

INFORMATION TO USERS

The most advanced technology has been used to photograph and reproduce this manuscript from the microfilm master. UMI films the original text directly from the copy submitted. Thus, some dissertation copies are in typewriter face, while others may be from a computer printer.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyrighted material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each oversize page is available as one exposure on a standard 35 mm slide or as a 17" × 23" black and white photographic print for an additional charge.

Photographs included in the original manuscript have been reproduced xerographically in this copy. 35 mm slides or 6" × 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.



300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA

PREVIEW

Order Number 8818607

**Electrolyte balances, blood pressure, and sugar preferences as
affected by intakes of various sugars**

Benes, Beverly Ann Backencamp, Ph.D.

The University of Nebraska - Lincoln, 1988

U·M·I

**300 N. Zeeb Rd.
Ann Arbor, MI 48106**

PREVIEW

PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark ✓.

1. Glossy photographs or pages _____
2. Colored illustrations, paper or print _____
3. Photographs with dark background _____
4. Illustrations are poor copy _____
5. Pages with black marks, not original copy _____
6. Print shows through as there is text on both sides of page _____
7. Indistinct, broken or small print on several pages ✓
8. Print exceeds margin requirements _____
9. Tightly bound copy with print lost in spine _____
10. Computer printout pages with indistinct print _____
11. Page(s) _____ lacking when material received, and not available from school or author.
12. Page(s) 208 seem to be missing in numbering only as text follows.
13. Two pages numbered 209. Text follows.
14. Curling and wrinkled pages ✓
15. Dissertation contains pages with print at a slant, filmed as received ✓
16. Other _____

U·M·I

PREVIEW

ELECTROLYTE BALANCES,
BLOOD PRESSURE, AND SUGAR PREFERENCES
AS AFFECTED BY INTAKES
OF VARIOUS SUGARS

by
Beverly Ann Backencamp Benes

A DISSERTATION
presented to the Faculty of
The Graduate College at the University of Nebraska
In Partial Fulfillment of Requirements
For the Degree of Doctor Of Philosophy
Major:
Interdepartmental Area of Nutrition

Under the Supervision of Professor Constance Kies

Lincoln, Nebraska

March 1988

TITLE

Electrolyte Balances, Blood Pressure, and Sugar Preferences

as Affected by Intakes of Various Sugars

BY

Beverly Ann Backencamp Benes

APPROVED

DATE

<u>Constance Kies</u>	<u>3/14/88</u>
<u>Hazel M. Fox</u>	<u>3/14/88</u>
<u>Thomas Sullivan</u>	<u>3/14/88</u>
<u>Herman Knoche</u>	<u>3/14/88</u>
<u>Lloyd Bullerman</u>	<u>3/14/88</u>
<u> </u>	<u> </u>
<u> </u>	<u> </u>

SUPERVISORY COMMITTEE

GRADUATE COLLEGE

UNIVERSITY OF NEBRASKA

ELECTROLYTE BALANCES,
BLOOD PRESSURE AND SUGAR PREFERENCE
AS AFFECTED BY INTAKES
OF VARIOUS SUGARS

Beverly Benes, Ph.D.

University of Nebraska

Advisor: Constance Kies

The overall objective of this project was to investigate the effect of consumption of various dietary sugars on electrolyte excretion, electrolyte balance, blood pressure, serum lipid level, and preference for sugar. Four studies comprised the project.

The first study consisted of feeding a controlled diet to two groups of 12 young adults. Subjects were fed a laboratory diet supplemented with sucrose, fructose, or high fructose corn syrup (HFCS). The test sugars fed at a level of 60 g/day did not significantly affect electrolyte excretion levels, serum lipid levels, or blood pressure. In Study II taste preference for sucrose in a lemonade solution and blood pressures were measured in hypertensive and normotensive elderly subjects. For the 39 subjects classified as normotensive sucrose preference tended to be positively correlated with systolic blood pressure, mean blood pressure, and weight. Hypertensive subjects exhibited an opposite trend in that sucrose preference was negatively correlated with mean blood pressure, body mass index, and weight. A consistent increase in sucrose preference with increasing age was not observed in this study. Differences in preferred sucrose solutions based on sex or race were not observed.

In Study III, the relationship of sodium and potassium intake and urinary potassium and chloride excretion to mean blood pressure of elderly subjects consuming self-selected diets was studied. Hypertension was not associated with increased dietary intakes of potassium or sodium. Nor, was hypertension associated with altered urinary potassium or chloride excretion.

Study IV was conducted at a workshop on home food preservation, stressing the reduction of salt and sugar in food preservation. The workshop was conducted for Extension Home Agents. Pre- and post-test evaluations indicated a significant increase in knowledge.

PREVIEW

ACKNOWLEDGMENTS

My sincere appreciation goes to Dr. Constance Kies for her direction, guidance, and encouragement while conducting my research and preparing this manuscript.

I am extremely thankful to all the members of my supervisory committee; Dr. Kies, my advisor; Dr. Hazel Fox and Dr. Thomas Sullivan, who were on my reading committee; Dr. Lloyd Bullerman and Dr. Herman Knocke for exercising their roles as committee members.

A special thanks to Donna Hahn, Lori Rausch, Bunny Penton, Barb Dripps, and Sandy Downs for their guidance and assistance in my research and teaching endeavors.

A project such as this manuscript is not accomplished without support and sacrifice from family, friends, and colleagues. To all that have shared in this experience with me I extend a very sincere thank you. I especially want to thank my dear friends, Crystal Ricketts, Donna Hahn, and Sue Potter for their moral support and friendship.

A very special thank you to my family, Ken, Brian, Lisa, and Scott for the love, support, and sacrifice of time they have given to me over these last few years.

PREVIEW

TABLE OF CONTENTS

	PAGE
ACKNOWLEDGMENTS	ii
LIST OF TABLES	iv
LIST OF APPENDIX TABLES	vi
INTRODUCTION	1
LITERATURE REVIEW	3
STUDY I: Effect of dietary sweeteners on electrolyte excretions, serum lipid profiles, and blood pressures in human adults	
Experimental Procedure	42
Results and Discussion	51
STUDY II: Elderly taste preference for a sucrose solution, blood pressure, and anthropometric relationships	
Experimental Procedure	67
Results and Discussion	72
STUDY III: Urinary potassium and chloride excretion as affected by normal dietary intakes of an elderly population	
Experimental Procedure	87
Results and Discussion	89
STUDY IV: Home food preservation workshop.	
Experimental Procedure	94
Results and Discussion	96
LITERATURE CITED	100
APPENDICES	111

LIST OF TABLES

TABLE	PAGE
1 Mechanisms that control arterial pressure	41
I-1 Experimental plans, Studies A and B	46
I-2 Basal diet, Study A	47
I-3 Basal diet, Study B	48
I-4 Randomization of diets, Studies A and B	49
I-5 Subject information, Studies A and B	50
I-6 Mean mineral intakes, excretions, and balances of human subjects (Study A)	62
I-7 Mean mineral intakes, excretions, and balances of human subjects (Study B)	63
I-8 Effects of sucrose, fructose, and HFCS feeding (Studies A and B) on blood serum total cholesterol, HDL cholesterol, triglyceride and chloride levels in human subjects . . .	64
I-9 Effects of sucrose and HFCS feeding (Study B) on systolic blood pressure, diastolic blood pressure, and MBP	65
I-10 Effect of sucrose, fructose, and HFCS (Studies A and B) on urine volumes of human subjects	66
II-1 Correlation coefficients between parameters measured (significant trends)	81
II-2 Sucrose preferences and blood pressures of older human adults for age, sex, body mass index (BMI), and race . .	82
II-3 Mean systolic, diastolic and mean blood pressure (MBP) values for the normotensive and hypertensive groups by age category	83
II-4 Characteristics of older human subjects by blood pressure group	84
II-5 Frequencies and percent of subjects for smoking habits, denture-wearing status, and medication use	85
II-6 Comparison of smoking habit and denture-wearing status for mean percent sucrose preference	86

LIST OF TABLES (continued)

TABLE	PAGE
III-1 Means of the whole group and the normotensive and hypertensive subgroups for mean blood pressure (MBP) urinary excretions of chloride and potassium, intakes of calories, potassium and sodium, Na:K ratio, and age . . .	93
IV-1 Responses to Pre- and Post-Tests	98

LIST OF APPENDIX TABLES

TABLE		PAGE
A-1	Dietary input form	111
A-2	Consent form for Study A	114
A-3	Consent form for Study B	116
A-4	Determination of total cholesterol	119
A-5	Determination of serum HDL-cholesterol	120
A-6	Determination of serum triglycerides	121
A-7	Sample preparation of feces and food	124
A-8	Determination of urine potassium	125
A-9	Determination of fecal potassium	126
A-10	Determination of urine sodium	127
A-11	Determination of fecal sodium	128
A-12	Chloride determination	129
A-13	Individual mean urinary chloride excretion values (mg/day)	131
A-14	Individual mean fecal potassium excretion values (mg/day)	132
A-15	Individual mean urinary potassium excretion values (mg/day)	133
A-16	Individual mean fecal sodium excretion values (mg/day) .	134
A-17	Individual mean urinary sodium excretion values (mg/day)	135
A-18	Individual mean urine volumes (ml/day)	136
A-19	Individual mean dry fecal weights (g/period)	137
A-20	Individual mean urinary excretion values of creatinine (g/day)	138
A-21	Individual systolic, diastolic, and mean blood pressure (mmHg) by period	139
A-22	Individual mean serum chloride values (mEq/L)	140

LIST OF APPENDIX TABLES (continued)

TABLE	PAGE
A-23 Individual mean serum total cholesterol (mg/dl)	141
A-24 Individual mean serum HDL cholesterol values (mg/dl) . .	142
A-25 Individual mean serum triglyceride values (mg/dl)	143
A-26 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on urinary chloride excretion for Study A	144
A-27 TTest for differences of urinary chloride excretion between periods 1 and 2 for Study A-sucrose	145
A-28 TTest for differences of urinary chloride excretion between periods 1 and 2 for Study A-fructose	145
A-29 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on fecal potassium excretions for Study A	146
A-30 TTest for differences of fecal potassium excretion between periods 1 and 2 for Study A-sucrose	147
A-31 TTest for differences of fecal potassium excretion between periods 1 and 2 for Study A-fructose	147
A-32 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on potassium urinary excretions for Study A	148
A-33 TTest for differences of urinary potassium excretion between periods 1 and 2 for Study A-sucrose	149
A-34 TTest for differences of urinary potassium excretion between periods 1 and 2 for Study A-fructose	149
A-35 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on potassium balances for Study A .	150
A-36 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on fecal sodium excretions for Study A	151
A-37 TTest for differences of fecal sodium excretion between periods 1 and 2 for Study A-sucrose	152

LIST OF APPENDIX TABLES (continued)

TABLE	PAGE
A-38 TTest for differences of fecal sodium excretion between periods 1 and 2 for Study A-fructose	152
A-39 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on urinary sodium excretion for Study A	153
A-40 TTest for differences of urinary sodium excretion between periods 1 and 2 for Study A-sucrose	154
A-41 TTest for differences of urinary sodium excretion between periods 1 and 2 for Study A-fructose	154
A-42 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on sodium balances for Study A . . .	155
A-43 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on urinary chloride excretions for Study B	156
A-44 TTest for differences of urinary chloride excretion between periods 1 and 2 for Study B-sucrose	157
A-45 TTest for differences of urinary chloride excretion between periods 1 and 2 for Study A-HFCS	157
A-46 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on fecal potassium excretions for Study B	158
A-47 TTest for differences of fecal potassium excretion between periods 1 and 2 for Study B-sucrose	159
A-48 TTest for differences of fecal potassium excretion between periods 1 and 2 for Study B-HFCS	159
A-49 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on urinary potassium excretions for Study B	160
A-50 TTest for differences of urinary potassium excretion between periods 1 and 2 for Study B-sucrose	161
A-51 TTest for differences of urinary potassium excretion between periods 1 and 2 for Study B-HFCS	161

LIST OF APPENDIX TABLES (continued)

TABLE	PAGE
A-52 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on potassium balances for Study B	162
A-53 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on fecal sodium excretions for Study B	163
A-54 TTest for differences of fecal sodium excretion between periods 1 and 2 for Study B-sucrose	164
A-55 TTest for differences of fecal sodium excretion between periods 1 and 2 for Study B-HFCS	164
A-56 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on urinary sodium excretion for Study B	165
A-57 TTest for differences of urinary sodium excretion between periods 1 and 2 for Study B-sucrose	166
A-58 TTest for differences of urinary sodium excretion between periods 1 and 2 for Study B-HFCS	166
A-59 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on sodium balances for Study B	167
A-60 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on the urine volumes for Study A	168
A-61 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on urine volumes for Study B	169
A-62 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on systolic blood pressure for Study B	170
A-63 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on diastolic blood pressure for Study B	171
A-64 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on mean blood pressure (MBP) for Study B	172
A-65 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on serum chloride values for Study A	173

LIST OF APPENDIX TABLES (continued)

TABLE	PAGE
A-66 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on serum total cholesterol values for Study A	174
A-67 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on serum HDL-cholesterol values for Study A	175
A-68 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on serum triglyceride values for Study A	176
A-69 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on serum chloride values for Study B	177
A-70 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on serum total cholesterol values for Study B	178
A-71 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on serum HDL-cholesterol values for Study B	179
A-72 ANOVA and Duncan's Multiple Range Test for the effect of dietary treatment on serum triglyceride values for Study B	180
B-1 Informed consent form	181
B-2 Subject information form	183
B-3 Food record form	186
B-4 Dietary questionnaire	189
B-5 Release form	194
B-6 Subject characteristics	195
B-7 Individual percent sucrose preferences	197
B-8 Individual mean blood pressures	198
B-9 Modified diets as reported by subjects	200
B-10 Distribution by age, sex, and race of subjects	201

LIST OF APPENDIX TABLES (continued)

TABLE	PAGE
B-11 Subject participation by Senior Diner Center	202
B-12 Percent participation by Senior Diner Center and participation by sex	202
B-13 Pearson correlation coefficients for systolic blood pressure, diastolic blood pressure, mean blood pressure (MBP), percent sucrose preference, body mass index (BMI), body weight, calorie intake, sex, age, and race by normotensive blood pressure condition	203
B-14 Pearson correlation coefficients for systolic blood pressure, diastolic blood pressure, mean blood pressure (MBP), percent sucrose preference, body mass index (BMI), body weight, calorie intake, sex, age, and race by hypertensive blood pressure condition	205
B-15 Pearson correlation coefficients for blood pressure condition, systolic blood pressure, diastolic blood pressure, mean blood pressure (MBP), percent sucrose preference, body mass index (BMI), body weight, calorie intake, sex, age, and race for the whole group	207
B-16 Pearson correlation coefficients for blood pressure condition, systolic blood pressure, diastolic blood pressure, mean blood pressure (MBP), percent sucrose preference, body mass index (BMI), body weight, calorie intake, sex, age, and race by body mass index grouping 1 (BMI \leq 23)	210
B-17 Pearson correlation coefficients for blood pressure condition, systolic blood pressure, diastolic blood pressure, mean blood pressure (MBP), percent sucrose preference, body mass index (BMI), body weight, calorie intake, sex, age, and race by body mass index grouping 2 (BMI 23-25)	213
B-18 Pearson correlation coefficients for blood pressure condition, systolic blood pressure, diastolic blood pressure, mean blood pressure (MBP), percent sucrose preference, body mass index (BMI), body weight, calorie intake, sex, age, and race by body mass index grouping 3 (BMI \geq 25)	215
B-19 Pearson correlation coefficients for blood pressure condition, systolic blood pressure, diastolic blood pressure, mean blood pressure (MBP), percent sucrose preference, body mass index (BMI), body weight, calorie intake, age, and race for all females	218

LIST OF APPENDIX TABLES (continued)

TABLE	PAGE
B-20 Pearson correlation coefficients for blood pressure condition, systolic blood pressure, diastolic blood pressure, mean blood pressure (MBP), percent sucrose preference, body mass index (BMI), body weight, calorie intake, age, and race for all males	220
B-21 ANOVA and Duncan's Multiple Range Test for the effect of blood pressure condition mean calorie intake	222
B-22 TTest procedure for differences in systolic blood pressures, diastolic blood pressures, and MBP due to sex	223
B-23 ANOVA and Duncan's Multiple Range Test for effect of blood pressure condition mean systolic blood pressure . .	224
B-24 ANOVA and Duncan's Multiple Range Test for effect of blood pressure condition mean diastolic pressure	225
B-25 ANOVA and Duncan's Multiple Range Test for effect of blood pressure condition on mean blood pressure (MBP) . .	226
B-26 ANOVA and Duncan's Multiple Range Test for effect of normotensive blood pressure condition on mean systolic blood pressure by age grouping	227
B-27 ANOVA and Duncan's Multiple Range Test for effect of normotensive blood pressure condition on mean diastolic blood pressure by age grouping	228
B-28 ANOVA and Duncan's Multiple Range Test for effect of normotensive blood pressure condition on mean blood pressure (MBP) by age grouping	229
B-29 ANOVA and Duncan's Multiple Range Test for effect of hypertensive blood pressure condition on mean systolic blood pressure by age grouping	230
B-30 ANOVA and Duncan's Multiple Range Test for effect of hypertensive blood pressure condition on mean diastolic blood pressure by age grouping	231
B-31 ANOVA and Duncan's Multiple Range Test for effect of hypertensive blood pressure condition on mean blood pressure (MBP) by age grouping	232

LIST OF APPENDIX TABLES (continued)

TABLE		PAGE
B-32	ANOVA and Duncan's Multiple Range Test for effect of age group 1 (60-65) on mean systolic blood pressure by blood pressure condition	233
B-33	ANOVA and Duncan's Multiple Range Test for effect of age group 1 (60-65) on mean systolic blood pressure by blood pressure condition	234
B-34	ANOVA and Duncan's Multiple Range Test for effect of age group 1 (60-65) on mean diastolic blood pressure by blood pressure condition	235
B-35	ANOVA and Duncan's Multiple Range Test for effect of age group 1 (60-65) on mean blood pressure (MBP) by blood pressure condition	236
B-36	ANOVA and Duncan's Multiple Range Test for effect of age group 2 (66-70) on mean systolic blood pressure by blood pressure condition	237
B-37	ANOVA and Duncan's Multiple Range Test for effect of age group 2 (66-70) on mean diastolic blood pressure by blood pressure condition	238
B-38	ANOVA and Duncan's Multiple Range Test for effect of age group 2 (66-70) on mean blood pressure (MBP) by blood pressure condition	239
B-39	ANOVA and Duncan's Multiple Range Test for effect of age group 3 (71-75) on mean systolic blood pressure by blood pressure condition	240
B-40	ANOVA and Duncan's Multiple Range Test for effect of age group 3 (71-75) on mean diastolic blood pressure by blood pressure condition	241
B-41	ANOVA and Duncan's Multiple Range Test for effect of age group 3 (71-75) on mean blood pressure (MBP) by blood pressure condition	242
B-42	ANOVA and Duncan's Multiple Range Test for effect of age group 4 (76-80) on mean systolic blood pressure by blood pressure condition	243
B-43	ANOVA and Duncan's Multiple Range Test for effect of age group 4 (76-80) on mean diastolic blood pressure by blood pressure condition	244

LIST OF APPENDIX TABLES (continued)

TABLE	PAGE
B-44 ANOVA and Duncan's Multiple Range Test for effect of age group 4 (76-80) on mean blood pressure (MBP) by blood pressure condition	245
B-45 ANOVA and Duncan's Multiple Range Test for effect of age group 5 (81-85) on mean systolic blood pressure by blood pressure condition	246
B-46 ANOVA and Duncan's Multiple Range Test for effect of age group 5 (81-85) on mean diastolic blood pressure by blood pressure condition	247
B-47 ANOVA and Duncan's Multiple Range Test for effect of age group 5 (81-85) on mean blood pressure (MBP) by blood pressure condition	248
B-48 ANOVA and Duncan's Multiple Range Test for effect of age group 6 (86-90) on mean systolic blood pressure by blood pressure condition	249
B-49 ANOVA and Duncan's Multiple Range Test for effect of age group 6 (86-90) on mean diastolic blood pressure by blood pressure condition	250
B-50 ANOVA and Duncan's Multiple Range Test for effect of age group 6 (86-90) on mean blood pressure (MBP) by blood pressure condition	251
B-51 ANOVA and Duncan's Multiple Range Test for effect of age grouping on mean percent sucrose preference	252
B-52 ANOVA and Duncan's Multiple Range Test for effect of sex on mean percent sucrose preference	253
B-53 ANOVA and Duncan's Multiple Range Test for effect of race/nationality grouping on mean percent sucrose preference	254
B-54 ANOVA for effect of weight index on mean percent sucrose preference	255
B-55 ANOVA and Duncan's Multiple Range Test for effect of blood pressure condition on mean percent sucrose preference	256
B-56 ANOVA and Simple Regression for mean blood pressure (MBP) with body mass index (BMI), weight, calorie intake, and mean percent sucrose preference for the whole group	257