

## PHYSICAL PROPERTIES AND ALCOHOL CONTENT OF COUNTRY MADE LIQUORS

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### Abstract

Country made liquors are consumed in both rural and urban areas of India. Twenty-five Countries made liquor samples were collected at random from National capital territory of Delhi. All these samples were analyzed for physical properties and alcohol content by Gas liquid chromatography in Toxicology Laboratory of Department of Forensic Medicine and Toxicology, AIIMS, New Delhi. The mean ethyl alcohol content was 32.88 %V/V (6.70 -96.61%V/V). No evidence of methyl alcohol was found in any of the samples. The mean Proof was 56.832(43.8-75)<sup>0</sup>. The Mean P<sub>H</sub> was 7.1 (4.0 – 8.5). 22 samples were Carmel in color and rest 3 was colorless. All samples were having strong burning taste and characterstic, but weak smell. 3 samples were sealed in polythene pouch, 2 in Plastic bottle and 20 in glass bottle. One sample was looking turbid and rests were clear.

**Keywords:** *Country made liquors, Ethyl alcohol, Methyl alcohol and Gas liquid chromatography.*

### Introduction

The use of alcohol as drink is an age-old story in Indian history even since the Vedic times. *Somarasa*, which was mentioned in the Vedas, was probably the earliest evidence of the use of intoxicants in India. Kautilya's *Arthasastra* listed a variety of liquors such as *Medaka*, *Prasanna*, *Asava*, *Arista*, *Maireya* and *Madhu*.

In modern India, liquors can be divided into three broad categories, namely Indian Made Foreign Liquor (IMFL), Beer and Country Liquor. Country liquors are consumed in both rural and urban areas of India and play an important role in the daily social, economic, nutritional and cultural life of the people. It is known by different names in different provinces of India like Gudamba in Andhra Pradesh, Khopri in Maharashtra and Lattha in Gujarat etc. Serious toxic effects are seen when the liquor is adulterated by denatured spirit, which contains methyl alcohol, or if it is prepared from French polish containing methyl alcohol.

Due to ingestion of this adulterated country made liquor, India has witnessed many outbreaks of methanol poisoning. In Delhi in November 1991, 252 persons lost their lives, 57 lost their eyesight. In Cuttack

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(Orissa), more than 200 persons including women and children had also lost their lives. In Bombay on the eve of Diwali in 1992, more than 50 persons lost their lives. These incidences also happened in Noida and Tamilnadu in 2001.

To prevent these kinds of unfortunate happenings, it is important to collect and analyze samples of country made liquors regularly for determining the concentration of ethyl alcohol and presence of methyl alcohol.

## Material & Method

### Study area:

The study was carried out in the Toxicology laboratory in the Dept. of Forensic medicine & Toxicology, AIIMS, New Delhi.

### Sample size:

It was decided from the beginning of the study that a convenient number of 25 samples will be taken to carry out the toxicological analysis for this study.

### Sample Collection:

Samples were collected at random from National capital territory of Delhi with the help of police and from the locally available country-made liquor shops (Fig.1).



Fig.1 Country made liquors

### Inclusion criteria:

The samples collected were looked for the following parameters like Brand name, Manufacturing date, Proof, Strength (conc. written on the alcohol sample), Manufacturing site and Area of sale.

### **Exclusion criteria:**

The samples not meeting the inclusion criteria were excluded from the analysis. Repeat samples of the same brand name in different package were also excluded from the analysis. Samples that were not sealed properly were also excluded from the analysis.

### **Sample analysis:**

Samples were analyzed with the available <sup>2</sup>GLC instrument AIMIL- NUCON Series 5700 in the laboratory (Fig.2).



**Fig.2 Gas liquid chromatography NUCON Series 5700**



**Fig. 3 Standard calibration of Ethanol**

### **Statistical analysis:**

Data was entered into MS-EXCEL software, and analyzed by Epi-Info software.

### **Methodology:**

Samples were collected on a routine basis based on the availability. Analysis in the laboratory was done simultaneously. Once sealed samples were collected, they were kept in room temperature in side the laboratory. The samples were assigned a serial number according to date of availability. The following day the information available on the label on the packet was recorded on a MS – EXCEL spreadsheet against the serial number. A note of color and turbidity within the container was kept for comparison purposes. After noting down the detailed information available on the label, the container was opened by using surgical BP blade. Under all aseptic measures the seal of the container was opened in presence of the Senior Scientist. One 10 ml autoclaved test-tube and a 10 ml disposable syringe was arranged beforehand for the safe transfer of the sample. With the use of 10 ml syringe, 5 ml of the sample was drawn from the container and transferred in to the test-tube. The test-tube containing the alcohol was immediately sealed with the help of sterilized cork. Physical examination of the alcohol was carried out under direct sunlight. After noting down the color, turbidity, smell & taste, pH of the sample was measured. A narrow range paper pH indicator strip was dipped down in to the test-tube and kept for 30 seconds. Then the pH paper strip was taken out and air-dried. The color of the dried pH paper strip was compared with the standard pH color chart.

After concluding with the physical properties of alcohol, quantitative estimation of alcohol was planned in the following manner. The GLC was set at standard parameters for analysis of alcohol. With the help of Hamilton syringe (10 µL), one micro liter of the undiluted sample was collected and first introduced into the GLC. According to standard retention time of alcohols the nature of the sample was confirmed. After noting down the results, the sample was diluted accordingly for quantification. The peak area recorded with the diluted sample was noted. The same was compared with the standard graph developed at the beginning of the study. At the end dilution factor was considered for final quantification of the sample. The quantity of alcohol of the samples derived from the standard chart in W/V was converted into V/V% and the results were compared with the concentration of the alcohol written on the sample.

### **Standard calibration of Ethanol**

Prior to start working with GLC system for samples, an Ethanol stock solution was made for Ethanol working standards. For Ethanol stock solution of the concentration 100mg/ml of water, 12.7ml of absolute ethanol (100% or 200% proof) was pipette and diluted to 1 liter of distilled water. For ethanol working standard of the concentration of 50mg/100ml, 5ml of ethanol stock was pipette and diluted to 100ml of distilled water. Accordingly a total of six working standard solutions were prepared for 25mg/100ml, 50 mg/100ml, 75 mg/100ml, 100 mg/100ml, 125 mg/100ml, and 150 mg/100ml (Fig 3).

Each of this working standard solution was run on GLC and the peak was recorded on the graph paper by the recorder. The peak area was calculated by multiplying the interpolated height of the peak with the width of the peak at half height. With the peak area determined in each case (in ascending order i.e. 25mg/100ml to 150mg/100ml) a calibration curve was plotted on the graph paper and preserved for comparison and determination of the alcohol concentration for the samples to be analyzed.

### **Analytical Parameters:**

Parameters selected in our system for analysis of liquor samples on G.L.C. are as follows: -

<b>Column</b>	<b>Porapak-Q, Mesh size 80-100 Stainless steel</b>
Oven temperature	130 C

Injector temperature	160 C
Flame Ionization	
Detector temperature	160 C
Attenuation	4
Sensitivity	100
Carrier Gas	2.5 kg/cm
Hydrogen	0.75kg/cm
Air	0.75kg/cm
Speed	10/10 cm per minute
Volume injected	1 l
Syringe used	Hamilton Micro liter Syringe (10 $\mu$ L)
Instrument used	AIMIL- NUCON Series 5700 Gas Chromatograph

## Observation and Result

In the present study of 25 country-made liquor samples were analyzed by Gas Liquid chromatography for ethyl and methyl alcohol content. Physical properties like color, turbidity, smell, taste, PH and manner of packing were also ascertained in each of the sample. Methyl alcohol was not found in any of the sample.

### Distribution of ethyl alcohol found in the GLC analysis

Results found from the GLC analysis were tabulated against the same code number. Ethyl alcohol content found from the GLC analysis also showed skewed distribution with mean ethyl alcohol content 32.88 % V/V and median of 30.20 % V/V. The standard deviation of the same was found to be 19.96. The ethyl alcohol content of the GLC analysis varied from 6.70 to 96.61% V/V (Table 1).

**Table 1**

S.N	Proof in degree	Conc. of ethyl alcohol found on the label in %V/V	Conc. of ethyl alcohol found in GLC analysis in %V/V
1	50	28.5	15.86
2	50	28.5	12.04
3	50	28.5	16.63
4	50	28.5	16.25
5	50	28.5	6.7
6	63	36	23.5
7	63	36	17.4
8	50	28.5	16.63
9	50	28.5	32.87
10	50	28.5	40.9
11	50	28.5	41.47
12	75	42.8	96.61
13	75	42.8	30.2

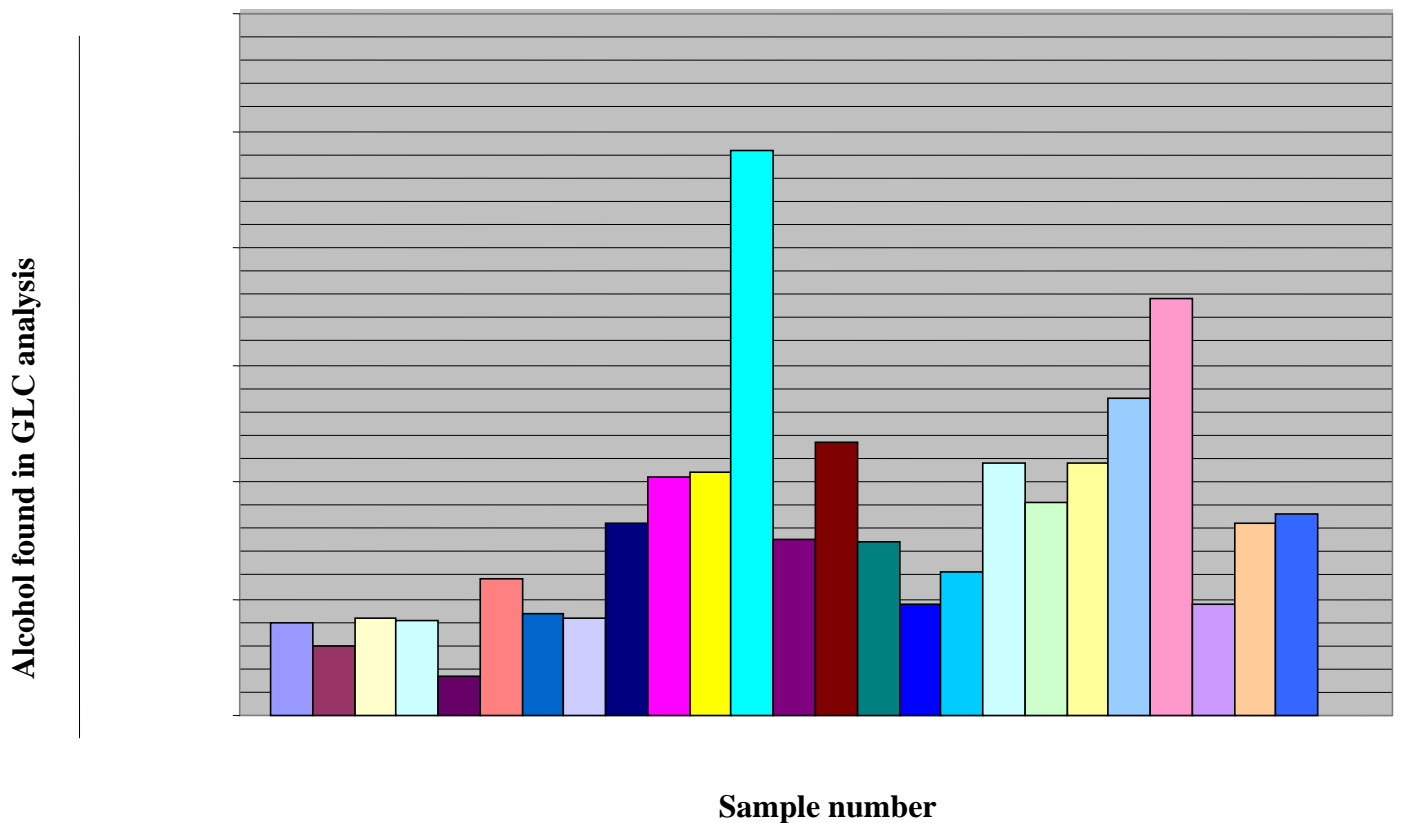
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S.N	Proof in degree	Conc. of ethyl alcohol found on the label in %V/V	Conc. of ethyl alcohol found in GLC analysis in %V/V
14	50	28.5	46.63
15	75	42.8	29.6
16	75	42.8	19.11
17	75	42.8	24.60
18	50	28.5	43.0
19	50	28.5	36.5
20	50	28.5	43.3
21	63	36	54.3
22	63	36	71.4
23	50	28.5	19.1
24	50	28.5	33.06
25	43.8	25	34.5

The results of the GLC analysis were plotted in the following graph against the serial number assigned to the sample (Fig.4).

**Fig. 4: Distribution of ethyl alcohol conc. in GLC analysis**



Out of the 25 samples observed, 22 samples were Carmel color and 3 were colorless. All samples were found clear except one, which was turbid. All samples were having strong burning taste and weak but characteristic smell. The mean P<sub>H</sub> was 7.1 ranging from 4 to 8.5.20. Alcohol samples were packed in glass bottle, 3 in polythene pouch and 2 in plastic bottle (Table 2).

### Physical properties and manner of packing of the samples

**Table 2**

S.NO	COLOUR	TUBIDITY	TASTE	SMELL	P <sub>H</sub>	MANNER OF PACKING
1	Carmel	Clear	SBT	Weak	7.0	Polythene pouch
2	Colorless	Clear	SBT	Weak	6.0	Polythene pouch
3	Carmel	Clear	SBT	Weak	6.0	Glass bottle
4	Carmel	Clear	SBT	Weak	8.0	Glass bottle
5	Carmel	Clear	SBT	Weak	6.0	Glass bottle
6	Carmel	Clear	SBT	Weak	6.0	Glass bottle
7	Carmel	Clear	SBT	Weak	6.0	Glass bottle
8	Carmel	Clear	SBT	Weak	6.0	Glass bottle
9	Carmel	Clear	SBT	Weak	6.0	Glass bottle
10	Carmel	Clear	SBT	Weak	6.0	Plastic bottle
11	Carmel	Clear	SBT	Weak	8.0	Plastic bottle
12	Colorless	Clear	SBT	Weak	8.5	Glass bottle
13	Carmel	Clear	SBT	Weak	6.0	Glass bottle
14	Carmel	Clear	SBT	Weak	8.5	Glass bottle
15	Colorless	Turbid	SBT	Weak	8.0	Glass bottle
16	Colorless	Clear	SBT	Weak	8.0	Glass bottle
17	Carmel	Clear	SBT	Weak	4.0	Glass bottle
18	Carmel	Clear	SBT	Weak	6.0	Glass bottle
19	Carmel	Clear	SBT	Weak	8.0	Glass bottle
20	Carmel	Clear	SBT	Weak	8.0	Glass bottle
21	Carmel	Clear	SBT	Weak	6.0	Glass bottle
22	Carmel	Clear	SBT	Weak	6.0	Glass bottle
23	Carmel	Clear	SBT	Weak	8.0	Glass bottle
24	Carmel	Clear	SBT	Weak	6.0	Polythene pouch
25	Carmel	Clear	SBT	Weak	6.0	Glass bottle

## Discussion

As literature in the field of country-made liquor is very less, the findings of the present study were compared with the available literature. The approximate percentages of alcohol in common beverages, as per ISI (Indian Standards Institution, now Bureau of Indian Standards)<sup>5</sup> specifications are shown in Table 3.

**Table. 3**

Beverages	Alcohol % by volume (v/v)	Proof in degree
Rum	42.8	75
Whisky, Brandy	42.8	75
Gin	42.8/40.0/37.2	75/70/65
Wines	8-15.5	14-27
Beers	2-10.0	3.5-17.5
Country liquors	11.4-45.7	20-80

According to a study conducted by Singh k et al<sup>3</sup>, in the Department of Gastroenterology, Postgraduate Institute of Medical Education and Research, Chandigarh, India, the mean ethanol content in illicit liquor (46 Indian home made brew samples) was found to be 16.47% V/V (range 1.11-36%). The mean P<sub>H</sub> was 4.20(range 2.70-9.41).

Nikander P et al<sup>4</sup> analyzed 15 Homemade but commercially available alcoholic beverages collected in Dar es Salaam, in Tanzania, for their ethanol content, additive, aflatoxin and heavy metals. Ethanol concentrations of the 15 home made brew samples ranged from 2.2 to 8.5% w/v or 2.78-10.78% V/V, whilst the 2 distilled samples contained ethanol 24.2 and 29.3%w/v. The amount of zinc in 4 samples was double the World Health Organization recommended maximum for drinking water (5mg/litre). Both distilled spirits were rich in fusel alcohols and one was fortified by caffeine.

Twenty-three countries made liquor samples were analyzed by NM Narawane et al<sup>6</sup>, in Department of Gastroenterology, KEM Hospital, and Mumbai. According to them, the ethanol content illicit country liquor varied from 23gm/100ml to 35 gm/100ml (median 23); licit country liquor had a narrow range (35-36.1gm/100ml; median 35.2).

In the present study, 25 countries made liquor samples were analyzed in the Department of Forensic Medicine and Toxicology, AIIMS, New Delhi. The mean ethyl alcohol content was 32.88 % V/V (6.70 - 96.61% V/V). No evidence of methyl alcohol was found in any of the samples. The mean Proof was 56.832 (43.8-75). The Mean P<sub>H</sub> was 7.1 (4.0 – 8.5). 22 samples were Carmel in color and 3 were colorless. All samples were having strong burning taste and characteristic, but weak smell. 3 samples were sealed in polythene pouch, 2 in Plastic bottle and 20 in glass bottle. One sample was looking turbid and rests were clear.

## Summary and Conclusion

Twenty-five countries made liquor samples were analyzed in department of Forensic medicine and Toxicology, All India Institute of Medical Sciences, New Delhi, with the GLC instrument for ethyl and methyl alcohol content. Physical properties and manner of packing were also ascertained in each of the sample. The study concluded with the following findings:

1. The mean ethyl alcohol content was 32.88 % V/V (6.70 -96.61% V/V)
2. No evidence of methyl alcohol in any of the samples found.
3. The mean Proof was 56.832(43.8-75)<sup>0</sup>
4. Mean P<sub>H</sub> 7.1 (4.0 – 8.5)

5. Color: Colorless- 3 samples  
Carmel-22 samples
6. Turbidity: Turbid-1 sample  
Rest-clear
7. Taste: All samples having strong burning taste
8. Smell: All samples having characteristic but weak smell
9. Manner of packing: Polythene pouch-3  
Plastic bottle-2  
Glass bottle-20

**Table 4: Comparison of alcohol content along with other studies**

Source	P <sub>H</sub>	Ethyl alcohol content %V/V	Other findings
2002-2003 Behera C et al AIIMS Present study	7.1(4.0-8.5)	32.88 (6.70-96.61)	Absence of methyl alcohol Mean Proof 56.832(43.8-75) <sup>0</sup>
Singh K et al: Chandigarh, India	4.20 (2.70-9.41)	Illicit country liquor 16.47 (1.11-36.88)	Total Acidity 2.85 (0.56-10.88)
Nikander P et al: Tanzania	NA	Country liquor 2.78-10.78	9 out of 15 samples were positive for Aflatoxin B
Narwane NM et al: Mumabi, India	NA	Licit country liquor 44.3-45.7 Illicit country liquor 36.85-44.30	NA
Bureau of Indian Standards (ISI)	NA	11.4-45.7	Proof 20-80 <sup>0</sup>

## References

1. Jain NC. Direct blood injection method for gas chromatographic determination of alcohols and other volatile compounds. *Clinical Chemistry* 1971; 17(2): 82.
2. Nucon Engineers. Gas chromatographs, AIMIL Nucon (Series5700).
3. Singh K, Narang AP, Verma RS, Chauhan DP, Nain CK. Total acidity, pH and ethanol content in illicit liquor (Indian home made brew). *Drug Alcohol Depend* 1988 Oct; 22(1-2): 129-31
4. Nikander P, Kilonzo GP, Huttunen P, Saarinen L, Kilima E, Pitkanen T. Ingredients and contaminants of traditional alcoholic beverages in Tanzania. *Tras R Soc Trop Med Hyg* 1991 Jan-Feb; 85(1): 133-5
5. Drinks and carbonated Beverages Sectional committee, Indian Standard: Alcoholic Drinks Methods of Test, 1<sup>st</sup> revision. New Delhi: Bureau of Indian Standards, 1990.
6. NM Narawane, Bhatia S, Abraham P, Sanghani S, Sawant SS. Consumption country liquor and its relation to alcoholic liver diseases in Mumbai. *JAPI* 1998, Vol 46, No 6 (510-13)

7. Kling W et al. Measurement of ethanol consumed in distilled spirits. Stud Alcohol 1989 Sept; 50 (5): 456-60
8. [http://www.aidaindia.org/aida/about\\_distillery.htm](http://www.aidaindia.org/aida/about_distillery.htm). About Distillery Industry of India
9. [http://www.buca.org/alcohol\\_history.html](http://www.buca.org/alcohol_history.html)
10. <http://www.westernplainsenergy.biz/ethanol.html>