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LETTER TO THE EDITOR

Increased production of illegal alcoholic beverages during the COVID-19 pandemic in Hamadan, Iran

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Dear Editor,

The coronavirus disease 2019 (COVID-19) was first reported in Dec 2019 in Wuhan, China, and quickly spread to other countries, with the World Health Organization (WHO) declaring the disease a pandemic on Mar 11, 2020 [1]. By Feb 2021, over 100 million people had been diagnosed with the disease, and more than two million had died. In Iran, the first case of COVID-19 was identified on Feb 19, 2020, in the city of Qom [2]. Due to the lack of a clear plan to quarantine infected areas, the disease spread rapidly in Iran, by Mar 2021, the number of COVID-19 patients and deaths reached more than 15,00,000 and 60,000, respectively [3]. A faulty understanding of effective treatments, on the one hand, and misconceptions about and the use of nonstandard and superstitious methods on the other, caused the consequences of this pandemic disease to vary and be somewhat unpredictable [4]. A recommendation to consume alcohol to fight COVID-19 was one of the irresponsible and superstitious suggestions made by some unprofessional people, which had deadly consequences around the world [5]. According to the Iranian Ministry of Health, more than 3000 people have been hospitalized for alcohol intoxication during the pandemic, 600 people have died [6]. Due to the lack of consumer awareness of beverages' ethanol contents, the prevalence of ethanol poisoning in Iran is predicted to be higher than in developed countries.

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Methanol is found naturally or unnaturally (as a counterfeit additive) at different levels in alcoholic beverages, and methanol intoxication was one of the most important causes of death due to poisoning with nonstandard alcoholic drinks in Iran, which was a problem that increased during the COVID-19 pandemic [7, 8]. It is estimated that the total number of people killed by alcoholic beverages contaminated with methanol from Mar to Apr 2020 was about ten times greater than the same period in 2019 [5].

Given the importance of alcohol poisoning in Iran, the present study investigates the ethanol and methanol contents of 600 samples of illegal alcoholic beverages during the COVID-19 pandemic in Hamadan, Iran.

In this study, 600 samples of illegal alcoholic beverages were collected from seized shipments by security police in Iran, during the period of Oct 2019 to Feb 2021. Then the samples were kept in appropriate conditions and analyzed using gas chromatograph (GC) instruments, in the toxicology laboratory, Hamadan Legal Medicine Organization, Hamadan, Iran. Briefly, 1 mL of alcoholic beverages was diluted with deionized water into 250-mL volumetric flasks. After vortex shaking, 1 µL sample was injected into the GC system.

Ethanol and methanol content was determined by a GC instrument (Agilent 6850; Agilent Technologies, Santa Clara, CA, USA) equipped with a splitless injector, flame ionization detector (FID), a mesh 80/100 Porapak Q column [0.91 m (L) × 1.8 mm (internal diameter) with 2 mm (outer diameter), stainless steel]. Ethanol and methanol with a purity of 99% (GC grade) were purchased from Merck (Darmstadt, Germany). The carrier gas was air/nitrogen. The detector and injector temperatures were 250 and 160 °C, respectively. The oven temperature was 30 °C for 2 min at the injection time, which reached 155 °C at the end of 6 min. It should be noted that retention times for methanol and ethanol were calculated 1.7 and 4.4 min, respectively.

The standard curve was plotted based on the ratios of the areas under the curve (AUCs) to the alcohol standard

concentrations in the range of 6.25–100 mg/dL. The limits of detection (LOD) and limits of quantification (LOQ) were calculated as signal/noise = 3 and signal/noise = 9, respectively [9, 10]. The reliability of data was assessed by conducting internal quality control experiments, in addition to using validated methods. In this regard, recoveries of alcohols were recorded by analyzing an herbal drink sample spiked with certain concentrations (6.25, 12.5 and 25 mg/dL) of either methanol or ethanol.

The r^2 indexes suggested an acceptable standard curve, which was linear in the 6.25–100 mg/dL range. Moreover, the calculated LOD and LOQ values indicated a good performance at the low limits. The relative standard deviation (RSD) values of the recovery experiments were within the acceptable ranges, showing the good accuracy and precision of this analytical method (Table 1). The mean and maximum levels of ethanol were determined to be 20.8 and 78.3 g/dL, respectively. In the period from Apr to Aug 2020, the production and supply of nonstandard alcoholic beverages in the Hamadan showed a significant increase, and the average ethanol contents were 2.4 and 2.9 times higher than the average ethanol contents during Oct 2019–Mar 2020 and Sep 2020–Feb 2021, respectively (Table 2). These increases appear to be related to the spread of rumours about the beneficial role of alcohol consumption in preventing COVID-19 [11]. In addition, the prohibition on the production of alcoholic beverage in Iran and the use of ethanol in varying and uncalculated amounts mean that ethanol contents did not follow a defined standard, which could be a reason for the wide

Table 1 Linearity range, detection limits and summary of method validation data for the gas chromatography system

Drug	Range (mg/dL)	Calibration equation	r^2	LOD (mg/dL)	LOQ (mg/dL)	Recovery (%)[a]	RSD (%)[b]
Ethanol	6.25–100	$y = 297.44x - 7.5801$	0.999	1.796	5.927	96.9	0.98–3.01
Methanol	6.25–100	$y = 227.48x - 51.648$	0.998	1.579	5.212	97.1	1.41–2.14

LOD limits of detection, *LOQ* limit of quantitation, *RSD* relative standard deviation

[a]The recovery experiments were performed by spiking 10 mg/dL of each alcohol into alcoholic beverages

[b]RSD was obtained from six different experiments for each test

Table 2 Ethanol and methanol contents in illegal alcoholic beverages in Hamadan, Iran

Month, year	Number (%)	Detection frequencies of ethanol content (*n*)				Ethanol content status (g/dL)			Methanol content status (g/dL)		
		0–5	5–20 (g/dL)	20 –50	50–100	Mean	Min	Max	*n*	Mean	(Methanol/ethanol) × 100 (%)
Oct 2019	1.33	0	5	3	0	17.0	5.54	32.4	0	–[a]	–
Nov 2019	6.33	10	18	10	0	12.9	1.78	40.2	0	–	–
Dec 2019	2.33	1	4	9	0	23.3	3.51	43.0	0	–	–
Jan 2020	1.66	0	4	6	0	20.4	9.29	36.9	0	–	–
Feb 2020	5.33	5	11	14	2	21.6	1.60	78.3	0	–	–
Mar 2020	2.50	0	2	13	0	30.9	9.60	39.6	2	32.1	70.7
Apr 2020	14.8	0	47	42	0	18.5	5.00	37.2	1	18.3	38.7
May 2020	7.33	0	17	26	1	24.9	7.67	59.4	1	36.4	70.2
Jun 2020	8.67	5	11	36	0	25.6	ND[b]	40.0	1	23.0	67.0
Jul 2020	16.0	23	59	14	0	10.1	ND	38.4	0	–	–
Aug 2020	10.3	1	38	23	0	17.7	4.93	36.5	0	–	–
Sep 2020	3.00	0	4	14	0	27.6	9.40	40.2	0	–	–
Oct 2020	2.82	1	9	7	0	19.6	3.60	44.7	0	–	–
Nov 2020	3.70	1	5	15	1	29.0	ND	53.3	0	–	–
Dec 2020	5.50	8	16	9	0	13.9	1.78	36.1	1	18.9	41.3
Jan 2021	2.83	3	4	10	0	19.9	ND	40.2	1	16.3	35.8
Feb 2021	5.50	7	11	13	2	21.0	1.60	54.1	0	–	–

Min minimum, *Max* maximum

[a]Not applicable

[b]Not detected

variations of ethanol contents found in the beverages investigated here.

In the present study, 45% (270 cases) of the alcoholic beverages sampled was more than 20 g/dL, and long-term consumption of these products is a health problem that must be considered. Although there is no reliable evidence regarding the per capita consumption of these products in Islamic countries such as Iran, the WHO has estimated the annual per capita consumption of alcoholic beverages in Iran at about 1000 mL [12]. Considering the average concentration range of ethanol in alcoholic beverages, its average daily intake in an adult with an average weight of 60 kg is estimated to be 0.57 g/day. Because this rate is much lower than the acceptable daily intake established by the WHO of 2.6 g/day, the risk of ethanol exposure in the Iranian population is not of a general concern [13]. Based on the average amount of ethanol in alcoholic beverages, a person in Iran would have to consume at least 12.5 mL/day of alcoholic beverages to be at risk of chronic ethanol toxicity.

During the COVID-19 pandemic, seven of the shipments had high amounts of methanol; the average methanol found in positive samples was determined to be 25.3 g/dL. Given that methanol production can be unavoidable when it results from the activation of the enzyme pectin methylesterase in the woody tissue of fruits [14], the European Union has set the permissible level of this alcohol at about 10% of a beverage's ethanol content [15]. However, the proportion of methanol to ethanol in contaminated alcoholic beverages in Iran has been estimated at more than 35% (Table 2), and it is unlikely that this amount of methanol would be produced only as a by-product of the beverage production process. Therefore, this methanol could have been intentionally added by illegal manufacturers seeking to maximize profits due to its low cost [16]. Once COVID-19 spread widely and excessive alcohol consumption increased dramatically in Iran, methanol poisoning also rose markedly. For instance, the evidence shows a sharp increase in the number of methanol poisoning cases during Mar and Apr 2020 (also see Table 2), as of 16 Apr 2020, there were 797 reported cases of methanol intoxication, including 97 deaths, in Iran's Fars province [8].

Taken collectively, our findings show that along with the COVID-19 prevalence, the production and supply of illegal alcoholic beverages increased in the Hamadan. The presence of unknown amounts of ethanol and methanol contamination in illegal alcoholic beverages in Iran posed a serious health challenge during the COVID-19 pandemic.

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Declarations

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

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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