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GOAT'S MILK FOR INFANT FEEDING.

W. H. JORDAN AND G. A. SMITH.

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* Connected with Grape Culture Investigations.

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GOAT'S MILK FOR INFANT FEEDING.

W. H. JORDAN AND G. A. SMITH.

SUMMARY.

1. During the years 1910–1912, inclusive, a herd of milch goats was kept at the Station. The number of animals of which complete records were kept varied from 10 to 26.

2. In the year 1912, 31 adult and 9 partially grown animals were fed. The quantity of food consumed was as follows:

Dry, coarse food	37,740	lbs.
Beets	1,550	"
Cut grass	24,000	"
Pasture	132	days
Grain	14,688	lbs.

3. The total cost of this food, at the prices then ruling, was $441.95. The average cost per month per goat varied from $0.481 to $0.992. The average cost of food per goat per year was $11.05, making the daily cost $0.03.

4. The yearly production of milk, including some animals in the first period of lactation, varied from 301.7 pounds to 1,845.2 pounds. The average yearly yield for 10 animals of which records were kept during 3 years, including 28 lactation periods, was 800.4 pounds.

5. The food cost of the milk per goat for all the goats during the year 1912 was 4 cents per quart and for the three years during which the record was kept 3.4 cents. The lowest cost was with the Saanen goat, No. 11, for the year 1911, which was estimated to be 1.27 cents per quart. The other items of cost, such as care and overhead charges, it is not possible to give with any accuracy. The average food cost for a quart of milk from the Station herd of 25 Jerseys during the three years has been found to be .92 cent per quart.

6. The range of composition of the mixed milk of the whole flock as determined during May and June of the year 1912 was as follows: Solids, 11.4 per ct. to 11.9 per ct.; solids not fat, 7.72 per ct. to 8.61 per ct.; fat, 3.5 per ct. to 3.8 per ct.

The composition of milk from individual goats was found to vary in total solids from 9.22 per ct. to 18.55 per ct.; in protein, from 2.24 per ct. to 4.96 per ct.; in casein, from 1.56 per ct. to 4.6 per ct.; in fat, from 1.08 per ct. to 8.4 per ct.; and in ash, from 0.43 per ct. to 0.8 per ct.

7. A chemical study of the goat's milk indicated no essential difference between the constitution of its casein and that of cow's milk. Marked and probably important differences were observed in the salts of the ash as compared with the ash of both cow's milk and human milk.

8. Extensive study of the use of goat's milk in infant feeding by Doctors Sherman and Lohnes, of Buffalo, showed that the curds of goat's milk when returned from the stomach were smaller and more flocculent than those of cow's milk. From the determination of the combined hydrochloric acid in the returned food, the authors conclude that the cow's milk had a greater stimulating effect on the stomach than goat's milk. The absorption of the food and gain in weight in comparing the two milks were indefinite for several reasons. The babies tolerated equally well similar amounts of goat's milk and cow's milk when used with the same diluents. The younger the child, the more the evidence pointed toward a greater gain on goat's milk.

9. Goat's milk was supplied to 18 cases of children that were not thriving on any other food that had been tried. In 17 cases a satisfactory state of nutrition was established through the use of goat's milk, the beneficial results in some instances being very marked. With certain of these children their situation was regarded as serious, and their restoration to a satisfactory nutritional condition was good evidence that goat's milk is often a very desirable resort for infant feeding.

[The Station herd of goats has been sold, so no milk is now available for any purpose.]

EXPERIMENTAL ANIMALS.

The value and use of the milch goat have received considerable attention during the past few years. Very few data seem to have been available concerning this animal. In view of this fact, the Board of Control of this institution, some eight or ten years ago, authorized the purchase and importation of not over six high-grade Swiss goats, of either the Saanen or Toggenberg breed. A quarantine, established because of outbreaks of foot-and-mouth disease on the Continent and in England, prevented carrying out this plan. Some two or three years later Mr. H. S. Greims, of New York City, offered to present to the Experiment Station a flock of goats then in his possession. The offer was accepted, and Mr. Greims very generously shipped the animals to the Station, with considerable apparatus, without charge to the institution. We understand that the flock was purchased from a Mr. Riddle, of New Jersey. As the venture had not proved entirely satisfactory to Mr. Greims, due to the loss of some of his best does and because of his difficulty in having them cared for and their records kept as he desired, he concluded to abandon the enterprise.

The flock included some very good animals, one full blood Saanen and several full blood Toggenbergs, but many of the other animals were of inferior value and of no especial breeding. Some of these were promptly discarded. The better animals were kept, and an attempt was made during several years to ascertain the amount of food consumed and the quantity and composition of the milk produced.

When the goats reached us on February 25, 1910, they were in poor condition. Several were very thin in flesh and did not respond to feed and care. No food combination that we could offer appealed to their appetites. A veterinarian who was called in for advice suggested no treatment that was of benefit. The affected animals gradually grew weaker and died. Finally two of the dead goats were sent to Dr. V. A. Moore, Dean of the State Veterinary College, Ithaca, N. Y. After a careful study of the case, the disease was pronounced to be Takosis. This disease had been studied by the Department of Animal Industry, at Washington, and a bulletin published by that Department (No. 45) gives a very complete history of several outbreaks of the trouble. Our experience agreed

with the facts as brought out in that bulletin. By placing the animals in a light, well ventilated stable, with sanitary surroundings, we were able gradually to get rid of the disease, and after 1911 did not have any more cases and have seen no signs of the trouble since.

There were received by us forty-nine goats, old and young, with two males, but owing to the conditions described we were not able to secure very many data in 1910. Only nine does were in condition to give milk that year. In 1911 conditions were much improved, as only two cases of Takosis developed, both in the spring. Early in 1912 all the animals were apparently normal, and of the twenty-eight old enough to breed twenty-three goats gave milk.

Cost of maintenance.— There were kept at the Station during the year beginning January 15, 1912, and ending January 14, 1913, twenty–eight adult females, three males, and nine kids that were dropped in 1911. It was not practicable with the number of goats that were kept together, and because of their uncontrollable, wasteful habit of eating, to keep a separate account of the amount of food consumed by individual animals. The whole amount for one day's feed was weighed and given the herd in two feeds, night and morning. As nearly as could be ascertained there was very little difference in the individual consumption of coarse food. About one pound of grain was fed daily to each animal. The food charged to the goats during one year was as follows:

TABLE I.— AMOUNT AND COST OF FEED FOR MILCH GOATS.

(Adult males, 3; adult females, 28; kids, 9.)

FOR YEAR 1912.

	Days fed.	Amount used.	Cost per 100 lbs.	Total cost.
		Lbs.		
Grain	365	14,688	$1.45	$212.96
Bean pods	199	18,180	.35	63.63
Beets, mangel	46	1,550	.20	3.11
Hay, mixed	273	19,560	.50	97.80
Grass	122	24,300	.15	36.45
Pasture	132	.....	.....	28.00
Total	.....	.....	.....	$441.95

COST OF FEED BY MONTHS.

1912		Average per goat
January 17 days	$19.25	.481
February 29 "	32.64	.816
March 31 "	34.93	.873
April 30 "	36.14	.904
May 31 "	33.68	.842
June 30 "	31.64	.791
July 31 "	38.30	.957
August 31 "	36.95	.924
September 30 "	39.42	.985
October 31 "	39.70	.992
November 30 "	38.62	.965
December 31 "	39.70	.992
January, 1913, 14 days	20.98	.524

Yield of milk.— For three years an accurate record was kept of the individual milk production of the animals we retained, together with certain animals that were bred after the goats were received. The record of total yearly yields follows:

TABLE II.— MILK YIELD OF MILCH GOATS.

	MILK YIELD.		
	1910	1911	1912
	Lbs.	*Lbs.*	*Lbs.*
No. 5. Full blood Schwartzenberg	678.3	913.3	600.7
No. 6. " " Short Haired Toggenberg	778.4	1,455.7	377.1
No. 7. " " " " "	186.5	763.5	870.7
No. 8. " " " " "	1,189.	838.3	*
No. 9. " " Long " "	210.3	1,167.1	705.5
No. 10. " " Short " "	†	1,361.4	869.2
No. 11. " " Saanen	1,028.5	1,845.2	1,391.1
No. 12. " " Schwartzenberg	120.5	613.	424.
No. 15. Toggenberg-Angora	496.5	801.3	725.5
No. 16. " "	457.	889.4	655.9
No. 17. " "	.....	211.	63.9
1910 kid of No. 5	.....	846.	861.
Toggenberg-American	.....	406.5	472.
1911 kid of No. 5	.....	.....	741.2
1911 kid of No. 5's 1910 kid	.....	.....	‡
1911 " " " 6	.....	.....	428.1
1911 " " " 10	.....	.....	528.1
1911 " " " 12	.....	.....	583.2
1911 " " " 16	.....	.....	336.8
Schwartzenberg-Toggenberg	.....	.....	409.9
Toggenberg-Saanen	.....	.....	439.1
" "	.....	.....	413.7
" American	.....	.....	489.6
" "	.....	.....	518.8
Saanen-Angora	.....	.....	301.7

* Would not breed. † Did not breed. ‡ No milk.

It is to be noted that during 1911, the production of four of these animals, Nos. 6, 9, 10 and 11, was very satisfactory. With only one animal did this standard of production continue during 1912, namely, No. 11. This pure bred Saanen appears to have been a somewhat unusual animal, as her milk yield in 1911 was 1845.2 pounds. During 1911 and 1912 several of the animals gave from 700 to 900 pounds of milk, which is perhaps as good a yield as may be expected, excepting from animals considerably above the average. It should be noted that the period of lactation is considerably shorter than with cows, continuing from 250 to 300 days with most of the does.

The cost of food and milk.— The average cost of food per goat for the year was $11.05, making the cost per day three cents. If it was possible to get any number of goats together like No. 11, the Saanen, the keeping of goats would be a profitable proposition for a family supply. On the basis of a food cost of eleven dollars a year, her milk, during the year of best production, would cost 1.27 cents a quart, the average for the three years being 1.65 cents a quart. The best Toggenberg one year produced milk for 1.62 cents a quart, but her average for the three years was 2.70 cents a quart. The average food cost of the milk, for 1912, of all the goats was 4 cents a quart, and the average cost for the three years was 3.4 cents a quart. The average fat content of the milk was 3.71 per ct., of total solids 11.76 per ct. The average food cost of a quart of milk with the Station herd of 25 Jerseys during the past three years has been .92 cent per quart; the average fat content 5.9 per ct., and total solids 15.20 per ct. This shows the cows to be cheaper producers of milk and milk solids than the goats under the conditions prevailing at this Station.

Composition of the mixed milk.— During May and June of the year 1912 the mixed milk of the herd was analyzed daily. This was done by the use of the lactometer and the Babcock test. Comparison of this method with the gravimetric method showed it to have the necessary accuracy. The results follow:

COMPOSITION OF MIXED MILK OF GOATS.

	Lactometer.	Fat.	Solids not fat.	Total solids.
		Per ct.	*Per ct.*	*Per ct.*
May 1	31.0	4.3	8.61	12.91
2	30.5	4.4	8.50	12.90
3	29.6	4.4	8.28	12.68
4	29.5	4.0	8.17	12.17
5	30.0	4.0	8.30	12.30
6	29.5	3.9	8.15	12.05
7	29.5	3.8	8.13	11.93
8	29.5	3.8	8.13	11.93
9	29.0	4.0	8.05	12.05
10	29.0	3.8	8.01	11.81
11	29.5	3.7	8.11	11.81
12	28.5	3.6	7.84	11.44
13	28.5	3.8	7.86	11.66
14	29.2	3.8	8.06	11.86
15	29.5	3.8	8.13	11.93
16	29.0	3.9	8.03	11.93
17	29.0	3.9	8.03	11.93
18	29.0	3.8	8.01	11.81
19	28.5	3.7	7.86	11.56
20	29.0	3.9	8.03	11.93
21	29.0	3.8	8.01	11.81
22	29.0	3.8	8.01	11.81
23	28.5	3.6	7.84	11.44
24	28.5	3.7	7.86	11.56
25	28.8	3.6	7.92	11.52
26	28.0	3.6	7.72	11.32
27	29.0	3.7	7.99	11.69
28	28.5	3.9	7.90	11.80
29	28.5	3.6	7.84	11.44
30	29.0	3.7	7.99	11.69
31	29.5	3.8	8.13	11.93
June 1	29.5	3.8	8.13	11.93
2	29.0	3.5	7.95	11.45
3	29.0	3.6	7.97	11.57
4	28.5	3.6	7.84	11.44
5	29.5	3.7	8.11	11.81
6	29.5	3.4	8.05	11.45
7	29.6	3.4	8.08	11.48
8	30.0	3.6	8.22	11.82
9	30.0	3.5	8.20	11.70
10	30.0	3.4	8.18	11.58
11	29.5	3.5	8.07	11.57
12	30.3	3.3	8.23	11.53
13	30.0	3.2	8.14	11.34
14	30.2	3.4	8.23	11.63
15	30.0	3.6	8.22	11.82
16	30.0	3.5	8.20	11.70
17	29.2	3.4	7.98	11.38

Examination of these figures shows that the percentage of fat in the mixed milk varied from 3.2 per ct. to 4.4 per ct. As a rule, the fat percentage ranged between 3.5 per ct. and 3.8 per ct. The solids-not-fat ranged from 7.72 per ct. to 8.61 per ct., the general range being between 7.8 per ct. and 8.2 per ct. The total solids ranged in general between 11.4 per ct. and 11.9 per ct. Analyses of the milk from individual animals showed much greater variation. This is illustrated by the figures which follow:

TABLE III.—ANALYSES OF MILK FROM INDIVIDUAL GOATS.

NUMBER OF GOAT.	Date of milking.	Specific gravity.	Fat.	Total solids.	Proteins.	Casein.	Ash.
			Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
5	Aug. 2	1.0269	3.7	11.43	2.87	2.10	0.51
5	Aug. 4	1.0269	4.0	11.93	2.86	2.08	0.44
5	Aug. 9	1.0264	3.7	11.47	2.88	2.13	0.49
6	Aug. 2	1.0280	2.5	10.18	2.55	1.90	0.52
6	Aug. 4	1.0278	2.5	9.91	2.24	1.56	0.44
6	Aug. 9	1.0286	2.7	10.49	2.48	1.64	0.48
7	Aug. 2	1.0278	3.8	11.42	2.58	1.95	0.56
7	Aug. 4	1.0286	3.8	11.54	2.58	1.83	0.51
7	Aug. 9	1.0280	3.9	11.80	2.57	1.71	0.57
8	Aug. 2	1.0287	3.0	10.56	2.54	1.78	0.57
8	Aug. 4	1.0282	2.6	10.23	2.37	1.56	0.50
8	Aug. 9	1.0286	3.0	10.73	2.48	1.66	0.49
9	Aug. 2	1.0294	3.4	11.53	3.03	2.12	0.57
9	Aug. 4	1.0295	3.1	11.08	2.78	2.00	0.54
9	Aug. 9	1.0298	3.4	11.11	2.77	1.83	0.51
11	Aug. 2	1.0274	2.4	9.61	2.50	1.86	0.45
11	Aug. 4	1.0266	2.2	9.22	2.27	1.56	0.51
11	Aug. 9	1.0275	2.4	9.66	2.34	1.59	0.43
12	Aug. 2	1.0354	3.6	13.73	4.74	3.78	0.65
12	Aug. 4	1.0359	3.8	14.51	5.21	3.82	0.56
12	Aug. 9	1.0322	5.6	15.18	4.15	3.26	0.53
15	Aug. 2	1.0294	2.2	10.29	3.08	2.32	0.50
15	Aug. 4	1.0300	1.8	9.90	2.98	2.26	0.52
15	Aug. 9	1.0287	3.0	10.23	2.88	2.13	0.53
16	Aug. 2	1.0293	2.8	11.18	3.26	2.64	0.55
16	Aug. 4	1.0294	2.8	10.95	3.30	2.54	0.40
16	Aug. 9	1.0303	3.4	11.79	3.33	2.48	0.61
20	Aug. 2	1.0314	7.8	17.63	4.96	4.06	0.76
20	Aug. 4	1.0336	6.0	16.17	4.95	4.02	0.73
20	Aug. 9	1.0303	8.4	18.55	4.83	3.85	0.80
23	Aug. 2	1.0300	6.3	15.47	3.83	3.14	0.70
23	Aug. 4	1.0296	6.0	15.23	3.70	2.90	0.59
23	Aug. 9	1.0310	6.5	16.13	3.94	3.07	0.68
General average.	.....	1.0294	3.82	12.12	3.21	2.40	0.55

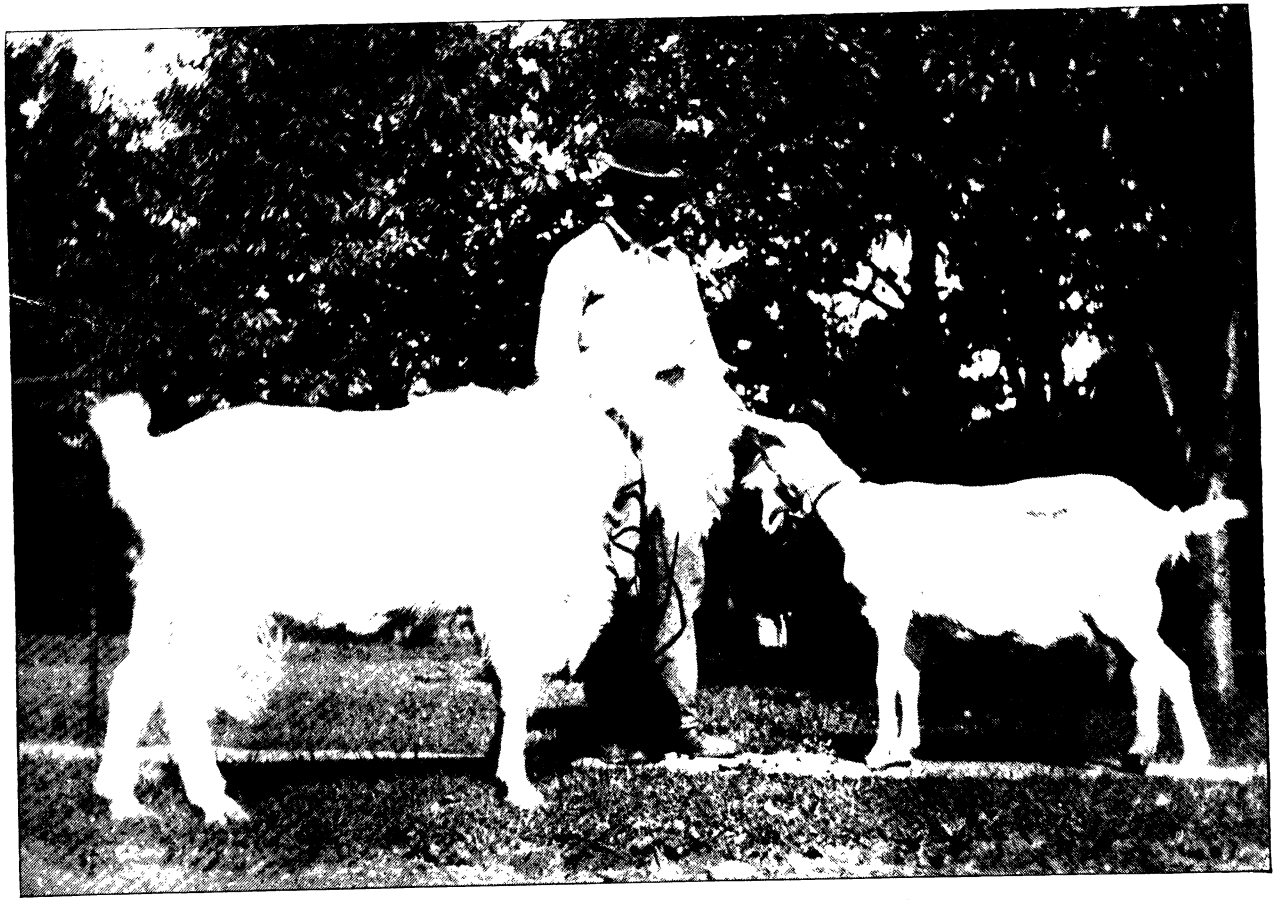

PLATE I.— TYPICAL BUCK AND DOE OF SAANEN MILCH GOAT.

Doe is No. 11 of Station; buck property of C. L. Nichols, Lockport, N. Y., to whose courtesy Station owes photograph from which

PLATE II.— MILKING A GOAT.

Milking should be done out doors or in room separated from stable, to avoid unpleasant odor in milk.

The data indicate a wide variation in composition. Animals Nos. 20 and 23 were well along in lactation.

A chemical study of goat's milk.— In 1915, Mr. A. W. Bosworth, at that time Associate Chemist at this institution, and L. L. Van Slyke, Chemist, made a somewhat elaborate chemical study of goat's milk in comparison with cow's milk and human milk. The results of this investigation may be seen in Technical Bulletin No. 46, issued by the Station in December, 1915, entitled " The Casein and Salts in Goat's Milk." It is not desirable to reproduce the text of that bulletin in this connection, but a few of the most important conclusions are here reviewed:

1. So far as could be judged from its combinations with bases, the casein of goat's milk does not differ essentially from that prepared from cow's milk.

2. Both goat's milk and cow's milk contain much larger percentages of solids than is the case with human milk.

3. Goat's milk contains practically the same amount of calcium phosphates as cow's milk, excepting that in goat's milk a certain proportion is in the tri-calcium form which is not true of cow's milk. In this respect both differ from human milk which appears to contain no calcium phosphates.

4. Cow's milk and goat's milk contain a much larger proportion of the magnesium phosphates than does human milk.

5. The proportion of mono-potassium phosphate was found to be practically the same in goat's milk and human milk. Cow's milk was found to contain di-potassium phosphate of which goat's milk and human milk were found to contain none.

6. The proportion of potassium citrate was found to be much larger in goat's milk than in either cow's milk or human milk; on the other hand, cow's milk was found to contain considerable sodium citrate, of which goat's milk contains none and human milk only a small proportion.

7. Goat's milk was found to contain both sodium and potassium chlorides, of which cow's milk and human milk contained none.

8. Calcium chloride was found in about equal proportion in cow's milk and goat's milk, being about twice as large in both cases as found in human milk.

As will be seen later, these differences in the composition of the three milks studied do not at present furnish an explanation of the

reason why goat's milk appears to have been better adapted in many instances to infant feeding than cow's milk.

GOAT'S MILK AS FOOD FOR INFANTS AND VERY YOUNG CHILDREN.

Experience seems to have indicated that goat's milk has a peculiar adaptability to feeding infants and young children in cases where they must be given artificial food and neither modified cow's milk nor the proprietary infant foods are fed with success. Because of this fact, it was determined to make a somewhat exhaustive study of the applicability of goat's milk to infant feeding.

An effort was made to get data in two ways: (1) By a somewhat extensive series of observations carried on in cooperation with Doctors DeWitt H. Sherman and Harry R. Lohnes, of Buffalo; and (2) by supplying goat's milk for use with infants in those cases where other foods had been found inapplicable. The physicians mentioned carried on their study in the Saint Mary's Infant Asylum and Maternity Hospital, in Buffalo, to which institution practically 16 quarts of goat's milk was shipped daily in an iced container. This milk was drawn under the best of conditions and was found to be in good condition at the time of arriving at the hospital.

The results of this work have been published in the *Journal of the American Medical Association.*[1] The text of the report is here reproduced:

PRACTICAL STUDY OF GOAT'S MILK IN INFANT FEEDING AS COMPARED TO COW'S MILK.

DE WITT H. SHERMAN, M. D., AND HARRY R. LOHNES, M. D.
Buffalo, N. Y.

This study was made to learn, if possible, the reason why goat's milk agrees better with some infants than cow's milk.

The babies were selected at random from the inmates of St. Mary's Infant Asylum and Maternity Hospital.

The goat's milk averaged from .5 per ct. to 1.50 per ct. richer in fats than the cow's milk used in this institution. Nevertheless, in making our modifications of the two milks the same amount of either milk was used in the stock formulae. Consequently the caloric value of the goat's milk modifications were greater than of the cow's milk.

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[1] *Jl. Amer. Med. Assn.* **62**:806, 807. 1914.

I will present our data under different headings, for example:

I. *Results of Gastric Analyses.*

All test meals were withdrawn one hour from the middle of the feeding. The *amount recovered* averaged, in fourteen cases, nearly twice as much of cow's milk formulae as goat's milk, the accurate ratio being 41 c.c. to 27 c.c. This points to the lower digestion of cow's milk.

The curds of the goat's milk formulae were smaller and more flocculent, corresponding to the appearance in test tube digestion.

The analyses in fifteen cases showed in goat's milk an average of:

Free hydrochloric acid	Once
Combined hydrochloric acid	22.00
Acid salts	5.53
Total acidity	28.4

The analyses in fourteen cases, the same infants, on *cow's milk* gave an average of:

Free hydrochloric acid	None
Combined hydrochloric acid	28.20
Acid salts	5.30
Total acidity	33.50

In a previous paper on "Gastric Analyses in Infants" we calculated the average gastric analysis on (a) barley water and (b) proprietary foods containing some proteids, fat, sugar and carbohydrates but no milk. For convenience of comparison we give below a table showing the averages of these and also of modified goat's and cow's milk, as shown above:

	Free hydrochloric acid.	Combined hydrochloric acid.	Acid salts.	Total acidity.
I. Barley water	2.10	5.60	.....	9.00
II. Proprietary foods containing some proteids, fat, sugar and carbohydrates, but no milk	0.	10.50	.....	17.40
III. Goat's milk with rice water and 2 per ct. cane sugar solution	0.	22.00	5.53	28.40
IV. Cow's milk with similar and other modifications	0.	28.20	5.30	33.50

This table indicates the greater stimulating effect on the stomach of cow's milk than goat's milk; the greater stimulating effect of both than of the proprietary foods made without milk; and finally the greater stimulating effect of all three than of barley water.

In some vomiting cases this table gives definite information as to the causal factor of this condition in these four kinds of foods — (a) through direct gastric stimulation, and (b) because of the size and density of curds, and (c) because of slower digestion.

As regards *absorption* and *gain* in weight our statistics are indefinite for three reasons. First, the babies being institution babies were apt to gain slowly: Second, owing to an epidemic of streptococcus infection which had swept through the infant's ward causing gastro-intestinal disturbances so serious that about one-fifth of the babies died, the digestion of those who did recover was more or less impaired; and third, because a certain number who were doing well were removed from the institution through adoption before our experiments were finished.

Of the number tested, sixteen cases in all, on similar formulae, twelve gained more rapidly on cow's milk modifications, and four on goat's milk. The gain of the former group was in the ratio of three to one. The gain of the latter group was in the ratio of nine to one. Consequently those who did gain on goat's milk gained more rapidly than on cow's milk, but fewer gained on goat's milk.

In *infantile atrophy and inanition*, three cases, goat's milk was no more suitable than any other food.

Taste of goat's milk.—At first the babies did not finish all their bottles, not liking the flavor of the food as well as of cow's milk. This surprised us because there seemed to us to be no unusual taste, as is usually supposed to be the case. If the milk is clean, we think the strong taste so common in Switzerland is unnecessary, and believe that the taste, as well as odor, is due to lack of udder cleanliness or possibly the type or food of the goat. But taken from three sources in this state — Geneva, East Aurora, and Buffalo — we have never found the strong taste or odor commonly supposed to be characteristic of goat's milk.

Fats.—In goat's milk the fat averaged from .5 per ct. to 1.50 per ct. higher than in cow's milk. The more thorough emulsification of the fat in goat's milk, possibly the finer fat globules, prevents the separation of the cream upon standing, as occurs in cow's milk. This fact may be an element in reducing the tendency to regurgitation in goat's milk as compared to cow's milk, and further, may be a very important factor in lessening the liability to sour vomiting due to fatty acid fermentation, so common in high fat mixtures of cow's milk.

Strength of formulae.—The babies, as a whole, tolerated equally well similar amounts of goat's or cow's milk with the same diluents, but as the goat's milk contained higher fat than cow's milk, they actually received more fat per feeding, and hence higher caloric value. It is consequently strange, that more babies gained, as stated above, on cow's milk than on goat's milk modifications.

In our formulae fat rarely averaged over $2\frac{1}{4}$ per ct. in goat's milk, and a little less than 2 per ct. in cow's milk.

Stools.—On goat's milk the stools were as a rule smaller and of a more vivid yellow color.

Age.—Age did not influence materially the ratio of gain on goat's versus cow's milk, but the younger the baby, the more the evidence pointed toward a greater gain on goat's milk.

Vomiting.—Of twenty-four children receiving both goat's and cow's milk formulae, five vomited goat's milk some, and none cow's milk. The explanation may be the slightly lower fat percentage in the cow's milk formulae. On the other hand, in certain cases goat's milk is often tolerated in similar amounts due to the fact that there is less gastric stimulation, that is, smaller, lighter curds.

After getting accustomed to goat's milk more children seemed hungry, and cried more at night than when taking cow's milk.

Type of modification commonest used was similar amounts of goats milk or cow's milk diluted with rice water and 2 per ct. cane sugar.

We are very much indebted to Doctor W. H. Jordan, director of the New York State Agricultural Experiment Station, for sending us for six weeks sixteen quarts a day of goat's milk in the best of condition. We are also indebted to Sister Frances and Sister Clare at St. Mary's Infant Asylum and Maternity Hospital for their assistance and cooperation in our work.

Practical results with individual children.— During several years the Station gave goat's milk without charge to all applicants, so far as the supply would permit, where it was desired to try this milk with infants or young children who were not thriving on any other kind of food. The only condition imposed was that reports should be made to the Experiment Station of the results of the experimental feeding. There follows the testimony of parents as to the outcome of the feeding and in a few instances the notes of attending physicians. It will be observed that this testimony is largely from parents, the professional judgment of physicians not being available in many of these cases. It is fair to conclude, however, that evidence so marked, even if given on an unprofessional basis, is not to be disregarded.

No. 1.— Mrs.———

I cannot thank you enough for the milk we are getting. Our baby has improved wonderfully on it. He has gained two pounds in the three weeks we have been using it. We tried everything we could find for him but nothing would agree with him until we got the goat's milk.

No. 2.— Mr.———

This milk has done more for our babe than any food we have used, as yet. Thanks to you for your kindness, I will report again at week end or according to your orders.

No. 3.— Mrs.———

I will give you as nearly as possible the results we had with the goat's milk. The baby had been troubled with constipation and with vomiting, showing large undigested curds. We started on the goat's milk, diluting it about one-fourth with water. She took to it kindly and conditions greatly improved. A little later I added between one and two tablespoons of cream to the goat's milk and that seemed to satisfy her better and still agreed with her. As warm weather come on, she turned against it, and I could not get her to take it any longer.

No. 4.— Mrs.———

We certainly appreciate your kindness in furnishing the milk and as you were interested in the results, I am delighted to say that our baby has gained in one month three and one-half pounds in weight, which is quite remarkable for her as for months her weight was the same, and she could not take the cow's milk.

No. 5.—

We began April 1st when the baby was 11½ months old feeding goat's milk as a supplement to mother's milk, giving 20 to 25 ounces a day. Prior to this time — was a healthy, breast-fed baby, normal, except that she was troubled with constipation. Weight 23 pounds April 28 and 23½ May 12th. During April and May she was perfectly well, except for being constipated, which condition grew worse. Toward the middle of June she became peevish and was apparently losing flesh. About June 25th, after the mother's milk was found by analysis to be deficient in fat, the child was placed on a diet of goat's milk, supplemented by a small portion of coddled egg, potato, etc. This change immediately relieved the constipation, which has given no further trouble. During July the baby was not very well, due perhaps to the cutting of several teeth. But from August on until October 1st she gradually gained in weight. October 4th the goat milk was replaced with cow's milk, but only for about six days, for she became quite sick, due perhaps to teething. Weight Nov. 10th, the end of the test, 25½ pounds. During this experience the milk has always digested easily. She has been a little slow about walking and teething as compared with other youngsters.

No. 6.— Mr.———

The child was six months old, weighed eight pounds, and in a very scrawny condition. Had not retained anything on its stomach to speak of for several days. The first feeding of goat's milk the child retained without the milk being adulterated, and it slept for ten hours, a thing the child had not done for weeks. For the 16 weeks the child was fed goat's milk, it averaged five-eighths of a pound per week gain. The child only gained three-eighths of a pound the first three weeks, which we considered very good for the condition she was in when we started. Since the child has been taken from goat's milk, it has had pure Holstein and is fat and perfectly healthy. She is now 21 months old and weighs 33½ pounds, is strong on her legs and has good teeth.

No. 7.— Dr.——— (Physician attending No. 6)

With reference to the use of goat's milk in the case of [No. 6], I would like to say that at the time this feeding was undertaken she showed marked signs of malnutrition and although various formulas had been tried she had gained scarcely anything over her birth weight when she was six months old. The goat's milk was used with my consent, not at my suggestion because I was not familiar with the possibility of obtaining a constant supply of this product. There are no doubt certain classes of cases in which goat's milk is a very suitable food for infants. This was one of those cases.

No. 8.— Mr.———

I am pleased to say that goat's milk has done wonders for my little girl. She was sick about five months and was nothing but skin and bones and could not keep anything on her stomach until we tried goat's milk. That seemed to agree with her and she began to pick up as soon as she began taking it. She is three years old in February, and is fatter than she ever was. I am thankful to you for the goat's milk.

No. 9.— Mrs.———

I began feeding my baby goat's milk from the Experiment Station about September 1, 1913, she being just then past three months old. I acted on the advice of Dr. ..... of this city and consulted with him as to the preparation of the milk. In the first month the baby had the milk only as supplementary feeding and a very small amount at a time, from 1 to 2 ounces per feeding. There was no disturbance whatever of the digestive tracts from the mixed feedings. Stools were normal and free from curd. After expiration of first month breast milk decreased and amount of goat's milk was considerably increased, still however only used as supplementary feeding. By end of third month of feeding, that is by time infant was six months old, she was entirely weaned from breast. She had been all the time well, had no flatulence, and gained fairly regularly, but at no time rapidly, one-fourth pound per week being her average gain. For another month she remained on the goat's milk and from that time on she developed a very constipated condition which I attributed to deficiency in fats in the goat's milk. As the condition persisted, I decided to change to cow's milk (Holstein special at first, later a richer milk). She made the change without disturbance and is now at nine months in excellent condition and making normal gain. I have had a much easier time with her feeding than with that of my other bottle-fed babies who were fed cow's milk at about the same age.

No. 10.— Mr.———

It is a very great pleasure for me to tell you that the goat's milk which you furnished us for the past three weeks has worked wonders. Previous to when I talked with you, the baby had been under the care of two physicians with no apparent relief for several weeks. Since feeding goat's milk we have had no occasion to call a physician or give any medicine. The baby has gained in weight and his general condition is greatly improved.

No. 11.— (Further report on No. 10).

In summing up our report in the use of goat's milk which you furnished us, will say that when we first used the milk the baby was about five months old, when born it weighed 9½ lbs., gained while its mother nursed it to 12, and then when we put it on cow's milk it gradually went back to 9 lbs. At five months was very weak, threw up everything, worried continuously and had been under the care of two physicians (at different times) for two months and was completely at a standstill. We noted an improvement in his condition after the very first feeding of goat's milk and have never had a setback yet. He has never had any medicine since first using it and now weighs 16 lbs. at eight months.

No. 12.— (From attending physician)

I am sorry to report that the goat's milk did not agree much better with my little patient than cow's milk. He is a child 20 months old, who does not seem able to absorb anything. Taking 9 ounces a day of goat's milk was all he could care for without developing signs and symptoms of fat poisoning. Of cow's milk he could generally take 8 ounces a day, but sometimes even that amount seemed to poison markedly. I gave him for a time breast milk. Of that he could take 16 ounces a day, but was not poisoned even though fat appeared in his stools and the odor was rancid.

No. 13.— (From attending physician)

Two months ago ——— was put on goat's milk for part feeding,— being nursed also. When put on goat's milk weighed 15 lbs.; muscles firm, fairly nourished. Took the milk well, is now in good condition and weighs 17 lbs.

No. 14.— Mr. ———

I am having Mrs. ——— keep a record of the baby's condition since beginning to take goat's milk. I had expected to write this letter at home where I could get the data to send you. However, I will send you that later but wish to say now that he has gained 4 ounces in the past week and has been happier and more easily cared for than at any time since last fall. I believe the milk is helping him. He is now about 18 months old and we are feeding him some [proprietary food], eggs and crackers and a little bacon during the day, though the amount is very small. These we were feeding him before we obtained goat's milk, as the doctor thought that a child of his age should have some such food. We have substituted goat's milk for the cow's milk we were giving him. I think that is what is being of such benefit to him.

No. 15.— (First report)

I herewith give you report on condition of my little daughter in connection with the use of goat's milk, which is as follows:

Age — 4 months 19 days
Weight at birth 8½ lbs. (Feb. 15, 1914)
Weight.....9¾ lbs. (April 26, 1914)
" .....9 lbs. (June 25, 1914)
Date started using goat's milk June 25th, weight 9 lbs.
July 3rd, " 9 lbs. 6 oz.

Net gain, 6 oz.

Upon advice of physician only used milk in proportion as shown below:
⅓ part sterilized milk
⅔ " " water
Starting July 3rd, will use as follows:
½ parts sterilized milk
½ " " water

As the proportion of milk is increased and that of the water decreased, expect that it will show a decided increase in weight.

No. 15.— (Second report)

In connection with the use of goat's milk as food for my young daughter, would advise that report for second week is as follows:

Weight on June 25th	9 lbs.
" " July 3rd	9 lbs. 6 oz.
" " " 10th	10 lbs. 6 oz.
Net gain	1 lb. 6 oz

The results thus far are very gratifying, I assure you, for we had used almost everything, and had despaired of saving her at all, until advised to procure the goat's milk. At present time we are using $\frac{2}{3}$ sterilized milk and $\frac{1}{3}$ sterilized water, and as she continues to improve will increase to full strength.

No. 15.— (Third report)

I herewith hand you statement in connection with use of goat milk for food of my young daughter, which is as follows:

Weight at start on June 25th	9 lbs.
Weight July 3rd	9 lbs. 6 oz.
" July 10th	10 lbs. 6 oz.
" July 17th	11 lbs. $2\frac{1}{4}$ oz.
Net gain	2 lbs. $2\frac{1}{4}$ oz.

Would also advise that we are using three-fourths milk now and only one-fourth sterilized water.

No. 16.— Mrs. ——— (First report, July 9, 1914)

We are very much pleased with the success of goat's milk with our baby during the month that he has been using it. He has gained ten ounces and is much happier and stronger. He is a year and a half old and only weighs thirteen pounds now. We have never been able to secure suitable food in spite of the most expert advice of noted baby specialists, so we feel that the goat's milk will prove to be a wonderful success in his case. Mr. ——— and I are very grateful to you for your kind help and interest in our behalf.

No. 16.— Mrs.——— (Second report, December 14, 1914)

I hope you will pardon my delay in sending you the results of our use of goat's milk for our baby. He was a year and a half old when we began using it in June. Up to that time nothing could be found to agree with him. He has been under the care of a famous baby specialist for weeks but with no results. He began to improve at once, gaining from four to ten ounces a week. In less than three months he had gained from a weight of twelve and a half pounds to over fifteen. At that time we found that he could handle cow's milk successfully. He has been making good progress since and has gained both in weight and strength. We feel that the use of goat's milk was of wonderful benefit to him, and we wish to thank you for your kindness in sending it.

No. 17.— Mr. ———

Last fall our baby was quite ill, and although we tried all kinds of modified milk and patented foods, we were unable to find any food which would nourish it. Finally thru your courtesy and that of Mr. ———, we tried goat's milk from the Experiment Station which was sent to us every day for several weeks. This the baby seemed to assimilate and digest perfectly, and it gave him a start from which he is still benefitting. I am taking this opportunity to express to you the appreciation of both Mrs. ——— and myself for your very great kindness in letting us have the goat's milk at that time.

No. 18.— (Report of attending physician)

In reference to the ——— child, I send you a few details. Should you wish I could send my notes, but I fear they would not be enlightening. It was 14 months old when I first saw it, weighing then about $17\frac{1}{2}$ pounds, a loss of $3\frac{1}{2}$ pounds during the past four months. It did well on a high-fat formula up to about nine months of age, and then suffered from constipation of a stubborn type. Later this turned to a diarrhoea, becoming a mild sub-acute catarrhal colitis, and presented all the usual symptoms of an intestinal indigestion, such as restlessness, pallor, languor, etc. Physical examination did not show anything grossly abnormal. The anterior fontanelle was too wide open. It had only four teeth and its muscles were very soft. Its intolerance for high fat was soon followed by a lack of tolerance of a very low fat of cow's milk. In other words, cow's milk in any form could not be given in sufficient ration in its formulae. I first gave its stomach a rest from all forms of milk, using [proprietary food]. I then started replacing gradually the [proprietary food] by the goat's milk you so generously provided. It progressed very well and was soon able to take more goat's milk in its formulae than it had ever taken cow's milk. It was also given flour ball and later some yolk of egg. Finally it was doing so well on a diet normal for its age that Mrs. ——— stopped writing to me. I do not remember seeing the baby after the first visit.