U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS.

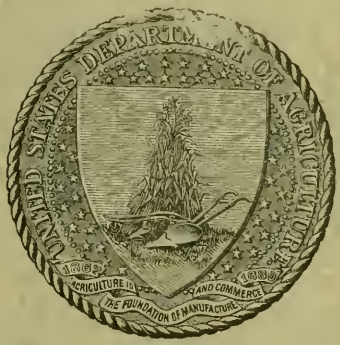
NUTRITION INVESTIGATIONS IN NEW MEXICO

IN

1897.

BY

ARTHUR GOSS, M. S.,
PROFESSOR OF CHEMISTRY, NEW MEXICO COLLEGE OF AGRICULTURE AND MECHANIC ARTS.



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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., May 15, 1898.

SIR: I have the honor to transmit herewith a report on food and dietary investigations in New Mexico, made by Arthur Goss, M. S., professor of chemistry in the New Mexico College of Agriculture and Mechanic Arts and chemist of the Agricultural Experiment Station of New Mexico. The work here reported is in continuation of that recorded in Bulletin No. 40 of this Office and consists of a study of the composition of a side of New Mexico beef and a dietary study of a poor Mexican family living near Las Cruces, N. Mex. In connection with the study of the composition of meat a considerable number of analyses were made. These investigations constitute a part of the nutrition investigations in charge of this Office. They were conducted under the immediate supervision of Prof. W. O. Atwater, special agent in charge of nutrition investigations, in accordance with instructions given by the Director of this Office. The New Mexico College and Station have cordially cooperated with the Department in this work. In the analytical work valuable assistance was rendered by A. M. Holt, M. S., assistant chemist of the station.

Professor Goss's report is respectfully submitted with the recommendation that it be published as Bulletin No. 54 of this Office.

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

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NUTRITION INVESTIGATIONS IN NEW MEXICO IN 1897.

OUTLINE OF THE WORK.

The nutrition investigations carried on by the New Mexico Experiment Station during the past year, herewith reported, include analyses of native beef and a dietary study. The larger part of the available time was devoted to the analytical study of a side of beef, taken from a steer representing as fairly as possible the average animal raised upon the New Mexico cattle ranges, for the purpose of obtaining data for a comparison of average New Mexico range beef with beef from other sections or from animals grown under different conditions.

The dietary study is a continuation of work previously reported[1] and was made with one of the families studied in the earlier investigation. The family was regarded as typical of the ordinary Mexicans of limited income, who make up the greater portion of the common laborers of New Mexico.

ANALYTICAL STUDY OF A SIDE OF NEW MEXICO RANGE BEEF.

GENERAL CONDITIONS INFLUENCING BEEF RAISING IN NEW MEXICO.

The location, climatic conditions, and surface conformation of New Mexico are such that the greater part of the Territory is pastoral rather than agricultural. From the general conditions under which cattle are raised in this Territory, marked differences in the composition of their flesh as compared with that of animals raised in other localities might be expected. A large area of the Territory is elevated table-land or mesa, varying in height from between 6,000 and 6,500 feet above sea level at the north to 4,000 feet in the south. This region is traversed by irregular and broken ranges of mountains and furrowed by rivers and streams, along which is found the only arable land.

Climate and rainfall.—The climate is exceedingly dry, so much so that meat left in the open air dries without putrefaction. The annual rainfall is very slight, the average for eight years being less than

[1] U. S. Dept. Agr., Office of Experiment Stations Bul. 40.

14½ inches. The average rainfall for Maine, Tennessee, and Texas is approximately 46, 53, and 29 inches, respectively. The rainy season, which is usually confined almost entirely to the late summer months, begins sometime between the middle of July and the middle of August and lasts only about four weeks.

To one unfamiliar with New Mexico conditions the apparently barren stretches of mesa which surround the valleys appear utterly worthless. But wherever there is sufficient water, either in streams or springs, grass is abundant, and under the influence of the summer rains plains that were apparently entirely bare will turn green and become valuable pasture land in a very short time. Even the seemingly dry barren mesa produces much valuable forage and supports large numbers of sheep and cattle throughout the entire year. The climate is such that shelter is not required.

Native grasses and forage plants.—The majority of the wild forage plants of New Mexico are grasses. They may be divided into two different groups—those which grow in the moist and alkaline soil of the valleys and those which are found on the mesa and which depend solely on the scant rainfall for their supply of moisture.

To the first group belong several rapidly growing annual grasses, among the most important being the grapevine mesquite, bunch grass (growing upon the alkali "flats" which will support little else), and salt grass. This salt grass or alkali grass forms a thick sod on the marshy alkali "flats" and "draws" which are of frequent occurrence in this western country. Provided there is sufficient water it grows well even when the alkali covers the surface of the soil with a thick white crust.

Of the second group, i. e., the mesa grasses, the most important are the gramas. Most of the species are perennial, but the "six-weeks grama" produces an abundant and valuable crop during the short rainy season.

In addition to the grasses two other plants—prickly pear and sotol—furnish an occasional supply of nourishment for the range animals. The prickly pear is a fleshy cactus, the stems of which are covered with barbed spines. Before feeding the spines are removed by burning. It is used in several regions of the West when fodder is scarce.[1]

Sotol is a plant resembling the yucca. The outer spiny leaves are cut away with a heavy knife exposing the central core of the plant, which contains no spines and which is the portion eaten by stock. Sotol contains a larger amount of nutrients than prickly pear, but neither of them is of any great value as a stock food when used alone.

With the increase in numbers on the ranges the cattle have acquired the habit of eating plants, such as prickly pear and sotol, which would ordinarily be rejected. These coarser plants are utilized when feed is

[1] In Australia and in North Africa and other Mediterranean regions this plant has been fed to a considerable extent, and is regarded very favorably. In Australia it is usually cooked by steaming.

short to tide over the cattle until the summer rains again cause the grasses to spring up. As a result range cattle are generally in very poor condition in the spring and are never very fat.

The following table gives the composition of the above-mentioned forage plants:[1]

TABLE 1.—*Composition of some of the New Mexico range grasses and forage plants.*

	Water.	Protein.	Ether extract.	Nitrogen-free extract.	Crude fiber.	Ash.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Ordinary grama grass (*Bouteloua oligostachya*)	6.1	7.4	1.7	44.1	30.3	10.5
Black grama grass (*B. eriopoda*)	4.8	5.3	1.7	45.6	32.0	10.8
Six weeks grama grass (*B. polystachya*)	4.8	9.8	1.9	42.0	30.9	10.7
Tall grama grass (*B. racemosa*)	6.4	6.3	1.8	41.3	34.8	9.4
Bunch grass (*Sporobolus airioides*)	6.4	7.0	1.8	42.5	33.5	8.9
Vine mesquite grass (*Panicum obtusum*)	4.3	8.9	2.5	45.6	30.4	8.4
Salt grass (*Distichlis spicata*)	5.5	6.6	2.0	45.7	28.6	11.6
Prickly pear (*Opuntia camanchica*)	72.7	1.1	.4	16.4	3.1	6.4
Sotol (*Dasylirion wheeleri*), head or inner portion, green	65.0	1.6	.8	22.5	8.5	1.6
Timothy hay[1] (average of 68 analyses)	13.2	5.9	2.5	45.0	29.0	4.4

[1] U. S. Dept. Agr., Office of Experiment Stations Bul. 11.

The grasses were analyzed in the air-dried condition because this is their condition on the range during the greater portion of the year. They spring up during the summer rains, and after the growing season is over they cure as they stand, making a fair quality of hay upon which the stock feed until the return of the rainy season.

On the whole, the hay from the range grasses analyzed compares very favorably with that grown in other parts of the country. It will be seen that, probably owing to the exceptionally dry climate, the New Mexico hays contain a very small proportion of water. They contain an unusually high percentage of ash, which is doubtless due to the large amount of soluble constituents, or alkali, present in New Mexico soils and in those of the arid region in general. The ash content of some of the plants grown in the arid regions is very remarkable. Samples of prickly pear analyzed at New Mexico Station have been found to contain more than 30 per cent ash in the dry matter.

METHODS OF ANALYSIS.

For the purpose of the investigation, a range steer 2½ years old, representing as nearly as possible the average animal at this time of the year (spring), was selected. After slaughtering, one side was divided into fifteen different cuts as outlined in the diagram (fig. 1, p. 10).

The methods of preparing the samples for analysis, of partial drying, and of determining the moisture and ash were the same as those commonly employed. Considerable trouble was encountered in grinding the samples. Most of them could be ground fine enough to pass a one-half millimeter sieve, but a few, like the leg, containing much tendon and similar tissue, could not be made to pass through so fine a mesh.

[1] New Mexico Experiment Station Bul. 17.

The methods of analysis were for the most part the same as ordinarily employed. In the case of the nitrogen and fat determinations slight modifications of the regular methods were made.

Fat in meat.—The fat was determined by extracting the water-free material in a Soxhlet extractor with anhydrous ether. Before beginning the analysis of the samples from the side of beef selected for investigation, a series of fat determinations were made with samples of round and sirloin steak in order to ascertain how long the extraction

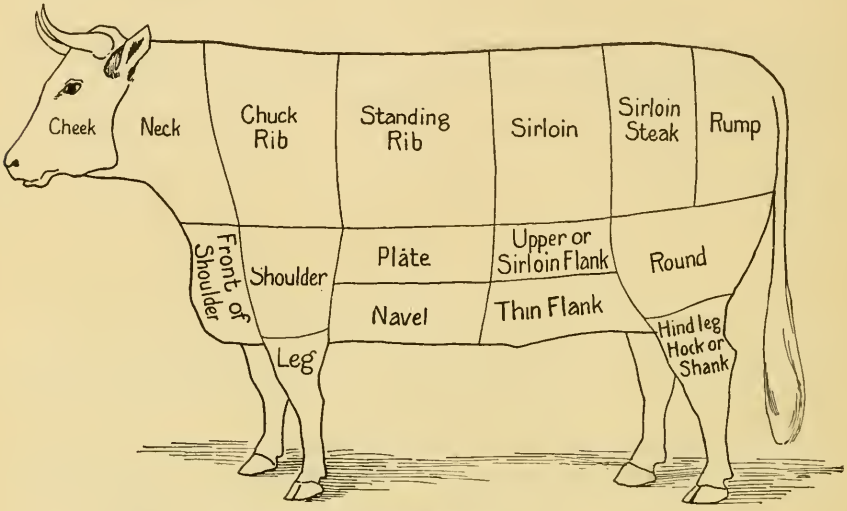

FIG. 1.—Diagram showing cuts of beef used in this investigation.

should be continued. The results of these determinations are given in the following table:

TABLE 2.—*Length of time necessary for complete extraction of fat from beef with ether.*

No. of sample.	Name of cut.	Fat removed in first 24 hours.	Fat removed in second 24 hours.	Total fat removed in 48 hours.
		Per cent.	*Per cent.*	*Per cent.*
547	Round steak:			
	First determination	7.87	0.21	8.08
	Second determination	7.91	.17	8.08
	Average	7.89	.19	8.08
546	Sirloin steak:			
	First determination	1.41	.22	1.63
	Second determination	1.55	.22	1.77
	Average	1.48	.22	1.70
548	Sirloin steak:			
	First determination	7.91	.15	8.06
	Second determination	7.55	.23	7.78
	Average	7.73	.19	7.92
	Mean of averages	5.70	.20	5.90

These results showed that it was necessary to extract with ether longer than twenty-four hours, and in all subsequent work extraction was continued for forty-eight hours, it being assumed that practically all the soluble material was removed in that time. In view, however, of the observations of Argutinsky,[1] Dormeyer,[2] Bogdanow,[3] Schulz,[4] E. Voit and Krummacher,[5] Polimanti,[6] Nerking,[7] and Frank[8] this question of the extraction of fats from animal tissue by ether demands further investigation. But there is hardly reason to assume that when the material is finely ground and extracted with anhydrous ether for forty-eight hours, the amount of fat which fails to be dissolved and extracted by the ether or the amount of material other than fat in the extract can be large.

The so-called fat, i. e., ether extract, is never absolutely pure fat. In the case of meat, in addition to very small quantities of other substances, the ether extract contains some nitrogenous material. In several cases the dried ether extract was transferred to Kjeldahl digestion flasks and the nitrogen in it determined in the usual manner. The average amount of nitrogen found, as will be seen by reference to Table 5, page 13, was 0.03 per cent. This is equivalent to 0.21 per cent of protein (using the factor 6.25). This amount should be deducted from the total ether extract and added to the protein when great accuracy is desired.

The amount of nitrogen, however, is so small that in ordinary practical work it could be safely neglected. Although care was taken to secure a clear filtrate in the fat flask, it is possible that the small amount of nitrogen came from particles of meat carried through mechanically in the two days' extraction to which the samples were submitted. It is possible that the ether extract contained small amounts of lecithin and other nitrogenous compounds which are soluble in ether.

Nitrogen in meat.—The Kjeldahl method was used for the determination of nitrogen. One gram of substance was taken for analysis. To insure accuracy, all the measuring vessels used were carefully calibrated and all the reagents were tested.

In order to determine the length of time necessary to digest the samples of meat with the sulphuric acid and mercuric oxid, samples of sirloin steak (No. 548) weighing 1 and 2 grams were digested for one-half, one, two, three, and four hours, respectively, with 30 cubic centimeters sulphuric acid and 0.7 gram mercuric oxid.

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[1] Arch. Physiol. [Pflüger], 55, p. 347.

[2] Ibid., 61, p. 341 (E. S. R., 7, p. 919); 65, p. 90.

[3] Ibid., 65, p. 81 (E. S. R., 8, p. 713); 68, pp. 408, 431 (E. S. R., 9, pp. 618, 681).

[4] Ibid., 66, p. 145 (E. S. R., 9, p. 373).

[5] Ztschr. Biol., 35 (1897), p. 555 (E. S. R., 9, p. 917).

[6] Arch. Physiol. [Pflüger], 70, p. 366 (E. S. R., 9, p. 1020).

[7] Ibid., 71, p. 427.

[8] Ztschr. Biol., 35 (1897), p. 549.

The percentages of nitrogen obtained were as follows:

Amounts of nitrogen found in meat digested different lengths of time.

	Per cent.
Samples weighing 1 gram:	
One-half hour	13.50
One hour	13.57
Two hours	13.61
Three hours	13.67
Four hours	13.65
Sample weighing 2 grams:	
One hour	13.51

These results indicate that, as Atwater and Woods have already pointed out,[1] it is necessary to digest meats somewhat longer than vegetable substances. In the comparative test reported digesting three hours was apparently sufficient, but for the sake of safety the digestion was continued for four hours in the analysis of the side of beef.

RESULTS OF ANALYSIS.

The ordinary methods, with the modifications and precautions noted above, were used in the analysis of the different cuts. The results are given in Tables 3, 4, and 5. Table 3 shows the weight of the different cuts and the percentage of waste and nutritive ingredients, together with the fuel value of each cut. The composition and fuel value of the edible portion of the different cuts are shown in Table 4. In Table 5 the results are calculated to a water-free basis. The fuel values are computed by assuming the fuel value of a pound of protein or carbohydrates to be 1,860, and that of a pound of fat to be 4,220 calories.

TABLE 3.—*Composition of side of beef from a New Mexico range steer.*

Reference No.	Portion taken for analysis.	Total weight.	Refuse (bone, skin, etc.).	Water.	Protein.	Fat.	Ash.	Fuel value per pound.
		Lbs. Oz.	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
540	Neck	12 10	75.2	18.3	6.0	0.2	0.3	120
519	Chuck rib	13 8	16.7	63.1	18.1	1.2	.9	385
526	Standing rib	31 8	31.7	52.1	14.7	.7	.8	305
525	Plate	7 0	64.3	25.5	9.5	.2	.5	185
524	Navel	2 2	2.9	66.6	28.5	.6	1.4	555
530	Shoulder	11 10	39.8	46.1	12.5	.9	.7	270
538	Leg	5 4	50.0	37.9	10.8	.8	.5	235
531	Front of shoulder	17 0	23.9	59.2	15.5	.6	.8	315
532	Average of fore quarter		37.4	47.5	13.7	.7	.7	285
522	Sirloin	12 13	28.8	49.9	19.5	.8	1.0	395
523	Sirloin steak	20 5	19.7	57.1	21.2	.9	1.1	430
528	Rump	14 0	28.6	51.4	18.5	.5	1.0	365
527	Round steak	25 0	16.0	61.5	20.5	.9	1.1	420
529	Hock, hind leg or shank	9 8	50.0	35.6	12.9	.8	.7	275
520	Upper or sirloin flank	3 10	6.9	67.1	24.1	.7	1.2	450
521	Lower or thin flank	4 6	2.9	68.3	26.6	1.0	1.2	495
537	Average of hind quarter		23.2	55.1	19.9	.8	1.0	400
539	Average of whole side		30.7	51.1	16.6	.7	.9	340
543	Tongue	5 5	55.3	32.4	7.9	4.0	.4	315
542	Liver	8 12		72.0	22.2	3.3	2.5	555
541	Brain	14		80.6	9.0	9.3	1.1	560

[1] U. S. Dept. Agr., Office of Experiment Stations Bul. 44, p. 25.

TABLE 4.—*Composition of edible portion of side of beef from a New Mexico range steer.*

Reference No.	Portion taken for analysis.	Water.	Protein.	Fat.	Ash.	Fuel value per pound.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
540	Neck	73.8	24.3	0.7	1.2	480
519	Chuck ribs	75.8	21.7	1.4	1.1	465
526	Standing rib	76.3	21.5	1.1	1.1	445
525	Plate	71.5	26.6	.6	1.3	520
524	Navel	68.6	29.4	.6	1.4	570
530	Shoulder	76.6	20.8	1.5	1.1	450
538	Leg	75.9	21.6	1.5	1.0	465
531	Front of shoulder	77.7	20.4	.8	1.1	415
532	Average of fore quarter	76.0	21.8	1.1	1.1	450
522	Sirloin	70.1	27.4	1.1	1.4	535
523	Sirloin steak	71.1	26.4	1.1	1.4	535
528	Rump	72.0	25.9	.7	1.4	510
527	Round steak	73.2	24.4	1.1	1.3	500
529	Hock, hind leg or shank	71.2	25.8	1.7	1.3	550
520	Upper or sirloin flank	72.1	25.9	.7	1.3	510
521	Lower or thin flank	70.3	27.4	1.0	1.3	550
537	Average of hind quarter	71.7	25.8	1.1	1.4	525
539	Average of whole side	73.8	23.9	1.1	1.2	490
543	Tongue	72.5	17.7	8.9	.9	705
542	Liver	72.0	22.2	3.3	2.5	555
541	Brain	80.6	9.0	9.3	1.1	560

TABLE 5.—*Composition of water-free substance in side of beef from a New Mexico range steer.*

Reference No.	Portion taken for analysis.	Nitrogen.	Protein.	Fat.	Nitrogen in ether extract.	Fat corrected for protein in ether extract.	Ash.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
540	Neck	15.31	92.8	2.7	.....	2.5	4.7
519	Chuck ribs	14.70	89.9	5.6	.....	5.4	4.7
526	Standing ribs	14.81	90.8	4.7	.....	4.5	4.7
525	Plate	15.51	93.4	2.1	0.03	1.9	4.7
524	Navel	15.65	93.8	2.0	.03	1.8	4.4
530	Shoulder	14.55	88.9	6.4	.....	6.2	4.9
538	Leg	14.85	89.8	6.1	.....	5.9	4.3
531	Front of shoulder	14.88	91.6	3.7	.....	3.5	4.9
532	Average of fore quarter	.....	90.8	4.5	.....	.....	4.7
522	Sirloin	14.69	91.7	3.6	.05	3.4	4.9
523	Sirloin steak	14.83	91.7	3.6	.03	3.4	4.9
528	Rump	15.12	92.6	2.6	.03	2.4	5.0
527	Round steak	14.69	91.1	4.0	.03	3.8	5.1
529	Hock, hind leg or shank	14.77	89.7	5.9	.04	5.7	4.6
520	Upper or sirloin flank	15.14	93.0	2.6	.03	2.4	4.6
521	Lower or thin flank	15.38	92.5	3.4	.03	3.2	4 3
537	Average of hind quarter	.....	91.5	3.7	.....	.....	4.8
539	Average of whole side	.....	91.1	4.1	.....	.....	4.8
	Average	.....	.....	.....	[1].03	.....	.....

[1] Equivalent to 0.21 per cent protein (N×6.25).

COMPARISON OF THE COMPOSITION OF BEEF FROM DIFFERENT PARTS OF THE UNITED STATES.

The following table gives the average composition of the side of New Mexico beef reported above and the average composition of similar sides of beef from Maine, Tennessee, and Texas.

TABLE 6.—*Average composition of sides of beef from different regions.*

	Refuse.	Water.	Protein.	Fat.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Maine[1]	16.1	50.2	14.4	18.6	0.7
Tennessee[2]	20.4	52.9	15.3	10.5	.8
Texas[3]	20.0	55.2	15.3	8.8	.7
New Mexico	30.7	51.1	16.6	.7	.9

[1] Maine Sta. Rpt. 1895, p. 57.
[2] U. S. Dept. Agr., Office of Experiment Stations Bul. 53.
[3] U. S. Dept. Agr., Office of Experiment Stations Bul. 28.

One of the most noteworthy features in connection with the composition of New Mexico beef as compared with the results of analyses of beef from other localities is the extremely low percentage of ether extract in the former. The maximum for any single cut, calculated on the water-free basis (see p. 13), is 6.4 per cent, the minimum 2 per cent, and the average 4.1 per cent. As has already been pointed out, this ether extract is not pure fat. Deducting the amount of protein found in it, leaves 3.94 per cent as the average of several determinations.

Although the beef was very lean, it is believed that it was fairly representative of New Mexico range beef in the spring. In the late summer and early fall the cattle are in better condition, owing to the better pasturage during the rainy season.

The low fat content is accompanied by a high proportion of refuse. This is but natural, for as the flesh approaches more closely to pure muscular tissue the proportion of tendon and bone increases.

DIETARY STUDY OF A POOR MEXICAN FAMILY.

The dietary work consists of a study of one of the families (No. 163) studied last year and reported elsewhere.[1] It was thought by continuing the investigation with a family whose dietary had already been studied that some idea could be obtained of the difference in the amounts of the various nutrients consumed at different times by the same people.

CONDITIONS OF LIFE.

The family, consisting of the father, mother, and 3-year-old son, is one of a colony of some twenty families in the same circumstances attached to one of the large ranches near Las Cruces. The rent of

[1] U. S. Dept. Agr., Office of Experiment Stations Bul. 40.

FIG. 1.—A ROW OF ADOBE HOUSES IN NEW MEXICO.

FIG. 2.—A MEXICAN FAMILY AT DINNER IN FRONT OF THEIR ADOBE HOUSE.

FIG. 3.—MEXICAN WOMEN PREPARING TORTILLAS.

the dwellings and small plats of land, upon which they raise the greater part of their food, is paid in grain. The houses are all built of adobe or sun-dried brick, with an earth floor and a flat roof made of sticks and brush covered with mud, and generally contain but one room about 20 feet square. There are usually a single door and one or two unglazed windows. That the houses and the household furnishings are of the simplest and most primitive kind may be seen from the accompanying illustrations.

Figure 3 (Plate I) shows the particular family whose dietary was studied at dinner. To the left may be seen an oven in which some of the cooking is done. The greater part of the cooking, however, is done over an open fire in one corner of the house.

In general the diet of such families consists almost entirely of vegetable foods, meats being very rarely purchased. The family studied used no meat during the fourteen days of the experiment previously reported and but 1½ pounds during the present study.

"Frijoles," or beans, "chili" (a variety of red pepper), and "tortillas," i. e., cakes made from flour or from the small blue corn, which is pounded in stone mortars by the women, make up the greater part of the food eaten. In the dietary reported, "fideos," a native product resembling macaroni, was also used to some extent. The amount of fat in the vegetable food eaten is comparatively small. The deficiency is made up by the use of lard or lard substitutes used freely in cooking.

The total income of the family derived from the irregular employment of the man for short periods at various kinds of work upon the ranch, did not exceed $100 per year.

DETAILS OF THE STUDY.

The dietary study was carried on by the methods described in previous publications[1] of this Office. Exact account was taken of all the food materials in the house (1) at the beginning of the experiment, (2) purchased during its progress, and (3) remaining at the end. The last subtracted from the sum of the first two showed the amount of food consumed, due allowance being made for the waste. Account was kept of the number of meals taken by the family and by visitors.

The composition of the food was calculated from analyses of New Mexico foods reported in a previous publication.[2] It was believed that additional analyses were not necessary, since the foods consumed during this and the previous dietary study were essentially the same. The waste was analyzed.

As a rule a woman requires less food than a man, and the amount required by children is still less, varying with the age. It is customary to assign certain factors which shall represent the amount of nutrients

[1] U. S. Dept. Agr., Office of Experiment Stations Bul. 46.
[2] U. S. Dept. Agr., Office of Experiment Stations Bul. 40.

required by children of different ages and by a woman as compared with an adult man. These factors, which are based in part upon experimental data and in part upon arbitrary assumption, are as follows:

Factors used in calculating meals consumed in dietary studies.

One meal of woman equivalent to 0.8 meal of man at moderate muscular labor.
One meal of boy 14 to 16 years of age, inclusive, equivalent to 0.8 meal of man.
One meal of girl 14 to 16 years of age, inclusive, equivalent to 0.7 meal of man.
One meal of child 10 to 13 years of age, inclusive, equivalent to 0.6 meal of man.
One meal of child 6 to 9 years of age, inclusive, equivalent to 0.5 meal of man.
One meal of child 2 to 5 years of age, inclusive, equivalent to 0.4 meal of man.
One meal of child under 2 years of age equivalent to 0.3 meal of man.

By means of the preceding factors it is easy to calculate the number of meals for one man which would be equivalent to those actually eaten by the different persons. This value divided by three gives the equivalent number of days for one man. The total quantity of nutrients consumed divided by the equivalent number of days for one man gives the quantities "per man per day," the unit by which dietaries are ordinarily compared.

The study began May 9, 1897, and continued 14 days.
The members of the family and number of meals taken were as follows:

	Meals.
Man 29 years old	42
Woman 23 years old (42 meals × 0.8 meal of man), equivalent to	34
Boy 3 years old (42 meals × 0.5 meal of man), equivalent to	21
Man (visitor) 60 years old	9
Children (visitors) equivalent to	2
Total number of meals taken equivalent to	108

Equivalent to 1 man 36 days.

In the following tables are given the results of the dietary study. Table 7 shows the amount, cost, and composition of the different food materials used, together with the composition and estimated value of the waste. In Table 8 is shown the relative proportions of the several classes of food materials in the dietary and the nutrients furnished by each class. Table 9 shows the amount, composition, fuel value, and cost of the food purchased, wasted, and actually eaten.

TABLE 7.—*Food materials and table and kitchen wastes in dietary study No. 225.*

Kind of food material.	Composition.			Total cost.	Weight used.			
	Protein.	Fat.	Carbohydrates.		Total food material.	Protein.	Fat.	Carbohydrates.
ANIMAL FOOD.								
Beef:	*Per ct.*	*Per ct.*	*Per cent.*		*Grams.*	*Grams.*	*Grams.*	*Grams.*
Ribs	22.6	3.0	.....	$0.10	595	134	18	.....
Lard	.....	100.0	.....	.40	1,730	.....	1,730	.....
Total animal food	.....	.....	.....	.50	2,325	134	1,748	.....

TABLE 7.—*Food materials and table and kitchen wastes, etc.*—Continued.

Kind of food material.	Composition.			Total cost.	Weight used.			
	Protein.	Fat.	Carbohydrates.		Total food material.	Protein.	Fat.	Carbohydrates.
VEGETABLE FOOD.	*Per ct.*	*Per ct.*	*Per cent.*		*Grams.*	*Grams.*	*Grams.*	*Grams.*
Frijoles, native beans	21.9	1.3	65.1	$0.25	2,980	652	39	1,940
Chili, red pepper	4.0	3.4	30.1	.42	1,105	44	38	332
Flour, native	9.9	1.3	80.1	.84	10,720	1,061	139	8,587
Corn, native blue	10.5	5.8	75.9	.30	10,570	1,110	613	8,023
Fideos	9.9	1.3	80.1	.10	770	76	10	617
Sugar	.....	.....	98.0	.15	1,080	.....	.....	1,058
Total vegetable food	.....	.....	.....	2.06	27,225	2,943	839	20,557
Total food	.....	.....	.....	2.56	29,550	3,077	2,587	20,557
Food accessories:								
Coffee, roasted	.....	.....	.....	.21	765	.....	.....	.....
Salt	.....	.....	.....	.01	370	.....	.....	.....
Waste, water-free[1]	13.7	6.1	76.9	.04	380	52	23	292

[1] Analyzed in connection with this dietary.

TABLE 8.—*Weights and percentages of food materials and nutritive ingredients used in dietary study No. 225.*

Kind of food material.	Weight in grams.				Weight in pounds.				Cost.
	Food material.	Protein.	Fat.	Carbohydrates.	Food material.	Protein.	Fat.	Carbohydrates.	
FOR FAMILY, 14 DAYS.									
Beef, veal, and mutton	595	134	18	.....	1.30	0.30	.....	.....	$0.10
Pork, lard, etc	1,730	.....	1,730	.....	3.80	.....	3.80	.....	.40
Total animal food	2,325	134	1,748	.....	5.10	.30	3.80	.....	.50
Cereals	22,060	2,247	762	17,227	48.60	5.00	1.70	38.00	1.24
Sugars and starches	1,080	.....	.....	1,058	2.40	.....	.....	2.30	.15
Vegetables	4,085	696	77	2,272	9.00	1.50	.20	5.00	.67
Total vegetable food	27,225	2,943	839	20,557	60.00	6.50	1.90	45.30	2.06
Total food	29,550	3,077	2,587	20,557	65.10	6.80	5.70	45.30	2.56
Total food, including coffee and salt	.....	.....	.....	.....	.....	.....	.....	.....	2.78
PER MAN PER DAY.									
Beef, veal, and mutton	17	4	1	.....	.04	.01	.....	.....	.....
Pork, lard, etc	48	.....	48	.....	.10	.....	.11	.....	.....
Total animal food	65	4	49	.....	.14	.01	.11	.....	.01
Cereals	613	63	21	479	1.35	.14	.05	1.06	.....
Sugars and starches	30	.....	.....	29	.07	.....	.....	.06	.....
Vegetables	113	19	2	63	.25	.04	.....	.14	.....
Total vegetable food	756	82	23	571	1.67	.18	.05	1.26	.06
Total food	821	86	72	571	1.81	.19	.16	1.26	.07
Total food, including coffee and salt	.....	.....	.....	.....	.....	.....	.....	.....	.08

TABLE 8.—*Weights and percentages of food materials, etc.*—Continued.

Kind of food material.	Weight in grams.				Weight in pounds.				Cost.
	Food material.	Protein.	Fat.	Carbohydrates.	Food material.	Protein.	Fat.	Carbohydrates.	
PERCENTAGES OF TOTAL FOOD.	*Per. ct.*	*Per. ct.*	*Per. ct.*	*Per cent.*					*Per. ct.*
Beef, veal, and mutton	2.0	4.4	0.7	.....	.....	.....	.....	.....	3.6
Pork, lard, etc	5.9	.....	66.9	.....	.....	.....	.....	.....	14.4
Total animal food	7.9	4.4	67.6	.....	.....	.....	.....	.....	18.0
Cereals	74.6	73.0	29.4	83.8	.....	.....	.....	.....	44.6
Sugars and starches	3.7	.....	.....	5.2	.....	.....	.....	.....	5.4
Vegetables	13.8	22.6	3.0	11.0	.....	.....	.....	.....	24.1
Total vegetable food	92.1	95.6	32.4	100.0	.....	.....	.....	.....	74.1
Coffee	.....	.....	.....	.....	.....	.....	.....	.....	7.6
Salt	.....	.....	.....	.....	.....	.....	.....	.....	.3
Total	.....	.....	.....	.....	.....	.....	.....	.....	100.0

TABLE 9.—*Nutrients and fuel value in food purchased, rejected, and eaten in dietary study No. 225.*

Kind of food material.	Cost.	Protein.	Fat.	Carbohydrates.	Fuel value.
Food purchased:		*Grams.*	*Grams.*	*Grams.*	*Calories.*
Animal	$0.50	134	1,748	.....	16,810
Vegetable	2.06	2,943	839	20,557	104,150
Total	2.56	3,077	2,587	20,557	120,960
Waste	.04	52	23	292	1,620
Food actually eaten	2.52	3,025	2,564	20,265	119,340
PER MAN PER DAY.					
Food purchased:					
Animal	.014	4	49	.....	470
Vegetable	.057	82	23	571	2,890
Total	.071	86	72	571	3,365
Waste	.....	1	1	8	45
Food actually eaten	.071	85	71	563	3,320
PERCENTAGES OF TOTAL FOOD PURCHASED.					
Food purchased:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Animal	19.5	4.4	67.6	.....	13.9
Vegetable	80.5	95.6	32.4	100.0	86.1
Total	100.0	100.0	100.0	100.0	100.0
Waste	1.6	1.7	.9	1.4	1.3
Food actually eaten	98.4	98.3	99.1	98.6	98.7

DISCUSSION OF RESULTS.

For purposes of comparison, the results of this dietary study and those previously made in New Mexico,[1] together with the average results of the dietary studies of negroes in Alabama[2] and the proposed

[1] U. S. Dept. Agr., Office of Experiment Stations Bul. 40.
[2] U. S. Dept. Agr., Office of Experiment Stations Bul. 38.

American dietary standard for a man at moderate muscular work, are given in the following table:

TABLE 10.—*Summary of results of dietary studies in New Mexico and Alabama compared with the dietary standard.*

[Per man per day.]

	Cost—		Nutrients.			Fuel value.	Nutritive ratio.
	Of food.	Of beverages, etc.	Protein.	Fat.	Carbohydrates.		
	Cents.	*Cents.*	*Grams.*	*Grams.*	*Grams.*	*Calories.*	
Dietary No. 225.—Mexican family of the poorer class, 1897	7	1	84	71	563	3,320	1: 8.6
Dietary No. 163.—Same family as above, 1896	6	2	104	71	701	3,960	1: 8.3
Dietary No. 164.—Mexican family in moderate circumstances, 1896	9	2	98	65	561	3,305	1: 7.2
Dietary No. 165.—Mexican family of the poorer class, 1896	6	1	89	77	625	3,645	1: 9.0
Mexican (average)	7	1½	68	73	572	3,320	1: 8.3
Negro (average)	8	.....	62	132	436	3,270	1:11.8
Standard for men at moderate muscular work	.....	.....	125	.....	.....	3,500	1: 5.8

From this table it will be seen that the amount of food consumed was somewhat less than was the case in the dietary study made in 1896, the fuel value per man per day being reduced from 3,960 to 3,320 calories. This reduction in heat value was caused by using smaller amounts of protein and carbohydrates, the fat being exactly the same. The nutritive ratio, however, remained practically unchanged.

The food accessories in this dietary consisted of coffee only, for which 21 cents was paid out of a total food expenditure of $2.78 during the period. That the family were accustomed to make the most of what they had is shown by the small amount of waste in this dietary. The waste was estimated to cost but 4 cents. This is an example of careful management that might well be imitated by others in more favored circumstances.

It is interesting to note that the Mexican family obtained for 7 cents more protein, more carbohydrates, and a greater fuel value than the negro family for 8 cents. The negro family, however, had more fat. This difference is due to the use of large amounts of fat pork (an expensive source of protein) by the negro families, while the Mexican family used but little meat and derived the protein in their diet almost entirely from vegetable sources.

It must be understood that the dietary standard here given is not in any way absolute, but represents what is considered at present, as the result of careful investigation, to be the closest estimate possible as to the actual amounts or relation between the amounts of protein, carbohydrates, and fat required to properly nourish a man engaged in moderately hard work. A diet made up on this basis should enable a man to do each day a fair amount of work and at the same time to keep his body in a well-balanced and well-nourished condition.

The great trouble with the dietary of the Mexican family as well as that of the negro is that the amount of protein is too small. Approximately stated, the food of the Mexican family furnished but two-thirds of the amount of protein called for by the standard, and the food of the negro families furnished but one-half the protein that is considered to be necessary, according to the best knowledge at the present, for proper nourishment.

At the same time the Mexican as well as the negro families ate an undue proportion, but not amount, of the fuel ingredients. A proper ratio is generally considered to be established when the quantity of protein is to the quantity of fuel ingredients—starch, sugar, and fat—as 1 to 5.8 or thereabouts. In both the negro and Mexican families the dietaries are deficient in protein and in fuel ingredients.