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Health Hazards Reduction of Alcohol using Mid-Infrared Ray

Umakanthan[1]*, Madhu Mathi[2], Umadevi[3] and Sivaramakrishnan[4]

[1]Veterinary hospital, Gokulam Annadhanam Temple Complex, Meenavilakku-Meenakshipuram Road, Anaikaraipatty Post, Bodinayakanur Taluk, Theni Dt, Tamil Nadu, India

[2]Veterinary hospital, Vadakupudhu Palayam Post, Kodumudi (via) Unjalur Taluk, Erode Dt, Tamil Nadu, India

[3]Assistant Professor, Department of Botany, The Standard Fireworks Rajaratnam College for Women, Sivakasi, Virudhunagar (Dt), Tamil Nadu, India

[4]Veterinary Assistant Surgeon, Veterinary Dispensary, Puliyal Post, Devakottai Taluk, Sivaganga Dt, Tamil Nadu, India

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***Corresponding author:** Umakanthan, Veterinary hospital, Gokulam Annadhanam Temple Complex, Plot no.: 1684, Meenavilakku-Meenakshipuram Road, Anaikaraipatty Post, Bodinayakanur Taluk, Theni Dt, Tamil Nadu, India

Abtract

Alcoholism is the cause and contributing factor in many diseases, resulting in significant health issues besides social and economic burdens and responsible for 6% of mortality (preventable). An effective treatment for alcohol addiction and abuse (85-90% relapsing) has yet to be developed. Now, overall alcohol consumption is rising, which is a threat. In this research, we invented a hand-held water-based 2-6 μm mid-infrared generating atomizer (MIRGA). MIRGA was sprayed from 0.25-0.50meter towards the marketed bottled alcohol. The applied mid-IR was found to have penetrated the alcohol bottle, acted and altered the chemistry of treated alcohol. The treated alcohol showed biochemical changes was less toxic, less irritating and a smoothie to drink, almost with no subsequent hangover and without compromise in feeling contentment and pleasure (intoxication effect). The study includes sensory expert panel testing, consumer tests, various laboratory analysis and the health, socioeconomic and financial benefits of MIRGA technology. The non-ionizing 2-6 μm mid-IR irradiated alcohol was found to provide many health benefits, with no compromise in intoxication both economically and without adversity to drinkers.

Keywords: Mirga, 2-6 μm mid-IR; Alcohol, Detoxification; Health benefits; Economy

Abbreviations: MIRGA: Mid-Infrared Generating Atomizer; HPLC: High-Performance Liquid Chromatography; GCMS: GAS Chromatography-Mass Spectrometry; FTIR: Fourier-Transform Infrared Spectroscopy; NMR:M Nuclear Magnetic Resonance Spectroscopy; VLDL: Very Low-Density Lipoprotein; ALDH: Aldehyde Dehydrogenase Inhibitor

Introduction

Alcohol drinking is a millennial habit, and its toxic and additive effects are well known to everyone. Also, alcohol acts as a solvent for tobacco carcinogens, improve immunity and multi drug resistance (Victor maza et al 2022). Despite the strong presence of drinking, governments levy high taxes on alcoholic drinks to reduce consumption and compensate for health care expenses. At present irrespective of age and sex alcoholics and levels of their alcohol intake are increasing. Generally, alcoholics do not like to undergo treatment or abstinence. Frequent alcohol consumption results in dependency and addiction, which have gained great attention. Alcohol dependency and prenatal exposure correlate with medical, psychological, behavioral, and social problems, including more crime/ violence and road accidents [1] (Maria et al 2022). Thus, there is an urgent need to develop an effective intervention. Since long, various steps have been taken to reduce alcoholism and treat related diseases [2,3] and (Maria et al 2022). Still, no effective solution has been found to reduce alcohol toxicity without diminishing the toxicity and pleasures of drinking, which formed the aim of this research. Considering the above factors, the authors have applied an infrared regimen for alcohol refinement using our recently invented 2-6μm mid-IR generating atomizer (MIRGA) technology. The applied 2-6 μm mid-IR is biologically safe and can penetrate natural and anthropogenic obscurants [4,5], viz., alcohol bottle and alcohol. The mid-IR altered the alcohol's chemical bonds hence the physico chemical properties.

Material and method

Mid-infrared generating device.

MIRGA is a 20 ml pocket-sized atomizer that contains an inorganic water-based solution (patent no.: 401387) (having approximately two sextillion cations and three sextillion anions). Every time spraying, the MIRGA generates 2-6µm mid-IR. Every time, spraying emits 0.06ml, which contains approximately seven quintillion cations and eleven quintillion anions. The design of the MIRGA and the estimation of emitted 2-6µm mid-IR has been dealt with in detail by Umakanthan et al., [6]; Umakanthan et al., [7]; Umakanthan et al., [8]; Umakanthan et al., [9]. (details presented in Supplementary text T1)

Mid-infrared application

MIRGA was sprayed from 0.25 to 0.50 meter towards the package (polythene, glass, tin) alcohol (method of spraying video link presented in Supplementary video V1). This distance is essential for the MIRGA sprayed solution to form ion clouds, oscillation and 2-6 µm mid-IR generation. The 2-6 mid-IR can penetrate the intervening package and act on the inside alcohol. Close spraying does not generate energy. MIRGA can be used like a body spray externally over bottled alcohol.

Sensory analysis

Over a decade, nearly 600 male and female volunteers above the age of 21 participated in the trial. The volunteers were from a diverse group ranging from occasional and social drinkers to dependent alcoholics. Fifteen sensory panel experts from distilleries were employed as tasters. The aroma, taste, irritation, palatability and hangover were recorded. To tasters a score from 1-9 was assigned in ascending order of acceptance: 1 - Dislike extremely, 2 - Dislike very much, 3 - Dislike moderately, 4 - Dislike slightly, 5 - Neither like nor dislike, 6 - Like slightly, 7 - Like moderately, 8 - Like very much, 9 - Like extremely [10,11]. The panel members are isolated among themselves from interaction and interference in the evaluation and performance, like this acceptability test conducted. Commercial brands with various levels of alcohol concentration were used.

Instrumental analysis

High-Performance Liquid Chromatography HPLC: The compound concentration was determined by high-performance liquid chromatography (HPLC) – Flexar Quaternary Pump – FXQPump-1 was used.

Gas chromatography-mass spectrometry (GC-MS): The chemical compound transformation was determined by Gas chromatography-mass spectrometry (GC-MS) analysis was performed on a ThermoFisher ITQ 900 instrument with an FID detector and HP-5 capillary column (polydimethylsiloxane with 5% phenyl groups, 30 m, 0.32 mm i.d., 0.25 µm film thickness) using helium as carrier gas.

Fourier-transform infrared spectroscopy (FTIR): Chemical bond changes were determined by Fourier-transform infrared spectroscopy (FTIR): Nicolet iS5, THERMO Electron Scientific Instruments LLC.

Nuclear magnetic resonance spectroscopy (NMR): Proton resonances were determined by Nuclear magnetic resonance spectroscopy (NMR): Proton NMR: Make: Bruker; Model: Avance III HD Nanobay 400 MHz FT-NMR spectrometer. Probe: 5mm multinuclear probes for solution studies. The NMR Probe is switchable between a high-frequency range (1H, 19F) and broadband frequency range (13C, 15N, 27Al, 31P, 29Si, etc. Software: Bruker Topspin.

Sample preparation

The volunteers were served alcoholic beverages at 0 and 24 hours. The time of 24 hours was chosen to allow the participants to recuperate from the intoxication and the adverse effects of drinking at 0 hours. On the 24th hour, 175 ml of X brand bottled alcohol was sorted into groups of 1 to 6. Each group had 20 bottles of alcohol and 1 to 6 MIRGA sprayings were performed from 0.25-0.50 meter towards each bottled alcohol (i.e., group 1 (20 bottles) received one spraying, group 2 (20 bottles) received two sprayings and so on...). The sprayed alcohol bottles were then opened and served to the volunteers. For example, different brands in 175 mL, 375 mL and 750 mL were tried. Appropriate controls were kept and tested. The volunteers' organoleptic, satiety, physical, psychological and social parameters were meticulously recorded from 0 to 48 hours, and a comparison was made.

Ethical statement and Informed consent: The institutional review board found sensory ethical approval unnecessary since the spraying was only done on the outer surface of the alcohol bottle, and 66% of solar radiation we receive daily is infrared [12]. As a result of this, informed consent was acquired from all the participants. More sprayings (6 times) are required because, by its nature, applying more energy to a target would denature its inherent characteristics. In MIRGA, we accounted for this natural tendency by raising the spraying numbers(six) while simultaneously carrying out sensory testing until the inherent characteristics (quality) of alcohol have almost or entirely vanished. A denatured sample is also analyzed using a variety of instruments. A comparison was also made between the control, four sprayed (quality enhanced) and six sprayed (quality reduced) samples. Different brands of control and alcohol were individually trialed without dilution and in a cocktail. The number of MIRGA sprayings required varied by 1 or 2 depending on brand and quantity.

Results and Discussion

Sensory panel result

Within 1-3 minutes of spraying, the sensory changes in alcohol felt by expert panels and consumers are presented in Table 1. A comparison between the control and 4 sprayed (quality enhanced) samples is drawn in Table 2.

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Table 1: Sensory panel expert tests.

Number of MIRGA spraying	Hedonic scale point obtained	An approximate sensory evaluation (Foolproof)				
		Aroma	Taste	Irritation	Palatability	Hangover
Control (Non sprayed)	5	Regular	Regular	Regular	Regular	Regular
1	6	Mild enhancement	Mild enhancement	Mild reduction	Mild enhancement	Medium
2	7	Slight enhancement	Slight enhancement	Slight reduction	Slight enhancement	Slight
3	8	Medium enhancement	Medium enhancement	Medium reduction	Medium enhancement	Mild
4	9	Extraordinary enhancement	Extraordinary enhancement	Extreme reduction	Highly palatable	Almost nil
5	4	Medium reduction	Medium reduction	Medium increase	Medium reduction	Regular
6	1	Quality became very poor and unpalatable				

Table 2: Comparative field trial data.

Sl. No	Tests performed	Non-sprayed (control)	4 sprayed (Trial)
1	Quantity of alcohol required for satiety	65-95%	55-65%
2	Taste	Regular	Enhanced
3	Flavor	Regular	Enhanced
4	Irritation to the alimentary tract	As usual	Smooth
5	Intoxication time	Regular	Extended up to 30%
6	Behavioral effects	Regular	Under control and sometimes regular
7	Hangover on the next day	Up to 97%	Less than 3%
8	Social effects	Adverse	Up to 60% masked and managed
9	Economy	Nil	35-45%
10	Overall appreciation	Good and sometimes Better	Better, best, superb, and much appreciated
11	The future possibility of MIRGA usage/ preference	-	Up to 97%

Instrumentation results (raw data of instrumentations presented in Supplementary data D1)

The control, four sprayed (like extremely) and six sprayed (dislike extremely) samples were subjected to laboratory analysis. The above samples utilized for instrumentation were taken from the same source; the only difference is the number of sprays they received.

HPLC: The area of each peak represents the compound's concentration. The area of the peak at retention time 7.4-7.6 is relatively more in the control sample than in the 3 and 6 sprayed samples and least in the 4 sprayed samples. As a result, the compound's concentration is higher in the 6 sprayed samples when compared to the other samples. The area of the peak at retention time 3.2 is relatively higher in the 6 sprayed samples as compared to the 4 sprayed, 3 sprayed and control samples. In comparison to the control, the area of the peak at retention time 4.3 is relatively higher in 3 sprayed, 4 sprayed and 6 sprayed samples. The concentration of compound at retention time 7.3 is higher in the 6 sprayed sample than in the control, while the concentration of compound at retention time 5.3 is lower in the 6 sprayed sample than in the control. In general, -amide compounds absorb at 210nm. As a result, amide compound degradation occurs with increasing spraying numbers (Figure 1).

GCMS: GCMS Tables 3 and 4 show that the samples contain several phthalic acid derivatives such as butyl, hexyl, pentyl and cyclo esters, with 1490.06 as the significant molecular weight compound present. Butyl 2-pentyl ester and isobutyl octyl ester of Phthalic acid were detected in 4 sprayed samples, whereas cyclohexyl ester and butyl octyl ester of Pthalic acid were detected in 6 sprayed samples. These are responsible for enhancing and reducing inherent characteristics in 4 and 6 sprayed alcohols, respectively. The low molecular mass intensity increased in the 4 and 6 sprayed samples, indicating the degradation of compounds (Figure 2) (Tables 3 and 4). From the control, 4 and 6 sprayed samples spectral area under each curve, it is found that the concentration of the long chain carboxylic acid esters is increasing in 4 and 6 sprayed samples. It also indicates that the-C-OH bonds are broken, and –C-OR bonds are formed. The control contains molecule $C_{18}H_{24}O_4$, whereas in 4 and 6 sprayed samples, the

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$C_{20}H_{30}O_4$ molecule is present. However, the concentration is increased in 6 sprayed samples. The carboxylic acid ester [13] contributes significantly to the sensory (fruity smell) impact of newly fermented wine (Table 3 & 4).

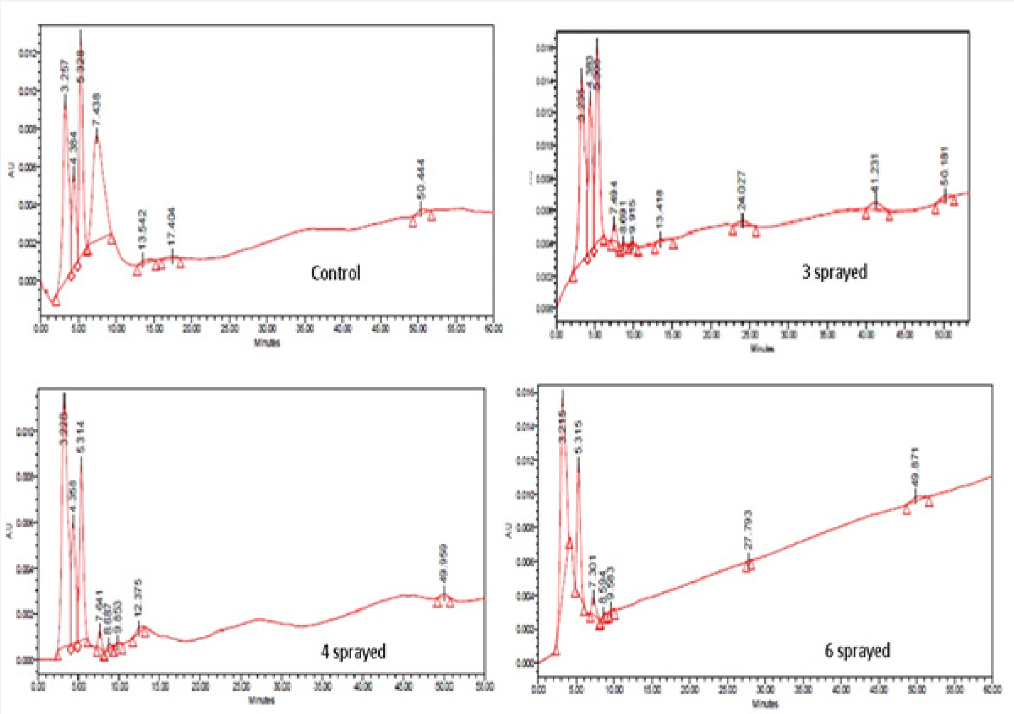

Figure 1: HPLC of alcohol samples.

Table 3: GC-MS analysis of Alcohol.

Name of Compound in Alcohol	Compound Present in each sample			
	Control	4 sprayed	6 sprayed	Remarks
R.T. (Min)	12.51	12.53	12.55	
1,2-Benzenedicarboxylic acid, butyl 2-ethylhexyl ester (Phthalic acid, butyl 2-ethylhexyl ester)	Present	Present	Present	A compound present in all three samples
1,2-Benzenedicarboxylic acid, butyl cyclohexyl ester (Phthalic acid, butyl cyclohexyl ester)	Absent	Absent	Present	Uniquely present in 6 sprayed sample
Dibutyl phthalate (Phthalic acid, dibutyl ester)	Present	Absent	Absent	Uniquely present in the control sample
Phthalic acid, butyl 2-pentyl ester	Absent	Present	Absent	Uniquely present in 4 sprayed sample Antioxidant and antimicrobial properties [44]
Phthalic acid, isobutyl octyl ester	Absent	Present	Absent	Uniquely present in 4 sprayed sample
1,2-Benzenedicarboxylic acid, butyl octyl ester (Phthalic acid, butyl octyl ester)	Absent	Absent	Present	Uniquely present in 6 sprayed sample

IR and absorption spectra: In the control sample, there is O-H bond stretching near 3746.62 cm-1, implying the presence of a water molecule. Because of the C-H stretching vibration, all of the samples have comparable peaks at 2930-2932 cm-1. Due to O-H stretch, the samples show comparable properties, with peaks at 3390-3394 cm-1. Due to C=C (aromatic), all samples have peaks at 1600-1650 cm-1. This shows the existence of flavoring agents. C-O stretch causes these characteristics to peak at 1076 cm-1. In comparison to the control, the intensity of this peak is comparatively lower. The peak at 1705 cm-1 seen in 6 sprayed samples is caused by the stretching vibration of the C=O group. This indicates that alcohol oxidation is occurring in 6 sprayed

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samples. The characteristics of the peak at 1205 cm-1, 924 cm-1 and 1039 cm-1 indicate that the glycerol content is higher in the 6 sprayed samples than in the 3 and 4 sprayed samples (Figure 3). According to the absorption spectra, the samples contain aromatic compounds. The intensity of the peak at 280nm due to enhanced aromatization increases with the number of sprayings, indicating an increase in the flavorful taste of wine. Aromatization occurs in 6 sprayed samples as compared to 4 sprayed samples. The amount of phenolic compound in 6 sprayed samples falls, as shown by the peak at 230nm.

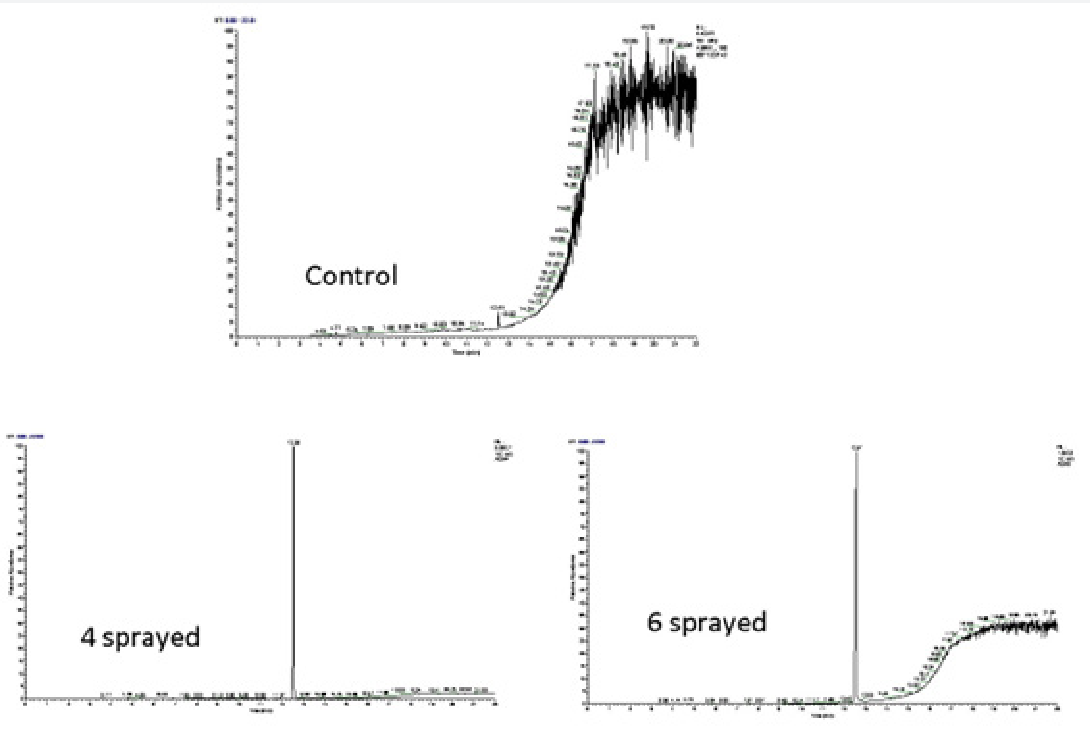

Figure 2: GC-MS of alcohol samples.

Proton NMR: Control: δ 1.04(t,3H) This is due to the -CH3 group; δ 3.51(q,2H). This is due to the -CH2 group; δ 4.6(s,1H). This is due to the -OH group. It appears downfield as it is deshielded by oxygen. 4 sprayed samples: δ 1.04(t,3H) This is due to the -CH3 group; 3.51(t,2H). This should be a quartet, but it's a triplet; δ 4.6(s,1H). This is due to the -OH group. It appears downfield as it is deshielded by oxygen. 6 sprayed samples: δ 1.04(t,3H) This is due to the -CH3 group; δ 3.52(q,2H). This is due to the -CH2 group; δ 4.6(s,1H). This is due to the -OH group. It appears downfield as it is deshielded by oxygen. In 4 sprayed samples, the quartet has been removed and a triplet has been found. This means that 4 times MIRGA spraying eliminated one proton from the -CH3 group (Figure 4).

Chemical changes and health benefits of MIRGA sprayed alcohol based on HPLC, GC-MS, FTIR and H-NMR interpretations.

Increased oxidation: The FTIR spectrum of the 4-sprayed sample shows a peak at 1750 cm-1 corresponding to the stretching vibration of the C=O group, indicating an oxidation event. In HPLC, the peak occurs at 7.5 mins, with the maximum at 200nm (acetaldehyde H-C=O). Alcohol's (acetaldehyde) chemical bond characteristics are altered (stretching vibration of C=O). Acetaldehyde is 15-fold more toxic than alcohol [14] and is related to many alcohol-induced pathologies [15]. Acetaldehydes possess genotoxic effect (Victor moza et al 2022). Acetaldehyde oxidation is a natural and healthy process. In this study, the bottled acetaldehyde was oxidized and made harmless by the externally applied 2-6 μm mid-infrared.

Degradation of bigger amide molecules to smaller molecules: According to the HPLC graphs, the 4-sprayed sample has an amide bond absorbance at 210 nm. We observed a higher level of degradation in the molecular size of the amide compounds in the 4- and 6-sprayed samples. Amides are carbonyl-group amines, the simplest and most volatile organic nitrogen compounds present in wine and grapes. Amide is a precursor of carcinogenic N-nitroso compounds in vivo [16]. Although amide hydrolysis is common in invivo but cannot be produced in vitro (within a bottle). Thus, the chemical bond alteration caused by the mid-IR radiation dissociated the large amide molecules into smaller ones, which prevented health complications such as heart blockage.

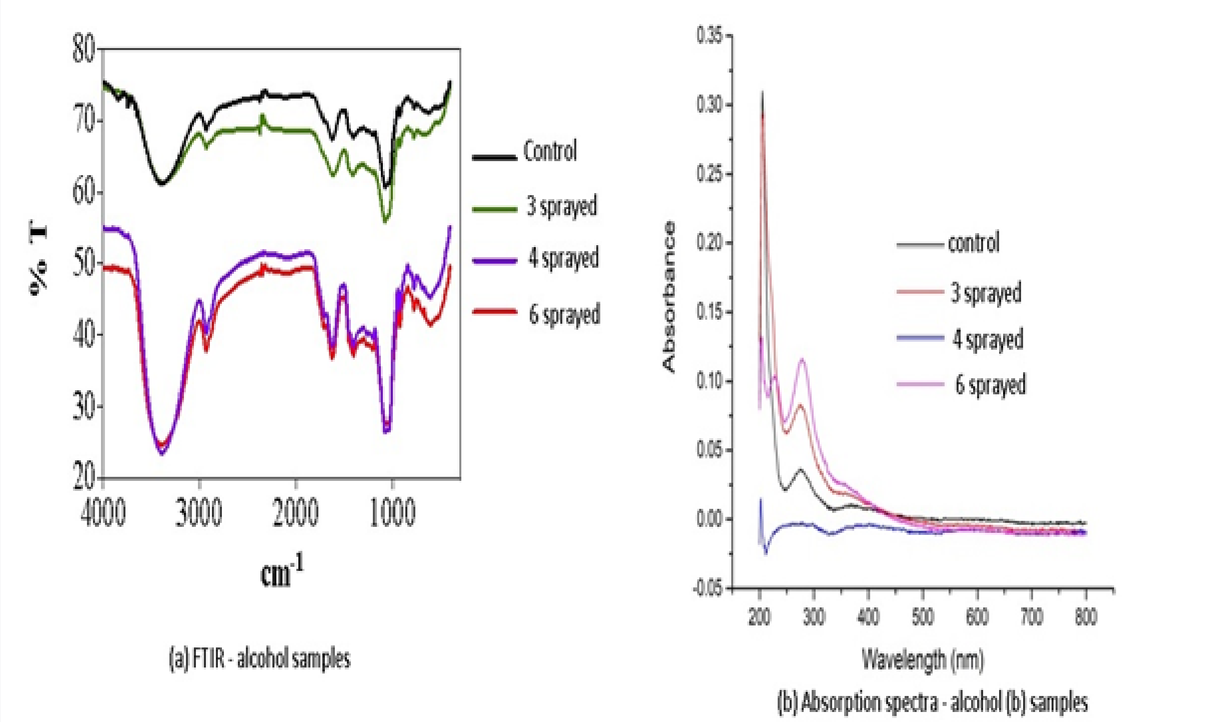

Figure 3: IR and absorption spectra of alcohol samples.

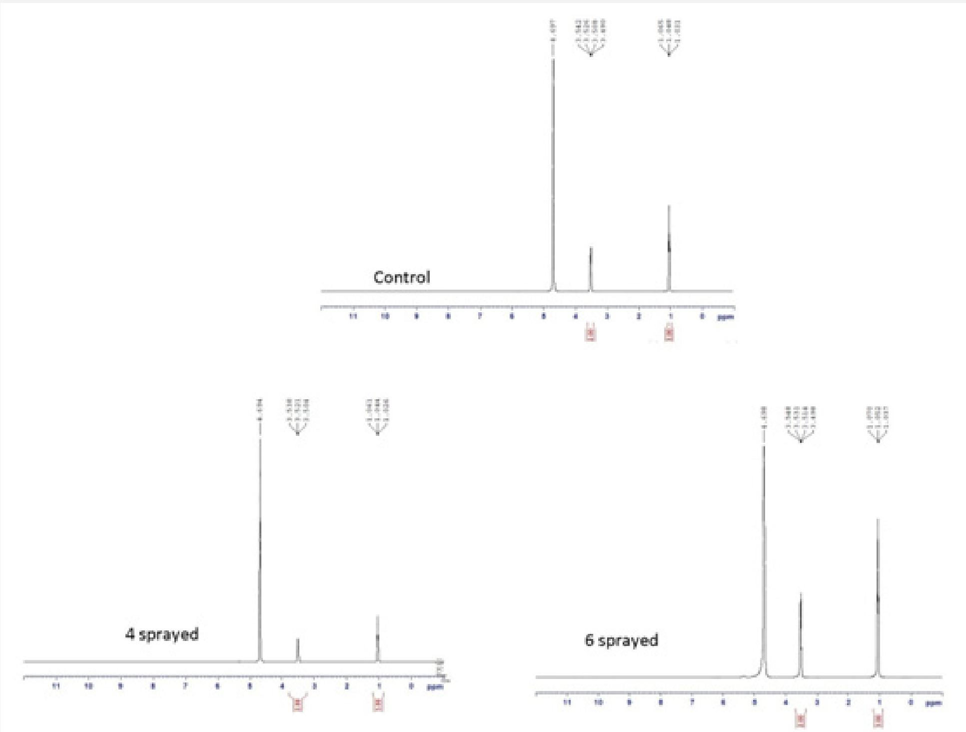

Figure 4: 1H-NMR of alcohol samples.

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Table 4: GC-MS - Quantitative analysis of major peaks of the samples.

Control		4 sprayed		6 sprayed	
Mass (relative %)	Intensity	Mass (relative %)	Intensity	Mass (relative %)	Intensity
149.06(80%)	1680012	149.06 (79%)	56611400	149.07 (79%)	100042544
150.07 (6.9%)	144708	150.04 (7.3%)	5260825	150.05 (6.2%)	7884472
121.14 (5.8%)	123229	121.15 (6.2%)	4454921	121.18 (5.3%)	6788015
223.02 (3.5%)	75110	166.96 (3.2%)	2627356	279 (5.1%)	6497517
92.99 (3.1%)	65733	223.04 (3.4%)	2462061	167.01 (3.9%)	4939347

Phenolic compound: In 4 sprayed samples, the peak intensity at 230 nm is due to the increased phenolic concentration, which results from the alteration in the chemical bond parameters of phenolic compounds. Increased phenolic compounds reduce the risk of many alcohol-induced diseases [17] (Martinez-Gonzalez et al 2019).

Aromatization: The UV spectra of the peaks at 3.2, 4.4- and 5.3-minutes show maxima between 270 and 280 nm, indicating improved aromatization. The sensory expert panel and consumers confirmed an enhanced flavor and taste in 4 sprayed alcohols during the experiments. In general, several botanicals are utilized in the aromatization of alcoholic beverages during the manufacturing process [18]. However, 4 times sprayings aromatized the alcohol more conveniently and economically by changing the chemical bonds of the alcohol.

The presence of higher levels of glycerol: The FTIR spectra of the 4-sprayed sample indicate high levels of glycerol due to the characteristic peaks at 1205 cm-1, 1924 cm-1 and 1039 cm-1. In our field trial, the volunteers who consumed the 4-sprayed sample reported feeling more energized after intoxication vanished. In general, alcohol increases the synthesis of very low-density lipoprotein (VLDL), which is the primary source of triglyceride in hypertriglyceridemia, causing health hazards [19]. However, in the present study, the altered chemical bonds of triglyceride caused by the applied 2-6μm mid-IR resulted in a higher level of glycerol - pyruvate - gluconeogenesis - glucose conversation, which gave more energy to the drinkers. All the experimental data shows that, depending on the number of sprayings, MIRGA altered the chemical bonds, consequently changing the structure, thereby chemical compound transformation, resulting in enhanced or reduced inherent characteristics.

Other benefits of MIRGA-sprayed alcohol

a. 97% of the volunteers felt no hangover on a subsequent day; thus, the temptation for further alcohol consumption was reduced.

b. After MIRGA spraying, the palatability of the alcoholic drink was improved.

c. Reduction in the health risks of alcohol.

d. Reduction in the unpleasant odor and irritation of alcohol.

e. MIRGA is highly economical, non-toxic and eco-friendly. No adverse or allergic reactions are found even upon spraying into the mouth, ears, eyes, human skin, animals and plants.

f. Direct spraying over the alcohol in an open glass or into the uncapped bottle reduced the number of sprays required to produce the same effects as spraying over the sealed bottle containing alcohol.

g. The invention background, a technique of mid-IR generation and the safety of MIRGA have been explained by Umakanthan et al., [6]; Umakanthan et al., [7]; Umakanthan et al., [8]; Umakanthan et al., [9]. (detailed discussion presented in Supplementary text T2).

The action of 2-6 μm mid-IR on alcohol

While spraying MIRGA, most of the generated mid-IR energy scatters through the air, penetrates the alcohol bottle and gets absorbed by alcohol molecules. Virtually all organic compounds (alcohol) absorb mid-IR radiation, which causes a change in the molecule's vibrational state from lower ground to an excited higher energy state [20]. This leads to changes in chemical bonds [21,22] and these bond parameter changes lead to consequent changes in alcohol's physical and chemical characters, configuration and compound transformation depending on the dose of mid-IR applied [23-26] as observed in this study. In short, depending on the number of MIRGA sprayings (energy given), alcohol's chemical bond configurations and subsequent physical and chemical characters can be altered to our desire. Mid-IR is a range in the infrared spectrum [27]. Naturally, infrared constitutes 66% of the sun's radiant energy that we receive daily [12]. In this study, the applied mid-IR absorbed [28] by molecules of alcohol and exerted a photostimulatory and photomodulatory effect [29,30]. This caused alterations in chemical bonds in alcohol, as demonstrated, viz. C=O stretching [21,22], C-OH breaking [31,32], formation of -C=OR [33], followed by chemical compound transformation, an example amide hydrolysis. Thereby, atomic rearrangement and physicochemical properties changed [34]; hence, alcohol acquired more health benefits.

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The results showed that 2-6 µm mid-IR generated from the MIRGA equipment caused chemical and molecular level changes in the alcohol components photodegradation. In this process, chemical components of the alcohol have absorbed the mid-IR generated by MIRGA spraying and the absorbed mid-IR photons have altered the chemical bonds of the alcohol molecule; thereby, the alcohol molecules are degraded/transformed into another molecule/ compound, as reported in the instrumentation results. Similar chemical changes were reported by Umakanthan et al. [6], Umakanthan et al. [7], Umakanthan et al. [8] and Umakanthan et al. [9], by using MIRGA in coffee, tea, cocoa, and edible salts. The inorganic compounds used in generating mid-IR are a perspective for biomedical applications [35,36], which is a new synthesis technique to prepare a functional material (2-6 µm mid-IR) [37,38]. It is known that combination of different compounds with excellent electronic properties, leads to new composite materials, which have earned great technological interest in recent years [39,40]. Alcoholism is traditional, hence alcoholism treatment too. Many therapies like de-addiction, pharmacological, placebo, psychological [1] and partial inhibition of aldehyde dehydrogenase inhibitor (ALDH) [41] in humans are under practice. Moreover, lesser inactivation of corticotrophin-releasing factor neurons in induced alcohol-dependence rats [42-44] was successfully done. However, the beneficial result depends only on the 'alcoholic's abstinence.' In our trial, using MIRGA made the alcohol safer or a healthy drink with regular pleasure. The MIRGA is safe, eco-friendly and economical - i.e., USD 0.3 per MIRGA unit emitting 300 sprayings. Umakanthan et al. [6] and Umakanthan et al. [9], have already disclosed the safety of MIRGA sprayed usable and MIRGA's primeval and future scope.

Conclusion

In this research, 2-6 µm mid-IR applied to the alcohol is found to provide many health benefits with economy and without adversity to drinkers. Further research is being conducted by altering the specificity of the MIRGA solution aimed to make the alcohol even better and healthier than what is argued in the present study. This technology has significant implications for multi-faculty research.

Author Contributions

i. Umakanthan: Conceptualization, Methodology, Resources, Supervision, Validation.

ii. Madhu Mathi: Data curation, Investigation, Writing - Original draft preparation.

iii. Umadevi and Sivaramakrishnan: Project administration, Visualization

iv. Umakanthan, Madhu Mathi: Writing- Reviewing and Editing.

Competing Interest

In accordance with the journal's policy and our ethical obligation as researchers, we submit that the authors Dr. Umakanthan and Dr. Madhu Mathi are the inventors and patentee of Indian patent for MIRGA (patent no.: 401387) which is a major material employed in this study.

Data and materials availability

All data is available in the manuscript and supplementary materials.

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