THESIS,

EXTRACTIVES FROM RAW COTTON FIBRE,

FOR THE DEGREE OF

SCHOOL OF CHEMISTRY,

BY

John A. Miller,

1885.
Extracts from Raw Cotton Fibre.

The magnitude which the manufacture of cotton goods has reached within the last fifty years, and the importance that the resinous, waxy, or fatty substances which surround the fibre, and the natural colouring matter which is enclosed within the cellular structure of the filament to remove in order to secure the intrinsic whiteness of the cotton and thus add to the clearness and brilliancy of the colours with which it may be dyed or printed, certainly warrants a more extended treatment than the time at my command allows me to give a subject of such importance.

The object then of this investigation is to ascertain the character, composition, and some of the properties of the various constituents of the raw cotton fibre.

That so little has been done seems a wonder when we consider the importance which this subject bears to the cotton industry in general and to bleaching in particular.
In Uri's Dictionary of Arts and Sciences, Vol I, Page 346 is found the following. The substances to be especially dealt with in bleaching are as follows:

a. - The resinous matter natural to the filament.
b. - The colouring matter of the plant.
c. - The paste of the weaver.
d. - A fatty matter.
e. - A Cupreous Soaps.
f. - A calcareous soap.
g. - The filth of the hands.
h. - Iron rust, earthy matter, and dust.
i. - The cotton fibre itself.

j. - The carbonous matter caused by singeing.
k. - The seed vessels.

Since the cotton used in this investigation was the raw fibre as it came from the carding machines, it will be of importance to consider only "a", "b", and "d". But more particularly "a", since it
is this waxy matter which hinders the absorption of moisture and thus prevents the fibre from receiving some of the darker colours which could be dyed without any blanching, providing impurities from manufacture were absent, although the finest colours could not be produced in this manner or cotton in general. "The matter which prevents the moisturing has not been thoroughly examined."

"It is soluble in alcohol and ether and some of it in oil of turpentine. It is therefore called a resinous, waxy or fatty body." It is dissolved by alkalies and thrown down by acids from strong solutions."

Persoz in his "Traité de l'Imprimerie des Tissus," says that the raw cotton fibre contains:

1. A certain quantity of colouring matter. "That the action of blanching material is hindered either by the nature of this substance or by some accompanying body."

2. A resin peculiar to the fibre, which is insoluble in water and dissolves with difficulty in alkalies. It acts as a protecting varnish to the colouring matter.
3. A certain quantity of fat, which for the most part is probably derived from the machinery used in spinning and weaving.

4. An indifferent substance (flour, starch and gum) which is added by the weaver.

5. Inorganic substances, principally salts, which are partly contained in the fibre and partly derived from other sources.

In 1868 Dr Edward Schunck F.R.S. undertook the investigation of this same subject, but paying especial attention to the waxy matter. From that time to this, as far as the literature at my command affords me the opportunity of learning, nothing has been done. The method which Dr Schunck pursued was as follows:

Five hundred (500) pounds of middling Orleans cotton fibre which was boiled with a strong solution of soda ash for seven and a half hours. The result was a dark brown liquor, which when treated with sulphuric acid in excess precipitated a rich brown flocculent matter. After the precipitate had settled the supernatant liquid was carefully
decanted and the precipitate freed of the presence of Na₂SO₄ and the excess of Na₂SO₄ by washing with cold water. The precipitate being placed in a cotton filter-sack and allowed to drain. In this manner a thick liquid was obtained which after drying appeared to be a brown, friable, horn-like mass transparent at the edges. Of this acid precipitate Dr. Schmuck found that it was almost entirely composed of organic substances, the following of which were recognized:

1. A variety of vegetable wax.
2. A solid fatty acid.
3. A colouring matter.
4. Acetic acid.
5. A trace of an albuminous body.

This vegetable wax or "cotton wax as it is called by its discoverer Dr. Schmuck has according to his analysis the following percentage composition:

- Carbon — 80.36
- Hydrogen — 14.51
- Oxygen — 5.11
It melts between 83° and 84° C. When perfectly pure it is practically insoluble in alkalies, while it is readily soluble in alcohol (C₂H₅O) and ether.

Dr. Bowman in his "Structure of the Cotton Fibre" says: "From these facts (insolubility in alkalies and solubility in C₂H₅O and C₄H₇O) it has been assumed that the wax is really deposited on the surface of the outer sheath of the fibre, and when the cotton is subjected to the action of the hot liquid in bleaching and other processes, this wax is simply melted and removed mechanically from the surface." A little further on Dr. Bowman says: "Many cottons also contain associated along with them more or less endochromine, which is irregularly distributed in the interior of the fibre." Along with the Egyptian cotton there is always a large amount of this colouring matter, which is present in sufficient quantity to give a decidedly reddish-brown or golden colour, and which is soluble in alcohol, but what its exact nature and composition is I have
not been able to determine." Dr. Schumck in a paper before referred
to, made a very careful examination of the colouring matter associated
with American and East Indian cotton, and found that it was
of two kinds, one of which is readily soluble in cold alcohol and
which he called "A", and the other which he named "B" soluble in
boiling alcohol. "These two substances yielded upon analysis
the following result:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>58.30</td>
<td>57.77</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>6.12</td>
<td>6.05</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>6.18</td>
<td>8.74</td>
</tr>
<tr>
<td>Oxygen</td>
<td>29.40</td>
<td>27.44</td>
</tr>
</tbody>
</table>

On these analyses Dr. Schumck remarks: "It will be seen
that the composition of the substance varied, especially as regards
the nitrogen, much more than it ought to have done, supposing
it to have been perfectly pure." As the above constitutes all the
available literature upon the subject in hand, it will be
form that comparatively little work has been done.

In our own work it appeared necessary to review first of all, nearly everything that has been done, and the first experiments were devoted to the determination of the value of various solvents in the separation of the substances adhering to the cotton, both from the film and from each other. The later experiments were confined to the purification of the several extracts at hand and the determination of their composition and several properties.

The solvents which gave the greatest promise of satisfactory results were turpentine, alcohol, water and sodium hydrate. In their application the following method was employed.

A certain quantity of cotton was placed in a continuous extractor and repeatedly washed with hot redistilled turpentine. This turpentine extract was placed in a retort and the excess of turpentine distilled off, the residue in the retort placed in a dish and evaporated to dryness at a low temperature. The residue was a slightly colored substance having the appearance of fat, hardly soluble in ether.
The cotton was then placed in a glass-stoppered bottle and thoroughly washed with hot alcohol. This alcoholic solution or extract "C" was distilled until the liquid in the retort measured about 75 cc. The retort was then emptied, rinsed and the liquid set aside to cool. A flocculent grey-coloured substance (C,) separated upon cooling, after thoroughly washing with cold alcohol, in which it is insoluble. This substance is dried and treated with benzine, in which menstruum (part of it dissolves) leaving a grey substance behind, which in all probability is nothing more than mechanical impurities.

The alcoholic filtrate was evaporated to dryness on a water-bath and the residue (C4) thoroughly washed with hot water and filtered.

The water solution (C4) of a rich brown colour and bitter taste consists of two substances, one of which (C4a) is precipitated by basic lead acetate, and the other (C4b) is not precipitated by that compound.

The residue (C5) which remains on the filter after washing (C4) with water was then treated with benzine, part of the residue
dissolves (C) which upon the evaporation of the truzine leaves a substance of the consistency and colour of vaseline.

The cotton was then boiled for three hours with distilled water. The result was a brown solution (D) after the concentration of which alcohol produces a brown precipitate (D). This precipitate adhered most tenaciously to the filter paper and could not be removed without the adherence of particles of the same.

Upon evaporating the filtrate to dryness a dark coloured residue (D2) remains, no part of which is soluble in petroleum naphtha.

If this residue be treated with 92% alcohol a portion dissolves (D3) the residue (D4) insoluble in 92% alcohol is readily soluble in cold water. If to the aqueous solution of (D4) is added basic lead acetate 57.88% is precipitated by it. The remaining 42.12% not precipitated by lead subacetate is a brown coloured substance partly soluble in 92% alcohol.

The cotton was then boiled with a 2½% solution of NaC0 for three hours. The result was a rich brown liquid from
which after concentration hydrochloric acid in slight excess precipitates
a dark brown substance (E). This precipitate like (Dr) adhered most
firmly to the filter paper and could not be removed but with
accompanying particles of paper. This substance is in all prob-
ability an albuminous body. The test made for its identity will
be given further on when we come to speak of the properties of
these various compounds. There remained after (E) had been fil-
tered off a brown liquid which contained much NaCl. This solution
was evaporated to dryness and washed with 75% alcohol which re-
moved a brown coloured substance and some NaCl. In order to determine
the absolute percentage of organic matter a portion of this substance
was weighed and then ignited; the loss of weight represents the
organic matter.

The quantities secured in the several treatments above described are
shown in the figures of the following table representing averages
of duplications secured with two samples of cotton.
<table>
<thead>
<tr>
<th>Sample of Cotton</th>
<th>X</th>
<th>Y</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total c_{2}h_{6}o extract</td>
<td>0.3135</td>
<td>0.4478</td>
<td>0.1996</td>
<td>0.2010</td>
</tr>
<tr>
<td>Portion soluble in ether</td>
<td>0.0627</td>
<td>0.1344</td>
<td>0.0572</td>
<td>0.1124</td>
</tr>
<tr>
<td>Insoluble in ether</td>
<td>0.8987</td>
<td>1.6970</td>
<td>0.1074</td>
<td>0.0902</td>
</tr>
<tr>
<td>Insoluble in benzene</td>
<td>0.0242</td>
<td>0.0461</td>
<td>0.1020</td>
<td>0.7838</td>
</tr>
<tr>
<td>C_{2} wax vegetable</td>
<td>0.0359</td>
<td>0.1698</td>
<td>0.5543</td>
<td>0.6086</td>
</tr>
<tr>
<td>Insol in h_{2}o + benzene</td>
<td>1.7775</td>
<td>2.1330</td>
<td>0.2791</td>
<td>0.0792</td>
</tr>
<tr>
<td>C_{7} soluble in water</td>
<td>0.1050</td>
<td>0.1902</td>
<td>1.3934</td>
<td>1.9246</td>
</tr>
<tr>
<td>Total h_{2}o extract</td>
<td>2.315</td>
<td>0.9693</td>
<td>0.2457</td>
<td>0.3420</td>
</tr>
<tr>
<td>Alcoholic ppt.</td>
<td>2.0699</td>
<td>0.6273</td>
<td>5.3041</td>
<td>5.2471%</td>
</tr>
<tr>
<td>D_{3} sol. in 92% c_{2}h_{6}0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D_{4} insol in 92% c_{2}h_{6}0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total water extract</td>
<td>5.3041</td>
<td>5.2471%</td>
<td>5.3041</td>
<td>5.2471%</td>
</tr>
</tbody>
</table>
Sampler B was the ordinary cotton obtained from dealers in dry goods. It contained sprinkled through it in very small quantities bits of leaf from the cotton plant. The other sampler "A" was a beautiful sample of clear cotton and was obtained through the courtesy of Mr. H. E. Kittredge, Editor of the Boston Journal of Commerce.

From the above data, it may easily be seen that the total amount of matter extracted differs materially in the two samples of cotton.

The amount of wax and fat which benzine extracts is small when compared with that which alcohol removes from the cotton fibres and stands in the relation of about two to one. After the wax has been removed there appears but little difficulty in removing the colouring matter, water extracting very nearly one-half of the total matter removed, and the greater part of this extract being a cinnamon-coloured nitrogenous substance the properties of which will be discussed later on.

It would therefore appear that if some means be devised by which the wax could be removed in a cheap manner, the remaining colours could be easily gotten rid of by means of boiling water.
We may now consider some of the properties of the various extracts and their ultimate composition.

Taking them in the order in which they were extracted, we have the substance soluble in ether (C<sub>4</sub>H<sub>14</sub>0<sub>0</sub>). It is a light yellow fatty substance melting at 68°C. and solidifying at 55°C.

Treated with fixed and volatile alkalies it forms a soap, from which acids either precipitate it unaltered or throws down an insoluble fatty acid. The ultimate composition of this ethereal extract is as follows:

<table>
<thead>
<tr>
<th>Found</th>
<th>Calculated for C&lt;sub&gt;12&lt;/sub&gt;H&lt;sub&gt;30&lt;/sub&gt;0&lt;sub&gt;2&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>71.158</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>15.708</td>
</tr>
<tr>
<td>Oxygen</td>
<td>13.134</td>
</tr>
<tr>
<td></td>
<td>100.000</td>
</tr>
</tbody>
</table>

As this in all probability is a mixture of fatty acids, it would hardly do to calculate for it a formula. If we do so however, the above is the most probable empirical formula.
The next or lignum extract, that is, totally soluble in benzene, was very small; there being being simply sufficient material to determine the melting point which was 82°C. The substance was white with the very least trace of colour. It had a hard waxy appearance. And in all probability is identical with the vegetable wax dissolved by alcohol.

The next important extraction was made with alcohol and yielded many interesting substances. The first which claims our attention is C1, or that portion of the alcoholic extract which separated from the solution upon cooling and was insoluble in benzene. It was an amorphous body of grey colour and had the appearance of moisturised dust. Of this grey powder 70.06% was organic and the remaining 29.94% inorganic. This ash consisted almost entirely of iron and calcium, in what form was not determined. Treated with the alkalis it remained unchanged. Fuming HCl dissolved it to a yellow solution. Nitric acid, apparently, has no effect upon it, and sulphuric acid merely darkens the substance.

Our attention is now called to a vegetable wax. It is a colourless,
rather hard substance soluble in hot alcohol (C₂H₆O), benzine, and readily soluble in hot methyl alcohol. Three determinations of the melting point gave the following 81°, 81.5° and 82°C. The average figures are.

An ultimate analysis of this wax gave the following percentage composition:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>73.22</td>
<td>73.3</td>
<td>73.26</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>12.52</td>
<td>12.50%</td>
<td>12.51%</td>
</tr>
<tr>
<td>Oxygen</td>
<td>14.26%</td>
<td>14.19%</td>
<td>14.22%</td>
</tr>
</tbody>
</table>

If we calculate for this a formula which will merely represent the ratio of the elements in this mixture of fatty or wax substance we have the following as most probable C₁₂H₂₄O₂. The calculated percentage composition would be viz:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>72.60</td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
<td>12.00</td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>16.40</td>
<td></td>
</tr>
</tbody>
</table>
This percentage composition and formula agree with that of lauric acid. The wax, as it may be called, is however not a simple substance but a compound or mixture of two or more substances as will be seen directly. Aqueous solutions of the alkalis have no effect upon this vegetable wax and the acids cause a slight coloration. If however it is boiled with a solution of alcoholic potassium (30 grams KNO to 500 c.c. of 27° Bé) the alcohol is expelled by boiling and the resulting aqueous solution treated with normal acid in slight excess, the substance or wax splits up into two or more substances of which 2.47% are soluble in the acid liquid and 97.53% insoluble.

This insoluble acid has a light yellow color and a strong, turgid odor resembling very much turpentine. An attempt was made to determine the percentage composition of this insoluble fatty or waxy substance but owing to an unfortunate accident in the process of combustion, the small quantity at hand was lost. More of the waxy insoluble portion might have been prepared but for the fact there was not sufficient wax left.
In percentage composition this wax approaches myristic acid more closely than laurie acid.

Cotton 74.74 — Myristic Acid — Lauric acid.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>73.26</td>
<td>73.68</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>12.573</td>
<td>12.28</td>
</tr>
<tr>
<td>Oxygen</td>
<td>14.227</td>
<td>14.04</td>
</tr>
</tbody>
</table>

While these three can scarcely be considered identical yet they approach each other very closely.

C₂ to the wax portion dissolved out by turpentine. It is soluble in hot C₂H₄O, C₂H₆O and slightly soluble in ether. With alkalis it forms a soap, acids decomposing it. A saturated alcoholic solution of lead acetate does not precipitate it from its alcohol solutions.

C₆+1

The next extract or that substance insoluble in turpentine and water requires our attention. Its percentage composition was not determined but it was merely but a few qualitative tests, but with no possibility of identification. Its colour it was light.
brown. Soluble in C₂H₂O. Insoluble in ether, benzine and water. Precipitated from alcoholic solutions by water. Fuming hydrochloric acid had no action on it. Concentrated sulphuric acid dissolved it with the formation of a pink to red solution: the addition of Ammonium hydrate (NH₄H₂O) to this solution causes it to change from red through green to a straw yellow. Concentrated nitric acid converted it first into a green substance, and then very light brown and then finally to a straw yellow. Alkalies do not affect it in any way. We judge from the depositment of this substance with the reagents guine, that it is most probably some chlorophyll colouring matter due to the tis of cotton plant leaf which were sprinkled through the sample.

We next find ourselves interested in one of the colouring matters proper (C₇). It is that portion of the alcoholic extract which was soluble in boiling water and forming from 0.5 - 0.6% of the cotton. Dissolved in water and treated with basic lead acetate a portion was precipitated (C₇a) being 14.48% of C₇ and the remainder (C₇b) 85.51% not precipitated by lead.
C7a. After decomposing the lead salt with hydric sulphide and filtering off the PbS formed, the solution evaporated to dryness over a water bath and the resulting substance submitted to various tests. First a determination of nitrogen was made according to Kjeldahl's method with negative results. An aqueous solution of this substance boiled with Kehl's solution (Violets' formula) caused no precipitate but changed colour of solution to green. No precipitate with BaCl₂. With FeCl₃ no change. AgNO₃, no precipitate. Boiled with acid and tested (sugar) with Kehl's solution, no precipitation of subioxide of copper. I regret that the quantity secured was not sufficient to ascertain the percentage composition.

C7b. The portion not precipitated by basic lead was submitted to an ultimate analysis with the following results for percentage composition.

Tests for nitrogen by heating with soda-lime and by the Kjeldahl method gave only negative results.
If now we calculate for this an empirical formula, it is in most probability \( C_4 \; H_{10} \; O_8 \).

We have now to consider the extract obtained by the action of boiling water. After this extract had been concentrated by evaporation, alcohol produces a precipitate— which was of a light brown colour. It adheres so very tenaciously to the filter paper that it could not be removed without some fibre of the paper adhering. It would not redissolve in boiling water. Treated with fuming \( \text{HCl} \) it partially dissolves to a yellow solution but with no tendency to the formation of a blue colour upon exposure to the atmosphere. The filtrate was then evaporated to dryness and treated with 92\% alcohol which dissolved out a cinnamon-coloured substance,
very easily soluble in water and alcohol. Boiled with Fehling's solution (Violets' formula) it causes no precipitate— but changes the colour of the solution to green. With Fe₂Cl₆ it causes a deepening of the colour. Boiled with HCl and then tested with Fehling's solution no change.

Basic lead acetate precipitates it from its solutions. It absorbs moisture with considerable rapidity.

An ultimate analysis of the substance gave the following percentage composition:

- Carbon — 24.37%
- Hydrogen — 9.81%
- Nitrogen — 16.08%
- Oxygen — 49.74%

Assuming this substance to be pure we calculate for it the following empirical formula C₂H₁₀(N₂O₃)₂. From the percentage composition it will be seen that the quantity of nitrogen present is sufficient to call it an albuminoid.
but the carbon is about one-half to small.

Dy. The residue which remained after treating with 92% alcohol is rather a complex mixture. With reagent it reacts as follows soluble in water, insoluble in C\textsubscript{2}H\textsubscript{4}O and C\textsubscript{2}H\textsubscript{4}O. Boils with Schlenk's solution nearly change solution to green. \textbf{BaCl\textsubscript{2}} produces a light precipitate. Boils with \textbf{NaH\textsubscript{2}} evolves \textbf{NH\textsubscript{3}}. Not precipitates from its aqueous solutions by \textbf{AgNO\textsubscript{3}}. \textbf{K\textsubscript{2}CO\textsubscript{3}} no change. When the substance was dissolved in water and basic lead acetate added to the solution 57.88\% is precipitated. This lead salt carefully dried was submitted to an analysis with the following results:

\[
\begin{align*}
\text{Lead (Pb)} & : 61.39\% \\
\text{Carbon} & : 9.272 \\
\text{Hydrogen} & : 2.693 \\
\text{Nitrogen} & : 3.322 \\
\text{Oxygen} & : 23.333
\end{align*}
\]

Assuming this substance to be pure as in all probability
it is, we have the following formula for the lead salt.

\[ \text{C}_3 \text{H}_7 \text{N}_7 \text{O}_5 \] with a probable formula for the organic substance of \[ \text{C}_3 \text{H}_{10} \text{N}_7 \text{O}_5 \].

The remaining 48.12% not precipitated by basic lead was evaporated to dryness after removal of lead by Hydrogen Sulphide. A portion of this residue dissolved in 92% alcohol.

The cotton having been treated with tannine, alcohol and water is next boiled with a 2½% solution of NaHCO₃. The extract is concentrated and a slight excess of HCl added, producing a brown precipitate adhering so tenaciously to the filter paper that it could not be removed without some of the filter fibre. With fuming HCl it forms a yellow solution which has a tendency to change to blue when allowed to remain exposed to the atmosphere.

The clear filtrate evaporates to dryness and treated with dilute alcohol gave a brown coloured solution. Evaporated to dryness and treated with \( \text{H}_2 \text{O}_3 \) it dissolves to a yellow solution. With concentrated \( \text{H}_2 \text{SO}_4 \) dissolves very readily with the formation of a
light brown solution. This sums up about the extent of the work and to give it in smaller space we tabulate it below.

<table>
<thead>
<tr>
<th>Brugine</th>
<th>Heat alcohol</th>
<th>Solution cooled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat - partly sol</td>
<td>In ether</td>
<td>Colored ppt.</td>
</tr>
<tr>
<td></td>
<td>In insoluble</td>
<td>Soluble</td>
</tr>
<tr>
<td>In Brugine</td>
<td>in Brugine vegetable wax</td>
<td>Solution</td>
</tr>
<tr>
<td></td>
<td>Brown colour bitter taste</td>
<td>Filtrate</td>
</tr>
<tr>
<td></td>
<td>Add Lead acetate</td>
<td>Solution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Residue like vaseline</td>
</tr>
</tbody>
</table>
**Knotin**

**Brown Solution**
Concentrate + add C₂H₂O

<table>
<thead>
<tr>
<th>Ppt brown Sticky</th>
<th>Solution</th>
<th>Residue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>evaporated to dryness, form colord</td>
<td>insol in benzine, treat with 92% C₂H₂O</td>
</tr>
<tr>
<td>Solution</td>
<td>nitroso</td>
<td>insol in H₂O</td>
</tr>
<tr>
<td>C₂H₁₀N₄O₂</td>
<td>Add Basic Pb(C₂H₅O₂)₂</td>
<td>51.88% Ppt.</td>
</tr>
</tbody>
</table>

Add recomposed with H₂S, forms ferrous salt

<table>
<thead>
<tr>
<th>Ppt. Light</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>insol.</td>
<td>NaCl</td>
</tr>
<tr>
<td>light brown</td>
<td>light brown</td>
</tr>
</tbody>
</table>

Organic substance washed with four NaCl
From the above results of several months of labor we learn:

1st. That the cotton fibre in its natural state is covered with certain extractive and coloring matters consisting of:

(a) Portion soluble in benzene
(b) A large portion soluble in toluene, ethyl and methyl alcohols.
(c) A very considerable portion soluble in H_2O
(d) An unimportant portion sol in Na H_2O.

2nd. That the waxes, which surround the outer sheath of the fibre, are important in their nature:

(a) Owing to the fact that they prevent the penetration of the dyestuff into the cotton fibre.
(b) Because they are insoluble in the liquids which are ordinarily employed in the process of bleaching. Their removal in the arts is most probably occasioned by mere melting of the wax and mechanical washing off by the hot liquids employed in bleaching.

3rd. That the waxes could be removed by means of C H_4 O (but for the cost) and the greater part of the colouring matter
extract by boiling water.

We can readily see that a much closer study of the properties of the substances would add to the benefits which the dyer or tanner would receive from investigations of this character.