Malting Potentials of Hybrid and Local Varieties of Rice

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ABSTRACT – ***In this study the malting characteristics of two hybrid rice varieties "Nerica 34 and Sipi" and a local variety called Faro 10 were evaluated. Parameters of interest included germination energy, Malting Loss, Malt Yield, and Diastatic Activity. The average percentage viability of the rice varieties was 96.38 %. Malt yield was inversely proportional to malting loss with the latter ranging from 1.48 – 60.0 %. Diastatic activity reached its peak on days 6,7 and 8 for Nerica 34, Faro 10 and Sipi respectively and ranged from 17.054 – 29.242 U/ml. Therefore, the studied rice varieties have good malting potentials and could become good sources of amylases for industrial use.***

Keywords: Rice varieties, Diastatic activity, Germination energy and Malt yield.

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1. INTRODUCTION

Rice is unquestionably an excellent source of energy among the cereals. The endosperm serves crucial economic and nutritious performance for the vast majority of humanity and animals (Roy *et al*., 1996). In Nigeria, two commonly cultivated varieties of rice are *Oryza sativa* (Asian rice) and *Oryza glaberrima* (African rice). These rice varieties have provided the energy needs of the populace and other uses over the years. Recently the utilization of rice has improved as it finds application in the brewing industry especially in the preparation of malt for both alcoholic and non-alcoholic beverages. Among the three tropical cereals (sorghum, rice, maize) recommended for use in Nigerian brewery industries, rice produces the highest average malt yield not only because of its high carbohydrate content but most importantly, its amylase content (Juliano, 1985). Notwithstanding the power of barley in brewing, its intolerance in Nigerian soil and high import duties created a platform for tropical cereals to be accessed for the same purpose. Because of the diverse uses of rice, new rice varieties have been introduced. In Ebonyi state, several breeds of rice have been introduced by the Biotech Centre of Ebonyi State University, Abakaliki. These varieties have been found to tolerate Ebonyi soil having high yield as well as good cooking properties.

Rice varieties grown in Ebonyi State, Nigeria have received little or no attention as major raw material for industrial development thereby reducing value of the produce. This study will perhaps encourage continued utilization of the most desired old variety and possibly reposition it for industrial uses. Hence, the need to evaluate the malting characteristics of hybrid and local varieties of rice from this study centre.

2. MATERIALS AND METHODS

2.1 Source of Rice Sample

Two new varieties of paddy rice namely, *Nerica 34* and Sipi were obtained from the Biotechnology Centre, Ebonyi State University (EBSU), Abakaliki, while a local variety *Faro 10* was obtained from Ikwo, the major rice-producing community both in Ebonyi State, Nigeria. The grains had been stored for less than three months before this study was carried out.

2.2 Sample Preparation

Rice samples were cleaned to remove contaminating debris by manual winnowing and sorting and subsequently immersed in clean water at ambient temperature for 5 minutes to sort out floating grains and to wash off adhering dirt.

2.3 Methods

2.3.1 Steeping of Rice Grain
Steeping was done with little modification of the method described by Owusu-Mensah *et al*. (2011). Rice sample of 50 g was accurately weighed using Mettler balance (P 1210) and soaked in 30 ml of 5 % potassium metabisulphite for 20 seconds. This was followed by thorough washing of the grain with distilled water to remove residual chemicals. Finally, the washed grain was steeped in 1000 ml of distilled water for 48 hours at ambient temperature. At intervals of 12 hours, the grain was drained and two hours air rest was allowed immediately after draining and then re-steeped in fresh distilled water. The steeping process was carried out in triplicates using plastic containers.

2.3.2 Germination of Rice Grain
Germination was done according to Ayernor and Hammond (2001). The steeped sample was spread on a clean jute sack, kept and allowed to germinate in a dark cupboard at ambient temperature (27 to 30 ^{o}C) for eight days. Clean tap water was sprinkled on the germinating grain at time intervals of twelve hours to avoid desiccation. This ensured a humidified environment for the grain.

2.3.3 Kilning of Rice Grain
This was done according to NienuPetra (2011). Germination was arrested by drying the sprouted rice grains at 40 – 53 ^{o}C for 5 - 6 hours in an incubator. The dried rice malt was milled with an electric food blender and the milled malt was packed in labeled low density polyethylene bag and stored in a refrigerator and taken for analysis.

2.4 Determination of Germination Energy
This was determined according to Ayernor and Hammond (2001). Germination energy was calculated as the ratio of germinated (viable) grains to the total grains malted multiplied by 100.

$$\text{Germination Energy, GE} = \frac{\text{Germinated grains}}{\text{Total grains}} \times 100$$

2.5 Determination of Malting Loss
Malting loss was evaluated using the method described by Asante *et al.* (2013) which involved weighing 50 rice seeds before malting and then reweighing the same rice sample after malting and drying. The difference in weight was further divided with the dry weight (50) of grain before malting.

$$\text{Malting Loss} = \frac{\text{Rice grain (wt)} - \text{Malt (dry weight)}}{\text{Rice grain (wt)}} \times 100$$

2.5.1 Determination of Malt Yield

Malt yield for each day of the malting period (germination period) was determined by taking the dry weights of an equal number of grains (50) before and after malting in the absence of any developed roots or shoots. Malt yield was calculated using the formula described by Asante *et al.* (2013).

$$\text{Malt Yield (\% on dry basis)} = \frac{\text{Malt (dry wt)}}{\text{Rice grain (dry wt)}} \times 100$$

2.6 Preparation of Rice Malt Extracts (RME)
The method described by Asante *et al.* (2013) was modified and employed in the extraction of enzyme. In this case, 1.5 g of each of the milled rice malt sample was accurately weighed into centrifuge tube and 6.0 ml of the extraction medium (0.05 M Sodium phosphate buffer of pH 8) was added to each tube. The mixture was stirred intermittently, after which it was allowed to stand for 30 minutes in order to extract the enzymes into the medium. The enzyme suspension was then centrifuged at the speed of 4500 rpm for 15 minutes using 'IEC CENTRA-3C' centrifuge and the supernatant decanted directly into clean test tube in readiness for diastatic activity determination.

2.7 Determination of Diastatic Activity of Rice Grain
The dinitrosalicyclic acid (DNSA) method was used to determine level of the total starch-degrading enzyme (diastase) on each day of the malting period. The level of alpha amylase produced was deduced from the amount of reducing sugar produced upon its reaction on soluble cassava starch. To the obtained supernatant of RME, 0.3 g of calcium chloride ($CaCl_2$) was added in order to maintain the structural integrity of the alpha amylase. The mixture was heated for 15 minutes at 70 ^{o}C to denature all available beta amylase (Asante et al., 2013). To 5.0 ml of pre-equilibrated cassava starch

solution, 1ml of the heated extract was added while stirring and the reaction lasted for 10 minutes before being terminated by the addition of 2.0 ml of 0.1 M Sodium hydroxide (NaOH) solution. The reducing sugar (maltose) formed after the reaction was measured by adding 1.0 ml of 3, 5- dintrosalicylic acid (DNSA) reagent to the mixture, mixed and further heated for 5 minutes at 80 ^oC. This was cooled and the absorbance was read at 540 nm using Spectronic 21D. The procedure was repeated for the standard and control solutions except that the standard solution was void of starch solution. The alpha amylase activity of the rice was determined using the formula given by Beleia and Varriano-Marston (1981) as modified by Asante *et al*. (2013).

$$\text{Enzyme Activity} = \left(\frac{\text{mg/ml (maltose)} \times 10^3}{\text{Mw. maltose} \times \text{time (min)}} \right) \times 2$$

2.8 Statistical Analysis

All data obtained from the malting parameters were subjected to statistical analysis (one-way ANOVA) to determine the significant differences between treatment means at P = 0.05. Means were separated using Least Significant Difference (LSD).

3. RESULTS AND DISCUSSION

3.1 Germination Energy (G.E)

Figure 1 shows the germinative energy of the rice varieties. Germinative energy gives an index of good germination of the grains during malting. Good germinative energy indicates that level of dormancy by the grain will be low. Grains must be of good quality to be used in brewing and be properly raised in nursery or applied in other areas where sprouted grains are required. It therefore gives an accurate insight or estimate on the quality of the grains.

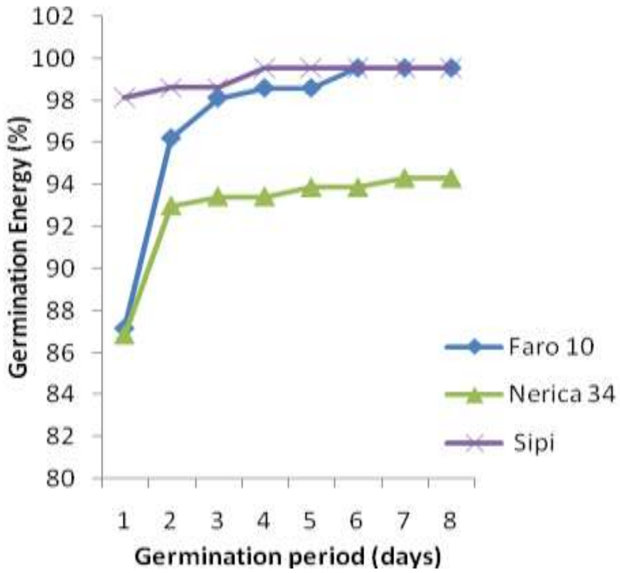

Fig. 1: Germination Energy of rice grains

The result reveals that within the first day of germination more than 80 % germination was achieved by the three varieties of rice. Within 3 days of germination more than 90 % of the three varieties of rice was observed to have germinated, showing that the grains qualify for malting (Agbale *et al*., 2007). The grains showed increased germination energy with increase in germination time up to day 6. This is indicative of the fact that these rice varieties have high potential in malting. At the termination of germination, *Faro 10* (local variety) and *Sipi* had G.E of 99 % while G.E of 94.30 % was observed for *Nerica 34*. Egwim and Oloyede (2006) observed G.E of 98 % for rice. According to Ayernor and Hammond (2001) the degree of grain maturity could contribute to the variation in germination energy. Thus, the grains showed that they were not only matured but also healthy. The germination energy of Nerica 34 differed significantly (P>0.05) from the other varieties.

3.2 Malting Loss

Malting loss is the material lost in converting the grain into malt. It occurs mainly due to the growth and respiration of the embryo. It is an indication of the extent of modification of the grain. These losses result from the conversion of grains to malt. In Figure 2, the malting losses of the rice varieties, which increased with increasing malting period, ranged from 1.48 to 60.0 % with *Sipi* recording the highest loss on the last day. On the average, the local variety (Faro 10), *Nerica 34* and *Sipi* lost 22.77 %, 23.83 % and 27.03 % of their constituents respectively. Statistical analysis showed that the malting losses differed insignificantly among the rice varieties at (P< 0.05). The malting losses reported in this work are similar to those obtained by Asante *et al*. (2013) and Ayernor and Ocloo (2007) which were not more than 60 % on the 9th day of malting. One of the factors contributing to these high malting losses is the rapid disintegration of the starch content of the grains. While Ayernor and Ocloo (2007) attributed these losses to chemical change and physiological activities that occurred in the grain during malting, Suhasini and Malleshi (1995) reported that metabolic activities and separation of vegetative growth as the causes of malting loss. But Ayernor and Ocloo (2007) found that leaching of minerals and other grain constituents during steeping and germination might also account for the malting losses. Thus, factors responsible for malting loss as observed by previous researchers must have played significant roles in the malting losses of these varieties of rice. Interestingly, the local variety showed good germination characteristics as the new varieties.

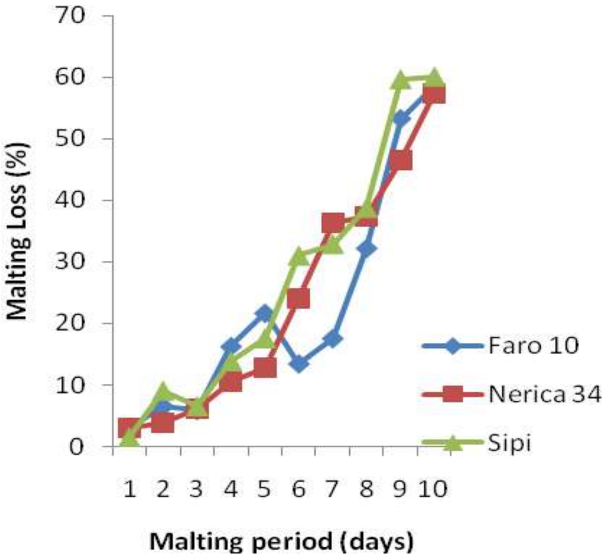

Fig. 2: Malting Losses of Rice Varieties

However, Wijngaard *et al*. (2005) pointed out that leaching of compounds from the grains during steeping contributed to the loss. The result indicated that there was no difference (P < 0. 05) in the malting loss of the rice varieties.

3.3 Malt Yield

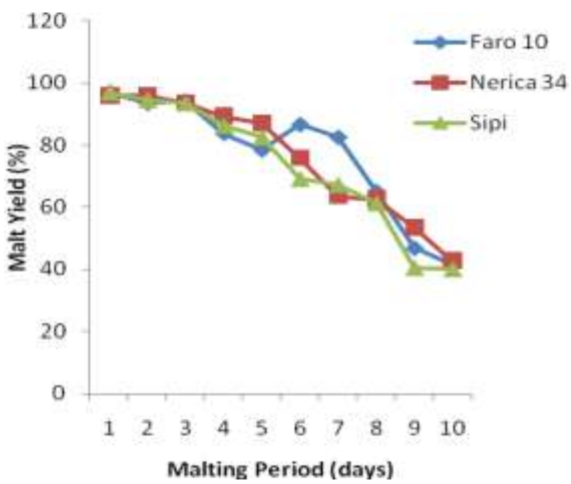

Fig.3: Malting Yields of Rice Varieties

Despite the losses incurred during the malting process, some useful materials in the grains still remained intact after malting, thereby constituting the malt yield. A comparison of Figure 3 obviously indicated that at increased malting period, malting loss increased while malt yield declined. Malt yield decreased from 97.08 to 40.0 %. *Nerica 34* showed highest malt yield of 42.64 % on the last day of malting. The malt yield of the rice grain differed insignificantly at p = 0.05. Ayernor and Ocloo (2007) also observed that the starch content and weight of their paddy rice decreased drastically as germination progressed. Asante *et al* (2013) also observed malt yield of less than 40 % on the last day of malting.

3.4 Diastatic Activity

Among the carbohydrate –degrading enzymes, α-amylase is the most important Afiukwa *et al*. (2009). Micro organisms, animals and plants are the different sources of these enzymes but germinating cereals yield high activities of these enzymes (Yaldagard *et al*., 2008). The major aim of malting is to promote the growth and development of the inactive hydrolytic enzymes (Dewar *et al*., 1997) and this begins from steeping. Figure 4 shows the diastatic activities of the rice varieties. Increased diastatic activities were observed on the first day of steeping as a result of the demand for energy required to initiate germination. Thus, the high diastatic activities observed in the grains (Azakawa *et al*., 1968).

Diastatic activity in *Sipi* declined slightly on the second day while those of *Nerica 34* and *Faro 10* declined on the 3rd and 4th days respectively. Similar trend was observed by Asante *et al*. (2013) and they attributed it to the inability of the scutellum to maintain the rate at which the diastases were produced. The growth and development of the roots and shoots require adequate energy which is released from the hydrolytic reactions in the grains. The aleurone layer, which was activated as a result of lower production of α-amylase, began to synthesize more α-amylase Asante *et al*. (2013). This led to the faster hydrolysis and increased diastatic activities until the optimum levels were reached. This occurred on malting days 6 (29.192 U/ml), 7 (28.654 U/ml) and 8 (29.242 U/ml) for *Nerica 34*, *Faro 10* and *Sipi* respectively.

As germination continued, the amount of starch reserve in the rice grains gradually reduced, leading to another mellow in the diastatic activity. At p = 0.05, the diastatic activities of the grains varied insignificantly. Thus, the time for enzyme activity varied among the rice varieties. Rahman *et al.* (2007) reported similar observation in the amylase and invertase activities of three Mungbean varieties.

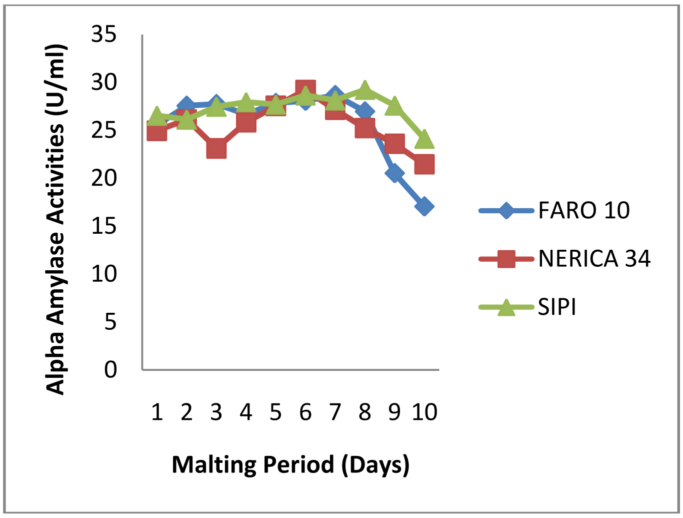

Fig. 4: Trend of α-amylase in the rice varieties

4. CONCLUSION

The malting characteristics of the studied varieties of rice proved to be excellent for malting. More than 99 % G.E was observed at the end of germination and the grains germinated rapidly. Notwithstanding, the grains lost greater percentage of their constituents after 8th day of malting and this yielded little rice malt. Both the local and hybrid varieties showed similar traits but on the average, *Sipi* variety was better than the other varieties.

5. REFERENCES

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