



145
140
THS

THE EFFECT OF A STRICT VEGETARIAN DIET ON THE
VOLUNTARY ACTIVITY AND BODY COMPOSITION OF
MALE ALBINO RATS

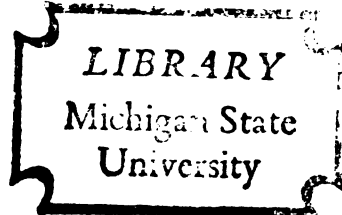
Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY

DANIEL ALLEN KLEIN

1969

FOOTING BY

44

[illegible]

ABSTRACT

THE EFFECT OF A STRICT VEGETARIAN DIET ON THE VOLUNTARY ACTIVITY AND BODY COMPOSITION OF MALE ALBINO RATS

By

Daniel Allen Klein

The purpose of this study was to determine the effects of a strict vegetarian diet on the voluntary activity and body composition of male albino rats.

The study was designed to determine if statistically significant differences exist between sixth-generation strict vegetarian rats and control rats with respect to voluntary activity and body composition.

At 45 days of age, two groups of animals were brought to the Human Energy Research Laboratory, Michigan State University. The groups were kept on their respective diets. Daily voluntary activity was recorded for each animal. At 100 days of age, the animals were sacrificed and body compositions were determined.

One-way analysis of variance was run between the groups on the following variables: voluntary activity, body weight, carcass weight, absolute water, percentage water, absolute fat, percentage fat, absolute protein, percentage protein, absolute ash, and percentage ash.

Because marked group differences in body weight and carcass weight automatically made most of the absolute comparisons statistically significant, only the percentage body composition variables were considered.

The strict vegetarian animals had a higher percentage fat and lower percentage of protein and ash. These differences were significant at the .005 level.

There was no significant difference with respect to activity.

Lack of temperature control in the laboratory could cause great variation in activity and eating patterns of the animals. In the writers' opinion, no final conclusions should be drawn as to the value of the strict vegetarian diet until further work can be done because of the lack of temperature control.

THE EFFECT OF A STRICT VEGETARIAN DIET
ON THE VOLUNTARY ACTIVITY AND BODY
COMPOSITION OF MALE ALBINO RATS

By

Daniel Allen Klein

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Health, Physical
Education, and Recreation

1969

G54053
3/1/19

DEDICATION

This thesis is dedicated to my wife,
Sharon, for her understanding inspiration and to
my mother whose encouragement has made it possible
to meet this goal in my education.

ACKNOWLEDGMENTS

The assistance of Dr. Robert Fadeley of Andrews University, without whose help and encouragement this study would not have been completed, is gratefully acknowledged.

Acknowledgment is extended to Dr. W. W. Heusner of the Michigan State University Human Energy Research Laboratory for providing a stimulating atmosphere in which to work and for his help in the many facets of conducting research.

TABLE OF CONTENTS

	Page
DEDICATION	ii
ACKNOWLEDGMENTS	iii
Chapter	
I. INTRODUCTION	1
Purpose of the Study	2
Need for the Study	2
Limitations of the Study	2
Definition of Terms	3
II. RELATED LITERATURE	5
III. METHODS	8
IV. RESULTS AND ANALYSIS	11
V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	14
Summary	14
Conclusions	14
Recommendations	15
BIBLIOGRAPHY	16
APPENDIX	18

CHAPTER I

INTRODUCTION

In 1962, Fadeley (5) studied the effects of various diets on the human radioactivity level. Two of the diets he studied were: (a) a typical American diet with an average amount of meat, and (b) a strict vegetarian diet. Individuals on the vegetarian diet had no foods of animal origin.

Fadeley (5) found that individuals who were on the typical American diet had significantly higher levels of body radiation than those using the strict vegetarian diet. Each type of diet was fed to a group of albino rats to determine if differences in body radiation would occur in rats with diet as the only variable. Group differences in the same direction were found which was statistically even more significant.

The writer became acquainted with Dr. Robert Fadeley in 1965. Because of the writer's interest in physical education and exercise, it was decided that Fadeley's animals should get some form of physical activity. Voluntary exercise wheels were built and attached to the animals' cages. To have a means of evaluating the subsequent effects of exercise, a technique was devised for

measuring whole-body strength in albino rats. Comparisons of voluntary exercise and whole-body strength indicated that the strict vegetarian diet was superior to the standard diet in the following ways:

1. Voluntary exercise was higher in the vegetarian animals than in those on the standard diet.
2. Whole body strength also was higher in the vegetarian animals.

Purpose of the Study

The purpose of this study was to determine the effects of a strict vegetarian diet on voluntary activity and body composition of male albino rats.

Need for the Study

The problem of feeding the masses of the earth is becoming increasingly acute. Approximately ten times the land area is needed to produce an equal amount of usable protein in animal form as from soybeans. It would be beneficial to mankind if a diet of vegetable proteins could be developed to meet human needs. In addition to wasting land, the raising of animals for protein has other disadvantages. Human consumption of meat increases body radiation and diseases (5, 12).

Limitations of the Study

Because of the difficulty of trying to work with a large number of humans, white albino rats were used.

Conclusions drawn from animal studies cannot be directly applied to humans. Therefore, it will be necessary to repeat the study controlling the dietary intakes of an experimental group of human subjects. It should be noted, however, that in many ways the internal chemistry of man and the rat are similar (10).

Lack of space and finances limited the original breeding stock to two pairs of animals in each dietary group. This is an extremely small genetic pool from which to draw succeeding generations. Only nineteen strict vegetarian and ten control male albino rats were available in the sixth generation for the study.

Environmental temperature and humidity could not be controlled throughout most of the study. High temperatures probably adversely affected the strict vegetarian animals due to food spoilage. The extent to which the animals were affected is not know.

Definition of Terms

In this report, certain terms will be used. Clarification is given to facilitate a better understanding.

Control Animals

These animals were male albino, sixth-generation rats that were fed the standard laboratory diet of Wayne Lab Blox.

Strict Vegetarian Animals

These animals were male albino, sixth-generation rats that were fed the experimental diet containing no food of animal origin.

Voluntary Exercise Animal Housing

All animals were housed in individual cages approximately 10 inches long, 8 inches wide, and 7 inches high. Each cage had an exercise wheel attached to it so the rat could have access to the wheel and exercise at will.

Average or Typical American Diet

This is a diet that a typical American family would use with various amounts of food products such as meat, bread, vegetables, etc.

CHAPTER II

RELATED LITARATURE

In the references that the writer reviewed, there was no study done with animals which were fed a strict vegetarian diet.

Therefore, the related literature has to do with observations made only on people who were on or given a vegetarian diet.

Dean (2, 3) working with children who had confirmed advanced cases of kwashiorkor, found that the children responded equally well to either of two diets. Observations were made on one group of children who were fed the more or less standard diet which is used to correct kwashiorkor. These children received dried, skimmed, cows' milk to supply most of their protein intake. They recovered well over a period of one month. Another group of children were fed soy milk to supply most of their protein. Their daily diet had about 65 grams of protein of which 7 grams came from bananas, 8 grams came from maize, and 51 grams came from soybeans. The twenty children who were on this diet recovered as well and as rapidly as did the children on the cows' milk diet.

These children were not given any animal products during their recovery period.

Other investigators have found that strict vegetarian diets are low in vitamin B₁₂ content. However, even when individuals are on a strict vegetarian diet for some time, they show no signs of anemia as might be expected (4, 13).

Some strict vegetarian diets are low in protein. It is thought that when the total amount of protein is low in the diet, the protein that is available is used very efficiently due to protein complementation (1).

Individuals who are on a strict vegetarian diet are, on the average, lighter (by twenty pounds) than individuals on a typical American diet. Even though lighter in weight, these individuals do not differ significantly in measurements of height, blood pressure, total protein, serum albumin, serum globulin, or other hematological variables (6).

Harding (7, 8, 9) found that serum cholesterol levels were thirty per cent lower in a group of strict vegetarians than in subjects maintained on a normal diet, despite the free use of vegetable fats in the strict vegetarian diet. Cholesterol levels seem to be related to the amount of animal fats ingested and independent of the vegetable fat intake. He also found that there was a significant negative correlation between the intake of

total unsaturated fatty acids and the serum cholesterol level. The strict vegetarians also had a much higher level of crude fiber in the diet. This fiber came from the unrefined and natural character of the food that they ate. It is thought that there might be an inverse relationship between serum cholesterol level and fiber intake in the diet.

Even though no previous work has been found with rats using a strict vegetarian diet, it should be noted that the diet which was fed to the experimental group of animals in this study was essentially the same diet that Fadeley (5) used with humans in his original radiation study.

CHAPTER III

METHODS

Eight male and nine female Holzman Albino Rats were purchased in 1965 by the Laboratory for Environmental Research at Andrews University, Berrien Springs. Two pairs were randomly assigned to a control dietary group and two pairs to an experimental vegetarian group. All the following generations came from these eight animals. Over a period of two and one-half years, each animal in each succeeding generation was raised on the same diet as its parents.

At forty-five days of age, nineteen experimental animals and ten control animals from the sixth generation were placed in the Michigan State University Human Energy Research Laboratory. Facilities for obtaining body composition information were available at Michigan State University. It was thought that this information would complement the previously obtained measurements of voluntary activity and whole-body strength.

Revolutions in individual voluntary-activity wheels were recorded daily. A mean daily activity value was calculated for each group over the entire investigative period.

The animals were sacrificed at about one hundred days of age. Body compositions were determined.

All the animals were housed in individual, voluntary-activity cages.

The control animals were fed Wayne Lab Blox ad libium.

The daily strict vegetarian diet for each experimental animal consisted of:

Grains

one part wheat
one part barley
one part oats
one part rice
one part rye
one-half part millet
one-fourth part peas

High Protein

Loma Linda Vegaburger	two ounces
-----------------------	------------

Soy Milk

Worthington Soyamel	two fluid ounces
---------------------	------------------

Other

carrot	small slice
green bean	one-third
lettuce	four square inches
green ripe olive	one-half
apple	one-twelfth
pecan meal	one-quarter teaspoon

The dry grains were ground and mixed because it was found that otherwise the animals would selectively eat certain grains which would negate the necessary protein

complementation. The grains were placed in a separate container in each cage in sufficient quantity so as to be continuously available.

Because the animals would not eat moist grain, the soy milk was placed in a second container. The remainder of the food was placed in a third container.

Both the control and experimental animals had free access to water. The experimental group's water intake was subjectively observed to be much lower than the control group's. This probably was due to the fact that the experimental animals had milk and that all of their food, except the grain, had a considerable amount of moisture content.

One-way analyses of variance were run between the dietary groups on the following variables: voluntary activity, body weight, carcass weight, absolute water, percentage water, absolute fat, percentage fat, absolute protein, percentage protein, absolute ash, and percentage ash. For this investigation, the probability of making a type I statistical error was limited to the .01 level.

CHAPTER IV

RESULTS AND ANALYSIS

The purpose of this study was to determine the effects of a strict vegetarian diet on the voluntary activity and body composition of male albino rats.

All raw data from the investigation are given in the Appendix.

Several one-way analyses of variance were run between the two dietary groups. The results are shown in Table 1.

There were large mean differences between the control and strict vegetarian animals in whole body weight and carcass weight. Because these differences automatically made most of the absolute comparisons statistically significant, only the relative body composition data will be discussed.

It can be seen from Table 1 that there were significant differences between the control and strict vegetarian animals with respect to percentage fat, percentage protein, and percentage ash. The strict vegetarian animals had a higher percentage of fat than the controls. The experimental animals had lower percentages of protein

TABLE 1.--One-way analysis of variance results between ten control and nineteen strict vegetarian male albino rats.

Variable	Group	\bar{X}	s	f	d
Voluntary Activity	Control	3044.29	2235.91	0.081	0.78
	St. Veg	2863.79	1194.74		
Body Weight	Control	370.60	31.42	48.98	0.0005
	St. Veg	296.37	24.74		
Carcass Weight	Control	289.80	28.07	41.19	0.0005
	St. Veg	231.37	20.51		
Absolute Water	Control	184.82	16.46	51.81	0.0005
	St. Veg	145.11	12.79		
Percentage Water	Control	63.82	0.76	4.19	0.051
	St. Veg	62.74	1.57		
Absolute Fat	Control	26.55	6.98	1.33	0.26
	St. Veg	29.30	5.66		
Percentage Fat	Control	9.04	1.70	19.83	0.0005
	St. Veg	12.66	2.25		
Absolute Protein	Control	64.85	5.50	60.53	0.0005
	St. Veg	49.02	5.05		
Percentage Protein	Control	22.41	0.51	21.36	0.0005
	St. Veg	21.17	0.76		
Absolute Ash	Control	11.88	0.94	316.26	0.0005
	St. Veg	6.13	0.76		
Percentage Ash	Control	4.12	0.31	262.93	0.0005
	St. Veg	2.64	0.18		

and ash. All of these results were significant at the 0.0005 level.

It was expected that there would be a significant difference in the voluntary activity levels between groups. In previous work by Fadeley, it was shown that the difference between groups with respect to activity was significant beyond the .001 level. The vegetarian animals were more active than the controls (5).

The results of this study do not agree with Fadeley's earlier findings. In the writer's opinion, the results of this study are in conflict with those of Fadeley because of the lack of temperature control in the present study. It is not known how much either of the two groups was affected by the high environmental temperature in the laboratory.

The strict vegetarian diet consists mainly of high moisture-content foods. It was found that in high temperatures, these foods spoiled rapidly leaving only the grain to be consumed ad libitum. The experimental animals may not have received sufficient protein and other nutrients for proper growth and activity.

The control animals' diet of dry pellets was not affected immediately by increases in temperature. A balanced food supply was continuously available.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

With the increasing world population and with animal protein becoming more undesirable for human use, it is imperative that a good diet be found from vegetable sources. Some evidence would suggest that a strict vegetarian diet would be as good as, and in some ways better than, the diets now generally used.

The purpose of this study was to investigate the effects of a strict vegetarian diet on male albino rats. Body composition and voluntary activity were compared between two dietary groups.

Conclusions

The following conclusions were drawn from the analyses of the data:

1. The strict vegetarian animals were lighter in body weight than the control animals.
2. The strict vegetarian animals had a higher percentage of fat than the control animals.

3. The strict vegetarian animals had a lower percentage of protein than the control animals.
4. The strict vegetarian animals had a lower percentage of ash than the control animals.
5. There was no significant difference between the groups with respect to voluntary activity.
6. The difference between groups in percentage of body water was not significant.
7. The author believes that, because of the lack of temperature control, the above results are not valid. There is no way to determine the differential group effects caused by the high temperatures in the laboratory. No final conclusion should be drawn as to the value of the strict vegetarian diet until further work can be done.

Recommendations

1. In a further study the environmental conditions need better control.
2. The effects of the strict vegetarian diet should be studied more closely in first-generation animals as well as in later generations.
3. More accurate tests of strength and endurance for the rat should be developed so that dietary effects on performance can be measured.
4. A pilot study should be done with humans.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Bogert, L. J. Nutrition and Physical Fitness. Philadelphia and London: W. B. Saunders Co., 1965.
2. Dean, R. F. A. Medical Research Council, No. 279.
3. Dean, R. F. A. British Medical Journal, 791-798, 1952.
4. Dhopeshwarkar, G. A. British Journal of Nutrition 10:105-110, 1956.
5. Fadeley, R. Unpublished Research, Andrews University, Berrien Springs, Michigan.
6. Hardinge, M. G. American Journal of Clinical Nutrition, 2:73-82, 1954.
7. Hardinge, M. G. American Journal of Clinical Nutrition, 2:83-88, 1954.
8. Hardinge, M. G. American Journal of Clinical Nutrition, 6:523-525, 1958.
9. Hardinge, M. G. American Journal of Clinical Nutrition, 10:516-524, 1962.
10. Rarick, G. L. Science and Medicine of Exercise and Sports. Edited by Warren R. Johnson. New York: Harper and Row, 1960.
11. Widdowson, E. M. Medical Research Council, No. 257.
12. White, E. G. Counsels on Diet and Foods. Washington D. C.: Review and Herald Publishing Association, Takoma Park, 1946.
13. Wokes, F. Nutritional Society Proceedings, 15:134-141, 1956.

APPENDIX

APPENDIX TABLE I.

	Body Wt. gms.	Car. Wt. gms.	% Water	% Fat	% Protein	% Ash	\bar{x} Act.
Control	377	296	62.98	10.13	21.88	3.91	3133
	354	270	63.88	9.02	22.31	4.34	4977
	360	282	64.25	8.18	22.25	4.45	2252
	343	265	64.40	8.16	22.31	3.94	4082
	402	326	64.17	8.89	22.38	3.71	1925
	350	274	64.26	7.98	22.62	4.39	2075
	314	240	65.08	5.70	23.75	4.43	8282
	397	312	63.36	10.23	22.19	3.85	1120
	411	320	62.57	11.93	22.19	3.73	1541
	398	313	63.29	10.16	22.19	4.41	1055
St. Veg.	286	226	61.36	14.26	21.62	2.75	2135
	275	216	61.87	14.32	20.19	2.69	2592
	300	231	62.35	13.12	20.94	2.55	1627
	326	257	62.08	13.63	20.44	2.68	4499
	298	237	61.21	14.97	20.62	2.38	1706
	330	261	63.77	10.07	22.31	3.06	2807
	266	208	62.95	12.98	20.81	2.61	4020
	282	216	64.14	11.00	21.25	2.75	2610
	320	258	61.99	13.18	20.88	2.69	3203
	250	199	65.85	8.77	21.62	2.64	2526
	274	207	63.00	12.77	20.69	2.49	1647
	280	215	61.05	15.68	19.81	2.42	1421
	313	245	63.04	12.04	21.25	2.89	2151
	295	229	59.48	17.20	20.56	2.54	3079
	298	228	62.31	13.50	21.06	2.46	4623
	340	264	62.30	12.22	22.31	2.70	1799
	294	231	63.29	11.48	21.94	2.74	2384
	274	211	65.47	8.35	22.62	2.83	5767
	330	257	64.61	10.93	21.38	2.38	3816



MICHIGAN STATE UNIVERSITY LIBRARIES



3 1293 01750 5680