

# Chemical Components of Noncommercial Alcohol Beverage Samples: A Study With the Viewpoint of Toxic Components in Mashhad, Iran

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## Abstract

**Background:** Iran has one of the lowest alcoholic beverage use rates in comparison with other countries, because it is legally forbidden and because of religious beliefs. Even so, unrecorded and noncommercial alcohol remains a considerable concern, which needs special attention.

**Objectives:** In the current research, we have studied the general composition of noncommercial alcohol samples to identify potentially toxic components in the context of the city of Mashhad in IR Iran.

**Patients and Methods:** Using a descriptive study, chemical composition records of alcohol samples obtained from Mashhad and its suburbs (from March 2013 to March 2014) were evaluated in terms of ethanol percentage and methanol percentage using gas chromatography. Likewise, the pH of the alcohol and the location of the sample were also considered. Some substances, such as inorganic elements, were not included because there was no information about these substances in the records.

**Results:** Of 877 reports of alcohol samples, more than 50% were obtained from Mashhad and the rest were from the suburbs. Of the reports, 57.5% were in the spring and summer, followed by 42.5% in the fall and winter. The mean (min-max) of ethanol percentage was 30.04% (0 - 98.4). In four cases, methanol was detected. The mean (min-max) of methanol percentage was 23% (4 - 95). The majority of the samples had an acidic pH.

**Conclusions:** The composition of unrecorded samples did not raise major toxicological concern beyond ethanol in alcohol products. However, concentration levels of methanol in some unrecorded alcohol samples made these samples detrimental for human consumption.

**Keywords:** Alcoholic Beverages, Chemical, Components, Ethanol, Methanol

## 1. Background

The net effect of alcohol consumption on health is detrimental, with an estimated 3.8% of all global deaths and 4.6% of global disability-adjusted life-years attributable to alcohol (1). Alcohol consumption is linked to long-term health and social consequences through three intermediate mechanisms: intoxication, dependence and direct biological and toxic effects (2). In addition to the volume and patterns of drinking, alcohol quality may also have an impact on health issues (2, 3). In most regions of the world, the legal availability of alcohol is generally accepted to be one of the primary controls on levels of alcohol consumption and expected harms. Licensing systems are, therefore, a key component of an overall alcohol control policy.

In Iran, alcohol consumption is forbidden due to legal

and religious grounds, and alcoholism is not considered a major public health concern. Despite this prohibition, alcoholic beverages are made and sold illegally in Iran. Hence, noncommercial and unrecorded alcohol remains a considerable concern that needs intelligent and realistic policy options. Generally, the consumption of noncommercial alcohol (i.e., homemade alcoholic beverages) among individuals in the lower classes of the population is higher than individuals in the upper classes, who normally are able to have access to commercial alcohol. There have been persistent claims that consumption of unrecorded alcohol causes harm due to toxic ingredients other than ethanol (3). The problem of inadmissible methanol in noncommercial alcohol samples is noticeable. Roughly, less than 0.1% of the global alcohol-attributed deaths are due to methanol (corresponds to 2,740 deaths based on the global burden of disease) (3, 4). Other than methanol,

there are other potential toxic effects of noncommercial alcohol samples due to ingredients other than ethanol. Recently, concerns have been raised about the higher levels of alcohols in noncommercial alcohol (5). There is also a continuing discussion on the presence of lead in noncommercial alcohol (6). In addition to methanol and lead poisonings, ethylene glycol, polyhexamethylene guanidine (PHMG) and acetaldehyde have occasionally been a concern (7, 8). Several cases of methanol poisoning due to noncommercial alcohol consumption were recorded during the last decade. However, there is no literature on the composition of noncommercial beverages in Iran. The forensic toxicology laboratory in the Mashhad legal medicine organization, as a major laboratory center in the east of Iran, provides routine analytical toxicology testing, and a large number of samples are accepted regularly for analysis. This paper presents results of chemical composition and potential harm analysis in obtained unrecorded alcohol samples from the context of the city of Mashhad in Iran.

## 2. Objectives

The purpose of our study was to identify potentially toxic components in noncommercial alcoholic beverages in the context of the city of Mashhad in IR Iran.

## 3. Patients and Methods

All samples (n = 887) were collected during law enforcement by the police in Mashhad and the suburbs between March 2013 and March 2014 and submitted to a legal medicine organization. Methanol and ethanol levels in the alcoholic beverages were determined through direct injection gas chromatography with a flame-ionization detector (GC-FID) method. Regarding the legal medicine organization rules, alcoholic samples were identified by a number, and the analyst was not aware of the content of the samples.

## 4. Results

In total, 887 samples were under study; more than 50% of samples were obtained from Mashhad and the rest were from suburbs. Of the samples, 32.5% were obtained in the spring, followed by 24.8% in the summer, 22.4% in the fall and 20.1% in the winter. The percentage of ethanol in our study was divided into three groups. As can be seen in Table 1, in just a few of the samples, the percentage of ethanol was more than 60%, whereas in a significant proportion (59.8%) of the samples the ethanol percentage was between 31% - 60%, and a noticeable proportion (38.5%) was less than 30%.

To sum up, the ethanol percentage in the samples ranged from 0% to 98.4%, with an average percentage of 30.04%.

In the total of 877 samples, four cases of methanol were detected. The mean of the methanol percentage was 23%. As outlined in Table 2, the results for the pH of the alcoholic samples are divided into five groups. It is evident that the overwhelming majority of samples have an acidic pH.

Table 1. Ethanol Percentage (V/V) in Noncommercial Alcoholic Samples

Percentage of Ethanol	Frequency (%)
Less than 30%	38.5
31% - 60%	59.8
More than 60%	1.7

Table 2. pH of Noncommercial Alcoholic Samples

pH of Alcoholic Beverage	Frequency (%)
Less than 4	9.1
4	44.5
5	3.9
6	29.3
7	13.2

## 5. Discussion

About 30% of global alcohol consumption comes from unrecorded sources, but there are huge regional differences (9). In consideration of the legal prohibition of alcohol production and consumption in Iran, illegally produced and smuggled alcohol remains a considerable concern.

Noncommercial alcoholic beverages seem to be that which is affordable for alcohol consumers. However, published data on the chemical composition of noncommercial alcoholic beverages is scarce in Iran. The percent of alcohol by volume is now the harmonized measurement for alcohol strength (8). The accurate and rapid determination of ethanol in alcoholic beverages is very important for safety and economic reasons (8, 10). Some studies have shown that the unrecorded alcoholic beverages have higher ethanol levels than those that are commercially available (3). The obvious example is the ethanol percent of illegal alcohol products in Russia, which has created public health concerns relating to the consumption of unrecorded alcohol, and are due mainly to the ethanol content (11, 12). Even so, in many studies a majority of unrecorded beverage samples had a uniform alcohol content

of around 40% by volume and a tiny minority had more than 60% by volume, which is similar to the commercial alcohols (3, 13, 14). In the current study, volume percentage of ethanol in a noticeable proportion of the samples (roughly three out of five) was 31% - 60% and in a negligible proportion (1.7%) was more than 60%. Comparing the current study with the others in the context of ethanol percentage, a similar pattern was seen in our samples. Regarding the toxicological point of view, it is not a warning for public health, but it is certainly important to identify the practical consequences of these illegal alcohols, such as the short-term consequences (e.g., unintentional injuries and deaths, suicide, violent behavior) and the long-term problems (e.g., liver cirrhosis, cardiovascular disease, mental problems and cancers). It is impossible to argue against the fact that the vast majority of alcohol-related deaths are due to ethanol (1, 14, 15). Data about all the potentially presenting compounds in unrecorded alcohol reveals the substantial acute toxic effects of methanol. The current European Union limit for naturally occurring methanol in alcoholic drinks is 0.4% by volume for methanol at 40% by volume for alcohol (16, 17).

It should be noted that the methanol content would need to exceed 2% (v/v) for toxic harm (16). In the current study, methanol was detected in only four cases of the samples, however, all of the four cases exceeded the methanol percent limit for toxicity (more than 2%), and the mean of the methanol percentage was 23%. There is no doubt that toxic effects are expected in the four cases, although we did not have access to objective evidence about the practical consequences of consumption based on the records; nevertheless, serious emphasis on prevention is necessary.

About three out of five alcoholic samples were obtained in spring and summer. It is interesting to note that higher alcohol consumption in these two seasons is mentioned in some other studies as well (18, 19). On one hand, noncommercial alcoholic beverage production, sale and consumption has no seasonal rhythm; on the other, it seems that alcohol users in our study are occasional rather than regular users. However, more study is needed to investigate the many unanswered questions regarding the impact of the seasons and weekdays on the sale and consumption of noncommercial alcoholic beverages.

There is a clear trend in pH of the samples, pH in just over three quarters of the samples was in the range of four to six. Total acidity in alcoholic beverages is initially due to the presence of volatile acids, such as acetic acid or tartaric acid, and dictates the chemical processes taking place in alcoholic beverages (10, 20). In the current research, we have studied the general composition of noncommercial alcohol samples. A more pervasive approach is required for other compounds (e.g., higher alcohols, metals, acetalde-

hyde, ethyl carbamate, diethyl phthalate). Annually, there are many cases admitted to the medical toxicology center of Mashhad because of methanol poisoning due to home-made alcohol consumption.

To conclude, the current study presents results from the chemical composition analysis and expected potential harm from noncommercial alcohol in Mashhad and its suburbs. This investigation provides inadequate evidence to infer the influence of noncommercial alcohol composition on alcohol-related clinical toxic effects over the effects of ethanol. We detected a relatively high percentage of methanol in four samples, and it is important to emphasize that detailed future research should focus on the other potential components in unrecorded alcohol.

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### Footnotes

**Authors' Contribution:** Study concept and design: Hamideh Ghorbani and Bita Dadpour; analysis and interpretation of data: Hamideh Ghorbani, Bita Dadpour and Amir Habibi Tamijani; drafting of the manuscript: Seyed Mohsen Vaziri, Haleh Malek Zadeh and Bita Dadpour; critical revision of the manuscript for important intellectual content: Amir Habibi Tamijani, Arya Hedjazi and Hamideh Ghorbani; statistical analysis: Seyed Mohsen Vaziri, Haleh Malek Zadeh, Bita Dadpour; administrative, technical, and material support: Hamid Khosrojerdi and Arya Hedjazi; study supervision: Arya Hedjazi, Hamid Khosrojerdi and Amir Habibi Tamijani.

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