Quality evaluation of some rice cultivars grown in Ghana

J. T. MANFUL, J. K. AKATSE & A. OSEI-YAW
J.T.M. & A. O-Y.: Food Research Institute, CSIR, P. O. Box M.20, Accra, Ghana; J.K.A.: Irrigation Development Centre, P.O. Box 273, Ashaiman, Ghana

SUMMARY

Ten cultivars of locally grown rice were screened for yield and other desirable agronomic characteristics. Their milling characteristics were evaluated by dehusking in a Satake (THU-34A) Testing Rice Husker and polishing in a BSO8A Single Pass Rice Pearler. The physical quality and proximate composition of the cultivars were determined. Cooking characteristics and sensory evaluation were carried out on the samples. Varieties B-189 and IR-72 had the highest average yields. Variety IR-66 had the shortest growth duration with IR-72 recording the lowest plant height. Akpafu variety had good milling characteristics, that is, low level brokens with ITA-304 being most susceptible to breakage. Variaty TOX-3108 had the highest overall cooking and sensory acceptability rating with Akpafu being the least acceptable. The suitability of each variety for various local dishes was also evaluated. Whilst B-189 was good for all local dishes, Akpafu was found to be best for "waakye".

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RÉSUMÉ

AKATSE, J. K., MANFUL, J. T., AKATSE, J.K. & OSEI-YAW, A. : *Evaluation de la qualité de quelques variétés du riz cultivée au Ghana.* Dix variétés du riz localement cultivées étaient passées au crible pour le rendement et d'autres caractéristiques agronomiques désirables. Leurs caractéristiques de moulure étaient évaluées par le décorticage dans le Satake (THU - 34 A). Décortiqueur pour l'evaluation du riz et par le cirage dans le BS08A Pearler de riz à seul passage. La qualité physique et la composition immédiate des variétés étaient déterminées. Les caractéristiques de cuisson et l'evaluation de sens étaient menées sur les échantillons. Les variétés B-189 et IR-72 avaient le plus haut moyen de rendements. Les variétés IR-66 avaient la plus courte durée de croissance avec IR-72 enregistrant la taille de plante la plus basse. La variété Akpafu avait des bonnes caractéristiques de moulures, c'est-à-dire, un niveau bas de cassé avec ITA-304 étant le plus susceptible à la casse. La variété TOX-3108 était la plus haute de tous les indices d'acceptabilité sensorielle et de cuisson avec Akpafu étant le moins acceptable. La convenance de chaque variété pour les divers plats locaux était également évaluée. Pendant que B-189 était bon pour les locaux plats, Akpafu était découvert d'être meilleur pour "Waakye".

Introduction

Rice is one of the four principal cereals cultivated and eaten in Ghana (MOFA, 1993). As far back as in 1968, a USDA/AID study (USDA/AID, 1968) concluded that rice research in Ghana was very inadequate and there was, therefore, the need to pay greater attention to expertise being developed elsewhere. However, Priestley (1978a,b) claimed that progress in this direction appeared to be slow.

Generally, rice research has aimed at finding varieties with the most suitable agronomic characteristics for growth under local conditions. In this regard, several factors must be considered in selecting rice varieties for growing purposes. Notable among these are:

(1) Suitability for growth under local conditions which include responsiveness to fertilizer, resistance to pests and diseases, susceptibility to lodging and shattering as well as crop-water relations.
(2) Quality of the product for end-use required.

Like that of numerous other food products, the quality of rice is usually evaluated according to its suitability for specific end-use for a particular

consumer (Rietz & Barmore, 1959). Rietz & Barmore (1959), therefore, considered rice quality to have two general meanings:

(1) Milling, cooking and processing qualities which refer to suitability of the grain for a particular end-use, and
(2) Physical quality which means cleanliness and freedom from foreign materials.

Webb & Stermer (1972) noted that rice quality is closely related to the quality of its milled whole kernels and quality evaluation is primarily a matter of determining its suitability for a particular use and whether it needs specific requirements of cleanliness and purity. Consumer acceptance and preference with respect to eating, cooking and processing qualities are important in judging rice, since they vary from country to country.

In the US, rice is evaluated according to size, shape, uniformity, milling yields, cooking and processing characteristics as well as cleanliness (USDA, 1972).

In Ghana, rice is grown almost exclusively for home consumption. Oteng (1989) divided the desirable grain qualities on the Ghanaian market into physical and cooking characteristics. The desirable physical characteristics include the absence of unhusked paddy and other foreign matter such as weed seeds, stones, pieces of metal and insects. Others are a low percentage of discoloured and immature grains. Most of these parameters are governed mainly by standard of production and processing techniques. Testing procedures for these are well documented. (Priestley, 1978a).

Many compositional and physico-chemical tests have been proposed as quality indicators of milled rice (Priestly, 1978b). These tests include:

(1) Varietal characteristics
(2) Amylose content
(3) Gelatinization temperatures
(4) Other starch characteristics
(5) Swelling and solubility properties of the whole grains and
(6) Rheological properties of the flour.

As rice is grown under variable conditions, variations in chemical compositions are considerable (Houston & Kohler, 1970; Grist, 1975). The degree of milling also introduces further compositional variability as variable amounts of nutrients are removed.

Grist (1975) noted that the fat content of rice is low and much of it is lost in the process of milling. The protein content of milled rice is low in comparison with other cereals, although whole grain contains about the same quantity as found in wheat.

The study tries to establish the quality characteristics of locally grown rice cultivars as it relates to their yield and other agronomic properties. Some of the quality characteristics examined include susceptibility to breakage on milling, other physical attributes, proximate composition as well as cooking and sensory evaluation of the varieties.

Materials and methods

Varieties

Ten (10) varieties (mainly IRRI, IITA, CRI and local lines) were obtained for test cropping. Two selection tests were conducted in August 1993 and November 1994. The varieties were transplanted 21 days after seeding (DAS) in rows of 9 per variety (nursery seed rate was 30 kg/ha). Plant spacing on the field was 20 cm × 20 at three plants per hill.

Agro-chemicals

Fertilizer was top-dressed in three splits as follows:

1st application	-	50 kg/ha each of N, P_2O_5 and K_2O on 14 days after transplanting (DAT).
2nd application	-	25 kg N/ha on 35 DAT
3rd application	-	25 kg N/ha on 65 DAT
Total fertilizer	-	100 kg N + 50 kg P_2O_5 + 50 kg K_2O/ha.

There were two applications each of the insecticide Sumithion (1 *l*/ha) and fungicide Fuji -1 (1*l*/ha). No herbicide was applied. All cultural activities (hand and bund weeding, irrigation, baiting, etc.) were carried out according to need and evenly to all varieties.

Plant measurements (height, tiller number) and other observations were made fortnightly during the crop's growth period. The varieties were harvested at maturity and yields were taken from 3 m^2 sample plots.

Milling

A 200-g sample of each cultivar was first dehusked in a Satake (THU-34A) Testing Rice Husker. The brown rice thus obtained was polished in a BSO8A single pass Rice Pearler with the degree of whiteness set between "Low" and "Medium" on the equipment. The level broken was determined using a TRG05A Testing Rice Grader.

Other physical characteristics

The levels of discoloured and chalky grains were determined by hand sorting of 100 g of milled grains.

Proximate analysis

Carried out using the AACC (1986) *Standard Methods of Analysis.*

Sensory evaluation

Known quantities of rice samples (300 g) were cooked in known volumes of water for the different samples. Salt was added to taste. The cooked samples were subjected to sensory evaluation using judges to assess the following characteristics of the cooked rice: colour, smell, taste and texture. These characteristics were given a nine point hedonic numerical value: 9 = like extremely; 1 = dislike extremely. The overall acceptability was also determined. Also recorded was the amount of water required to cook a unit sample and the swelling capacity. The different local dishes each cultivar was suitable for was finally determined.

TABLE 1

Yield Components and Crop Characteristics of the Rice Cultivars

Cultivar	*Yield (t/ha)*	*Panicle No. per m^2*	*Grain No. per panicle*	*1000-GW (g)*	*Plant ht (cm)*	*Panicle length (cm)*	*Growth duration (days)*
TOX-3108	5.12	294	89	25.8	115	21.7	127
ITA-304	4.79	231	163	27.9	113	24.8	125
B-189	5.72	259	171	27.1	113	25.2	125
Akpafu	2.84	166	189	21.7	127	26.3	109
GK-88	5.12	325	126	26.2	107	23.1	113
GK-49	4.99	316	140	28.1	111	23.8	123
IR-66	4.62	353	151	22.4	93	22.7	103
IR-64	5.28	303	110	27.8	98	24.1	123
IR-72	5.72	462	82	25.3	88	19.7	123
GRUG-7	5.20	297	133	28.2	114	22.8	124
Mean	4.94	301	135	26.1	108	23.4	120
LSD	0.59	56	25	0.5	8	1.3	6

Results and discussion

All the agronomic characteristics investigated are shown in Table 1. The mean yield for the varieties was 4.94 t/ha. Varieties B-189 and IR-72 recorded the highest average yields of 5.72 t/ha.

The mean growth duration was 120 days with IR-66 having the shortest growth period of 103 days. The Akpafu local variety was the tallest with a plant height of 127 cm while IR-72 was the shortest with a height of 88 cm.

The Akpafu variety which is a short duration type also recorded the lowest yield of 2.84 t/ha. Apparently being an upland or valley bottom variety, it had too much water under the wet paddy irrigated conditions. This variety would be investigated further.

The 1000-grain weight (1000 - GW) is an indication of the size of the grain. The short duration varieties (Akpafu and IR-66) had small grain sizes (low 1000-GW) and consequently recorded the lowest yields. This is because as the grain filling had to be completed in a shorter time, grain size had to be relatively small to obtain fully filled grains. Longer duration varieties (B-189 and IR-

TABLE 2

Physical Quality Evaluation of Rice Cultivars

Cultivar	Moisture (%) Paddy	Moisture (%) Brown rice	Brown rice (per cent)	White rice (per cent)	Broken (per cent)	Discoloured (per cent)	Chalky grains (per cent)
DG-49	15.6	14.5	80.0	67.8	22.8	2.7	0.5
Akpafu	15.6	14.5	77.5	69.4	12.0	4.8	0.4
IR-72	15.7	14.3	78.5	67.0	24.0	1.5	0.4
ITA-304	15.3	14.1	80.0	68.5	31.8	3.8	0.4
GK-88	15.7	14.3	78.0	64.0	20.5	0.8	0.4
IR-66	15.3	14.9	76.3	61.8	31.5	3.1	1.5
GRUG-7	15.9	15.1	78.0	67.5	22.3	1.4	0.6
B-189	15.7	14.6	75.5	63.5	28.0	0.5	0.1
TOX-3108	15.8	14.2	77.5	67.0	18.3	0.1	-
IR-64	15.2	13.9	80.0	68.5	19.0	-	-
Mean	15.6	14.4	78.1	66.5	23.0	2.1	0.5
LSD	0.2	0.3	1.1	1.8	4.4	0.7	0.4

TABLE 3

Proximate Analysis of Rice Cultivars

Cultivar	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	Per cent carbohydrate (including fibre)	Energy (Kcal/ 100g)
GK-49	12.5	0.5	9.1	0.6	77.3	350
IR-72	12.3	0.5	8.7	0.6	77.9	351
GRUG-7	13.1	0.6	7.5	0.5	77.3	349
IR-66	12.5	0.6	9.3	0.6	77.0	351
TOX-3108	12.1	0.7	8.7	0.6	77.9	353
GK-88	12.5	0.6	8.7	0.7	77.5	350
ITA-304	12.4	0.5	7.9	0.6	78.6	351
IR-64	12.0	0.5	9.5	0.5	77.5	353
Akpafu	12.4	0.6	9.8	0.7	76.5	341
B-189	12.8	0.6	7.7	0.6	78.3	349
Mean	12.5	0.6	8.7	0.6	77.6	351
LSD	0.2	0.1	0.6	0.1	0.4	1.0

72) had larger grains that allowed for adequate grain filling and good yield (Table 1).

The varieties investigated showed considerable variations in their physical qualities. The yield of rice from paddy during milling is, according to Bhattacharya (1980), determined by three factors:

1. The degree of milling, that is the extent of bran removal which all things being equal is indicative of grain hardness.

2. The husk content of the variety.

3. The level of grain breakage.

Since during these experiments, the Rice Pearler was set at the same point for all samples and brokens were inclusive of white rice yield, the most important determinant of white rice yield under these circumstances were husk contents of the variety and the degree of hardness of the grain.

Varieties GK-49, ITA-304 and IR-64 had the highest Brown Rice percentage of 80 indicating a low percentage of husk in the paddy. Variety B-189 had the lowest Brown Rice percentage of 75.5 (Table 2). Akpafu had the highest yield of White Rice of 69.4 per cent and the lowest level of brokens of 12.0 per cent. Variety IR-66 had the lowest White Rice yield of 61.8 per cent and a high brokens level of 31.5 per cent. Variety IR-64 which had a comparatively low brokens level also had neither discoloured nor chalky grains. Meanwhile, Akpafu had a discoloured grain level of 4.8 per cent with IR-66 having a chalky grain level of 1.5 per cent (Table 2).

Table 3 shows the proximate composition of

TABLE 4

Volume of Water used for Cooking and the Swelling Capacity of Rice Cultivars

Cultivar	*Vol. of water (ml)*	*Wt of raw grains (g)*	*Cooked wt (g)*	*Majority comments - whether sticky or non-sticky*
TOX-3108	600	300	675	Non-sticky
ITA-304	700	300	850	Non-sticky
B-189	600	300	850	Sticky
IR-72	960	300	750	Sticky
Akpafu	750	300	700	Non-sticky
GK-88	600	300	600	Non-sticky
GK-49	600	300	750	Sticky
IR-66	1200	300	105	Non-sticky
GRUG-7	960	300	750	Sticky
IR-64	1200	300	900	Non-sticky
Mean	817		788	
LSD	175		92	

TABLE 5

*Mean Scores * for overall Acceptance and for the Different Characteristics of the Rice Cultivars*

Cultivar	*Colour*	*Smell*	*Texture*	*Taste*	*Overall acceptance*
TOX-3108	8.35	8.00	7.76	7.82	7.89
ITA-304	7.52	7.35	6.94	6.94	7.18
B-189	8.00	7.64	6.49	7.10	7.42
Akpafu	4.17	5.00	4.82	5.30	4.82
GK-88	7.12	6.60	6.25	6.75	6.70
GK-49	6.62	6.12	5.87	6.62	6.30
IR-66	5.50	6.25	6.00	6.37	6.03
IR-64	8.00	7.25	6.30	6.75	7.10
IR-72	7.00	7.30	6.50	6.50	6.82
GRUG-7	6.90	7.00	6.40	7.12	6.86
Mean	6.92	6.85	6.38	6.73	6.72
LSD	0.90	0.63	0.54	0.45	0.61

*9 = Like extremely
1 = Dislike extremely

cultivars investigated. These compared favourably with those reported by Adair (1972), Manful & Andah (1989), Eyeson & Ankrah (1975) as well as Mc Cance & Widdowson (1991). The high protein content of 9.8 per cent for the Akpafu variety is worth mentioning. This is very probably due to the fact that that the Akpafu variety has a hard grain which does not lend itself to easy polishing. Hence a large part of the bran layer which contains most of the proteins and minerals are retained after polishing. Variety GRUG-7 had the lowest protein level of 7.5 per cent (Table 3).

In the sensory evaluation of the cultivars, B-189, IR-72, GK-49 and GRUG-7 were judged to be rather sticky. The rest were non-sticky (Table 4). Variety IR-66 and IR-64 required about 4 times their own weight of water for cooking. These two cultivars also had the highest swelling capacities of

TABLE 6

Local Dishes Suitable for each Cultivar of Rice

Cultivar	*Functional properties*	*Suitable uses*
TOX-3108	Non-sticky; Low swelling	Plain rice, jollof rice rice porridge, *waakye* and *omo tuo*
ITA-304	Non-sticky; High swelling	Plain rice, jollof rice, *waakye*, rice porridge and *omo tuo*
B-189	Sticky; High swelling	*Waakye*, rice porridge and *omo tuo*
Akpafu	Non-sticky; Low swelling	*Waakye*
GK-88 swelling	Non-sticky; Low rice	Plain rice and jollof
GK-49	Sticky; Medium swelling	rice porridge, *omo tuo* and *waakye*
IR-66	Non-sticky; High swelling	Plain rice and *waakye*
IR-72	Sticky; Medium swelling	*Waakye*, rice porridge and *omo tuo*
GRUG-7	Sticky; Medium swelling	*Omo tuo*, *waakye* and rice porridge

Plain Rice - Boiled rice with some salt to taste. Usually eaten with stews and soups

Jollof Rice - Rice boiled together with a sauce which may

contain vegetables, fish or meat.

Waakye - Rice cooked together with cowpeas and given a purplish colouration with sorghum straw extract. Usually eaten with a pepper sauce or stews.

Omotuo - Rice is boiled just as in plain rice but mashed with a wooden stirrer and rolled into balls. Usually eaten with soups.

over three times their weight (Table 4).

Table 5 shows the sensory acceptability ratings of the cultivars on a hedonic scale of 1 to 9. TOX-3108, B-189, ITA-304 and IR-64 had acceptance ratings of higher than 7.00. The least acceptable cultivar was Akpafu with a rating of 4.82.

The type of local dishes for which each cultivar is best suited for are shown in Table 6. While B-189 and TOX-3108 are excellent for all local dishes, Akpafu was assessed to be best suited for "waakye".

Conclusion

Varieties B-189, TOX-3108, GK-88, IR-66 and IR-72 showed good agronomic traits in the field. Their yields were generally high and field resistance to pest and diseases were fairly adequate.

However, B-189, IR-66 and ITA-304 were highly susceptible to breakage on milling. Variety IR-66 also had a high level of chalky and discoloured grains.

In the overall sensory acceptance of the cultivars, TOX-3108, B-189, ITA-304, IR-64 had very high acceptability ratings.

It is expected that after a number of such screening and evaluation exercises, rice cultivation with good agronomic as well as cooking and eating characteristics would be identified and recommended to farmers for cultivation.

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