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Effect of Heavy Consumption of Alcoholic Beverages on the Perception of Sweet and Salty Taste

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Abstract

Aims: To determine the threshold index of sweet and salty tastes in alcoholics undergoing treatment.

Methods: Taste threshold was assessed using type 3-Alternative Forced Choice in a control group (92 non-alcoholic volunteers) and a test group (92 alcoholics in therapy). The test group completed a structured questionnaire on lifestyle and habits.

Results: Significant difference were found between the threshold rates found in the test (3.78) and control groups (1.39). In the salty stimulus, no significant difference was noted in the threshold detection between the control (0.17) and test groups (0.30). A significant correlation was observed between the index Pearson's threshold to sweet taste in the test group and their reported alcohol consumption. The test group reported characteristics such as loss of appetite (93%), weight loss during consumption (62%) and weight gain after quitting drinking (72%).

Conclusion: That the alcoholic group reported less sensitivity to sweet taste suggests that drinking habits may influence choice of foods, with a greater preference for foods with higher sucrose concentration. This contribute to poor health, because excess consumption of sugar raises risk for several diseases. No conclusive results were found for the salty stimulus.

INTRODUCTION

Alcohol consumption has social and health consequences associated with mortality and disability (WHO, 2011). Excessive consumption of alcohol can cause several diseases related to food choices. Studies have linked alcohol consumption to malnutrition (Santolaria *et al.*, 2003), type 2 diabetes mellitus (Carlsson *et al.*, 2005; Baliunas *et al.*, 2009), liver disease and development of oral and pharyngeal cancer (Boffetta and Hashibe, 2006; Brennan *et al.*, 2004; Pelucchi *et al.*, 2011; Turati *et al.*, 2012).

Balanced nutrition, in addition to providing a better life quality and wellness, contributes to the prevention of diseases (Wijnkoop *et al.*, 2013). One of the factors that influence the choice of food by consumers is its sensory properties, which involves taste.

According to Neto *et al.* (2011), drinking alcohol in high amounts can compromise the functions of taste, by changing the sensitivity of taste receptors.

Alcohol interferes with the absorption of nutrients (such as vitamin B complex, vitamin A and zinc [Zn]), which generates functional and morphological changes in the saliva and taste buds of excessive drinkers (Heckmann, 2009). In addition, it has been proposed that Zn present in the sensory receptors and in certain brain regions mediates perception and interpretation of sensations produced by

the sensory organs and is also necessary for the functioning of the taste buds (Cerchiari *et al.*, 2006). Thus, deficiencies of Zn caused by alcohol consumption can be a factor in reducing taste sensitivity.

The sensory qualities of a food influence food consumption behavior; therefore, deficiency in the perception of taste can disturb food intake, leading to nutritional and even immune deficiencies (Elman and Pinto, 2007; Alves and Dantas, 2011; Dutcosky, 2011; Neto *et al.*, 2011).

The sensations produced by the sensory organs after stimulation of a certain intensity, duration, extent, quality and whether pleasurable or not can be measured, analyzed and interpreted via sensory analysis, a science that is based on the interaction of sensory organs (sight, taste, touch, smell and hearing) to measure the sensory properties and acceptability of food (Lanzillotti and Lanzillotti, 1999).

The threshold index test identifies the minimum intensity of a stimulus that is necessary for perceiving certain sense (ABNT NBR 13172-1994, ISO 13301-2002).

Studies on taste-detection thresholds have revealed that some habits and attitudes can influence the perception of food taste and, therefore, the eating habits of people, including inadequate consumption of food ultimately harming health. Kirsten (2012) evaluated the taste threshold of salt in adolescents and its relationship with blood pressure, nutritional status and sex. Santos *et al.* (2014) analyzed changes in the smell and taste perceptions among non-smokers and smokers as well as the influence of these aspects in the appearance of compensatory movements during swallowing. However, only limited research is available on the relation between the alcohol habits and changes in taste detection.

Based on the preceding information, this study aimed to determine the taste sensitivity through the threshold index for sweet and salty tastes in alcoholics in therapy.

MATERIALS AND METHODS

This study was approved by the Research Ethics Committee of the State University of Southwest Bahia (CEP/UESB) under Protocol 22822113.6.0000.0055. It meets ethical aspects listed in the Resolution No. 466 of 12 December 2012 of the National Health Council (CNS).

The aim was to compare response to taste in a group of alcoholics and a group of non-alcoholics; a power calculation in accordance with the methodologies of ABNT NBR 13172-1994 (Brazilian Association of Technical Standards) and ISO 13301-2002 (International Organization for Standardization, 13301-2002) recommended 92 subjects in each group.

We excluded subjects with conditions that influence the perception of taste: smoking; pregnancy; diabetes; over 65 years; colds or fever; complications in the oral cavity; consumption of alcohol 96 h prior the test.

The control group (non-alcoholic) were volunteers who did not consume any alcoholic beverage or consumed only on occasional basis (e.g. parties, on weekends, holidays).They were recruited (to match approximately the age of the study group) from the State University of Southwest Bahia (students, staff, faculty and visitors to the institution) and a supermarket in the city of Jequié. They comprised 42% women and 58% men, aged from 18 to 60 years (mean 36 years); 70% had no higher education; 78% had a monthly income less than US $ 2000.00.

The study group (alcoholics) were individuals undergoing treatment for physical or psychological dependence on alcohol, at Alcoholics Anonymous (AA) or the Psychosocial Care Center—Alcohol and Other Drugs (CAPS AD). Their ages ranged from 18 to 60 years old (mean 36 years); 42% women and 58% men; 78% reported an average income below US $ 2000.00 (at the time of study); 69% had no higher education.

Testing was conducted in the Food Technology Laboratory of the State University of Southwest Bahia and in the meeting places of the AA and CAPS AD groups.

All subjects were informed about the aspects of the study before applying the tests and questionnaire as well as guaranteed anonymity and confidentiality. The volunteers who agreed to participate gave a signed consent.

Assessment tools

The evaluation of sensory perception among the participants was performed by applying the sensitivity test to determine the detection threshold index and the sweet and salty taste of individuals.

For this procedure, we used the quick method of determining the threshold index test. Each taster held a series of six sensory tests of type 3-AFC (i.e. 3-Alternative Forced Choice) for both the sweet and salty taste. Samples were tested in a continuous mode in a triangular form using increasing intensity of solute concentration. In each 3-AFC test, the taster received three coded samples assigned with 3-digit random numbers (two being controls—only with mineral water, and a test containing the evaluated substance at a certain concentration) and asked to identify, through a record, the sample that were judged to be different.

For the sweet taste, we used the concentrations 0.5, 1.0, 2.0, 4.0, 8.0, 16.0 g/l sucrose, and for the salty taste the concentrations 0.09, 0.18, 0.36, 0.72, 1.5, 3.0 g/l NaCl. The test procedures and solute concentrations were performed according to the ABNT NBR 13172-1994 (Brazilian Association of Technical Standards) and ISO 13301-2002 (International Organization for Standardization, 13301-2002).

Participants were arranged in single cabins, where the samples were served for each individual in 50 ml plastic cups coded with a 3-digit number. Samples were served along with a form, a cup containing water for rinsing the mouth and a glass for disposal if the taster did not ingest the sample. The lower solute concentrations were served first.

Samples were prepared at the State University of Southwest Bahia Food Technology Laboratory using mineral water and solutes such as sucrose and sodium chloride, as quantified by analytical scale (Shimadzu AUW220D), in addition samples were placed in containers at room temperature.

Test results were calculated from the threshold of each participant. For this purpose, we tabulated the data and then applied Equation 1 to determine the individual threshold of each evaluator.

$$A_i = \log(L_i) = \frac{\log(C_0) + \log(C_+)}{2} \quad (1)$$

C_0 and C_+ were considered as the highest and lowest concentration detected/recognized by a particular taster, in that case, individual taster threshold was given by Equation 2:

$$L_i = 10^{Ai} \quad (2)$$

After determination of the individual thresholds for each participant, Equation 3 was applied for obtaining the threshold of the two groups

by calculating the geometric mean of the L_i values.

$$B = \frac{1}{n}\sum_{i=1}^{n}\log(L_i) \quad (3)$$

Thus, for a group of n tasters, threshold index was given by Equation 4:

$$L_g = 10^B \quad (4)$$

The comparison between the control group and the test group's threshold was performed by statistical analysis using an unpaired analysis of variance using SPSS (Statistical Package for Social Sciences).

The percentage of correct answers in each session was evaluated using the distribution of frequencies of correct answers using SPSS.

The alcoholics completed a structured questionnaire: age, sex, weight, height, education, professional activity; smoking, typical alcohol consumption in ml per day, the last date of consumption, any weight change after acquiring the habit of frequent consumption, any weight change after reducing or quitting frequent consumption, medical diseases.

Analysis of the structured questionnaire responses, and the Pearson's correlation (5% probability) were performed using Statistical Package for Social Sciences (SPSS; version 15.0). Pearson's correlation analysis (5% probability) was also used to relate the taste threshold index and alcohol consumption in ml per day.

RESULTS

Fig. 1 shows the percentage of individuals in each group who reported that the sample contained sucrose in each test session: the control group gave correct answers in 13 compared with 1% in the alcohol subjects, at the first level (0.5 g/l sucrose), indicating that the control group could differentiate the sweet water solution even in sessions in which the sugar concentration was extremely low. This trend to greater sensitivity in controls was observed at all sucrose concentrations.

Data were analyzed by unpaired comparison between the threshold index of the control and test group. It was found that a threshold ratio in the test group was 3.78, whereas that in the control group it was 1.39. The alcoholics showed lesser sensitivity to sweet taste stimuli by the test of unpaired analysis of variance ($P < 0.05$).The questionnaire revealed that only 7% of alcoholics reported no loss of appetite while consuming alcohol, 9% little loss, 14.5% moderate loss and 69.5% major loss. Weight gain after quitting alcohol was reported by 72%.

Within the alcoholics, Pearson's correlation between index threshold for the sweet taste and alcohol consumption, evaluated through the questionnaire, was $r = 0.816$ ($P < 0.05$), indicating, according to Callegari-Jacques (2003, p. 90), a 'strong' relation: the higher the intake of alcoholic beverages, the greater the threshold index for the sweet taste.

The loss of sensitivity for the sweet taste stimulus as detected in alcoholic subjects was not observed for the salty stimulus. No significant difference using unpaired analysis of variance was noted in results of salty stimulus between the control and test groups, which had a threshold rate of 0.15 and 0.34, respectively, suggesting that alcohol consumption did not significantly alter the sensitivity to the perception of salty taste among alcoholics undergoing treatment (Fig. 2).

Although no difference was noted in the mean threshold index between the control and test groups toward the salty stimulus, by unpaired analysis of variance, in the detection frequency analysis of salty taste in each session, it is possible to observe the difference between the % correct answers in the sessions (Fig. 3).

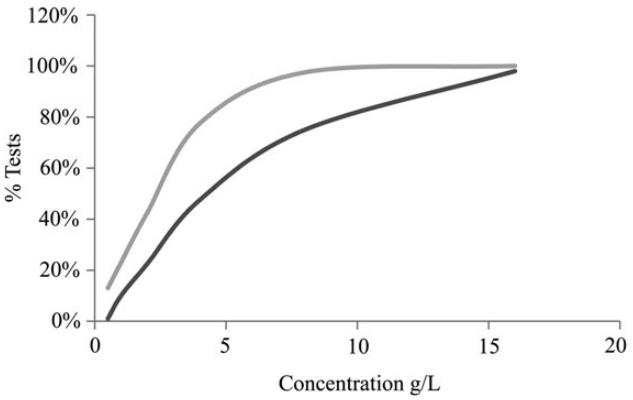

Fig. 1. Distribution of the percent of correct answers of the test and control groups in each of the series with increasing sucrose concentration. Note: Session 1: 0.5 g/l; session 1: 1.0 g/l; session 3: 2.0 g/l; session 4:4.0 g/l, session 5: 8.0 g/l, session 6: 16.0 g/l. Solid line indicates test group and gray line indicates control group.

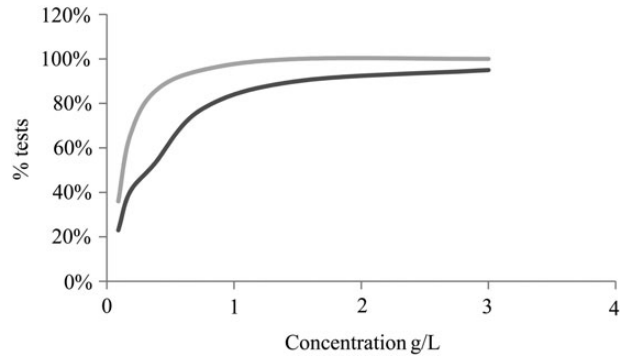

Fig. 2. Distribution of the percent of correct answers of the test and control groups in each of the series with increasing concentration of sodium chloride. Note: Session 1: 0.09 g/l; session 1: 0.18 g/l; session 3: 0.37 g/l; session 4:0.75 g/l, session 5: 1.5 g/l, session 6: 3.0 g/l. Solid line indicates test group and gray line indicates control group.

In the first test session (0.09 g/l sodium chloride), 37% of the control subjects could detect the salty taste, which was greater than that in the test group (28% of the subjects detected). The largest % difference between the groups occurred in the third session (0.37 g/l sodium chloride), in which 47% of the non-alcoholics detected the salty taste from among alcoholics undergoing treatment (12%).

In the frequency test, among subjects who detected the sweet taste from a particular session, 22% of the control group participants detected the taste in the first session (0.5 g/l sucrose), while in the test group only 3% reported such a response (Fig. 4).

DISCUSSION

We observed that, for alcoholics to detect the sweet taste in food, it would tend need a higher sugar content. Thus, it may be that alcoholics tend to add more sugar in their food such as in coffees and juices and have a preference for sweet food, leading to excessive consumption of sugar, thus resulting in diseases. Low taste sensitivity may cause loss of food acceptance, which may explain reduced appetite.

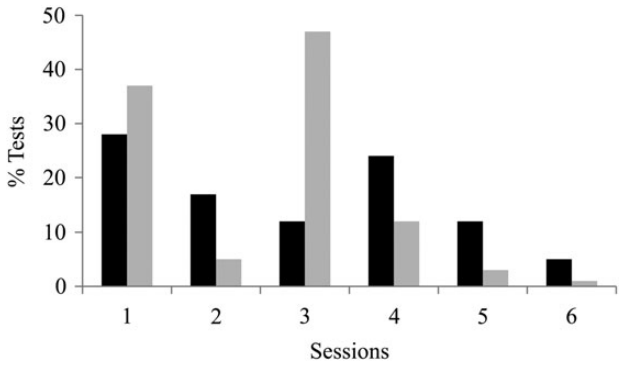

Fig. 3. Distribution of the percent of correct answers in the test and control groups in each test session for the salty test. Note: Session 1: 0.09 g/l; session 1: 0.18 g/l; session 3: 0.37 g/l; session 4:0.75 g/l, session 5: 1.5 g/l, session 6: 3.0 g/l. Black bar indicates test group and gray bar indicates control group.

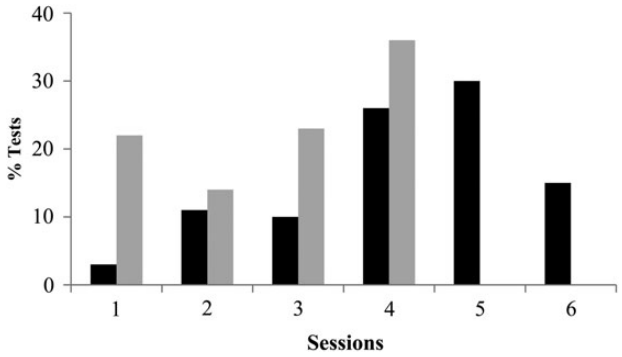

Fig. 4. Distribution of the percent of correct answers in the test and control groups in each test session for the sweet test. Note: Session 1: 0.5 g/L; session 1: 1.0 g/l; session 3: 2.0 g/l; session 4:4.0 g/l, session 5: 8.0 g/l, session 6: 16.0 g/l. Black bar indicates test group and gray bar indicates control group.

Loss of appetite might be related to the calories consumed as alcohol (Santolaria *et al.*, 2003). However, loss of appetite may also be related to a decrease in taste sensitivity, which may reduce the sensory pleasure in food, reducing its acceptability.

Loss of appetite may explain weight loss and even malnutrition, as reported by Santolaria *et al.* (2003). In this work, on being questioned about weight loss while consuming alcoholic beverages, 62% individuals reported positively. Weight gain on abstinence was widely reported, which might be related to the recovery of taste sensitivity and, therefore, the sensory pleasure of eating.

Several articles report that the sensory preference for sweet taste is a risk factor for developing alcohol dependence (Kampov-Polevoy *et al.*, 1999; Lanier *et al.*, 2005; Pepino and Menella, 2007). Alcohol dependence has a substantial genetic component, as evidenced in research with family, twin and adoption. Efforts to identify risk markers for alcoholism included taste sensitivity studies.

Blednov *et al.* (2008) on the study to directly evaluate the association between perception of taste and alcohol intake used mutant mice lacking the gene expressed in the sweet taste. Null mutant mice for the sweet taste gene showed lower preference for ethanol and they consumed less alcohol in a choice test, compared with the wild type from the same litter. These null mice also showed lower preference for sucrose solutions than the wild type from the same litter.

In addition to genetic variance, various biochemical reactions are reported as the cause for decreased perception of the sweet taste for alcohol drinkers.

Zinc deficiency, caused by the excessive consumption of alcohol, causes atrophy and keratinization of the taste buds, which is generated by organic changes that leads to dysgeusia and glossodynia (Cerchiari *et al.*, 2006). Zn deficiency may cause hypogeusia since it is a component of gustin, a protein present only in human parotid saliva (Henki *et al.*, 1999). Furthermore, anatomical abnormalities have been observed in the taste buds of rats presenting with Zn deficiency, which show decrease in taste sensitivity (Goto *et al.*, 2001).

Chronic alcohol intake is related to significant changes in the parotid saliva secretion and composition, which results in increased apoptosis in the salivary glands (Dutta *et al.*, 1992; Slomiany *et al.*, 1997). This observation was also stated by Actis *et al.* (2006), who reported that the total salivary proteins had lower concentrations among alcoholic subjects and, with the changes in the composition and salivary excretion, no change in taste sensitivity was noted.

Morphological changes found in the salivary glands of chronic alcoholics (Ferraris and Arriaga, 2000) range from extremely dilated ducts with desquamated cells and stasis of content to epithelial atrophy.

Although there are previous reports of the association between sensitivity for sweet taste and alcohol consumption, the effects of duration of alcohol consumption or type of alcoholic beverage consumed has not been examined and that suggest a need for further research. Low sensitivity for sweet taste observed in alcoholics may be a risk factor for the development of various diseases, for example, Wernicke's encephalopathy. In industrialized countries, 90% of cases of thiamine deficiency are associated with alcohol abuse (Thomson and Marshall, 2006). Thiamine is directly related to the total caloric intake and the proportion of calories provided as carbohydrates, thus, calorie and high-carbohydrate diet may increase the demand for thiamine (Sechi and Serra, 2007). Thiamine is specifically required for the metabolism of carbohydrates, and their demand is related to ingestion of nutrients. Low taste sensitivity to sweet taste observed in alcoholics, can lead to increased carbohydrate intake, and consequently increases the demand for thiamine, which can lead to Wernicke's encephalopathy (Thomaz *et al.*, 2014).

CONCLUSION

Although no statistical difference was noted in the detection thresholds for salty taste, it is not conclusive that the habit of drinking alcohol excessively does not change the perception of salty taste, given that a trend in the salt frequency test was found.

However, the consumption of alcohol for a long period may negatively affect perception of sweet, which may lead to increased consumption of sweetened substances by people suffering from this condition and thereby affect the nutritional status of alcoholics and even contribute to thiamine deficiency and diabetes.

CONFLICT OF INTEREST STATEMENT

None declared.

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