THE VALUE OF COD LIVER OIL FOR BUILDING BODILY RESISTANCE OF INDUSTRIAL WORKERS

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Industrial absenteeism caused by illness is a constant source of annoyance to both employer and employe. Illness, particularly if long continued, increases the expenses of the employe at a time when he may be receiving a decreased income due to an absence from his regular task. Industrial absenteeism is also annoying to the employer since it interrupts the normal routine of manufacturing processes, frequently necessitates substitute workers and often involves the employment of workers who are inexperienced in the particular job. All of this creates confusion and adds to manufacturing costs. Hence it is highly desirable from the standpoint of both employer and employe to reduce industrial absenteeism as much as possible.

Mills of the Committee on the Cost of Medical Care has reported (1) that wage earners in the United States are absent from their work on account of illness at least 250,000,000 working days per year. Studies by sick benefit associations, the Metropolitan Life Insurance Company (2) and Brundage of the United States Department of Public Health (3) show that over 40 per cent of time lost by wage earners is caused by colds and respiratory diseases. In view of this enormous economic waste it seemed highly desirable to study the possibility of reducing industrial absenteeism caused by colds and respiratory diseases.

EXPERIMENTAL

Three hundred thirty-nine men and women employed at a variety of tasks, such as office work, light machine work and heavier machine work were fed five tablespoonsful of cod liver oil per week at their forenoon rest period. Three hundred nine men and women of corresponding age, weight, general living conditions, and employed at identical tasks did not receive cod liver oil and thus served as controls. It should be noted that the members of the control group were in reality not true controls, for those who were not troubled seriously with colds naturally gravitated towards the control group whereas those who experienced a good deal of annoyance, inconvenience, and lost time on account of colds, requested that they be included in the cod liver oil group.

The twenty weeks' experimental period lasted from November to April, which was the season when colds are most prevalent. The cod liver oil which was administered complied with the U. S. P. specifications (4) for chemical and physical characteristics. Its vitamin potency exceeded 1,000 Vitamin A and 150 Vitamin D units per gram. The subjects of this study were distributed in twelve rooms which varied somewhat with respect to exposure and amount of sunlight that they received. Data regarding the distribution of the subjects are reported in Table 1.

TABLE 1—DISTRIBUTION OF SUBJECTS

Room No.	Cod Liver Oil Group Male	Fe-male	Total	Control Group Male	Fe-male	Total
1...	64	20	84	67	24	91
2...	26	3	29	29	3	32
3...	17	43	60	15	40	55
4...	14	1	15	0	0	0
5...	30	17	47	9	16	25
6...	0	24	24	0	24	24
7...	0	4	4	0	6	6
8...	0	13	13	0	16	16
9...	0	23	23	0	25	25
10...	3	8	11	0	10	10
11...	0	10	10	0	7	7
12...	0	19	19	0	18	18
Total	154	185	339	120	189	309

In order that the results obtained might apply to average industrial workers the subjects were selected so as to cover a wide age and weight range. Information concerning the age and weight of the subjects will be found in Table 2.

TABLE 2—AGE AND WEIGHT RANGE OF SUBJECTS

	Cod Liver Oil Group Per cent	Control Group Per cent
Age Range		
20 Years and under	2.9	3.8
21–30 Years	43.7	50.4
31–45 Years	36.9	38.5
45 Years and over	16.5	7.1
Weight Range		
7% or more below ideal..	41.3	29.8
0.1%–6.9% below ideal...	27.7	25.6
0.0%–6.9% above ideal...	17.1	19.7
7% or more above ideal..	13.9	24.9

As the study progressed data were accumulated regarding (a) changes in body weight, (b) the number of mild and severe colds, (c) the number of subjects who had no colds during the experimental period, and (d) the amount of time lost from work due to colds and respiratory troubles.

In order to ascertain the type of subject that gained or lost weight, the subjects were divided into four weight classes; namely, those that were 7 per cent or more under ideal weight (5), those between 0.1 per cent and 6.9 per cent below ideal weight, those 0.0 per cent to 6.9 per cent above ideal weight and those 7 per cent or more over ideal weight. At the conclusion of the study it was found that 205 members of the cod liver oil group and 168 members of the control group gained in weight during the twenty weeks' experiment. The amount gained per person was approximately the same for both groups. The average gain in weight per subject was fairly uniform for the four weight classes of both the cod liver oil and the control groups. One hundred four members of the cod liver oil group lost weight during the experimental period as compared with 124 members of the control group. Thus it is seen that 10 per cent more

members of the control than of the cod liver oil group lost weight. The average loss in body weight per subject varied for the different weight classes. In this connection it is interesting to note that the loss in weight for the members of the cod liver oil group who were 7.0 per cent or more over ideal weight was twice that of those who were below ideal weight. While this result was to be desired it is problematical whether or not it would be duplicated in other studies of a similar nature. Detailed data concerning the gain and loss of weight by the subjects will be found in Table 3.

TABLE 3—CHANGES IN BODY WEIGHT DURING EXPERIMENT

Classification of Subjects	Increase: Subjects No.	Increase: Subjects %	Increase: Aver. Lbs.	Decrease: Subjects No.	Decrease: Subjects %	Decrease: Aver. Lbs.	No Change: Subjects No.	No Change: Subjects %
Cod Liver Oil Group								
7% or more below ideal	87	62.1	2.4	38	27.1	1.8	15	10.7
0.1%–6.9% below ideal	68	72.3	2.8	20	21.2	2.0	6	6.3
0.0%–6.9% above ideal	31	53.4	3.1	21	36.2	2.4	6	10.3
7% or more above ideal	19	40.4	2.3	25	53.1	3.6	3	6.3
Average[1]	205[2]	60.4	2.7	104	30.6	2.5	30	8.8
Control Group								
7% or more below ideal	56	60.8	2.6	28	30.4	1.7	8	8.6
0.1%–6.9% below ideal	44	55.6	2.7	31	39.2	1.9	4	5.0
0.0%–6.9% above ideal	30	49.1	2.8	30	49.1	2.1	1	1.6
7% or more above ideal	38	49.2	3.0	35	45.4	2.0	4	5.2
Average[1]	168[2]	54.3	2.8	124	40.1	1.2	17	5.5

[1]Weighted averages. [2]Total for group.

Eighty-nine members of the cod liver oil group had severe colds during the winter as compared with 102 members of the control group. Thus 13 per cent more members of the control group than of the cod liver oil group had severe colds. There were three cases of influenza and one of bronchitis in the control group, but none in the cod liver oil group. Inspection of Table 4 will reveal that nearly three-quarters of the severe colds for the cod liver oil group occurred in rooms 2, 3 and 12 and over 80 per cent of the severe colds for the control group were in rooms 1, 2, 3, 5 and 9. It is not known why severe colds were quite prevalent for both the cod liver oil and control groups in rooms 2 and 3. Also there is no explanation for the variation in the occurrence of severe colds in the different rooms. Ordinarily the severe colds entailed considerable lost time, and frequently also caused the worker to be less efficient for a time after he returned to work. Hence the difference of 13 per cent of severe colds constituted a factor of definite importance to both employer and employe.

The number of subjects of the cold liver oil and control groups which had mild colds during the study are reported in Table 4 for each group of the twelve rooms under observation. It will be noted that the mild colds were more generally distributed through the various rooms than were the severe colds. It is also interesting to note that the rooms in which the majority of severe colds were prevalent also had a relatively high prevalence of mild colds. No explanation is available for the excessive number, 105, of mild colds for the control group in room 1.

One hundred and twenty-eight members of the cod liver oil group had no colds (Table 4) during the winter as compared with sixty-eight members in the control group. In other words, there were twice as many in the cod liver oil group as in the control group that had no colds during the winter. Obviously, the subjects that had no colds during the experiment lost no time from work on account of colds. Hence the difference between 128 members of the cod liver oil group and 68 members of the control group which had no colds had an inmportant influence on the amount of time lost from work due to colds by the two groups.

The men of the cod liver oil group lost 1,587 hours' time (Table 5) during the year previous to receiving cod liver oil. During the past winter the same men lost only 650 hours or they were absent from work less than half as much as when they received cod liver oil as during the previous year. The women of the cod liver oil group lost 3,325 hours' time during the winter previous to taking cod liver oil and 2,971 hours during the winter that they received cod liver oil. The reverse was found to be the case for the control group. The men of the control group lost 743 hours in the year previous to the experiment and 1,270 hours during the past winter. The women of the control group lost 3,069 hours the year previous to the experiment and 3,288 hours last winter. Without doubt the larger absence for the control group during the past winter than for the previous year was due to the severe weather of the past winter.

These results are in accord with those obtained in a previous study (6); namely, during a three-year period a group of subjects which received cod liver oil were absent from work, due to colds and respiratory diseases, 1.1 per cent of the total possible working hours, whereas a similar control group was absent 3.1 per cent. The total absence for the control group was 24,580 hours. If the control group had responded to cod liver oil in the same manner as the subjects of the cod liver oil group (1.10 per cent absence) the lost time would have been 8,721 hours. The difference, 15,861 hours, at a $20 wage scale and a forty-hour week would have amounted to $7,930.

TABLE 4—PREVALENCE OF COLDS

Room No.	Cod Liver Oil Group: Severe	Mild	None	Control Group: Severe	Mild	None
1	5	41	52	37	105	12
2	13	36	4	10	39	5
3	32	44	13	16	34	17
4	5	19	2	0	0	0
5	6	34	22	11	28	7
6	1	19	10	0	0	0
7	1	0	3	3	4	1
8	3	8	7	4	12	6
9	0	32	5	11	15	12
10	1	14	3	0	0	0
11	5	2	4	3	2	4
12	17	13	3	7	12	4
Total	89	262	128	102	251	68

TABLE 5—ABSENCES DUE TO ILLNESS

Room No.	1932–33 Absence Hours	1933–34 Absence Hours	1932–33 Absence Hours	1933–34 Absence Hours
			MALE	FEMALE
COD LIVER OIL GROUP				
1	498	228	239	629
2	101	130	17	24
3	522	72	1004	584
4	68	24	4	12
5	398	196	413	92
6	...	...	349	723
7	...	...	34	...
8	...	...	266	180
9	...	...	546	562
10	...	...	65	16
11	...	...	236	102
12	...	...	152	47
Total	1587	650	3325	2971
CONTROL GROUP				
1	239	681	415	121
2	248	97	52	4
3	132	28	500	816
4	...	...	...	...
5	124	464	305	470
6	...	...	680	293
7	...	...	21	213
8	...	...	364	348
9	...	...	245	578
10	...	...	292	70
11	...	...	140	115
12	...	...	55	260
Total	743	1270	3069	3288

SUMMARY

The results of this investigation show that by feeding five tablespoonfuls weekly of vitamin-rich cod liver oil to average industrial

employees the number of severe colds can be materially reduced, the number of persons having no colds may be increased, and the amount of time lost from work may be very significantly decreased. Obviously cod liver oil should not be looked upon as a panacea but the results of this investigation show that lost time due to colds and similar troubles may be materially reduced by the regular consumption of cod liver oil and thus the annoyance and expense which lost time causes the employer and the employee can be significantly reduced.

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CAPRIFIED FIG SEED OIL

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The seeds from California caprified figs, which are separated in the manufacture of fig paste, are now a waste product amounting to between 5 and 10 tons a season. As no reference to fig seed oil from any source could be found in the literature, samples of the seed and of the cold expressed oil were sent to the authors for investigation by E. M. Chace, in charge of the Fruit and Vegetable Chemistry Laboratory of the Bureau of Chemistry and Soils at Los Angeles, California.

The caprified fig seeds were found to contain 30.44 per cent of oil and 6.30 per cent of moisture The expressed oil was a brilliant yellow liquid, which remained fluid even when cooled and held for some hours at 10° C. It has a mild but pleasant characteristic dried-fig taste. The chemical and physical characteristics of the oil are given in Table I.

TABLE I—CHEMICAL AND PHYSICAL CHARACTERISTICS

Refractive index at 25°	1.4775
Iodine number (Hanus)	169.4
Thiocyanogen value	108.4
Saponification value	190.1
Acid value	0.87
Acetyl value (André-Cook)	6.1
Unsaponifiable matter, %	1.07
Saturated acids (corrected), %	8.46
Unsaturated acids (corrected), %	85.66

The iodine number indicates that the oil belongs to the drying-oil class.

Unsaturated Acids

The percentages of oleic, linoleic and linolenic acids in the oil were calculated in the customary manner, using the iodine number and the thiocyanogen value. The results are given in Table II.

TABLE II

	Unsaturated Acids, Per Cent	Acids in Oil, Per Cent
Oleic acid	22.17	18.99
Linoleic acid	39.36	33.72
Linolenic acid	38.47	32.95
	100.00	85.66

Saturated Acids

The saturated acids, which were separated from the saponified oil by the lead-salt ether method, were esterified with anhydrous ethyl alcohol in the presence of dry hydrogen chloride gas (J. Amer. Chem. Soc. 42, p. 1200, 1920). The esters, amounting to 40.00 grams, were freed from solvent and moisture, and fractionally distilled under a pressure of 3 mm. from a Ladenburg fractionation flask. Four fractions were collected and weighed. The composition of each fraction was determined by the method previously described (J. Amer. Chem. Soc. 46, p. 775, 1924). The results calculated from the analytical data are given in Table III.

TABLE III

	Saturated Oils, Per Cent	Acids in Oil, Per Cent
Palmitic acid	61.84	5.23
Stearic acid	25.71	2.18
Arachidic acid	12.45	1.05
	100.00	8.46

The acids were recovered from the ester fractions and the small undistilled residue by saponifying with alcoholic potash and then decomposing the soaps with hydrochloric acid. The acids in each case were collected and completely separated from the potassium chloride and any hydrochloric acid by remelting with hot distilled water in the usual manner. The dried acids obtained from the four ester fractions and the undistilled residue were subjected to fractional crystallization from ethyl alcohol. No myristic acid could be detected, nor was any indicated by the mean molecular weight of the saturated acids in the first ester fraction. Part of the arachidic acid was found in the acids from fraction four and the remainder in the undistilled ester residue. Repeated crystallization of this acid failed to yield a fraction with a melting point above 77°, indicating the absence of lignoceric acid.

The acids which were isolated in each case confirmed the deductions previously made from the mean molecular weights of the saturated acid esters.

The composition of the oil in terms of glycerides is given in Table IV.

TABLE IV—PERCENTAGES OF FATTY ACIDS IN OIL AS GLYCERIDES

Glycerides of—	Per Cent
Oleic acid	19.8
Linoleic acid	35.1
Linolenic acid	34.2
Palmitic acid	5.5
Stearic acid	2.3
Arachidic acid	1.1

The oil could be used for either edible or technical purposes.