

Effect of Carbohydrates in alcohol elimination

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Study Aims: To study the influence of small amounts of carbohydrates on alcohol intake and elimination in a group of volunteers.

Evaluating the possible influence of carbohydrate type on alcohol elimination in this group of volunteers.

Subject Background: Works such as those of Ramchandi et al. (2001) have evaluated the effect of food on alcoholic drink pharmacokinetics after oral intake. These foods increase alcohol elimination rates reducing alcohol expired during the study, as well as reducing their blood intoxication.

Similar results have been obtained by Jones et al. (1997) using the same kind of foods but with caloric contents close to 3000 kcal. It is currently known that there are important delays in gastric emptying depending on the type of food.

In view of these considerations, a study is proposed in order to evaluate the influence of foods with a caloric contribution of 250 kcal, markedly less than that used in these prior studies and whether the solid or liquid form of the foods administered may have an influence on body alcohol elimination rates and on maximum values obtained in excreted alcohol curves.

Materials: Glucidic cereal extract in liquid form (Pirofructol®) containing 68.6 grams of carbohydrates and 275 kcal per 100 grams. The remaining components are usual in a Mediterranean breakfast.

Methods: A prior study is performed in which the amount of alcohol is adjusted in order to be able to evaluate the alcohol elimination curve by means of a previously calibrated breath test. This study allows fixing at 0.40 - 0.50 g of ethanol per kg of weight. Similar doses (0.40 - 0.65 g/kg) were used in blood and breath ethanol concentration comparison studies by Jones A. W. and Andersson (2003).

A multiple study is performed with 16 subjects performed in four sessions. The subjects are divided into four groups of four individuals each, each group performing one test per session. Subjects had a minimum 7 day interval between tests.

All the subjects have fasted for at least 12 hours and have not taken alcohol in the previous 48 hours

In test I, the subjects ingest a 28 ml dose of ethanol in the form of a 40% w/w solution.

In test II, the subjects ingest the same alcohol dose, then taking a solid breakfast less than 5 minutes later containing the equivalent to 34.8 g % of carbohydrates and 154.8 kcal. (usual Mediterranean breakfast values).

In test III, the subjects ingest the same alcohol dose, taking a liquid breakfast less than 5 minutes later with the same carbohydrate and kcal content (equivalent to 34.8 g % of carbohydrates and 151.5 kcal).

In test IV, the subjects ingest the same alcohol dose, taking a liquid food supplement with the same carbohydrate proportion less than 5 minutes later (equivalent to 34.0 g % of carbohydrates and 96.25 kcal), usual Mediterranean breakfast values.

Table I shows the content and composition of each one of the meals performed in this study.

Table I. Composition and content of each one of the tests.

Content	Test I	Test II	Test III	Test IV
Alcoholic Sol.	(equiv. to 28 ml ethanol)	(equiv. to 28 ml ethanol)	(equiv. to 28 ml ethanol)	(equiv. to 28 ml ethanol)
		60 g white bread tomato salt 100 ml water	25 g sugar dissolved in water 90 ml milk	52.5 ml pirofructol
Total carbohydrates		60 g	25 g	36 g
% carbohydrate calories		34.8	34.8	35.8
Total Calories (Kcal)		154.8	151.5	144.37

Procedure: At the beginning of each session the subjects are subjected to a first breath test in which the absence of breath alcohol is determined. The subjects ingest the carbohydrate in less than 10 minutes and 5 minutes later they take the alcohol samples. A breath test is performed every 15 minutes during a 2 hour and 45 minute time period. The breath alcohol analyzer (Dräger alcoltest 7410) was the same for all tests and was previously calibrated.

Data Analysis: BrAC_{0-inf}, C_{max}, t_{max} and I_{min-I} are determined for each subject. Comparison of the different parameters is performed using a one-way analysis of variance method and a multivariate analysis to study the influence of sex and the different food groups in the BrAC study.

Results: The results for alcohol exhaled by each volunteer for each of the different tests is shown in Figures 1-16.

C_{max} and t_{max} values are calculated from the maximum values for each volunteer. First order elimination kinetics are shown for all volunteers, which are used to calculate elimination constant I adjusted to an independent model. Finally, the area under the curve is calculated for the amount of alcohol exhaled (BrAC) for each volunteer.

The comparison between the different studies is determined from these parameters.

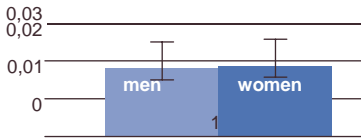
Annex I Graphs. Table II shows the characteristics for the subjects included in this study.

Table II. Demographic study of the volunteers subjected to the study.

	Women (n=8)	Men (n=8)
Weight (kg)	56.01 ± 4.03	69.46 ± 6.54
Body mass (kg/m ²)	20.10 ± 2.72	21.21 ± 1.35

As expected, women showed a smaller body weight value than men ($p < 0.0001$). However, there is no significant difference in the body mass study ($p = 0.3555$) between the values observed in the women and men groups. These results can be related to elimination constants (I) observed in the women and men groups with empty stomachs (see Figure 17). In this case there are no significant differences ($p = 0.6762$) between both groups, observing a high standard deviation in both groups, attributed to

the existence of some volunteers who are quite separated from these mean values.



There being four volunteers with high I, two men with values of 0.024 y 0.026 min^{-1} and two women with values of 0.026 and 0.027 min^{-1} .

Whereas there are two other volunteers, one man and one woman with low I (0.011 min^{-1} in both cases). These previous studies allow us to incorporate these subjects in different groups having greater or smaller alcohol elimination rates.

When studying the C_{max} and $e t_{\text{max}}$ values in these volunteers with empty stomachs it is observed that maximum concentrations are $0.25 \pm 0.063 \%$ without significant differences ($p= 0.1403$) found between the men and women groups, not very high excreted alcohol values but which may be easily detected in inhaled air. These concentrations are reached for t_{max} values of 28.12 ± 10.78 without there being significant differences between men and women ($p= 0.6420$). Appearance of these t_{max} values in less than 30 minutes show the rapid absorption and elimination of alcohol when the stomach is empty.

For volunteers that fasted, the area under the curve of alcohol amounts eliminated through breath with respect to time (BrAC) was $24.20 \pm 7.19 \text{ mg \% min}$, there being significant differences ($p < 0.0001$) between the area for men (18.67 ± 4.67) and that for women (30.51 ± 2.83). This difference can be attributed to the fact that, although there are no significant differences in C_{max} and t_{max} values, the significant differences in weight between women and men involved in this study does show greater influence in this BrAC parameter.

Alcohol elimination kinetics profiles are attributed to the low doses of alcohol administered and to the fact that elimination mechanisms for these doses are not saturated. This is confirmed by the studies of Ramchandani et al. (2001) in systems in which alcohol elimination mechanisms are saturated where a plateau is reached with high values indicating that alcohol enzyme metabolizing mechanisms are saturated.

These first results in the fasting group allows us to consider that the subject group is adequate for our studies, that the alcohol dose administered does not seem to saturate the body's alcohol elimination mechanism and that these are doses that are easy to quantify with our breath alcohol determination technique.

Considering the study time of 2 hours and 45 minutes as a suitable time, since all volunteers had values under 0.04% , a value considered by Mcknight et al., (2002) as a limit in order to relate blood levels with exhaled alcohol levels. Correlations between blood levels and exhaled air levels have been recently demonstrated by Jachau et al. (2004).

Based on these results, the results obtained when fasting are compared with the results obtained with different carbohydrate diets with the aim of ascertaining whether carbohydrates influence alcohol elimination or whether it is just the presence of solid food which modifies the gastric transit time, influencing alcohol elimination by breath.

The alcohol elimination profile is lower when intake has been performed in the presence of solid-state carbohydrates. According to the results obtained it is demonstrated that the use of low carbohydrate doses in solid form reduces the maximum amount of alcohol eliminated, as well as delaying the appearance of these maximum values. The independent model (I) elimination constant of alcohol in the presence of solid state carbohydrates is $0.020 \pm 0.006 \text{ min}^{-1}$.

This result is important since it does not differ from the values obtained when fasting, indicating that the low Kcal contribution value in this diet does not increase blood flow in the liver, which would explain the fact that alcohol elimination rates are not modified (Svensson et al. 1983).

Other studies consider that the presence of solids in the stomach can alter gastric emptying times, thus reducing absorption and elimination of different active ingredients. Parameters such as weight, menstrual cycle time and body mass index modify the gastric emptying time. Thus, Brogna et al. (1998) observe an inverted relationship between gastric emptying time and the body mass index. The difference in body mass between the women and men groups could produce faster gastric emptying and modify the BrAC exhaled alcohol area, a result that will be taken into account in these multivariate BrAC studies for men and women.

The alcohol elimination profile in these samples is lower than on an empty stomach and their maximum values are reached at greater times. However, when compared to solid carbohydrate profiles, very similar profiles are observed. C_{\max} values of 0.20 ± 0.005 are significantly lower ($p=0.0281$), whereas there are no significant differences ($p=0.2101$) with C_{\max} values obtained with solid carbohydrates. Similar results are obtained with t_{\max} values, which are longer than those obtained when fasting ($p=0.057$). Neither are there any differences with t_{\max} values for solid carbohydrate samples.

Finally, it is worth noting that BrAC values in these liquid carbohydrate samples are lower than in the samples when fasting, with values of $14.78 \pm 7.12 \text{ mg\% min}$ for men and $125.58 \pm 6.51 \text{ mg\% min}$ for women, and an interaction was observed between volunteer sex and type of

food used. In contrast to C_{max} and t_{max} and I, BrAC values are greater than those obtained with solid food. This fact is important, since solid foods show lower amounts for their eliminated alcohol BrAC. This could be related to smaller alcohol absorption when alcohol is administered with solids, or to the fact that some monosaccharides such as glucose show an active transport mechanism that makes them show greater amounts of alcohol in their BrAC. In view of the results it does not seem that there are differences in alcohol elimination when ingested together with a low amount of carbohydrates. In order to definitely clarify the importance of carbohydrate type, the influence of joint administration of liquid carbohydrates without glucose is evaluated.

Studies with Pirofructol: The alcohol elimination profile in the presence of pirofructol is lower than for samples when fasting and with liquid carbohydrates using sugar. Generally, eliminated alcohol profiles were found to be similar to those obtained with solid carbohydrates.

C_{max} and t_{max} values are 0.17 ± 0.006 mg% and 49.69 ± 27.23 min., respectively. The C_{max} value shows significant differences with samples administered when fasting ($p=0.0010$), whereas there are no significant differences in samples administered with sugar solutions and solid carbohydrates ($p=0.1432$ and $p=0.7492$ respectively). t_{max} values show significant differences with samples when fasting ($p=0.0062$), whereas there are no differences either with solid carbohydrate samples (0.3930) or with sugar samples ($p=0.3747$). These C_{max} and t_{max} values are statistically similar to those of sugar. However, a clear difference is observed in BrAC values, the lowest values of this parameter being 12.58 ± 3.98 mg% min for men and 16.60 ± 3.59 mg% min for women.

Significantly lower values were found when compared to the fasting group and the group taking alcohol with liquid carbohydrates in sugar form (see results in Table IV). Performing multivariate analyses allows observing the existence of a significant interaction between volunteer sex and the type of food used in each test.

Between the fasting and solid groups the interaction is similar, parallel slopes being observed between group A (fasting) and group B (solid carbohydrates), whereas glucose solutions (represented by line G) show a greater slope in the figure, which would be related to greater influence in women with respect to men. The lower slope in the pirofructol test (represented by line P) shows how sex between men and women seems to have less of an influence on the eliminated alcohol area (BrAC).

The importance of this fact is observed in that for low alcohol doses it seems that joint administration of small amounts of carbohydrates results in a significant delay in C_{max} and t_{max} values, the solid or liquid form of these carbohydrates not seeming to have an influence. On the other hand it is important to stress that the amount of alcohol eliminated is related to the amounts of alcohol absorbed and metabolized. In this study performed with a low dose of alcohol that does not saturate alcohol elimination kinetics, alcohol absorption is seen to vary with respect to the type and nature of the carbohydrate administered at the time of ingestion. Therefore, glucose in liquid form seems to accelerate gastric emptying. Authors such as Haruka Sasaki et al. (1983) consider that this solids gastric emptying process is regulated by changes in glucose, insulin and somatostatin circulation levels and that glucose solution administration can facilitate this gastric emptying mechanism. These solutions produce greater BrAC values than those produced by other carbohydrates. Solid carbohydrates stay longer in the stomach and pass the first portions of the intestinal tract together with the alcohol. These mechanisms reduce alcohol gastric absorption and at an intestinal level these carbohydrates reduce alcohol absorption and its BrAC. Pirofructol is a liquid carbohydrate that is mixed with alcohol in the stomach. Alcohol and pirofructol pass through the stomach in a short time due to stomach liquid emptying. This process reduces the amount of alcohol absorbed in the stomach. Pirofructol permanence together with alcohol also reduces intestinal absorption, since they are not sugars with active transport.

Final Discussion: The results obtained allow considering that the number of volunteers is suitable for performing these studies. Significant differences were only found between the mean weight of the women and men groups, no differences appearing in body mass values. In the pharmacokinetic parameters of I , C_{max} and t_{max} , differences are not observed between the men and women groups. In these cases the influence of different carbohydrates was studied against the fasting test by means of one way analyses of variance. Only BrAC shows significant differences between the men and women groups, in this

case the comparison will be performed by means of a multivariate analysis.

Studies with Pirofructol: The presence of carbohydrates influences alcohol elimination in parameters such as C_{max} , t_{max} and BrAC, a significant decrease being observed in the amounts of alcohol eliminated in all parameters. Only the 1 independent model elimination constant was similar in all groups, a result that relates to a small alcohol intake that does not affect elimination kinetics. Ramchandani et al., (2001) demonstrate that food and its composition are some of the factors regulating alcohol elimination rates from the body. The lowest values of BrAC were obtained in the test using Pirofructol, followed by the samples with solid carbohydrates, samples with glucose solution and finally samples when fasting. Furthermore, the test with Pirofructol was the one showing the least variations between pharmacokinetic parameters in women and men out of all tests in this study.

These results allow us to consider that fructose carbohydrates in solution such as Pirofructol reduce eliminated alcohol's C_{max} , delaying its t_{max} and the area of BrAC-excreted alcohol is smaller. These results allow us to select these carbohydrates as those achieving the lowest values of alcohol elimination.

Literature

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