ABSTRACT
Among the beneficial properties of yerba mate, it has been proven that it produces a decrease in appetite, weight loss and a decrease in fat deposits. Sensory properties influence the palatability of food and ultimately influence the amount consumed. It is very frequent that infusions of mate alone or sweetened produce judgments of the type “I drink mate and I am satiated”. The aim of this study was to quantify the specific sensory satiety (SSS) and the desire to eat (DE) of these infusions in females with normal body weight. Thirty female university students and professors participated, who reported their weight and height to determine the body mass index (BMI). To determine the SSS and DE, 1.2% W/V (MT) mate infusion was prepared, 5% W/V sweetened MT with sugar (MT-A) or Stevia rebaudiana B extract at 0.03% P/V (MT-B). In all cases, the infusions were prepared by placing the mate bag containing 3 g of sample in contact with 250 ml of water at 90 °C for 6 minutes. The infusions were consumed at 70°C. For the SSS and DE evaluations, crackers, vanilla-flavored light yogurt, and unsweetened corn flakes were presented as controls. The consumers evaluated in three sessions the perceived pleasure/desire to eat before and after consuming a 250 ml cup of each infusion and a 4 g portion of the controls using unstructured scales of 100 mm length. The SSS and the DE were calculated as the difference of the magnitudes of pleasure pre and post ingestion introducing the correction factor calculated from the respective magnitudes assigned to the controls. Data were analyzed using the General Linear Model and Tukey's test for post hoc contrasts to check for significant effects of reported SSS or DE for the three
infusions. Referring to the BMI, all the women reported weights and heights that denote normal weight (average BMI = 20.9). The appearance of satiety occurs both in MT, MT\-A and MT\-B (average SSE = -11.8) and there is also a decrease in the desire to eat after mate overload (average DE = -13.5). It can be concluded that the SSS and the DE, which regulate the cessation of intake, are maintained even though the caloric density and the taste of these infusions change. It remains to find out if these mechanisms are down regulated due to the increase in body weight, which would cause a lack of satiety and the desire to eat this type of infusions.

**Keywords:** sensory specific satiety, desire to eat, infusion, mate, stevia rebaudiana extract, sugar.

**RESUMO**

Entre as propriedades benéficas da erva, mate, está comprovado que produz diminuição do apetite, perda de peso e diminuição dos depósitos de gordura. As propriedades sensoriais influenciam a palatabilidade dos alimentos e, por fim, influenciam a quantidade consumida. É muito frequente que infusões de mate isoladas ou adoçadas produzam julgamentos do tipo "eu bebo mate e estou satisfeita" daí o interesse em quantificar a saciedade sensorial específica (SSE) e o desejo de ingerir (DI) dessas infusões em mulheres com peso corporal normal. Participaram 30 universitárias e professoras, que informaram seu peso e altura para determinação do índice de massa corporal (IMC). Para determinar o SSE e DI, preparou-se mate cozido 1,2% P/V (MT), 5% P/V MT adoçado com açúcar (MT, A) ou extrato de Stevia rebaudiana B a 0,03% P/V (MT, B). Em todos os casos, as infusões foram preparadas colocando-se o saquinho de erva mate contendo 3 g de amostra em contato com 250 ml de água a 90 °C por 6 minutos. As infusões foram consumidas a 70°C. Para a avaliação de SSE e DI, crackers, iogurte light com sabor de baunilha e flocos de milho sem açúcar foram apresentados como controles. Os consumidores avaliaram em três sessões a percepção de prazer/vontade de comer antes e após consumir um copo de 250 ml de cada infusão e uma porção de 4 g dos controles por meio de escalas não estruturadas de 100 mm de comprimento. O SSE e o DI foram calculados como a diferença das magnitudes de prazer pré e pós, ingestão introduzindo o fator de correção calculado a partir das respectivas magnitudes atribuídas aos controles. Os dados foram analisados usando o Modelo Linear Geral e o teste de Tukey para contrastes post hoc para verificar efeitos significativos de SSE ou DI relatados para as três infusões. Referente ao IMC, todas as mulheres relataram pesos e alturas que denotam peso normal (IMC médio = 20,9). O aparecimento de saciedade ocorre tanto em MT, MT, A quanto em MT, B (média SSE = ,11,8) e há também diminuição da vontade de comer após sobrecarga de chimarrão (média ID = ,13,5). Pode-se concluir que o SSE e o DI, que regulam a cessação da ingestão, são mantidos mesmo que a densidade calórica e o sabor dessas infusões mudem. Resta saber se esses mecanismos são desregulados pelo aumento do peso corporal, o que causaria falta de saciedade e vontade de ingerir esse tipo de infusão.

**Palavras-chave:** saciedade sensorial específica, vontade de comer, infusões, mate, extrato de stevia rebaudiana, açúcar.
INTRODUCTION

Infusions of yerba mate are historically consumed for their stimulating and energizing properties, but other beneficial health properties are currently being studied. Specifically, it has been verified in animals that extracts of *I. paraguariensis* produce a decrease in appetite, weight loss, decrease in fat deposits, levels of fats in the liver and blood, glucose, insulin and leptin. (Alkhatib, and Atcheson, 2017, Arcari et al., 2013, Kim et al., 2015), as well as a decrease in serum cholesterol and triglyceride levels (Mosimann et al., 2006, Gan et al., 2018). These effects are attributed to the saponins present in yerba mate infusions and their binding to bile salts (Lunceford and Gugliucci, 2005) and the inhibition of the passive diffusion of cholic acid and the formation of micelles (Heck and Mejia, 2007). The decrease in plasma cholesterol and LDL levels due to the consumption of yerba mate infusions in humans was also confirmed (De Moraes et al, 2009). Other works suggest that yerba mate extracts inhibit pancreatic lipase activity, which reduces lipid absorption and therefore the caloric intake of food ingested together with the infusion. (Bracesco et al, 2011; Sugimoto et al, 2009). Furthermore, natural extracts of Yerba mate were used to avoid lipid oxidation (DeCampos, et al., 2007, García Coró et al., 2020).

It should not be ignored that the sensory properties of food and beverages influence their palatability and ultimately influence the amount consumed (da Silva et al., 2021). It is very frequent that infusions of mate alone or sweetened produce judgments of the type "I drink some mate and I am full or satiated." Hence, it is not only interesting to know the acceptability of the product by consumer panels (Frank and Van Der Klaauw 1994, Le Coutre, 2003, Bertoli et al., 2014) but also its satiating properties. The hedonic response to taste stimuli will depend on the metabolic state (hunger, satiety). For example, at breakfast, a cup of coffee with milk produces a positive hedonic response, but this response decreases after the second cup. The change measured before 2 minutes after the intake has finished cannot be attributed to postabsorptive changes (aliesthesia), it depends exclusively on the sensory stimulus and gives rise to the phenomenon called sensory specific satiety (SSS). This phenomenon regulates the intake of chosen foods during a meal and is specific, because no decrease in the hedonic judgment of other foods is observed (Hollis and Henry, 2007, Rolls, 1990)). Foods differ in the extent to produce SSS. For example foods with a high level of protein produce more sensory, specific satiety than foods with a low protein level. SSS protocols were evaluated for specific foods
products in both laboratory and real-life settings (García, Burgos et al., 2015, Hendricks et al., 2021).

In this way, sensory stimuli from foods are related to satiety and food intake. The mechanism of SSS reinforces the role of variety in increasing food intake (Brondel et al., 2009). The notion of food reward is also important, which is the momentary value that a food produces for the individual at the moment of ingestion, this is the desire for intake (DI) (Rogers and Hardman, 2015). For all of the above, it is useful to ascertain the satiating power of infusions with zero caloric density (unsweetened mate or sweetened with Stevia rebaudiana extract) and with caloric density of 0.05 Kcal/ml (sugar, sweetened mate). It is also of interest to know if the satiating power of the infusion varies with the taste of it (bitter mate with respect to sweetened infusions) and how the desire for intake (DI) varies with taste quality.

2 MATERIALS AND METHOD

2.1 PARTICIPANTS

Thirty women, students and teachers from the Faculty of Pharmacy and Biochemistry, University of Buenos Aires participated in this experiment. All participants met the general criteria for inclusion in the study: age 20-60 years, no allergies or restrictions to the foods used in the study, no smoking, no dieting to lose or gain weight, not pregnant or lactating, not taking medications that affect appetite and not training the day before the experimental development. Each participant reported their weight and height to determine the body mass index (BMI) and completed an eating habits questionnaire and another 28-item questionnaire that assessed dietary restriction (6), disinhibition (9), emotionally mediated intake (3) (Angle et al., 2009) and another scale of neophobia traits (10 items) (Pliner and Hobden, 1992).

2.2 EXPERIMENTAL DESIGN

A within-subjects design was used in this experiment. They participated in three sessions in the Laboratory of Chemical Senses of the Department of Physiology of the Faculty of Pharmacy and Biochemistry, UBA. During each session, the participants consumed one of the three infusions and their presentation was balanced among the participants.
2.3 EXPERIMENTAL PROCEDURE

Experimental sessions were scheduled between 11 a.m. and 1 p.m. on 3 days, separated by at least one week. To maximize the visual and cognitive cues related to the infusions, the infusions were served in 300 mL clear glass bowls at 70 °C. The participants were instructed to consume the entire volume served (250 ml) or claim a second portion if they were not satiated, but some volunteers left a residual volume, which was measured to record the actual volume consumed in each case. It was also indicated that consumption should take place within a period of no more than 15 minutes. They were asked to have a uniform rate of consumption, so that half the infusion was consumed in half the time taken for total consumption.

Before ingesting each infusion and immediately after its consumption, the participants received a tray containing samples of four foods: the experimental infusion and three other foods. Consumers responded to two questions to assess palatability using unstructured scales of 100 mm length. The questions were: "How pleasant is this food?" and "How much of this food would you eat right now?" For the first question, this scale was presented anchored to the left with "not at all" and to the right with "very" For the second question, the line was anchored to the left with "Not at all" and to the right with "A large amount ". Participants were instructed to consume the tested foods in the order in which they were presented. They were told to keep the sample in their mouths while they assigned their judgments about pleasure and consumption and to swallow it once the evaluation was completed.

At the beginning of each session, the participants recorded the time they finished breakfast, made its qualitative description, and quantified their appetite. Participants were asked to refrain from drinking alcohol and try to maintain consistent times to eat a similar breakfast on each of the test days. They received instructions not to chew gum, eat food or flavored drinks during the three hours prior to each experimental session, but they could consume water up to 1 hour before the test in order not to feel thirsty at the time of the test, a factor that could bias the volume ingested.

2.4 INFUSIONS ASSESSED AND CONTROL FOODS

To determine the SSS of bitter and sweet infusions, mate tea was prepared at 1.2% P/V (MT), MT sweetened with sugar at 5% P/V (MT,A) or Stevia rebaudiana B extract at 0.03 % P/V (MT,B) . In all cases, the infusions were prepared by placing the mate bag containing 3 g of sample in contact with 250 ml of water at 90 °C for 6 minutes.
The cooled infusions were consumed at 70°C. For SSS evaluation, three foods accompanied an aliquot of the test infusion. All of them were selected to provide sensory properties different from those of the infusions. The control foods were presented in 30 ml dosage cups and included 5 g of unsalted cracker cookies (d = 4.32 Kcal/g), vanilla flavored light yogurt (d = 0.45 Kcal/g), infusion of mate tea (d = 0 for MT and MT,B) or d = 0.05 Kcal/ml for MT,A 20 ml), sugar, free corn flakes (d=3.73 Kcal/g).

2.5 DATA ANALYSIS

The data were analyzed with the statistical program SPSS,PC for Windows (version 11.5). The General Linear Model and Tukey's test for a posteriori contrasts were applied to verify significant effects of perceived pleasure or reported appetite for the three infusions before and after the overload consumed. P <0.05 was considered significant.

SSS is defined as the difference between the palatability change for the ingested infusion and the mean palatability change score for the unconsumed food (the three control food samples). The DI is defined as the difference between the appetite change for the ingested infusion and the average appetite change score for the same three foods not consumed.

3 RESULTS AND DISCUSSION

Data from the 30 participants aged between 21 and 55 years (mean 23.9; SD: 6.8) were analyzed. the mean height and weight measured were 1.65m ± 0.07 and 56.5kg ± 7.0, respectively. The mean calculated BMI was 21.7kg/m2 ±2.4.

The survey data showed that they did not have the habit of following a hypocaloric diet or did so only once a year and reported having normal gustatory and olfactory sensitivity. With reference to the questionnaire on personality and intake, they showed an average value of restricted intake of 10.3, range of the scale from 6 to 24, disinhibition of 19.5, range of the scale from 9 to 36 and intake mediated by emotions of 6.3. scale range from 3 to 12. Therefore, the mean values of the group were below the mean value in all cases. The neophobia responses showed an average value of 30 on a scale of 10 to 70, so again the group showed average values below the average value of the scale. However, the individual values exceed these mean values in some cases, so it is expected that the survey be administered to a larger number of students and teachers in order to describe the relationships between these psychological traits and food intake (related to the frequency of consumption). of foods of different caloric density).
The descriptions of the breakfasts consumed by the participants indicate that the caloric intake corresponding to breakfast ranges between 200 and 400 kcal, which corresponds to 10 to 20% of a 2000 kcal diet, taken as a reference value to calculate the intake. recommended nutrient.

Figure 1 shows the form given to the participants, recording the order of the food to be consumed and the values of liking and the desire of food intake.
The appearance of satiety occurs both in MT, MT,A and MT,B, see Table 1 (mean SSE = ,11.8) and there is also a decrease in the desire to ingest after mate overload (mean DE = ,13.5). These results showed that the oro,sensory exposure to taste of the infusions is an important aspect to obtain satiety and to reduce also the desire to ingest each one of the infusions. Because sensory,specific satiety is sensory,based there is no a dependence on macronutrient composition. The protocol of sensory,specific satiety determined the pleasantness ratings two minutes after eating as proposed by early works (Rolls 1990), and this lapse does not allow sufficient time for the food to be absorbed inducing metabolic feedback. Our results agree with the explanation given by Johnson and Vickers (1993). They concluded that consumption of a given food will decrease the liking of that food as well as the liking of an uneaten food with similar sensory attributes. This supports the preeminence of sensory attributes over the macronutrient composition.
Table 1: Magnitudes of sensory specific satiety and desire to eat for the three infusions

<table>
<thead>
<tr>
<th>INFUSION</th>
<th>SSE ± SEM*</th>
<th>DE ± SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT</td>
<td>7.17 ± 2.24</td>
<td>9.63 ± 3.64</td>
</tr>
<tr>
<td>MT.A</td>
<td>13.04 ± 3.39</td>
<td>14.12 ± 4.38</td>
</tr>
<tr>
<td>MT.B</td>
<td>15.71 ± 3.34</td>
<td>17.31 ± 3.65</td>
</tr>
</tbody>
</table>

*(SEM: error standar error of the mean, n=30)

However, no differences were observed in the magnitudes of SSE and DE for the different infusions (p > 0.05).

4 CONCLUSIONS

It can be concluded that the SSS and the DE, which regulate the cessation of intake, are maintained even though the caloric density and the taste of these infusions change. It remains to find out if these mechanisms are deregulated by the increase in body weight, which would cause a lack of satiety and that the desire to ingest this type of infusion does not decrease in overweight or obese women.

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