OKLAHOMA
AGRICULTURAL EXPERIMENT
STATION

BULLETIN NO. 89 JUNE, 1910

THE CHEMISTRY OF THE KAFIR CORN KERNEL

CHEMISTRY

KAFIR CORN READY FOR HARVEST

STILLWATER, OKLAHOMA

A. & M. COLLEGE PRINTING DEPARTMENT

STATE BOARD OF AGRICULTURE

1909-1910

Hon. J. P. Connors, *President*	Canadian
Hon. W. R. Lindsay, *Vice President*	Choteau
Hon. R. F. Wilson, *Treasurer*	Valliant
Hon. O. A. Brewer	Helena
Hon. G. T. Bryan	Perry
Hon. A. C. Cobb	Wagoner
Hon. J. W. L. Corley	Howe
Hon. Dan Diehl	Gotebo
Hon. J. C. Elliott	Pauls Valley
Hon. Frank Ikard	Chickasha
Hon. Ewers White	McLoud

J. H. Connell, M. S.	*President of the College*

STATION STAFF

1909-1910

B. C. Pittuck, B. S.	*Assistant Director*
L. L. Lewis, M. S., D. V. M.	*Veterinarian and Bacteriologist*
O. M. Morris, B. S.	*Horticulturist and Botanist*
W. A. Linklater, B. S. A.	*Animal Husbandman*
Roy C. Potts, B. S.	*Dairyman*
C. E. Sanborn, M. A.	*Entomologist*
	Chemist
A. H. Wright, B. S.	*Assistant Agronomist*
R. O. Baird, B. S.	*Assistant Chemist*
A. L. Lovett, B. S.	*Assistant Entomologist*
Chas. Crawford, B. S.	*Assistant Chemist*
G. M. Lambert, B. S. A.	*Assistant Dairyman*
W. A. Starin, M. A.	*Assistant Bacteriologist*
S. W. Black	*Assistant in Agronomy*
W. W. Evans	*Farm Superintendent*
J. L. McKeown	*Financial Secretary*
Lula Tourtellotte	*Clerk*

Visitors are welcome at all times.

The publications of this Station are sent free to residents of Oklahoma on request. All communications should be addressed, not to individuals or departments, but to the

Experiment Station, Stillwater, Oklahoma.

THE CHEMISTRY OF THE KAFIR CORN KERNEL

R. O. Baird

Introduction

Kafir corn, *Andropogon sorghum vulgaris,* comes under the general classification of sorghums, which is supposed to have originated from a single species native to tropical Africa, and takes its name from the well known Kafir tribe. The value of Kafir corn as a drought resistant crop has been clearly proved. It can be depended upon for good yields under conditions distinctly unfavorable to Indian corn. Its value in the semi-arid regions of the United States cannot be overestimated, as it is better able to withstand the drought and hot winds than any other crop. The hot winds may cause this species of plant to wither, but if favorable conditions follow a period of drought it resumes growth, and produces good yields. During the past few years a large acreage has been devoted to this crop and almost entirely for the purpose of producing roughage for live stock. The value of the grain is not fully appreciated, though its milling qualities are given more consideration today than ever before.

TWO WELL DEVELOPED HEADS OF KAFIR CORN

In order to determine the value of the Kafir corn kernel as a food and as a raw product in manufacture the experiments herein reported were planned as follows:

1. A study of the chemical compounds which make up the proximate constituents of Kafir kernel and a comparison with the ingredients of Indian corn.

2. Fixing the value of the physical and chemical constants of the Kafir fat.

3. The relation between the inorganic plant constituents of Kafir corn and Indian corn, and the approximate amount of plant foods removed from the soil by each.

4. A comparison of the chemical constituents and constants of the Kafir corn kernel with those of other grains and seeds.

5. The value of Kafir kernel as a food for man and domestic animals compared with Indian corn.

The proximate constituents of the Kafir corn kernel indicate its value as a food for man and domestic animals, and reveal the possibility of its being used as a raw product in certain important commercial operations, having for their purpose the manufacture of starch, syrup, alcohol, and oil.

In order to show the relative value of the proximate constituents of the Kafir corn kernel, some standard must be chosen for comparison. As Indian corn, in conditions of growth and nature of environment, is somewhat similar to Kafir corn, it will be used for comparison.

All results are expressed in per cent. unless otherwise indicated.

Comparisons

The following table, by C. G. Hopkins, shows the results of fifty analyses of Indian corn, expressed in terms of the air dried material. The samples were taken from the same field.

TABLE I.

COMPOSITION OF INDIAN CORN.

	Ash	Protein	Fat	Carbohydrates
Maximum	1.74	13.88	6.02	85.78
Minimum	1.09	8.35	3.95	78.92
Difference	0.65	5.53	2.07	6.87

*University of Illionis. Bulletin No. 53.

The following table gives the proximate constituents of domestic and foreign corn:

TABLE 2.

COMPOSITION OF INDIAN CORN.

	Weight of 100 Kernels Grams	Moisture	Protein	Fat	Crude Fibre	Ash	Carbo-hydrates
Domestic:—							
Maximum	*a*48.312	*b*12.32	*a*11.55	*a*5.06	*b*2.00	*b*1.55	*b*75.07
Mean	38.979	10.93	9.88	4.17	1.71	1.36	71.95
Minimum	10.608	*b* 9.58	*b* 8.58	2.94	*b*1.00	*a*1.19	*a*68.97
Foreign:—							
Maximum	*e*46.487	*f*12.60	*g*11.55	*e*4.85	*f*2.20	*g*1.80	*e*71.85
Mean	28.553	11.71	10.72	4.15	1.87	1.54	69.65
Minimum	*f*18.428	*e*10.43	*e* 9.80	*f*4.02	*e*1.57	*f*1.26	*g*68.92

(*a*) Kentucky; (*b*) Indiana; (*c*) Wisconsin; (*d*) New Hampshire; (*e*) New South Wales; (*f*) Bulgaria; (*g*) Argentine Republic.

Tables 3 and 4 below show the composition of corn meal and Kafir meal as analyzed by the writer.

TABLE 3.

COMPOSITION OF CORN MEAL.

Sample	Moisture	Ash	Protein	Fibre	N.—Free Extract	Fat	Nitrogen
3301—Corn meal	11.59	1.38	9.70	2.16	71.64	3.53	1.551
3803—Shelled corn	12.56	1.23	9.63	....	72.96	3.62	1.540
3804—Corn meal	12.54	1.35	9.27	....	72.91	3.93	1.484
3307—Corn meal	14.58	1.28	9.71	2.03	71.40	1.00	1.553
3366—Corn meal	13.81	1.35	9.30	2.13	72.26	1.11	1.487
3382—Corn meal	13.03	1.47	9.74	2.13	72.30	1.33	1.558
4121—Corn meal	11.26	1.29	8.84	....	74.25	4.26	1.414
4706—Corn chops	10.89	1.02	8.57	1.99	74.27	3.26	1.372
4716—Corn chops	9.74	1.27	10.06	2.65	72.29	3.99	1.610
4717—Corn chops	9.70	1.22	10.06	2.54	72.12	4.36	1.610

TABLE 4.

COMPOSITION OF KAFIR MEAL.

Sample	Moisture	Ash	Protein	Fibre	N.—Free Extract	Fat	Nitrogen
3302—Kafir meal	12.43	1.13	11.25	1.89	71.09	2.21	1.800
3804—Kafir meal	12.63	1.28	11.47	....	71.83	2.79	1.834
3308—Kafir meal	13.50	1.25	11.47	1.79	69.47	2.52	1.834
3367—Kafir meal	13.46	1.23	10.60	1.86	70.80	2.05	1.697
3383—Kafir meal	13.31	1.27	10.95	1.85	71.31	1.32	1.751
4122—Kafir meal	12.02	1.26	10.06	....	73.72	2.94	1.610
4123—Kafir meal	12.06	1.23	9.89	....	73.87	2.95	1.582
4720—Kafir grain	10.08	1.40	9.19	2.15	74.31	2.87	1.477

Analyses of food consituents of Indian corn and Kafir corn made at the Kansas Agricultural Experiment Station:

TABLE 5.

INDIAN CORN AND KAFIR CORN.

	Moisture	Ash	Protein	Crude Fibre	Fat	N.—Free Extract
Corn kernels	10.90	1.50	10.50	2.10	5.40	69.60
Kafir kernels	9.31	1.53	9.92	1.35	2.97	74.92

From the preceding analyses of Indian corn and Kafir corn by the different stations, the conclusion can be reasonably drawn that Kafir corn, being similar in composition to Indian corn, is therefore a valuable food. The analyses presented by Tables 3 and 4 show that the protein and carbohydrates in Kafir corn are slightly higher and the fat somewhat lower in per cent. than in Indian corn.

Experimental

The samples of Kafir corn kernels were obtained from local dealers and from the Oklahoma Experiment Station fields. Sample No. 4764 was taken from a "no treatment" field while sample No. 4765 was taken from a plat which had been well manured.

About one bushel of each sample was secured, well mixed, freed from the hulls, and then ground to a fine meal, a well mixed sample taken and then placed in air tight jars.

Analytical Methods

MOISTURE: The moisture was determined by drying five grams of the sample for 12 hours at 100 degrees Centigrade.

ASH: The ash was determined by incinerating five grams of the sample until no loss of weight was noticed on further heating. The time required was about eight hours.

CRUDE FIBRE: This determination was made by the official method given on page 56, Bulletin 107, Association of Official Agricultural Chemists.

ETHER EXTRACT: The indirect method was used, and the determination carried out as directed on page 39, Bulletin 107, Official and Provisional Methods of the Association of Official Agricultural Chemists.

NITROGEN: The Gunning method was used in this determination.

NITROGEN FREE EXTRACT: Was determined by substracting from 100 the sum of the percentages of moisture, ash, crude fibre, ether extract, and protein.

STARCH: This determination was accomplished by the direct acid-hydrolysis (modified Sachsse method). The diastase method for the determination of starch was tried several times, but the results did not agree, and were never high enough in starch.

Reducing sugars, sucrose, galactans, and pentosans were determined by the official methods.

Physical and Chemical Constants

SPECIFIC GRAVITY: A 25cc gravity bottle was used in this determination. The weighings were made at 15.5 degrees Centigrade.

MELTING POINT OF THE FAT: This determination was carried out according to the method proposed by Wiley.

SOLIDIFYING POINT—TITER TEST: The method of Dalican was used for this determination.*

IODIN ABSORPTION VALUE: Hubl's method for the absorption of iodin was used according to the official method.

SAPONIFICATION NUMBER: The method used in this determination was that of Koettstorfer.

ACETYL VALUE: This determination was made as directed on pages 268 and 269, Chemical Technology,—Analysis of Oils, Fats, and Waxes, Volume I,—Lewkowitsch.

Soluble and insoluble acids, Reichert Meissl Number, free fatty acids, Maumene number and inorganic plant constituents were determined according to the well known standard methods.

The following results were obtained:

TABLE 6.

ANALYSES OF KAFIR CORN.

Sample	Moisture	Ash	Crude Fibre	Fat	Protein	N.—Free Extract
4760	13.471	1.453	2.648	3.416	12.850	66.162
4762	12.250	1.196	2.470	3.541	12.970	67,573
4763	11.474	1.277	3.319	3.570	11.920	68.440
4764	12.805	1.599	2.957	3.517	11.060	68.061
4765	13.105	1.700	2.890	3.896	11.990	66.419

The analyses show that the proximate constituents of Kafir corn vary somewhat, that manuring improves the valuable food constituents as shown in samples 4764 and 4765, manured and unmanured respectively, and that Kafir corn contains almost as high a percentage of valuable food constituents as Indian corn.

The following table shows the maximum, minimum, and mean of the writer's analyses of five samples of Kafir kernels:

TABLE 7.

ANALYTICAL RESULTS AVERAGED.

	Moisture	Ash	Fat	Protein	Fibre	N.—Free Extract
Maximum	13.448	1.668	3.800	12.850	2.90	70.826
Minimum	11.264	1.196	3.464	11.370	1.88	65.334
Mean	12.356	1.432	3.632	12.110	2.39	68.080

*U. S. Bureau of Chemistry, Bulletin 107, (revised), page 135. Dictionary of Applied Science, Thorpe III, page 50. Food Inspection, Leach, page 403.

The following table will show more clearly the comparison of the food constituents of Indian corn and Kafir corn:

TABLE 8.

FOOD VALUES.

	Kafir Corn	Indian Corn
Average yield per acre	30. bu.	35 bu.
Feeding value, considering corn 100	90	100
Pounds of protein per acre, considering 11.3 per cent. of Kafir corn and 10.5 per cent Indian corn	219.84	205.80
Pounds of fat per acre, considering Kafir corn 3 per cent. and Indian corn 3.5 per cent	50.4	68.6
Pounds of nitrogen free extract per acre, considering Kafir corn 70 per cent., Indian corn 72.5 per cent	1176.0	1421.0
Value per acre, considering corn worth 37.5 cents and Kafir corn worth 30 cents per bu	$9.00	$13.125

Nitrogen Free Extract

Under this head is included the starch, glucose or dextrose, sucrose, galactans and pentosans. The determination of these compounds show more completely the value of the nitrogen free extract.

The following table contains the results of the analysis of the nitrogen free extract:

TABLE 9.

COMPOSITION OF NITROGEN FREE EXTRACT.

Sample	N.—Free Extract	Starch	Pentosans	Galactans	Glucose	Sucrose
4760	66.162	59.484	3.92	0.240	1.375	0.275
4762	67.573	60.713	3.79	0.150	1.362	0.406
4763	68.440	59.031	4.41	0.136	1.360	0.493
4764	68.061	57.125	4.53	0.119	1.440	0.669
4765	66.419	57.956	5.04	0.104	1.345	0.795

From the preceding table the following conclusions can be reasonably drawn:

That Kafir corn kernel has as much sucrose, reducing sugars and pentrose bodies as Indian corn. The analyses also show that 90 per cent. or more of the nitrogen free extract can be utilized as a food.

The following table has been computed from Table 9, and shows the value of Kafir corn for the production of alcohol as compared with Indian corn:

TABLE 10.

PRODUCTION OF ALCOHOL.

	Kafir Corn	Indian Corn
Pounds of fermentable material (starch and sugars) in one bushel	38.0	39.2
Approximate pounds of alcohol per bushel	18.0	19.0
Gallons of alcohol in one bushel	2.56	2.7
Cost of grain* to produce one gallon of alcohol	12c	14c

*Corn 37½c; Kafir 30c per bushel.

Kafir Fat

EXTRACTING THE FAT: Equal quantities of the five samples of the Kafir corn kernel were well mixed, ground to a very fine meal, and the fat extracted with gasoline. Large bottles were used in the extraction, and the mixture of meal and gasoline was shaken thoroughly every few hours. After standing for 24 hours the gasoline and the extracted fat were put into another bottle with a new charge of meal, and this process continued for five days, each charge of meal being extracted five times. The liquid was then filtered, evaporated, and purified.

In the evaporation of the mixture most of the gasoline was removed by the aid of heat and a suction pump. The liquid was placed in 500cc Jena flasks, attached to a suction pump, and the flasks placed in a bucket of water. The water was heated from 55 to 60 degrees Centigrade, the suction started, and the process continued for about 36 hours.

The golden liquid was then put into a liter flask, placed in a water oven at 100 degrees C., and perfectly dry carbon di-oxide drawn through it by a suction pump, from 40 to 50 hours, or until the fat was purified. This process removed the remaining gasoline and any water that may have been present.

The fat on cooling became solid, not unlike vasaline, though somewhat harder. It had a yellow color with a greenish hue, a pleasant though not marked odor, and a pleasant vegetable oily taste.

The following table will give the results of examinations of the fat of the Kafir corn kernel:

TABLE 11.

CONSTANTS OF KAFIR CORN FAT.

Specific Gravity	Melting Point	Titer Test	Iodin Value	Soluble Acids	Insoluble Acids	Saponification Value
0.9398	44.4°C.	34.1°C.	109.9763	0.635	93.04	249.7
0.9397	44.0°C.	33.8°C.	109.4250	0.682	93.41	248.5

Reichert Meissl No.	Liquid Acids	Solid Acids	Free Fatty Acids	Acetyl Value	Maumene Number	Unsaponifiable Residue
6.1404	86.44	7.40	26.934	42.2176	68.2°C.	1.720
6.0664	85.52	7.55	27.096	42.2380	68.0°C.	1.707

In order to make a comparison, some of the physical and chemical constants of corn oil are given below:

TABLE 12.

CONSTANTS OF CORN OIL.

Specific Gravity	Melting Point	Titer Test	Iodin Value	Saponfiication No.	Insoluble Acids	Reichert Meissl No.	Acetyl Value	Maumene Number
0.9274	18.0°C.	14.0°C.	111.0	188.0	82.2	4.2	7.80	5.6°C.
0.9213	20.0°C.	16.0°C.	180.0	193.0	95.7	9.9	8.75	8.6°C.

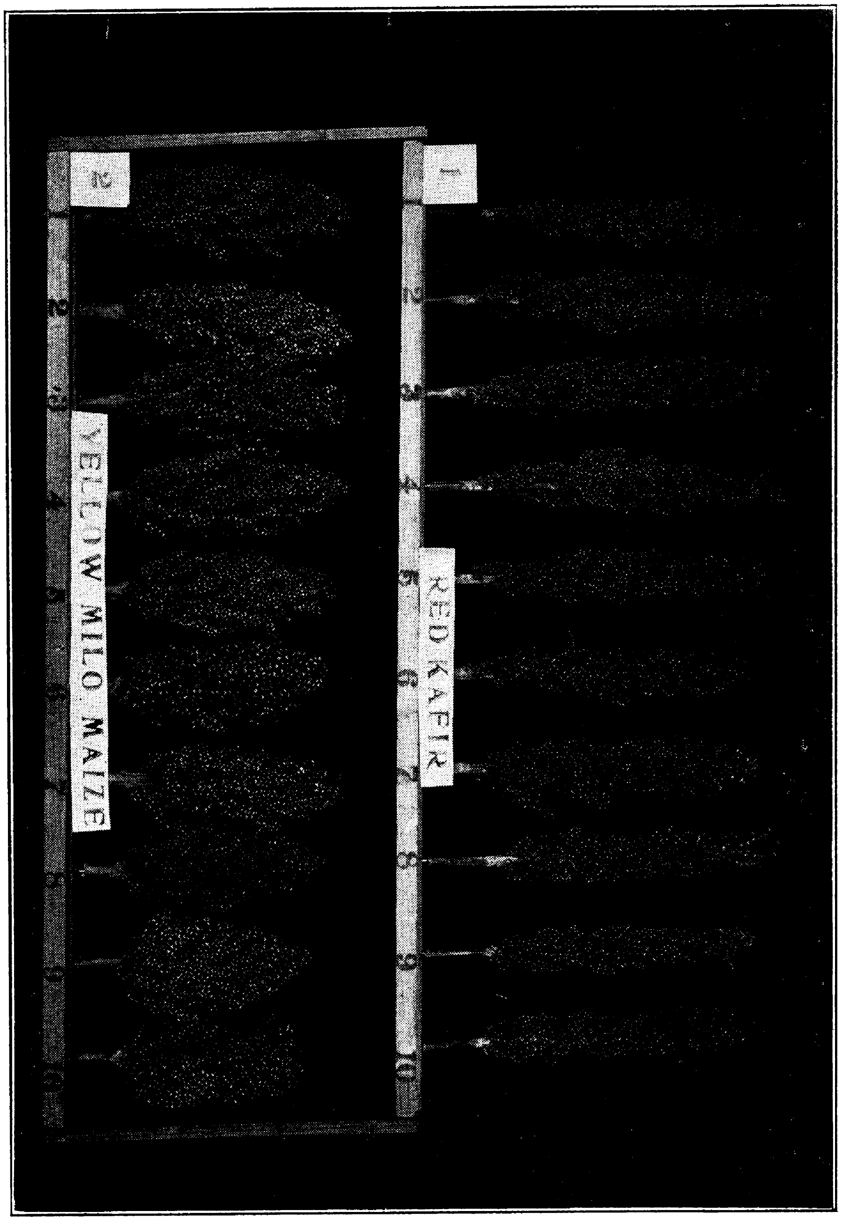
The melting point of Kafir corn fat is 44.2 degrees C., and that of corn oil is 18 to 20 degrees C. This and the higher Titer test of the Kafir fat shows that the latter contains more of the solid fatty acids than corn oil. The indications are that Kafir fat could be utilized much more satisfactorily than corn oil for soap making. An experiment demonstrated that the fat could not be used as a lubricant owing to the high percentage of acids. The fat might, however, be used with other oils, especially the edible fats and oils, as it has an agreeable taste and odor.

Owing to its high melting point it might be used with such fats as lard, oleomargarine and butterine. The fat was found to be practically non-drying.

SOLUBILITY: The fat is soluble in gasoline, ether, chloroform, carbon bi-sulphid, and to some extent in absolute alcohol.

Determination of the Inorganic Plant Constituents of the Kafir Corn Kernel

PREPARATION OF THE ASH: The ground meal was charred in a muffle furnace, and the charred material extracted with a 10 per cent. solution of acetic acid. The acid was washed out with hot water, and the combined filtrates evaporated and burned to a white ash. The residue was also burned to a white ash, and the two thoroughly mixed and placed in ground glass stoppered bottles until used for analysis.


2
YELLOW MILO MAIZE
1
RED KAFIR

Below is given the results of the complete analysis of Kafir kernel ash:

TABLE 13.

ASH OF KAFIR CORN.

Sample	3898	3958	3230	3231	Average
Sand	4.30	3.33	5.73	2.88	4.06
Soluble Silica	0.96	1.28	2.25	4.15	2.16
Carbon	0.24	0.31	0.28	0.17	0.25
Sulphur Tri-oxid	0.19	0.17	1.22	0.51	0.52
Chlorin	0.45	0.48	0.58	0.44	0.49
Sodium Oxid	0.94	0.96	2.42	2.39	1.18
Phosphorus Pentoxid	43.76	44.21	37.47	46.72	43.04
Iron and Aluminum Oxids	1.19	1.18	2.08	1.84	1.57
Calcium Oxid	1.95	2.15	1.64	1.46	1.80
Magnesium Oxid	18.86	18.56	16.67	15.25	17.34
Potassium Oxid	27.11	26.99	29.78	24.82	27.17

TABLE 14.

ASH OF INDIAN CORN

	By Wolff*	By Ford**
Potassium Oxid	29.80	29.15
Sodium Oxid	1.10	1.76
Calcium Oxid	2.20	1.60
Iron and Aluminum Oxid	0.80***	1.64
Phosphorus Pentoxid	45.60	49.58
Magnesium Oxid	15.50	13.29
Sulhur Trioxid	0.80	0.54
Silica	2.10	2.45
Chlorin	0.90	0.66

*Wolff's Aschen Analysen, 1880. See also Thorp's Distionary of Applied Chemistry, Volume I, page 497, 1890.

**Oklahoma Experiment Station.

***Wolff reported Iron oxid only.

From the above analyses it will be seen that 87.55 per cent. of the Kafir ash and 92.29 per cent. of the corn ash is in the form of potassium and magnesium phosphates. The average per cent. of ash in Kafir corn kernel is 1.433 while that of corn is 1.372.

The following table shows approximately the amount of potassium oxid, phosphorus pentoxid, and nitrogen, which is removed from the soil by an average crop of Kafir kernel and corn kernel:

TABLE 15.

PLANT FOOD REMOVED FROM SOIL.

	Kafir Kernel	Corn Kernel
Average yield in bushels per acre	30.000	35.000
Pounds per bushel of potassium oxid	0.218	0.227
Pounds per acre of potassium oxid	6.540	7.945
Pounds per bushel of phosphorus pentoxid	0.345	0.366
Pounds per acre of phosphorus pentoxid	10.362	12.810
Pounds per bushel of nitrogen	1.089	1.023
Pounds per acre of nitrogen	32.940	35.798

As shown by the above table, corn takes up from the soil a larger quantity of the three important plant foods than Kafir kernel, and as a feed, corn is shown by analysis to be very little if any better than Kafir corn. Kafir corn is better adapted to stand dry weather and hot winds than corn, and it is therefore a good crop for this section of the country.

The value of Kafir kernel as a food for man has not been firmly established, but owing to its great similarity to Indian corn, the conclusion can safely be drawn that in the near future it will have a great value in the milling industry. Its value as a food for live stock and poultry has been established by this laboratory through digestion trials with steers and chickens.

The following tables and summary are taken from Bulletins 37 and 46 of the Oklahoma Agricultural Experiment Station:

TABLE 16.

PER CENT. DIGESTIBLE MATTER IN KAFIR FEEDS, CALCULATED FROM ANALYSES.

	Dry Matter	Ash	Protein	Fibre	N.—Free Extract	Ether Extract
Shredded Kafir stover	56.3	19.0	30.5	67.0	58.2	79.3
White Kafir corn, fed dry	41.7	63.9	43.6	45.4	40.8	44.8
Soaked Kafir corn	38.0	65.7	40.2	35.2	38.0	38.8
Mature Kafir heads	24.3	53.6	12.3	27.4	30.8	31.1
Ground Kafir meal	64.2	......	53.3	......	75.9	46.1
Kafir fodder, field cured	60.6	7.8	38.1	60.4	66.4	61.0

Average of analyses made at this Station are given in the following tables:

TABLE 17.

PER CENT. COMPOSITION, AS SAMPLED.

	No. of Analyses	Water	Ash	Protein	Fibre	N.—Free Extract	Ether Extract
Kafir stover, field cured	6	19.18	8.02	4.83	26.78	30.60	1.57
Kafir fodder, field cured	2	9.65	4.74	5.64	21.78	55.79	2.40
Kafir heads	1	21.63	2.38	8.40	6.92	58.26	2.41
Kafir corn	6	12.52	1.26	10.86	1.94	70.48	2.94

Combining the above tables, the per cent. of digestible matter is given. Carbohydrates and fat in Table 18 includes the sum of the digestible fibre, nitrogen free extract, and two and one-fourth times the fat.

TABLE 18.

PERCENTAGE OF DIGESTIBLE MATTER.

	Dry Matter	Protein	Carbohydrates and Fat	Total	Nutritive Ratio
Shredded Kafir stover	80.82	1.48	43.78	45.26	1:29.5
Kafir fodder, field cured	90.35	2.15	53.49	55.64	1:24.9
Mature Kafir heads	78.37	1.03	21.53	22.56	1:20.9
Kafir corn	87.48	......	....	....	....
Whole grain fed to hogs	......	4.73	32.60	37.33	1:6.9
Whole grain soaked	......	4.37	30.03	34.40	1:6.9
Coarsely ground	......	5.79	56.54	62.33	1:9.8

For comparison, the following results for Indian corn are here inserted. The data for corn are, in each case calculated to the same content of moisture as the average Oklahoma anlysis.

The analyses are taken from "The Computation of Rations for Farm Animals" by Armsby. Digestion coefficients for corn stover, corn fodder, corn meal, and corn and cob meal, are averages compiled by Lindsey.*

*Massachusetts Hatch Station Report for 1897.

TABLE 19.

PERCENTAGE COMPOSITION.

	Number Analyses	Water	Ash	Protein	Fibre	N.—Free Extract	Ether Extract
Corn stover, field cured....	60	19.18	4.58	5.12	26.58	43.06	1.48
Corn fodder, field cured....	35	9.65	4.22	7.03	22.35	54.25	2.50
Corn ears, ground	7	21.63	1.39	7.84	6.09	59.82	3.23
Corn	154	12.52	1.47	10.22	1.86	69.01	4.92

The next table has been calculated from the above anlyses and the coefficients indicated.

TABLE 20.

PERCENTAGE OF DIGESTIBLE MATTER.

	Dry Matter	Protein	Carbohydrates and Fat	Total	Nutritive Ratio
Corn stover, field cured........	80.82	2.05	43.89	45.94	1:31.4
Corn fodder	90.35	3.87	58.37	62.14	1:15
Corn and cob meal................	78.37	4.08	61.49	65.57	1:15.1
Corn fed whole to hogs........	87.48	8.07	68.27	76.34	1: 8.5
Corn meal	87.48	6.13	74.36	80.49	1:12

TABLE 21.

PER CENT. DIGESTIBLE MATTER, FED TO CHICKENS.

	Matter Organic	Protein	Fibre	N.—Free Extract	Ether Extract
Kafir corn	87.7	52.9	20.1	96.3	73.7
Kafir meal	87.2	42.6	35.5	96.5	82.7
Corn	86.4	49.8	......	92.5	91.7
Corn meal	85.5	48.4	......	91.5	93.1

In the following table the carbohydrates and fat includes the sum of the digestible fibre, nitrogen free extract, and two and one-fourth times the fat.

TABLE 22.

PER CENT. DIGESTIBLE MATTER.

	Dry Matter	Protein	Carbohydrates and Fat	Total	Nutritive Ratio
Kafir corn	89.17	6.18	73.09	79.37	1:11.6
Kafir meal	89.17	5.06	74.11	79.17	1:14.6
Corn	89.89	4.48	77.49	81.97	1:17.2
Corn meal	89.89	4.36	76.90	81.26	1:17.6

Summary of Digestion Trials

1. Kafir heads contained one-third as much digestible matter as average corn and cob meal.

2. Kafir corn fed in the heads was neither more nor less digestible than when fed after threshing.

3. Kafir corn fed to steers after soaking for twelve hours was less digestible than when fed dry.

4. Kafir corn fed dry contained 40 per cent. less digestible matter than coarsely ground Kafir meal.

5. Kafir meal, coarsely ground, contained 20 per cent. less digestible matter than average corn meal.

6. **It Paid to Grind Kafir Corn.** One hundred pounds of Kafir meal contained as much digestible matter as one hundred and sixty-seven pounds of Kafir corn.

7. A gain of 13 per cent. in the amount of digestible matter was secured when Kafir fodder was threshed, the grain ground and fed to steers along with the shredded stover from the fodder.

8. A gain of less than 2 per cent. in the amount of digestible matter was secured when Kafir fodder was threshed, and the resulting Kafir corn fed to steers along with the shredded stover from the fodder.

9. Chickens digested Kafir corn and corn more completely when the grain was fed whole than when the meal was fed.

10. The Kafir corn and Kafir meal fed to chickens yielded but 2 per cent. less total digestible matter than corresponding corn products.

11. Kafir corn was a more suitable ration, considering only the relative amounts of growth making and fat forming materials for chickens than Kafir meal, corn, or corn meal.

Conclusions

1. Kafir kernel ranks close to corn as a food, as shown by the analyses of the proximate constituents.

2. Alcohol and glucose can be produced cheaper from Kafir kernel than corn when only the cost of the raw material is taken into consideration.

3. Kafir fat is without value as a lubricant, but in the manufacture of soaps and fatty acids, it is better than corn oil.

4. That Kafir corn is an excellent crop for semi-arid regions, and it will improve in accordance with the improvement of the conditions of growth and environment.

5. Kafir corn removes a smaller quantity of the important plant foods from the soil than corn, as shown by the analyses of the ash of both grains grown under similar conditions.

6. Kafir corn ranks close to corn as a feed for cattle and hogs. That it is as good, if not better, for poultry was shown by digestion trials carried on at this Station.