Ethanol Content of Various Foods and Soft Drinks and their Potential for Interference with a Breath-Alcohol Test

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Abstract

A variety of breads and soft drinks were tested and found to contain low concentrations of alcohol. The potential for these products to generate false readings on an evidential breath-alcohol instrument was evaluated. Alcohol-free subjects ingested these products and then provided breath samples into a DataMaster. It was found that breath samples provided immediately after consumption of some of these products, or with them still present in the mouth, did produce low levels of apparent breath alcohol, which may or may not be rejected as invalid by the breath-test instrument. If the subject swallowed or expectorated the food or beverage and then observed a 15-min deprivation period during which nothing was introduced into the mouth, the apparent effect was eliminated. These findings emphasize the need for the mandatory pretest alcohol-deprivation period and the benefits of duplicate breath sampling.

Introduction

It is well known that alcohol is retained in the mouth for a short period following consumption of alcoholic beverages, or following use of alcohol-containing breath sprays or mouth washes (1). Breath-alcohol tests given immediately following the use of these products can cause inaccurate results, and a 15-min alcohol deprivation period is therefore an appropriate part of any evidential breath-alcohol test. Other workers have evaluated the kinetics of mouth-alcohol elimination (1) and the effects of dental adhesives and appliances on mouth-alcohol retention (2). We have evaluated other factors related to mouth-alcohol retention, including the effect of wearing oral jewelry in a pierced tongue (3) and the effects of ethanol-containing aerosol medications (4). In both of these cases, and in common with the two earlier reports, we found that a 15-min alcohol-deprivation period provided an assurance against interference of these products or processes with the breath-alcohol test.

A newsletter for attorneys specializing in driving-under-the-influence (DUI) litigation (5) recently indicated that bread in the mouth could produce an apparent breath-alcohol reading on an Intoxilyzer 5000. That author and a commentator implied that, in some way, this jeopardized the results of breath tests conducted on that instrument. In another report (6), it was noted that certain common non-alcoholic beverages, including sodas and fruit juices, did in fact contain small amounts of ethanol, and the authors warned of the potential for these to adversely effect breath-alcohol results if they were consumed immediately before the breath test.

Many breath-test instruments, including the BAC DataMaster (National Patent Analytical Systems, Mansfield, OH), monitor the exhalation profile as a subject exhales into the instrument, and if a sufficiently negative slope (decline of 0.001 g/210 L over four consecutive, quarter-second averages) is detected, the sample is considered a result of mouth alcohol and is rejected as invalid. We have, however, observed instances where, in the absence of a 15-min deprivation period, low levels of mouth alcohol (0.01–0.02 g/210 L) in alcohol-free subjects do not create a sufficiently steep slope to cause the samples to be rejected.

We conducted a series of experiments in order to evaluate the alcohol content of some baked foods and non-alcoholic beverages, and then evaluated the potential for their consumption immediately before a breath-alcohol test to either trigger the invalid sample detection (mouth alcohol) systems, or to produce inaccurate breath-alcohol results.

Methods

A number of soft drinks (Table I) and a variety of baked goods (Table II) were purchased from grocery stores and bakeries in the Seattle area. Aliquots of the beverages were sampled and placed in 10-mL headspace vials. Likewise, portions (100 mg) of the breads, excluding the crust, were sampled, weighed, and placed in 10-mL headspace vials for alcohol analysis. If the bread contained fruit, the fruit was removed and tested separately. A solution (800 µL) of n-propanol in water (1 g/L) was added as an internal standard. The samples were analyzed in triplicate by headspace gas chromatography (7).

A DataMaster instrument was calibrated before testing and determined to have a precision of better than 3% and an accuracy of better than 5%. The instrument was attached to an analogue/

digital converter (MacLab, Milford, MA) to allow real-time monitoring of the exhalation profiles. A subject rinsed her mouth for 20 s with alcohol/water solutions at different concentrations, expectorated, and provided breath samples into the DataMaster.

Table I. Ethanol Content of Various Soft Drinks

Product	Ethanol concentration* (g/100mL)
Calistoga Lime Flavor	0.084
Diet 7Up	0.075
Canada Dry Ginger Ale	0.063
Diet Sprite	0.051
Calistoga Lemon Flavor	0.051
Hawaiian Punch	0.012
Mandarin Orange Slice	0.000

*Mean of three determinations.

Table II. Ethanol Content of Various Baked Goods

Product	Contains yeast*	Ethanol concentration[†] (g/100g)
Downey's Original Jim Beam Kentucky Bourbon Cake	Y	1.662
Apple from Great Harvest Apple Walnut Roll	Y	1.066
Rosemary Onion Bread	Y	0.980
Great Harvest Apple Walnut Roll	Y	0.956
Raisin from Sun Maid Raisin Bread	Y	0.601
Home Pride Wheat Bread	Y	0.470
Thomas' Sourdough English Muffin	Y	0.445
Domino's Raw Pizza Dough	Y	0.420
Original Wonder Bread	Y	0.371
QFC Plain Donut	Y	0.347
Oroweat Extra Sour Rye Bread	Y	0.326
Ala Francaise Sourdough Round	Y	0.307
QFC Chocolate Donut	Y	0.289
Sun Maid Raisin Bread	Y	0.276
Oroweat Oatnut Bread	Y	0.272
Oroweat 3-Seed Bread	Y	0.248
Home Pride Wheat Hamburger Buns	Y	0.189
Francisco Outdoor Rolls (Hoagie-type roll)	Y	0.132
Basson Baker Pita Bread	Y	0.109
Crumpet	Y	0.100
Domino's Pizza Crust (edge)	Y	0.088
Domino's Pizza Crust (base)	Y	0.081
Noah's Bagel	Y	0.040
Crisp Bread (toasted totally dry bread)	Y	0.006
Bread Stick	Y	0.004
Mini Preztel	Y	0.000
Hostess Twinkie	N	0.029
QFC Poppy Seed Muffin	N	0.000
Ritz Cracker	N	0.000
Triscuit Cracker	N	0.000
Graham Cracker	N	0.000
Sun Maid Raisin	N	0.000

* Ingredients list indicates yeast.
† Mean of three determinations.

Similarly, the beverages were introduced into the mouth, rinsed for 20 s, expectorated, and breath samples provided into the DataMaster. Bite-sized samples of each of the breads were introduced into the mouths of alcohol-free subjects, who chewed the bread for 20 s without swallowing and then gave multiple breath samples into the DataMaster. The bread was swallowed 46 s after the first breath, and successive breath samples were provided. The response of the DataMaster was noted. All subjects gave informed consent.

Results and Discussion

The experiments to evaluate the slope detector gave the following results. Breath samples obtained immediately following rinsing with solutions of alcohol and water at a concentration of 0.149 g/100 mL or less, were not detected as invalid, and did repeatedly produce apparent breath alcohol readings on the DataMaster, in the range 0.012–0.017 g/100 mL. Higher solution concentrations (0.183–0.248 g/100 mL), produced invalid sample response, and no breath-test result was obtained. When that happened, subsequent breath samples were provided until the apparent ethanol concentration returned to zero, which occurred within 3.5 min in every case. It is evident from these results that the slope detector feature was unable to distinguish mouth-alcohol concentrations at these very low levels; however, a 15-min alcohol-deprivation period before the test would prevent any interference by the alcohol rinse. Obviously, the higher the concentration of alcohol used in the rinse, the longer the time required for complete elimination. Our previous experience and reports of other authors (2) have shown, however, that 15 min is also adequate for the elimination of the effects of rinsing with 40 g/100 mL alcohol/water solutions and that in cases where the subject is not alcohol free, the time to re-establish the baseline breath-alcohol reading is even less.

The soft drinks selected for testing were among those reported by Goldberger et al. (6) to have the highest alcohol content. Table I shows the alcohol concentration of the beverages tested, the highest of which was 0.084 g/100 mL (Calistoga lime). Having established here that solution alcohol concentrations of 0.183 g/100 mL or greater will result in invalid samples, it was anticipated that these beverages would not trigger the invalid sample detector and might be accepted as apparently valid breath samples. In practice, this was this was, in fact, observed; however, in 28 tests, the range of readings observed immediately after a 20-s rinse with the beverage was 0.000–0.007 g/210 L in all cases. When a second breath sample was provided 2 min later, the reported result was 0.000 or 0.001g/210L. There appears to be little potential, therefore, for these sodas, even when consumed immediately before

the breath sample is provided, to affect the breath test in a meaningful way. Furthermore, when the 15-min alcohol-deprivation period is observed, the effect is eliminated entirely.

Table II shows the alcohol content by weight of each of the breads tested. Most baked products with listed contents indicating they contained yeast did in fact have some alcohol present. Alcohol is produced by the fermentation process in yeasts by their action on simple sugars used in preparing the dough. Carbon dioxide, a by-product of fermentation, is responsible for the rising of the dough. There have been two reports of ethanol intoxication in dogs that ate uncooked pizza dough (8) and sourdough (9). In the latter case, approximately 250 mL of a sourdough starter with an alcohol content of 13% was consumed, resulting in a blood-alcohol concentration of 0.328 g/100 mL in the dog. The animal recovered.

Although most of the alcohol in the dough is lost during the baking process, some is evidently retained in the matrix of the bread. The actual amount is very low in the context of the alcohol content of alcoholic beverages, however. Domestic beer in the United States, for example, is approximately 4% alcohol by weight. The highest alcohol concentration in the breads tested was 0.98% by weight, and the alcohol concentration in the bourbon cake was 1.66%. A person would have to consume about 3 lbs of bread, or 1.75 lbs of bourbon cake, to get an amount of alcohol equivalent to that contained in one 4%, 12-oz. beer. The likelihood of anyone testing positive for alcohol from cooked bread consumption, let alone becoming intoxicated, is therefore remote.

The breath samples given by the subjects with bread still in their mouths did cause a response on the DataMaster. Breath samples following chewing of breads with high alcohol content, such as the apple walnut bread, produced apparent readings, which were accepted by the instrument, of as high as 0.027 g/210 L. Importantly, the reading after 2 min (as would be obtained in an evidential test with duplicate testing) was 0.005 g/210L or less in all cases. The highest reading obtained in approximately 20 attempts (0.046 g/210 L) was obtained 1 min and 15 s after chewing the bourbon cake. Previous samples were rejected as invalid. Again, the duplicate sample provided 2 min after the accepted sample was 0.006 g/210 L or less in every case. Chewing technique and breathing pattern significantly altered the apparent peak breath-alcohol concentration and the apparent, accepted breath-alcohol result, but it is evident that the mouth-alcohol or invalid-sample detector cannot distinguish between alcohol in breath coming from the lungs and alcohol resulting from equilibration in the tissues of the oral mucosa following chewing or rinsing. Also important are the short duration of this effect and the fact that the 15-min deprivation period before the breath test would eliminate the possibility of this interference. Similarly important is the additional protection provided against mouth alcohol interference by the use of duplicate breath sampling because the majority of any mouth alcohol is eliminated during this 2-min interval.

These findings emphasize the importance of administrative safeguards against interference of mouth alcohol with the test. The breath-test protocol in the state of Washington (10) requires the subject to affirm, or the operator to check, that the subject has nothing in his or her mouth before the breath test. This check is then followed by a 15-min deprivation period, during which the subject "has nothing to eat, drink, or smoke". Based on the above findings, this protocol would in practice prevent any interference from alcohol in bread or soft drinks with the results of a breath-alcohol test.

Conclusion

The importance that judges and juries in criminal cases attach to quantitative breath-alcohol results justifies a serious review of factors raised as potential deficiencies in the accuracy and reliability of the breath-alcohol test. Exogenous or mouth alcohol causing interference with the subject's true breath-alcohol concentration is often raised as one such concern. Both leavened breads and some soft drinks contain sufficient amounts of alcohol to cause this effect, albeit at a very low level. We found that, particularly at low concentrations but as high as 0.046 g/210 L, mouth alcohol, rather than expiratory breath alcohol, may be reported as apparent true breath alcohol when the required deprivation period is not observed. The slope detector is only one element of the protections to the subject against mouth-alcohol interference. When all three protections, slope detector, duplicate testing, and 15-min deprivation period, are present, the potential for mouth-alcohol interference from bread or soft drinks is reduced to zero.

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