernel average length. From 10 cooked kernel average length we minus average length of precooked length of the same grains and determined the actual elongation. Actual elongation was measured in mm.

RESULTS AND DISCUSSION

Comparisons of elongation ratio of the parental materials at different temperature conditions with different ageing times. At 90ºC temperature all the four varieties showed minimum kernel elongation ratio with 1 h ageing time and all the four except Putri performed maximum elongation ratio with 5 h ageing time. Putri showed it (1.85) at 3 h ageing but at 5 h it also showed a good elongation ratio (1.84). At 90ºC temperature 5 h ageing is best for good kernel elongation for the selected parental materials. But it may take 3 h for fine rice like Putri (Fig. 1).

At 100ºC temperature, the scenario was bit changed, because here with 5 h ageing time only Mahsuri (1.84) and it's derivatives mutant line (Mahsuri Mutant) showed maximum elongation ratio (2.31). Again the Putri showed maximum elongation at 3 h ageing time (1.91) and here 9192 followed Putri that showed maximum elongation 1.85. But for lowest elongation all four varieties followed the trend of 1 hour ageing time. Elongation ratios were increased in all varieties at 100ºC compare to 90ºC (Fig. 1, 2). The scenario was totally changed at 110ºC, where all the four varieties showed maximum elongation ratio with 3 h ageing time, though the mutant line (Mahsuri Mutant) followed it's previous trend and showed maximum elongation ratio (2.29) also with 5 h ageing time. But at initial stage (1 h ageing time) all of them showed lowest elongation ratio (Fig. 3). At this stage all the four varieties showed highest elongation ratio compare to the previous two temperature conditions. But of course we observed that at this stage cooked rice was not much flaky as at 100ºC and Mahsuri mutant showed breaking tendency. Putri showed more flakiness at this stage compare to others. From the above results, we can conclude that to get a good elongation ratio for the parental materials (Mahsuri, Mahsuri Mutant, 9192) and the check variety (Putri), 110ºC with 3 h ageing time is best and convenient.

Fig. 1. Comparison of elongation ratio of four rice varieties with five different ageing times at 90ºC

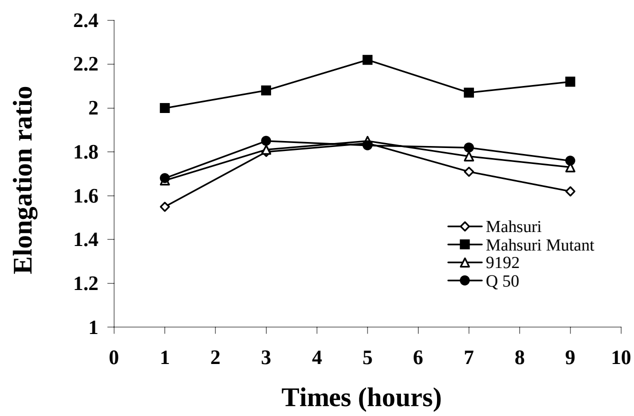


Fig. 2. Comparison of elongation ratio of four rice varieties with five different ageing times at 100ºC

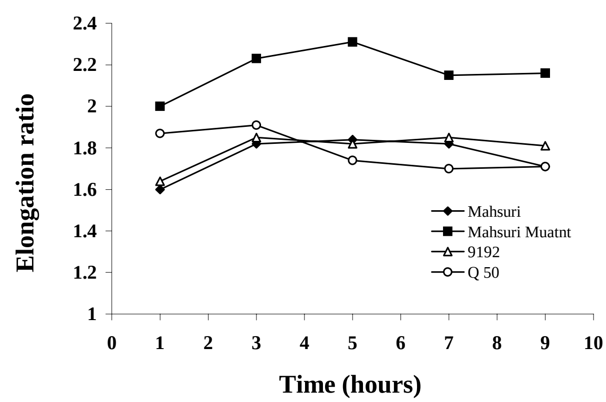
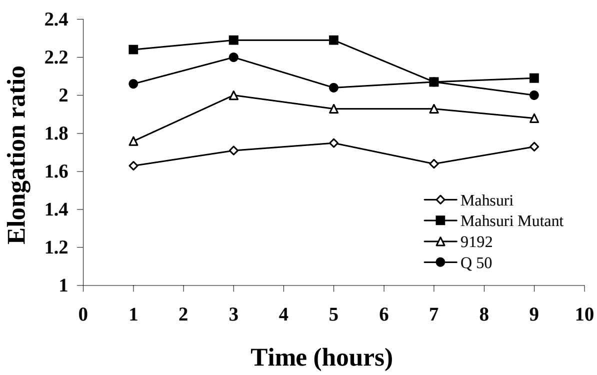


Fig. 3. Comparison of elongation ratio of four rice varieties with five different ageing times at 110ºC



improve rice cooking and eating quality. The proper ageing method (time and temperature) optimized for the parental materials in this study can be used to screen early generation materials of the mentioned parental based crosses. Additionally, the commercial rice grain traders as well as the consumers can use it.

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Table I. Analysis of variance of elongation ratios, proportionate changes and actual elongations in different varieties, times and temperatures

Source	Elongation ratio		Proportionate change		Actual elongation	
	DF	MS	DF	MS	DF	MS
Variety	3	1.43508**	3	1.75420**	3	104.929**
Temperature	2	0.34698**	2	0.12970**	2	12.0417**
Time	4	0.18200**	4	0.06596**	4	5.8999**
Variety*Temperature	6	0.10842**	6	0.20261**	6	4.4335**
Variety*Time	12	0.03139**	12	0.00932**	12	0.6508**
Temperature*Time	8	0.01209^{NS}	8	0.02504**	8	0.4013**
Variety*Temp*Time	24	0.01317*	24	0.01175**	24	0.3440*
Error	120	0.00839	120	0.00026**	120	0.1214**
Total	179		179		179	

***=Highly significant at 0.01 level of probability; **=Significant at 0.05 level of probability, ^{NS}=Non significant

Table II. Kernel expansion of four Malaysian rice varieties with different conditions

Variety	Proportionate change			Actual elongation			Elongation ratio		
	Fresh	N. aged	A. aged	Fresh	N. aged	A. aged	Fresh	N. aged	A. aged
Mahsuri	0.13	0.17	0.23	3.3	4.2	4.6	1.64	1.73	1.84
M. Mutant	0.41	0.43	0.65	4.30	7.50	8.50	1.77	2.15	2.30
9192	0.27	0.36	0.60	3.6	4.7	6.75	1.53	1.59	2.29
Putri	0.34	0.90	0.90	3.8	7.0	8.1	1.61	1.85	2.08

Highest observed values have used in all three conditions, A = Artificial, N = Natural

Analysis of the influencing factors and their interaction on kernel elongation, proportionate change and actual elongation. It is evident from Table I that variety, temperature and time significantly influenced elongation ratio, proportionate change and actual elongation. Variety X time interaction, variety X temperature interaction and variety X temperature X time interactions also significantly influenced these physical properties of rice kernel. Temperature X time interaction does not significantly influence elongation ratio, but this interaction influenced proportionate change and actual elongation.

Expansion observations in fresh kernels. The effects of ageing rice easily understood when freshly harvested kernel was used to determine actual elongation, proportionate change and elongation ratio (Table II).

CONCLUSION

Ageing is one of the most influencing factors to

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