Comparison of Lipid Content and Fatty Acid Composition of Malted and Non-Malted Barley

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Abstract— *Lipid content and fatty acid composition were determined in trial samples (Malted and Non-Malted Barley). The lipid content did not exceed 2.7% inany trial samples. Moreover, there is a significant difference between the lipid (p > 0.05) contents of Malted and Non-Malted Barley samples. It is a higher percentage in the non-malted barley than that the malted barley. Analysis of the fatty acids by chromatography has shown, the highest percentage of fatty acid in both trial samples, the Linolenic and Linolelaidic acids concentrations were higher in the Non-Malted Barley samples (50.424%) and (48.144%) respectively as compared to the Malted Barley samples (25.374%) and (45.958%) respectively; small amounts of Elaidic acid (0.759%) and Arachidicacid (0.798%) are also found.The results of this study show that, the compositions of fatty acids of malted are very similar to those of the non-barley used to make them.*

Keywords— Lipid, Fatty acid composition, malted, Non-Malted Barley

I. INTRODUCTION

Barley is one of the most important agricultural crops, grown in large amounts around the world and ranked fourth among top 10 crop plants in the world behind wheat, rice and maize (Taketa*et al*. 2008).According to the latest USDA report,the worldbarley production was approximately 134 million tonnes in 2011. Barley is an economically important cereals and traditional used in the production of malt, human food and animal feed (Ighwela *et al*. 2011). In addition, the 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).In 1999 Bhatty conducted an analysis of the nutritional characteristics of barley and it is has a different nutritional composition from other crops. Study of chemical composition parameters of barley are very important for malt quality parameters (protein, lipid and carbohydrate), and also allow the identification of relationships between these parameters (Knežević*et al*. 2004). Based on the fact that the malt is one of the main raw sources for brewing, its quality must be severely evaluated (Savin and Molina-Cano, 2002).Lipids are considered the third storage material in barley and malt. The level of lipid detected in barley grains has been estimated by numerous authors as between 0.85 and 4.8% on a dry weight basis (Anness, 1984., Osman *et al*, 2002.,Bravi*et al*, 2012., Makeri*et al.*2013). In addition, estimation of lipid as total long-chain fatty acids is specific and gives information on the components of most importance in malted and non-malted barley. Furthermore, thedifference in the fatty acid structure of the lipids involved isimportant because net increases in lipid content may lead to changes in overall fattyacid structure, maybe resulting inrancidity problems duringstorage (De La Roche et*al.* 1976). However, little information has been published on direct measurements of lipid content and fatty acid composition of malted and non-malted barley. Consequently, the purpose of this study was to examine the changes in lipid content and fatty acids composition between malted and non-malted barley.

II. MATERIAL AND METHODS

Sources of barley seeds

For this study, barley samples used were from Libya. They were obtained from a local market. The grain was cleaned and stored for analysis until being used, at room temperature. All the tests were performed in triplicate on a dry weight basis.

Malting

The barley wassteeped at 28-30°C for 20 hrsby placing them in perforated nylon bags (Morall*et a*l 1986, Taylor and Dewar 1992). After steeping, the grains were treated in 2% of sodium hypochlorite solution for 10 mints and then washed five times with excess water.Steeped barley was germinated at 28°C for seven days in a germinator equipped with a humidifier. The germinated seeds were dried for 24 hrs at 45°C in an oven (Memmert, Germinay).The samples of barley and malted barley were placed in a Grinding Mill (Model 4L) and the flour was sieved through a 250 µm sieve and stored for analysis.

Extraction of Lipids

The lipidwere extracted from barley and malted barley according to method as described in AOAC (1990) method using 2055 Sextet Avanti Extraction unit. Briefly, lipids were extracted from barley and malted barley by using petroleum extraction. The method depends upon the heating of solvent, which is allowed to pass through the sample to extract the lipid. The extract was collected in a cup and, when the process is completed, the solvent is evaporated and the remaining crude lipid is dried and weighed. Lipid contents were routinely determined in triplicate.

Fatty acid analysis

The fatty acid analysis determinations were performed on samples of Malted and Non-Malted Barley according to Abdulkadir and Tsuchiya, 2008. The samples were homogenized, freeze-dried for 24 h, and stored at – 40 °C before analysis. Three replicates of each barley and malted barley samples (200-300mg) were mixed with 4 ml of hexane and 1 ml of internal standard solution in a 50 ml centrifuge tube. After adding 2ml of 14% BF_3 in methanol and a magnetic stirring bar, the head apace of tube was flushed with nitrogen gas and then closed tightly with a Teflon-lined screw-cap. The capped tube was heated on a hot plate at 100 °C for 120 min under continuous stirring. After cooling temperature, one ml of hexane was added followed by 2 ml of distilled water. The tube was then shaken vigorously for 1 min and centrifuged for 3 min at 2500 rpm (650xg). Of the two phases which formed, the upper phase was hexane layer containing the fatty acid methyl ester (FAMEs). Finally, ~1-2ml of the hexane layer was transferred using a Pasteur pipette into a clean sample vial to be injected into GC- FID for FAME analysis.

Fatty acid concentrations (CFA, mg/g of dry sample) were calculated by comparing the peak area of fatty acid in the sample with the peak area of internal standard as follows:

$$CFA = AS/AIS \times CIS/WS$$

AS= peak area of fatty acid in the sample in chromatogram
AIS= peak area of internal standard in chromatogram
CIS= concentration of internal standard (mg)
WS= weight of sample (g)

Qualitatively (as a percentage), composition of individual fatty acids were calculated by comparing the peak area of each fatty acid with the total peak area of all fatty acids in the sample.

Gas chromatoghraphy (GC) analysis

The FAMEs were separated and quantified by gas chromatographequipped with mass spectrometer (GCMS-QP2010 Ultra). Separation was performed with column ppms-5 (30m length x 0.25 mm internal diameter, 0.15µm thickness). Under pressure 50.0 kPa, with column flow 0.96 mL/min, linear velocity 35.5 cm/sec, and helium was used as carrier gas. 1µl of FAMEs samples in hexane were injected at 50^oC and hold for 1 min then the oven temperature was raised to 300^oC at a rate of 5^oC min^{-1}, and then finally held constant for 5 min.

III. ANALYSIS OF DATA

Analysis of variance (ANOVA) was carried out using SPSS 20 Software to determine level of significance at 95%,and the means of percentage of individual fatty acids, and its standard deviations (SD).

IV. RESULTS AND DISCUSSION

The total lipid content (% ether extract) obtained from the current studyranged from 2.70to 2.74 % in samples of non-malted barley and in samples of malted barley varied from 1.72 to 2.11 (Table 1). These results are similar which foundby (Oscarsson et al, 1996) and were lower than values have been reported by Anness , 1984 , Osman et al, 2002 and Makeri, et al. (2013), but were higher than values obtained by (Fedak and Roche 1977). In addition, the lipid content oftogether showed a significant difference; it is a higher percentage of lipid in the non-malted barley than that 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 lipid content of the malted barley is desirable because lipids can destroy foaming capacities of malt (Okafor and Aniche, 1980).

Table 1. Means and ranges of lipid content in Malted and

Dietary group	Mean lipid content	Range in lipid content
Non-Malted Barley	2.73 ±0.02a	2.70-2.74
Malted Barley	1.94 ±0.19b	1.72-2.11

Non-Malted Barley

The total and individual fatty acid concentrations of in Malted and Non-Malted Barley are presented in Table 2. As many as 11 fatty acids were identified using the one-step method in Malted and Non-Malted Barley samples, 5 fatty acids in Non-Malted Barley samples and 10 fatty acids in Malted Barley samples. The predominant fatty acids in Non-Malted Barley were γ-Linolenic acid and Linolelaidic

acid with an overall mean 50.424±1.208 % and 48.144±1.273 % respectively. It is followed in decreasing amounts by Eicosapentaenoic with mean (2.028±0.0%) and Palmitic with mean (1.509±0.0%). Traceamount fromElaidic (0.759±0.0) .On other hands, theLinolelaidic acid is the major fatty acid in Malted Barley samples with an overall mean of 45.958±0.917%. It is followed in decreasing amounts by γ-Linolenic acid (25.374±0.506%), Stearic acid (18.474±0.369%), Palmitic acid (2.707±0.054%), Lauric acid (2.322±0.046%),Linolenic acid (2.123±0.042%), Eicosadienoic acid (1.904±0.038 %) and Behenic acid (1.778±0.0%).Trace amount from Arachidic acid (0.798±0.0%). In addition, the shorter carbon-chained fatty acids, C12:0 were major components in the surface lipids and were found only in the malted barley lipids, while in Non-Malted Barley were found in fatty acid with C16:0. Further, the highest percentage of fatty acid in both trial samples, the Linolenic andLinolelaidic acids concentrations were higher in the Non-Malted Barley samples (50.424%) and (48.144%) respectively as compared to the Malted Barley samples (25.374%) and (45.958%) respectively.

These compositional differences are most likely due to deterioration of the grain during storage, (Pomeranz, 1966). Differences in fatty acid composition of the trial samples lipids and the surface lipids did not reflect increasing germination properties of barley during the storage period. Fedak and Roche 1977, reported similar results for the fatty acid composition in the Non-Malted Barley and Malted Barley. However were lower than values have been reported by Bhatty and Rossagel, 1980,

Table 2. Means of Fatty Acids Components of Malted and Non-Malted Barley

Designation	Fatty acid	MeanNon-Malted Barley	Mean malted barley
C12:0	Lauric	non	2.322±0.046
C16:0	Palmitic	1.509±0.000	2.707±0.054
C18:0	Stearic	non	18.474±0.369
C18:1(n-9)	Elaidic	0.759±0.000	0.839±0.000
C18:2(n-6)	Linolelaidic	48.144±1.273	45.958±0.917
C18:3(n-3)	γ-Linolenic	50.424±1.208	25.374±0.506
C18:3n3	Linolenic	non	2.123±0.042
C20:0	Arachidic	non	0.798±0.000
C20:2(n-6)	Eicosadienoic	non	1.904±0.038
C20:5n3	Eicosapentaenoic	2.028±0.000	non
C22:0	Behenic	non	1.778±0.000

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