PHYSICO-CHEMICAL AND ORGANOLEPTIC PROPERTIES OF TRADITIONAL RICE VARIETIES FROM FINSCHAFEN

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ABSTRACT

Studies of the physico-chemical characteristics of six traditional rice varieties grown in the Finschafen area of Papua New Guinea, revealed significant differences in the physical characteristics. All the varieties had grain of medium shape and size and soft gel consistency. They belonged to the intermediate amylose group. The high final gelatinization types (Qangwaneng, Sunlong white and Sunlong red) took longer time to cook and absorbed more water than the high-intermediate (Sikong and Brown) and the intermediate (Padibengbeng) types. There were significant differences in the cohesiveness, texture and flavour of the varieties. Overall, Brown possessed sensory qualities closest to those of Trukai, a commercial modern variety, while Sunlong red was the least liked. The relatively low protein content of Sikong could be of nutritional concern.

Keywords: *Traditional Finschafen rice, physical, chemical, organoleptic evaluation.*

INTRODUCTION

Rice (*Oryza sativa* L.) was introduced in Papua New Guinea (PNG) about one hundred years ago. Time, location and climate selected what is called "local germplasm". The traditional rice growing areas are Finschafen in the Morobe Province, Maprik in the Sepik Province and Bereina in the Central Province. (Wohuinangu and Kap 1982). Even though rice is a very important staple crop, the areas sown to rice are very small. The traditional rice varieites have poor yield and are also said to have low milling quality. The country depends almost entirely on imported rice to meet consumers demand. Intensive research is currently being undertaken to identify agronomically superior varieties. The trials are being carried out with modern varieties. It is generally accepted that the rapid spread of high yielding modern varieties are leading to the disappearance of the unimproved indigenous varieties and wild strains. These unimproved varieties are irreplaceable germplasm which could be used in breeding programs.

There is a need to collect local Papua New Guinea rice germplasm, evaluate them for their quality characteristics and recommend novel types if any for crosses for future use. This is the first work on the physico-chemical and organoleptic properties of Papua New Guinea's traditional rice varieties.

METHODOLOGY

Samples of six varieties of paddy rice (Sikong, Qangwaneng, Sunlong red, Sunlong white, Brown and Padibengbeng) were obtained from local farmers in the Finschafen area of Morobe Province. These varieties are grown by the Finschafen farmers mainly for home consumption and are rarely sold. Sunlong red and Sunlong white are different from Sunlong, an improved modern variety, not grown in PNG but imported solely for direct sale in the commercial outlets. Milled Trukai rice, also an imported commercial variety was purchased from a local supermarket in Lae and was used in the organoleptic tests only. The paddy samples were dehulled (Satake Rice Mill JHU), milled (Satake Rice Testing Mill) and stored at 4°C until tested for physico-chemical properties. Grain length, width and average weight of 100 healthy kernels were measured with a travelling microscope and by weighing (Khan and Reddy 1991).

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Moisture, ash, crude fat and protein content were estimated by methods of AOAC (Helrich 1990). Amylose content was determined by the simplified method of Juliano (1971) with some modification. 10 ml of 0.1N HCl were used instead of 2 ml acetic acid. Gel consistency and alkaline digestion gelatinization temperatures were estimated by the method of Cagampang *et al.* (1973) and Little *et al.* (1958) respectively. Water uptake was determined by the method of Myklestad *et al.* (1968).

Flavour, texture and grain separation of the warm, cooked rice samples were determined according to Lamond (1977). Eleven trained panelists were used. Cooking times were previously established by the method of Perez *et al.* (191993). 0.1% salt was used.

The results were analysed for their variance and Duncan's Multiple Range Test was used to detect statistical differences using IRRISTAT 93 soft ware.

RESULTS

There were significant variety differences in the dimensions of the rice grain, with the length to width ratio ranging from 2.1 to 2.7 (Table 1). All the varieties were classified as medium size and medium shape in accordance with Juliano (1993).

The ash and crude fat did not vary but protein content differed significantly. The means for protein content ranged from 5 to 8.1% (Table 1). Sikong variety had the lowest protein content. The differences in protein content could be important in ensuring adequate protein intake from a rice staple. The amylose content differed significantly but not greatly with the values ranging from 23.7 to 25.1% (Table 1), thus classifying all the samples as of intermediate amylose type (Juliano 1979). The alkali spread values showed that all the varieties were fairly resistant to alkali digestion (2 to 3.5 for spreading and 1 to 2 for clearing), placing them in the intermediate to high

Table 1. **Physico-chemical properties of traditional rice from Finschafen.**

	Variety					
Property	Sikong	Qangwaneng	Sunlong red	Sunlong white	Brown	Padibengbeng
Ash %[1]	0.25 a	0.17 a	0.24 a	0.21 a	0.13 a	0.26 a
Crude fat %[1]	0.23 a	0.63 a	0.61 a	0.64 a	0.42 a	0.41 a
Crude protein %[1]	5.00 a	6.85 bc	6.30 b	7.40 bc	8.11 c	7.35 bc
Amylose %[1]	24.3 ab	23.7 a	24.0 a	24.8 bc	25.1 c	24.4 bc
Alkali spread value	2.5 a	2.3 a	2.3 a	2.0 a	3.0 a	3.5 a
Alkali clearing value	1.0 a	2.0 a	1.3 a	1.5 a	1.5 a	1.5 a
Gel consistency (mm)	100 a	100 a	100 a	100 a	100 a	90.5 a
Length/width ratio	2.1 a	2.5 b	2.5 b	2.0 a	2.7 c	2.1 a
100-grain weight (g)	20.1 b	23.2 d	18.4 a	20.4 bc	22.6 c	23.3 d

Note: 1. - Dry Basis.
Means with the same letter in a row are not significantly different ($P < 0.05$).

Table 2. **Classification of traditional rice from Finschafen.**

	Variety					
Property	Sikong	Qangwaneng	Sunlong red	Sunlong white	Brown	Padibengbeng
Amylose Type	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate
Final GT Type	High-Intermediate	High	High	High	High-Intermediate	Intermediate
Gel Type	Soft	Soft	Soft	Soft	Soft	Soft
Shape	Medium	Medium	Medium	Medium	Medium	Medium
Size	Medium	Medium	Medium	Medium	Medium	Medium

Table 3. **Cooking and eating properties of traditional rice from Finschafen.**

	Variety						
Property	Sikong	Qangwaneng	Sunlong red	Sunlong white	Brown	Padibengbeng	Trukai[2]
Cooking time (min)	13.5 a	16.0 b	14.0 ab	14.0 ab	13.5 a	13.0 a	-
Water uptake g H_2O/g rice	2.50 a	2.60 a	2.53 a	2.74 a	2.30 a	2.20 a	-
Grain separation[1]	3.2 b	3.5 b	2.0 a	4.7 c	5.0 c	3.6 b	3.8 b
Texture[1]	4.2 ab	5.1 abc	3.9 a	5.2 abc	4.8 abc	5.7 bc	6.3 c
Flavour[1]	3.6 ab	4.3 abc	3.4 a	4.6 bcd	5.1c d	4.6 bcd	5.5 d

[1] Based on a scale of 1-7:7= best score 1 = worst score.
Means with same letters in a row are not significantly different ($P < 0.05$)

[2] Cooking time and water uptake not determined Rice cooked using time from an unpublished report of Amoa *et al.*

final gelatinization temperature groups (Table 2), in accordance with the classification by Juliano (1973). All the varieties had a gel consistency value of 100 mm with the exception of Padibengbeng which had a value of 90.5 mm. All the varieties therefore belong to the soft gel type (Cagampang *et al.* 1973) (Table 2), meaning that the cooked rice will not set to a hard gel. Soft to medium gel consistency is preferred to hard gel consistency in rice (Juliano 1993). While significant variation in the cooking time was observed among the varieties, water uptake did not vary significantly (Table 3). Comparing Tables 2 and 3, Padibengbeng, an intermediate gelatinization type, took the shortest time to cook (13 mins), while Qangwaneng, a high gelatinization type, recorded the highest cooking time (16 mins). The rest of the varieties with either high or high-intermediate gelatinization temperatures had cooking times in between 13 and 16 mins. The results are in accordance with those of Juliano and Perez (1983), who stated that rice with higher gelatinization temperatures required more time to cook than those with low gelatinization temperatures.

The organoleptic scores for grain separation, texture and flavor are summarized in Table 3. There were significant differences between varieties in all the attributes tested. With regards to grain separation, varieties Trukai, Padibengbeng, Qangwaneng and Sikong were equally liked. Varieties Sunlong white and Brown were the most liked. Panelists disliked the cohesiveness of Sunlong red. There were no significant differences in the texture of varieties Qangwaneng, Sunlong white, Brown, Padibengbeng and Trukai. Sikong and Sunlong red differed significantly from the rest of the traditional rice varieties with the texture of Sunlong red being the least liked. Trukai was the most liked. Sunlong white, Brown, Padibengbeng and Trukai possessed the most desirable rice flavor. The flavour of Sikong and Qangwaneng were intermediate, while once again that of Sunlong red was found to be poor. Over all, Sunlong red was the least liked with regards to all the characteristics tested. Trukai, the imported variety was the dominant rice with the most desirable sensory characteristics.

DISCUSSION

Quality in rice encompasses storage, milling and market quality, cooking and eating qualtiy and nutritive quality of the grain. Papua New Guineans prefer medium to long grain rice, that remains reasonably soft when cooked. The cohesiveness of the cooked grain should be low. Grain size, shape and appearance largely determine the market acceptability of milled rice. These physical properties are among the first characteristics evaluated in any rice breeding program. All the Finschafen traditional rice varieties were of medium shape and size. Both long and medium grained modern rice varieties are sold on the market in Papua New Guinea with the long grain rice fetching a higher price than the medium grain.

It is possible to translate consumer preference for cooking quality into measurable chemical properties. Cooking quality depends on a number of characteristics such as the amylose content, gel consistency, grain elongation and aroma. The cooking of rice results in the swelling of the starch granules in the endosperm. Cooking and eating characteristics are therefore largely determined by the properties of the starch that make up 90% of milled rice. It has been shown that amylose content of the rice starch is the major eating quality factor, and is thus used in rice breeding studies. It correlates directly with volume expansion and water absorption during cooking and hardness of the cooked rice (Juliano 1985). The higher the proportion of amylose, the greater is the tendency to cook dry and fluffy. None of the Finschafen rice varieties were of the waxy or glutinous type (amylose content < 7%). The 23.7 to 25.1% amylose values obtained put all of them in the intermediate amylose group (amylose content 20-25%). Their cooking characteristics would therefore seem to be similar to those of Sunlong, an imported commercial variety with similar amylose content, as opposed to those of Trukai, an imported variety, but of the low amylose type (7-20%) (unpublished report of Amoa 1995 *et al.*).

Gelatinization temperature (GT) of starch granules refers to the water temperature at which at least 90% of the starch granules have gelatinized or swollen irreversibly in hot water and is indexed in the rice breeding program by the alkali spreading value (Little *et al.* 1958). Rice with low GT disintegrates completely, whereas rice with intermediate GT shows only partial disintegration. Rice with high GT remains largely unaffected in the alkali solution (Khush *et al.* 1979). The alkali spread values of the Finschafen rice place them in the intermediate to high gelatinization temperature gradient from the surface to the core of the grain. The cooking times recorded for the traditional Finschafen rice varieties seem to follow this trend (Table 3). Because GT correlates directly with cooking time, a low GT favours fuel conservation, provided eating quality is not adversely affected. The GT and the cooking times of the Finschafen varieties seem to contrast from those of Trukai which

has a low GT (unpublished report of Amoa *1995 et al.*).

Varieties with the same amylose content may have different consumer acceptabilities. This is because within the same amylose group, varieties with softer gel consistency are preferred and cooked rice is more tender. Padibengbeng seems to be an exception in that even though it had the lowest gel consistency value, its texture was the most preferred after Trukai.

CONCLUSION

All the six varieties of traditional rice grown in the Finschafen area showed physico-chemical characteristics for rice in the medium grained, intermediate amylose classification group. None of them was aromatic. Their organoleptic characteristics were also inferior to those of Trukai, with Trukai being preferred in most of the organoleptic characteristics. Over all, Brown possessed organoleptic characteristics closest to Trukai while Sunlong red was the least liked. Despite the seemingly inferior organoleptic qualities, these traditional rice have been growing in the area for years and are likely to have developed resistance to various diseases and other adverse environmental conditions. They could be cross-bred into modern varieties to produce varieties that are consumer acceptable.

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