EXTRACTION AND ANALYSIS OF MALT FROM GERMINATED BARLEY SEEDS

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ABSTRACT

This study was conducted under laboratory conditions to evaluate germinated barley seeds brought from Libya (semi-temperate) to Malaysia (Tropical area). Rate of germination, malt yield and proximate analysis for several quality parameters were measured. The results showed that germinated barley has high malt yield (72%) with good quality. The dry matter content of the malted samples ranged from 94– 95%. There is a significant difference in protein (at p > 0.05) between the malted and non-malted barley. The highest value of protein in the malted barley is 12.85%; while in the non-malted barley, it is the lowest (4.12%). There is a significant difference between the lipid and ash (at p > 0.05); the lipid and ash contents of the malted barley samples were 1.94% and 2.53% of the dry matter, respectively. For the dry matter, there was no significant difference in fiber percentage and Nitrogen Free Extract (NFE) percentage. The malt in the germinated barley was found to be acceptable and of good quality with a slight difference when compared with the malt produced under non-tropical environment. Hence, this method could be used as an alternative in the production of malt in non-barley producing cultures.

Key words : Malted barley, Aseptic technique, Seeds sterilization, Tropical areas.

INTRODUCTION

Barley is one of the most important cereal crops in the world. It is widely grown and ranked fourth among top 10 crop plants in the world after wheat, rice and maize (Taketa et al, 2008). Barley is an economically important cereal used for producing malt, brewing industries, human food and animal feed used for broilers (Angkanaporn et al, 1996), cows (Christen, et al. 1999), fish (Al-Asgah and Ali 1994; Al-Ogaily, et al. 1996). In addition, barley is a primary source of carbohydrates. It also provides trace minerals, dietary fibre and bioactive compounds (Madhujith and Shahidi, 2006). Malt is a cereal that can be steeped, germinated under controlled conditions (moisture, temperature and time) and dried either by sun or an oven (Beta, et al, 1995). Traditionally, barley as a cereal chosen for malting. However, barley cultivation in tropical areas has not been successful. Thus, for producing malted food, barley malt is imported from temperate regions (Beta, et al, 1995 and Elbeydi et al, 2007). The malting process involves the breakdown of starch, protein and nucleic acid molecules in barley grains into sugars, amino acids and nucleotides (Swanston et al., 1995; Jones, 2005). The enzymes produced during germination break down starch into sugar maltose, which is then fermented by yeast to produce alcohol and carbon dioxide (Jones, 2005).
This study aims to achieve two objectives: to extract and determine maltose content in barley seeds and to examine proximate composition of non-malted barley and malted barley.

**MATERIALS AND METHODS**

**Sources of barley seeds**

For this study, the samples of barley seeds included De-canter and Chariot. They were harvested in 2010 and imported from Libya. These varieties were supplied by Home Grown Cereals Authority. The grain was cleaned and stored for analysis. All the tests were performed in triplicate on a dry weight basis.

**Production of malt**

Germination of barley seeds was carried out in the laboratory of Fresh Water Fish Hatchery, in the Faculty of Agro Technology and Food Science (FASM), at University Malaysia Terengganu (UMT), using the methods described by Sharma and Gujral (2010) with some modifications (see Fig.1). The seeds were placed in a late lunar month at (from night 23rd to 27th) to accelerate the process of germination. Prior to germination process, working tables and forceps used were sanitized with 95% of ethanol. The samples were steeped by placing them in perforated nylon bags and steeped for 20 hrs, under running tap water at 28-30°C (Morall et al 1986, Taylor and Dewar 1992). After steeping, the grains were sterilized in 2% of sodium hypochlorite solution for 10 mins and then rinsed five times with excess water. The grains were then germinated at 28°C and 95% RH, for seven days in a germinator equipped with a humidifier.

**Dehusking and milling the barley**

The germinated seeds were dried in oven (Memmert, Germinay) at 45°C for 24 hrs. The dried malt was cleaned by removing the roots and shoots. Barley flour was prepared by grinding dehusked barley in a Grinding Mill (Model 4L) and the flour was sieved through a 250 µm sieve. Two fractions were obtained which were defined as refined flour and bran. The bran was reground in an electric grinder (Herbs Grinding, Model: DF-20) and passed through 250 µm sieve before analysis. Final germination percentages were calculated through the total number of seeds germinated divided by total number of seeds used (Ghazi et al, 2007).

**Determination of chemical composition of malted and non-malted barley**

The sample moisture content can be determined based on the dry matter analysis (103 °C / 6 hrs). Crude protein was determined by using Kjeltec ™, 2100 FOSS (AOAC, 1990) using an oven to dry the samples (55°C/ 24hrs). then the outcome of analysis was multiplied by the protein factor (6.25). Ash analysis was determined by using method described in (AOAC, 1990). The lipid was extracted by using petroleum extraction method as described in AOAC (1990) method using 2055 Sextet Avanti Extraction unit, FOSS at 400 °C / 6 hrs. For crude fiber, raw fiber extractor, Fiber Tech MT, 1020 (based on Tecator Technology MT Technology) was used. For Nitrogen Free Extract (NFE), it was calculated by difference.

**Determination of maltose in barley malt content**

Maltose content was determined by Titrimetric method, (AOAC, 1990).

**Preparation of the Extract:** 5.675 g flour was transferred into a 100 or 125 ml Erlenmeyer flask and 5 mL of alcohol (40 %) was added followed with 50.0 mL acetate buffer solution. Then, the flask was shaked to bring flour into suspension. Immediately 2 ml Na tungstate solution was added and shaked until well mixed. The mixture was then filtered using Whatman No. 4. The first 8-10 drops of filtrate were discarded.

**Determination of maltose:** 5 ml of the flour extract were pipetted into a 75 ml test tube and 10 ml of K₃Fe (CN)₆ solution were added to the test tube. The test tube was vigorously immersed in a boiling water bath. The solution in the test tube was placed 3-5 cm below the surface of boiling water for 20 min. The solution was cooled under running tap
water and after that it was poured into a 100 or 125 ml Erlenmeyer flask. The test tube was rinsed with 25 ml HOAc-salts solution. One mL of starch-KI solution was added and titrated with 0.1N Na2S2O3 solution until blue color completely disappeared (a 10 ml micro buret is recommended). The mixture was titrated by subtracting ml 0.1N Na2S2O3 from 10.00. In case of slight blank in K3Fe(CN)6-Na2S2O3 titration, it was corrected by subtracting from Na2S2O3 equivt. of K3Fe(CN)6 solution. This difference represents a definite amount of reducing sugar/10 g flour, calculated as maltose from the (table 939.03 of AOAC 1990).

Statistical analysis:

Data were statistically analyzed using t-test to compare the chemical compositions between the malted and non-malted barley; the analysis was supported by correlation two tailed using Genstat5 program.

RESULTS AND DISCUSSION

In this study, barley seeds were germinated under laboratory conditions in Malaysia to produce malt. The rate of germination was 72%. Although this percentage was high under tropical conditions, it is lower in Northeastern North Dakota in United States and Pakistan where the percentage 95% and 86% respectively (Bryan and John, 1992, Ahmed, et al, 2003).

Chemical composition of the malted barley

The proximate analysis of the malted barley and barley seeds is shown in Table 1. There was a significant difference in protein. The highest value of protein recorded 12% in the malted barley; while in the non-malted barley, it was the lowest (4%). A positive correlation was observed between the protein and moisture (P > 0.01). In general, germinated seeds have a higher protein content. The increase in the protein content is attributed to the passive variation due to the decrease in the carbohydrate compound used for respiration (Opuku et al, 1981). In addition, there was also an increase in the nitrogen level. This is in agreement with AAFCO (1994) whereby it reported a relatively high level in crude protein for the feed grain, ranging from 8 to 13 % because most barley feed contains the hull where the fiber content is relatively high, 5-7%. There was a significant difference in the lipid; it was higher in the non-malted barley than the malted barley. The low levels of lipid obtained from the malted barley samples were expected because the cereal used was carbohydrate source with a higher level of simple sugar (Lewis and Young, 1995). However, the low fat content of the malted barley is desirable because lipids can destroy foaming capacities of malt (Okafor and Iwouno, 1990). There was a significant difference in the ash content; it is higher in the barley than the malted barley. This may be due to some micro elements reduction during germination (Oluymemisi, 1991; Vidal-Valverde et al 1994; Udayasekhara, 1995). There was no significant difference in the dry matter content of the malted barley and barley samples and

Fig 1: The preparation steps of germinated barley seeds.
it ranges from 94–95% which is suitable for the dry matter content according to TS 4500 because it should not be less than the limit 85.5%. Besides the dry matter, there was no significant difference in the percentage of Fiber and NFE because the fibers content has high cellulose which cannot be converted during germination, and also cellulose constituents does not contribute to fermentable extracts in the malt (Noonan, 1997).

**Maltose concentration in malted barley**

Based on the experimental results, sugar concentrations were then calculated using Tabulated Data (Table 939.03 of AOAC 1990). The results showed a high variability in terms of maltose for the malted barley; the content of maltose varied between 70% and 74% DM. The increase in maltose sugar contents that was observed after germinating the barley seeds probably reflect an increase in carbohydrate metabolism in response to the increased water uptake by germinating the seeds. These results are consistent with the findings of Fernando et al (2000) who found that seed carbohydrate metabolism could be considered as a dynamic process involving often concomitantly occurring processes of polysaccharide degradation and synthesis of new compounds. The results obtained in this study were in line with the results obtained on other seeds by Khetarpaul and Chauhan (1990) who reported that the total soluble sugars, both reducing and non-reducing sugars increased significantly while germinating pearl millet, Demuyakor and Ohta (1992) have studied the malt characteristics of sorghum vulgar from Ghana and reported that dextrin, maltose and glucose increased during germination. Choi (1984), indicated that starch in the endosperm degraded slowly during germination and sugar levels increased following the degradation of starch.

**CONCLUSIONS**

Based on the results obtained in this study, malt barley can be processed and cultivated outside the barley growing region as in a tropical region where it has a high potential as a local substitute in malt industries for feed production. Thus, the malted barley selected therefore represents a potential material for different uses. Protein, lipid and ash were significantly higher the levels in malted barley.

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