IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Assessment Of Dilution In Country-Made Liquor (Desi Sharab) Obtained From Different Locations Of Damoh District Of Madhya Pradesh, India Using Ph Meter, Pycnometer And Uv-Visible Spectrophotometric Technique

[1] Laxmi Priya Pradhan, [2]Shanya Dubey, [3]Devasish Bose, [4]Priyanka Pahade, [5]Abhilasha Durgbanshi

[1]Research Scholar, [2]Student, [3]Professor, [4]Scientific Officer, [5]Assistant Professor

[1]Department of Criminology and Forensic Science,

[1]Doctor Harisingh Gour Vishwavidyalaya (A Central University), Sagar, Madhya Pradesh, 470003, India

Abstract: The quality and safety of country-made liquors (Desi Sharab) remain a critical public health concern in India due to frequent adulteration and dilution. This study is particularly dedicated towards adulteration through dilution. In this study, country-made liquor samples sold by the name '*Desi Madira Mashala Sharab' in short* (Desi Sharab) were collected and analyzed using pH measurement, pycnometry and UV–Visible spectrophotometry. The pH values ranged between 5.08 and 6.32, showing that most samples were slightly acidic in nature and pH values near neutral, indicating dilution. The results obtained from pycnometer revealed that only **sample A** which is directly collected from the Bapuna Alcobrew Pvt. Ltd. distillery (42.72% v/v) matched close to the labelled ethanol content of 42.8%. In contrast to this, other examined samples, showed significantly reduced ethanol content in the range of 25.37–41.74% v/v (~40% dilution). UV–Visible spectroscopy shows that in the diluted 'Desi Sharab' samples (obtained in pycnometer analysis) the absorbance for caramelized sugar was higher than standard 'Desi Sharab' sample. These results establish that the combination of pycnometry and UV-Visible spectrophotometry provides reliable, cost-effectiv, and non-destructive approach for routine monitoring of liquor authenticity.

Index Terms - Ethanol, Country-made liquors, Desi Sharab, Dilution, pycnometer, UV-Visible Spectrophotometry

I. INTRODUCTION

Different category of substance of abuse is a common problem all around the world. It involves the use of psychoactive substances including prescribed medications, alcoholic beverages and drugs. Among different types of abusive substances, alcohol is primitive in all ages. It is consumed worldwide, with varying cultures often associated with social rituals and celebrations. Alcoholic beverages have been produced since at least 9500 BC(1). In ancient civilizations, the early production of beer and wine has been documented in the literature. In India, between 3000 and 2000 B.C., an alcoholic beverage distilled from rice was known as sura (2). In the sixteenth century, alcohol (called "spirits") was used mainly for medicinal purposes. At the beginning of the 18th century, the British Parliament passed a law to encourage the use of grain for distilling spirits. Cheap spirits flooded the market and peaked in the mid-eighteenth century. The British also implemented this law in India during their colonial and commercial expansion. In India, the sugar refineries were first set up in Bengal to combat the vast demand for sugar in the United Kingdom. Molasses was a by-product of the sugar refineries and using it to make rum helped shore up the business model (3,4).

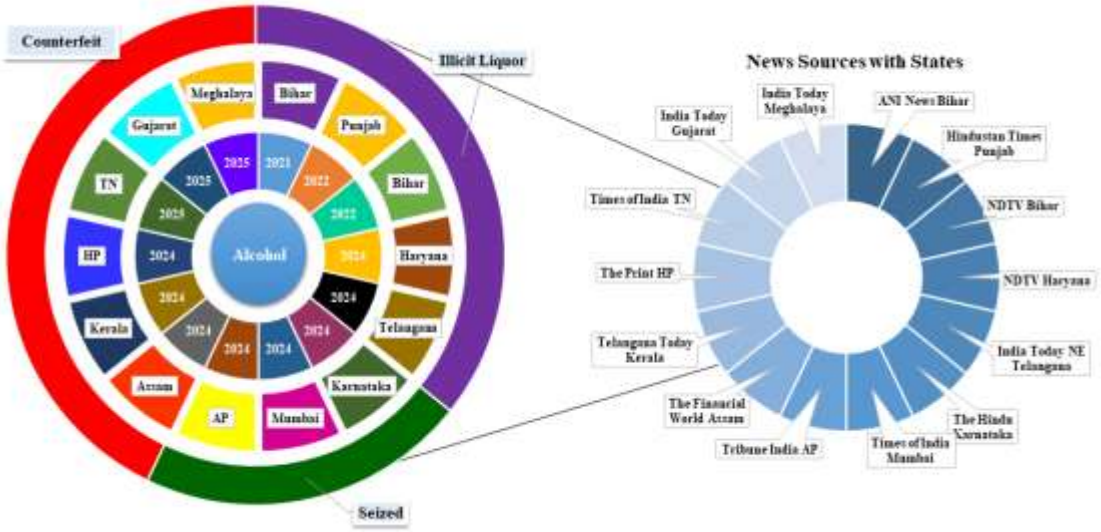

Figure 1. The pie chart shows the seized, counterfeit, illicit liquor, location, year and sources

The Indian alcoholic beverage market is the second-largest spirits market in the world, forecasted to expand at a CAGR of ~11.3% by value and ~6.1% by volume from 2023 to 2028. Distilled beverages accounted for nearly 92.0% of the overall pure alcohol consumption in India (5). There has been an increase in the number of people who have achieved the legal drinking age and the number of women who consume alcohol. However, with the increasing demand and easy availability of industrial alcohol, along with the standard practice of alcoholic beverage production, illicit liquor manufacturing has gained popularity in the past few years. The compiled data from 2021 to 2025 (**Table 1S**) reveals a widespread and persistent problem of illicit liquor manufacturing and distribution across India. Different large-scale operations have been uncovered in states like Maharashtra, Gujarat, Tamil Nadu, Kerala, Himachal Pradesh, Assam etc. and even in dry states of Gujarat and Bihar (**Figure 1**). These rackets operate through sophisticated methods like smuggling industrial alcohol, chemically modifying it with additives and colourants and packaging it in counterfeit branded bottles (**Table 1).** Masterminds of these rackets are capable of producing thousands of litres of spurious liquor using spirit, extra neutral alcohol (ENA), duplicated and reused bottles, fake labels, caps and bottling equipment. This illicit liquor poses severe public health risks. As evidenced by repeated incidents of poisoning and deaths, such as those in Bihar, Himachal Pradesh, and Tamil Nadu, linked to the consumption of toxic or methanol-containing beverages (**Table 2**). Furthermore, the social and economic impact of this illegal practice is that organized criminal networks have operated it. This issue is severe in dry states like Gujarat and Bihar, where prohibition laws unintentionally foster a black market.

Table 1S. Selected cases of illicit liquor from the news.

S.No	Location	Description	Year	Name of News Source	References
1.	Bihar	Officials allegedly involved in illegal trade	2021	ANI News	(6)
2.	Ambala, Haryana	Massive ENA, chemicals & fake labels	2022	The Financial World	(7)
3.	Pathankot, Punjab	109 cartons of illicit liquor seized	2022	Hindustan Times	(8)
4.	Saran, Bihar	Bihar Toxic Liquor Trade	2024	NDTV News	(9)
5.	Assam (Tamulpur)	1,000+ illicit liquor cases seized	2024	India Today NE	(10)
6.	Kochi, Kerala	Excise busts illicit liquor racket in Kochi.	2024	The Hindu	(11)
7.	Surajpur, Himachal Pradesh	3,280 L spirit in interstate racket	2024	Tribune India	(12)
8.	Karnataka	Multiple inter-state rackets	2024	The Print	(13)
9.	Vijaywada, Andhra Pradesh	Major illicit liquor racket busted	2024	The Times of India	(14)
10.	Dharavi, Mumbai	Duplication of branded liquor	2025	The Times of India	(15)
11.	Telangana (Nalgonda)	Locally bottled spurious liquor	2025	Telangana Today	(16)
12.	Coimbatore, Tamil Nadu	5,000L of raw alcohol could yield 20,000L	2025	India Today	(17)
13.	Mehsana, Gujarat	Fake foreign liquor in a field factory	2025	India Today	(18)
14.	Ri-Bhoi, Meghalaya	Counterfeit McDowell's unit found	2025	Shillong Times	(19)

Table 1. The modus operandi of illicit liquor is manufacturing and distribution

S.No.	Technique	Description	Source	References
1.	Spirit dilution	One litre of spirit is diluted to make around four litres of alcoholic beverages.	India Today	(17)
2.	Branded bottles/stickers reuse	Fake scotch racket busted, junk dealer supplied empty bottles	DNA India, Financial World	(20)
3.	Use of extra neutral alcohol and chemicals	Maharashtra, Madhya Pradesh and Punjab	Financial World	(21–23)
4.	Knowledge via the Internet	The mastermind of the fake liquor manufacturer is self-trained from online sources.	Hindustan Times	(24)

Table 2. Alcohol consumption-related health and mortality impact.

S. No.	Category	Data	Description	Source	References
1.	Global alcohol-related deaths in 2019	2.6 million	2 million men and 0.6 million women	WHO Fact Sheet	(25)
2.	Hooch deaths in Bihar from 2016–2024	156 confirmed	Under prohibition, hooch fatalities were recorded	Telegraph India	(26)
3.	Kallakurichi hooch tragedy in Tamil Nadu	66 dead	Packet arrack consumed in Kallakurichi	The Hindu	(27)
4.	Mandi, Himachal tragedy	7 dead	Spurious liquor consumption	Tribune India	(28)

The composition of liquor is mainly based on the raw material used for its production. In the case of country-made liquor, commonly called 'Desi Sharab' and marketed as 'Desi Sharab', it is mainly prepared by mixing spirit (obtained from a distillery) and caramelized sugar (for imparting colour and taste). In general, liquor samples contain a fixed volume of ethanol (obtained from the fermentation and distillation of different fruits, grains, etc.), class-I caramel colour and water, which is brewed in authorized distilleries under strict Standard Operating Protocols (SOPs) (29). However, in 'Desi Sharab', this procedure is not strictly followed as it is generally for the consumption of the poor and mostly illiterate population of India.

For decades, ethanol content including low volatile by-products of fermentation like methanol, isopropanol etc., in beverages and spirits has been evaluated using screening techniques like colour test (30) and density measurement apparatus (31). Similarly, for more detailed profiling sophisticated instrumentation like gas chromatography (GC) (32), liquid chromatography (HPLC) (33), UV-Visible Spectroscopy (34), mid infrared characterization spectroscopy (35), near infrared spectroscopy(36)or raman spectroscopy (37) have also been used. However, these techniques are time-consuming and require sophisticated lab setup, technical expertise and costly instruments. If not analyzing the alcohol to characterize constituents, then simpler techniques like pycnometer and UV-Visible spectroscopy could be the best choice for rapid and accurate determination of percentages or strength of ethyl alcohol in alcoholic beverages and adulterants if any (38). The determination of strength in alcoholic beverages and spirits is imperative due to customs legislation as well as intoxication in cases of abuse. In the present research work, pH meter, pycnometer and UV-Visible spectroscopy have

been used for the percentage determination of ethyl alcohol and caramel colour in 'Desi Sharab's collected from the Damoh district of Madhya Pradesh, India. This district of Madhya Pradesh was selected because it has a massive movement of the banned liquor that has been executed by the local people as well as by the women of this region. In media there is report that many sites were developed here for the illegal liquor manufacturing. Therefore, this district of Madhya Pradesh was selected for the present study. The reason behind this study was to establish whether the 'Desi Sharab' has been prepared using established SOPs where the amount or concentration of each component is fixed. Any dilution or counterfeiting is directly related to exemption from excise duty which is ultimately the loss of economy of a country. This is because the illegal manufactured liquors are sold without any excise duty and license to the village locations. The purpose of selling in rural areas is that most people who consume this 'Desi Sharab' belong to the lower socioeconomic group or labour class and they have not much idea about fortification in the liquor. Sometimes the diluted liquor has also been sold to the occasional drinker and strange people who are just passing through the shop and have the possibility of not visiting that area again.

II. Materials and Reagents

Instrumentation

A Shimadzu UV-Visible double-beam spectrophotometer from Shimadzu Corporation Japan, equipped with UVProbe software, version 2.61, with a range of 190-800 nm and a 1 nm spectral bandwidth, 220- 240V, has been utilized in the present work. A pH meter LABWAN 902 (Mumbai, India) equipped with a combined Ag/AgCl glass electrode, was used for measuring the pH of the liquor. An analytical balance, Mettler-Toledo ME204 (Pocklington, United Kingdom) was used to weigh the samples and a pycnometer 25mL ASGI was used in this study.

Chemicals

Ultra-pure type-I water obtained using an Indion Lab-Q ultrapure type-I water maker (Ion Exchange, Ltd., Mumbai, India), ethanol (99%) was analytical grade or equivalent and was brought from the Central Drug House Pvt. Ltd., New Delhi (India). Buffer tablets pH 4, 7 and 9 were obtained from Loba Chemie Laboratory Reagent and Fine Chemicals, Mumbai, India.

Sampling and Sample Preparation

In the present study, a total of 25 samples (bottle size 180 mL) of country-made liquor (laal desi madira shrab mashala) were collected from local desi sharabdukan or composite shop from different villages of Damoh district (Raneh, Damoh, Damoh samanna bypass, Nohata, Banwar, Kanti, Hindoriya, Kumhari, Fatehpur, Magron, Hatta, Sojma, Patha, Nepar, Sadpur, Pathariya, Khagar, Muhari, Sehri, Ghana, Kusmi, Amghat, Jabera, Pura and Satpara) of Madhya Pradesh (**Figure 2**) and marked as **sample A** to **Y**. One sample (marked as **A**) was directly collected from Bapuna Alcobrew Pvt. Ltd. distillery where the bottling and labelling of 'Desi Sharab' was done. This sample was considered as a standard compared to other samples collected from different localities across the Damoh district of Madhya Pradesh.

A stock or control liquor sample containing 50 µg/mL of caramelized sugar purchased from Standardcon Pvt. Ltd., Mumbai, Maharashtra was mixed with water in the same ratio as mentioned in the label and stored at 4 °C. Test solution were freshly prepared by diluting them with ultrapure type-I water (20µL of the sample in 4mL of ultrapure type-I water) for UV-Visible Spectrophotometer examination. The collected 'Desi Sharab' samples were directly taken and used for the estimation of ethanol content using a pycnometer.

III. Methodology

pH Measurement

The pH of 'Desi Sharab' is the most important parameter for determining the fermentation efficiency, chemical stability and microbiological safety of the liquor samples (39). The raw base material used to prepare this liquor is a fermented mash of molasses, cereals, potato, cassava, fruits, jaggery or any other source of fermentable carbohydrates (3). These raw materials have a pH in the range of 6-7, during the early stages of fermentation, which continuously drops to a somewhat acidic range of 4.0–5.0 when this yeast breaks down carbohydrates into ethanol and organic acids(40). However, this controlled acidification plays a crucial role because it creates an unfavorable environment for the growth of microorganisms, thereby ensuring the microbial stability of the 'Desi Sharab' (41). In addition, pH has a direct effect on the quality of the liquor. A maintained acidic range can provide a smoother taste to liquor, whereas too much acidity can produce an undesirable sourness (42).

Furthermore, ethanol maintains its chemical stability at this slightly acidic pH, lowering the chances of undesirable by-product formation. Since unusual deviations in pH of the 'Desi Sharab' may indicate contamination during storage, adulteration with industrial alcohol or dilution. Therefore, the pH of 'Desi Sharab' within the safe acidic range is crucial for checking the safety and acceptability of adulteration by its consumers.

For this purpose, the 'Desi Sharab' pH was tested using a pH meter. Before noting the pH value of the liquor, the pH meter was calibrated using buffer solutions of pH 4, 7 and 9. The pH of different alcohol samples was measured and for this the probe of the pH meter was rinsed thoroughly as per protocol and with a small volume of the sample over its tip to avoid cross-sample contamination. After that, it was dipped into the sample up to a depth of 2-3 cm, and the pH value was recorded up to the second digit of decimal value. The same procedure was repeated five times for each sample to assess precision.

Pycnometer Analysis

The pycnometer method is a well-established official method for determining alcohol by volume based on the specific gravity of a particular liquid, in which the weight of a fixed volume of liquid has been taken using a weighing balance (31). In the present study, a 25 mL pycnometer was carefully cleaned with ultrapure type-I water and dried in the oven. Further, it was placed in the desiccator for 10-15 min. and the weight of the empty pycnometer was recorded using a weighing balance (WE). In the successive experiments, the weight of water (WW) and liquor sample (WL) has been taken similarly.

The specific gravity of 'Desi Sharab" and that of the standard and control were calculated using the formula –

$$Specific\ Gravity\ = \frac{Weight\ of\ liquor\ sample\ (WL) - weight\ of\ empty\ pycnometer(WE)}{Weight\ of\ water\ (WW)}$$

IV. RESULTS AND DISCUSSION

UV-Visible Spectrophotometry

The present study focuses on determining the adulteration of 'Desi Sharab' through dilution. Once diluted, it tends to lose its colour. To make up the colour, the seller adds caramelized sugar prepared locally, which usually does not match the original caramelized sugar which is used in the manufacturing of Desi Sharab. UV–Visible spectrophotometry is the most accurate method for identification and quantification of caramelized sugar in diluted alcohol. Using this technique the strength of the caramelized sugar could easily be measured in the visible region using absorption maxima. Apart from this UV-Visible spectrophotometer helps to detect other volatile components which are produced during fermentation and they escape during distillation, finally making their way to the end product, i.e. desi sharab.

In the analysis of 'Desi Sharab' UV-Visible spectrophotometer can be utilized to indirectly quantify ethanol content by exploiting the absorbance characteristics of caramelized sugar, which are added to provide the colour and aroma (43). 'Desi Sharab' generally contains caramelized sugar which is prepared under controlled thermal or acidic conditions to form chromophoric compounds such as furfural and hydroxymethylfurfural. Both of these chromophores show strong absorption in the UV-Visible range (between 278-420 nm) (44).

A calibration curve was prepared for ethanol percentage determination by preparing a standard ethanol solution containing known concentrations of caramelized sugar. Following caramelization, the absorbance of these standards is measured at 278 nm wavelength using a UV-Visible Spectrophotometer. Another calibration curve was also been prepared for 'Desi Sharab' to check the possible dilution in the sample using a similar strategy to that used for the standard alcohol samples. The absorbance values are then plotted against the corresponding ethanol concentrations to generate a regression model.

Results and Discussion

The adulteration in country-made liquors is a widely used practice, primarily driven by the desire for increased profit margins among liquor vendors. This is due to a lack of strict quality control and frequent regulatory oversight making counterfeiting relatively easy to perform. There are a number of ways by which liquors are counterfeited; among all these one of the most common forms of adulteration involves the dilution of the original liquor with water, significantly reducing the actual ethanol concentration. A burned sugar solution (caramelized) is often added to make the adulterated or diluted liquor which visually appears similar to the licensed product from the authorized dealers. This caramelized sugar imparts a similar colour and masks the visual signs of dilution, deceiving unsuspecting consumers. The method of dilution typically involves removing about one-half or one-third of the contents from a standard 180 mL bottle of desi sharab and

transferring it into an empty bottle which is exactly counterfeited like the standard one. The vendor then fills the original and new bottles with a mixture of water and caramelized sugar solution, effectively creating an additional liquor bottle from the same original volume of alcohol. In some cases, this process is extended further by converting two bottles into three, depending on the time of sale, availability and demand. This method allows sellers to double or significantly increase their inventory. The modus operandi that the vendor adopts to sell these diluted products is non-regular customers, passersby, strangers or heavily drunk customers. For the purpose of this study, emphasis was laid on the examination of ethyl alcohol in 'Desi Sharab' purchased from different vendors in the Damoh district, Madhya Pradesh, India. The investigation was mainly divided into two parts, one of which is a routine laboratory method and the other is based on instrumental analysis. The advantage of both methods is their non-destructive nature. The beauty of the pycnometer method is that it can be performed with minimal resources at any small laboratory without the requirement of a sophisticated setup and a minimal cost of sample analysis. On the other hand, the UV-Visible spectrophotometric method is best as the variation of concentration was minimal and therefore by using this method the counterfeiting (dilution) in the alcoholic beverages could be assessed with good precision and accuracy. For this purpose, samples of 'Desi Sharab' collected from local *desi sharab* shops located in various villages of the Damoh district of Madhya Pradesh have been analyzed. Each sample consisted of a 180 mL bottle of 'Desi Sharab'. In order to detect the adulteration due to water, ethanol content of the samples was determined by pycnometer analysis and UV-Visible spectrophotometer and the obtained results were compared with the labelled proof percentage on the bottle.

pH Result

The obtained pH values of 25 'Desi Sharab' **samples (A–Y)** measured using a calibrated pH meter are presented in **Table 3** and **Figure 2** in which the pH range of 'Desi Sharab' samples were in the range of 5.08 to 6.32 with most samples grouping around the mid- range showing a slightly acidic nature which **i**s typical of 'Desi Sharab'.

The lowest pH was found in **sample A (5.08)**, indicating the highest acidity among the tested samples, while the highest pH was observed in **sample B (6.32)** which is near-neutral conditions. **Samples O (6.12)**, **R (6.25)** and **U (5.98)** also recorded higher pH values compared to the rest, suggesting possible variations in raw material composition, adulteration and dilution. Whereas, samples such as **sample D** (5.11), S (5.12) and **sample C** (5.18) had shown lower pH levels and a consistently acidic nature. Most of the samples fell within the range of **5.3–5.7**, indicating relatively stable acidity across different batches. This uniformity suggests a degree of consistency in the production or fermentation process, though slight variations are evident. The distribution of pH values implies that most of the liquors are within the acceptable range for safe consumption **(4.5–6.0)**, with only a few samples slightly exceeding the upper limit.

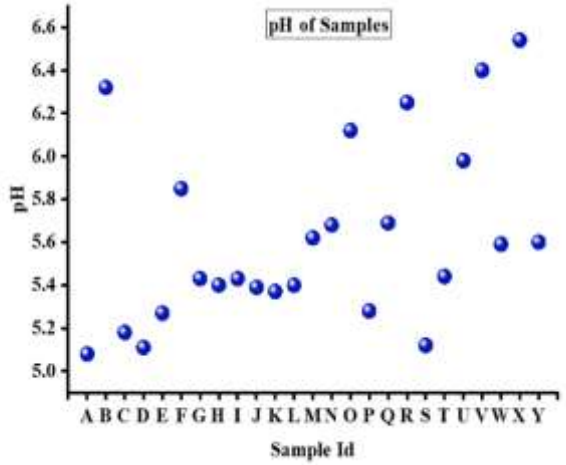

Figure 2. The obtained pH values of different 'Desi Sharab' sample.

From an adulteration, counterfeiting, rebottling and dilution perspective, samples with higher pH values (**e.g., B, O, R)** may require further monitoring, as near-neutral pH conditions could permit the survival of undesirable microorganisms, potentially compromising product stability. However, samples with lower pH values show substantial acidification, which is generally favourable for microbial inhibition, though excessive acidity may alter sensory properties.

Overall, the results indicated that there is a slight batch-to-batch (50.8-6.54)variability in the pH values, but remain largely within the expected slightly acidic pH window, ensuring both fermentation efficiency and microbial safety. However, there is no direct relationship between the pH of diluted liquor and standard liquor because the water which has been used to dilute the counterfeited sample was might be fall in the range of 5-6 (**Figure 2**), therefore in the diluted samples the pH has not be shifted towards the basic side.

Pycnometer Results

On the basis of the equation of specific gravity the percentage of ethyl alcohol has been determined in different samples of 'Desi Sharab' by maintaining the laboratory temperature at 25°C (**Table 3**). The data shows that the bottle label shows 42.8% v/v ethyl alcohol but most of the analyzed samples fell below the mentioned percentage, except **sample A** which was collected directly from the Bapuna Alcobrew Pvt. Ltd. distillery where bottling of the distillery outlet is done for distribution to different liquor shops or composite. In the whole examination **sample A** was considered as the standard sample and it contains 42.7% alcohol which is close to the percentage of alcohol mentioned on the label. The minimum percentage of alcohol was 25.37% in **sample R**. The median values of alcohol percentage ranged from 25.37% to 26.50% (**Figure 3**). The data shows that the analyzed 'Desi Sharab' were counterfeited by duplicating the bottle and label or simply diluting the distilleries outlets in the used bottles.

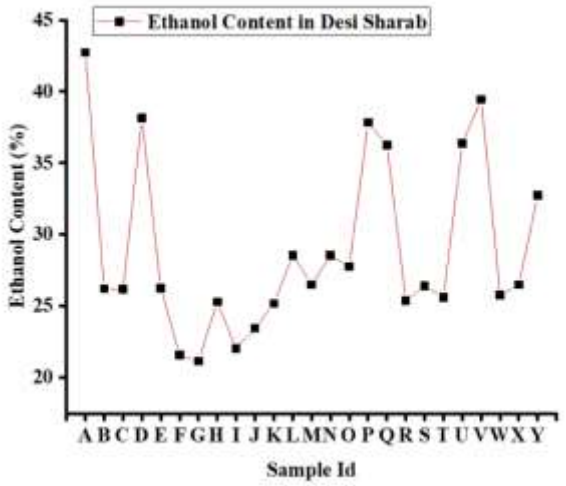

Figure 3. Ethanol content of different 'Desi Sharab' obtained using a pycnometer.

Table 3. Pycnometer, pH and UV-Visible spectrophotometer data of 'Desi Sharab' sample.

S. No.	Marking	pH	Absorbance	Specific Gravity by pycnometer	Conc. of ethanol (%w/w) found in Pycnometer analysis	Proof/percentage (v/v)
1.	A	5.08	0.048	0.9426	42.72	25°/42.8
2.	B	6.32	0.033	0.9669	26.22	25°/42.8
3.	C	5.18	0.032	0.9671	26.18	25°/42.8
4.	D	5.11	0.035	0.9641	28.55	25°/42.8
5.	E	5.27	0.043	0.9510	37.71	25°/42.8
6.	F	5.85	0.045	0.9457	40.93	25°/42.8
7.	G	5.43	0.046	0.9455	41.05	25°/42.8
8.	H	5.4	0.046	0.9454	41.11	25°/42.8
9.	I	5.43	0.044	0.9482	39.44	25°/42.8
10.	J	5.39	0.047	0.9443	41.74	25°/42.8
11.	K	5.37	0.042	0.9585	32.73	25°/472.8
12.	L	5.4	0.036	0.9676	25.77	25°/42.8

13.	M	5.62	0.035	0.9667	26.50	25°/42.8
14.	N	5.68	0.037	0.9641	28.55	25°/42.8
15.	O	6.12	0.036	0.9751	27.77	25°/42.8
16.	P	5.28	0.043	0.9508	37.84	25°/42.8
17.	Q	5.69	0.041	0.9533	36.25	25°/42.8
18.	R	6.25	0.035	0.9681	25.37	25°/42.8
19	S	5.12	0.038	0.9668	26.42	25°/42.8
20.	T	5.44	0.037	0.9678	25.61	25°/42.8
21.	U	5.98	0.041	0.9531	36.38	25°/42.8
22.	V	6.4	0.044	0.9482	39.44	25°/42.8
23.	W	5.59	0.036	0.9676	25.77	25°/42.8
24.	X	6.54	0.035	0.9667	26.50	25°/42.8
25.	Y	5.6	0.042	0.9585	32.73	25°/42.8

UV-Visible Spectrophotometric Result

In the present research work the alcohol concentration was measured on the basis of the absorbance of caramel in different 'Desi Sharab' samples. The standard caramel solution and twenty-five samples were analyzed using a UV-Visible Spectrophotometer.

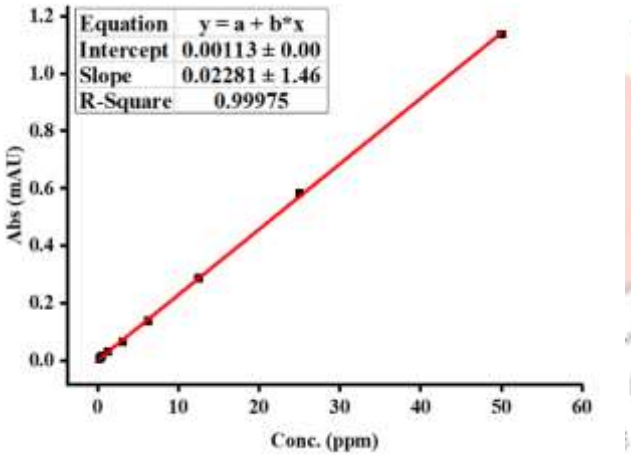

Figure 4. Calibration curve for standard caramelized sugar sample prepared in ethanol.

The calibration curve obtained for the caramelized sugar mixed with ethanol (fixed concentration) was examined using UV-Visible spectrophotometer **(Figure 4**), which showed good linearity with a correlation coefficient (R^2) 0.9997. The slope of 0.0228 indicates the sensitivity of the method, it shows that each 1% increase in ethanol concentration produced an absorbance increase of approximately 0.022 units at the selected wavelength. The near-zero intercept (0.0011) confirms minimal background interference, suggesting good blank correction. Similarly, the calibration curve has been prepared in **sample A** for comparison purposes. It also has a correlation coefficient close to 0.9994. The intercept and slope were -0.0158 and 0.0580, respectively (**Figure 5**). The high R^2 value demonstrates that more than 99.9% of the variability in absorbance is explained by ethanol concentration, validating the suitability of Beer–Lambert's law for this system. Using the regression model, the ethanol content of unknown 'Desi Sharab' samples can be determined by substituting the absorbance values into the equation and solving for concentration.

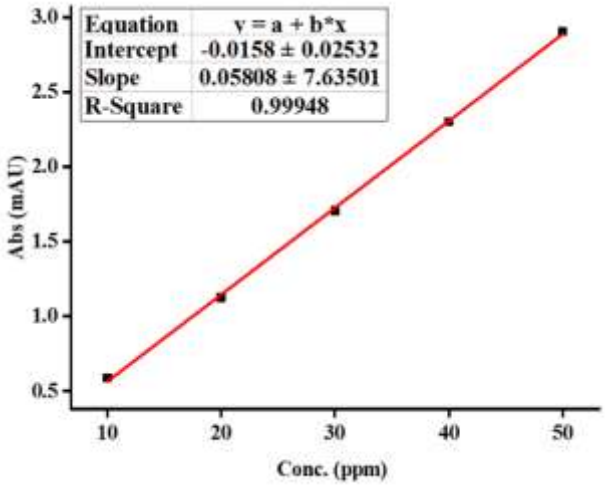

Figure 5. Calibration curve prepared for sample A.

The obtained spectra of the standard caramel solution have been presented in **Figure 6**, and the 'Desi Sharab' graph is presented in **Figure 7** (**samples A, D** and **K**), showing the high, mid and low concentrations of caramelized sugar found in 'Desi Sharab' sample. It is clear from **Table 3** that the absorbance can be used to assess the dilution of ethanol in 'Desi Sharab' samples. A maximum absorbance has been recorded in **sample B** with 26.22% ethanol content (**Table 3**). The absorbance does not show a direct correlation between the ethanol content and the concentration of caramelized sugar. In most cases, the absorbance of the caramelized sugar content in the real samples was more commonly in the range of 0.041 -0.045 mAU, as compared to the distillery sample (**sample A**-bottling outlet liquor sample) in which the absorbance was around 0.036 mAU and the found percentage of ethyl alcohol was 42.7% (pycnometer analysis). After that in the case of 39.44% ethyl alcohol the absorption maxima were around 0.044 mAU which shows the possible dilution in the liquor sample.

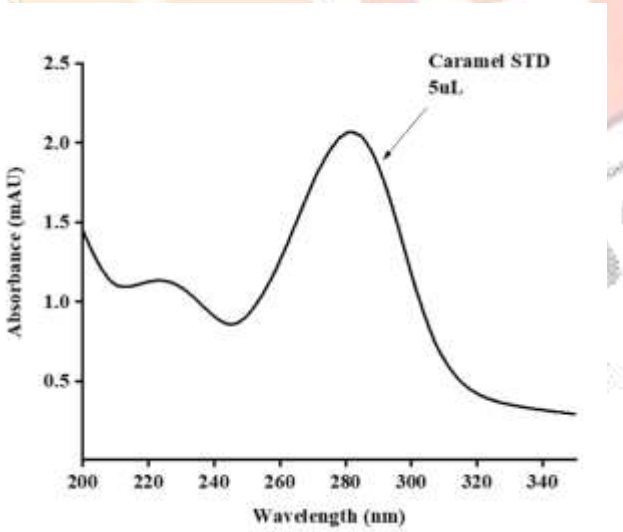

Figure 6. Standard caramel solution (4 mL H_2O+5 µL caramel solution of 50 ppm) UV-Visible graph.

In comparison to **sample A,** other samples have different absorption maxima which are higher in most of the liquor samples ranging from 0.036 to 0.049 mAU. All the absorption maxima values differ with different percentages of ethyl alcohol the obtained results of UV-Visible Spectrophotometric and pycnometer analysis show a counterfeiting (dilution) in 'Desi Sharab' because all the obtained values show a variation (in some samples large) from the standard sample (**sample A**). However, using these techniques, it could be postulated that 'Desi Sharab' samples (**Sample B-C, E-O, R-T, W-X**) were illegally prepared by counterfeiting the registered label and sealing of the bottle as the ethanol content and absorption maxima for caramel colour are higher in these samples in comparison to **samples A** and **Y.**

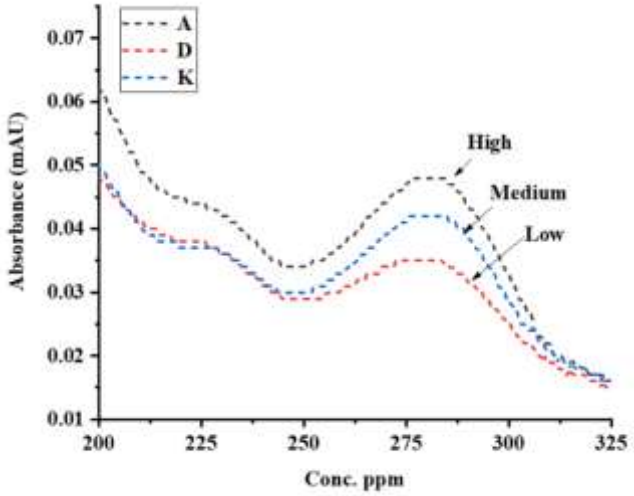

Figure 7. The UV-Visible graph of 'Desi Sharab' for high, mid and low caramelized sugar.

This spectrophotometric approach provides a rapid, economical and relatively simple method for ethanol quantification, particularly in contexts where advanced chromatographic methods (e.g., GC or HPLC) may not be feasible. Moreover, the method holds significance for the quality assessment and counterfeiting (dilution), adulteration detection of 'Desi Sharab' where variations in ethanol content pose regulatory and public health concerns.

V. Conclusion

The present study highlights the level of adulteration and counterfeiting in country-made liquor, specifically '*Desi Sharab'* collected from various locations in the Damoh district of Madhya Pradesh, India. In this study, pycnometer and UV–Visible spectrophotometric methods have been systematically used to evaluate the ethanol concentration and the absorbance of caramelized sugar was used as an indirect marker of liquor dilution. The pH analysis of 25 'Desi Sharab' samples marked from **A–Y** ranges from 5.08 to 6.32, with most sample values clustering between 5.3 and 5.7. This pH suggests that most samples possess a slightly acidic nature which is also the nature of typical of fermented liquors. However, the higher pH values observed in **samples B** (6.32), **O** (6.12) and **R** (6.25) could indicate dilution with neutral water or substandard handling conditions. Pycnometer analysis shows a significant difference in ethanol concentration. The labelled proof value was 42.8% v/v, and only **sample A** (42.72% v/v) contained a concentration close to this ethanol concentration.

In contrast, several retail samples showed marked dilution with ethanol content as low as 25.37% (**sample R**) and medium values were around 26-28%. Such reduction in ethanol concentration corresponds to almost 35-40% loss in ethanol strength compared to the standard, showing deliberate dilution practices. UV-Visible spectrophotometric analysis shows the marked changes in the absorbance, where most of the samples showed high absorbance compared to the standard one. Caramelized sugar absorbance maxima were strongly correlated with ethanol concentration ($R^2 = 0.999$). For instance, **sample A** exhibited an absorbance of 0.048 mAU corresponding to 42.7% ethanol, while samples with reduced ethanol (e.g., **sample C**, 26.18%) displayed lower absorbance values (~0.032 mAU). This linearity underscores the potential of caramel absorbance as a rapid, non-destructive method for assessing dilution in such liquors. Overall, the combined application of pycnometer and UV–Visible spectroscopy proved efficient, economical, and reliable in detecting counterfeiting (dilution) in the country '*Desi Sharab'*. The findings clearly establish that a significant fraction of the '*Desi Sharab'* sold in retail outlets across the Damoh district is adulterated through dilution or counterfeiting branded bottles. Such practices compromise product quality and pose a significant threat to consumer health. Regulatory authorities may adopt these simple analytical techniques for large-scale screening to ensure quality assurance, safeguard public health and curb the thriving illicit liquor trade in India.

VI. Future Recommendation

The present research work has been carried out on the 'Desi Madira Mashala Sharab', which is cost-effective, has the lowest rate and high ethanol content, and is particularly popular among the labour class. There are other cost-effective liquors, such as desi plain sharab, and other regional liquors, such as mahua sharab and toddy, which are mainly found in the selected study region. But in comparison to 'Desi Sharab', all these have low ethanol content. Therefore, the abuser or daily drinker of liquor mainly prefers Mashala sharab. The purpose of the present research work was to screen for possible counterfeiting in the 'Desi Sharab'. The literature and research show that many racketeers are involved in the counterfeiting of not only cost-effective alcoholic liquors but also in the branded ones. In the future, the branded and regional alcoholic beverages will also be examined from different locations in India to check for possible counterfeiting and different techniques.

VII. Acknowledgment

The authors are thankful to DST-FIST and DST-PURSE (Department of Science and Technology; Government of India) for supporting with FIST and PURSE scheme (Sl.No.64 Dated 31-05-2016). Laxmi Priya Pradhan [Y19442501], grateful to Dr. Harisingh Gour University, Sagar, India for providing a Junior Research Fellowship.

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