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Beer under Social Conditions

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THE MOUTH ALCOHOL EFFECT AFTER A "MOUTHFUL" OF BEER UNDER SOCIAL CONDITIONS

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ABSTRACT

Fifteen male and fifteen female alcohol-free subjects consumed a "mouthful" of beer (5%v/v alcohol) from a beer bottle. Intoxilyzer[®] 5000C tests were conducted five and ten minutes after the consumption of beer. The volume of beer consumed by the male subjects (range 26-146 mL, mean 85 mL) was significantly greater than the volume consumed by the female subjects (range 16-141 mL, mean 37 mL). The subjects were allowed to talk during the experiment to simulate social conditions. A positive breath alcohol concentration (BrAC) occurred in 13 subjects (43%) five minutes after the consumption of beer (range 0.007-0.016 g/210 L breath, mean 0.011 g/210 L). Ten minutes after the consumption of beer, the measured BrAC's in all subjects were zero. There was no apparent correlation between the BrAC and the amount of beer consumed. The Intoxilyzer[®] 5000C did not identify any of these low BrAC's as "mouth alcohol". This study shows the duration of a significant mouth alcohol effect for consuming beer under social conditions is less than the usual 15-20 minutes. This decreased deprivation time may facilitate more rapid breath alcohol screening tests in the field.

RÉSUMÉ

Quinze hommes et quinze femmes qui s'étaient abstenus de toute consommation alcoolique avant l'expérience ont avalé une "gorgée" de bière (alcool de 5% v/v). Le volume de bière consommée par les hommes (écart de 26 à 146 mL, moyenne de 85 mL) était significativement plus grand que le volume de bière consommée par les femmes (écart de 16 à 141 mL, moyenne de 37 mL). Il était permis aux sujets de parler durant cette expérience afin de simuler des conditions sociales. De l'alcool a été décelé dans l'haleine de treize des sujets (43%) cinq minutes après la consommation de bière (écart de 0.007 à 0.016g/210L d'haleine, moyenne de 0.011g/210L). Cependant, aucun alcool n'a été décelé dans l'haleine de tous les sujets dix minutes après la consommation de la gorgée de bière. Il n'y avait aucune relation apparente entre la consommation d'alcool dans l'haleine et la quantité de bière qui avait été consommée. L'instrument Intoxilyzer[®] 5000C n'a pas identifié ces faibles concentrations d'alcool dans l'haleine comme étant de "l'alcool dans la bouche". Cette étude démontre que la durée de temps durant lequel l'alcool de la bouche a un effet significatif, après la consommation de bière dans des circonstances sociales, est inférieure à la période anticipée de 15 à 20 minutes. Ce phénomène pourrait donc faciliter un criblage plus rapide de l'alcool dans l'haleine durant des épreuves réelles.

INTRODUCTION

The effect of residual alcohol in the oral cavity (mouth alcohol effect) is potentially the most serious problem that can affect breath alcohol testing. Various measures have been adopted to prevent this from occurring, including duplicate breath alcohol testing, mouth alcohol detectors and deprivation times of 15 - 20 minutes (1). The mouth alcohol effect

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has been studied for many years, but most testing has involved rinsing the mouth with various alcoholic beverages, spitting it out, and conducting multiple breath testing every one to three minutes (2-4). This is not a realistic representation of what occurs in the field. Most alcoholic beverages are not rinsed in the mouth, but swallowed, and breath tests are not conducted every one to three minutes. This study was conducted to determine the mouth alcohol effect under more realistic conditions after drinking a "mouthful" of beer.

The volume associated with the ingestion of a "mouthful" of beer was also measured, as this is a frequently asked question in forensic cases. Namely, what effect would a last mouthful of beer consumed just before or after a driving incident have on the blood alcohol concentration. Knowledge of such volumes would allow the forensic alcohol toxicologist to predict the effect of the absorbed alcohol from the mouthful of beer on any calculated or estimated BAC outside of the mouth alcohol effect examined in this paper.

METHOD

Fifteen male and fifteen female alcohol-free subjects were asked to consume a normal or usual "mouthful" of beer from a standard beer bottle that was opened in front of them. The subjects did not have dentures or any other oral appliances in their mouths. Each bottle was labelled as containing 341 mL of beer (5% alcohol v/v). After consumption of the beer, the subjects were allowed to talk freely in order to simulate social conditions. The subjects were then tested on an Intoxilyzer[®] 5000C (CMI Inc. Owensboro, Ky, USA) five and ten minutes after the consumption of beer. The Intoxilyzer[®] 5000C is a three-wave-length infrared evidentiary breath alcohol instrument approved for use in Canada (5). A spit-trap mouthpiece was changed after every breath test.

The breath alcohol concentrations (BrAC's) are reported in this study as grams of alcohol in 210 litres of breath (g/210 L). This unit is equivalent (when multiplied by 1000) to a blood alcohol concentration (BAC) measured in milligrams of alcohol in 100 millilitres of blood when using the forensically acceptable blood/breath alcohol ratio of 2100:1. The Criminal Code of Canada and the Recommended Standards and Procedures of the Canadian Society of Forensic Science Alcohol Test Committee use these units (mg/100 mL) to define a BAC whether it is obtained from blood or breath samples (6).

The Intoxilyzer[®] 5000C records all BrAC's < 0.007 g/210 L as 0.000. The accuracy of the Intoxilyzer was checked before and after each sequence of testing of the subjects using a simulator (Model 34C, Guth Laboratories Inc., Harrisburg, PA, USA) and all results were within $\pm 5\%$ of the target value of 0.100 g/210 L.

The volume of beer consumed was determined by measuring the volume of beer remaining in the bottle using a graduated cylinder, and subtracting that amount from the labelled volume (341 mL). The tests were conducted after lunch in order to ensure that the beer was absorbed slowly and coupled with the "first-pass" effect, no significant positive Intoxilyzer result or breath alcohol concentration (BrAC) should be obtained from the absorption of the beer within the ten minute study period (7).

RESULTS AND DISCUSSION

Table 1 shows the volume of a "mouthful" of beer consumed by the male subjects and the BrAC's after five and ten minutes. Table 2 shows the volume of the "mouthful" of beer consumed by the female subjects and the BrAC's after five and ten minutes. The tables are arranged according to the volume of the mouthful of beer.

The volume of beer consumed by the male subjects (range 26 – 146 mL, mean 85 mL) was significantly greater than the volume consumed by the female subjects (range 16-141 mL, mean 37 mL) ($p = 0.001$).

TABLE 1

Volume of Beer Consumed and Intoxilyzer® Results (BrAC) After Five and Ten Minutes for Male Subjects

Subject #	Volume of Beer Consumed/(mL)	BrAC After Five Minutes/ (g/210 L)	BrAC After Ten Minutes/ (g/210 L)
1	146	0	0
2	141	0.011	0
3	131	0.013	0
4	106	0	0
5	106	0	0
6	101	0.013	0
7	101	0.008	0
8	91	0.007	0
9	86	0	0
10	71	0	0
11	71	0.012	0
12	41	0	0
13	31	0	0
14	26	0.013	0
15	26	0	0
Range	26-146	0-0.013	0
Mean	85	0.005	0
SD	40	0.006	0

TABLE 2

Volume of Beer Consumed and Intoxilyzer® Results (BrACs) After Five and Ten Minutes for Female Subjects

Subject #	Volume of Beer Consumed/(mL)	BrAC After Five Minutes/ (g/210 L)	BrAC After Ten Minutes/ (g/210 L)
16	141	0.016	0
17	46	0	0
18	41	0.015	0
19	41	0	0
20	41	0	0
21	41	0.007	0
22	31	0	0
23	26	0.008	0
24	26	0	0
25	26	0	0
26	26	0	0
27	21	0.009	0
28	21	0.013	0
29	16	0	0
30	16	0	0
Range	16-141	0-0.016	0
Mean	37	0.005	0
SD	30	0.006	0

After five minutes, the consumption of beer caused a BrAC > 0.010 g/210 L in only eight (27%) of the subjects. The highest BrAC obtained after five minutes due to mouth alcohol was 0.016 g/210 L. After ten minutes, all subjects had an apparent BrAC of 0.000 or zero as recorded by the Intoxilyzer® (i.e. < 0.007 g/210 L). There was no correlation between the amount consumed and the BrAC due to mouth alcohol at five minutes ($r^2 = 0.08646$).

There are several reasons for the more rapid dissipation of the mouth alcohol effect after swallowing beer observed in this study. According to Denny and Williams (8), there are

four major areas in the human mouth that can trap alcohol: the back of the throat, the top of the tongue, underneath the tongue, and between the gums and mouth walls. Swallowing causes only the back of the throat and top of the tongue to come into significant contact with the alcoholic beverage and it is generally believed that these areas are more rapidly cleared of alcohol. In contrast, rinsing the mouth with an alcoholic beverage, which is the method typically used in mouth alcohol studies, causes the alcoholic beverage to also be in contact with the oral cavity underneath the tongue and between the gums and mouth walls; this is believed to cause a prolonged "tailing" of the mouth alcohol effect (8).

Another reason that the mouth alcohol effect disappeared more rapidly in our study is that beer, which contained 5% alcohol by volume was used. In general, the higher the alcohol concentration the greater the mouth alcohol effect. Caddy et al. (9) showed that when 15 mL of three different alcoholic beverages are retained in the mouth for 15 seconds and then expectorated, beer (4% alcohol/vol) had the shortest time for the mouth alcohol effect (9.3 minutes). Wine (12% alcohol/vol) had a duration of 12.3 minutes, and vodka (40% alcohol/vol), 15.3 minutes.

The last factor is that the subjects were allowed to talk freely as would occur in a social situation and did not have their mouths closed as is typically found in mouth alcohol studies. It is expected that by allowing the subject to talk, there would be a greater evaporation of the alcohol in the mouth causing a more rapid disappearance of the mouth alcohol effect.

The shorter duration and magnitude of the mouth alcohol effect after the consumption of beer may facilitate more rapid roadside breath alcohol testing and refute claims of the results being substantially affected by the mouth alcohol unless a clear 15 to 20 minutes have elapsed after the consumption of an alcoholic beverage. The Recommended Standards and Procedures of the Canadian Society of Forensic Science Alcohol Test Committee indicates that a breath test shall not be conducted until at least fifteen minutes after the time the subject *stated* alcohol has been consumed (6). It has been argued in Ontario Criminal courts that the subject was either confused or inaccurate about the time told to the police that alcohol was last consumed, and that perhaps only ten minutes had elapsed. Therefore, it has been argued, the breath alcohol screening results were very inaccurate due to the mouth alcohol effect, and the police could not have reasonably formed the grounds to arrest the subject (i.e. that the subject's BAC was over 80 mg/100mL).

The approved screening devices used in Ontario are all calibrated to indicate a FAIL or "F" at a BrAC of 0.100 g/210 L or more (10). Even assuming that the zero result recorded by the Intoxilyzer in our study could be up to 0.006 g/210 L, the FAIL result would still accurately indicate that the BAC was over 80 mg/100 mL even if the beer had been consumed only ten minutes prior. The police would, therefore, still have proper grounds for the arrest.

An interesting aspect of our study is that there appears to be no correlation between the volume of beer consumed and the duration and extent of the mouth alcohol effect. This is probably related to the fact that during the swallowing of the beer the surface area in contact with the beer (the back of the throat and the top of the tongue) is approximately the same no matter what volume of beer passes over this area while swallowing.

The Intoxilyzer[®] 5000C did not identify any of the positive BrAC's in the alcohol-free subjects as being mouth alcohol. This is in agreement with other studies and indicates for evidential breath alcohol testing that total reliance should not be placed on mouth alcohol detection systems, especially at low BrAC's (1,11).

Finally, the volume of beer consumed in a mouthful was significantly greater for male subjects than female subjects. As shown in Tables 1 and 2, the mean volume consumed by males was 85 mL compared to 37 mL for females. Another study found that the mean volume for a "sip of beer" from a glass in 16 male subjects was 39 mL when consumed free of charge in the laboratory, however, this volume decreased to 27 mL when the subjects paid for the consumed beer in a barroom (12). The differences between this early study and ours may be due in part to the fact that in our study the beer was consumed from a beer bottle rather than a glass.

The volume of a mouthful of beer found in this study may be of use to the forensic alcohol toxicologist in cases where there is evidence that the subject consumed a mouthful of beer just prior to or after driving. The appropriate volumes can be used to calculate the effect of this mouthful of beer on the subject's BAC (13).

CONCLUSION

Under more realistic conditions (i.e. swallowing a mouthful of beer and talking freely) any significant mouth alcohol effect disappeared within ten minutes. Even after five minutes a BrAC > 0.010 g/210 L occurred in only eight of the subjects (27 %) and the highest false positive BrAC was 0.016 g/210 L. Thus, in the field during roadside breath alcohol screening, a full 15 to 20 minutes deprivation time may not be required if the subject has consumed beer.

ACKNOWLEDGEMENTS

We wish to acknowledge the support and assistance of Steve Lintlop and Brendon Lalonde.

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