Measures Affecting Alcohol in Malt Beverages According to Islamic Religion

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Abstract: Eight different sorts of malt beverages were collected from the local markets of western province of Saudi Arabia. The studied samples were subjected to the determination of physicochemical Characteristics such as pH, conductivity and TDS. Also, the concentration of 15 major and trace elements has been determined using inductively coupled plasma-atomic emission spectrometry. The levels of all investigated elements were below the maximum tolerance levels reported by international regulatory standard. The beverages were tested quantitatively by capillary gas chromatography for their alcohol content through three steps. Firstly, the studied samples were directly analyzed, secondary, the samples were analyzed after exposing to air and finally the samples were analyzed in presence of yeast. It has been found that there is no ethanol content when the samples analyzed directly, minor concentration of ethanol content was found after exposing malt beverages to air ranging from 12.7 ppm in Hillsgurg to 1940.6 ppm in Efes. Considerable variability in the alcoholic strength was found in presence of yeast due to fermentation, overall, the range of concentrations was 0.4621 Vol % in Budwisers to 3.416 Vol % in Hillsgurg. [Ashraf Yehia. El-Naggar. **Measures Affecting Alcohol in Malt Beverages According to Islamic Religion**. *J Am Sci* 2012;8(10):455-460]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 66

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1. Introduction

Malt Beverage is the one of the world's oldest (Nelson, Max 2005) and most widely consumed drink and the third most popular drink overall after water and tea (Dallas Safriet 1994). The production of malt beverages, comprises four main stages: brew house operations, fermentation, aging or secondary fermentation, and packaging (Richard D. Rapoport et al 1983, David Reisdorph 1993, Dallas Safriet 1995).

The alcohol in malt beverage is produced by the brewing and fermentation of starches which are mainly derived from cereal grains most commonly malted barley although wheat, maize(corn), and rice are also used (Dallas Safriet 1994).

Islam religions forbid, discourage, or restrict the drinking of alcoholic beverages because of Short-term effects of alcohol consumption include intoxication and dehydration. Long-term effects of alcohol include changes in the metabolism of the liver and brain and addiction to alcohol (alcoholism) (Nutt D. et al 2007, Meyer, J. S. and Linda F. Q. 2005, Oscar B. M and Marinkovic K 2003 and Klatsky, A L and Friedman, G D 1995).

In many countries, people drink malt beverages at lunch and dinner. Studies have found that when food is eaten before drinking alcohol, alcohol absorption is reduced (Liang, H et al 2010 and Ramchandani et al 2001) and the rate at which alcohol is eliminated from the blood is increased. The mechanism for the faster alcohol elimination appears to be unrelated to the type of food. The likely mechanism is food-induced increases in alcohol-metabolizing enzymes and liver blood flow (Jorge G et al 2008).

Capillary gas chromatography (CGC) connected with flame ionization detector (FID)is a powerful tool in the analysis of alcohols in malt beverage products. Minimal sample preparation, in general, is required. The flavor compounds tend to be volatile in nature, which fulfills one of the main requirements of CGC. In this guide, we will discuss how CGC can be used to (1) monitor alcohol content in alcoholic beverages, (2) determine the volatile profile of a product, and (3) detect trace level impurities.

Accurate and precise determination of major, trace toxic and heavy elements in foods and beverages has recently become a national challenge in many counties. Due to the positive effects as the removal of bad odors and tastes as well as the fermentation process and negative effects as Beverage spoilage and hazing caused by the presence of such elements, their concentration can be a significant parameter affecting the beverage consumption and conservation (Ahmed Y.A. et al 2010, Pawel P., Bartlomiej P. 2010, Mehmet B. 2010 and 2007).

Our goal in this work was to analysis of eight samples of malt beverages collected from local

markets in the western province in Saudi Arabia via capillary gas chromatography for their alcohol content according to Islamic Religion. Also, to assess 15 mineral and heavy toxic elements levels in comparison with the maximum permitted levels reported by the international regulatory standards.

2. Material and Methods

Sample collection

Eight malt beverages samples of different international brands were collected from the local markets of western province of Saudi Arabia. The collected samples are given in Table.

Table (1) The origin of the investigated malts beverage samples.

Sample No.	Brand	origin
1	Budweiser	USA
2	Efes	Turkey
3	Holsten	Germany
4	Rockers	Gordon
5	Barbican	UAE
6	Hillsburg	KSA
7	Bario	KSA
8	Moussy	France

Physicochemical Properties

Sample preparation

The collected eight different commercial brands of malt drinks were stored in a refrigerator to reduce the temperature to 18 - 20°C.

Determination of pH

HANNA Instruments pH-meter was used to measure the pH after calibration with standard pH tablets of pH 4, 7, and 9.2.

Determination of conductivity

HANNA Instruments conductivity-meter was used to obtain conductivity as readout after calibrating the instrument.

Determination of total dissolved solid

The samples were analyzed on HI 991300 TDS-meter directly with the principle of dispersion of light due to suspension. Total solid was determined using the Total solids method (2009).

Metal Analysis

In a degassing step and prior to the analysis, 25 ml aliquots of each samples was gently stirred using a magnetic stirring to evaporate the gases. The investigated samples were properly diluted, acidified and analyzed directly without further treatment using the inductively coupled plasma-atomic emission spectrometer, ICP-AES (Optima 2100 DV, Norwalk, CT, USA). The optimized conditions of the plasma were 40-MHz , 1300 W, and the outer, intermediate and Ar carrier gas flow rates were 15.0, 0.2 and 0.8 L/min, respectively. Using an auto-sampler (AS 93 Plus) the measured samples were nebulized downstream to the plasma and the concentrations were automatically determined using the standard calibration graph.

Gas Chromatography:-

The studied malt beverage samples were analyzed using Perkin Elmer gas chromatograph of model 580 series equipped with flame ionization detector (FID), using HP-5 fused silica capillary column Packed with 95 % dimethyl polysiloxane and 5 % vinyl as stationary phase, 30 meter in length, 0.53 mm int. diameter, and thickness film 0.5 µm. Helium was used as mobile phase, all gas flow rates were set to manufacturer specifications, performing conditioning and standardization of the system. The flow rate was measured from the end of the column with a soap bubble flow rate. Methane as an unretained marker was used to correct the dead volume in the column. Injections were made in split mode with a split ratio of 1:15. Glass linear is packed with deactivated glass wool which changed after six injections .The column oven was programmed from 80 ºC (hold 1 min) to 300 ºC at a rate 10 ºC / minute with 190 minute hold at 300 ºC. The injector temperature is set at 300 ºC and the detector temperature is 320 ºC. The data was estimated by integration of the area under the resolved chromatographic profile, using Total Chrom, Ver. 6.2.1 Software, via Interface NCI 900, Manual Injection of 1 µ L of samples after washing syringe with sample's solvent and injected 1 µ L of solvent.

3. Results and discussion

Physicochemical Characteristics:

The Physicochemical Characteristics of the eight selected malt beverage samples such as pH, conductivity and TDS were studied and given in Table 2. It has been found that the samples Bario, Barbican, Moussy and Hillsburg had lower pH values of 3.2, 3.3, 3.35 and 3.5 respectively. This indicated that they are more acidic than the other local malt drinks. The other malt drinks are quite acidic with pH of 3.9 (Efes), 4.65 (Budweiser), 4.88 (Holsten) and 4.94 (Rockers). These data were compatible with that of Obuzor (Obuzor and Ajaezi 2010) who recorded that pH values of Malt drinks are within 3.36- 4.86.

Conductivity is the ability of electricity to pass through water, using the impurities contained in the water as the "conductor." When water has lots of impurities, it is more "conductive,". Malt beverage conduct electricity because it contains minerals and it follows that the malt brand with the highest

concentration of minerals will conduct the most. The order of conductivity, which is also the order of Total Dissolved Solids (TDS) (Gloria, 2010) in this study is Holsten > Budweiser > Efes > Bario > Rockers > Moussy, Barbican > Hillsburg. It is not surprising for this trend since conductivity is often used as an estimate of TDS content of water samples (Maurice, S.M. 2010).

Table 2: Physico-chemical analysis of local beverage

Product	Parameters		
	pH	Conductivity. (mS/cm)	TDS (mg/l)
Holsten	4.88 (±0.255)	1.2 (±0.1)	733.5 (±10.00)
Moussy	3.35 (±0.354)	0.70 (±0.1)	441 (±14.00)
Barbican	3.3(±0.424)	0.70 (±0.095)	412 (±26.00)
Efes	3.9 (±0.424)	0.83 (±0.058)	520 (±26.00)
Bario	3.2 (±0.424)	0.81 (±0.081)	505 (±28.00)
Rockers	4.94 (±0.332)	0.75 (±0.092)	437 (±12.00)
Hillsburg	3.5 (±0.424)	0.60 (±0.1)	350 (±9.00)
Budweiser	4.65 (±0.354)	1.17 (±0.115)	732 (±6.00)

All samples were done in triplicate. Include the standard deviation for each attribute and each sample. Standard deviation of each attribute is given in bracket and sample's in column.

Metal analysis

Although some analytical methods require sample pretreatment for the destruction of the organic matrix such as microwave dissolution, dry ashing, and wet digestion (Jorge G et al 2008), the direct measurements of heavy metals in beer and malt beverage have been also performed (Gleen Woods 2007). The data obtained from the treated beverages samples were almost comparable with those obtained with the direct analysis after simple dilution and acidification of the tested samples.

The concentration of 15 mineral nutrients and toxic elements in 8 malts beverages have been assessed directly after simple acidification and dilution of the samples. The multi elements analysis of the investigated malt beverages samples were performed accurately and precisely using ICP-AES. The samples were measured in triplicates and the relative standard deviation was automatically calculated. The RSD was < 2 % and the correlation coefficient was > 0.99998. The results obtained are summarized in Table (2). The levels of the mineral and toxic elements measured in all tested samples were in good agreement with those obtained in similar studies (Theresa Hague et al 2008, Amanda Terol et al 2011). Moreover, all elements detected in the investigated samples in this work were found below the maximum tolerance levels (MTLs) reported by the international regulatory standards (FAO/WHO, 1983 and Y.Y. Choi 2011).

Depending on the origin, wide variations in the types and levels of elements were detected in the investigated beverages. While Ni was detected only in two samples (3 and 7), some of the investigated metals were not detected. In contrast, the mineral nutrients elements (Ca, Mg, Na, K) were detected with relatively high levels in all samples.

Table (3) Metal concentration in various malts beverage*, µg L-1

	1	2	3	4
Pb	25	25	20	5
Cd	5	10	ND	ND
As	30	120	40	20
Cr	20	10	20	ND
Mn	50	125	20	10
Zn	30	45	ND	20
Cu	10	5	20	20
Ni	ND	ND	200	ND
Fe	120	430	40	100
Al	610	370	80	110
Ba	26	22	10	12
Ca*	31.38	14.41	10.85	7.27
Mg*	45.23	38.80	21.32	11.99
Na*	26.49	16.11	6.65	18.40
K*	254.60	211.25	14.17	72.16
	5	6	7	8
Pb	ND	ND	8	20
Cd	ND	10	9	5
As	90	130	80	60
Cr	ND	10	ND	15
Mn	8	10	12	10
Zn	10	ND	ND	5
Cu	ND	ND	10	ND
Ni	ND	ND	5	ND
Fe	10	30	140	100
Al	30	30	100	80
Ba	8	ND	10	12
Ca*	5.18	5.46	5.49	5.00
Mg*	0.450	2.97	6.31	4.27
Na*	20.58	19.66	4.31	19.11
K*	3.08	33.19	30.98	31.95

* The concentrations of Ca, Mg, Na and K are presented in mg L¬-1.

Analysis of Alcohols in Malt Beverages

Malt beverages contain a wide range of volatile compounds, including alcohols. Gas chromatography (GC) is a powerful analytical tool in the analysis of these compounds without preliminary extractions. Minimal sample preparation, in general, is required, since the samples are in the liquid state in an alcohol or alcohol/water matrix.

In this work, alcohols in malt beverages also can be monitored by capillary GC. Since capillary columns offer efficient separations, capillary GC is especially useful in analyses of structurally similar compounds, such as the fusel alcohols. The unique polarity of the Rtx-5 stationary phase ensures excellent resolution of a range of alcohols. The concentration of alcohol in a beverage is usually stated as the percentage of alcohol by volume.

The CGC analysis of the studied samples was done in three steps, the first for the samples after the glass bottle was opened directly, the second after exposing the samples to air during drinking and the third in presence of yeast to see the effect of fermentation.

Firstly, the calibration curve was achieved depending on the relation between the different concentrations of ethanol against the area of each concentration which is summarized in Figure 1.

The linear relationship between area and concentration is:

$y = 3.4928x$

Using the linear relationship and Figure 1, the minor amounts of the produced ethanol in the studied samples was determined quantitatively.

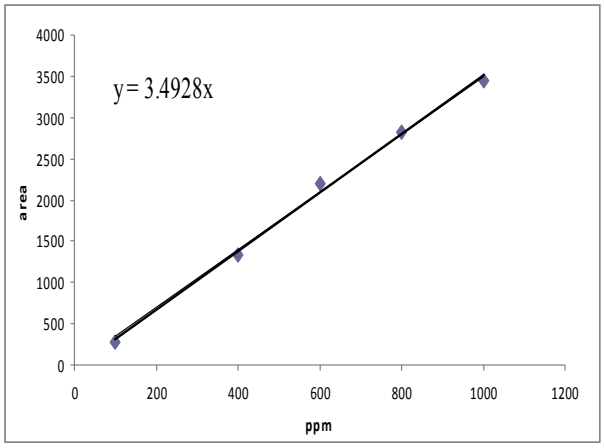

Figure 1. Calibration curve for ethanol concentration against area.

(i) Directly analysis of malt beverage by CGC

The selected samples were injected directly inside CGC without exposed it to air in order to determine the minor amounts of ethanol if it is present. The quantitative determination of ethanol was achieved depending on the previous calibration standard curve mentioned above. It has been found that all studied samples have no ethanol contents in their compositions. This result reflecting their agreement with the rules of Islamic religion.

(ii) **Analysis of malt beverage after exposing to air by CGC**

The studied samples were exposed to air after 24 hours. Then the samples were injected in CGC at the same conditions of the standard calibration curve in order to pick up the produced minor amounts of ethanol after exposing to air and also, to determine the other produced oxidation products. The result was given in Table 4 and figure 2. It has been found that all sample produce ethanol after exposing to air but with minor amounts ranging from 12.7 ppm in Hillsburg to 1940.6 in Efes sample. Also, all samples produce other two oxidation products of concentrations higher than ethanol when exposed to air, the first may be aldhyde and the second may be acid product. Although the produced ethanol is below the maximum tolerance levels reported by international regulatory standard, this result retards with the Islamic religion which prevent the presence of ethanol in malt beverage samples even at minor concentrations.

So, we advice all Muslim peoples to drink all types of malt beverages without exposing it to air for a long time to prevent the production of alcohols and to follow the Islamic rules. The malt beverages were halal drink when taken directly.

(iii) Analysis of malt beverage after fermentation in presence of yeast

Fermentation is a biological process (4) in which yeast converts sugars and starch into ethyl alcohol and carbon dioxide and is expressed chemically as:

$C6H12O6 + 2PO43- + 2ADP \rightarrow 2C2H5OH + 2CO2 + 2ATP$

Behind this simplified chemical reaction is a series of complex biochemical reactions. These reactions (known as the .Glycolytic pathway) involve a number of enzymes and the reactions take place anaerobically inside the cells of brewing yeast.

The studied malt beverage samples were subjected to quantitative analysis by CGC in presence of yeast without exposing to air. The process of fermentation occurs, the produced ethanol contents from fermentation process was given in Table 5 and shown in Figure 3. It has been found that all studied malt beverage samples produce high concentrations of ethanol as a product of fermentation ranging from 4621 ppm in Budweiser to 34160.3 ppm in Hillsburg.

Also, most samples produce other products of minor amounts which eluted at retention time higher than ethanol, these products are may be aldhyde and acid. These oxidation products as a result of fermentation process as shown in Figure 3.

Finally, the Muslim peoples would dink these types of malt beverages directly without exposing it to air for a long time and also, without eating food through drinking to prevent the chance of alcohol production.

These precautions important to the avoidance of double in the formation of alcohol which forbidden from Islamic religion.

Table 4. Concentration of ethanol in the studied malt beverage samples in presence of air after 24 hrs.

Sample name	Ethanol (ppm)	Ethanol (WT%)	Oxidative product 1	Oxidative product 2
Budweiser	240.0	0.024	96.4	32.0
Efes Classic	1940.6	0.194	264.9	81.9
Holsten	290.0	0.290	120.2	44.3
Barbican	142.0	0.014	180.2	72.2
Hillsburg	12.7	0.001	601.9	157.6
Bario	73.0	0.007	290.9	98.3
Rockers	551.9	0.055	134.2	56.8
Mossy	70.7	0.007	66.3	21.3

Table 5. Concentration of ethanol in the studied malt beverage samples in presence of yeast after 24 hrs.

Sample name	Ethanol (ppm)	Ethanol (WT%)	Oxidative product 1	Oxidative product 2
Budweiser	4621.1	0.462	30.3	-
Efes Classic	9202.4	0.920	188.4	
Holsten	6523.2	0.652	95.6	**25.0**
Barbican	10703.9	1.070	25.6	18.4
Hillsburg	34160.3	3.416	90.5	43.8
Bario	22328.5	2.233	33.9	15.4
Rockers	5634.3	0.563	60.7	-
Mossy	12799.6	1.280	33.1	-

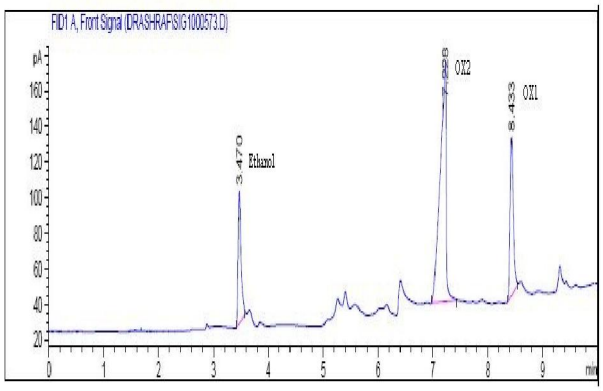

Figure 2. GC Chromatogram of Barbican after exposing to air

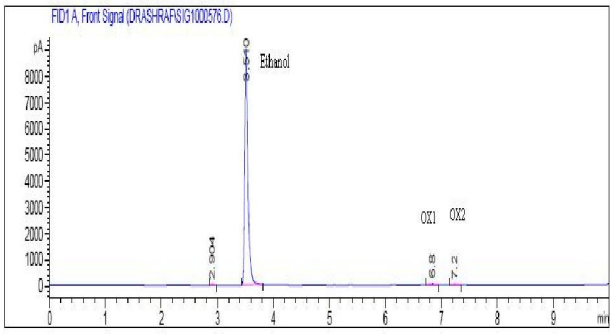

Figure 3. GC Chromatogram of Barbican in presence of yeast.

Conclusions

1. The samples Bario, Barbican, Moussy and Hillsburg are more acidic than the other local malt drinks due to their lower pH values.
2. The order of conductivity, which is also the order of Total Dissolved Solids (TDS) in this study is Holsten > Budweiser > Efes > Bario > Rockers > Moussy, Barbican > Hillsburg.
3. The levels of the mineral and toxic elements measured in all tested samples were found below the maximum tolerance levels reported by the international regulatory standards.
4. The studied samples have no ethanol contents in their compositions. This result reflecting their agreement with the Islamic religion.
5. There is a production of minor amounts of ethanol and other oxidation products after exposing to air for a long time, the production of ethanol increases in presence of yeast due to fermentation.
6. In order to follow Islamic religion, it is preferred to drink these types of malt beverages directly before exposing to air and fare from food to prevent the production of ethanol as a product of oxidation and fermentation.

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