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RESEARCH ARTICLE

QUANTITATIVE ESTIMATION OF ALCOHOL IN ALCOHOLIC BEVERAGES BY USING DENSITOMETER AND ALCOLYZER

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ABSTRACT

This paper describe how one research team can uses variety of different solvents to analyze their different effect on density of alcohol to better understand the characteristics of alcohol. On many occasions now need to drink, so drinking security has become a bigger problem. There are many fake alcohol incidents endanger people's lives. Different adulterants like methanol, ammonium chloride, Urea in poisoning cases are investigated by using Alcolyzer instrumentation technique. Adulterated alcoholic beverages are legal alcoholic products that have been illicitly tampered with, for instance by criminally adulterating them with water purposely putting them into new container to conceal their true origin or adding toxic substances to manipulate the qualities of alcoholic beverages, which cause serious health difficulties like metabolic problems, blindness, permanent neurological damage and even death [Magnúsdóttir *et al*., 2010]. This way of counterfeiting alcoholic drink was the reason of massive alcohol poisoning. Poisoning by toxic chemicals such as Methanol, Urea, Acetone, Ammonium chloride, also for treating patient of alcohol toxicant Normal saline (9%) solution is admistrated which cause neuro-depressive effect.

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INTRODUCTION

An alcohol is an organic compound having OH (hydroxyl group). It can be diluted to a certain percentage in order to reduce its effect in human body who intakes it. An alcohol in alcoholic beverages i.e. ethanol is most widely used psychoactive drug in the world and is employed as depressant [I Journals: *(IJSRC) ISSN:* 2015]. The lethal dose of alcohol is 5 to 8g/Kg in adult and 3g/Kg in children, 300g of alcohol can kill which is equal to about 1 liter of spirits or four bottles of wine [Vonghia *et al*., 2008]. Its effectiveness decreases when the concentration in the product is less than 70% and increase when the concentration is greater than 75% [Dumas-Campagna *et al*., 2014]. Exposure to ethanol to in air and water is very low as it is broken down by sunlight. Most people will be exposed to ethanol in form of alcoholic beverages in which ethanol is found at varying concentration from 4% to 45%. However exposure to higher concentration may occur in an occupational setting such as in industry or a laboratory, where 100% ethanol is sometimes used. Ethanol can cause adverse effects on the reproductive system in males and females and on fertility. It can also affect the foetus, such as causing fetal alcoholic syndrome which is characterized by organ abnormalities, lower birth rate, abnormal brain development and behavioral problems. However such effects are achieved only due to the consumption of alcoholic beverages rather than occupational exposure or use of consumer products containing ethanol [Bull, 2010]. The quantitative detection was done by using Densitometer and Alcolyzer. The Alcolyzer modules are based on patented NIR (Near infrared spectroscopy) analysis method to determine the alcohol content of various alcoholic beverages with highest accuracy. Different measuring modules used as Beer, Wine, Cider, Vodka, Whiskey cognac, Tequila, Rum, Molasses, Wash [Instruction Manual].

Alcohol % v/v calculated by using a specific function of absorption intensity of NIR line of alcohol.

$\boldsymbol{\rho}$100% alcohol (20˚c) = 0.7924g/cm^3
$\boldsymbol{\rho}$ = Density

Specific gravity of alcohol = $\boldsymbol{\rho}$ alcohol/$\boldsymbol{\rho}$ water

The different adulterants used for adulteration of alcohol was Water, Methanol, Urea, Ammonium chloride, and the Normal saline (solution of 0.9% sodium chloride in distilled water)used for the treatment of alcohol toxicant. Any amount of water content will help to dilute alcohol concentration in body, so the higher water content, the less concentrated alcohol will become.

Alcohol metabolism rate in human body: The average metabolic capacity to remove alcohol is about 170 to 240 g/day

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for a person with a body weight of 70 Kg, this would be equivalent to an average metabolic rate of about 7g/hr. which translate to about one drink per hour. Since alcoholic may consume 200 to 300g of ethanol per day [Clin Liver Dis, 2012]. Methanol has been added to legally produce wines to increase their "bite". It is a potent toxicant in humans occurs naturally at a low level in most alcoholic beverages without causing harm, tolerable daily dose of Methanol in adult as 2g and toxic dose is 8g. Dose of 3-20ml cause serious damage to Central nervous system (CNS), and gastrointestinal tract irritation. Also an adult can consume 100ml standard measures of a drink containing 40% alcohol by volume over a period of 2 hrs. The maximum concentration of methanol in such drink would be 2 %(v/v) by volume. Industrial alcohol contains 4% of methanol, as the consumption of alcohol by criminals making alcohol, which was after drinking, it will produce methanol poisoning. Lethal dose of methanol is about 70 ml, the maximum alcohol limit for human consumption 0.1g/Kg. The minimal lethal dose is considered to be in range of 300-1000 mg/kg. Ocular toxicity ranges from photophobia and blurred vision and an ingestion of 4-10ml of methanol in adults may cause permanent blindness. Although the body has the capacity to metabolize the low doses of methanol to which people regularly exposed, it cannot handle high dose because too much methanol overwhelms the body. The normal blood concentration of methanol from endogenous sources is less than 0.5mg/l, but dietary sources may increase blood methanol level. As the methanol concentration increases in alcoholic beverages it causes no changes in density of alcohol, density remains at 0.80g/cm^3. But cause high toxicity [Paine *et al*., 2001; Robert Kavet and Kathleen M. Nauss, 1990; Methanol (Environmental Health Criteria, 1997; 196)-ipcs inchem]. Urea reacts with alcohol to form Urethanes, The discovery of widespread presence of ethylcarbamate or urethane in alcoholic beverages first occurs during the mid-1980s. It is not actually toxic to humans. Acute toxicity studies so that the lowest fatal dose in rats, mice and rabbits equals to 1.2g/Kg or more. When urethane was used medicinally, about 50% of the patients exhibited hemorrhages. The compound has almost no odor and a cooling saline, bitter taste. The contents of urethane in alcoholic beverages vary over a wide range. The levels of urethane in wine ranged from 8µ/L, in stone-fruit brandies ranged from 100 to 22,000µg/kg, 80% of its present in spirits was formed during the distillation step and in beer 5.8µg/kg [Washington, 2016; National toxicology Program, Department of Health and Human Services, Report on carcinogens, 13th edition]. 0.9 % normal saline is frequently use of treat patient with acute alcohol in toxicant despite the lack of evidence for its efficacy. The theory behind the administration of normal saline not only counteract the dehydration effect of alcohol but might also have a dilution effect on the level of alcohol and it neurodepressive effect making a patients sober faster and there for spend the less time in emergency departments [Original research on Intravenous 0.9% sodium chloride therapy does not reduce length of stay of alcohol-intoxication patients in the emergency department: A randomized controlled trial, 2013]

MATERIALS

Highly pure methanol (99.9%) and ethanol (99.9%) of density 0.792g/cm^3 and 0.790g/cm^3 respectively, obtained from the MERK were used for preparing samples in different concentration, urea(Carmol brand) in solid form from market was bought, Distilled water from laboratory was collected, 10% Ammonium chloride solution and 0.9% normal saline were prepared. The laboratory work was carried out at the chemistry division of Forensic science laboratory, Lucknow and was carried out by using instrument Densitometer and Alcolyzer Anton Paar DMA 4100M.

METHODS

Adulteration of Ethanol was done with different adulterants like Distilled water, Methanol, Urea, Ammonium chloride, Normal saline.

For Adulteration of ethanol with different adulterants: The percentage of ethanol was taken by increasing the ethanol concentration with the difference of 10 ml for each dilution with different adulterants and makeup up to 100 ml.

Procedure for sampling in instrument

At first dilution of ethanol with different adulterants was done and makeup to 50 ml solution mixture of 90%, 80%, 70%, 60%, 50%, ethanol solution. All the mixture was kept in plastic tubes and sampled in instrument densitometer and X-sampler alcolyzer, and the method setup was at Ethanol OIML- ITS-90 (%v/v) and density was measured.

RESULTS AND DISCUSSION

Adulteration of ethanol with water

Observation:-

Table 1.

Ethanol % taken	Ethanol % v/v	Density (in g/cm^3)
90%	86.57%	0.8401
80%	79.51%	0.8606
70%	70.02%	0.8855
60%	56.74%	0.9163
50%	47.81%	0.9344
40%	37.46%	0.9520
30%	27.12%	0.9657
20%	18.75%	0.9751
10%	9.45%	0.9854

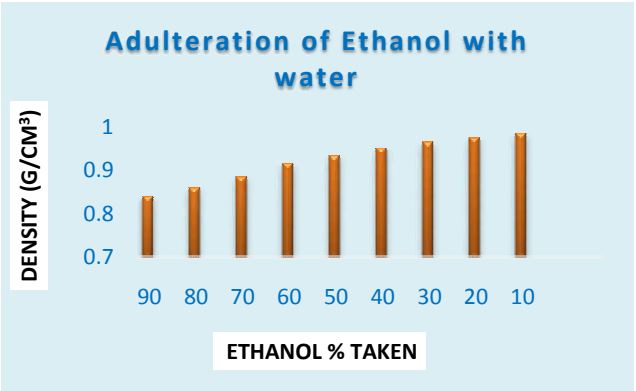
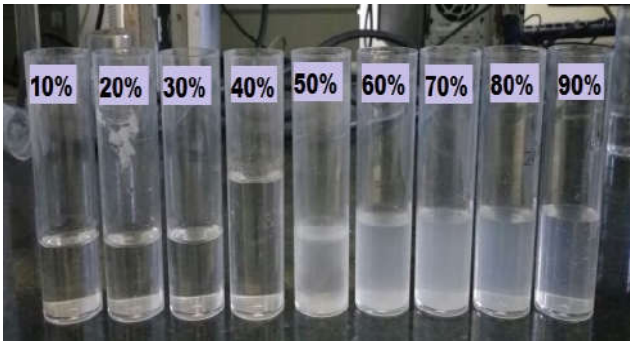


Figure 1

Discussion

As we adulterated ethanol with water simultaneously density increases while alcohol percent decreases as shown in **Table 1** and **Figure 1**. The interesting thing observed was that up to the dilution of 50% color of solution become cloudy immediately but above 50% dilution there is no change in color.



Showing color change while adulterating ethanol with water.

Adulteration of ethanol with methanol

Observation

Table 2.

Ethanol % taken	Ethanol % v/v	Density (g/cm^3)
50%	95.99%	0.8075
40%	96.89%	0.8038
30%	97.16%	0.8026
20%	97.67%	0.8003
10%	97.21%	0.8024

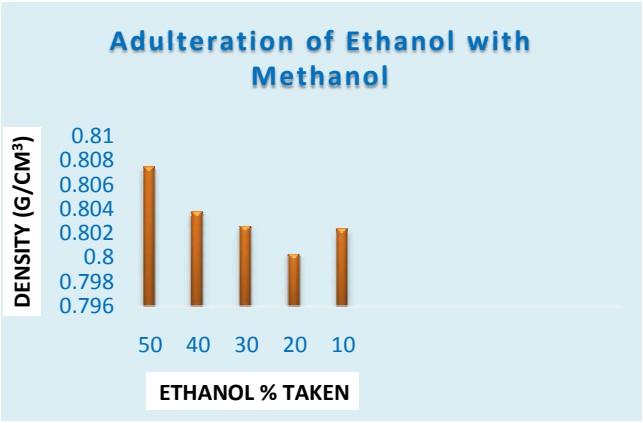


Figure 2.

Discussion

As we adulterated the ethanol with methanol only slight variation was observed in density of ethanol while ethanol percentage decreases initially and after that it become almost constant, as shown in Table 2 and Figure 2.

Adulteration of ethanol with Ammonium chloride solution (10%)

Observation

Table 3.

Ethanol % taken	Ethanol % v/v	Density (g/cm^3)
50%	45.32%	0.9390
40%	33.31%	0.9579
30%	14.32%	0.9797
20%	1.61%	0.9958
10%	Out of range	1.0098

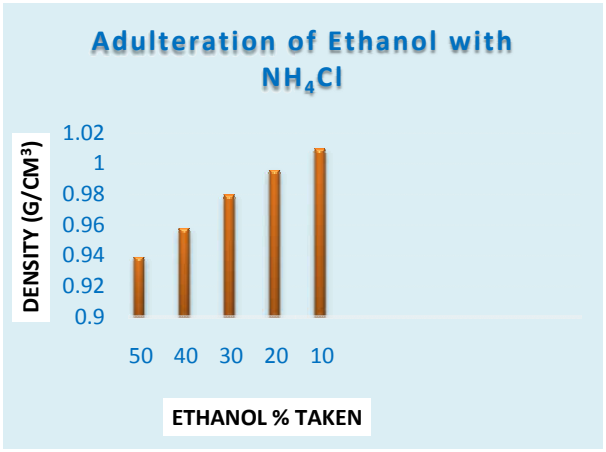


Figure 3.

Discussion

As we adulterated the ethanol with Ammonium chloride, as the ethanol percentage decreases density increases as shown in Table 3 and Figure 3. An interesting thing observed was at 10% dilution of ethanol, density approximately reached to the density of water (pure water at room temperature is about 1g/cm^3) [Density, Department of Physical sciences Kingsborough community College, The city university of New York Winter 2010].

Adulteration of ethanol with methanol and ammonium chloride

Observation

*Mixture of ethanol % and methanol % taken in 1:1 ratio, was adulterated by NH_4Clsolution (10%)

Table 4.

* Mixture % taken	Ethanol %v/v	Density (g/cm^3)
50%	40.63%	0.9470
40%	25.28%	0.9678
30%	9.24%	0.9856
20%	Out of range	1.0022
10%	Out of range	1.0079

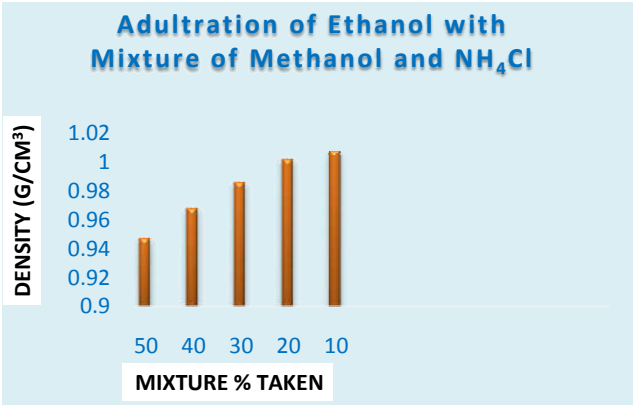


Figure 4.

Discussion

As we adulterated the ethanol with mixture of Methanol and ammonium chloride, while decreasing ethanol percentage, density increases. Also at 10% and 20% dilution density was

approximately reached to that of water density as shown in Table 4 and Figure 4.

Adulteration of ethanol with Urea (solid)

Observation

Table 5.

Concentration taken(in ml)		Ethanol % v/v	Density (g/cm^3)
100% Ethanol(ml)	Urea(gm)		
50	0.5	93.03%	0.8188
50	1.0	92.17%	0.8218
50	1.5	91.84%	0.8230
50	2.0	88.97%	0.8326

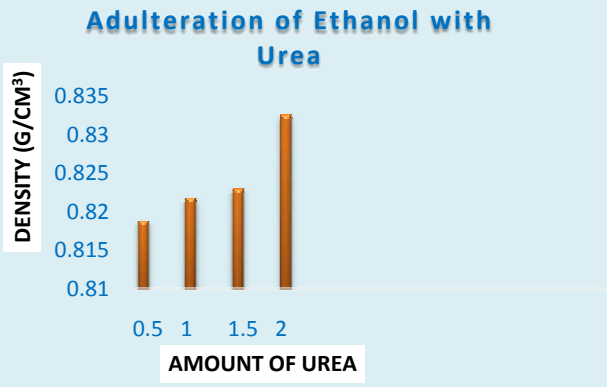


Figure 5.

Discussion

As we added urea in ethanol (taking constant amount of 50ml) density was slightly increases as the quantity of urea increases, shown in given Table 5 and Figure 5.

Dilution of ethanol with Normal saline

Observation

Table 6.

Ethanol % taken	Normal saline	Ethanol % v/v	Density (g/cm^3)
60%	6%	23.47%	0.9698
50%	5%	39.66%	0.9486
40%	4%	43.01%	0.9430
30%	3%	33.21%	0.9581
20%	2%	20.75%	0.9729
10%	1%	5.75%	0.9901

Note: - Percentage of normal saline was taken different for each dilution.

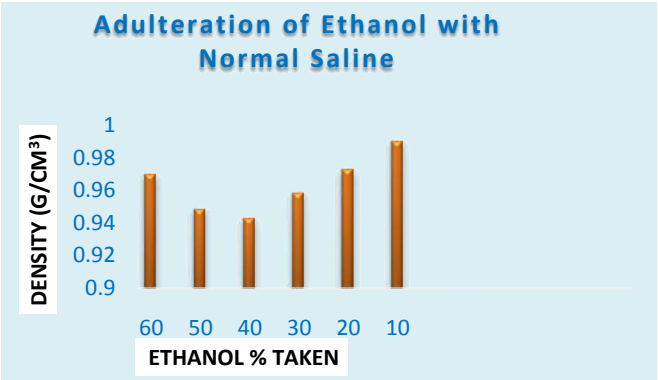


Figure 6.

Discussion

As we diluted ethanol with normal saline, by decreasing the ethanol percentage, density also decreases up to 40% and after that density increases as shown in Table 6 and Figure 6.

Conclusion

It is widely accepted in the scientific community that inhaling the Alcoholic Beverages is responsible for adverse health effects. Adulteration of ethanol with different adulterants was done for determination of density change for different ethanol concentration. While adulterating ethanol with water, Ammonium Chloride solution and the mixture (NH_4Cl +Methanol) density increases while ethanol percentage decreases. But in case of Normal saline dilution up to 40% density decreases and after it increases. And in case of adulteration with Methanol and Urea there is very slight change in density of ethanol. The very interesting thing observed in this experiment was the colour change of solution when adulterating with water. Also when adulteration was done with NH_4Cl solution and mixture of NH_4Cl and Methanol at 10% and 20% density reached to the density of water. Therefore in this experiment it is shown that how this adulterants are used for manipulating the quantity of alcoholic beverages cause serious health difficulties like Metabolic and neurological damage and effect on fertility, But Normal saline used for treating patient with acute alcohol in toxicant and it cause neuro-depressive effect making patient sober faster.

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