
Bulletin No. 166. December, 1899.

New York Agricultural Experiment Station.

Geneva, N. Y.

What Chemistry Finds in Feeds.


Published by the Station.
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*Connected with Fertilizer Control.
†Connected with Second Judicial Department Branch Station.
WHAT CHEMISTRY FINDS IN FEEDS.

F. H. HALL.

COMPOSITION OF FEEDING STUFFS.

The use of purchased feeding stuffs for animals has become widespread in all dairy sections. Why analyze feeds? Few milk producers grow all the grains their herds consume; and too often the milk shipper or butter maker has found it necessary to leave a large part of his month's check with the feed dealer who has supplied the bran, oil meal, buckwheat middlings or mixed feeds which the cows have eaten. So great has been the demand for these supplemental cattle foods that hundreds of brands have been placed on the market. These vary in quality all the way from some so-called "middlings" made up largely of mill sweepings and refuse, or the "corn-and-oat-feeds" composed of oat hulls and poor corn meal, to cotton seed meal with 50 per ct. of blood-and-muscle-making matter.

The chances for deception have been many and not all of them have been neglected. The farmer has had to depend largely upon the honor and intelligence of the dealer; for beyond a few general indexes of value, like color, taste and texture, the buyer can judge of the worth of a feeding stuff only by its effect upon his stock after feeding it some time. Even then he is not likely to know with great exactness its relative efficiency as compared with some other feed of similar or different composition. Usually feeding tests as conducted on the farm give no closer answer than this: "My cows gave more (or less) milk when fed bran than when fed buckwheat middlings.''

Careful feeding tests, however, with exact measurements of food and product and with chemical analysis of the materials used and determinations of the digestibility of these foods, show that the value of any feeding stuff depends almost wholly upon the amount

*This is a brief review of Bulletin No. 166 of this Station on Commercial Feeding Stuffs in New York, by W. H. Jordan and C. G. Jenter. Anyone specially interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed on the Station mailing list to receive future bulletins, popular or complete as desired. Bulletins are issued at irregular intervals, as investigations are completed, not monthly.
of digestible carbohydrates, fat and protein it contains. The percentages of these substances present can be quite easily determined by chemical analysis; so the use of such analyses, with digestion coefficients, is our quickest and best method for comparing food values.

The study of tables of analyses of feeds, the use of feeding standards and the discussion of "narrow" and "wide" rations have brought feeders to know that a certain relation must exist between the compounds in the food to produce the best results in feeding. This relation is not one mathematically absolute but it varies within quite wide limits according to the kind of animal and other conditions; yet we know that, while the greater part of the food is required to furnish heat and energy, from one-seventh to one-fourth of it should be of materials to make blood, repair wastes and build up tissue. In other words we should not have too great an amount of the fuels, the carbohydrate compounds, like sugar, starch, gum and fiber, and the fatty compounds as compared with the builders, the protein or nitrogenous compounds like the gluten of wheat, the casein of milk and the albumins of peas and oats.

Classification of feeding stuffs.

The materials used for feed, almost without exception, contain more of the combined carbohydrates and fats than of the nitrogenous compounds; but the ratios vary. Accordingly it has until recently been the custom to class as nitrogenous foods those containing larger amounts of protein than needed to make a well balanced ration, and to class as carbohydrate foods those containing less than this proportion of protein and a correspondingly larger amount of sugar, starch and fat. A closer classification than this must be used, however, if we wish to talk intelligently. It is absurd to speak in the same general terms of "nitrogenous feeding stuffs" when we include in the list wheat bran with 15 per ct. of protein and cotton seed meal which may have 50 per ct. Accordingly the following classification is suggested, using as examples a few of the most important foods in each class:

Class I. Containing 30 to 45 per ct. protein and 50 to 60 per ct. carbohydrates; and including cotton seed meal, linseed meal and the gluten meals, such as the Chicago, King, Cream and Hammond.

Class II. Containing 20 to 30 per ct. protein and 60 to 70 per ct. carbohydrates; and including gluten feeds, such as the Buffalo, Golden, Diamond, Davenport, Climax and Standard, as now made, Atlas meal, dried brewer's grains, malt sprouts, buckwheat middlings and peas and beans.
Class III. Containing 14 to 20 per ct. of protein and 70 to 75 per ct. carbohydrates; and including brans and middlings from wheat and rye, certain so-called mixed feeds of a proprietary character, these being in part oat feeds fortified with some more highly nitrogenous material.

Class IV. Containing 8 to 14 per ct. of protein and 75 to 85 per ct. carbohydrates; and including barley, corn, oats, rye, wheat, cerealine, hominy and oat feeds, corn and oat chop, corn bran, corn germ feed and chop feed in general.

The hays and other fodders belong in Class IV more nearly than in any other.

Principles to guide purchasers. Of the food compounds, the carbohydrates are most plentiful and are usually found in sufficient quantity in the crops grown on the farm. The dry matter of the corn crop, both stalk and ear, consists largely of sugar, starch and digestible fiber; while hay from grasses, and the cereal grains also add proportionately more to the fuels of nutrition than to building material. In the past we have obtained but small amounts of protein in our farm foods; though we are now learning wisdom and depending more largely upon home grown clover hay, alfalfa, peas-and-oats, cow peas and similar protein-rich forage.

As protein rather than carbohydrates is the lacking element of farm crops, it has come to be taken as the principal index of food value in purchasing. Fat has a fuel value 2 1/4 times as great as sugar or starch. So it, also, must be considered in comparing feeds. These two classes of compounds, protein and fat, must be guaranteed to the purchaser, according to the new feeding stuffs law of the State. Carbohydrates, however, should not be neglected in our study of commercial feeding stuffs; for, of course an equal amount of digestible starch has the same value in purchased foods that it has in food grown on the farm; and if we need it we can afford to pay a reasonable price for it. But further than this the carbohydrates, and especially the fiber, should be studied; for we find in their examination, the best clue to adulteration.

Adulterations.

In all the samples examined by the Station in 1898 and 1899 the worst cases of adulteration were found in mixed feeds: Oat feeds, wheat feeds, corn-and-oat feeds, corn, oat-and-barley feeds, chop feeds, and various others with proprietary names. The most common addition to the ground grains and legitimate milling by-products, of which these feeds consist, is oat hulls from the breakfast-food mills. Oat hulls form only one-fourth or one-third of the natural grain, but they were found to make up one-
half the weight of some of these feeds. These hulls contain large amounts of indigestible fiber (woody matter of as much value for food as sawdust or shavings) and are worth no more than so much oat straw at best. In 26 cases out of 34 of these mixed feeds examined, the fiber content is larger than in average oats, and in 16 cases it runs from one-tenth higher to three times as high as in the entire oat grain, notwithstanding the fact that these mixtures contain corn meal which is low in fiber content. Such a large amount of fiber is usually accompanied by a large carbohydrate content and a correspondingly low percentage of protein; but some sellers are keen enough to add oil meal or gluten meal to bring up the protein. Even then the mixture is a fraud. Even if the apparent amounts of valuable ingredients are there, the digestible matter is not there; and the energy required to masticate and move the indigestible material through the system uses up a large part of the digestible nutrients. Yet such feeds usually sell in market for prices that would purchase equal amounts of corn meal and ground oats.

**Corn cobs.** Evidence was also found that a Kentucky manufacturing company is shipping into the State a mixed feed containing large amounts of ground corn cobs, a material of even less value as a food than oat hulls. In almost no case was there found any evidence of systematic addition of mineral matter to feeds, though the ash content of some of the brans and middlings indicated that the mill floors were very thoroughly swept and that the sweepings did not all go into the stove or out doors. In no instance was there even the slightest ground for belief that “Mineraline” or soapstone was used as an adulterant.

**Mineral adulteration.**

**Analyses of Samples.**

**Methods.** Samples of feeds have been collected during the past two winters and analyzed chemically, physically and often microscopically. This work has been done by the Station as a matter of investigation, not under the feeding stuffs law, as the latter has but just passed into effect. Accordingly, the names of manufacturers and dealers and the names of brands can not be given in many instances, even in the complete bulletin. Here we have room only for statement of general conditions found to exist in feeds of different classes.

**Cotton-seed meal.** Cotton-seed meal is the fine nutty-flavored meal which comes from grinding the cake left after the seeds of cotton have been stripped of their woolly covering and tough husks or hulls, cooked and compressed to extract the oil. It should be light yellow in
color, a darker hue usually indicating inferiority. Protein may range from 42 per ct. to 46 per ct. or more in good samples. Of 16 samples only two showed evidence of adulteration, due to grinding in the woody hulls; but the price did not follow the percentage of protein. Cotton-seed feed is a combination of the meal and the hulls and is usually of very inferior value.

Oil meal. Oil meal or linseed meal is made from flax seed after the oil has been extracted. Old, or pressure, process meal and new, or naptha extraction, process meal differ mainly in fat, the former containing three or four pounds more per hundred. Protein of new process meal is perhaps less digestible because of cooking. Nineteen samples were examined and all were good. One was somewhat low in protein but with no sign of adulteration. The old process meal averaged 35\(\frac{3}{4}\) per ct. protein and 7.2 per ct. fat; the new process, four-tenths of 1 per ct. more protein, half as much fat.

The gluten products are residues of corn left in the manufacture of glucose. Gluten meals consist mainly of hard or flinty portions after the bran, the germ or chit of the corn kernel and part of the starch have been removed. They should contain at least 30 per ct. of protein to be classed as meals and may go to 40 per ct. Two samples analyzed were good but the less nitrogenous sold for the higher price.

Gluten feeds. The gluten feeds are a mixture of the meal with the bran and germs and are less rich in protein than the meals, ranging from 18.8 per ct. to 28.1 per ct. This marked difference seems to be quite constant between the brands, samples of Joliet and Diamond brands running low. The average of all analyses showed 23.7 per ct. protein, 55.7 per ct. carbohydrates, 4.5 per ct. fat and only 6 per ct. fiber.

Malt sprouts are the dried shoots from germinated Brewery and barley. But few samples were analyzed and distillery products. these were found normal in composition, with from 24.66 per ct. to 30.37 per ct. of protein. Brewer's grains are the barley grains from which the starch has been removed by growth and fermentation. In fresh state they contain too much water to justify paying a very large price. Dried they furnish about as much protein as the malt sprouts.

Buckwheat middlings and other buckwheat products were found of good quality, but varied widely by-products. in protein content, the middlings and feed running from 24.8 per ct. to 33.7 per ct., while the single sample of "ships" showed 33.75 per ct. protein, 9.2 per ct. fat.
Wheat offals. Wheat brans were found pure, but not constant in composition, the protein ranging from 13.4 per ct. to 17.1 per ct., and the starch from 17.5 per ct. to 30.6 per ct. The mixed wheat feeds are combinations of the offals of wheat milling and showed only the natural variations. Wheat middlings, with one exception, proved normal in composition, showing only variations similar to bran and due to same cause, difference in milling processes. Middlings contain more protein, more starch, a little more fat and less fiber than bran and are more digestible. It would seem that preference should not be given to bran as a feed.

Hominy feed or hominy chop consists of the hull, germ and part of the starch of corn grains; and contains less starch, about the same amount of protein and more fiber and fat than corn meal. The samples analyzed appeared quite uniform in composition, except Hudnut's which contained 7 per ct. more protein than the average. The average was about 10.5 per ct. protein, 46 per ct. starch and sugar and 7.75 per ct. fat. The prices were much less uniform than the percentages.

Miscellaneous feeds. Pea meal is not quite so good a feeding stuff as the average gluten feed. It contains about 1 per ct. less protein, 3 per ct. less fat and nearly 3 times as much fiber.

Rye feed corresponds quite closely in composition to wheat bran. Certain feeds which are refuses from starch manufacture, a starch feed and a so-called "gluten feed," are very low in protein content, being very like corn meal in composition. These should not be confused with the true gluten meals and gluten feeds.

Patent foods. Condimental cattle foods, made up of some simple feeding stuff like linseed meal, middlings, corn bran, etc., with a small quantity of charcoal, sulphur, fenugreek, gentian, salt, iron compounds, pepper and other cheap drugs, were found on sale in great numbers and at exorbitant prices, varying from $100 to $500 a ton. This is from $70 to $470 per ton more than the best of them are worth as feeds. Their value as medicines is problematical. They are at best little more than tonics, and would be of no use whatever in the case of severe disease. In such cases, a competent veterinarian should be consulted. If the animal is well it needs no medicine, not even a tonic. If, in any case some condiment or tonic is needed, it can be found in simple drugs kept in nearly every stable or household, or which can be purchased at the drug store for a small fraction of the price you would pay for them in a patent food. These can be mixed with linseed meal or middlings without calling in the highly paid services of any professional compounder of nostrums.