Quantifying the toxicity of local (Aragi) and impacted (whiskey) alcoholic beverages available in Khartoum – Sudan

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Abstract

Introduction: Alcohol is formed when yeast ferments (breaks down without oxygen) the sugars in different food. For example, wine is made from the sugar in grapes, beer from the sugar in malted barley (a type of grain), and cider from the sugar in apples, vodka from the sugar in potatoes, beets or other plants. **Results:** When looking into BAC in mg/ml of different forms of Aragi and comparing it to whisky, the following was found. Aragi of all types is significantly less concentrated than Whisky. **Conclusion:** This study shows the chemical composition of Aragi and whiskey and quantitatively and qualitatively by chromatographic methods.

Keywords: Aragi; Toxicity; Chromotographic methods; Whisky; Alcohol; Beverages

Introduction:

Alcohol is formed when yeast ferments the sugars in different food. For example, wine is made from the sugar in grapes, beer from the sugar in malted barley, and cider from the sugar in apples, vodka from the sugar in potatoes, beets or other plants. Alcohol is classed as a ‘sedative hypnotic’ drug. At lower doses, alcohol can act as a stimulant, inducing feelings of euphoria and talkativeness, but drinking too much alcohol at one session can lead to drowsiness, respiratory depression, coma or even death. As well as its acute and potentially lethal sedative effect at high doses, alcohol has effects on every organ in the body and these effects depend on the blood alcohol concentration over time.[(1)]

Local alcoholic beverages (Aragi) are the traditional alcoholic beverage in Western Asia, especially in the Eastern Mediterranean countries of Syria, Lebanon, Jordan, and Sudan.

Aragi is a stronger flavored liquor, and is usually mixed in proportions of approximately one-part Aragi to two-parts water in a traditional Eastern Mediterranean water vessel called an ibrik. The mixture is then poured into ice-filled cups, usually small. This dilution causes the clear liquor to turn a translucent milky-white color; this is because anethole, the essential oil of anise, is soluble in alcohol but not in water. This results in an emulsion whose fine droplets scatter the light and turn the liquid translucent, a phenomenon known as louching. Aragi is commonly served with mezza, which may include dozens of small traditional dishes. In general, Aragi drinkers prefer to consume it this way, rather than alone. It is also consumed with raw meat dishes or barbecues, along with dishes flavored with garlic sauce. [(2)]

Manufacturing begins with the vineyards, and quality grapevines are the key to making good Aragi. The vines should be very mature and usually of a golden color. Instead of being irrigated, the vineyards are left to the care of the Mediterranean climate and make use of the natural rain and sun. The grapes, which are harvested in late September and October, are crushed and put in barrels together with the juice and left to ferment for three weeks. Occasionally the whole mix is stirred to release the CO_2.

Numerous types of stills exist, most usually made of stainless steel or copper. Pot and column stills are two types; which will affect the final taste and specificity of the Aragi. The authentic copper stills with a Moorish shape are the most sought after. (3)
The alcohol collected in the first distillation undergoes a second distillation, but this time it is mixed with aniseed. The ratio of alcohol to aniseed may vary and it is one of the major factors in the quality of the final product. The finished product is produced during a final distillation which takes place at the lowest possible temperature. For a quality Aragi, the finished spirit is then aged in clay amphoras to allow the angel's share to evaporate. The remaining liquid after this step is the most suitable for consumption. (4)
Imported alcohol (vodka, wine, beer, whiskey, etc.) is a type of distilled alcoholic beverage made from fermented grain mash. Various grains (which may be malted) are used for different varieties, including barley, corn, rye, and wheat. Whisky is typically aged in wooden casks, which are often old sherry casks or may also be made of charred white oak. (5)

Objectives:
General objective: To determine chemical composition of Aragi and whiskey in Khartoum locality.

Specific objectives:

- To identify alcohol contents quantitatively and qualitatively by chromatographic methods
- To identify toxic constitutes in local alcoholic beverage fermented and distilled.
- To compare results with that of imported alcoholic beverage.
- To correlate concentration with alcoholic beverages units and to determine the number of units in each alcoholic drink.

To correlate the volume, BAC (Blood Alcoholic concentration) and expected clinical signs.

Chemical Composition of wine:
The number of compounds identified in wine increased dramatically since the development of gas chromatography (GC), high pressure liquid chromatography (HPLC), a thin layer chromatography (TLC), infrared spectroscopy (IRS), and nuclear magnetic resonance (NMR). The interface of mass spectrometry (MS) to GC and to HPLC has been especially valuable in identifying unknown compounds. More than 500 compounds have been recognized in wine so far, of which 160 are esters.
Wines generally contain 0.8-1.2g of aromatic compounds per liter, of which the most common are fusel alcohols, volatile acids, and fatty acid esters. Fusel alcohols often constitute 50%of all volatile substances in individual wines. Carbonyls, phenols, lactones, terpenes, hydrocarbons, sulfur, and nitrogen compounds, although present in much lower concentrations, are more important qualitatively and contribute specific sensory characteristics relevant to the fragrance of a wine. Taste and mouth-feel sensations are due primarily to the few compounds that occur individually at concentrations >100mg/L. These include water, ethanol, organic acids, sugars, and glycerol. Tannins occur in red wine and rarely in content and their precipitation during pressing. (7)

Water:
Water is the major chemical constituent of wine and is critical in establishing its fundamental characteristics. It is an essential component in many of the chemical reactions involved in grape growth and juice fermentation and in wine aging. (8)

Sugars:

The principal grape sugars are glucose and fructose, and they occur in roughly equal proportions at maturity, whereas more mature grapes often have a higher proportion of fructose. Sucrose is rarely found in wine, and other sugars are found in insignificant amounts. The primary wine yeast, Saccharomyces cerevisiae, derives most of its metabolic energy from glucose and fructose and has limited ability to ferment other substances. Residual sugars in dry wines, generally below 1.5g/L, consist mostly of pentose such as arabinose, rhamnose, and xylose. Generally, sweetness is detected at levels higher than 1Brix and this is influenced by other constituents such as ethanol, acids, and tannins.

In addition to being essential for fermentation and production of ethanol, sugars are metabolized to higher alcohols, fatty acid esters, and aldehydes, which give different wines their individual aromatic compounds. (9)

Polysaccharides:

Polysaccharides are generally low in wine. They are partially water soluble and are extracted into the juice during crushing and pressing. Hot pressing of crushed or whole berries enhances skin extraction, but during fermentation polysaccharides form complex colloids in the presence of alcohol and tend to precipitate. The addition of pectolytic enzymes following crushing significantly reduces the pectin. (10)

Acid:

In wine, acids are divided into two categories: volatile and fixed. The first refers to acids that can be readily removed by distillation, whereas the latter refers to the carboxylic acid. The most common volatile acid in wine is as cetric acid. Quantitatively, carboxylic acids such as tartaric, malic, lactic, succinic, oxalic, fumaric, and citric acids control the pH of wine. (11)

Phenols:

Phenols are a large and complex group of compounds of particular importance to the characteristics and quality of red wines. Their concentration in white wine is much lower, phenols and related compounds can affect the appearance taste, mouth-feel, fragrance, and antimicrobial properties of wine. They may come from the fruit (skins and seeds).(12)

Ethanol:

The most important and abundant alcohol in wine is ethanol. Under standard fermentation conditions, ethanol can accumulate to ~14-15%, but, generally, ethanol concentrations in wine range between 10_13%. The primary factors controlling ethanol production are sugars temperature, and yeast strain. Ethanol is crucial to the stability, aging, and sensory properties of wine. As its production increases during fermentation, it increasingly limits the growth of most microorganisms, allowing Saccharomyces cerevisiae to dominate the fermentation process. The inhibitory activity of ethanol, combined with the acidity of the wine and the added potassium metabisulfite, allows wine to remain sound for years in the absence of air. During skin fermentation of red grapes, ethanol acts as an important solvent in the extraction of pigments and tannins. It also influences the types and amounts of aromatic compounds produced by affecting the metabolic activity of yeasts. Furthermore, ethanol acts as an essential reactant in the formation of volatile compounds produced during fermentation and those formed during aging in wood cooperate. The dissolving action of ethanol probably reduces the evaporation of aromatic compounds along with carbon dioxide during fermentation. Together with other alcohols, ethanol slowly reacts with organic acids to produce esters and influences their stability. Moreover, it also reacts slowly with aldehydes to produce acetate. (13)

Methanol:

Methanol is a minor constituent of wine (0.1-0.2g/L) and has no direct sensory effect. It is predominantly generated from the enzymatic breakdown of pectins. On degradation; methyl groups associated with pectins are released as methanol. Oxidation of methanol in the body produces formaldehyde and formic acid, which are toxic to the central nervous system. Wine has the lowest concentration of methanol of all fermented beverages. Other potentially significant higher alcohols in wine are the straight-chain alcohols:1-propanol, 2-methyl -1-propanol, 2-metyl-1-butanol and 3-methyl-1-butanol. The formation of higher alcohols occurs as a by-product of yeast fermentation and is markedly influenced by vilification practices such as temperature, presence of oxygen, suspended solids, and yeast strain. Higher alcohols may originate from amino acid deamination and grape-derived aldehydes, and by the reductive denitrification of amino acids. [14]

Toxicity of Wine:

Wine contains ethyl alcohol, the same chemical that is present in beer and distilled spirits. Wine consumption has short-term psychological and physiological effects on the user. Different concentration of alcohol in the human body has different effects on a person. The effects of alcohol depend on the amount an individual has drunk, percentage of alcohol in the wine and the timespan that the consumption took place, the amount of food eaten and whether an individual has taken other prescription, over- the-counter or street drugs, among other factors. Drinking enough to cause a blood alcohol concentration (BAC) of 0.03%-0.12% typically causes an overall improvement in mood and possible euphoria, increased self-confidence and sociability, decreased anxiety, a flushed, red appearance in the face and impaired judgment and fine muscle coordination. A BAC of 0.09%to 0.25% causes lethargy, sedation, balance problems and blurred vision. A BAC from 0.18%to 0.30% causes profound confusion, impaired speech, staggering, dizziness and vomiting. A BAC from 0.25% to 0.40% causes stupor, unconsciousness, anterograde amnesia, vomiting, and death may occur due to pulmonary aspiration and respiratory depression. A BAC from 0.35%to 0.80% causes a coma, respiratory depression and possibly fatal alcohol poisoning, The main active ingredient of wine is alcohol, and, therefore, the health effects of alcohol apply to wine. Drinking small quantities of alcohol (less than one drink in women and two in men) is associated with a decreased risk of heart disease, stroke, diabetes mellitus, and early death. Drinking more than this amount, however, increases the risk of heart disease, high blood pressure, atrial fibrillation, and stroke.

In 2008, researchers from Kingston University in London [15] discovered red wine to contain high levels of toxic metals relative to other beverages in the sample. Although the metal ions were also present in other plant-based beverages, the sample wine tested significantly higher for all metal ions, especially vanadium. Finally, there are many reports of contaminants in wines that pose potential health risks, including pesticide and fungicide residents, acetic acid, bacteria, lead, fungi and mycotoxins such as ochratoxin a, that may also be present in beer. It is also known that alcoholic beverages may be adulterated or contaminated with methanol. [15]

Limit takes of alcohol in men and women:

The recommended limits for men are 3-4 units a day and for women it’s 2-3 units a day. It’s also recommended that everyone has at least 2 or 3 days off alcohol a week.

An online tool which allows people to monitor what they’re drinking in terms of units, and also to see the calorie content of popular drink may prove useful [16].

Research Methodology:

Samples:

Sample (1) Aragi Algraif
Sample (2) Aragi Almashtal
Sample (3) Aragi Alsonot
Sample (4) Aragi Altaif
Sample (5) Aragi Arkweet
Sample (6) Aragi Establat
Sample (7) whiskey

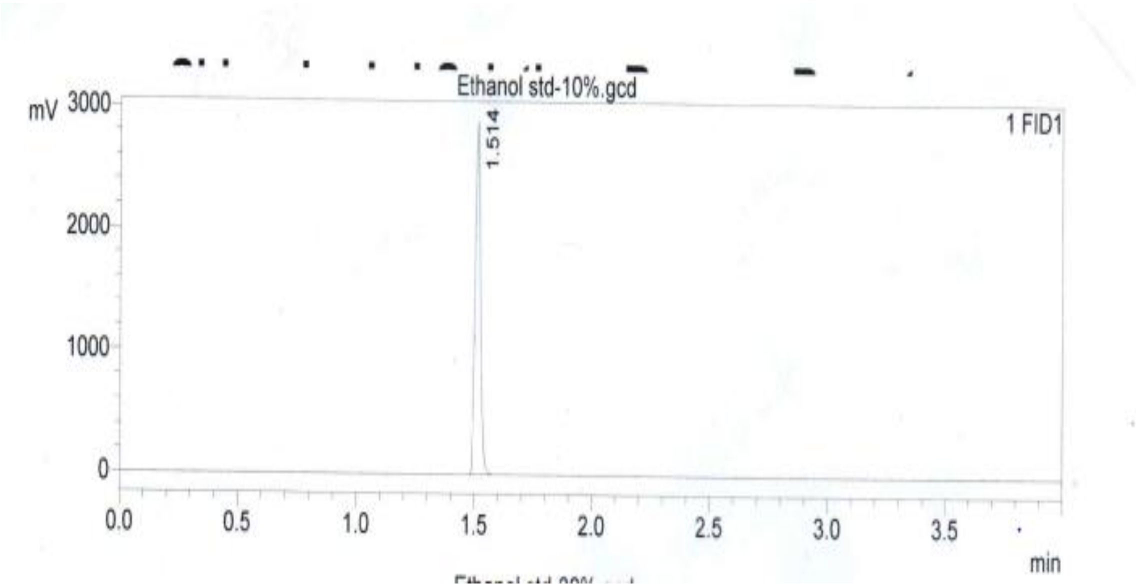
Chemicals and Reagents:

- Ethanol – HPLC (99.5%)
- Distilled water

Equipment and Instruments:

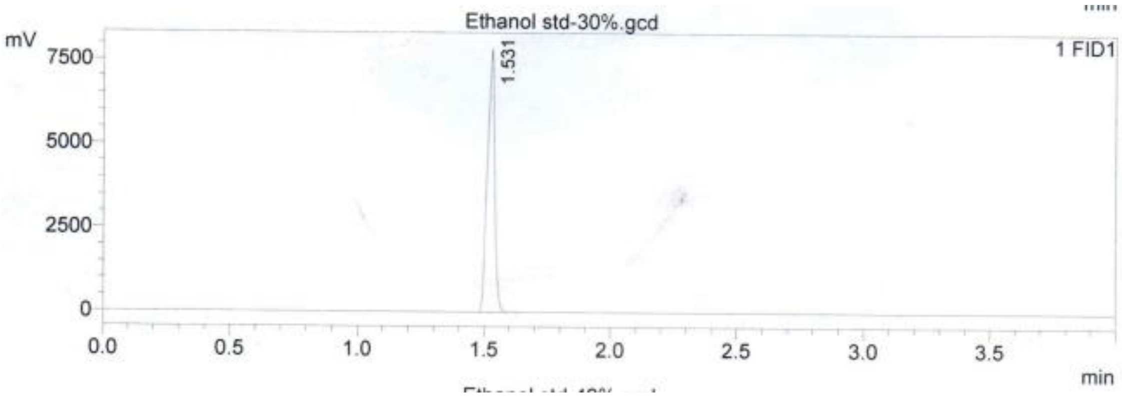
- Shimalzu gas chromatograph with FID detector.
- Shimalzu us Auto sampler.
- Fixed micropipettes (100-1000)
- Manual crimper (20mm)
- Volumetric flasks (100ml)
- Vials (10ml)
- Graduated cylinder (100ml)
- Fortex (mixer)

Results:

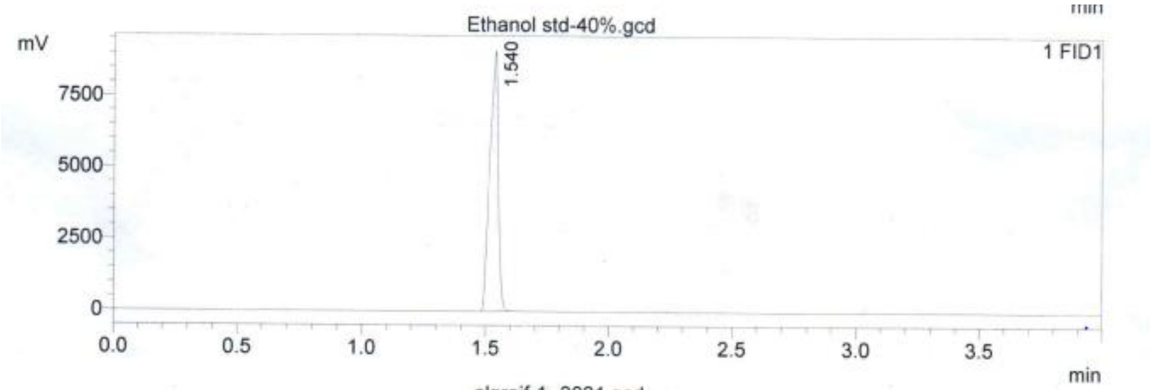


Peak	Name	Ret. Time	Area	Height	Area%
1	Ethanol 10%	1.514	4648976	2896359	100.68

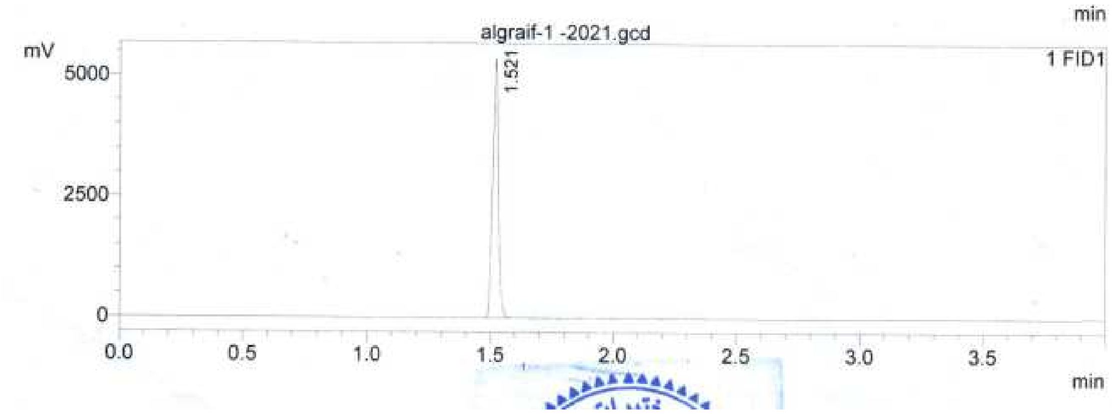
Peak	Name	Ret. Time	Area	Height	Area%
2	Ethanol 30%	1.531	16014793	7884992	99%



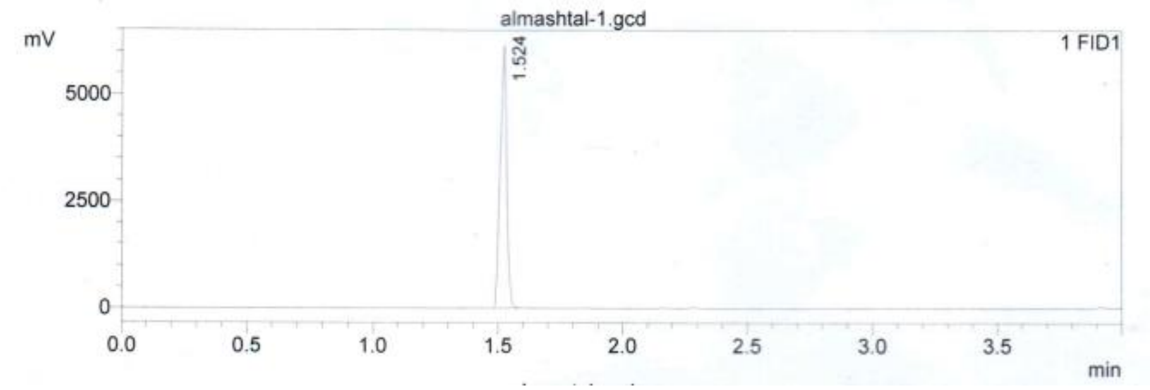
Peak	Name	Ret. Time	Area	Height	Area%
3	Ethanol 40%	1.540	21969905	9117027	100%



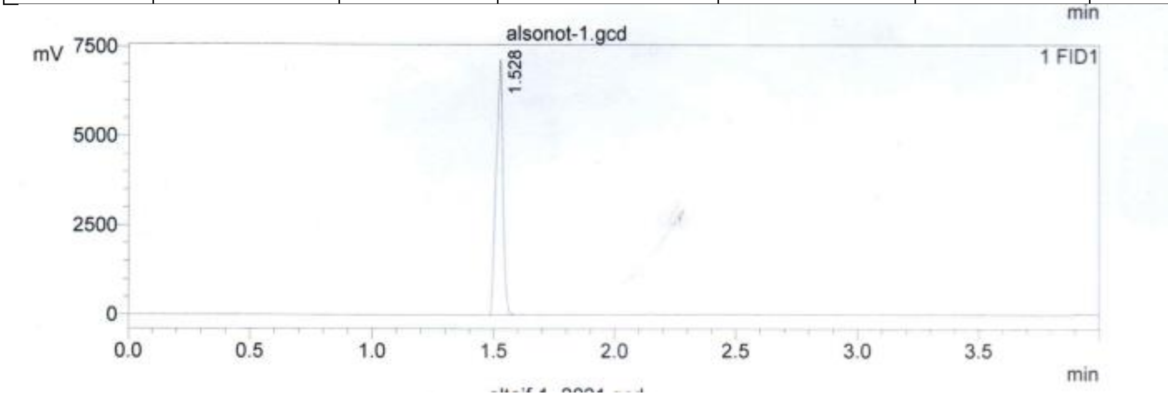
Peak	Name	Ret. Time	Area	Height	Area%	Other content
4	Algraif 2021	1.521	9057750	5387455	44%	No



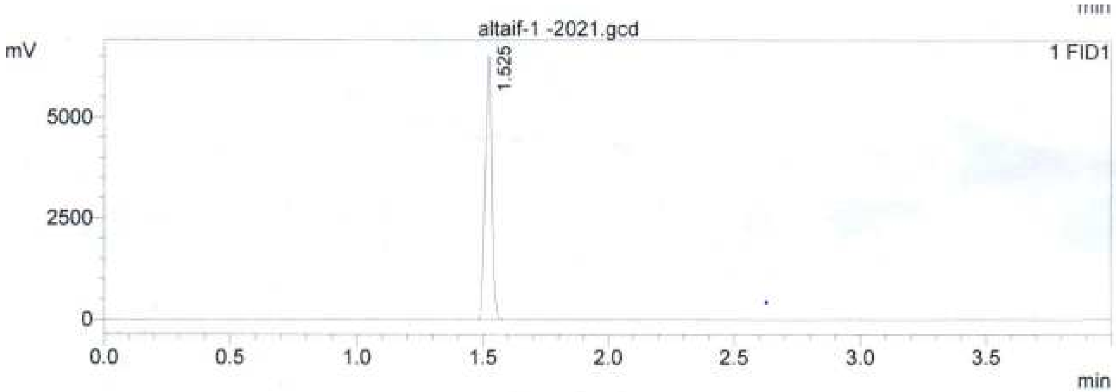
Peak	Name	Ret. Time	Area	Height	Area%	Other content
5	Almashtal 2021	1.524	10912692	61637408	52%	No



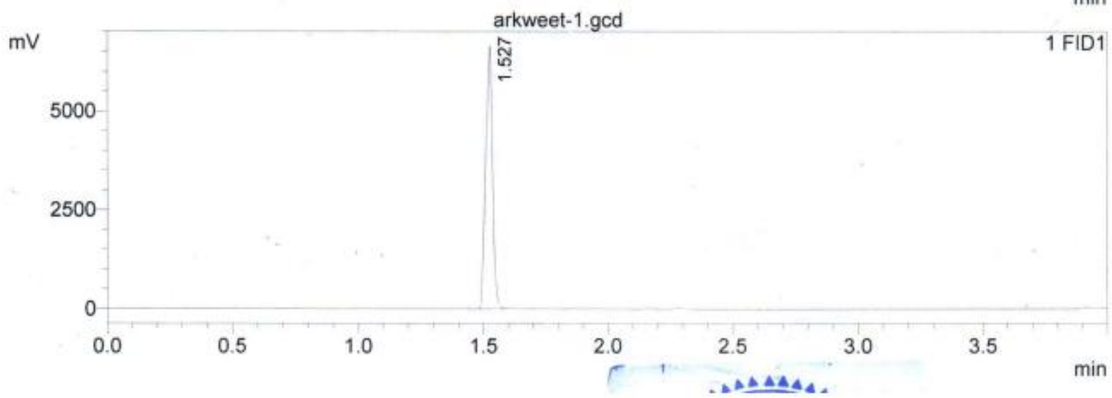
Peak	Name	Ret. Time	Area	Height	Area%	Other content
6	Asonotl 2021	1.528	13750264	7173408	64%	No



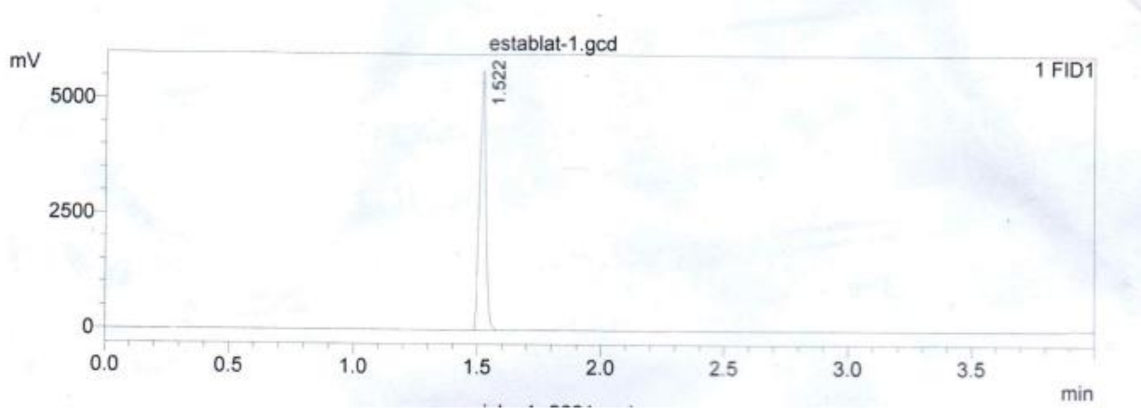
Peak	Name	Ret. Time	Area	Height	Area%	Other content
7	Altaif 2021	1.525	11909719	6548000	56%	No



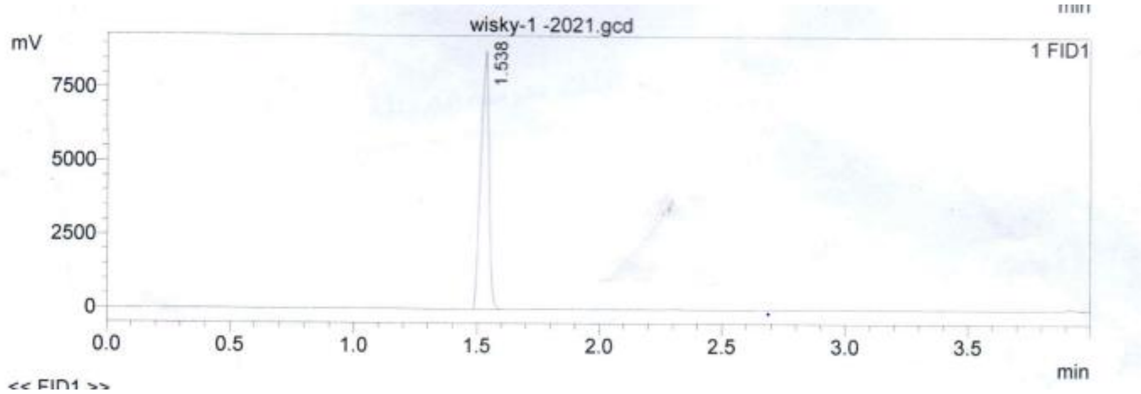
Peak	Name	Ret. Time	Area	Height	Area%	Other content
8	Arkweet 2021	1.527	12441360	6640404	58%	No



Peak	Name	Ret. Time	Area	Height	Area%	Other content
9	Establat	1.522	9691068	5675909	47%	No



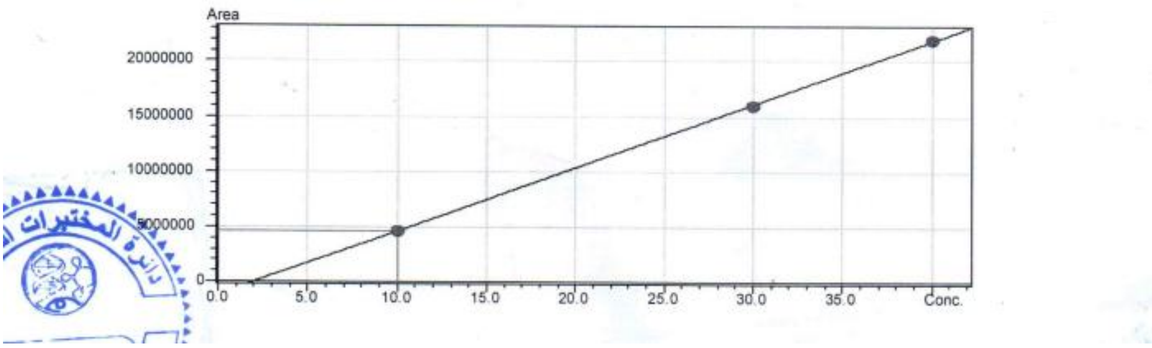
Peak	Name	Ret. Time	Area	Height	Area%	Other content
10	wisky 2021	1.538	20313204	8831971	93%	No



min

<< FID1 >>
ID#1 Compound Name: Ethanol

Data File Name	Sample Name	Sample ID	Ret. Time	Area	Height	Conc.
Ethanol std-10%.gcd	Ethanol std-10%	Ethanol std-10%	1.514	4648976	2896359	10.068
Ethanol std-30%.gcd	Ethanol std-30%	Ethanol std-30%	1.531	16014793	7884992	29.797
Ethanol std-40%.gcd	Ethanol std-40%	Ethanol std-40%	1.540	21969905	9117027	40.135
algraif-1 -2021.gcd	algraif-1 -2021	algraif-1 -2021	1.521	9057750	5387455	17.721
almashtal-1.gcd	almashtal-1	almashtal-1	1.524	10912692	6163762	20.941
alsonot-1.gcd	alsonot-1	alsonot-1	1.528	13750264	7173408	25.866
altaif-1 -2021.gcd	altaif-1 -2021	altaif-1 -2021	1.525	11909719	6548000	22.671
arkweet-1.gcd	arkweet-1	arkweet-1	1.527	12441360	6640404	23.594
establat-1.gcd	establat-1	establat-1	1.522	9691068	5675909	18.820
wisky-1 -2021.gcd	wisky-1 -2021	wisky-1 -2021	1.538	20313204	8831971	37.259
Average			1.527	13070973	6631929	24.687
%RSD			0.514	39.968	27.310	36.734
Maximum			1.540	21969905	9117027	40.135
Minimum			1.514	4648976	2896359	10.068
Standard Deviation			0.008	5224209	1811161	9.069



Sample	Concentration %	No.unit /600ml	Days of male	Days of female
Whisky	37.259	40	13.3	20
Aragi algraif	17.7	10.62	3.54	5.3
Aragi almashtal	20.9	12.54	4.18	6.27
Aragi alsonot	25.8	15.48	5.16	7.7
Aragi altaif	22.6	13.56	4.5	6.78
Aragi arkawet	23.5	14.1	4.7	7.05
Aragi establat	18.8	11.2	3.76	5.6

BAC:

BAC refers to the percent of alcohol (ethyl alcohol or ethanol) in a person's blood stream. A BAC of .1% means that an individual's blood supply contains one part alcohol for every 1000 parts blood.

$$BAC = \frac{dose \times concentration \times 8}{BW \times volume \times 10}$$

Sample	BAC mg/ml	Clinical finding
Whisky	7.6	Coma
Aragi algraif	2.02	Moderate
Aragi almashtal	2.38	Moderate
Aragi alsonot	2.9	Moderate
Aragi altaif	2.5	Moderate
Aragi arkawet	2.6	Moderate
Aragi establat	2.1	Moderate

Discussion:

Alcohol is a toxic and psychoactive substance with dependence producing properties. Alcohol consumption contributes significant morbidity and mortality. Overall, harmful use of alcohol is responsible for 5.1% of the global burden of disease. Harmful use of alcohol is accountable for 7.1% and 2.2% of the global burden of disease for males and females, respectively. Alcohol is the leading risk factor for premature mortality and disability among those aged 15 to 49 years, accounting for 10 percent of all deaths in this age group. Disadvantaged and especially vulnerable populations have higher rates of alcohol-related deaths and hospitalization. (17)

Immune System:

Drinking a lot on a single occasion slows your body's ability to ward off infections – even up to 24 hours after getting drunk. (18)

Clinical findings:

	Conc.	Signs
Mild	0.5-1.5 mg/ml	-Slight visual impairment. -Slight muscular incoordination. -Slowing of reaction time.
Moderate	1.3-3 mg/ml	- Sensory loss. - Slowing of speech. - Further slowing of reaction time. - Muscular incoordination.
Severe	3-5mg/ml	-Marked muscular incoordination. -Blurred vision.

		-Severe hypoglycemia.
Coma	5mg/ml	-Unconsciousness. -Slowed respiration -Complete loss of sensation -Death

Punishment for drinking alcohol in Islam:

As for drinking alcohol, there is a specific Islamic *Hadd* for that. In the early days of Islam, people who had stopped drinking prohibited others and those who committed the offence were lashed 40 times. They use to flail the drinker with anything that came to hand - a piece of cloth, a shoe, a stick - just to let the person feel that he or she had indulged in something prohibited. Later on, when there was a complaint that people were returning to the old ways of drinking, `Umar, Islam's 2nd caliphate, consulted the Muslims around, and `Ali, Islam's 4th caliphate, said: "I think that drinking will make a person lose his mind and consequently start abusing others, uttering false accusations against them. So, I think he deserves the same punishment for a person who falsely accuses other persons (*Qadhif*) that is 80 lashes." Henceforth, that became the standard of punishment for drinkers to stop them from falling into that. [19]

Conclusion:
This study showed chemical compositions of Aragi and whiskey and quantitatively and qualitatively by chromatographic methods. It also showed toxic constitutes in local alcoholic beverage fermented and distilled and compare results with that of imported alcoholic beverage.

Recommendations:

- Increased awareness of the damages that alcohol may cause to the human body
- Further studies on the appropriate approach to limiting the consumption of alcohol
- Teaching youngsters about the negative effects of alcohol during their 'explorative' years
- Increasing funding for rehabilitation centers worldwide that focus on treating alcohol dependence.

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