4. 2 per cent. ammonia in water.
5. 2 per cent. ammonia in alcohol.
6. N/200 calcium hypochlorite.

Very delicate reagents were found to give better comparative results, and for the same reason the time of exposure was limited to one hour. Strips of the paper in Erlenmeyer flasks were covered with the reagent and the immediate effect as well as that after each fifteen minutes was noted. Only the final result after an hour's action is recorded in the table. It is noteworthy that water, which with the exception of the copy papers does not affect the ink as a solvent, does remove it mechanically to a material extent, and with the other reagents also the largest part of their effect is due to the displacement of the ink bodily, and not to any chemical or solvent action.

* * * * *

Beginning with Table III the papers which show the best writing qualities and the most resistant ink are numbers 2288, 2289, 2291*a*, 2291*b*, 2300 and 2303 among the black record class; numbers 2302 and 2382 of the blue record; number 2291*c* among the copy papers and possibly number 2301 of the purple record. Numbers 2288, 2289, 2300 and 2303 from Table I have the best paper backing but 2303 does not give a good stretch test and from Table II has but 44 per cent. of ink, indicating that it would be short-lived. Number 2288 has also a small quantity of ink. The choice lies then between numbers 2289 and 2300, made by different manufacturers of established high standing, number 2300 having the advantage of being a feather weight paper with exceptionally high tensile strength and stretch.

The purple record papers were made by the same firm and are of nearly equal quality, the advantage being slightly in favor of 2301 in the tests of the writing and the strength of the paper foundation, and with the disadvantage of having somewhat less ink. Of the blue record papers, number 2382 though of lighter weight has the greater strength and much more available ink. Of the copy papers, number 2291*c* has very high strength and stretch but unfortunately only a small amount of ink. For some of the tests of writing number 2306 stands higher than 2291*c* and the strength of the paper is greater, but the amount of ink is possibly too low to give long service.

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GLUTEN FEEDS—ARTIFICIALLY COLORED.

By Edward Gudeman.

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Gluten feeds are the by-products obtained in the starch, glucose, corn sirup and starch-sugar industries. In the process of manufacture the corn (Indian maize) is soaked for a given time in a warm, very dilute sulphurous acid solution. The surplus liquor, used for this soaking, is drained off and the thoroughly softened corn put through the milling process and by mechanical means the following by-products are separated: the oil-bearing germ, the bran (shell) and the gluten. The bran and the gluten are often dried as such, giving the well-recognized commercial feeding-stuffs, known as corn bran and gluten meal. A mixture of the corn bran with the gluten, generally made before either of them are fully dried, mixed in the same proportion as obtained from the original corn, gives the well-known standard gluten feed. Gluten feed is low in water-soluble carbohydrates, fat and ash, and has a distinct brilliant golden-yellow color. This color varies only slightly in shade, depending on the color of the corn used and on the age of the feed.

The surplus water used in softening the corn (steep-water) is often evaporated to a sirupy condition and added to the wet gluten feed. This steep-water contains a large percentage of water-soluble carbohydrates, protein and ash, and has a high nutritive and fertilizing value. Gluten feed to which evaporated steep-water has been added is high in water-soluble carbohydrates and ash, has a character similar to a mixed molasses feed, a characteristic burnt flavor and odor, and is brown in color.

The oil-bearing part of the corn, the germ, is separated as such, dried and the corn oil expressed by direct pressure, leaving as a by-product the corn oil cake, a high-grade commercial feeding-stuff, containing about 12 per cent. of corn oil. This corn oil cake is often finely ground and added to the gluten feed, thereby increasing the oil contents. Such mixed gluten feeds are grayish-brown in color. In some cases both the evaporated steep-water and the ground oil cake are added to the gluten feed, producing a grade, high in water-soluble carbohydrates, ash and oil, with the peculiar burnt flavor and odor, having an off color.

The color of a gluten feed is no indication of its nutritive value nor directly of its quality, still preference is often given by the buyers to the bright yellow gluten feeds. Examinations of a large number of these feeds as found in the United States during the past year, have shown that many of these gluten feeds were artificially colored with coal tar colors. Some of the colors used combine very strongly with some of the component parts of the gluten feeds and often cannot be completely separated when making an examination for colors by the accepted method,[1] although in every case, a slight modification of the method gave positive results. Only in exceptional cases was it found necessary to apply the modified test, using a preliminary ammonia treatment, to bring the color into solution. In all cases the boiling of the acid solution should be

[1] Sostegni, Carpentieri and Arata, *Bull.* 107 [rev.], pages 190–191, Bureau of Chemistry, Dept. of Agriculture.

prolonged to at least one-half hour, to get a good transfer of the color from the feed to the wool. Using an alcoholic acid solution for the first transfer gives a much stronger dye test, but more of the natural color of the feed is thereby extracted.[1]

The following modification or preliminary treatment was found to extract the color more completely, but can be applied only if the product on heating does not become semi-solid, due to formation of starch paste. 5–10 grams of the gluten feed are allowed to stand, with occasional shaking for about one-half hour, with 150 cc. of a 1 per cent. ammonia solution. The mass is then heated to gentle boiling and kept boiling for about 1 hour, adding boiling water to keep up original bulk. The solution is then separated, either by draining or pressing and allowed to cool. This solution, which need not be clear, and seldom is, is then used to make the dye test with the wool, being acidified with hydrochloric acid, the wool added and the solution boiled for at least one-half hour. This dyed wool is then treated with ammonia to separate the vegetable and natural color, the solution again made acid and the second sample of wool dyed, again boiling the acid solution for not less than one-half hour. The boiling of the acid solutions must be prolonged beyond the time given in the method[2] to get a good transfer, using 5–10 grams of the feed, with 150 cc. of 1 per cent. hydrochloric acid to the wool. When testing the feeds direct, without preliminary treatment and without filtration, it is advisable to prolong the boiling for over 1 hour, especially if the amount of color used is very small. The use of mordants (bisulphate of sodium or potassium) in the acid baths, reduces the time of operation.[2]

The coloring of the second wool sample, ranging from a bright canary-yellow to a deep reddish-yellow is positive proof of added coal tar color to the gluten feed.

If the percentage of oil is high in the gluten feed, it may be extracted before making color examination. The extracted oil must then be separately examined for added color, using the same methods and precautions as in the detection of added color to butter. On account of the insolubility of many coal tar colors in petroleum ether, this solvent is given preference in making oil extractions, in the examination of feedstuffs for artificial color.

Examinations of ninety samples of gluten feeds, as found in the United States markets during the past year, have shown sixty-eight samples as containing added color, having been artificially dyed, or over 75 per cent. of the total number examined. Of six samples received direct from manufacturers, only one showed a very slight amount of added color.

Examinations made on different kinds of corn, ranging from white

[1] Method suggested by Dr. E. H. Jenkins, Conn. Expt. Station.

[2] *Bull.* 107 [rev.].

to dark red, and on the component parts of corn (bran, germ and gluten), in all cases gave negative results for added color, tested under like conditions with the gluten feeds. The evaporated steep-water often gives a faint color reaction, similar to caramel (sugar) coloring, on the first wool sample.

The artificial coloring of feed-stuffs is contrary to the Federal Food Act and to many State Food Acts, unless it is specifically stated that the food product is artificially colored. The purpose of adding color to gluten feeds is only for deception, to make them appear better than they really are or to hide some inferiority, such as the use of rotten, burnt or fermented corn. The buyers of gluten feeds are fully aware that these products cannot be of absolutely uniform color or shade, due to variation in color of the raw material used, the corn. It cannot even be justly claimed that a high artificial color makes feeds more palatable, as it is very doubtful whether the esthetic taste or the idiosyncrasy of the animals have been sufficiently developed to discriminate between brown, grayish-brown or golden-yellow gluten feeds.

I wish to express my thanks to Messrs. Hills, Jenkins, Jordan, Voorhees, Wheeler and Woods, Directors of the Vermont, Connecticut, New York, New Jersey, Rhode Island and Maine Experiment Stations, for some of the samples gathered in their respective states and forwarded to me.

Nothing was known to me as to the history or as to the manufacturers of these samples of gluten feeds, they were submitted under identification marks only.

POSTAL TELEGRAPH BUILDING, CHICAGO.

[CONTRIBUTIONS FROM THE HAVEMEYER LABORATORIES OF COLUMBIA UNIVERSITY, NO. 158.]

THE CALORIFIC POWER OF PETROLEUM OILS AND THE RELATION OF DENSITY TO CALORIFIC POWER.

BY H. C. SHERMAN AND A. H. KROPFF.

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The purpose of this paper is to put on record the calorific power of a considerable number of representative American petroleum oils and to point out an approximate relationship between the density and the calorific power of such oils.

While among the homologues of a given series of hydrocarbons, decreasing proportions of hydrogen might be assumed to involve an increase in density and decrease in heat of combustion or calorific power, it would not necessarily follow that such a relation would obtain for the mixtures of hydrocarbons which constitute the crude petroleums or their commercial products. Nor have we been able to find in the literature suffi-