QUALITY PARAMETERS FOR MALAYSIAN RICE VARIETIES

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Keywords: Rice quality, Local varieties, Physical, Chemical, Cooking and Eating properties.

RINGKASAN

Sebagai makanan asas penduduk-penduduk di negara ini, mutu padi dan beras merupakan faktor penting yang perlu mendapat perhatian besar. Jenis-jenis padi yang dikeluarkan hendaklah mempunyai mutu yang tinggi dari segi sifat-sifat yang dapat dilihat secara mata kasar, mutu pengilangan, mutu masakan dan rasa. Ciri-ciri fizikal dan kimia seperti saiz, rupa, bentuk, berat, kekerasan biji, sifat-sifat kanji, protein, aroma dan nisbah pemanjangan adalah di antara kriteria-kriteria yang menentukan mutu jenis-jenis padi. Beras jenis panjang, mempunyai rupa bentuk yang menarik dan mutu pengilangan yang tinggi, beramilos sederhana atau tinggi, suhu pengelatinan sederhana dan gel yang lembut adalah lebih digemari.

Proses-proses lepastuai seperti pengeringan, penyimpanan dan pengilangan mempengaruhi mutu padi dan beras. Proses keusangan tidak diketahui dengan jelas tetapi ianya melibatkan pertukaran-pertukaran yang berfaedah dari segi mutu pengilangan, masakan dan rasa jenis-jenis padi tempatan.

INTRODUCTION

Together with yield, resistance to major pests and diseases, grain quality plays an important role in the development of any new rice variety. As a staple food, consumers are very conscious of the quality of rice that they consumed. Any new variety released for commercial production should possess a good or at least an acceptable quality in combination with other agronomic features required by the local rice industry.

Rice grain quality requirements vary from country to country and from one ethnic group to another. Rice is also widely used for the manufacture of many food items and the quality that is suitable for one product may not be suitable for another. However, as rice is mainly consumed in whole kernel form in this country, either boiled or steamed, the properties of the intact kernel are of particular significance.

Genetic make-up of the grain, environmental conditions and cultural practices have great influence on rice quality. In addition, other factors such as those associated with handling, drying and storage also affect the grain quality. The objective of this paper is to identify and discuss the major quality parameters considered to be important in evaluating the quality of the Malaysian rice varieties.

MATERIALS AND METHODS

Ten varieties of non-glutinous and two varieties of glutinous rice, grown locally, were studied. Samples were dried to 13% - 14% moisture content and stored at room temperature for at least three months before being analysed.

Grain dimensions were determined on 25 grains of paddy, brown rice and milled rice and classified based on the established standard for milled rice. Grain shape was determined from the length to breadth ratio following the Food and Agricultural Organization classification and weight was determined based on the weight of 1 000 grains and the hectolitre weight. General appearance was assessed from the colour using a whiteness meter, and the presence of chalky grains.

Satake Huller and McGill Mill No. 3 were used to evaluate the milling quality of the samples. The milling components were

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determined after separation by the grader, test sieves and handpicking.

Amylose content was analysed using the simplified assay for milled rice amylose (JULIANO, 1971). Gelatinization temperature was estimated by the alkali digestion method of LITTLE, HILDER and DAWSON (1958) and gel consistency test was based on the method of CAGAMPANG, PEREZ and JULIANO (1973). Protein, crude fat, crude fibre, ash and silica contents were determined by the methods described in the AOAC (1970). Anthrone reagent was used to estimate the starch and sugar contents (YOSHIDA, FORNO, COCK and GOMEZ, 1976).

The amylography of the rice samples were evaluated using the Brabender Amylograph. The amylographic values of interest determined were pasting temperature, peak viscosity, breakdown, consistency and set-back.

The cooking properties were determined on 20 g samples cooked for 20 minutes in excess water. Water uptake ratio was calculated from the weight of cooked and raw rice and volume expansion ratio was determined from the volume of cooked and uncooked rice measured by displacement method.

Cooking time was estimated by RANGHINO's method (1966).

For sensory evaluation studies, the rice to water ratio was adjusted based on the amylose content of the sample. The properties of cooked rice evaluated were aroma, flavour, tenderness, cohesiveness, colour (whiteness) and glossiness using 1 to 9 scoring scale with higher number indicating the intensity of the character (*Appendix 1*).

RESULTS AND DISCUSSION

Rice varieties

Nine officially released rice varieties, two popularly grown varieties and one semitraditional variety were used in this study (*Table 1*). They differ widely with respect to physical, chemical, cooking and eating qualities.

Grain dimensions, shape and appearance

Grain size and shape are among the first quality criteria being considered in developing rice varieties for commercial produc-

Variety	Parent/combinations	Year released	Grain-type
Anak Dara	_	unreleased	Medium
Kadaria	IR8/Engkatek/Sacupak	1981	Medium
Mahsuri	Mayang Ebos 80 ² /Taichu 65	1965	Medium
Mat Candu	_	unreleased	Long/slender
Pongsu Seribu	(dry-land variety)	unreleased	Medium
Pulut Malaysia I	Pulut Sutera/Ria	1974	Long/slender
Pulut Siding	(Pulut Sutera/Ria) ² //Tjina	1981	Long/slender
Sekencang	Jaya ³ /Tadukan	1979	Long/slender
Sekembang	IR8//Engkatek/Sacupak///Ria 163	1979	Medium
Setanjung	IR22/Pazudofusu	1979	Long/medium
Sri Malaysia I	Peta/Tangkai Rotan	1974	Medium
Sri Malaysia II	Ria/Pankhari 203	1974	Long/slender

Table 1. Malaysian rice varieties

tion. They are primary quality factors in marketing, grading and processing.

In this country, rice varieties are classified as long (>6.2 mm), medium (5.2 mm - 6.2 mm) and short (< 5.2 mm) based on the length of the whole kernel milled rice. Presently only the first two categories are being produced commercially. Local short

grains are confined to traditional varieties *e.g.* padi Burong and Kukor and are being planted only for specific purposes.

All rice varieties released to date are medium or long grains (*Table 2*). Although preference is towards long and slender grain, this has to be compromised with other quality factors such as yield and price.

	Forms	(Grain (mm)		Length/	1 000-	Hectolitre	Hardness
Variety	of rice	Length	Width	Thickness	breadth (ratio)	grain wt. (g)	wt. (kg/litre)	(kg)
Anak Dara	Paddy Brown rice Milled rice	8.15 5.93 5.69	2.62 2.22 2.15	1.74 1.53 1.49	3.08 2.67 2.73	18.77 14.81 13.40	56.2	3.66
Kadaria	Paddy Brown rice Milled rice	8.18 5.97 5.83	2.51 2.19 2.11	1.77 1.55 1.52	3.26 2.66 2.76	18.15 14.65 13.82	55.45	3.28
Mahsuri	Paddy Brown rice Milled rice	7.75 5.46 5.38	2.41 2.12 2.04	1.82 1.56 1.53	3.22 2.58 2.64	16.56 13.08 11.81	57.55	3.65
Mat Candu	Paddy Brown rice Milled rice	9.30 6.54 6.41	2.43 2.07 1.97	1.81 1.58 1.52	3.83 3.16 3.25	20.35 16.31 14.72	55.00	3.51
Pongsu Seribu	Paddy Brown rice Milled rice	8.33 5.90 5.75	2.48 2.13 2.12	1.78 1.55 1.50	3.35 2.76 2.71	17.80 14.13 12.90	53.25	3.49
Pulut Malaysia I	Paddy Brown rice Milled rice	9.54 6.65 6.36	2.37 2.12 2.03	1.96 1.66 1.60	4.03 3.14 3.13	21.53 16.93 14.65	49.50	2.93
Pulut Siding	Paddy Brown rice Milled rice	10.22 7.36 7.23	2.64 2.15 2.11	1.99 1.75 1.69	3.87 3.42 3.43	26.24 20.71 18.61	50.25	3.65
Sekencang	Paddy Brown rice Milled rice	9.23 6.77 6.74	2.65 2.20 2.13	1.91 1.65 1.61	3.48 2.97 3.16	24.39 19.06 17.06	54.70	3.80
Sekembang	Paddy Brown rice Milled rice	8.92 6.34 6.00	2.52 2.19 2.10	1.90 1.66 1.62	3.54 2.89 2.86	21.09 17.33 15.47	52.30	3.62
Setanjung	Paddy Brown rice Milled rice	8.78 6.51 6.47	2.75 2.42 2.27	2.06 1.84 1.79	3.19 2.69 2.85	27.08 21.77 19.83	59.90	4.32
Sri Malaysia I	Paddy Brown rice Milled rice	8.27 5.92 5.66	2.90 2.56 2.49	2.02 1.71 1.64	2.85 2.31 2.27	23.44 19.04 16.88	57.50	2.78
Sri Malaysia II	Paddy Brown rice Milled rice	9.96 7.26 7.01	2.75 2.30 2.22	2.08 1.81 1.77	3.62 3.16 3.16	29.15 22.81 20.61	54.75	3.61

Table 2. Physical properties of some local rice varieties

Classification of rice grains based solely on grain length may sometimes create problem particularly with varieties which are broad or thick or of marginal length *e.g.* Setanjung. It is felt that in classifying local rice varieties, both grain length and shape should be taken into consideration.

The standard for classifying shape for the local rice varieties has not been established. However, the FOOD AND AGRICULTURAL ORGANIZATION (1956) standard can be used. It was observed that slender shape is usually associated with long grains.

Grain appearance is largely determined by the colour and the amount of chalkiness in the grain. Good quality rice should have bright, clear and highly translucent milled rice kernel, free from inherent chalky spots in addition to other desired quality traits.

Although chalkiness has no direct effect on cooking and eating quality, chalky grains are undesirable as they are more prone to breakages during milling (*Table 3*). The starch granules in the chalky areas are less densely packed and with air spaces between the granules (DEL ROSARIO BRIONES. VIDAL and JULIANO, 1968: TASHIRO and EBATA, 1975). In every standard grade of rice, there are specific ranges of the amount of chalky grain permissible to each grade. The maximum level of chalky grain allowed for long grain (A grades) is 10% and for medium (B grades) and short (C grades) are 15 per cent. Manufacturers of rice products usually place limitation on the amount of chalkiness allowed as it contributes to the nonuniformity of the manufactured products.

Chalkiness is an inherent character but it is also very much influenced by environmental factors, particularly those that interrupt normal grain filling (TASHIRO and EBATA, 1975), such as infection by neck blast and drought stress during ripening.

Another physical trait of significance is test weight per unit volume (kg/hectolitre) which is closely related to kernel weight and bulk density of the grain. In addition to its usefulness in estimating the amount of paddy

Variety	Total milling recovery	Head rice	Husk	Bran
Anak Dara	67.2	78.2	23.1	9.7
Kadaria	67.8	79.9	22.0	10.2
Mahsuri	68.0	82.9	22.2	9.8
Mat Candu	66.5	69.5	23.3	11.2
Pongsu Seribu	67.2	79.4	23.3	9.5
Pulut Malaysia I	66.6	83.4	21.5	11.9
Pulut Siding	66.2	70.4	23.0	10.8
Sekencang	68.3	73.0	22.1	9.6
Sekembang	70.5	78.8	20.1	9.4
Setanjung	70.4	76.3	20.8	8.8
Sri Malaysia I	64.5	54.4	23.9	11.6
Sri Malaysia II	67.5	64.5	22.4	10.1

Table 3. Milling qualities (%) of some local rice varieties

in storage systems, it is also a useful index to milling recovery in measuring the relative amount of dokage or foreign matter, shrivelled or immature kernel.

Milling quality

Milling quality, commonly given as the total milling (whole and broken grains) and head rice yield, is the measure of paddy performance during the milling process. In general, the milling products of the local rice varieties constitute of 20%-25% husks, 8%-11% bran and 65%-70% total milled rice (*Table 3*). The product which is of economic significance, is the head rice.

Head rice vield varies widely. depending on many factors such as variety. grain type, chalkiness, cultural practices. environmental factors and drying, storage and milling conditions. In general, varieties with long or extra long grains, excessively slender or bold shape, partially flatten grains and those having chalky grains give lower head rice yield. Some varieties e.g. Setanjung and Sri Malaysia II are particularly sensitive to stress imposed during the post-harvest operations. Therefore, in determining the milling potential of a variety, these factors should be noted and wherever possible minimized.

A major problem in determining the milling quality of rice is the measurement of the milling degree. To compare rice on the basis of their milling quality, the degree of milling must be comparable. However, although milling degree can be categorized as well milled, reasonably well milled, lightly milled and undermilled, there is no precise defination for them.

Generally, the preference is for well milled rice although this may result in lowering the nutrient value since proteins, fats, vitamins and minerals are concentrated in the germ and the outer layer of the starchy endosperm.

Cooking, eating and processing qualities

Cooking, eating and processing characteristics of rice are largely determined by the properties of the starch that makes up more than 80% of milled rice (*Table 4*). The starch components, particularly the amylose content or the amylose:amylopectin ratio,

Variety	Starch	Sugar	Protein (brown rice)	Fat	Ash	Crude fibre	Silica
Anak Dara	85.6	0.3	8.2	0.3	0.6	0.4	0.09
Kadaria	88.0	0.6	7.7	0.2	0.6	0.4	0.04
Mahsuri	86.9	0.5	8.3	0.4	0.7	0.2	0.04
Mat Candu	87.2	0.7	7.3	0.2	0.4	-	0.02
Pongsu Seribu	88.0	0.7	9.8	0.3	0.6	0.3	0.14
Pulut Malaysia I	87.6	0.6	7.3	0.5	0.7	_	0.05
Pulut Siding	84.0	0.3	7.7	0.4	0.5	0.3	0.04
Sekencang	80.0	0.7	9.3	0.2	0.8	0.2	0.11
Sekembang	86.4	0.7	9.2	0.2	0.6	0.3	0.05
Setanjung	84.8	0.8	8.4	0.2	0.5	_	0.04
Sri Malaysia I	84.8	0.7	6.3	0.2	0.6	0.4	0.03
Sri Malaysia II	86.4	0.3	7.2	0.2	0.4	0.3	0.16

Table 4. Chemical compositions (%) of some local rice varieties

its temperature of gelatinization and its pasting characteristics are largely responsible for major differences in rice cooking and processing behaviour.

I. Starch

(i) Amylose

Rice starch is composed of a major branched fraction, amylopectin, and a linear fraction, amylose. Amylose content is considered to be the single most important characteristic for predicting rice cooking and processing behaviour (JULIANO, 1972).

Most of the popularly grown local varieties are of high amylose (>25% amylose) (*Table 5*). Popular varieties such as Mahsuri has moderately high amylose and Mat Candu has high amylose. Most of the traditional varieties tested to date are of intermediate amylose (20% - 25% amylose).

High amylose rices show high volume of expansion and a high degree of flakiness (*Tables 6* and 7). These rices cook dry, are less tender and become hard upon cooling. Cooked rice is most resistant to disintegration than lower amylose rices. Intermediate amylose rices such as Sekencang, Jaya and Pongsu Seribu, cook moist and tender and do not become hard upon cooling. Low amylose rices cook moist and sticky and are preferred for their tenderness, stickiness, glossiness and taste by the Japanese, Koreans and Taiwanese. Waxy rice expands the least during cooking and cooked rice are glossy and sticky.

Water absorption during cooking is influenced by the amylose content. For sensory evaluation studies in order to attain similar doneness of cooked rice, the rice to water ratio was adjusted to 1:1.8 for intermediate amylose rice, 1:1.9 for moderately high amylose rice and 1:2.0 for high amylose rice.

(ii) Gelatinization temperature

It is a range of temperature within which the starch granules begin to swell irreversibly in hot water. Final gelatinization temperature ranges from 55° C to 79° Centigrade. The property is not strictly variety-specific, for it may vary by several degrees within a single variety.

Gelatinization temperature was estimated by the extent of alkali spreading and cleaning of milled rice soaked in 1.7%potassium hydroxide for 23 hours at room temperature (LITTLE *et al.*, 1958). Varieties

	Protein	Amylose	Alkali	Gel	Gel	Amyle	ograph visc	osity (B.U.)	Ins	tron
Variety	(%)	(%)	spreading value	consistency to (mm)	emperature (°C)	Peak	Set-back	Consistency	Hardness (kg)	Stickness (g/min)
Anak Dara	5.8	27.2	3.7	63	76.5	760	250	460	_	
Kadaria	6.2	28.1	5.0	81	72.0	735	260	460	7.85	1.37
Mahsuri	6.2	26.9	5.0	51	73.7	715	148	418	_	
Mat Candu	6.3	29.0	4.5	64	73.3	770	90	380	-	_
Pongsu Seribu	4.7	23.5	5.0	77	72.0	660	-240	145		_
Pulut Malaysia I	5.4	1.1	6.3	100	64.5	285	-175	20	_	_
Pulut Siding	5.8	1.4	6.4	100	60.0	395	-182	38	3.40	69.71
Sekencang	7.3	22.3	2.1	77	76.5	820	-275	170	6.90	10.40
Sekembang	6.7	28.0	7.0	51	69.0	720	_	_	8.28	1.17
Setanjung	7.0	29.2	7.0	50	68.7	795	780	830	7.13	0.94
Sri Malaysia I	4.3	28.8	3.0	100	76.5	600	- 20	260		_
Sri Malaysia II	5.2	29.1	7.0	38	64.5	840	_	_	8.15	1.34

Table 5. Quality characteristics of local milled rice

Variety	Cooking time (min)	Water uptake ratio	Volume expansion ratio	Solid loss (g)	pH of cooking water
Anak Dara	16.0	3.28	4.76	2.07	5
Kadaria	18.0	3.18	4.54	1.40	5-6
Mahsuri	15.5	3.17	4.57	2.02	5-6
Mat Candu	16.5	3.24	4.47	6.22	5
Pongsu Seribu	15.5	2.76	3.88	2.72	5-6
Pulut Malaysia I	13.0	2.76	3.68	2.70	5
Pulut Siding	13.5	2.55	3.36	3.88	5-6
Sekencang	16.5	2.94	3.94	3.86	5 - 6
Sekembang	15.0	3.00	4.29	6.22	5
Setaniung	18.0	3.08	4.08	2.10	5
Sri Malaysia I	20.0	2.61	3.46	2.00	4
Sri Malaysia II	15.0	3.09	4.19	2.05	5

Table 6. Cooking properties of local rice varieties

Table 7. Organoleptic evaluation of cooked rice

Variety	Flavour	Tenderness	Cohesiveness	Glossiness	Colour
Anak Dara	5.5	5.7	3.7	4.5	8.7
Kadaria	5.1	4.6	3.8	5.6	8.0
Mahsuri	5.8	4.8	3.8	5.6	8.3
Mat Candu	6.4	4.5	3.8	5.0	8.7
Pongsu Seribu	6.2	6.1	6.2	5.2	8.0
Pulut Malaysia I	6.4	8.6	8.6	8.2	7.5
Pulut Siding	5.7	8.3	8.3	9.0	7.5
Sekencang	5.8	6.5	6.3	6.7	8.5
Sekembang	4.4	4.4	3.3	5.8	8.8
Setaniung	4.7	4.6	3.6	5.9	8.6
Sri Malaysia I	3.2	7.5	6.0	8.3	9.0
Sri Malaysia II	4.2	4.2	2.9	5.2	8.9

with low gelatinization temperature (< 70° C) *e.g.* Setanjung, Sekembang and Pulut Siding disintegrated completely, whereas varieties with intermediate gelatinization temperature (70° C- 74° C) such as Mahsuri and Mat Candu, showed only partial disintegration. Rices with high gelatinization temperature (> 74° C) *e.g.* Sekencang and Jaya remained largely unaffected in the alkali solution (*Plate 1*). The effect of starch gelatinization temperature on rice quality is still not fully clear. However, it was observed that varieties with intermediate gelatinization temperature was preferred to that of high or low gelatinization temperature.

Gelatinization temperature may have some bearing on the processing quality of the rice grain. It was noted that varieties suitable



Plate 1. Degradation patterns of rice grains by alkali.

for parboiling and canning and for quickcook processing in the U.S.A. have an intermediate gelatinization temperature. Low gelatinization temperature rices seem to be preferred for certain processed products such as baby food and breakfast cereals and for brewing (MATZ and BEACHELL, 1969). High gelatinizing types are generally considered undesirable for most cooking and processing uses.

(iii) Gel consistency

Gel consistency is a useful index of softness of cooked rice particularly for rice with high amylose content. It is a measure of the flow characteristics of milled rice gel and is indexed by the length (mm) of the cold horizontal gel (CAGAMPANG *et al.*, 1973) (*Plate 2*).

Low and intermediate amylose rices usually have soft gel consistency. High amylose varieties may have hard, medium or soft gel consistency (*Table 5*). Generally, soft gel consistency is preferred over medium or hard consistency. In high amylose rices, soft gel consistency is mainly associated with intermediate gelatinization temperature e.g. Mat Candu and hard gel consistency is associated with low gelatinization temperature e.g. Sri Malaysia II.

Gel consistency measures the tendency of the gelatinized starch to retrograde on cooling, since it correlates with Amylograph set-back viscosity (CAGAMPANG *et al.*, 1973) and with Amylograph consistency (viscosity on cooking to 50° C – final viscosity at 94°C) particularly among high amylose rices. Rices with a consistency of over 600 B.U. are confirmed to have hard-medium gel consistency (*Table 5*).

II. Protein

The protein content, although subject to extreme varietal and environmental variability averages about 7% in milled rice and 8% in brown rice (*Tables 4* and 5). Protein is only a secondary factor in rice quality but it makes a fundamental contribu-



Plate 2. Gel consistency test.

tion to nutritive quality of milled rice. High protein samples are more resistant to abrasive milling, yield less bran and polish, have higher head rice yields and may be somewhat darker than lower protein samples.

Considerable variability in protein is caused by environmental factors such as season of the year (wet or dry), plant population density and time and rate of nitrogen application (IRRI, 1963; JULIANO, ALBANO and CAGAMPANG, 1964; JULIANO, IGNACIO, PANGANIBAN and PEREZ, 1968; DE DATTA, OBCEMEA and JENA, 1972).

III. Aroma

Many high quality varieties such as Basmati of India and Pakistan, Khao Dawk Mali of Thailand, Rojolele of Indonesia, are aromatic. Although scented or aromatic grain is a relatively minor quality factor of limited importance, they command high prices and are used on special occasions.

Malaysian lowland varieties are generally non-aromatic. Several traditional

or hill paddy which are known to be aromatic include Tangkai Langsat, Pongsu Seribu, Besar Kura, Kuku Belang, Dang Laka and Jawi Hitam.

Aroma in rice is a varietal as well as an environmental character, but neither the active principle nor its distribution in the grain is fully understood (GRIST, 1959).

IV. Grain elongation

Some rices show extreme elongation on cooking while most varieties expand girthwise. Grain elongation is considered a highly desirable trait in some high quality rices. Basmati rices of India and Pakistan elongate 100% upon cooking. The Malaysian rice variety which shows similar property is a mutant from Mahsuri.

Storage

Storage causes rice to age. Aging involves changes in the physical and chemical characteristics that modify the cooking, processing, eating and nutritional qualities. Aroma is lost, seed viability decreases and the grains become progressively harder resulting in lower grain breakage on milling. Volume expansion and water absorption of milled rice increase during cooking but cooked rice is less tender, less sticky and more flaky.

The exact mechanism of aging is not fully understood. Depending on environmental conditions, storage time and initial condition of rice grains, aging may result in desirable or undesirable effects on the end product. However, it was observed that adequate storage brings about desirable changes in properties and characteristics of rice particularly those with intermediate amylose content. In this country, rice is stored for one to three months or longer before it is milled for consumption.

CONCLUSION

In view of differences in preferences and uses of rice, it is very difficult to clearly define rice quality. Although quality criteria have been established, they differ depending on the consumers and the end-uses of rice.

In this country, rice is mainly consumed boiled or steamed. Physical and chemical properties that relate to appearance, head rice recovery, cooking and eating quality are of significant importance. Although the preferences are towards long, slender and translucent grains, these criteria however do not reflect the cooking and eating qualities of the rice. There are medium-grain varieties which are superior in these qualities. Nevertheless, grain dimensions, shape and appearance are important facets of grading and marketing and they are the first quality parameters that breeders look for in developing new rice varieties.

High total milling recovery and high percentage of head rice yield are important quality criteria very much demanded by the rice millers. Although these are inherited traits, they are very much influenced by environment and post-harvest processes. The physico-chemical characteristics of rice, particularly the starch compositions and properties are the main factors in determining the cooking, eating and processing qualities. The amylose:amylopectin ratio as indexed by the amylose content largely influence water absorption, volume expansion during cooking and the texture of cooked rice. However, hardness of cooked rice is also influenced by other factors such as gel consistency and gelatinization temperature.

Except for Jaya and Sekencang, most of the commercially grown varieties are of high amylose. Although the preference seems to be towards moderately high to high amylose varieties with intermediate gelatinization temperature and soft gel consistency, there is an indication that intermediate amylose rices with intermediate gelatinization temperature and soft gel are more preferred. The latter, however, are traditional varieties or hill paddy, some of which are aromatic.

Although protein content has some effect on the appearance, milling, cooking, eating and processing properties, its importance is largely from the nutritional standpoint. Local lowland varieties are low in protein content. Other quality parameters of limited importance are aroma and grain elongation.

It is difficult to identify and quantify all the factors that are responsible for rice quality per se. Although physico-chemical test criteria have been useful for evaluating many aspects of cooking, eating and processing qualities, they do not explain all the known differences in rice cooking, eating and processing behaviour. Furthermore some important criteria e.g. aroma, flavour, taste and texture are determined subjectively. In view of human differences in sensitivity and preferences, differences in opinion sometime arise. Rice quality determination is further complicated by effects due to aging, storage and other post-harvest processes.

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SUMMARY

As a staple diet, the quality of rice is an important factor which demands great attention. Any rice variety released should be of high quality with respect to physical properties, milling, cooking and eating qualities. Physical and chemical characteristics such as grain size, appearance, shape, weight, hardness, starch properties, protein, aroma and degree of elongation are some of the criteria which determine the quality of rice. Preference is for long, slender and translucent grains with high head rice recovery, intermediate to high amylose content, intermediate gelatinization temperature and soft gel consistency.

Post-harvest processes such as drying, storage and milling affect rice quality to some extent. The mechanism of aging is not fully understood but it has some desirable effect on the milling, cooking and eating qualities of the local rice varieties.

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Appendix 1. Sensory evaluation of cooked rice

Nar	ne:	Date:		·	Re	ef. No.: .		
	Characteristics				Ref. No.:			
	• · · · · · · · · · · · · · · · · · · ·		1	2	3	4	5	6
A .	AROMA 9 - very strong 7 - strong 5 - moderately strong 3 - weak 1 - none							
B.	FLAVOUR 9 - very full characteristic 7 - full characteristic 5 - moderately full 3 - slightly weak 1 - very weak							
с.	TENDERNESS 9 – very tender 7 – tender 5 – moderately tender 3 – slightly hard 1 – hard							
D.	COHESIVENESS 9 – pasty 7 – very sticky 5 – moderately sticky 3 – partially separated 1 – well separated							
Е.	COLOUR 9 - white 7 - creamish-white 5 - greyish-white 3 - light brown 1 - brown							
F.	GLOSSINESS 9 - very glossy 7 - glossy 5 - moderately glossy 3 - dull 1 - very dull							