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Effect of Air-Rest Treatment on Rice Malt

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Abstract

To improve the malting qualities of rice grain, paddy rice (Jasmine 85) was air-rested for 2 to 8 h while in steep and malted for 12 days at 28 $\pm$ 1^{o}C. Out-of-steep moisture content, germination energy, shoot length, and diastatic activity of the rice grains were evaluated to determine the efficiency of the air-rest treatment. Air-rested rice grains absorbed 0.5 to 5% moisture more than the untreated (control). Six-hour air-rested grains absorbed the highest moisture content of 36.6% after 48 h of steeping. The highest germination energy (93%) and diastatic activity (1002 U/g dry malt) were recorded in the 6-hour air-rested grains. Moreover, malts resulting from this treatment had their optimum diastatic activity (2086 U/g dry malt) on the 8th day after germination, occurring earlier than the control (2001 U/g dry malt) which peaked at the 10th day. Applying air-rest treatment during rice malting improves its hydrolytic potential.

Keywords: air-rest, diastatic activity, germination, malt, moisture content

1. Introduction

Air-rest treatment is one of the physiological innovations that enhances germination, and diastatic activity of cereal grains (Wijngaard, Ulmer, Neumann, & Arendt, 2005; Dewar, Taylor, & Berjak, 1997). During air-rest, soaked grains are exposed to atmospheric oxygen for a stipulated period of time during which the grain undergoes aerobic respiration. The grain, which is living, needs sufficient oxygen for its metabolic activities to release energy for growth. When sufficient oxygen is present and the grain is not water sensitive, grain can chit (germinate) while in steep (Wijngaard *et al.*, 2005). Briggs (1998) also reported that application of air-rest during modern steeping enhances chitting, and the chitted grain takes up moisture more rapidly, germinates faster and produces more diastase. The use of long and short periods of air-rest by some malsters testifies to the fact that controlled exposure of grains to air during steeping is a major technological advancement (Briggs, 1998).

In Ghana, rice grains are usually soaked continually without any air-rest treatment. Agbale, Adamafio, Agyeman, and Sackey (2007), and Hammond and Ayernor (2001), soaked rice grains for 14 h and 24 h respectively in the preparation of rice malt extract for sugar syrup and alcohol production without air-rest. Aeration (air-rest treatment) during steeping is not a common practice in Ghana. This current study therefore investigated the effect of this technology on rice grain with the objective of increasing it diastatic power for the production of high quality malt-based products for the brewing and like industries. The outcome of this investigation will go a long way to boost the utilization of local raw materials thereby creating ready market, and increasing the Gross Domestic Product (GDP) at large.

2. Materials and Method

Jasmine 85 paddy rice was obtained from Crop Research Institute (CRI), Kumasi, Ghana. The randomized complete block design with three replicates was used for all the experimental runs.

2.1. Malting and Air-Rest Treatment

1.5 g of paddy rice (Jasmine 85) was soaked in 200 mL distilled water for 12 h at a temperature of $28 \pm 1^{o}C$, subjected to different air-rest treatment (2, 4, 6, and 8 h) and re-steeped for another 12 h. During the air-rest period, the steep liquor was drain off for the stipulated period of time during which the grain underwent aerobic respiration. To assess the efficiency of the air-rest treatment, out-of-steep moisture content (SMC), germination energy, and shoot length of the resultant rice malts were measured (Hammond & Ayernor, 2001; AOAC, 1990). In addition, the diastatic activity of the rice malt was also determined using the 3,5-dinitrosalicyclic acid (DNSA) methods for reducing sugars (Osman, 2002; Cantizares-Macias, Hernandez-Garciadiego, & Gomez-Ruiz, 2001).

2.2. Out-of-Steep Moisture Content (SMC) Determination

The SMC of the soaked rice grains was determined using the Association of Official Analytical Chemist [AOAC] approved method (1990). Two grams (2.0g) of each pre-soaked grain sample was weighed into a previously dried and weighed glass crucible. The glass crucible with the sample was placed in a forced air oven (Genlab) for 5 h at a temperature of $105^{o}C$. After cooling in a dessicator, the glass crucible together with its content was weighed again. The differences in weights were recorded and used for the calculation of the SMCs mean values.

2.3. Percentage (%) Germination Determination

Two grams (2.0g) of rice grains were soaked in distilled water with air-rest treatments and germinated in a malting chamber at a temperature of $28 \pm 1^{o}C$. The grains were placed in petri dishes lined with two Whatman's filter papers and sterilized jute sack. 5-10 mL of distilled water was added to the grains daily. The germination was carried out in the dark. To assess the rate of the grain emergence, emergence counts were made in 48 h. The ratio of germinated grains to the total grains was calculated and recorded as the percentage germination energy of the grain (Bam, Kumaga, Ofori, & Aisedu, 2006; Hammond & Ayernor, 2001).

2.4. Shoot Length Determination

The shoot and root lengths of ten seedlings per replicate for each treatment were measured using a measuring ruler. The means were calculated and recorded as the average lengths (Hammond & Ayernor, 2001).

2.5. Diastase Assay Using DNSA Method

To 0.25 mL pre-equilibrated soluble starch solution, 0.05 mL of appropriated diluted (dilution factor; 50) Rice Malt Extract (RME) was added while mixing and incubated for 10 minutes at $60^{o}C$.

The reaction was terminated by adding 2 mL of 0.1M NaOH solution. 1.0 mL freshly prepared DNSA reagent was added, mixed and boiled for 5 minutes at 80°C. After cooling, the absorbance of the mixture as well as the control and the standard were read at 480nm from spectrophotometer (Heλious UV spectrophotometer). The standard and control were treated similarly except that the RME was added to the control after NaOH. The diastase activity was then calculated according to Osman's formula (Osman 2002).

2.6. Statistical Analysis

Data obtained were analyzed using Microsoft Excel Programme and Statistical Package for Social Sciences (SPSS) - version 13 to determine significant differences or otherwise between the treatment means at $p = 0.05$.

3. Results and Discussion

3.1. SMC and Germination Energy of Air-Rested Rice Grains

Table 1 shows the out-of-steep moisture content (SMC), germination energies, and diastatic activities of air-rested rice grains. The moisture content, germination energy, and diastatic activity of the soaked rice grains generally increased with increasing air-rest periods. Air-rested rice grains absorbed 0.5 to 5% moisture more than the untreated (control). The 6-hour air-rested grains absorbed the highest moisture content of 36.6% after 48 h steep. The highest germination energy of 92.6% and diastatic activity of 1001.7 U/g were also recorded in the 6-h treated grains. The increase in the water absorption could be attributed to the fact that the interior layers of the grains absorbed some amount of water at the expense of the peripheries during the resting periods. This resulted in the increase of the water potential gradient between the grain and the steep liquor after re-steeping and hence the further increase in the rate of water uptake. Air-rest treatment is known to accelerate water uptake and initiate germination of grains whilst in steep (Wijngaard *et al*., 2005). When steeped grains are drained and air rested, their interiors continue to hydrate at the expense of the surface film of moisture. Nevertheless, if the grain surface film is re-established by re-steeping, the hydration resumes at a faster rate (Briggs, 1998). The decrease in moisture content of the 8-hour air-rested grains could therefore be attributed to excessive loss of water during the long resting period which affected the final moisture content and the subsequent modification of the grains.

Table 1. Out-of-Steep Moisture Content (SMC), germination energy and diastase activity of air-rested rice grains[1, 2]

Air-Rest Regimes (Steep: Air-Rest: Steep)	SMC (%)	Germination Energy (%)	Diastatic Activity[3] (U/g Dry Malt)
24:0:24	34.86 (0.10)[a]	90.50 (0.55)[a]	667.81 (2.1)[a]
24:2:24	35.50 (0.12)[b]	91.21 (0.2)[b]	923.44(1.6)[b]
24:4:24	36.01 (0.08)[c]	92.01 (0.15)[c]	924.06 (2.5)[b]
24:6:24	36.61(0.09)[d]	92.58 (0.70)[d]	1001.72(2.6)[c]
24:8:24	35.01 (0.2)[a]	90.50 (0.75)[a]	925.73(2.2)[b]

[1]*Standard error are presented in parenthesis*

[2]*Mean values in each column with the same superscript are not significantly different (p = 0.05) based on LSD test.*

[3]*Diastatic activity was calculated at out-of-steep.*

The efficiency of the air-resting treatment became more apparent when the diastatic activity of the soaked grains was evaluated. The results indicate that to obtain rice malt with high diastatic activity, rice grains should be air-rested for 6 h during steeping. Such physiological innovation will ensure sufficient availability of oxygen to improve the synthesis of hydrolytic enzymes.

3.2 Air-Rest and Shoot Length Development of Rice Grains

The effect of oxygen availability on enzymes production and endosperm modification was highly manifested in the rate of shoot emergence and growth. The shoot lengths of the grains increased with increasing air-rest periods (Figure 1). However, the effect was more pronounced in the 6-hour air-rested grains producing the highest mean length of 5.24 cm. The significant differences ($p = 0.009$) in shoot lengths between the control and the 6-hour air-rested grains could be attributed to the increased rate of respiration and the associated changes during the steeping and germination processes. Respiration provides most of the energy that drives grain metabolism and the growth of shoots and roots (Briggs, 1998). Air resting rice grains for 6 hours while in steep could further enhance diastatic activity of rice malt.

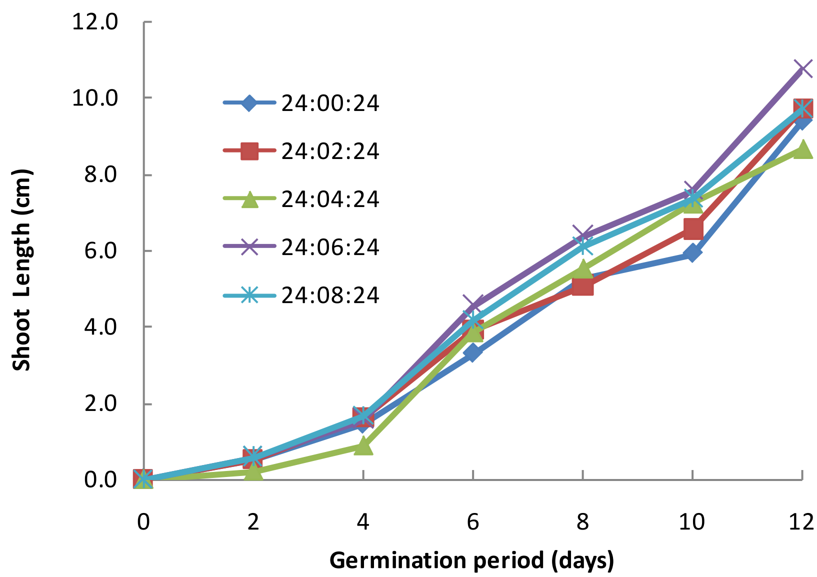

Figure 1. Air-rested rice grains shoot length as affected by germination period

3.3 Air-Rest Treatment and Diastatic Activity of Rice Malt

In general, diastatic activity increased alongside germination period to a point, with 6-hour air-rested rice grains producing the highest mean activity of 1528.01U/g dry malt compared with the untreated grains (1456.33U/g dry malt) (Figure 2). Agbale *et al.* (2007) and Hammond and Ayernor (2001) observed a similar trend on enzymatic activities of rice malt enzymes with diastatic activity increasing with increased malting period. The air-rest treatment had a significant effect on the diastatic activity of the malt. Moreover, malts resulting from this treatment had their optimum diastatic activity at day 8 after germination, occurring earlier than the control which peaked at the 10th day. The decrease in diastase production in general could be attributed to the physiological feedback from the embryo switching off the production of hormones such as gibberellic acid, decreasing the production of diastase. During germination, the embryo takes simple sugar produced from the enzymatic hydrolysis, restoring its internal levels. This condition seems to terminate gibberellic acid supplies to the aleurone layers in a regulatory feedback loop, putting a check on the enzyme production (Briggs, 1998).

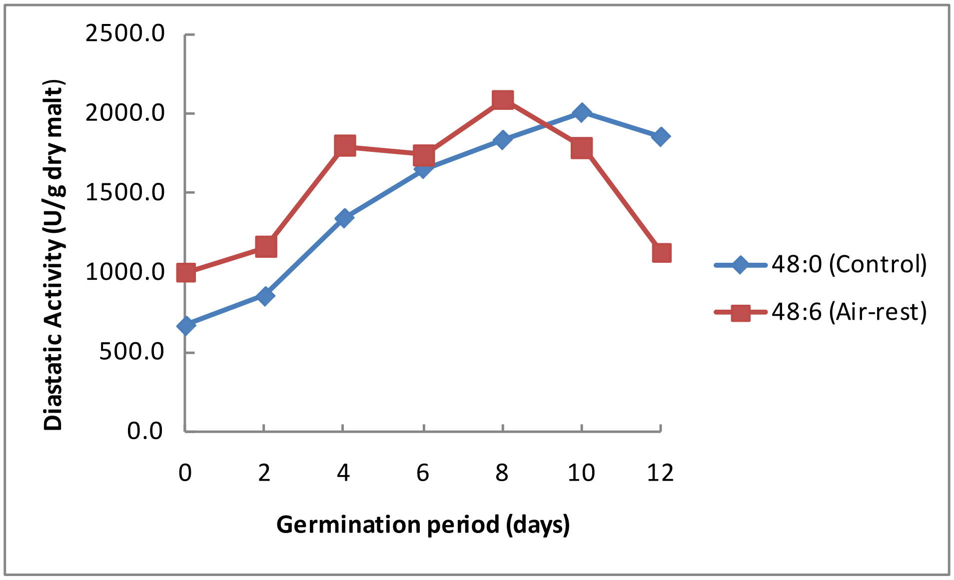

Figure 2. Diastatic activities of air-rested rice grains

4. Potential Benefits of Air-Rested Rice Malts

Application of air-rest treatment during malting of rice grains improves its diastatic power. Six-hour air-rest treatment was found to significantly stimulate higher production of diastase for efficient conversion of more soluble starch to fermentable sugars. The maximum diastatic activity of the air-rested malt was found on the 8^{th} day of germination whilst that of the untreated occurred on the 10^{th} day. It is therefore recommended that rice grains should be air-rested for about 6 h during malting to stimulate higher production of amylases within a shorter malting period. The increased diastatic activity achieved through air-resting implies that lesser quantity of malt would be used in scientific and industrial starch hydrolysis resulting in significant cost-savings.

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