PHARMACOLOGICAL ACTIONS OF HIGHER ALIPHATIC ALCOHOLS

E. Rüdel1, W. Bonte, R. Sprung, C. Frauenrath

Institute for Forensic Medicine and University Chair for Medical Statistics, University of Göttingen, Germany

MACHATA and PROKOP (7) reported 1971, that after consumption of alcoholic beverages the herein contained higher aliphatic alcohols, esters, aldehydes and other carbonyl compound were resorbed and can be detected in the blood samples of the consumers. The same authors (10) pointed out in 1974 that the objective and subjective actions caused by alcoholic drinks do not only depend on the consumed ethanol quantity, but also are influenced to a certain degree by the kind of beverage used. According to their opinion, especially the higher aliphatic alcohols, are highly toxic substances with specific actions on the central nervous system. High doses of them can develop narcotic effects and can actuate multiple objective and subjective alterations as referred to by JAROSCH (5). According to LOHS and GIBEL (6) the contribution of the congeners has not been regarded sufficiently under the treatment of alcohol intoxication. Repeatedly the higher alcohols were presumed to be responsible for hangover symptoms: TAKAL et al. (12) observed within the postalcoholic phase after consumption of brandy more striking impairments of various intellectual functions than after beer.

CHAPMAN (4) compared the subjective hangover symptoms after drinking tests with whisky and vodka. PROKOP and MACHATA (10) point out that there is a direct connection to presence of congeners. Their meanwhile developed gaschromatographic assay technique improved by BONTE et al. (2) allowed now a more subtle investigation of the pharmacological actions of the higher aliphatic alcohols.
METHOD

10 test persons were given 3.75 ml/kg body weight of a synthetic beverage containing 40% ethanol in orange juice and an additional 1 g/l of the respective alcohol. The admixed alcohols were propanol-1 and -2, butanol-1 and -2, isobutanol, 2- and 3-methylbutanol-1 and a mixture of propanol-1, isobutanol and 3-methylbutanol-1. In addition the same subjects were given a congener-free ethanol solution and orange juice without any admixture. The experiments were performed on the same day of the week, and the same time, in double-blind manner. The following tests were performed one hour before drinking at 7 p.m., one hour after termination of drinking at 11 p.m., and in the next morning at 7 a.m.:

1. Reactiometer test (apparatus of Bettendorf/Brussels)
2. Bimanuell coordination test (apparatus of Bettendorf/Brussels)
3. Attention-stress test (d2 test of BRICKENKAMP (3))

The tests were previously exercised until learning effects could be excluded.

To cover physiological and psychological conditions we followed proposals of OSGOOD et al. (9), STAAK and EYSSELEN (11) and BONTE and VOLCK (1) and projected polarity profiles. We worked out 16 contradictory paired statements of the following categories:

1. General mood and physical feeling
2. Activity potential
3. Subjective productivity
4. Subjective hangover symptoms

The probands were allowed to decide between 5 degrees of perception with the contradictions on the two extremes and a medial neutral point. Scored were the alterations during the hangover time against the sober test before the drinking experiment.

During the performance tests the subjects had to undergo blood and urine samples.

RESULTS

The congener content of alcoholic beverages influence the ethanol resorption. The maximum ethanol concentration of pure ethanol is markedly higher at the drinking end as in all cases of ethanol plus respective aliphatic alcohol. Here the maximum of ethanol concentration will be reached one or two hours past drinking end. The test persons
were virtually alcohol-free at 7 a.m. except one subject, which had small amounts of ethanol up to 0.3 % in all trials. During acute alcoholisation disinhibitions and other performance deteriorations consistently appeared, which depending on the subject and the type of test situation could change tenfold when compared to the amount of initial performance when being sober. We think that this is due to the prevailing influence of ethanol. This will be substantiated by the fact that during the test with pure ethanol the performances deviate much more, certainly caused also by the blood alcohol concentrations. In the trial with pure ethanol it could be seen, that all probands except one subject reach or surpass the initial sober abilities in the following morning.

Testing the reaction time during the phase of hangover there were practically no relevant changes in the total time as compared to the initial performance when being sober. The increase of the total time in the morning trials of about 1.25 cannot be viewed as a real performance deterioration. The error quotas, however, were markedly higher during the hangover phase as compared to the initial sober time. We presume that an increase in performance deterioration in the morning trial is linked to the increase of the carbon-chaine length of the aliphatic alcohol. In the test with a mixture of several aliphatic alcohols the deterioration is fourfold as compared to the initial values.

With the bimanuell coordination test there were no significant differences in total testing time neither were there during the single testing phases apart from other individual reactions partly viewed as signs of disinhibition (seen as time shortening), partly as reduced physical skill (seen in time prolongation). An interesting result was, that each subject showed principally identical test reactions, due to the small numbers, however, it was impossible to classify typical groups.

Related to the initial sober performance in comparison with the acute and the hangover phase the error rate increased in the butanol-2 test to 170 % (acute phase) and to 150 % (hangover phase), and in the 2-methylbutanol-1 test to 250 % and 170 %, respectively. During the 2-methylbutanol-1 trial even the quota of the correction time compared to the total time was markedly increased and was on the average
threefold as well as in the acute, as in the hangover phase. Accordingly in the hangover phase we found correction times per error that were 1.6fold while sober.

In the attention-stress test d2 in the acute phase a decrease of total performance only to 90% was noticed and was even seen to be in the hangover phase lower than the initial performances. The insignificant fluctuations in this test observed in all phases even in the acute one could possibly explained by the fact that the test persons were well trained although they always received different test sheets. The tests of the subjective feeling (polarity profiles) revealed obvious correlation between the chain-length of the consumed aliphatic alcohols and the conditions of feeling poorly. In the sober test there were no relevant shifts whereas beginning with propanol-1 and -2 and more with butanol-1 and -2, isobutanol, 2- and 3-methylbutanol-1 as well as in trials with combination mixtures a significant deterioration of the subjective feeling could be observed.

DISCUSSION

An outstanding result of our experiments was, that the performance deteriorations of the single subjects partly show great variations. We presume, that individual physiological and psychological conditions can cause different hangover symptoms. In our opinion driving ability can be even impaired, when the blood is ethanol-free in the hangover phase. Those persons, which showed significant objective deficiency symptoms in the morning after the tests also felt to be in poor condition subjectively. During the test blood samples were collected and examined for the consumed aliphatic alcohols. As we were unable to find higher alcohols in the hangover phase and 2- and 3-methylbutanol -1 even in the acute alcoholisation phase we conclude that not only the aliphatic alcohols themselves, but more likely their oxidation products, aldehydes, ketones and especially the carbonic acids are pharmacological active.

REFERENCES

2. BONTE, W., STOEPPELMANN, G., RUEDELL, E., SPRUNG, R.: Vollautomatischer Nachweis von Begleitstoffen alkoholischer Getraenke in Körperfliissigkeiten (to be prepared)
3. BRICKENKAMP, R.: Test d2, Aufmerksamkeits-Belastungstest. Verlag für Psychologie, Dr.C.J.Hogrefe, Göttingen