PHYSICAL QUALITIES OF DEVELOPED RICE SAMPLES

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1.0 Introduction

Rice (*Oryza spp.)* is the staple food for over half the world's population making it the most widely consumed stable (Muthayya *et al.,* 2014). It provides the about 20% of the world's dietary energy supply (IRRI). China and India are the major rice producing Countries; producing about 50% of the global production. It is able to grow in a wide range of soil types from deep watered to dry and hilly lands (Luh, 1991).

1.1 Botany of Rice

It is a semi- aquatic annual grass plant and morphologically characterized by long sheathed leaves with hollow and erected stem. It takes about 70 to 160 days to mature depending on the cultivar and environmental conditions (Luh, 1991). Two species, *Oryza Sativa* and *Oryza Glaberrima* are globally cultivated for human consumption (Linares, 2002). The *indicas, japonicas* and *javanicas* have been identified as the three well known and broad sub-species within the *Oryza Sativa* species (Kennedy and Burlingame, 2003).

The *Oryza Sativa* and *Oryza Glaberima* are the major types of rice produced in Ghana. (FAO/RMM, 2013). Among the three, *indicas* and *japonicas* are the most common with *indicas* representing 80% of the cultivated rice (Kennedy and Burlingame, 2003). The *Oryza indicas* are generally referred to as long grain whereas the *Oryza japonicas* are short or medium grains by nature. The *Oryza indicas* naturally appear as flaky and dry while the *Orsyza japonicas* are characterized by stickiness (FAO, 2000). The *indicas* are generally low yielding.

1.2 Physical Properties of Rice

The quality of rice is important to all stakeholders in the rice value chain affecting mostly producers and consumers. The quality and quantity losses occur at the pre- and post-harvest stages. The assessment of the quality of rice grains based on both physical and eating quality. The physical parameters defining the quality of rice include percentage unbroken or whole kernel after milling whereas that of the eating qualities depend mainly on the starch composition (Manful, 2013).

Milling yield, grain size and shape and general appearance are important determinants of milling quality. The proportion of whole kennel and broken kennels produced during the milling of rice determines the milling yield; the remaining grains usually of three-quarters or more of the normal length is whole grain yield (Koutroubas *et al.*, 2004). Whole grain yield and broken grains constitutes total milling yield. Studies have shown that the breakage of grains during milling mostly depends on the variety, size and shape of the grain (Koutroubas *et al.*, 2004).

Grain chalkiness can be broadly described as the presence of whiteness usually on the edges or central part of the milled rice (Manful, 2013). Chalkiness in grains occurs during the early stage of grain development due to adverse climatic conditions such as high temperature during grain filling. Rice grain can be said to be chalky if part or the entire milled rice is opaque.

Grain size and shape (length – width ratio) is a very stable property that can be used to measure the varietal purity of a sample. Comparing the length-width ratio of the sample with a published ratio for the variety will give an indication of varietal purity of the rice sample. A significant deviation means that the sample is impure that is it is either a different variety or a mixture of varieties.

Objective

The objective of the study was to assess the physical quality of the rice samples.

2.0 Materials and Methods

2.1 Raw Materials

Twelve rice samples (V_1B_1, V_1B_2, V_1B_3, V_2B_1, V_2B_2, V_2B_3, V_3B_1, V_3B_2, V_3B_3, V_4B_1, V_4B_2, and V_4B_3) were brought from CSIR-Crops Research Institute, Kumasi. Samples were stored in the laboratory at room temperature for 24 hours. V1, V2 and V4 are rice samples developed by CSIR-Crops Research Institute. V3 is Nerica 1, best aromatic upland rice variety in Africa.

Figure 1: Paddy rice samples

2.2 Preparation of Raw Materials

Samples were sun dried for 48 hours to attain a constant moisture content of 12. The rice samples (paddy) were milled using rice miller (SATAKE THU 359). Samples were polished using rice polisher (Ricepal 32). The rice samples were sealed in polyethylene bag and stored at room temperature prior to analysis.

2.3 Physical Analysis on Rice

1. Milling Recovery (% Head Rice)

Milled rice samples obtained was separated into whole and broken grains using a Test rice grader. The milling recoveries (% head rice) were then estimated using the following equations (Graham-Acquaah *et al*., 2015).

$$\text{Head rice ratio (\%)} = 100 \times \frac{\text{weight of head rice}}{\text{weight of milled rice}}$$

2. Moisture Content of Rice

   The Portable moisture meter (Kett Riceter -L) was used to determine the moisture content of the rice samples. Measurements were taken in replicates and average expressed as percentage moisture content of the rice samples.

3. Discoloured rice

   Rice samples were physically observed using a hand held magnifying glass. With the help of forceps, discoloured grains were identified and separated from the entire rice samples. The weight of the grains was measured.

4. Hundred (100) Grain Weight

   One hundred (100) grains were randomly selected from seed batch. The weight of the selected grains were measured and recorded. Measurements were done in replicates and the average expressed as weight of hundred grain.

5. Grain Size and Shape

   Random samples is first obtained from the seed batch. Ten grains are selected at random from the sample of seed. With the help of the Dial indicating outside caliper, the dimensions (length and width) of each seed was measured and recorded.

6. Chalky grains

   The hand held magnifying glass was used to identify the presence of chalky grains in the seed batch of the grains. The weight of the identified chalky grains was measured.

7. Foreign Matter

   The hand held magnifying glass was used to identify the presence of all foreign matter (insect fragments, debris, stones etc) in the seed batch of the grains.

8. Other Grains

   With the help of the hand held magnifying glass, the presence of other grains in the seed batch was identified and weighed.

3.0 Results and Discussions

3.1 Physical Properties of Rice

3.1.1 Head Rice

The physical quality of rice is largely determined by the level of whole unbroken grains obtained. Head rice (whole grain) yield is defined as the amount of whole grain recovered after milling a unit amount of paddy (Manful, 2013). It is a significant factor in determining yield of a given sample of rice. There was significant differences ($p<0.05$) in the % head rice among the four major rice samples. *V4* recorded the lowest % head rice (51.47) with *V1* measuring the highest % head rice of 67.24. The results therefore indicates the presence of lower broken grains in *V1* making *V1 t*he most preferred variety among the four rice samples (Table 1). The differences in the % head rice may be due to the genetic composition, varietal differences and production (Singh *et al*., 2003).

Table 1: Physical Qualities of Rice (Milling Recovery and Grain Dimensions)

Rice Variety	% Moisture Content	(%) Head Rice	Mean Grain Length mm	Mean Grain Width mm	Length/Width
V1	11.13 ± 0.12 [a]	67.24 ± 1.57	8.23 ± 0.65	2.37 ± 0.47	3.57±.74
V2	11.03 ± 0.06 [a]	63.54 ± 2.39	7.95 ± 0.46	2.46 ± 0.58	3.42±1.5
V3	11.30 ± 0.44 a	58.56 ± 1.93	7.57 ± 0.35	2.52 ± 0.22	3.01±0.20
V4	11.13 ± 0.06 [a]	51.47 ± 1.25	9.38 ± 0.04	2.09 ± 0.18	4.5 ± 0.18

V1, V2 and V4 are CSIR- CRI-developed. V3 is Nerica 1, best aromatic upland rice variety in Africa

Manful, (2013) classified milled rice into four groups depending on the total % head rice obtained after milling. According to Him, the classification includes; Premium (above 57%), Grade 1 (48 to 56.9%), Grade 2 (39 to 47.9%) and Grade 3 (30 to 38.9%). Therefore in reference to the above classification, *V1*, *V2* and *V3* can be classified as Premium grade with *V4* being classified under Grade 1.

3.1.2 Moisture Content

There was significantly no difference ($p<0.05$) in the moisture contents among the four rice samples. The moisture content (%) of the rice samples ranged from 11.03 to 11.30. It is essential for moisture content of milled rice to be lower than 14% for storage. At below 12%, milled rice is in best state for seed storage and at less than 9%, milled rice can best be stored for long term preservation. Rice with moisture content at 11% as obtained can be sure to be safe from fungal, insect and rat damage when properly stored at cool, dry and airy place.

3.1.3 Grain Size and Shape

Another physical quality parameter determining factor is the size and shape of grain. Grain length is defined as a measure of the longest dimension of the grain. Grain size and shape (length – width ratio) is a very stable property that can be used to measure the varietal purity of a sample. There was significant differences in the grain length ($p<0.05$) among the rice samples. According to IRRI, (2002) rice grain length or size can be categorized into 4 classes which include: Extra-long (above 7.5 mm), Long (6.6 to 7.5 mm), Medium (5.5 to 6.6 mm) and Short (5.5 mm or less). Based on the above classification (Table 2), all four rice samples can be classified as extra-long grain rice with length ranging from 7.57 to 8.38 mm.

Table 2: International Standards for the classification of rice size and shape

Size		Shape	
Classification	Range	Classification	Range
Extra Long	Above 7.5 mm	Slender	Above 3.0
Long	6.6 to 7.5 mm	Medium	2.1 to 3.0
Medium	5.5 to 6.6 mm	Bold	1.1 to 2.0
Short	5.5 mm or less	Round	Less than 1.1

With respect to the grain shape, there was no significant difference in the grain shape among the rice samples. Therefore based on the above classification, all four rice samples can be classified as slender in shape. However, the length/width ratios of the samples measured ranged from 3.01 to 4.5.

Table 3: Physical Qualities of Rice (Chalky and Other grains)

Rice Variety	%Chalky Grains	100Grain Weight (g)	%Discoloured Grains	Foreign matter	Other Grains
V1	9.86 ± 1.41^{c}	2.5 ± 0.61^{a}	0.93 ± 0.51^{a}	0.00 ± 0	0.00 ± 0
V2	6.54 ± 5.35^{b}	2.3 ± 0.26^{a}	1.27 ± 0.7^{b}	0.00 ± 0	0.00 ± 0
V3	3.24 ± 1.62^{a}	2.8 ± 0.50^{a}	1.80 ± 0.87^{c}	0.00 ± 0	0.00 ± 0
V4	2.97 ± 0.68^{a}	2.6 ± 0.00^{a}	0.7 ± 0.10^{a}	0.00 ± 0	0.00 ± 0

V1, V2 and V4 are CSIR- CRI-developed. V3 is Nerica 1, best aromatic upland rice variety in Africa

3.1.4 Grain Chalkiness

Chalkiness in grain is described as the presence of whiteness on the edges or central part of the milled rice (Manful, 2013). It usually occurs at the early stage of grain development under high temperature (Tashiro and Wardlaw (1991) and it adversely affects consumer preference and acceptability. There was significant differences ($p<0.05$) in the grain chalkiness of the samples. The highest grain chalkiness was measured in *V1* (9.86%). This was followed by *V2* (6.54%) with *V3* and *V4* measuring 3.24 and 2.97% respectively. The tolerance limit for chalky grains is 11% according to the Codex commission (1990). In view of this all four rice samples can be said to be of acceptable limit of chalky grains. The presence of chalky grains in the rice samples was from 2.97 to 9.86%. Although all four samples had acceptable limit of chalky grains, *V4* and *V3* was observed to be of the least amount of chalky grains making it most preferred compared to *V1* and *V2* (Table 3).

Further to the classification for grain chalkiness, the International Rice Research Institute IRRI, (2002) also documented 4 classes of chalky grains which include: none (0), small (below 10%),

medium (11 to 20%) and large (above 20%). Therefore based on the above classification, it can be inferred that the presence of chalky grains in all four rice was below 10% indicating that all samples had small amount of chalky grains.

3.1.5 100 Grain weight

There was no significant difference in the weight of 100 grains of all samples. Generally, the weight of 100 grains among the four rice samples was from 2.3 to 2.8 g. However, *V3* recorded the highest weight per 100 grains followed by *V4* (2.6 g) and *V1* (2.5 g). The least weight per 100 grains was measured in *V2* (2.3 g). It must be noted that the slight differences in the weights of the grains can be attributed to genetic composition. Since grain yield is one key factor influencing consumer preference for rice it can be deuced that *V3* will be most preferred among the 4 samples.

3.1.6 Discoloured Grains

The presence of discoloured grains largely affects consumer choice of rice. Globally there is low patronage for rice with high presence of discoloured and chalky grains. Rice producers are required to limit the presence of high levels of discoloured grains by selecting varieties that are naturally of low discoloured grains. There was significant difference in the levels of discoloured grains of the samples. *V3* recorded the highest amount of discoloured grains of 1.80 %. This was followed by *V2* (1.27%), *V1* (0.93%) and *V4* (0.7%). It is important to note that *V4* and *V1* is likely to be the most preferred variety among the four samples since they have the least amount of discoloured grains.

3.1.7 Foreign matter

The presence of unwanted foreign matter is a great limitation to the patronage of a given rice sample on the global market. These foreign matter can be stones, debris, insect fragments, broken glass ware etc. that may be presence in the sample. From the analysis there was no measurable amount of the foreign matter in all four samples. In a rare situation as this, it can be concluded that the samples provided for the analysis was generally clean. This can be due to the harvesting, storage and handling conditions in which the samples were subjected to prior to the analysis.

3.1.8 Other Grains

The measurement of other grains in rice analysis is usually seen to be a post-harvest defect on the part of the producer and is highly unaccepted. With respect to the presence of other grains, there was absolutely no measure of other grains in the samples. This means there was absence of other grains such as sorghum, millet, maize etc. This is a clear indication that the rice samples provided for the analysis was of pure breed with no mixture of other grains. Again one can relate the pure state of the rice samples to the practice of Good Manufacturing Practices (GMPs) observed by the producer.

4.0 Conclusion

In conclusion, there was significant difference ($p<0.05$) in the percentage head rice and discoloured grains. *V1* measured the highest % head rice of 67.24 and least amount of discoloured grains among the samples. All four samples were classified as extra-long grain rice. There was significant difference in the percentage chalky grains; V4 measured the least amount of chalky grains of 2.97. There was no significant difference in the weight of 100 grain count among the samples. There was no measurable amount of foreign matter and other grains in all samples.

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