A STUDY OF THE CHANGES IN BASAL METABOLISM PRODUCED BY DRINKING CHICORY, COFFEE, CHICORY–COFFEE, DECAFFEINATED COFFEE AND TEA BREWS

THESIS FOR THE DEGREE OF M. S.

Anne Marold

1930

THESIS

Metabolism

Home economics

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A thesis presented for the

Degree of Master of Science

By

Anne Harold

Michigan State College

1930

THESIS

ACKNOWLEDGEMENT

The writer is very greatly indebted to Dr. Marie Dye for the encouragement and helpful suggestions given throughout this study.

She is also very grateful to the four College girls whose splendid cooperation as subjects made this study possible; to Winston F. Allen who preformed the caffeine analysis; and to Dr. Nellie Halliday for final reading of the manuscript.

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INTRODUCTION

The objects of the present study were (1) to check the results obtained by Schimmel, Dye, and Robinson (1929)[22] from an investigation of the changes in basal metabolism produced by drinking chicory, coffee, and chicory-coffee brews; and (2) to carry the problem further: to compare the changes in basal metabolism produced by drinking (a) coffee and decaffeinated coffee brews of similar concentration, (b) green and black tea brews containing approximately equal amounts of caffeine, and (c) tea and coffee brews containing approximately equal amounts of caffeine.

REVIEW OF LITERATURE

It was necessary to determine whether or not the ingestion of 200 cc. of water at 50 - 60° C produced a measurable effect on the basal metabolism, in order that this effect, if it were significant, would not be attributed to the ingestion of the various brews.

Laschtschenko (1898)[12], working in Rubner's laboratory, concluded that the drinking of water at room temperature (approximately 18° C) has no influence upon carbon dioxide production. Water at 32° - 33° C produced a very slight increase; but at 37° C there was practically no increase. Speck (1892)[27], likewise, found that drinking large amounts of water had no influence upon oxygen consumption or carbon dioxide production. Loewy (1888)[49], also, reports no definite increment in the metabolism as a result of the ingestion of pure water.

On the basis of results obtained from five calorimeter and six respiration experiments on six subjects who were given 200 - 500 cc. of water somewhat over 50° C, Benedict and Carpenter (1918)[1] concluded that when not over 500 grams of water are taken, the ingestion of water at a temperature of either 22° or 55° C produces no significant increment above the basal metabolism.

Cannon, Querido, Britton and Bright (1927)[4] gave 750 cc. of water at 34.5° C; and the maximum heat production was 5.4% eleven minutes after the water was ingested. In agreement with these results, Lublin (1928)[16] found an increase in metabolism of 3% to 8% above the basal value within two hours after the ingestion of 800 - 1000 cc. of water; and Grollman (1929)[8] found a 5 - 10% rise in oxygen consumption within one-half hour after the ingestion of 1000 - 1200 cc. of water at 38° C.

From a study of the gaseous exchange as affected by water at 37° C, Carpenter and Fox (1929)[5] concluded that the heat pro-

duction is slightly increased (2%) for 1½ hours in experiments with 200 cc. of water; for 2 hours (1%) with 250 cc. of water; and for 2 hours (7%) with 500 cc. of water at 37° C.

Schimmel, Dye and Robinson (1929)[22], performed eight experiments to determine the effect of ingestion of 200 cc. of water between 50° and 60° C on basal metabolism. Out of these eight experiments six showed a negative increment of from 4.2% to 0.14% and two, a slight increase of 0.60% and 0.57% respectively. As they considered these results insignificant in this type of experiment, they concluded that 200 cc. of water at 50 - 60° C has no effect on basal metabolism.

Many studies have been made on the effect of caffeine and caffeine beverages on metabolism.

Bocker (1849)[2], concluded that the taking of coffee decreases both intensively and extensively the respiratory processes. Hoppe (1857)[10], however, found an increase in carbon dioxide output after taking caffeine.

Edward Smith (1859)[24], working with an apparatus of the open circuit type drew the following generalizations concerning the effects of drinking tea, coffee, and chicory (a non-caffeine brew):- (a) tea, coffee and chicory are respiratory stimulants with variable degrees of influence; (b) the rate of respiration is not altered significantly, but depth of inspiration is always increased; (c) rate of pulsation is usually slightly increased,

(d) green tea has somewhat more influence than black particularly in lessening rate and increasing depth of inspiration; (e) the maximum influence of both tea and coffee is attained from in 35 - 60 minutes. The duration varies from 1 - 2 hours, and there are many individual variations; (f) a rise from 15 - 30% in carbon dioxide output occurs after taking 50 - 100 grams of black or green tea leaves or ½ oz. of strong coffee.

Reichert (1890)(21) made an intensive study of the effect of caffeine on the metabolism of dogs. He injected 0.035 grams of caffeine per kilogram subcutaneously and produced an average increase in metabolism of 30.6%; 0.7 grams per kilogram caused an average increase of 43.6%; and 1.05 grams per kilogram, an average increase of 71.4%. He claims that caffeine increases heat production; and, as a corollary, increases destructive tissue metamorphosis.

Speck (1892)(27), studied the effect of coffee drinking in two experiments and found a small but visable rise in carbon dioxide production and oxygen consumption, indicating to his mind a distinct stimulus to digestive activities.

Edsall and Means (1914)(7), reported experiments on the effect of caffeine on the metabolism of two normal men. In one, after 0.324 grams of caffeine sodium salicylate, were given subcutaneously, there was an average rise of 10.6% in metabolism. The maximum of 13.9% was reached in the first hour. With the other subject there was an average rise of 3%, and a maximum of 5.7% after 0.39 grams were

given in this way. Higgins and Means (1915)[9] obtained similar results. In one normal subject after 0.32 grams of caffeine sodium benzoate were injected subcutaneously, there was an average rise of 13.8%. The maximum rise of 15.4% occurred within the first hour. In another normal subject a similar dose was followed by an average rise of 4.5% and a maximum rise of 7.2% which occurred during the second hour. In neither Higgins' and Means' nor Lusk and Means' experiments were there any consistent changes in respiratory quotients; that is, the proportion of fat, carbohydrate, and protein utilized showed no deviation from the normal.

Means, Aub, and DuBois (1917)[18] found an increase from 7 - 23% in the metabolism of four normal subjects after receiving 8 - 10 grams of caffeine alkaloid (8.6 mg. per kilogram body weight). No significant changes in pulse rate, in respiratory quotient, in proportion of the various food stuffs metabolised, or in percentage of heat loss in water vaporization were noticed.

On the basis of an 8 - 9% increase in metabolism observed after the ingestion of 325 grams of coffee infusion at 60° C, Benedict and Carpenter concluded that coffee, owing to its caffeine content acts as a stimulus to metabolism and suggested that experiments with caffeine-free coffee would be of interest.

Lohr (1923)[15] gave subcutaneous injections of 0.1 - 0.175 grams of caffeine sodium salicylate to guinea pigs and observed an increase in total metabolism and a slight increase in the

respiratory quotient.

From a study of the action of coffee and tea on the respiratory exchange in diabetes, Malamud (1926)[17], concluded that the action of these beverages on the basal metabolism is variable. They increase pulmonary ventilation but do not modify heart rate. He found the variations of respiratory quotients to be large and irregular.

Milka (1927)[19] reported that the respiratory metabolism of men and rabbits is increased by caffeine. Smith (1928)[25], likewise, observed that caffeine caused an increase in ventilation which usually began one minute after injection and lasted 2 - 10 minutes. Dogs were used in his experimental work.

Schimmel, Dye, and Robinson[22] carried out two experiments with three subjects. They gave 200 cc. of coffee brew made with 30 grams of coffee and containing 0.25 grams of caffeine. The average increases agree rather closely with the three subjects. No. 2 and No. 3 showed average increases of 5.32% and 6.29%, respectively, over a 2½ hour period; and No. 1, 6% over a three hour period. The maximum increases for the three subjects were 9.8%, 13.6%, and 12.6%, respectively, and occurred most frequently within the first hour.

Sollman, Torald, & Pilcher (1912)[26], gave doses up to 20 milligrams per kilogram body weight and found heart rate was increased. Cushney (1913)[6], observed that caffeine affects frequency of respiration more constantly than depth; i.e., it quickens

respiration and renders it shallower. Busquet and Tiffeneau (1913)[3], working with dogs, found that caffeine strongly increased the rate of heart beat, and coffee did the same. Decaffeinated coffee, however, had no effect. Thus they concluded that the caffeine in the coffee was the cause of the stimulation. On administering caffeine and its citrate in doses averaging 0.7 grams, Taylor (1914)[28] observed a slight rise in temperature (3.6°), and in pulse rate, but no permanent change in either pulse or respiratory rate. Likewise Hyde, Root and Curl (1917)[11] found that 1.42 grains of caffeine given to two men under basal conditions gradually increased the pulse rate during the first hour. In both subjects it returned to normal within three hours. With a larger dose (2.24 grains) the increase in pulse appeared more rapidly. Vittorio (1923)[30] noticed that small doses of caffeine (1 - 28 milligrams per kilogram body weight) injected intravenously into dogs caused a dimunition in the frequency of the heart beat while larger doses increased it.

In the experiments already cited performed by Schimmel, Dye and Robinson (1929)[22] the respiration rate was not affected in any noticeable manner. Occasionally it was slightly increased after taking the coffee brew; but in some cases no effect was noticed. The pulse rate varied somewhat and was slightly decreased with two subjects after taking of coffee and coffee-chicory, but no effect was noted with the water or chicory alone.

The comparative effects of coffee and tea were studied by

Lehmann (1913)[13]. He concluded that the action of coffee and tea depends entirely upon the caffeine content of these beverages. Some persons seem to stand one drink better than the other. Coffee is better supported in a state of fatigue.

Trigg (1919)[29] studied the physiological effects of caffeine-free coffee. He decided that decaffeinated coffee, to which caffeole has been added, tends to counteract the effects of caffeine and thus has a depressant action.

The literature contains very few references concerning chicory and its effect on basal metabolism. Schimmel, Dye, and Robinson (1929)[22], carried out seven experiments in which they gave a chicory brew made with 10 grams of chicory. They found no significant changes in metabolism. In order to determine whether chicory when brewed with coffee alters the well known effects of the latter, they performed eight experiments using a brew made from 30 grams of coffee and 3.33 grams of chicory. They found the results of these experiments agreed quite closely with the experiments on coffee alone; so they concluded that the addition of 10% chicory does not alter the effect of a coffee brew. The results of the caffeine analysis which they carried out showed that the addition of chicory to coffee does not alter the amount of caffeine or caffetannic acid found in the brew.

Smith and Bartell (1924)[23], report no increase in the amount of the soluble constituents of coffee going into solution resulting from the presence of chicory in the brew. They claim

that its presence in the coffee infusion appears to cause the aromatic constituents to be held in the brew through a process of chemical reaction between caffeol and the apparently soluble constituents of chicory.

At this point, it might be well to quote Means, Aub, and DuBois (1927)[18]: "As one looks over the enormous literature on the various actions of caffeine, one gets the impression that the numerous contradictory statements are not necessarily due to faulty observations, but possibly because the action of caffeine on any given function is extremely variable, often diametrically opposite in different individuals, and in the same individuals with varying doses. Nevertheless the experiments cited in the literature show that an elevation in basal metabolism is a very frequent action, although its intensity varies considerably in different individuals. In general there seems to be a larger rise with larger doses."

Briefly stated, previous work indicates that:

(a) 200 cc. of water at 50 - 60° has no effect on respiratory metabolism.

(b) Coffee increases metabolism from 3 - 23.4%; depending upon its caffeine content. The addition of 10% chicory does not materially change this effect.

(c) Tea, like coffee, increases metabolism due to its caffeine content.

(d) A brew made with 10 grams chicory in 200 cc. of water has no effect on metabolism.

EXPERIMENTAL

Seven series of experiments were performed on each of four normal subjects to determine the effect of water and of six different brews, respectively, on basal metabolism.

The Benedict Portable apparatus with a kymograph attachment was used to measure energy metabolism. The subjects were studied in the morning, and had had no food since the night before. A basal metabolism determination was made after a thirty minute rest period; the brew to be studied was then given, and the metabolism determined at successive intervals of one-half, one, two, two and one-half, and sometimes three and one-half hours. Each test was run for nine minutes, and if the first part of the period did not check with the second part the determination was repeated.

To avoid the possible effect of any temperature change on metabolism, the brews were between 50° and 60° C. when administered. They were prepared as follows:

1. Series A. Water.

   200 cc. of distilled water were heated to the above temperature.

2. Series B. Chicory.

   10 grams of chicory, [illegible] ground, were put into 200 cc. of water at 90° C and this temperature was maintained for 10

minutes. The mixture was stirred constantly and filtered immediately.

3. Series C. Coffee.

The coffee brew was made by the same method as the chicory brew using 30 grams of Richelieu coffee (the particles of which were practically the same size as those of the chicory) in 200 cc. of water.

4. Series D. Chicory-Coffee.

The chicory coffee mixture was made by the same method using 30 grams coffee and 10% (3.33 grams) chicory in 222 cc. of water.

5. Series E. Decaffeinated Coffee.

The decaffeinated coffee brew was made by the same method and the concentration was the same as that of the coffee brew. 30 grams of medium ground Kellogg's Kaffee Hag (a coffee with 97% of the caffeine removed) were used in 200 cc. of water.

6. Series F. Black Tea.

200 cc. of boiling water were poured over 11 grams of Chase and Sanborn's black tea. The infusion was kept at a temperature of 90° for five minutes. It was filtered with suction and the residue washed with 50 cc. of water.

7. Series G. Green Tea.

The green tea infusion was made by the same method as the black tea infusion using 15 grams of Chase and Sanborn's green tea in 200 cc. of water.

The amount of caffeine present in each of the above brews was determined by the official Lower-Chesnut method, as given in the Official and Tentative Methods of Analysis, Association of Official Agricultural Chemists. The results of this analysis are given in Table I.

The caffeine brews may be considered approximately comparable as regards their caffeine content; each containing about 0.2 gram caffeine.

Subjects

Four college girls who were in good general health were used in this study. A description of these subjects is given in Table II.

Table III has been computed to show the amount of caffeine per unit of body weight ingested by each of the subjects. Each brew contained approximately 0.2 grams of caffeine. The subjects were similar in size, but the grams of caffeine ingested per kilogram of body weight varied from 0.0034 grams to 0.0041 grams, or 19%.

CAFFEINE ANALYSIS OF BREWS

Table I

Series	Brew	Caffeine (duplicates) in 200 cc. of brew	Average caffeine in 200 cc. of brew
		grams	grams
B	Chicory*	0.00091 0.00083	0.0087
C	Coffee	0.22387 0.22000	0.22193
D	Chicory Coffee	0.19128 0.19041	0.19090
E	Decaffeinated Coffee (Kaffee Hag)	0.00299 0.00241	0.00270
F	Black Tea	0.27218 0.27073	0.27145**
G	Green Tea	0.20040 0.19022	0.19531

* While it is known that chicory contains no caffeine, a very small amount is found according to this analysis. This is due to the fact that a nitrogen determination is made on the final chloroform extract; and if small amounts of nitrogenous substances other than caffeine are carried down, they may be erroneously considered as caffeine. The amount is negligable in most cases.

** 0.27145 grams of caffeine were found in a brew made with 15 grams of tea. The brew used in the metabolism studies was made with 11 grams of tea and contained 0.1980 grams of caffeine.

DESCRIPTION OF SUBJECTS

Table II

Subj. No.	Subject	Age	Height		Weight		Body Surface	Remarks
			in.	cm.	lb.	kg.	sq. meters	
1	J. T.	19	63.75	160.8	118	53.53	1.55	Very seldom drinks coffee or tea
2	E. H.	21	62.75	159.4	108	49.2	1.48	Drinks coffee and tea occasionally.
3	B. D.	19	64.50	163.8	130	58.97	1.64	Drinks more tea than coffee. Comparatively little of either, however.
4	R. P.	22	66.00	167.6	122	55.34	1.62	Drinks tea daily, and coffee about two or three times each week.

CAFFEINE PER KILOGRAM BODY WEIGHT

Table III

Subj. No.	Caffeine per kilogram body weight
	grams
1	0.0037
2	0.0041
3	0.0034
4	0.0036

DISCUSSION OF RESULTS

Series A - Water Studies

The results of these experiments are given in tables IV and XIII.

200 cc. of water ingested at 50° - 60° C appear to have no effect on metabolism.

Subject 1 showed comparatively large negative increments; from -0.43 to -4.59%, probably due to a more relaxed condition toward the end of the morning. Then, too, the water studies were made first, and the subject was perhaps more tense for the first test, not being thoroughly accustomed to the apparatus on account of. Subjects 2 and 4 showed average increases ranging from -1.59% to 1.85% which are insignificant in this type of experiment. An average increment of 3.18% was noted with subject 3, 2½ hours after ingestion of the water. This was probably due to fatigue toward the end of the morning. The average increments for the four subjects over a period of 2½ hours were -3.03%, -0.28%, -0.03%, and 0.37% respectively, and for the four -0.71%.

These results agree closely with those obtained by Schimmel, Dye, and Robinson (1929)[22] on a similar experiment. These investigators performed eight experiments; six of these showed a negative increment of from 4.20% to 0.14%, and two showed slight increases of 0.60% and 0.57%. Benedict and Carpenter (1918)[1] also failed to find any significant increases in metabolism when not over 500 cc. of water were ingested.

Series B - Chicory Studies

A ten percent chicory brew contains no caffeine and, apparently, has no effect upon basal metabolism.

Eleven experiments were performed with chicory, and the results (tables V and XIV) obtained, in general, resemble those obtained in Series A (water metabolism studies). Subject 1 showed an average negative increment* of 0.38% over a period of 2½ hours in three chicory experiments; and an average negative increment of 3.08% over a similar period in three water experiments. However, the fact that the subject was more accustomed to the apparatus and was more relaxed for the basal tests in the chicory studies might help to explain the small variations in these results. The other three subjects showed average increments over a 2½-hour period of -1.28, 0.15 and 0.07 respectively. The average for the group was -0.36%.

These results agree with those obtained by Schimmel, Dye, and Robinson (1929)(22), who found an average negative increment of -0.68% for three people in seven studies.

* The average increases over 2½-hour periods, in all cases, were obtained by computing arithematical averages of the four percentage deviations noted from the basal metabolism in the 0.5, 1.0, 2.0 and 2.5-hour intervals.

Series C - Coffee Studies

The coffee brew containing approximately 0.22 grams of caffeine, caused an average increase of 6.95% over a 2½-hour period in sixteen experiments on four subjects. The results of these experiments are given in tables VI and XV.

With subject No. 1 the greatest average increase was 13.86%; and it occurred 2½-hours after drinking the brew. There was considerable variation from day to day. The peak effects reached on four different experimental days were 14.94%, 7.35%, 20.60% and 12.55%. All of these, however, occurred 2½-hours after ingestion of the brew. A 3½-hour determination on one day showed a slight fall (1%) as compared with the 2½-hour test; although it was still 11.74% above the basal rate. Two average high peaks of 9.34% and 9.63% occurring 1 and 2½ hours after the drinking of the brew were noted with subject 2. Perhaps the first peak was caused by the distastefulness of the brew, or the immediate reaction of the brew on the stomach. The second peak may have been due to the caffeine stimulation. Each of the four experimental days consistently showed high peaks at the one and two-and one-half hour periods with a slight fall at the two hour period. It is difficult to explain these results, but the intermittant effect may have been due to a spasmodic caffeine stimulation. The results obtained with subject No. 3 are very confusing. The maximum increase varied from 3.93% on one day to 16.33% on another in the five experiments performed. On some days (C9 and C10) the subject showed no outward signs of stimulation, and slept between

most of the test periods. On other days, she appeared drowsy before and during the basal test, but on drinking the brew she seemed wide awake and warm. The stimulatory effect on this subject varied greatly from day to day. The maximum average increase for subject 4 was 8.66% and occurred one hour after the taking of the coffee. The metabolism had not yet returned to the basal level after two and one-half hours.

The four subjects showed the following average increases over a 2½-hour period: 9.13%, 7.08%, 4.93%, and 6.65%. The average increase in metabolism for subjects 1, 2 and 4 was 7.62% as contrasted with 6.92%, the average increase for all four subjects. These averages do not vary greatly even though subject 3 showed very inconsistent rises in metabolism.

The average increases found by Schimmel, Dye, & Robinson (1929) on each of three subjects were 5.32%, 6.29% and 6%; or an average of 6.00% for all three.

The increases in metabolism do not appear to be proportional to the amount of caffeine taken per kilogram of body weight. The fact that subject 3 received the smallest amount of caffeine per kilogram of body weight, and showed the smallest average per cent increase in metabolism cannot be considered as significant, because the results for this subject are very inconsistant. Subject 1 showed an average increase of 9.13% on receiving 0.0037 grams caffeine per kilogram body weight; subject 2, an average increase of 7.08% on receiving 0.0041 grams caffeine per kilogram

body weight; and subject 4, an average increase of 6.65% on receiving 0.0036 grams caffeine per kilogram body weight.

Series D - Chicory-Coffee Brew

Fifteen experiments were carried out with chicory-coffee brew, and the results (tables VII and XVI), in general, resemble those obtained with the coffee alone.

The maximum average rise for subject 1 was 13.73% and occurred 2½ hours after the drinking of the brew. This agrees very closely with the maximum rise in the coffee experiments, 13.86%, which also occurred at the 2½-hour period.

The maximum increase with subject No. 2 also occurred at the end of the 2½-hour period. There was only one high peak as contrasted with the two high peaks occurring in the coffee experiments on this subject. Although it is doubtful, this difference may be due to the action of chicory on some constituent in the coffee thus causing a repression of the stimulation which occurs at the one hour period in the coffee experiments. Smith and Bartell, as previously quoted, (23) (1924) claim that the presence of chicory in a coffee infusion appears to cause the aromatic constituents to be held in the brew through a process of chemical reaction between caffeol and the apparently soluble constituents of chicory. However, only one out of four subjects shows such results. Possibly the reaction is due to some peculiar difference in the reaction of the individual toward these two brews. No increase in metabolism due to the ingestion of the coffee-chicory brew is found with subject 3. The results very much resemble those obtained with water and the

chicory brew. This subject shows an average increase over a 2½-hour period of 4.93% in the coffee experiments and a negative increment of 0.98% in the chicory-coffee experiments. These results, however, are misleading, and cannot be considered significant as the results obtained in the coffee studies were very variable and inconsistent.

The average increases of the chicory-coffee experiments ran consistently higher than those of the coffee experiments for subject 4. The maximum average increase was 12.75% and it occurred at the 2½ hour period. In the coffee experiments the average maximum of 8.66% was attained in one hour.

Schimmel, Dye, and Robinson (1923)(22), found no significant differences in the experiments with coffee and chicory-coffee. The results of the present study, likewise, show no significant differences. The average rise for four subjects over a 2½-hour period for the coffee brew was 6.15%, and for the chicory-coffee brew 6.95%. Omitting subject 3 for reasons already given, the average rise for the other three subjects over a 2½-hour period for the coffee brew was 7.62%, and for the chicory-coffee brew 8.51%.

Series E - Decaffeinated Coffee Studies

The decaffeinated coffee studies show results (Tables VIII and XVII) which are comparable to the water and chicory studies.

Subject No. 1 showed no significant changes in metabolism until the 2½-hour period, when an average increase of 5.13% was noted. Subject No. 2, likewise, showed a tendency toward a

higher metabolism at this period. One experiment showed an increase of 4.81%. In general the increases are not as evident as in subject 1. The average increase 2½ hours after drinking the brew was 2.46%; an increase which is quite insignificant. No stimulation was evident with subject 3; the average change from her basal level varied from -1.30% to 0.15%. These changes are negligible. Subject 4 showed the greatest stimulation. Her metabolism increased 5.96%, as compared with the basal value, at the end of the 2-hour period. The average increases for the four subjects over a 2½-hour period were 2.06%, 0.54%, -0.47%, and 3.70%; with an average of 1.47% for the four.

Series F - Black Tea Metabolism Studies

Seven experiments on three subjects were performed to study the effect of black tea on metabolism (tables IX and XVIII). In general, black tea seemed to have a greater effect than coffee or chicory-coffee even though the caffeine content of all three brews was equal.

The maximum rise, in the case of subject 1 was 12.01% and occurred at the 2½-hour period. This is about 4% higher than the maximum increases in the coffee and chicory-coffee experiments. The latter experiments, however, show greater stimulation in the ½-hour period than do the black tea experiments. The average increase over a 2½-hour period for black tea was 7.02%, for coffee 9.13% and for chicory-coffee 10.51%. The stimulation caused by the coffee brews seems more generally to be distributed

over the 2½ hours; whereas that caused by the black tea seems concentrated on the 2½-hour period. Subject 3 showed an average increment of 11.47%; as contrasted with the increments shown by this same subject of 4.93% and -0.98% in the coffee and chicory-coffee studies, respectively. The maximum increase shown in the different experiments vary greatly. A maximum increase of 9.53% occurred at the 2-hour period on the first day; one of 17.56% at the 2½-hour period the second day; and one of 25.16% at the 1-hour period the third day. The results, as a whole, are more consistant than are those obtained in the coffee and chicory coffee studies for this subject. Only one experiment was performed on subject 4. This experiment showed a maximum rise of 16.05% at the end of the ½-hour period. There was a gradual decrease in the successive intervals; but at the end of the 2½-hour period it was still 8.10% above the basal level. The average increase over a 2½-hour period for the three subjects studied was 7.62%, 11.47%, and 12.92%; with an average of 10.67% for the three.

Series G - Green Tea Metabolism Studies

The green tea brew containing approximately 0.2 grams of caffeine caused an average increase of 12.45% in five experiments on two subjects (Tables X and XIX).

The increases caused by green tea in the experiments on subject 1 were higher than those caused by black tea. The maximum increase in the green tea studies was 19.11% and it occurred at the 2½-hour period; the maximum increase in the black tea studies

was 12.61% and it also occurred at the 2½-hour period. Subject 4 showed a maximum rise of 18.93% which occurred at the end of the 2½-hour period. A similar increase (18.68% was reached at the end of the 1-hour period. The average increment over a 2½-hour period for the two subjects studied were 9.89% and 15.03%. These are somewhat higher than those obtained with the black tea (7.62% and 12.92%). Green tea is known to contain more tannin than black tea; possibly this may account for the greater increase in metabolism.

Discussion of tables.

Tables IV to X inclusive give the basal metabolic rate and the increase from this rate in terms of both calories and percent for each experiment performed on each subject. The results are compiled according to the brews studied.

Tables XIII to XIX inclusive give the details of the experiments performed. They show the rise in metabolism in relation to the pulse and respiration rates for each subject.

Summaries of all of the results obtained are found in tables XI and XII. In the former the results are compiled to show the varying effects of the different brews on each individual subject; in the latter, to show the effect of each brew on the four different subjects. For instance, table XI shows that chicory-coffee causes the greatest average rise in the metabolism of subject 1 (10.56%) over a 2½-hour period; in comparison with

rises shown by green tea (9.89%), coffee (9.13%), and black tea (7.62%). Likewise, it can readily be seen that coffee has the maximum effect on subject 2, black tea on subject 3, and green tea on subject 4. This table indicates that brews of approximately the same caffeine content affected the subjects differently. Many individual variations are shown. From the average figures obtained the brews can be classed roughly in the following order from the most to the least stimulating: (1) green tea, (2) black tea, (3) coffee, (4) coffee-chicory, (5) decaffeinated coffee, (6) chicory, and (7) water. The changes produced by water and chicory are negative increments, and are negligable.

Table XII indicates that a similar brew effects four individuals very differently. Coffee, for example, causes an average increase over a 2½-hour period of 9.13% for subject 1, 7.08% for subject 2, 6.65% for subject 4, and 6.65% for subject 3.

SUMMARY

1. 200 cc. of water at 50° - 60° C appears to have no effect on basal metabolism.

2. A 10% chicory brew contains no caffeine and, apparently, has no effect on basal metabolism.

3. A coffee brew made with 30 grams of coffee and containing approximately 0.22 grams of caffeine causes an average increase of 7.62% over a 2½-hour period in 11 experiments on three subjects.

4. Addition of 10% chicory to the coffee brew does not significantly change the effects of the latter. An average increase of 8.51% was found over a 2½-hour period in 11 experiments on three subjects.

5. A decaffeinated coffee brew made with 30 grams of Kaffee Hag contains approximately 0.003 grams of caffeine and causes an average rise of 1.47% over a 2½-hour period in 13 experiments on four subjects. This increase is insignificant.

6. A black tea brew made with 11 grams of tea and containing approximately 0.2 grams of caffeine causes an average increase of 10.67% over a 2½-hour period in seven experiments on three subjects.

7. A green tea brew made with 15 grams of tea and containing approximately 0.2 grams of caffeine caused an average increase of 12.45% over a 2½-hour period in five experiments on two subjects.

TABLE IV - SERIES A - WATER METABOLISM STUDIES

Exp. No	Subj. No.	Basal	Calories/hour: Hrs. after brew 0.5	1.0	2.0	2.5	Change from Basal 1: Hrs. after brew 0.5	1.0	2.0	2.5	Av. increase from Basal
		cal.	cal.	cal.	cal.	cal.	%	%	%	%	%
A 1	1	50.82	47.14	48.65	50.63	53.63	-7.24	-4.27	-0.37	5.53	
A 2	1	50.51	48.85	48.27	48.30	49.30	-3.29	-4.42	-4.18	-2.40	
A 3	1	55.05	52.24	53.73	51.47	52.56	-3.24	-2.34	-6.27	-4.43	
Average 1							-4.59	-3.68	-3.61	-0.43	-3.08
A 4	2	48.11	47.63	47.89	47.41	45.57	-1.00	-0.23	-1.46	-5.28	
A 5	2	49.16	50.08		51.13	49.61	1.87		4.02	0.93	
A 6	2	48.49	47.70	49.08	46.33	48.28	-1.63	2.91	-4.45	-0.43	
Average 2							-0.25	1.34	-0.63	-1.59	-0.28
A 7	3	56.07	55.92	53.37	52.64	56.57	-0.29	-3.92	-6.12	0.89	
A 8	3	50.19	51.62	50.13	50.08	53.42	2.85	-0.08	-0.24	6.43	
A 9	3	54.46	53.98	53.26	55.13	55.67	-0.88	-2.20	1.23	2.22	
Average 3							0.49	-2.07	-1.71	3.18	-0.03
A 10	4	52.42	54.25	52.60	54.08	53.56	3.28	0.34	2.98	2.15	
A 11	4	52.39	52.61	51.38	50.81	52.24	0.42	-1.93	-3.02	-0.29	
Average 4							1.85	-0.80	-0.52	0.93	0.37
AVERAGE							-0.63	-1.30	-1.62	0.52	-0.76

TABLE V - SERIES B - CHICORY METABOLISM STUDIES

Exp. No.	Subj No.	Basal	Calories/hour — Hrs. after brew				Change from basal — Hrs. after brew				
			0.5	1.0	2.0	2.5	0.5	1.0	2.0	2.5	
		CAL.	CAL.	CAL.	CAL.	CAL.	%	%	%	%	%
B 1	1	46.69	46.29	46.98	47.05	47.36	-0.36	0.62	0.77	1.43	
B 2	1	49.20	49.97	49.48	48.54	48.89	1.16	0.57	-1.34	-0.63	
B3	1	47.80	48.02	47.36	46.20	46.65	0.46	-0.92	-3.35	-2.41	
Average 1							0.25	0.09	-1.31	-0.54	-0.38
B 4	2	47.01	46.26	47.30	48.40	47.69	-1.60	0.64	2.96	1.45	
B 5	2	49.05	47.80	48.69	46.86	46.07	-2.55	-0.73	-4.46	-6.08	
B 6	2	47.58	46.05	46.40	47.34	48.14	-3.21	-2.48	-0.50	1.18	
Average 2							-2.45	-0.86	-0.67	-1.15	-1.28
B 7	3	56.82	58.97	55.84	59.68	57.56	3.78	-1.72	5.03	1.30	
B 8	3	56.52	55.24	54.86	54.27		-2.26	-2.92	-3.40		
B 9	3	57.18	57.38	57.34	58.61	56.48	0.35	0.30	2.51	-1.22	
Average 3							0.62	-1.45	1.38	0.04	0.15
B 10	4	51.88	53.12	52.13	51.30	51.56	2.39	0.48	-1.12	-0.62	
B 11	4	49.20	48.69	49.47	49.01	49.36	-1.04	0.55	-0.41	0.33	
Average 4							0.68	0.52	-0.77	-0.15	0.07
AVERAGE							-0.23	-0.43	-0.34	-0.45	-0.36

TABLE VI - SERIES C - COFFEE NET BOLIC STUDIES

Exp. No.	Subj. No.	Basal	Calories/hour: Hrs after brew 0.5	1.0	2.0	2.5	3.5	Change from basal: Hours after brew 0.5	1.0	2.0	2.5	3.5	Av. increase in 2½ hr. per.
		Cal.	Cal.	Cal.	Cal.	Cal.	Cal.	%	%	%	%	%	%
C 1	1	47.20	49.59	50.28	51.98	54.25		5.91	6.53	10.13	14.94		
C 2	1	47.65	49.92	50.00	50.52	51.15		3.71	4.93	6.02	7.35		
C 3	1	48.35	51.22	51.08	55.55	58.31		5.94	5.65	14.89	20.60		
C 4	1	49.49	52.52	55.10	54.13	55.70	55.30	6.12	11.34	9.38	12.55	11.74	
Average 1								5.42	7.11	10.11	13.86	11.74	9.13
C 5	2	50.20	50.87	53.33	52.92	55.21		1.33	6.24	5.42	9.98		
C 6	2	47.01	52.46	51.56	48.83	49.76		11.59	9.68	3.87	5.85		
C 7	2	49.32	49.50	55.37	53.21	54.67		0.37	11.80	7.89	10.85		
C 8	2	48.89	49.87	52.59	51.26	54.68		2.01	9.62	4.85	11.84		
Average 2								3.83	9.34	5.51	9.63		7.08
C 9	3	55.21	55.39	55.41	56.21	57.38		0.33	0.36	1.81	3.93		
C 10	3	55.77	55.10	55.22	55.27	59.04		-1.20	-0.99	-0.90	5.95		
C 11	3	54.85	56.22	55.10	59.45	59.41		2.50	0.46	8.39	8.31		
C 12	3	53.91	56.42	58.03	58.21	58.92	56.06	4.65	7.64	7.97	9.29	5.84	
C 13	3	51.51	52.36	57.08	57.93	59.36	59.92	1.65	10.81	12.44	15.24	16.33	
Average 3								1.59	3.66	5.94	8.54	11.09	4.93
C 14	4	56.90	60.06	62.50	61.89	60.48		5.55	9.84	7.01	6.29		
C 15	4	56.90	57.14	61.34	60.18	60.33		4.22	7.80	5.76	6.03		
C 16	4	50.74	51.93	55.07	56.15			2.35	8.34	10.47			
Average 4								4.04	8.66	7.75	6.16		6.65
Average for 1, 2, and 4								4.43	8.37	7.79	9.88		7.62
AVERAGE								3.72	7.19	7.33	9.55	11.42)	6.95

TABLE VII - SERIES D - COFFEE-CHICORY METABOLISM STUDIES

Exp. No.	Subj. No.	Calories/hour: Basal	Calories/hour: Hrs. after Basal 0.5	1.0	2.0	2.5	Change from Basal: Hrs. after Basal 0.5	1.0	2.0	2.5	3.5	Average inc in 2½ hr period
		Cal.	Cal.	Cal.	Cal.	Cal.	%	%	%	%	%	%
D 1	1	48.82	53.27	53.31	53.88	55.71	9.12	9.20	10.36	14.11		
D 2	1	48.78	54.40	53.98	54.27	56.89	11.52	10.66	11.25	16.63		
D 3	1	50.60	55.17	55.30	53.45	54.03	9.03	9.29	5.63	6.79		
D 4	1	47.01	48.98	53.75	51.05	55.30	4.19	14.33	8.59	17.40		
Average 1							8.47	10.87	8.96	13.98		10.56
D 5	2	50.79	50.79	52.48	52.29	54.93	0.00	3.13	2.95	8.15		
D 6	2	50.09	51,44	51.82	54.33	54.15	2.70	3.43	8.46	8.13		
D 7	2	45.31	46.66	46.34	49.53	48.86	2.98	2.27	9.31	7.83		
D 8	2	48.49	50.62	50.39	51.10	53.74	4.39	3.92	5.38	10.83		
Average 2							2.52	3.19	6.53	8.74		5.18
D 9	3	60.77	61.06	60.35	58.50	59.85	0.48	-0.69	-3.72	-1.51		
D 10	3	58.23	58.55	57.98	55.55	56.97	0.55	-0.45	-4.43	-2.16		
D 11	3	52.14	51.60	51.94	51.02	52.79	-1.04	-0.40	-2.15	1.25		
D 12	3	58.63	58.90	58.64	58.90	57.46	0.29	0.02	0.29	-1.98	0.29	
						58.90						
Average 3							0.07	-0.38	-2.50	-1.10	0.29	-0.98
D 13	4	50.02	54.72	54.87	60.42	57.86	9.40	9.70	20.79	15.67		
D 14	4	50.34	54.90	53.72	52.17	56.21	9.06	6.71	3.83	11.26		
D 15	4	51,48	54.06	56.42	54.66	57.09	5.01	9.60	6.18	10.90		
Average 4							7.82	8.67	10.27	12.61		9.84
Average for Subjects 1, 2, and 4							6.72	7.58	8.59	11.69		8.51
AVERAGE							4.72	5.59	5.82	8.50	0.29	6.15

TABLE VIII - SERIES E - MAXFEE MAG (DECAFFEINATED COFFEE) STUDIES

Exp. No.	Subj.	Basal	Calories/hour hrs after brew 0.5	1.0	2.0	2.5	3.5	Change in Metabolism hrs. after brew 0.5	1.0	2.0	2.5	3.5	
		Cal.	Cal.	Cal.	Cal.	Cal.	Cal.	%	%	%	%	%	
E 1	1	48.48	50.74	50.16	49.34	51.41		4.66	3.47	1.57	6.03		
E 2	1	47.38	48.16	49.37	48.52	50.33		0.53	3.09	1.45	5.07		
E 3	1	47.63	47.30	46.80	47.51	50.21		-0.69	-1.77	-0.25	5.40		
E 4	1	49.54	50.68	48.85	49.81	51.52		2.30	-1.39	-0.55	4.00		
Average 1								1.71	0.85	0.55	5.13		2.06
E 5	2	51.02	47.07	44.22	42.97	45.95		4.55	-1.78	-4.55	2.07		
E 6	2	48.46	48.51	48.29	48.21	48.62		0.01	-0.16	-0.52	0.33		
E 7	2	46.14	46.36	47.38	46.40	48.13		0.48	2.63	0.56	4.31		
E 8	2	47.47	46.96	47.25	46.99	48.99		-1.07	-0.46	-1.01	3.20		
Average 2								1.01	0.06	-1.38	2.48		0.52
E 9	3	54.87	54.47	54.64	54.04	55.52		-0.73	-0.42	-1.51	1.18		
E 10	3	54.62	53.54	55.38	55.25	54.29		-1.79	1.39	1.15	-0.60		
E 11	3	58.43	57.63	57.78	58.80	57.03	58.51	-1.37	-1.11	0.63	-2.40	0.15	
Average 3								-1.30	-0.05	0.09	-0.91	0.15	-0.50
E 12	4	48.05	48.70	49.19	51.36	50.33		1.35	2.37	6.89	4.87		
E 13	4	45.16	44.03	48.90	47.43	46.64		-2.52	8.36	5.03	3.27		
Average 4								-0.59	5.37	5.96	4.07	4.87	3.70
AVERAGE								0.21	1.58	1.31	2.77	2.51	1.47

TABLE LX - SERIES F - BLACK TEA METABOLISM STUDIES

Exp. No.	Subj. No.	Basal	Calories/hour: Hrs. after infusion 0.5	1.0	2.0	2.5	3.5	Change from Basal: Hrs. after infusion 0.5	1.0	2.0	2.5	3.5	Av. Increase in 2 hr. period
		Cal.	Cal.	Cal.	Cal.	Cal.	Cal.	%	%	%	%	%	%
F 1	1	52.09	52.17	55.64	58.22	59.92		0.15	6.82	11.77	15.01		
F 2	1	52.09	50.74	53.93	54.18	65.05	53.53	-2.40	3.51	4.01	24.84	2.77	
F 3	1	51.28	52.17	63.99	53.05	50.24		1.54	24.79	3.45	-2.02		
Average 1								-0.24	11.71	6.41	12.61	2.77	7.62
F 4	3	53.40	58.33	57.57	58.49	58.19		9.23	7.81	9.53	8.97		
F 5	3	50.62	54.37	55.44	55.27	59.51		7.48	9.52	9.19	17.56		
F 6	3	52.99	56.12	65.26	64.58	62.22	56.64	5.91	23.16	21.87	17.40	6.89	
Average 3								7.54	13.50	10.20	14.64	6.89	11.47
F 7	4	47.23	54.81	54.13		51.04		16.05	14.61		8.10		12.92
AVERAGE								7.78	13.27	8.31	11.78	4.83	10.67

TABLE X - GREEN TEA METABOLISM STUDIES - SERIES G

Exp. No.	Subj. No.	Basal	Calories/hour: Hrs. after infusion 0.5	1.0	2.0	2.5	3.5	Change from Basal: Hrs. after infusion 0.5	1.0	2.0	2.5	3.5	
		Cal.	Cal.	Cal.	Cal.	Cal.	Cal.						%
G 1	1	47.76	50.12	49.70	54.98	57.06		4.94	4.06	15.69	19.45		
G 2	1	47.33	50.50	52.61	51.75	53.23		4.54	11.16	9.33	12.47		
G 3	1	44.56	45.47	46.11	47.49	55.92		1.97	3.41	6.51	25.41		
Average 1								3.82	6.21	10.51	19.11		9.89
G 4	4	47.77	53.17	55.15	56.28	55.95	55.95	11.30	15.45	17.71	16.83	16.83	
G 5	4	47.86	50.74	58.35	52.46	57.93		6.02	21,91	9.99	21.02		
Average 4								8.66	18.68	13.85	18.93	16.83	15.03
AVERAGE								6.24	12.45	12.08	19.02	16.83	12.45

TABLE XI - COMPARISON OF BREWS STUDIED

Subject No.	Series	Brew Studied	Average increase in Metabolism Hours after brew 0.5	1.5	2.0	2.5	3.5	Av. increase over 2½ hr. period
1	A	Water	-4.59	-5.08	-3.81	-0.43		-3.08
	B	Chicory	0.25	0.09	-1.31	-0.54		-0.38
	C	Coffee	5.42	7.11	10.11	13.86	11.74	9.13
	D	Chicory-Coffee	8.46	10.87	8.93	13.96		10.56
	E	Decaffeinated Coffee	1.71	0.85	0.55	5.13		2.06
	F	Black Tea	-0.24	11.71	6141	12.61	2.77	7.62
	G	Green Tea	3.82	6.21	10.31	19.11		9.89
2	A	Water	-0.25	1.34	-0.63	-1.59		-0.28
	B	Chicory	-2.45	-0.66	-0.67	-1.15		-1.28
	C	Coffee	3.83	9.34	5.51	9.63		7.08
	D	Chicory-Coffee	2.52	3.19	6.53	8.74		5.18
	E	Decaffeinated Coffee	1.01	0.06	-1.38	2.48		0.52
3	A	Water	0.49	-2.07	-1.71	3.18		-0.03
	B	Chicory	0.62	-1.45	1.38	0.04		0.15
	C	Coffee	1.59	3.66	5.94	8.54	11.09	4.93
	D	Chic.-Coffee	0.07	-0.38	-2.50	-1.10	0.29	-0.93
	E	Decaffeinated Coffee	-1.30	-0.05	0.09	-0.91	0.15	-0.50
	F	Black Tea	7.54	13.51	10.20	14.64	6.89	11.47
4	A	Water	1.85	-0.80	0.52	0.93		0.37
	B	Chicory	0.68	0.52	-0.77	-0.15		0.07
	C	Coffee	4.04	8.66	7.75	6.16		6.65
	D	Chic.-Coffee	7.82	8.67	10.27	12.61		9.84
	E	Decaffeinated Coffee	-0.59	5.37	5.96	4.07	4.87	3.70
	F	Black Tea	16.05	14.61		8.10		12.92
	G	Green Tea	8.66	18.68	13.85	18.96	16.83	15.03
Average	A	Water	0.63	-1.30	-1.62	0.52		-0.76
	B	Chicory	-0.23	-0.43	-0.34	-0.45		-0.36
	C	Coffee	3.72	7.19	7.33	9.55	11.42	6.95
	D	Chic.-Coffee	4.71	5.59	5.82	8.52	0.29	6.15
	E	Decaffeinated Coffee	0.21	1.58	1.31	2.77	2.51	1.47
	F	Black Tea	7.78	13.27	8.31	11.78		10.67
	G	Green Tea	6.24	12.45	12.08	19.02	16.83	12.45

TABLE XII - COMPARISONS OF BREWS STUDIED

Series	Brew Studied	Subject No.	Average increase in metabolism hours after brews					Average increase in 5 hour period
			0.5	1.0	2.0	2.5	3.5	
A	Water	1	-4.59	-3.68	-3.61	-3.43		-3.08
		2	-3.25	1.34	-0.63	-1.59		-3.38
		3	0.49	-2.07	-1.71	3.13		-0.03
		4	1.05	-3.00	-3.52	3.93		+0.37
		Aver	-0.63	-1.80	-1.82	0.52		-0.76
B	Chicory	1	0.25	0.09	-1.51	-0.54		-0.33
		2	-2.45	-3.83	-0.87	-1.15		-1.23
		3	0.52	-1.45	1.53	0.04		0.15
		4	0.68	0.52	-0.77	-0.15		0.07
		Aver	-0.23	-0.43	-0.34	-0.45		-0.36
C	Coffee	1	5.42	7.11	10.11	13.83	11.74	9.13
		2	3.83	5.04	5.51	9.63		7.08
		3	1.59	3.66	5.94	8.54	11.09	4.93
		4	4.04	5.88	7.75	8.15		6.65
		Aver.	3.72	7.19	7.53	9.55	11.42	6.95
D	Coffee-Chicory	1	8.48	10.87	8.96	13.96		10.56
		2	2.52	3.19	5.53	8.74		5.18
		3	0.07	-0.38	-2.50	-1.10	0.29	-0.98
		4	7.82	8.67	10.27	12.61		9.84
		Aver	4.72	5.59	5.82	8.50	0.29	6.15
E	Decaffeinated Coffee (Kaffee Hag)	1	1.71	0.85	0.55	5.13		2.06
		2	1.01	0.06	-1.38	2.48		0.52
		3	-1.30	-0.05	0.09	-0.91	0.15	-0.50
		4	-0.59	5.37	5.96	4.07	4.87	3.70
		Aver	0.21	1.58	1.31	2.77	2.51	1.47
F	Black Tea	1	-0.24	11.71	6.41	12.61	2.77	7.62
		3	7.54	13.51	10.20	14.64	6.89	11.48
		4	16.05	14.61		8.10		12.92
		Aver	7.78	13.28	8.31	11.78	4.83	10.67
G	Green Tea	1	3.82	6.21	10.31	19.11		9.89
		4	8.66	18.68	13.85	18.93	16.83	15.03
		Aver	6.24	12.45	12.08	19.02	16.83	12.45

TABLE XIII SERIES A - WATER METABOLISM STUDIES

Exper. Series and No.	Date	Subj. No.	Hrs. after Water	Av. Resp Rate	Av. Pulse Rate	Cal. per hour	% change from basal	Comments
				15	71	50.82		Irregular breathing
A 1	2/22	1	0.5	16	70	47.14	-7.24	Quiet - Irreg breathing
			1.0	15	70	48.65	-4.27	Quiet - breathing reg.
			1.5	17	76	50.63	-0.37	Quiet
			2.5	18	78	53.63	5.53	Restless and tired
				16	64	50.51		Quiet
A 2	3/1	1	0.5	15	68	48.85	-3.29	Irreg. Breathing
			1.0	15	70	48.27	-4.42	Reg. short breaths
			2.0	16	72	48.50	-4.18	Quiet
			2.5	18	74	49.30	-2.40	Quiet
				14	67	55.05		Drowsy
A 3	3/8	1	0.5	14	75	52.24	-3.24	Asleep before test
			1.0	15	72	53.73	-2.34	Quiet
			2.0	16	72	51.47	-6.27	Drowsy
			2.5	16	70	52.56	-4.43	Tired - quiet
				12	69	48.11		Drowsy - quiet
A 4	2/26	2	0.5	13	69	47.63	-1.00	Deep breathing
			1.0	13	71	47.89	-0.23	Quiet
			2.0	13	66	47.41	-1.46	Quiet
			2.5	13	75	45.57	-5.28	Tired toward end
				12	74	49.16		Quiet
A 5	3/9	2	0.5	12	66	50.08	1.87	Quiet
			1.0	13	72	53.86	9.56	Asleep before test - restless
			2.0	11	66	51.13	4.02	Drowsy
			2.5	11	67	49.61	0.93	Short-uneven breathing
				12	64	48.49		Very quiet
A 6	3/16	2	0.5	11	68	47.70	-1.63	Very quiet
			1.0	11	65	49.08	2.91	Drowsy
			2.0	12	66	46.33	-4.45	Asleep before test
			2.5	12	64	48.28	-0.43	Quiet
				11	62	56.07		Irreg. breathing
A 7	3/31	3	0.5	11	60	55.92	-0.29	Quiet
			1.0	10	58	53.87	-3.92	Quiet
			2.0	11	61	52.64	-6.12	Very quiet
			2.5	11	61	56.57	+0.89	Very quiet

TABLE XIII SERIES A - WATER METABOLISM STUDIES (2)

Exper. Series & No.	Date	Subj. No.	Hrs. after Water	Av. Resp Rate	Av. Pulse Rate	Cal. per hour	% change from basal	Comments
				13	64	50.19		Quiet
A 8	5/10	3	0.5	14	64	51.62	2.65	Coughed once
			1.0	14	61	50.15	-0.06	Quiet
			2.0	14	62	50.08	-0.24	Drowsy
			2.5	16	61	53.42	6.43	Excited over a broken glass
				13	62	54.46		Drowsy
A 9	7/7	3	0.5	13	62	53.98	-0.88	Asleep before test
			1.0	13	68	53.25	-2.20	Quiet
			2.0	14	67	55.13	1.23	Quiet
			2.5	15	70	55.67	2.22	Moved hand once
				11	72	52.42		Asleep during rest period
A 10	3/27	4	0.5	12	69	54.25	3.28	Moved arm once
			1.0	12	68	52.60	0.34	Very quiet
			2.0	13	79	54.08	2.98	Very quiet
			2.5	13	76	53.56	2.15	Very quiet
				12	68	52.39		
A 11	7/22	4	0.5	15	68	52.61	+0.42	Asleep most of morning. Very drowsy in between tests.
			1.0	13	66	51.38	-1.93	
			2.0	13	64	50.81	-3.02	
			2.5	15	68	52.24	-0.29	

TABLE XIV SERIES B - CHICORY METABOLISM STUDIES

Exper. Series & No.	Date	Subj. No.	Hrs. after Brew	Av. Resp. Rate	Av. Pulse Rate	Cal. per hour	% incr. from basal	Comments
				13	72	46.89		Slept between every
B 1	4/29	1	0.5	16	71	46.29	-0.86	basal - seemed
			1.0	13	68	46.98	0.02	quite exhausted
			2.0	13	74	47.05	0.77	
			2.5	18	72	47.36	1.43	Quiet
				15	74	49.20		Sleepy
B 2	5/1	1	0.5	15	70	49.97	1.16	Quiet
			1.0	16	74	49.48	0.57	Quiet
			2.0	16	70	48.54	-1.54	Quiet
			2.5	16	70	48.89	-0.63	Quiet
				17	68	47.80		Disliked brew
B 3	7/1	1	0.5	17	66	48.02	0.46	Drowsy
			1.0	15	71	47.36	-0.92	Asleep before test
			2.0	16	68	46.20	-3.35	Disturbance in next room
			2.5	16	76	46.65	-2.41	Drowsy
				13	70	47.01		Quiet
B 4	4/26	2	0.5	13	63	46.26	-1.60	Quiet
			1.0	13	67	47.30	0.64	Drowsy
			2.0	15	67	48.40	2.96	Disturbed over a dream during rest period
			2.5	14	62	47.69	1.45	Quiet
				11	64	49.05		
B 5	5/4	2	0.5	12	62	47.80	-2.55	Quiet all morning.
			1.0	12	64	48.69	-0.73	Slept between
			2.0	13	60	46.86	-4.46	tests.
			2.5	14	66	46.07	-6.08	
				13.	61	47.58		
B 6	5/10	2	0.5	14	62	46.05	-3.21	Rather drowsy.
			1.0	15	60	46.40	-2.48	Quiet all morning.
			2.0	15	62	47.34	-0.50	
			2.5	15	62	48.14	1.18	
				13	62	56.82		
B 7	4/1	3	0.5	11	61	58.97	3.78	Very quiet all
			1.0	11	58	55.84	-1.72	morning. Slept
			2.0	13	60	59.68	5.03	between metabolism
			2.5	12	58	57.56	1.30	tests.

TABLE XIV SERIES B - CHICORY METABOLISM STUDIES (2)

Exper. Series & No.	Date	Subj No.	Hrs. after Brew	Av. Resp. Rate	Av. Pulse Rate	Cal. per hr.	% incr. from basal	Comments
				15	68	56.52		
B 8	4/2	3	0.5	12	57	55.24	-2.26	Drowsy all morning - fell asleep between tests
			1.0	14	59	54.86	-2.92	
			2.0	14	60	54.27	-3.40	
			2.5	16	61	62.71	10.95	
				13	74	57.16		
B 9	4/26	3	0.5	13	74	57.36	0.35	Quiet all morning. Asleep before 2 hr. test.
			1.0	14	78	57.34	0.30	
			2.0	13	80	58.61	2.51	
			2.5	15	79	56.4[illegible]	-1.22	
				13	62	51.6[illegible]		
B 10	4/1	4	0.5	11	61	53.12	2.59	Quiet
			1.0	11	60	52.13	0.48	Fell asleep
			2.0	9	60	51.30	-1.12	Very deep respiration
			2.5	10	61	51.56	-0.62	
				11	62	49.2[illegible]		
B 11	4/2	4	0.5	11	61	48.69	-1.04	Relaxed and very quiet all morning.
			1.0	12	62	49.47	0.55	
			2.0	12	62	49.01	-0.41	
			2.5	11	60	49.36	0.33	

TABLE XV SERIES C - COFFEE METABOLISM STUDIES

Exper. Series & No.	Date	Subj. No.	Hrs. after Brew	Av. Resp. Rate	Av. Pulse Rate	Cal. per hour	% incr from basal	Comments
				15	72	47.20		Drowsy
C 1	4/24	1	0.5	15	78	49.59	5.91	Awake after drinking
			1.0	17	74	50.28	6.53	coffee
			2.0	18	82	51.98	10.13	Excited over noise in
			2.5	18	76	54.25	14.94	next room.
				15	79	47.65		Quiet
C 2	4/30	1	0.5	17	78	49.92	3.71	Moved slightly
			1.0	16	81	50.00	4.93	Wide awake after
			2.0	16	76	50.52	6.02	brew.
			2.5	18	76	51.15	7.35	
				13	70	48.35		Drowsy
C 3	5/5	1	0.5	15	74	51.22	5.94	Very wide awake
			1.0	16	72	51.08	5.65	Uneven breathing
			2.0	17	74	55.55	14.89	Moved arm once
			2.5	17	70	58.31	20.60	
				13	70	49.49		Asleep during rest period
C 4	7/5	1	0.5	15	76	52.52	6.12	Awake after drinking
			1.0	17	80	55.10	11.34	brew
			2.0	17	74	54.13	9.38	
			2.5	17	74	55.70	12.55	
			3.5	18	74	55.30	11.74	
				13	64	50.20		
C 5	3/19	2	0.5	13	62	50.87	1.33	Regular deep breathing
			1.0	13	64	53.33	6.24	Warm after coffee
			2.0	13	64	52.92	5.42	Asleep before test
			2.5	14	65	55.21	9.98	
				14	70	47.01		Very quiet
C 6	3/23	2	0.5	13	68	52.46	11.59	Breathing deep and even
			1.0	14	70	51.56	9.68	
			2.0	13	67	48.83	3.87	
			2.5	14	70	49.76	5.85	
				15	68	49.32		Very quiet
C 7	3/26	2	0.5	15	66	49.50	0.37	
			1.0	16	64	55.37	11.80	
			2.0	15	71	53.21	7.89	Asleep before test
			2.5	14	70	54.67	10.85	
				11	66	48.89		A very warm day.
C 8	6/16	2	0.5	12	75	49.87	2.01	Subject very quiet -
			1.0	12	68	52.59	9.62	warm after coffee.
			2.0	13	71	51.26	4.85	
			2.5	12	68	54.68	11.84	

TABLE XV SERIES C - COFFEE METABOLIC STUDIES (2)

Exper. Series & No.	Date	Subj. No.	Hrs. after Brew	Av. Resp. Rate	Av. Pulse Rate	Cal. per Hr.	% incr. from basal	Comments
				16	61	55.21		
C 9	3/5	3	0.5	13	58	55.39	0.33	Drowsy and quiet all morning
			1.0	13	56	55.41	0.36	
			2.0	14	60	56.21	1.81	
			2.5	14	60	57.58	3.93	
				14	65	55.77		Talked before first test and while drinking brew. Quiet otherwise.
C 10	3/19	3	0.5	15	55	55.10	-1.20	
			1.0	14	50	55.22	-0.99	
			2.0	16	58	55.27	-0.90	
			2.5	14	55	59.04	5.95	
				14	70	54.85		Very quiet all morning.
C 11	3/27	3	0.5	15	66	56.22	2.50	
			1.0	14	64	55.10	0.46	Awake toward end of morning.
			2.0	14	68	59.45	8.39	
			2.5	14	70	59.41	8.31	
				14	64	53.91		
C 12	4/3	3	0.5	13	62	56.42	4.65	Very quiet all morning.
			1.0	13	68	58.03	7.64	
			2.0	14	64	58.21	7.97	Seemed very quide awake.
			2.5	15	62	58.92	9.29	
			3.5	15	66	56.06	5.84	
				13	54	51.51		Much noise in little theatre. Was distracted but quiet. Seemed warm and wide awake.
C 13	7/9	3	0.5	13	56	52.36	1.65	
			1.0	15	59	57.08	10.81	
			2.0	17	63	57.93	12.44	
			2.5	15	59	59.36	15.24	
			3.5	15	62	59.92	16.33	
				11	66	56.90		
C 14	3/28	4	0.5	13	66	60.06	5.55	Very quiet and relaxed.
			1.0	14	60	62.50	9.84	
			2.0	10	63	61.89	7.01	
			2.5	10	65	60.48	6.29	
				13	71	56.90		
C 15	3/29	4	0.5	16	63	57.14	4.22	Even breathing - very quiet
			1.0	19	60	61.34	7.80	
			2.0	11	62	60.18	5.76	
			2.5	14	64	60.33	6.03	
				11	73	50.74		
C 16	6/16	4	0.5	14	60	51.93	2.35	Seemed tired toward end of morning
			1.0	15	62	55.07	8.34	
			2.0	12	66	56.15	10.47	

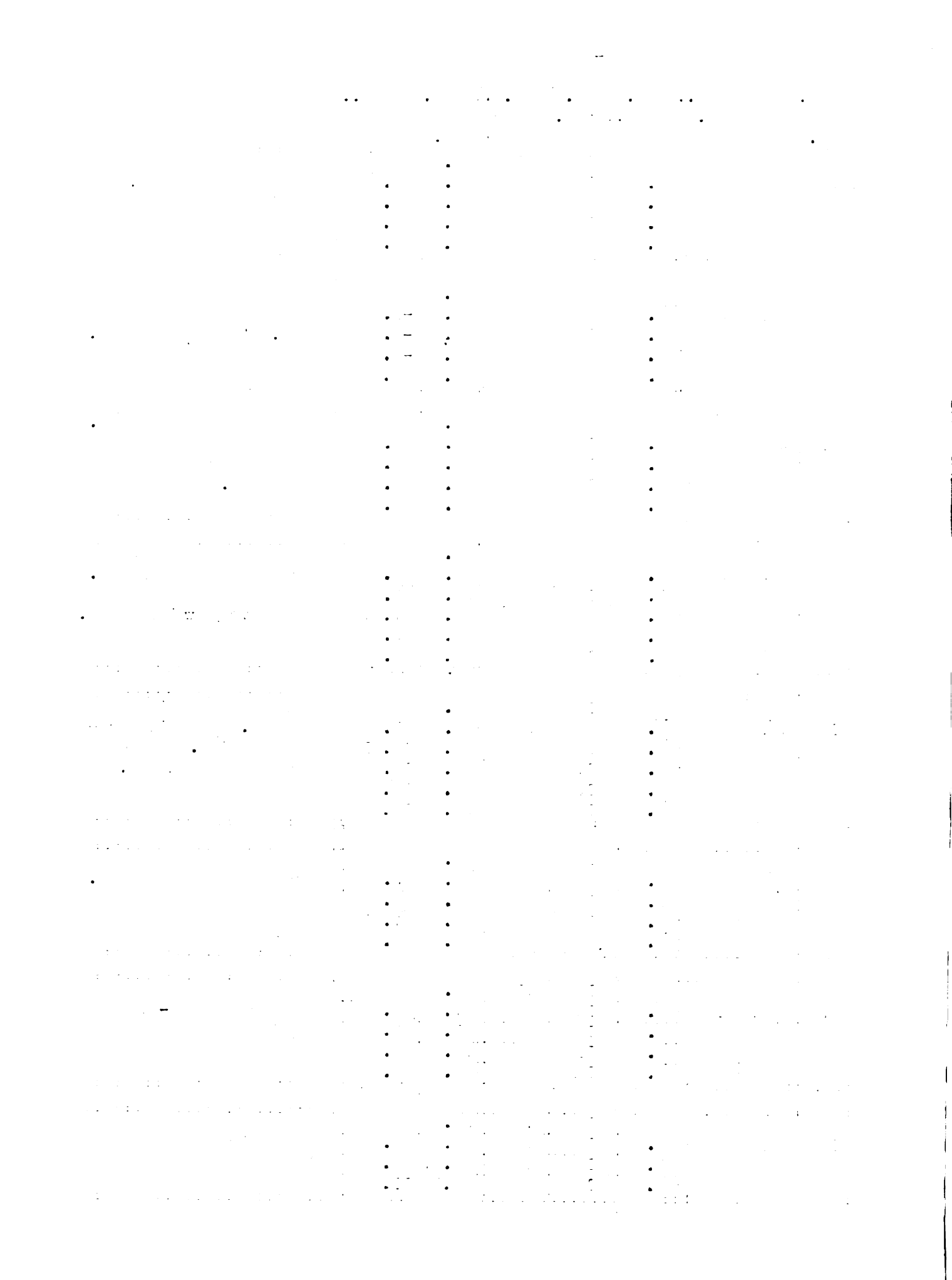

TABLE XVI SERIES D - COFFEE CHRONIC METABOLISM STUDIES

Exper. Series & No.	Date	Subj. No.	Hrs. after Brew	Av. Resp. Rate	Av. Pulse Rate	Cal. per hour	% incr. from basal	Comments
				15	73	49.82		Very quiet.
D 1	4/17	1	0.5	17	81	55.27	9.12	Spasmotic breathing.
			1.0	16	72	55.31	9.20	
			2.0	16	74	56.88	10.56	
			2.5	18	80	55.71	14.11	
				16	74	48.78		
D 2	4/21	1	0.5	19	77	54.40	11.52	Even breathing.
			1.0	19	78	53.98	10.66	Awake after brew.
			2.0	18	79	54.27	11.25	
			2.5	19	85	56.89	16.63	
				15	83	50.60		
D 3	5/7	1	0.5	17	75	55.17	9.03	Very quiet all
			1.0	16	80	55.30	9.29	morning.
			2.0	18	84	53.45	5.63	
			2.5	17	84	54.03	6.79	
				14	66	47.01		Quiet
D 4	7/2	1	0.5	15	66	48.98	4.19	
			1.0	16	70	53.75	14.33	Restless after drink-
			2.0	16	67	51.05	8.59	ing brew.
			2.5	17	67	55.30	17.40	
				14	85	50.79		Hurried over to get
D 5	4/13	2	0.5	15	70	50.79	0.00	in on time. First
			1.0	15	76	52.48	3.13	metabolism perhaps
			2.0	14	82	52.29	2.95	high - rested 35
			2.5	15	80	54.93	8.15	minutes.
				15	68	50.09		
D 6	6/14	2	0.5	15	76	51.44	2.70	Very quiet all
			1.0	15	84	51.82	3.43	morning.
			2.0	14	82	54.33	8.46	
			2.5	13	76	54.15	8.13	
				16	60	45.31		
D 7	5/11	2	0.5	16	68	46.66	2.98	Shallow breathing
			1.0	15	62	46.34	2.27	Quiet.
			2.0	15	67	49.53	9.31	Deep breathing.
			2.5	14	62	48.86	7.83	
				14	61	48.49		
D 8	5/17	2	0.5	15	61	50.62	4.39	Very quiet.
			1.0	13	59	50.39	3.92	Wide awake all morning.
			2.0	14	62	51.10	5.38	
			2.5	15	64	53.74	10.83	

TABLE XVI SERIES D - COFFEE CHICORY METABOLISM STUDIES (2)

Exper. Series & No.	Date	Subj. No.	Hrs. after Brew	Av. Resp. Rate	Av. Pulse Rate	Cal. per hour	% incr. from basal	Comments
				14	63	50.77		
D 9	4/3	3	0.5	16	60	51.06	0.48	Quiet all morning.
			1.0	15	60	50.35	-0.89	Asleep between tests.
			2.0	15	58	48.90	-3.72	
			2.5	15	62	50.05	-1.51	
				14	60	53.13		
D 10	4/4	3	0.5	14	58	53.55	0.35	Felt warm after
			1.0	15	55	57.98	-0.15	drinking brew.
			2.0	17	53	55.55	-4.43	Very quiet.
			2.5	13	60	53.97	-2.13	
				14	57	52.14		Quiet
D 11	4/12	3	0.5	14	54	51.60	-1.04	Breathing even.
			1.0	15	54	51.94	-0.40	Asleep between tests.
			2.0	15	58	51.02	-2.15	
			2.5	15	56	52.79	1.25	
				14	62	50.63		
D 12	5/17	3	0.5	15	60	50.90	0.29	Quiet - rather drowsy
			1.0	14	57	50.64	0.02	all morning.
			2.0	15	58	50.90	0.29	
			2.5	16	59	57.46	-1.98	
			3.5	16	58	50.90	0.29	
				14	63	50.02		Very quiet
D 13	4/3	4	0.5	16	60	54.72	9.40	all morning.
			1.0	15	60	54.87	9.70	Asleep between
			2.0	15	58	60.42	20.79	3rd & 4th tests.
			2.5	16	62	57.86	15.67	
				14	65	50.34		Very quiet
D 14	4/4	4	0.5	16	59	54.90	9.06	Asleep between
			1.0	18	56	53.72	6.71	each test
			2.0	15	58	52.17	3.83	
			2.5	15	60	56.21	11.26	
				14	65	51.48		Talked a bit before
D 15	4/19	4	0.5	14	55	54.06	5.01	first test. Quiet
			1.0	15	50	56.42	9.60	rest of morning. Asleep
			2.0	14	58	54.66	6.18	before #4. Very slow
			2.5	8	55	57.09	10.90	breathing.

Table XVII SERIES E - DECAFFEINATED COFFEE METABOLISM STUDIES

Exper. Series and No.	Date	Subj. No.	Hrs. after Brew	Av. Resp. Rate	Av. Pulse Rate	Cal. per Hour	% Change from Basal	Comments
E 1	6/26	1		14	70	48.48		Asleep
			0.5	15	73	50.74	4.66	Very quiet
			1.0	15	72	50.16	3.47	Drowsy all
			2.0	15	70	49.54	1.57	Morning
			2.5	16	73	51.41	6.03	
E 2	6/27	1		14	70	47.98		Asleep
			0.5	12	68	48.16	0.56	Drowsy all
			1.0	12	70	49.37	3.09	Morning
			2.0	12	63	48.52	1.43	Slept between
			2.5	15	70	50.33	5.07	tests
E 3	6/28	1		16	71	47.63		Asleep bf test
			0.5	12	67	47.30	-0.69	Moved arm once
			1.0	12	67	46.80	-1.77	Asleep between
			2.0	12	70	47.51	-0.25	tests
			2.5	15	71	50.21	5.40	
E 4	6/30	1		14	72	49.54		Sleepy all
			0.5	13	70	50.63	2.30	Morning
			1.0	13	70	48.85	-1.39	Very quiet
			2.0	15	70	49.81	-0.55	
			2.5	17	76	51.52	4.00	
E 5	5/24	2		16	58	51.02		Very even
			0.5	14	60	47.07	4.55	breathing.
			1.0	13	58	44.22	-1.78	Quiet and
			2.0	13	60	42.97	-4.55	sleepy all
			2.5	13	60	45.95	2.07	morning
E 6	5/25	2		14	64	48.46		
			0.5	14	60	48.51	0.08	Quiet and
			1.0	14	58	48.29	-0.16	sleepy all
			2.0	15	57	48.21	-0.52	morning
			2.5	15	60	48.62	0.33	
E 7	6/8	2		13	72	48.14		Very quiet
			0.5	13	65	48.36	0.48	
			1.0	14	66	47.38	2.63	Startled, slammed
			2.0	13	64	46.40	0.56	Irritated & amused
			2.5	14	70	48.13	4.31	Sleepy/ by fly
E 8	6/22	2		14	68	47.47		
			0.5	14	70	46.96	-1.07	Sleepy all
			1.0	15	64	47.25	-0.46	morning
			2.0	15	69	46.99	-1.01	Even breathing
			2.5	14	69	48.99	3.20	

TABLE XVII SERIES E - DECAFFEINATED COFFEE STUDIES 2

Exper Series & No.	Date	Subj. No.	Hrs. af Brew	Av. Resp Rate	Pulse Rate	Cal. Hour	% incr. from basal	Comments
				15	60	54.67		
E 9	5/24	3	0.5	13	62	54.47	-0.73	Very quiet
			1.0	13	64	54.04	-0.42	all morning
			2.0	14	63	54.04	-1.51	
			2.5	15	60	55.52	1.18	Moved arm once
				14	80	54.62		Subj. had a
E 10	6/7	3	0.5	16	79	53.54	-1.79	slight cold
			1.0	15	68	55.38	1.39	Very sleepy
			2.0	15	78	55.25	1.15	all morning
			2.5	15	72	54.29	-0.60	
				13	60	58.43		
E 11	7/5	3	0.5	13	62	57.63	-1.37	Sleepy and
			1.0	14	60	57.78	-1.11	quiet all
			2.0	15	62	58.80	0.63	morning
			2.5	15	64	57.03	-2.40	
			3.5	13	68	58.51	0.15	
				12	64	48.05		Asleep before
E 12	7/24	4	0.5	14	68	48.70	1.35	each test
			1.0	12	70	49.19	2.37	A rainy, sleepy
			2.0	12	67	51.36	6.89	day. Subject
			2.5	14	68	50.38	4.87	quiet
			3.5	15	72	50.38	4.87	
				11	64	45.16		Subject asleep
E 13	7/26	4	0.5	11	68	44.03	-2.52	between each
			1.0	11	65	48.90	8.36	test. Very
			2.0	13	72	47.43	5.03	quiet all
			2.5	11	72	46.64	3.27	morning

TABLE XVIII SERIES F - BLACK TEA METABOLISM STUDIES

Exper. No.	Date	Subj. No.	Hrs. after Brew	Av. Resp. Rate	Av. Pulse Rate	Cal. per Hour.	% inc. from Basal	Comments
				16	76	52.09		Asleep before test
F 1	7/15	1	0.5	15	80	52.17	0.15	Nauseated after
			1.0	17	80	55.64	6.82	drinking tea.
			2.0	18	80	58.22	11.77	Very quiet
			2.5	18	80	59.92	15.01	
				15	84	52.09		Nauseated 10 min.
F 2	7/17	1	0.5	14	86	50.74	-2.40	after drinking
			1.0	16	86	55.93	5.51	tea. Felt warm
			2.0	16	80	54.18	4.01	all morning
			2.5	14	80	65.03	24.84	Very quiet.
			3.5	17	82	53.53	2.77	
				14	82	51.28		Basal showed rather
F 3	7/18	1	0.5	17	84	52.17	1.54	uneven breathing
			1.0	16	80	62.99	24.79	Other tests even
			2.0	17	79	53.05	3.45	quiet all A. M.
			2.5	15	80	50.24	-2.02	wide awake
				10	61	53.40		1st and last tests
F 4	7/15	3	0.5	15	62	58.33	9.23	show irregular
			1.0	13	60	57.57	7.81	breathing. Other
			2.0	15	60	58.49	9.53	tests regular
			2.5	15	60	58.19	8.97	Felt warm after brew
				13	64	50.62		Felt warm after
F 5	7/17	3	0.5	15	64	54.37	7.48	taking tea.
			1.0	18	60	55.41	9.52	Seemed more stim-
			2.0	18	66	55.27	9.19	ulated by tea than
			2.5	17	66	59.51	17.56	coffee.
				16	60	52.99		Very quiet
F 6	7/18	3	0.5	16	64	56.12	5.91	all morning
			1.0	16	60	65.26	23.16	Felt nauseated
			2.0	17	60	64.58	21.81	10 min. after
			2.5	18	60	62.22	17.40	drinking tea
			3.5	15	60	56.64	6.89	for just a few min.
				14	68	47.23		Subj. sleepy
F 7	7/24	4	0.5	15	68	54.81	16.05	all morning.
			1.0	14	68	54.13	14.61	even after brew
			2.0	14	70			Very warm just
			2.5	14	70	51.04	8.10	after taking brew

TABLE XIX - SERIES G - GREEN TEA METABOLISM STUDIES

Exper No.	Date	Subj No.	Hrs. after Brew	Av. Resp Rate	Av. Pulse Rate	Cal. per hour	% incr. from basal	Comments
				16	75	47.76		Very nauseated after drinking tea. Quiet and awake all morning.
G 1	7/21	1	0.5	16	72	50.12	4.94	
			1.0	15	74	49.70	4.06	
			2.0	19	76	54.96	15.09	
			2.5	19	70	57.06	19.45	
				13	68	47.33		Uneven - shallow breathing. Quiet and awake all morning.
G 2	7/23	1	0.5	16	70	50.50	4.54	
			1.0	18	72	52.61	11.16	
			2.0	15	70	51.75	9.33	
			2.5	17	70	53.23	12.47	
				12	72	44.56		Quiet and awake all morning. Nauseated 15 minutes after taking tea.
G 3	7/25	1	0.5	17	72	45.47	1.97	
			1.0	15	74	46.11	3.41	
			2.0	14	74	47.49	6.51	
			2.5	19	74	55.92	25.41	
				8	72	47.77		Deep even breathing all morning. Felt nauseated first half hour after brew.
G 4	7/21	4	0.5	11	67	53.17	11.30	
			1.0	12	72	55.15	15.45	
			2.0	12	68	56.23	17.71	
			2.5	10	72	55.95	16.83	
			3.5	10	68	55.95	16.83	
				9	72	47.86		Very even breathing - quiet all morning. Nauseated after tea.
G 5	7/23	4	0.5	11	72	50.74	6.02	
			1.0	13	80	58.35	21.91	
			2.0	13	63	52.46	9.99	
			2.5	13	65	57.93	21.02	

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