

Quantification of Ethanol in Commercial Hand Sanitizers by Fourier Transform Infrared Spectrometry and UV-Visible Spectrometry



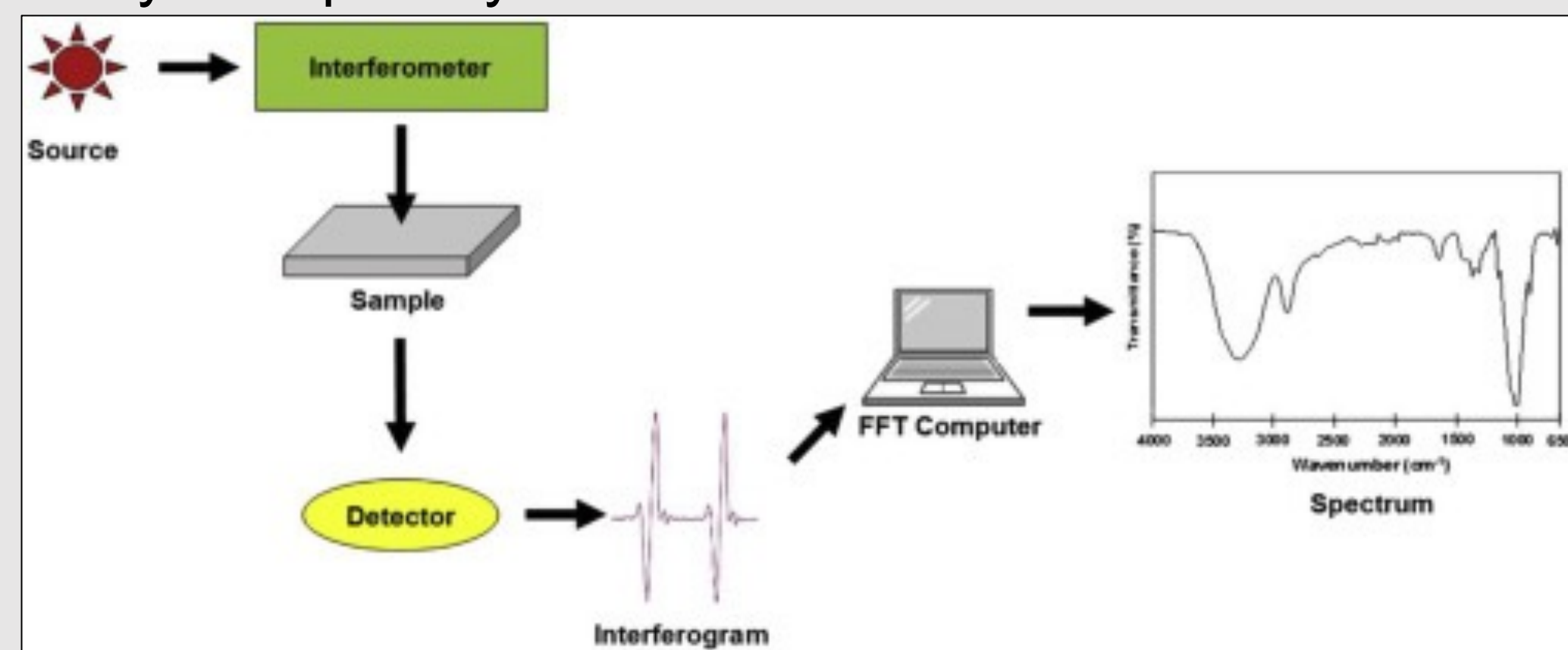
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Introduction

- The emergence of novel bacterial or viral pathogens has always posed serious risks to public health such as “Severe Acute Respiratory Syndrome Coronavirus 2” or SARS-CoV-2, known for causing COVID-19.
- In both healthcare and community settings, alcohol-based hand sanitizers have become a popular alternative to handwashing to prevent the spread of bacterial and viral infections like COVID-19, making it one of the essential ways in decreasing healthcare burden.
- Given the popularity of hand sanitizers during this pandemic, it is important to understand which types of hand sanitizers work best against this novel virus.
- Hand sanitizer manufacturers are required to ensure that hand sanitizer alcohol concentration meets the requirements set by health agencies.
- We have developed analytical methods based on Fourier transform infrared spectrometry (FTIR) and UV-visible spectrometry (UV-VIS) to quantify the content of ethanol in 22 commercial alcohol-based hand sanitizers.
- The methods presented in this study provide a quick and reliable way to identify and measure the ethanol concentrations in hand sanitizer.

Methods

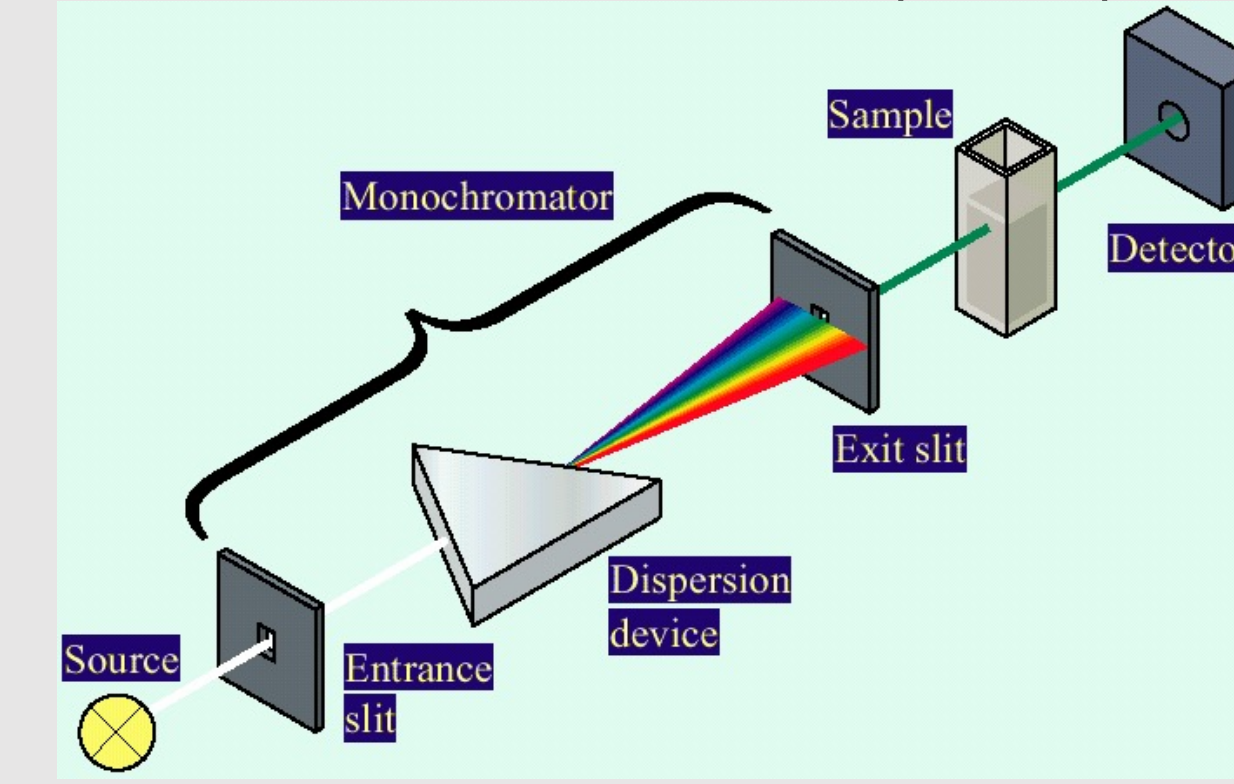
- FTIR analysis measures the range of wavelengths in the infrared region that are absorbed by a material.
- This is accomplished through the application of infrared radiation (IR) to a material. The resulting signal at the detector is a spectrum representing a molecular ‘fingerprint’ of the sample.
- The usefulness of FTIR arises because different chemical structures produce different fingerprints which can be used to identify and quantify molecules.



- A calibration curve was created using the absorbance levels (~9200 nm) obtained from running 50%, 60%, 70%, 80%, and 90% ethanol standards on the FTIR.
- Absorbance levels of the 22 hand sanitizers were also obtained.
- The acquired absorbances of the hand sanitizers were tested against the standards to determine the real quantity of ethanol present in each hand sanitizer.
- The experimental and listed percentages of ethanol were then compared to ensure the hand sanitizers fit the the listed ethanol concentration as required from national health agencies.

Methods

- UV-VIS can be used as another means to quantify the amount of molecules in a sample.
- UV-VIS is an analytical technique used to measure the amount of discrete wavelengths of UV or visible light that is absorbed by or transmitted through a sample in comparison to a reference sample (blank).
- This property is influenced by the sample composition, potentially providing information on what is in the sample and at what concentration.
- A calibration curve was created using the absorbance levels (~600 nm) obtained from running 0.2%, 0.4%, 0.6%, 0.8%, and 1.0% ethanol standards on the UV-VIS.
- Standards were prepared with 2% ethanol and a color reagent; ceric ammonium nitrate.



Results

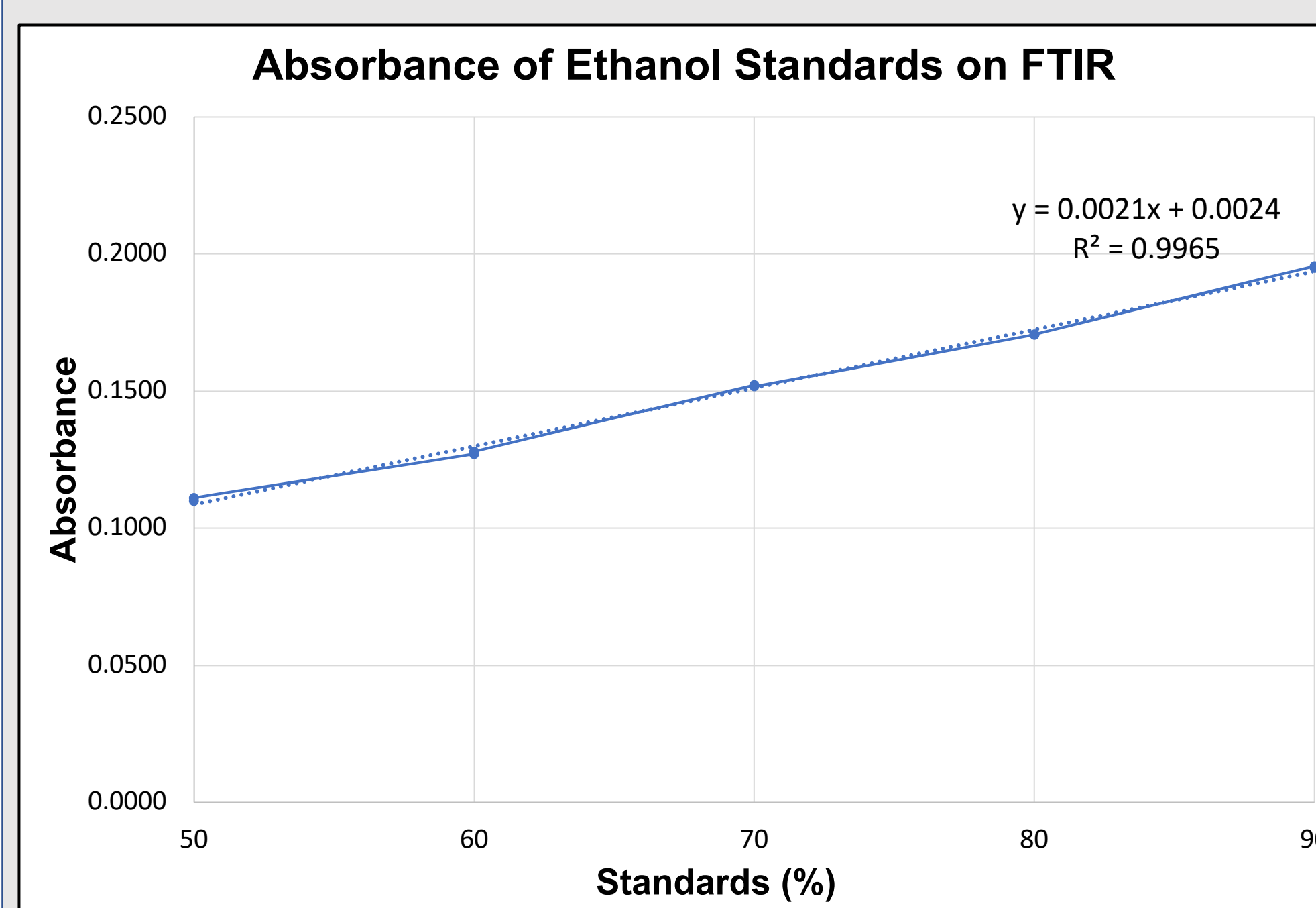


Figure 1. Calibration curve indicating the absorbance levels of the ethanol standards made at 50%, 60%, 70%, 80%, and 90% on FTIR. The equation was further used to quantify ethanol concentrations in hand sanitizers.

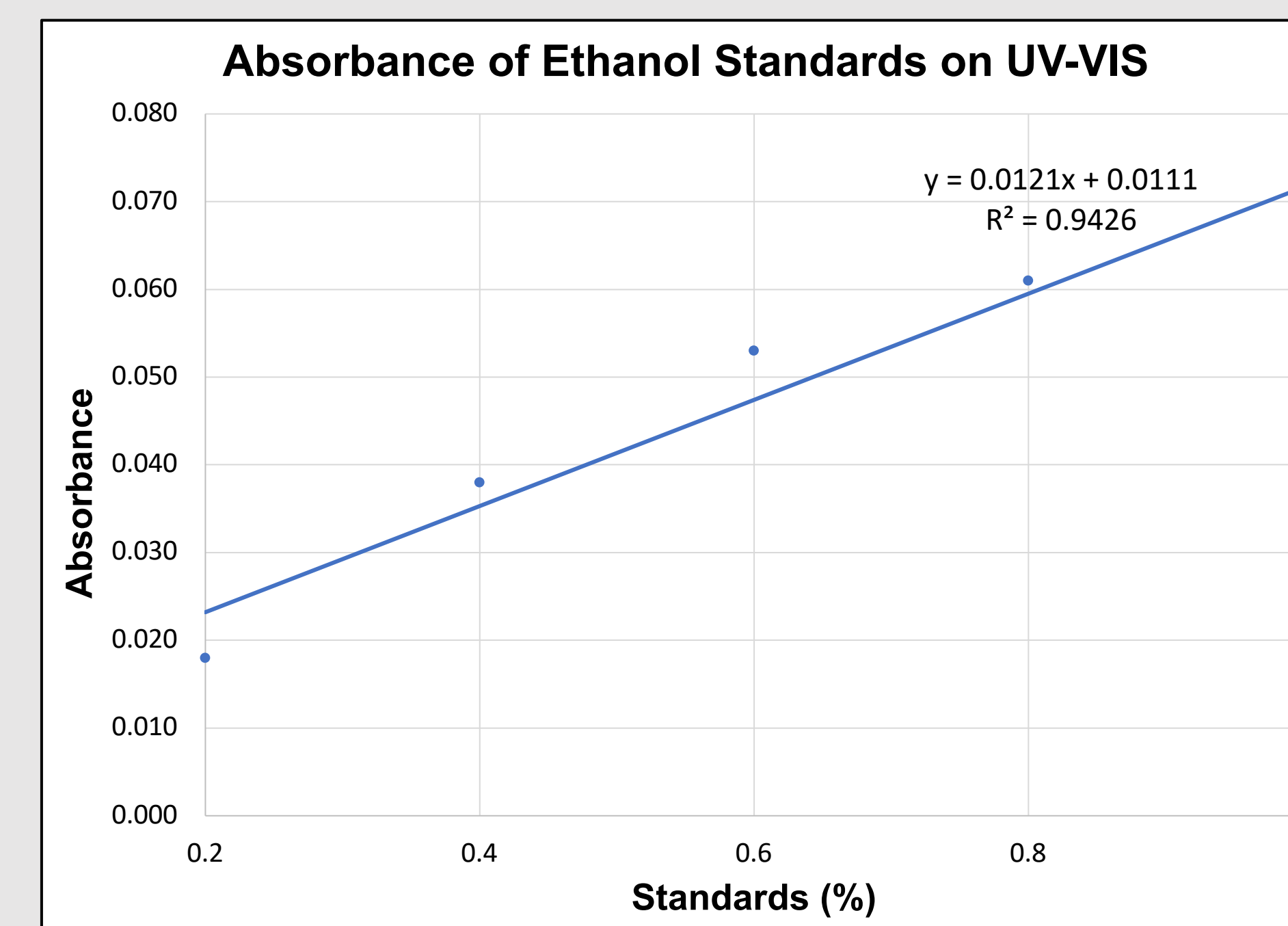


Figure 2. Calibration curve indicating the absorbance levels of the ethanol standards made at 0.2%, 0.4%, 0.6%, 0.8%, and 1% on UV-VIS. The equation was further used to quantify ethanol concentrations in hand sanitizers.

Commercial Name of Hand Sanitizer	Average Absorbance (Au) (n=2)	Listed Percentage (%)	Experimental Percentage (%)
All Clean	0.15490	70	73
Allora	0.13890	72	65
Delton +	0.14376	70	67
Delon + (Gel)	0.15590	62	73
Deserving Health	0.13730	70	64
Every Man Jack	0.13903	62	65
Germs Be Gone!	0.15303	65	72
Germ Force	0.14516	62.5	68
Hand MD	0.14113	62	66
Isocol	0.13250	62	62
Jaloma	0.13760	62	64
Lifebuoy	0.15323	70	72
Mellow	0.14520	70	68
Natural Concepts	0.15330	65	72
One Step	0.15320	70	72
Pomada	0.13473	70	63
SafeCheck	0.15780	75	74
Simply Clean	0.12600	62	59
Tag Vodka	0.15790	70	74
Wish	0.14793	75	69
Zensa	0.14526	65	68
Zytec	0.14660	70	69

Table 1. Average absorbance (n=2) of 22 hand sanitizers with their listed and experimental ethanol percentages.

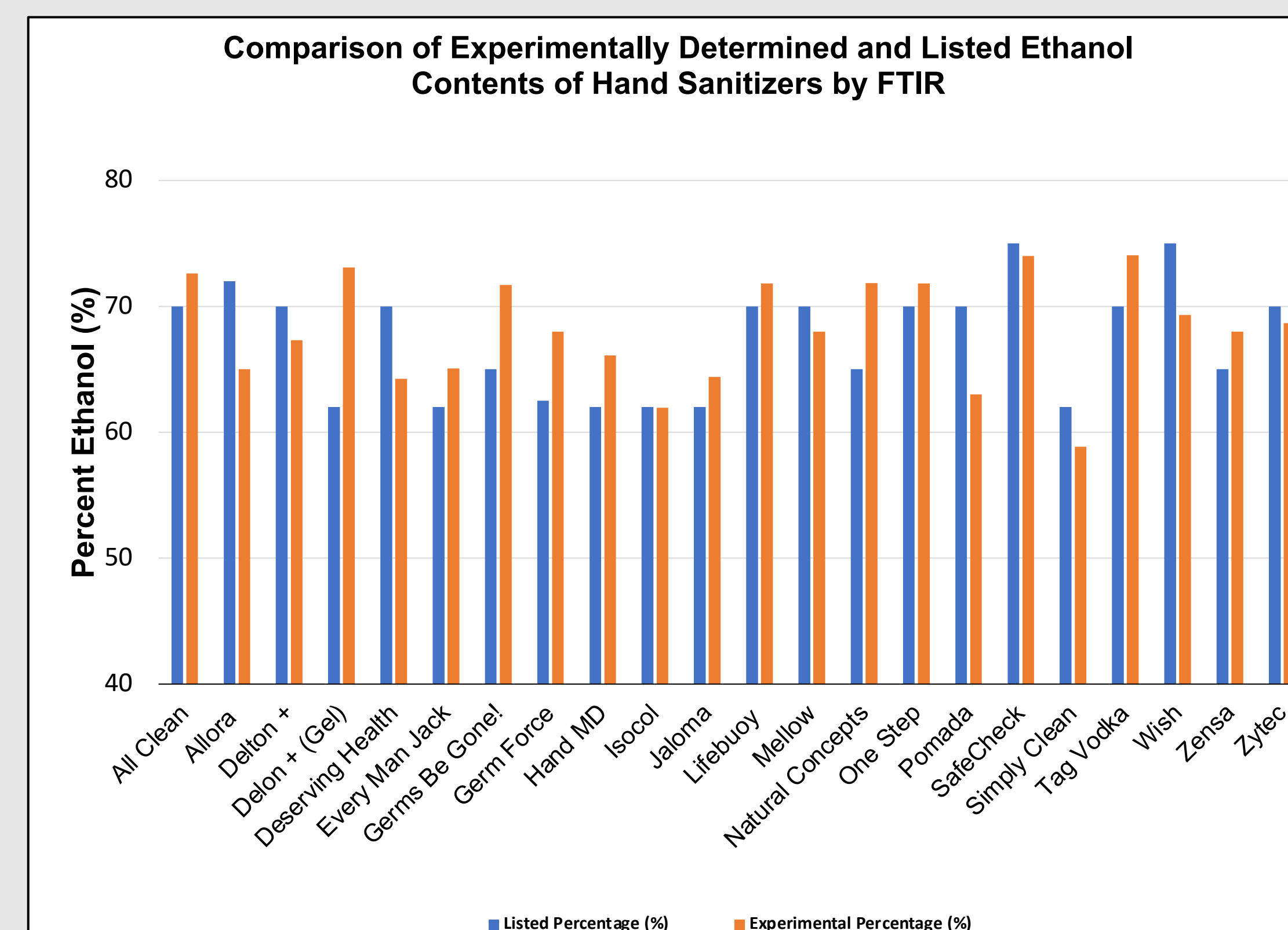


Figure 3. Comparison between the experimentally determined and listed ethanol contents of the 22 hand sanitizers tested by FTIR.

Discussion

- Through this experiment, we can conclude that the listed ethanol content on most of the 22 commercially sold hand sanitizers was almost accurate as the values were very close to our experimental values.
- The average listed ethanol content in the 22 randomly selected samples and our experimental values was 67.34% ± 4.34 and 68.14% ± 4.18, respectively. There is no significant differences in the mean values.
- Because of the minimal difference between listed and experimental values, it can be inferred that the technique used (i.e., FTIR) was able to quantify ethanol concentration accurately and efficiently.
- UV-VIS displayed an accurate calibration curve.
- Our experiment confirms that even in the midst of a pandemic, the commercial suppliers met health agencies’ guidelines for alcohol content in hand sanitizers.

Future Work

- Currently, the UV-VIS method is ongoing and will be applied to analyzing all the hand sanitizers already analyzed with FTIR. This will be done to further validate the observations made thus far.
- Doing so will further confirm that the results from the hand sanitizers tested so far are accurate.

Acknowledgements

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