

Effects of different concentrations of sugarcane alcohol on food intake and nutritional status of male and female periadolescent rats

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Abstract

The present study evaluated the effects of food and alcohol intake on the nutritional and metabolic status of male and female periadolescent rats submitted to single (15%) and multiple (10%, 20%, 30%) concentrations of hydroalcoholic solutions of sugar-based alcohol associated with a feed mixture. Thirty-six periadolescent Wistar rats were used and randomly arranged into three groups: Group A (control; 0% ethanol; six males and six females), Group B (15% ethanol; six males and six females), and Group C (10%, 20%, and 30% ethanol; six males and six females). Food consumption, body weight, water intake (mL), ethanol intake (g/kg/day), ethanol preference in relation to water and different concentrations, and serum biochemical dosages (glucose, total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein (HDL) cholesterol, very low-density lipoprotein fraction, triglycerides, cholesterol/HDL [CT/HDL], albumin) were analyzed. Males from Group C ingested more feed than females, which consumed reducing amounts throughout the weeks studied. Males also had heavier body weight, which increased throughout the experimental period. The animals ingested more water (females ingested more than males) in the first experimental week. Group C had a higher ethanol intake and greater preference for ethanol over water in both genders than Group B, which decreased over the subsequent weeks. Serum glucose was lower in Group A, whereas the CT/HDL ratio was lower in Group C. These findings allow the conclusion that nutritional and metabolic impact resulting from alcohol intake is different between genders and between the different forms in which the drug is offered. It is important to warn the population about the concentrations of alcohol intake, which may influence the growth and development of adolescents, thereby compromising their quality of life. © 2009 Elsevier Inc. All rights reserved.

Keywords: Wistar rats; Ethanol; Gender; Adolescent; Nutritional status; Biochemical profile

Introduction

The abusive intake of alcoholic beverages is a public health problem throughout the world, leading to social-, economic-, political-, and family-related problems as well as those related to health (Galduróz and Caetano, 2004). Alcoholism does not spare any particular social class, gender, age, or race (Reis and Rodrigues, 2003). There is a high prevalence among the adult population, and adolescents are also afflicted by this social disease (Soldera et al., 2004).

Brazil occupies 63rd place in terms of per capita alcohol use by the age of 15 years among 153 countries, which is a reasonably discrete consumption. However, when comparing the evolution of consumption in 137 countries between the 1970s and 1990s, Brazil has had an increase of 74.5% (Galduróz and Caetano, 2004; World Health

Organization [WHO], 1999). Among the different regions of Brazil, studies have revealed a greater percentage of individuals with alcohol dependence in the Northeastern (16.9%) and Northern (16.3%) regions, whereas percentages in the other regions are about 10% (Carlini et al., 2002).

According to the WHO (1996), early exposure to alcohol can cause quantitatively more harm to dependent individuals than any other drug when ingested in greater quantities and more frequently (Reis and Rodrigues, 2003).

Regarding the type of alcoholic beverages consumed in Brazil, studies have revealed that beer appears in first place, with the consumption of 54 L per capita/year, followed by sugar-based alcohol (12 L per capita/year) and wine (1.8 L per capita/year). In 2002, Brazil had an annual production of 1.3 billion liters of sugar-based alcohol, 14.8 million liters of which were exported (Galduróz and Caetano, 2004).

Sugar-based alcohol, known locally as cachaça or aguardente, can be obtained through fermentation and later distillation of sugary liquids from juice or macerated vegetal material. Thus, the definition of aguardente is generic and

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the beverage can be made from oranges, grapes, bananas, barley, corn, rice, beets, manioc, potato, sugarcane, and bamboo. The compositions used in the present study refer mainly to material transformed into ethanol. The preparation and corrections of the raw material include diverse operations to make the sugary liquid susceptible to the fermentation process (Aguardente, 2002).

Experimental designs to determine alcohol consumption preferences that enable rodents the free choice between water and alcohol solutions evaluating the quantities consumed of each fluid are used as attempts to approach the consumption of alcoholic beverages by human beings. These models demonstrate few variations, even in studies conducted under different laboratory conditions (Crabbe et al., 1999; Spanagel, 2000).

Sensitivity to ethanol varies with age, with a lower metabolic rate in juvenile rats than adults (Silveri and Spear, 2000; Sircar and Sircar, 2006). This increased tolerance to ethanol by adolescent rats may have negative repercussions to the neurobehavioral processes of these animals (Acheson et al., 1999; Crews et al., 2000; Markwiese et al., 1998; Silveri and Spear, 1998; Sircar and Sircar, 2005; Slawewski et al., 2001; Swartzwelder et al., 1998; White et al., 2000) unlike what happens in humans, experimental studies have demonstrated that, in a number of lineages, female rats consume more ethanol than males when consumption is expressed as grams of ethanol per kilogram of weight per day (g/kg/day) (Cailhol and Mormede, 2001; Ford et al., 2002; Lancaster and Spiegel, 1992; Li and Lumeng, 1984). It appears that differences in alcohol intake patterns between genders are more related to the pharmacokinetics of ethanol than the influence of sex hormones, thereby increasing the susceptibility of females to developing diseases related to alcohol consumption (Piano et al., 2005; Sato et al., 2001).

The findings point to the undisputable fact that the consumption of alcoholic beverages affects males and females alike in increasingly younger age groups, which has led to an increased interest in the topic in recent decades. However, relatively little is yet known and a large number of implications are yet to be clarified. The present study investigated the hypothesis that the consumption by male and female periadolescent rats of different concentrations of ethanol can have different negative repercussions to the nutritional and metabolic status of these animals. Thus, the aim of this study was to determine preferences in the consumption of different concentrations of a hydroalcoholic solution of sweetened sugarcane alcohol (widely consumed in northeastern Brazil) in association with regional foods.

Materials and methods

Animals and diet

Thirty-six periadolescent Wistar rats (Norvegicus, variety Albinus) (18 males and 18 females) from the Bioterium of the Department of Nutrition of the Universidade Federal de

Pernambuco (UFPE) were kept under standard lighting conditions (12 h light/12 h darkness) and a constant temperature of $24^{\circ}\text{C} \pm 1^{\circ}\text{C}$ (Merusse and Lapichick, 1996). The experimental protocol developed in the present work received approval from the Ethics Commission on Animal Experimentation of the Biological Sciences Center, UFPE-protocol # 03/07.

On the 30th day postbirth, the animals received a feed blend as the exclusive nutritional source. Animals were randomized into three treatment groups: Group A (control), receiving 0% ethanol ($n = 12$; 6 males and 6 females); Group B, receiving 15% ethanol ($n = 12$; 6 males and 6 females); and Group C receiving solutions of 10%, 20%, and 30% ethanol ($n = 12$; 6 males and 6 females). These alcohol contents were maintained for a period of 30 days. In all groups, the animals were kept in individual cages, received chow, water, and respective hydroalcoholic solutions of sweetened sugarcane rum (40% alc/v).

The chow was composed of the following regional food items: common bean variety (*Phaseolus vulgaris* L.), common rice (*Oryza sativa* L.), manioc flour (*Manihot esculenta* crantz), chicken meat (*Gallus gallus*), and soybean oil. The centesimal composition of foods used in the diet was determined according to methodology proposed by the Adolfo Lutz Institute (Instituto Adolfo Lutz, 1985).

The beans, rice, and chicken were cooked separately in water for 2 h, dried in an oven (60°C) for 12 h, and pulverized in a grinder (Flour Grind Mill-Chuo Boeki Kaisha) for the attainment of the respective flours. The experimental diet was prepared weekly and stored at an appropriate temperature. Table 1 displays the diet composition, balanced according to the American Institute of Nutrition, for the growth phase (Reeves et al., 1993).

Method

The rats received the chow ad libitum; similar amounts were offered to males and females alike. Liquids were offered in a system of freedom of choice: water and hydroalcoholic solutions of sugarcane rum at 15% (Group B), 10%, 20%, and 30% (Group C) for a period of 4 weeks. Chow and fluids were offered daily, whereas food consumption and body weight were measured on a weekly basis. For the calculation of the food intake, the offered and rejected portions of diet were used, taken 7 days after offering.

The body weight was measured on scales of electrical precision (Ohaus), with a capacity for 2.6/oz, and the variation corresponded to the difference among initial body weight (30th day), body weight at the end of each experimental week, and total weight, calculated from the difference between the weight of the animal at the beginning and end of the experiment.

The water and ethanol intake corresponded to the amount of solution daily ingested by the animals in milliliters. For the calculation of the fluid ingestion, the offered and rejected portions of water/solution were used, taken 24 h after offering.

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