BIOCHEMICAL PERSPECTIVE OF ALCOHOL PROHIBITION IN ISLAM AND IMPLICATIONS ON LEGAL ALCOHOL CONTENT OF DRINKS IN ISLAMIC COUNTRIES

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Abstract: An analysis of the concepts of intoxication in blood and the required amount of alcohol to reach that level was analyzed from physiological and religious perspectives. Exact value of potentially allowed alcohol concentration was determined. The results indicate a BAC of 0.05% (w/v) as a set level for intoxication. The determined pure alcohol amount required to reach this level was 27 g (for a 70 kg female) at least. Accordingly, the determined allowed alcohol concentration is 0.45% (w/v) for what would be considered non-intoxicating. This was compared to published results regarding the reported alcohol content of various foods and drinks. A sensitivity analysis was conducted to allow for variation in the considered BAC and the corresponding alcohol concentration in drinks. An analysis of alcohol content in various cooked foods showed an interesting spread in the alcohol content. A review of set legal limits in some Islamic countries is recommended.

Keywords: Intoxication, BAC, alcohol concentration, drink, food, sensitivity analysis.

Abbreviations:

ADH : Alcohol dehydrogenase
ALDH : Aldehyde dehydrogenase
BAC : Blood alcohol concentration
g : Gram
L : Liter
mg : Milligram
w/v : Weight to volume ratio
w/w : Weight to weight ratio
SI : International System of Units

A. Introduction

The ill-effects of alcohol are well known throughout the general and scientific communities. From a religious perspective, alcohol is banned in Islam according to the general prohibition in Quran. It is clear that alcohol is prohibited for its intoxicating effect. Since the only ingredient responsible for intoxication in alcoholic beverages is alcohol itself, this paper will focus on the analysis of physiological and chemical perspectives of ethyl alcohol, also known as ethanol. A general understanding of alcohol metabolism in the body and its presence in a variety of foods is a natural prelude to addressing the religious perspective.

1. Metabolism of ethanol

It's been known that ethanol undergoes a specific biological metabolism pathway in the human body. Starting with absorption, where the stomach absorbs 20% of the ethanol and the remaining is absorbed by the small intestines (Freudenrich 2015). Studies have revealed that complete absorption requires 30-60 minutes to be reached (Benjamin 2015). However several factors lead to variations of the rate of absorption, including alcohol consumption on an empty or full stomach, the rate at which alcohol is consumed, age, weight, and gender. It is commonly known that once the gastrointestinal tract absorbs ethanol it is then distributed across the whole body. Excessive alcohol consumption allows alcohol to reach the central nervous system and causes signs of impairment. Once alcohol reaches the liver, the alcohol dehydrogenase (ADH) enzyme, catalyzes the formation of acetaldehyde, which is subsequently further metabolized to acetate by aldehyde dehydrogenase enzyme (ALDH).

2. Mellanby biphasic effect

Experiments conducted on human subjects showed that a given blood alcohol concentration BAC has a stronger effect on the drinker's impairment status while his BAC is increasing than for similar BAC obtained after peaking. This is called the Mellanby effect. The drinker senses euphoria until his BAC reaches 0.055 g/dL. After this level, more drinks will make him feel worse and he starts to show impairment signs and symptoms of dysphoria. Clearly, the biphasic effect of alcohol opposes the known myth that the more alcohol we consume, the better we feel. (Hanson 2015)

3. Alcohol in foods and drinks

Several studies have been conducted on alcohol level in various food and drinks and the following two graphs indicate some of the values obtained for various food (figure 1) and drink (figure 2) brand names. The bars in the graphs are marked in different patterns depending on whether their alcohol content is higher or lower than 0.5%, a value which will carry a special significance within this study.

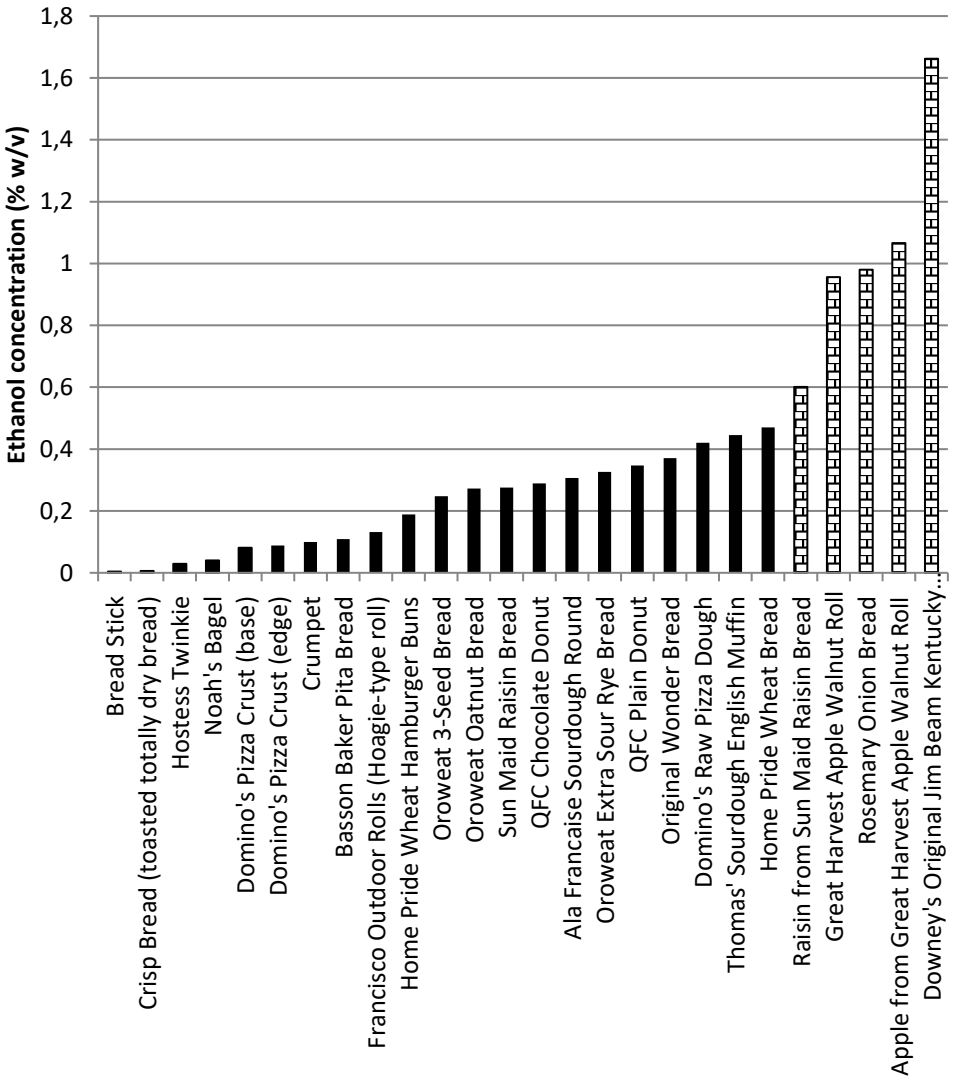

Fig. 1 Ethanol content in various foods. Derived from data obtained from (Logan and Distefano 1998)

Within the context of the same study (Logan and Distefano 1998), it was found that Mini Preztel, QFC Poppy Seed Muffin , Ritz Cracker, Triscuit Cracker , Graham Cracker and
Sun Maid Raisin were also tested and their alcohol concentrations were below the detection limit of 0.001% (w/v) alcohol content.

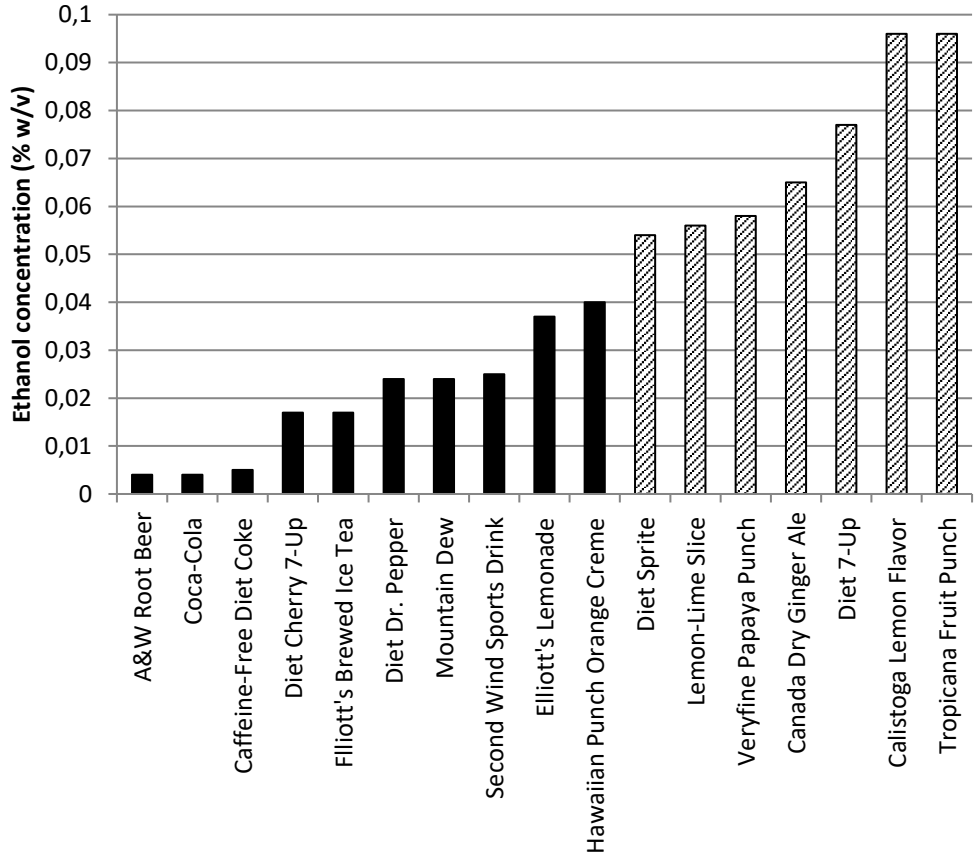

Fig. 2 Ethanol content in various drinks. Derived from data obtained from (Goldberger, Cone, and Kadehjian 1996)

Within the drinks category (Goldberger, Cone, and Kadehjian 1996), Caffeine-Free Diet Pepsi , Coors Sparkling Water Original , Diet Orange Slice, Diet Pepsi , Diet Rite Cola, Gatorade Lemon-Lime, Pepsi Cola, Sunkist Orange , Very fine Fruit Punch and Welchade Grape Drink all showed less than the detection limit of 0.001% (w/v) alcohol content whereas Grape Crush and RC Cola showed less than 0.002% (w/v)

4. The religious perspective

"O you who have believed, indeed, intoxicants, gambling, [sacrificing on] stone alters [to other than Allah], and divining arrows are but defilement from the work of Satan, so avoid it that you may be successful." (Surah Al-Mai'dah, 90) (Quran 2015)

As narrated by Abi Daoud and translated by current scholars (Sunnah 2015b) the Prophet said: "If a large amount of anything causes intoxication, a small amount of it is prohibited." This Saying is not specific regarding the amounts of alcohol that may not be used. A more specific Saying specifies: "Every intoxicant is forbidden; if a 'faraq' of anything causes intoxication, a handful of it is forbidden." In other narrations, the word "handful" is replaced by "awqieh" or "mouthful". The mouthful part is defined according to the translation and study of what the words "Haswa" and "Jaraa" (mentioned in Saying narrations) mean in Arabic (Almaani 2015).

This paper aims at quantifying the exact alcohol content that would be associated with prohibition in Islam. To achieve that, three questions must be answered:

1. What defines intoxication or drunkenness?
2. What do the units specified in the Saying mean in today's units?
3. What is the alcohol concentration in drinks that would lead to intoxication?

B. Methodology

The BAC is reported in a variety of formats and so is the alcohol concentration in a given drink. These formats include percentage based on weight or volume of alcohol, to blood volume ratio. It may also be presented as mg/mL, g/L, g/dL, mL/dL or mL/L. In addition, similar units are used for alcohol concentration in drinks. For the purposes of clarity and consistency, all concentrations in this paper will be represented as percentages of alcohol in liquid in a weight of alcohol to volume of liquid (drink or blood). This is normally viewed as grams of alcohol per deciliter of blood or drink (g/dL). This will be represented as (% w/v) throughout with the exception of the section on alcohols in foods where the percentage is represented as % w/w, since the volume of food is not relevant.

To identify the percentage allowed in a given drink according to Islam, the following methodology is adopted:

1. Determining of the exact Blood Alcohol Concentration (BAC) that would classify a given person as drunk.
2. Determining the exact amount of alcohol needed to reach the determined BAC above.

3. Determining of the maximum possible ingestion amount of food or drink.
4. Identifying all factors involved in the fate of alcohol in blood including endogenous alcohol production and the enzymatic processing of alcohol; and defining the quantity and time factors that insures a certain acceptable BAC.
5. Transforming the old units referred to in the prophet's saying into modern standard units.
6. Deducing the alcohol concentration in a drink that does not allow for intoxication.
7. Concluding about various drinks and dishes that contain alcohol.

C. Results

1. Definition of drunkenness BAC

One of the most accurate measures of the effect of alcohol on human behaviour is the measure of alcohol concentration in blood (BAC). This value eliminates a lot of variables but not all of them. Within the context of a general study, the results in Table 1 below show that despite the fact that some people (4%) may get drunk at level below 0.05%, this 4% of the population forms the exception rather than the rule. Accordingly, it may not be taken into consideration. On the other hand, the 32% of people classified as drunk in the 0.051-0.10% ranges merit attention. Accordingly, a BAC level of 0.05% will be adopted as the level at which a person will be considered drunk.

Table 1
Correlation between BAC level and Impairment
in a study of 6500 subject (Benjamin 2015)

Blood Alcohol Concentration (% w/v)	Average % of Individuals diagnosed as drunk
< 0.05	4
0.051- 0.10	**32**
0.101-0.15	62
0.151-0.2	89
0.201-0.25	95
0.251-0.3	98
0.301-0.35	99

This analysis is corroborated by Table 2 that specifies the psychomotor effects of BAC on humans. The indicated effects show the initial symptoms of a drunken person at a 0.05% BAC level.

Table 2.
Psychomotor effects of BAC on humans (CDC 2015)

Blood Alcohol Concentration (BAC w/v)	**Typical Effects**
0.02%	Some loss of judgment Relaxation Slight body warmth Altered mood
0.05%	Exaggerated behavior May have loss of small-muscle control (e.g., focusing your eyes) Impaired judgment Usually good feeling Lowered alertness Release of inhibition
0.08%	Muscle coordination becomes poor (e.g., balance, speech, vision, reaction time, and hearing) Harder to detect danger Judgment, self-control, reasoning, and memory are impaired
0.10%	Clear deterioration of reaction time and control Slurred speech, poor coordination, and slowed thinking
0.15%	Far less muscle control than normal Vomiting may occur (unless this level is reached slowly or a person has developed a tolerance for alcohol) Major loss of balance

Furthermore, a general overview of the BAC limit in several countries that would lead to classification of a given driver as driving under the influence or as a drunk driver is shown in figure 3. A significant majority of countries has indicated 0.05% as the maximum allowed level. For the purposes of this analysis a 0.05% BAC limit at which intoxication is assumed to take effect is rather well supported.

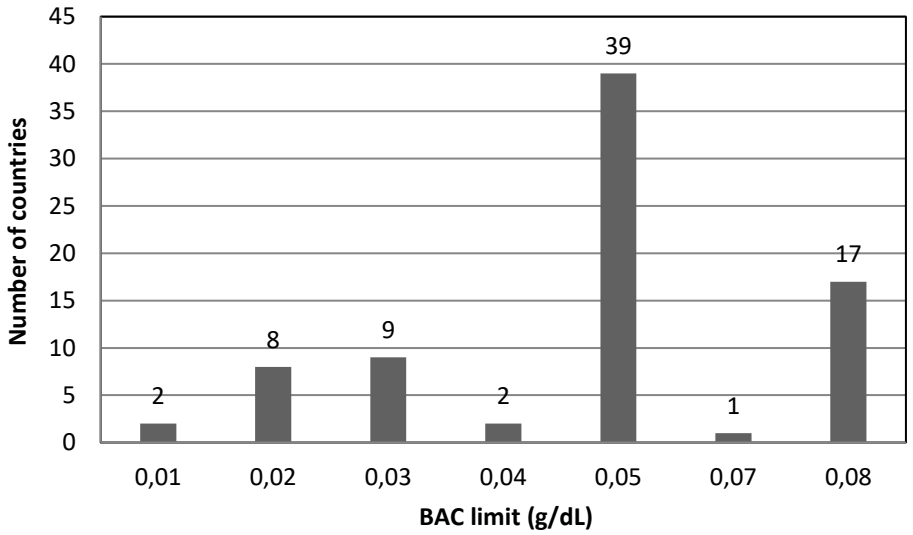

Fig. 3 BAC limit in various countries (Policies 2013)

2. The Stomach capacity

The stomach capacity is 2-4 L under normal circumstances (Johnson, Brusca, and Holt 1994). However, the maximum volume that an average person can drink is 6 L (Mills 2013) under extreme competition style condition. Unfortunately, the consumption of that amount of beer resulted in the competitor's death.

3. Widmark Equation

The Widmark equation is the most comprehensive and scientifically accepted equation that simulates the effect of alcohol consumption on BAC (Gullberg 2007). This equation is represented as follows. The variables, explanation and values are shown in Table 3.

BAC=(NZd-Wrßt)/Wr

Table 3
Widmark equation Variables

Abbreviation	Explanation	Original units	SI units	Used Values	
				Male	Female
BAC	Blood alcohol concentration	kg/L	Kg/L	Var	Var
N	Number of drinks	-	-	Var	Var
Z	Ethanol per drink	fl.oz.	L	Var	Var
d	Density of alcohol	oz/fl.oz.	Kg/L	0.79	0.79

W	Body weight	oz	Kg	80 (average)	70 (average)
r	Volume of distribution	L/Kg	L/Kg	0.7	0.6
ß	alcohol elimination rate	Kg/L/h	Kg/L/h	0.000174	0.00015
t	time since drinking began	h	h	1	1

The values shown in Table 3 are based on accepted literature values. The Widmark formula was then used to estimate the amount of alcohol required to reach a 0.05% (w/v) BAC level. An average 80 kg male individual needs to drink 50 mL (39 g) of pure ethanol while an average 70 kg female needs to drink 35 mL (27 g) of pure ethanol to reach the determined drunkenness level.

4. Endogenous alcohol production and enzymatic processing

Endogenous alcohol production leads to a BAC of 0.113 mg/dL or 0.000113 g/dL (Al-Awadhi et al. 2004). The rate of enzymatic processing of alcohol by alcohol dehydrogenase (ADH) is 0.017 $g.dL^{-1}.h^{-1}$ for males and 0.015 $g.dL^{-1}.h^{-1}$ for females (Johnson, Brusca, and Holt 1994, Jones, Wigmore, and House 2006). Based on this rate, it can be assumed that an alcohol intake of 0.015 g/dL.h will not result in an increase in blood alcohol concentration. For an average 80 kg male, this translates to the consumption of approximately 13 mL or 10 g of pure ethanol per hour according to the Widmark equation. For a 70 kg female, the intake is equivalent to 8 mL or 6 g per hour approximately. To understand the uppermost limit that may be attained, a BAC >4.0 g/kg or 422 mg/100L is considered fatal (Jones, Wigmore, and House 2006).

5. Translation of Arabic units to SI units

All the weight and volume terms in Saying are ones used at the time and are from within the immediate environment they were living in. The more modern weight and volume units were not known then. However, several scholars have attempted to transform the verbal values into SI units. Their work is presented in the table below in addition to some experimental work by the authors.

Table 4
Transformation of Arabic units to SI units

Unit	Volume in mL	Reference
Handful	15	Authors
Mouthful	60	(Hitchings et al. 2013) and authors (average)
Awqieh	119	(Jomaa 2001)
Faraq	6120	(Jomaa 2001)

D. Discussion

The maximum volume that an average person can drink is 6 L (Mills 2013). This is remarkably close to the volume of "Faraq" (6.12 L). To be on the safe side, the mentioned numbers mean that a person can drink 6.12 L of a drink containing 39 g of ethanol for males and 27 g for females, before reaching the 0.05% (w/v) BAC which is used to define intoxication. This means that a drink with an alcohol concentration of 0.64% (w/v) for males and 0.45% (w/v) for females may be tolerated without getting intoxicated. The significantly lower value for females is a result of the lower average weight taken and the smaller volume of distribution used in the Widmark formula. Since there is no discrimination between males and females in the religious legality of alcohol, the lower value should be taken.

On the lower limit, it is very interesting to note that the lower limit of 15 mL of alcohol obtained from the lowest value of the notations of "handful", "mouthful" and "Awqieh" would not get one intoxicated even if that person was drinking pure ethanol since at least 35 mL are required. Whether the prophet meant this handful as an indication of any small amount or whether it is meant as a value in itself remains to be analyzed. He could have used any other unit of measure that is much less than a handful which have been commonly used like a drop or an ant or other very fine units relating to dates. The following are some mentioned weights that are much smaller than a handful:

"So whoever does an atom's weight of good will see it, And whoever does an **atom's weight** of evil will see it." Zalzalah 7-8. (International 2015) The atom translation has also been referred to as the amount of sand that sticks to one's hand when he places it on the ground.

"He causes the night to enter the day, and He causes the day to enter the night and has subjected the sun and the moon - each running [its course] for a specified term. That is Allah , your Lord; to Him belongs sovereignty. And those whom

you invoke other than Him do not possess [as much as] the membrane of a date seed." Fatir 13, (International 2015b)

"Have you not seen those who claim themselves to be pure? Rather, Allah purifies whom He wills, and injustice is not done to them, [even] as much as a thread [inside a date seed]." An-Nisaa 49. (International 2015c)

Or have they a share of dominion? Then [if that were so], they would not give the people [even as much as] the speck on a date seed. An-Nisaa 53 (International 2015c)

Many values for the upper limit have also been mentioned such as the prophet saying: 'If the water is more than two Qullahs, it will not become filthy.'(Sunnah 2015a). Qullah measures around 100 L (Jomaa 2001).

Accordingly, the choice of "Faraq" and "handful" may be taken to indicate an actual amount rather than simply a very large amount and a very small amount as some scholars have said. It is interesting to note that scholars have allowed the consumption of medications dissolved in alcohol (League 2015). Normally these drugs are taken in amounts less than 15 mL. Accordingly, another perspective of this may be that in addition to the medical necessity aspect, one may argue that this amount does not exceed the volume specified by the prophet.

One has to be very careful in such an analysis as some may use this argument to allow the drinking of one or two sips of alcoholic beverages which is clearly forbidden in Islam. This aspect has been covered by the general prohibition stated by the Saying.

> "The Prophet said: Allah has cursed wine, its drinker, its server, its seller, its buyer, its presser, the one for whom it is pressed, the one who conveys it, and the one to whom it is conveyed."

It is commonly understood that wine, as translated here, actually covers all intoxicating alcoholic drinks. Therefore, according to our classification, once a drink exceeds the 0.45% (w/v), it automatically becomes forbidden (Haram) to handle.

1. International alcoholic drink classification

Several countries have specified certain alcohol content for a given beverage to be considered alcoholic. The values vary widely from 0.05% to 2.8% as can be seen in Table 5. These values are remarkably close to the determined value and sometimes exceed it, with the exception of limits set by Arab countries.

Table 5
Alcohol level required to reach the alcoholic drink classification in various countries (TTB 2015, Taha 2011)

Country	Classification as non-alcoholic	
	% (v/v)	% (w/v)
Denmark	0.50	0.40
Finland	2.80	2.21
Italy	1.20	0.95
Sweden	0.50	0.40
UK	0.05	0.04
Norway	0.70	0.55
US	0.50	0.40
Australia	0.50	0.40
New Zealand	0.50	0.40
Korea, South	0.50	0.40
Kuwait	0.05	0.04
UAE	0.05	0.04
Qatar	0.05	0.04

2. Various opinions on the legality (halal) of alcohol percentages

A number of scholars and non-scholars have vehemently expressed their opinions in this discussion with usually no scientific support. These opinions are commonly misrepresented, misinterpreted and simply misunderstood. According to the Qaradawi official website, the allowed percentage of alcohol in a drink is 0.5% (AlRaysouni 2008) whereas, in a different article from the same website, the allowed percentage is referred to as 0.05% (Qaradawi 2008a). Upon referring to the original verbal statement made by Qaradawi which is available in video format (Qaradawi 2008b), the percentage is clarified as 0.05%. This percentage has been frequently misrepresented as 0.5% in many references (Harrison 2008), and sometimes the mentioned percentage within the same article is confused between 5 per thousand and 0.05% which may be attributed to misunderstanding of what 5 per thousand means (Alarabiya 2008). In addition, the original article where this Fatwa was published in Arab newspaper specifies 0.5% and then refers to the Qatari standards of 0.05% (Lasheeb 2008) which may have spurred the confusion about the exact percentage the scholar was referring to. It is clear that the best reference is the video statement in which he refers to 0.05%.

Other scholars have indicated that any amount of alcohol makes a drink "haram" (AlSaadi 2012) which is a clear misunderstanding of how chemicals are analyzed in reality. Since one can find alcohol in many commonly used non-alcoholic products, the exact percentage for such classification must be determined. A number of discussion groups have indicated various opinions on the subject, varying widely in the determination of what is allowed and what is not.(AlSaadi 2012)

Some scholars have allowed 1-3% of alcohol (AlFiqhi 2014) which is a clear misrepresentation of what is intended and the authors believe that the scholar intended to say that 1-3 % of beer in water (not alcohol in water) is allowed. With an average of 4% alcoholic content in beer, these values translate to 0.04% to 0.12 % alcoholic content in a given drink. It is also clear that these numbers are based on simple conjecture rather than on a detailed scientific analysis.

The most scientific approach to analyzing whether a certain concentration is allowed or not has been done by Sheikh Usama alRifai (AlKari 2010) in which he analyzed the alcohol content of non-alcoholic beer and the concentration required to make someone drunk. We find a major flaw in his calculation where he was informed that the amount needed to reach a BAC of 0.8 g/L is 6 grams of pure alcohol. According to the Widmark formula and after 1 hour for an average 80 kg male, the actual amount of alcohol needed is 72 mL or 60 g. This leads to a major 10-fold difference in the conclusion.

The alcohol content of certain fruits and drinks have raised the concerns of scientists for both religious reasons and for accuracy of BAC and alcohol breath tests. According to a study by the Turkish scientists (Gündüz, Yılmaz, and Gören 2013, Ahmet C. Gören 2013) a group of alcoholic and non-alcoholic drinks were extensively studied and the results are summarized in Figures 4-6 categorized according to different scales for clarity purposes. The numbers next to the product probably indicate a different brand name. The first graph shows drinks with alcohol content greater than 0.5% (w/v). Based on our previous analysis, these are considered alcoholic and forbidden. The second graph shows drinks with alcohol content between 0.5% and 0.05% (w/v) which may be considered allowed by the current study but forbidden under the laws of many Arab countries. This category raises serious concerns about the levels set by these countries since cabbage for example cannot be considered alcoholic nor can peach nectar. Vinegar has been allowed by virtually all Muslim scholars. The combinations of these Fatwas or religious decisions and the numbers shown in the Turkish study tend to support our analysis in regard to the allowed percentage of alcohol in drinks. The third graph is for those drinks with less than 0.05% (w/v) alcohol concentration and are considered

safe and allowed by all, except those who claim that any alcohol content is not allowed.

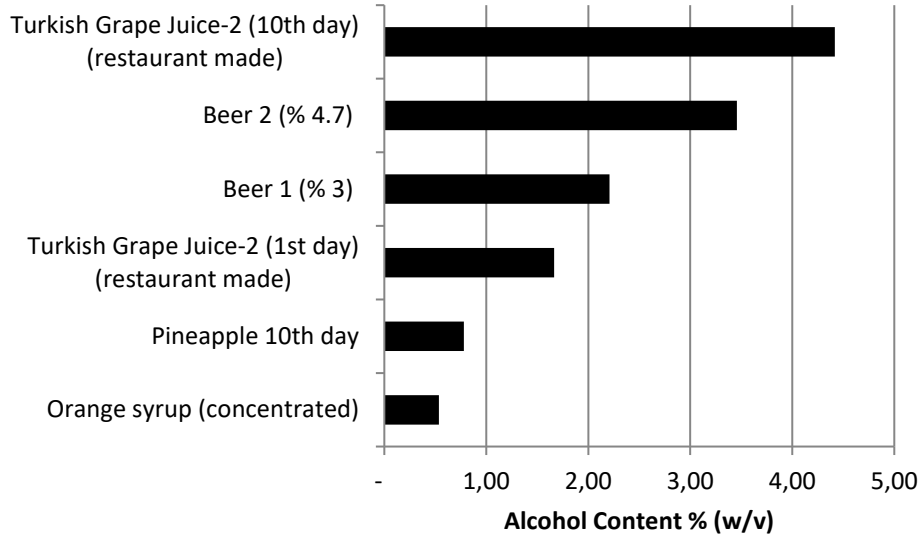

Fig. 4 Drinks with alcohol concentration above 0.5% (w/v) (Ahmet C. Gören 2013)

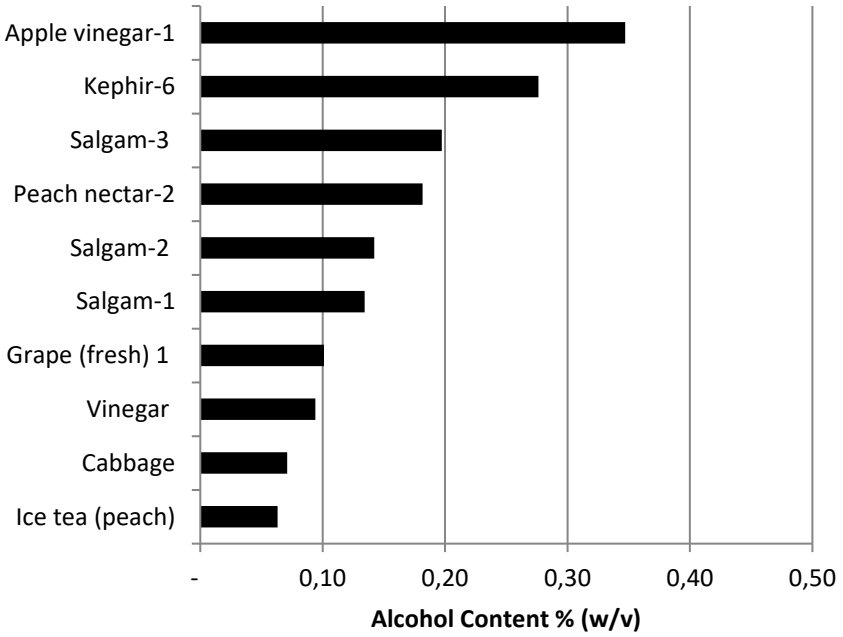

Fig. 5 Drinks with alcohol concentration between 0.05% and 0.5% (w/v) (Ahmet C. Gören 2013)

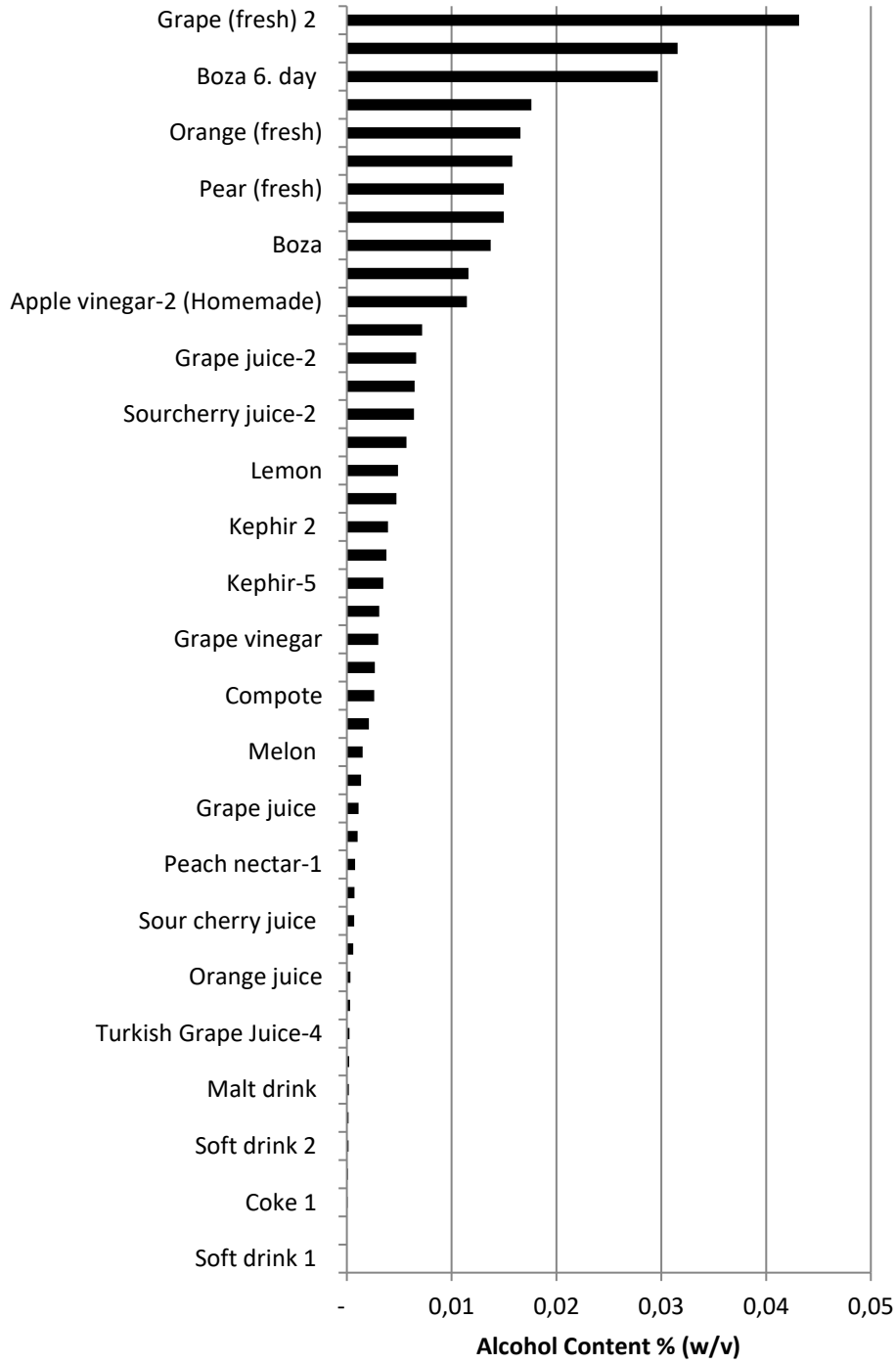

Fig. 6 Drinks with alcohol concentration below 0.05% (w/v) (Ahmet C. Gören 2013)

What is of concern in these graphs however, is the pineapple alcohol level after 10 days of storage in a refrigerator and that of concentrated orange syrup. Both seem to undergo sufficient fermentation to increase the level of alcohol in them above the safe levels determined by this study. A careful study remains to be conducted regarding all sugar containing fruits to examine the fermentation processes taking place under modern storage and transport conditions and their effect on alcohol levels.

E. Implications on foods cooked with alcohol

Another major concern for Muslims is the alcohol content in food that may have added alcohol or is cooked in alcohol. This section will attempt to analyze the alcohol content in a variety of foods.

Sushi experiment:

While keeping in mind that the alcohol content of soya sauce is around 2% which is clearly within the intoxicating range, an experiment was conducted to determine the amount of soy sauce absorbed into sushi upon normal dipping. This amount corresponded to an average of 0.09% (w/w) alcohol in the sampled soy-sauce-dipped sushi. This is well below the 0.45% needed for intoxication and accordingly, it is hard to classify sushi as an intoxicating dish, even when dipped in soy sauce.

Various Chinese dishes:

A number of traditional Chinese recipes were analyzed for their soy sauce content. With an average 2% alcohol content in soy sauce and with the assumption that none of the alcohol evaporates during the cooking process (to err on the safe side), all the analyzed dishes had an alcohol level less than 0.45% as shown in Table 6.

Table 6

Alcohol content in traditional Chinese dishes (Yummly 2015)

Dishes	% alcohol in Dish (w/w)
Chinese orange chicken	0.07
Ginger-Soy Steamed fish	0.06
Authentic Chinese steamed fish	0.07
Restaurant-style Chinese steamed fish	0.11
Rice noodles with chicken	0.05

Chinese steamed white fish fillet with tofu	0.05
Glazed Salmon with spicy broccoli	0.10
Salmon Teriyaki	0.08
Spicy Chinese Vegetable stir fry with chicken	0.17
Sesame Tuna and rice	0.03

International dishes with alcohol additives

Many international dishes have alcohol content in various forms and some are sampled in Table 7. The reported percentage was based on an estimation of the overall dish weight. The majority of these dishes show alcohol content exceeding the 0.45% determined in this study. Two factors need to be taken into consideration. How these two factors interplay to give a final accurate alcohol content is to be determined.

1. Alcohol content percentage will be affected by cooking which results in a reduced ethanol content as a result of evaporation. According to a USDA report (USDA 2007) alcohol content decreases to various extents when the food is cooked but is never fully evaporated even after 2.5 hours of simmering.
2. Alcohol content % is represented as w/w which is different than w/v. Since foods are expected to have a density greater than 1 g/mL, this variable makes the reported percentage higher when expressed in w/v.

Table 7
International dishes with alcoholic additives (Yummly 2015)

Country	Dish	Alcoholic additive	% alcohol in Dish (w/w)
China	Chinese honey chicken	1 tbsp of rice wine	0.20
	Chicken With Chinese Rice Wine And Old Ginger	150 ml of rice wine	**3.11**
	Drunken clam (manila clams with chinese cooking wine)	2 cups of rice wine	**10.97**
	Garlic-Ginger shrimp	59 ml of rice wine	**0.98**
France	Chicken Francese	118 ml of white wine	**0.85**
	Moules Mariniere	237 ml of white wine	**2.04**
	Coq au vin	473 ml of red wine+ 59ml cognac	**1.72**
	French onion soup	59ml of white wine+ 59ml cognac	0.43

Italy	Juicy Italian Chicken	59 ml of white wine	**1.12**
	Italian Fish soup	237 ml of white wine	**0.60**
	Sole Piccata	118 ml of white wine	**1.73**
UK	British Columbia Bouillabaisse	355ml of white wine	**1.48**
Germany	German-style Beef Roast	148 ml of red wine	**0.58**
	Chicken in Riesling	237 ml of white wine	**0.85**
Sweden	Swedish mushroom soup	100 ml of white wine	**0.66**
	Kona Chicken	59 ml of white wine	0.33
	Gravadlax (Swedish cured salmon)	15ml of white wine vinegar	0.03

Despite the above mentioned percentages for alcohol in food, and the fact that some alcohol laced dishes may not be intoxicating, it is to be kept in mind that in the Islamic religion, the purchase, transport and use of alcoholic products is strictly forbidden as per the Prophet's saying:

> "The Prophet said: Allah has cursed wine, its drinker, its server, its seller, its buyer, its presser, the one for whom it is pressed, the one who conveys it, and the one to whom it is conveyed."

Accordingly, Muslims may not cook these dishes and they should try to avoid them by all means, but it may be concluded that eating such dishes with low alcohol concentration may not be necessarily intoxicating.

F. Conclusion

Drinks containing less than 0.45 % (w/v) of alcohol cannot cause intoxication for the average person as defined in this study. Similarly, some dishes containing small amounts of alcohols may not be considered intoxicating; however, most alcoholic dishes contain large amounts of alcohols that make them prohibited in Islam. The scientifically determined percentage for non-intoxicating drinks is significantly higher than that determined by some Muslim scholars (0.05%) and some Arab countries. The origin of the adopted 0.05% is not clear and no scientific proof is given for this value. The value obtained in this study is very close to the 0.40% (w/v) adopted by several western countries for the determination of what is classified as an alcoholic beverage. The argument that "any alcohol-containing drink is forbidden regardless of the alcohol content" is refuted. Alcohol content of dishes is significantly harder to work with but the general prohibition applies for the use of alcoholic sauces,

whether they are wine, cognac or any other form. This prohibits Muslims from cooking these dishes.

The standards set by some Muslim countries for classifying something as alcoholic is in contradiction with approved norms of what is or is not alcoholic. To this end, a variety of products would not pass the limits set by the government (Figure 5) such as cabbage, ice tea, grape juice, vinegar and salgam. Accordingly, a major review of the laws in these countries is needed.

Some researchers may not agree with the original premise in this paper and may wish to assume a different BAC level as an indicator of intoxication. To give a broader idea of the ranges involved in various assumptions, Table 8 shows the various BAC levels that may be assumed taking into consideration the complete range of values adopted by all countries to define intoxication. Even at the lowest BAC level of 0.01%, one can observe that the allowed alcohol concentration in drinks according to the analysis in this paper is around 0.17% (w/v). When Qatar is taken as a case study, the allowed BAC for driving is 0.00 %. (Moderation 2015) This scientifically means that up to 0.005% may be accepted. This value means that a person can safely consume a 0.045% alcohol content drink without reaching this level. This is in line with Qatar classification of drinks with 0.04% (w/v) alcohol content as intoxicating.

Table 8
Sensitivity analysis

BAC	alcohol concentration (% w/v)	
	Male	Female
0.01	0.26	0.17
0.02	0.36	0.24
0.03	0.45	0.31
0.04	0.55	0.38
0.05	**0.64**	**0.45**
0.06	0.74	0.51
0.07	0.84	0.58
0.08	0.93	0.65

As a Muslim scholar once said, "knowledge for us is the clarification of what is allowed by trusted scholars, as for strictness, it can be done by all".(IslamWeb 2015) It is the hope of the authors that Muslim scholars will take this study and the methodology used to issue future religious views in this regard. In addition, we invite all scientists to review the scientific content and methodology to

confirm, refine, or refute our analysis in the hope that such a scientific and objective discussion will enhance the quality of this work.

G. Conflict of Interest

There are no financial or other relations that could lead to a conflict of interest.

H. Bibliography

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