Published in final edited form as:

Physiol Behav. 2008 July 5; 94(4): 627–629. doi:10.1016/j.physbeh.2008.03.016.

Binge-type behavior in rats consuming trans-fat-free shortening

F.H.E. Wojnicki¹, G. Charny², and R.L.W. Corwin¹

¹The Pennsylvania State University, Nutritional Sciences Dept, 126 S. Henderson, University Park, PA, 16802, USA.

²Uniformed Services University of Health Sciences, F. Edward Hebert School of Medicine, Bethesda, MD. 20814-5119

Abstract

Studies from this and another laboratory involving an animal model of binge-type behavior have used vegetable shortening containing trans-fats. Due to reformulations by vegetable shortening manufacturers to remove trans-fats from their products, only trans-fat-free shortenings are now available. The goal of the present study was to assess binge-type behavior in rats with trans-fat and trans-free vegetable shortening. Trans-fat-free shortening was provided to three different groups of non-food-deprived male Sprague Dawley rats on different schedules of access: continuous access (24 hr/day — 7 days/week), daily access (1 hr every day), and intermittent access (1 hr on Mondays, Wednesdays, Fridays). Trans-fat shortening was provided to a fourth group on the intermittent access schedule. A fifth group had no shortening access (chow only). Both intermittent groups (trans-fat-free and trans-fat) consumed significantly more shortening during the 1-hr period of availability than did the daily group, and there was no difference in shortening intakes between the intermittent groups. These results are identical to previous reports of binge-type behavior in rats using this model. Thus, binge-type behavior in the present behavioral model depends upon the schedule of access, not the presence of trans fats in the shortening.

Keywords

intermittent access; limited access; restricted access; eating disorders; solid fat

INTRODUCTION

A behavioral model of binge-type eating has been described in which vegetable shortening serves as the binge food [1-7]. When a 1-2 hr period of availability to vegetable shortening is provided on an intermittent access schedule (Mondays, Wednesdays and Fridays [1-6] or every third day [7]), rats consume significantly more shortening during this brief period of time than do rats with 1-2 hr of shortening provided every day. Furthermore, rats on the intermittent access schedule consume as much vegetable shortening during the brief access period as rats with continuous shortening access consume in 24-hr (24 hr/day — 7 days/week) [4].

Correspondence to: Rebecca L. Corwin The Pennsylvania State University College of Health and Human Development Nutritional Sciences Department 126 S. Henderson University Park, PA 16801 Phone: 814-8654-6519 Fax: 814-863-6103 Email: rxc13@psu.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

All of these studies have used Crisco™ vegetable shortening (J.M. Smucker Co., Orrville, OH) in which every 12 g contained 1.5 g of trans-fatty acids (12.5% trans fat by weight). Due to reformulations by vegetable shortening manufacturers to remove trans-fats from their products, only trans-free shortenings are now available. Little is known about the effects of trans fats on behavioral outcomes; however there is evidence that levels of dopamine and its metabolites in several brain regions differ when the trans-fat content of the diet is altered [8]. Since dopamine is thought to be involved in the expression of binge eating [9], the reformulation of shortening raises the issue of whether rats will still binge on trans-free shortening. The present study examined binge-type behavior in rats with trans-fat and trans-fat-free vegetable shortening.

MATERIALS and METHODS

Animals

Sixty male Sprague Dawley rats (Harlan, Indianapolis, IN), 60 days of age and weighing 227-255g (240.7 ± 0.86) at the start of the study, were individually housed in hanging stainless steel wire cages in a temperature- and humidity-controlled environment placed on a 12:12 light:dark cycle. One rat was removed from the study due to a large weight disparity. All remaining rats were maintained on a nutritionally complete commercial laboratory rodent chow (Laboratory Rodent Diet 5001, PMI Feeds, Richmond IN; percent of energy as protein: 28.05%, fat: 12.14%, carbohydrate: 59.81%; 3.3 kcal/g). Chow and tap water were available ad libitum throughout the entire study. All procedures were approved by the Pennsylvania State University Institutional Animal Care and Use Committee.

During the first ten days of adaptation to the vivarium, chow intake was measured on a daily basis, body weights were determined two times, and continuous access to trans-free solid vegetable shortening (Crisco® All-Vegetable shortening, J.M Smucker Co., Orrville, OH) was provided during a single overnight period. Four groups of 12 rats each and one group of 11 rats were then matched by body weight, average amount of chow consumed during 3 consecutive 24-hr periods, and the amount of trans-free shortening consumed during the overnight access period [$F(4,58) < 1$, NS for all].

For the next six weeks chow was available ad libitum to all groups, except where noted below. One group of rats ($n=12$) was placed on an intermittent schedule of access (Mondays, Wednesdays, and Fridays) to trans-fat shortening (I-T), a second group ($n=12$) was placed on an intermittent schedule of access (Mondays, Wednesdays, and Fridays) to trans-free shortening (I-TF), and a third group ($n=12$) was given daily access to trans-free shortening (D-TF). For these three groups shortening was provided for 1 hr in glass jars clipped to the front of the cages, starting 2.5 hours prior to the start of the dark cycle. A fourth group ($n=12$) was given continuous access (24 hr/day — 7 days/week) to trans-free shortening (24/7-TF) and a fifth group ($n=11$) only had access to chow (C), i.e. no shortening was provided. On Mondays, Wednesdays and Fridays chow was removed from the cages of all groups 1 hr prior to shortening availability and then replaced after the period of shortening availability. For the chow group, chow was made available at the same time shortening was made available to the other groups. On Sundays, Tuesdays, Thursdays and Saturdays, chow was removed from the cages of the daily group 1-hr prior to shortening availability and then replaced after the period of shortening availability. At the same time, the 24-hr intake of shortening was measured for the 24/7 group and the shortening jars were immediately replaced in the cages. Due to a limited supply of trans-fat shortening, only the I-T group received Crisco™ containing trans-fat.

Statistics

For all groups, the average 1-hr intakes (chow or shortening) on Mondays, Wednesdays and Fridays during weeks five and six were analyzed (Figure 1 data). The total 24-hr energy intakes

(chow only, or chow plus shortening) for each day of week five were also analyzed (Figure 2 data). The average shortening intake and 1-hr energy intake (shortening or chow), average daily energy intake and body weights were analyzed using 1-way ANOVA with [group] as the between subject measure. Daily energy intake during week five was analyzed using 2-way ANOVA with [group] as the between subject measure and [day] as the within subject (repeated) measure. Differences among groups were assessed using Tukey's Studentized Range (HSD) post-hoc test.

RESULTS

Energy intake during the 1-hr period of shortening availability was significantly affected by the shortening access schedule [$F(4,58) = 28.53$, $p 0.0001$] (Fig. 1A). Both of the intermittent groups (I-T and I-TF) consumed significantly more shortening during the 1-hr period than did either the daily (D-TF) or the continuous access (24/7-TF) group. Furthermore, the intakes of the intermittent groups (I-T and I-TF) were not statistically different. The 1-hr energy intake of the Chow (C) group did not differ statistically from that of the continuous access group (24/7-TF).

The shortening access schedule also influenced comparisons between the 1-hr shortening intakes of the intermittent and daily groups (I-T, I-TF, D-TF) and the 24-hr shortening intake of the continuous access (24/7-TF) group [$F(3,47) = 3.93$, $p 0.0144$]. However, in contrast to the 1-hr intake, the 24-hr shortening intake of the 24/7-TF group did not differ statistically from the 1-hr intakes of the D-TF, I-TF or I-T groups (Fig. 1B).

Total daily energy intake (chow only or chow + shortening) for each of the groups during week five is shown in Figure 2. There was a main effect of day [$F(6,324) = 29.99$, $p 0.0001$] and a day by schedule interaction [$F(24, 324) = 17.41$, $p 0.0001$]. Both of the Intermittent groups (I-TF, I-T) overate on days that shortening was available and underate on non-shortening days relative to the chow (C) group. Despite the overeat/under-eat pattern, there were no differences among the groups with respect to average daily energy intake [$F(4, 58) = 0.71$, p n.s.]. In addition, there were no differences in body weight among the groups [$F(4, 58) = 0.45$, p n.s.].

DISCUSSION

The present results demonstrate that previously reported effects of access schedule on consumption of vegetable shortening [1-7] are also obtained with trans-free shortening. Specifically, both the 1-hr intakes and the overeat/undereat patterns depend upon the schedule of access (intermittent v daily), and are unaffected by the composition of the vegetable shortening (trans v trans-free). Intakes of the intermittent groups (I-T and I-TF) were nearly identical. Furthermore, the intermittent groups (I-T and I-TF) consumed as much shortening in 1 hr as the rats with continuous shortening access (24 hr/day — 7days/week) consumed in a 24-hr period. Thus, trans-fats do not appear to be critical to the expression of binge-type eating in rats when intermittent access to shortening for brief periods of time is provided. Whether other forms of ingestive behavior are influenced by trans fats in the diet is not known.

ACKNOWLEDGEMENTS

This work was funded by 1-R01-MH67943 (RLC).

The first and third authors wish to acknowledge the USUHS MSII Summer Research Project and the DOD for providing us the opportunity to work with one of America's many finest, and for their continued protection of the United States of America. The views expressed are those of the authors of this paper and not that of the Uniformed Services University, the United States Department of Defense or the United States Government.

REFERENCES

1. Corwin RL. Binge-type eating induced by limited access in rats does not require energy restriction on the previous day. *Appetite* 2004;42:139–142. [PubMed: 15010177]
2. Corwin RL, Buda-Levin A. Behavioral models of binge-type eating. *Physiol. Behav* 2004;82:123–130. [PubMed: 15234600]
3. Corwin RL, Wojnicki FHE, Fisher JO, Dimitriou SG, Rice HB, Young MA. Limited access to a dietary fat option affects ingestive behavior but not body composition in male rats. *Physiol. Behav* 1998;65:545–553. [PubMed: 9877422]
4. Dimitriou SG, Rice HB, Corwin RL. Effects of limited access to a fat option on food intake and body composition in female rats. *Int. J. Eat. Disord* 2000;28:436–445. [PubMed: 11054791]
5. Thomas MA, Rice HB, Weinstock D, Corwin RL. Effects of aging on food intake and body composition in rats. *Physiol. Behav* 2002;76:487–500. [PubMed: 12126984]
6. Wojnicki FHW, Roberts DCS, Corwin R. Effects of baclofen on operant performance for food pellets and vegetable shortening after a history of binge-type behavior in non-food-deprived rats. *Pharmacol. Biochem. Behav* 2006;84:197–206. [PubMed: 16782181]
7. Davis JF, Melhorn SJ, Shurdan JD, Heiman JU, Tschop MH, Clegg DJ, Benoit SC. Comparison of hydrogenated vegetable shortening and nutritionally complete high-fat diet on limited access-binge behavior in rats. *Physiol. Behav.* 2007in press
8. Acar N, Chardigny J-M, Darbois M, Pasquis B, Sebedio J-L. Modification of the dopaminergic neurotransmitters in striatum, frontal cortex and hippocampus of rats fed for 21 months with trans isomers of α -linolenic acid. *Neurosci. Res* 2003;45:375–382. [PubMed: 12657450]
9. Rada, p.; Avena, NM.; Hoebel, BG. Daily bingeing on sugar repeatedly releases dopamine in the accumbens shell. *Neuroscience* 2005;134:737–744. [PubMed: 15987666]

Figure 1.

A. Average 1-hr intakes (kcal) during the 1-hr period of availability; chow for the C group and shortening for the 24/7-TF, D-TF, I-TF and I-T groups. Group designations: C = Chow only, 24/7 = continuous trans-free, D-TF = Daily trans-free, I-TF = intermittent trans-free, I-T = intermittent trans. Different letters indicate significant differences among the groups. Vertical lines indicate SEM.

Figure1B. 24-hr shortening intake (kcal) for the 24/7-TF group. Different numbers indicate significant differences among the 24-hr shortening intake of the 24/7-TF group and the 1-hr shortening intakes of the D-TF, I-TF and I-T groups.

Figure 2. Daily total energy intake (shortening and/or chow) during week five. Abbreviations same as Fig.1. * indicates significant differences between the Intermittent and Chow groups.