This Candidate requests this Thesis out on him, and he has been informed of the conditions.

With its Composition and Adulteration in Milk.

The subject of Milk and its adulteration is not one to which much attention has been paid in London either by the scientific investigators or by the food analyst. The supply of true milk must be a matter of the first importance when we consider there are countries that necessary it is to children for the first few years of life and also the impossibility of treating many physical diseases without it. So universal is the practice of adulteration and so difficult is it to prevent it that most institutions where milk is used in quantity and becomes boiled.
persons kept cows for their own use. In provincial districts where bungalows are surrounded by a large compound it is usual to keep cows, animals are moderate in price their food cheap and nursing plentiful. In towns however the usual way of obtaining milk is the case of European families is to have the animal brought to the house and milked in the presence of a member of the family. It is no exaggeration to say that it is almost impossible to buy undiluted milk of any milk vendor in Calcutta. The poor European and native populations are thus placed at a great disadvantage in the matter of milk supply which may in some degree account for the very
high rate of infant mortality prevailing there viz. 39.8 per 1000 under one year of age and also the amongst the children of soldiers.

In no more striking way is the ingratitude of the ordinary native apparent than in saving his own labour and cursing good water into milk and then even under very close watching those living in Christian countries and who have not visited the East cannot form any adequate conception of the amount of supervision necessary to the proper performance of any duty, hence the trouble and difficulty in obtaining genuine samples of milk for analyses, suck milk must be drawn from the Animals either in the presence of the Analyst himself or in that of some European whose word
can be relied on. It is greatly to be desired that some system of dairy control and inspection existed, and bye-laws were passed to regulate the production and sale of such an important article of daily domestic consumption as milk, doubtless each will come in time for even in our own country and in America acts of this nature have only recently been taken thus it cannot be considered exceptional that so little has been done here. A very good set of rules applicable to cantonments (military stations) were framed and introduced by Surgeon General Anstee in 1873 and received the sanction of Lord Napier but their application did not become general. No unlicensed milk vendor was allowed to bring his produce to market.
all the milk was tested by a medical officer
and if genuine was sent at a part of the canton-
ment called the milk-market under supervision
of an European non-commissioned officer. Cowshed
milk was rigorously inspected. Adulterated
milk was seized and destroyed and the offender
brought before the Cantonment Magistrate and
fined. This plan although it worked well in
small stations could not be applied to
cities where milk adulterators were occasionally
prevalent under a section of the Indian
Penal Code which provided that if anything
injurious was mixed with an article of food
the offender could be punished. As water was
not in those days regarded by the magistrates as injurious
the prosecution often failed. The adherents accepted
At present, the law stands thus:

Sec. 365 of the Calcutta Municipal Consolidation Act of 1888 Ch xi Part vii gives power to the Municipal Commissioners to seize articles unfit for food exposed for sale and Sec. 366 gives power to destroy such articles with the consent of the owner, if the owner consent to the article seized or being taken before the Chairman Vice-Chairman Health Officer or any Commissioners and proclaimed unfit for human food may be forthwith destroyed and the owner prosecuted.

The observations then recorded were carried out during the rains and part of the hot and cold season extending from July to November. The cows 16 of 18 in number are kept in the grounds of the Italian Hospital of the
for the use of H.M. European Troops stationed in Fort William—the condition, housing, and health of the Animals from a sanitary point of view are all that can be desired and the feeding not other than usual.

They were thus constantly under notice and samples of milk were drawn for analysis under the writer's personal observations.

An epidemic of cholera had occurred in Alipore Jail a large jail in the suburbs of Calcutta in the vicinity of the Station Hospital during 1887 which was traced to contaminated milk and another in the Station Hospital while under the writer’s medical charge last year. None the cases were not kept in the Hospital Compound. Sagardwip milk was
Constantly surreptitiously bought in and processed off as genuine milk and then mixed with the pure milk to make up any deficiency in the quantity required to supply the hospital.

The cows are kept in an open shed built of bricks and well drained the floor is a cement one and the cows may be said to live constantly in the open air. strict cleanliness is enforced. The daily food consists of chopped rice straw 20 lb. Mustard Oil Cake 5 lb. Broken rice and husks 8 lb.

Rice dzer is sometimes given, the oil cake treated with water is only very mildly fungicidal and in its general appearance closely resembles the branded cake used for the winter food of cows in Ireland. All are the ordinary type of Bengali.
comes from the district of Bhangulpore. In the month of June 1869 the quantity of milk given by 10 cows was measured by means of an ordinary pair of glass measures and the quantities noted are given in the following table:

<table>
<thead>
<tr>
<th>Days of Observation</th>
<th>Morning Yield of Milk</th>
<th>Evening Yield of Milk</th>
<th>Total Daily Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pts. 07</td>
<td>Pts. 07</td>
<td>Pts. 07</td>
</tr>
<tr>
<td>1st.</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>2nd.</td>
<td>3</td>
<td>1.5</td>
<td>4.5</td>
</tr>
<tr>
<td>3rd.</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>4th.</td>
<td>3</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>5th.</td>
<td>3</td>
<td>17</td>
<td>20</td>
</tr>
</tbody>
</table>

It will thus be apparent that the quantity of milk obtained in the evening is always less than that obtained in the morning. If a sample of the average quantity obtained daily from each of the 10 cows was mixed and subjected to the tests amounting in order to determine the total solids in the milk of different animals, ten cows were
Completely milked the kine well shaken and samples taken. The ten milks were then reduced to the temperature of 15.5° C. by means of an ice bath and the specific gravity ascertained with the hydrometer to shade temperatures at the time of the observation being 90°F.

<table>
<thead>
<tr>
<th>Number of Calf</th>
<th>Specific Gravity of Milk at 15.5° C.</th>
<th>Daily Yield of Milk</th>
<th>Age of Calf</th>
</tr>
</thead>
<tbody>
<tr>
<td>No 1</td>
<td>1.030</td>
<td>4 pts 6 oz.</td>
<td>7 months</td>
</tr>
<tr>
<td>2</td>
<td>1.031</td>
<td>3 pts 15 oz.</td>
<td>6 months</td>
</tr>
<tr>
<td>3</td>
<td>1.033</td>
<td>4 pts 2 oz.</td>
<td>5 months</td>
</tr>
<tr>
<td>4</td>
<td>1.031</td>
<td>11 pts 0 oz.</td>
<td>4 months</td>
</tr>
<tr>
<td>5</td>
<td>1.029</td>
<td>9 pts 5 oz.</td>
<td>4 months</td>
</tr>
<tr>
<td>6</td>
<td>1.028</td>
<td>8 pts 12 oz.</td>
<td>2 months</td>
</tr>
</tbody>
</table>

In a subsequent occasion in the same month 25th June 1889 the other samples were taken of milk yielded by the same animals and the total solids and ash estimated. The results of this investigation are given in the subject table.
<table>
<thead>
<tr>
<th>Number of Cow</th>
<th>Total Solids Per Cent</th>
<th>Ash Per Cent</th>
<th>Milk - Daily yield in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>15.28</td>
<td>.81</td>
<td>86</td>
</tr>
<tr>
<td>2</td>
<td>11.33</td>
<td>.79</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>17.31</td>
<td>.71</td>
<td>82</td>
</tr>
<tr>
<td>4</td>
<td>15.35</td>
<td>.74</td>
<td>220</td>
</tr>
<tr>
<td>5</td>
<td>13.03</td>
<td>.64</td>
<td>180</td>
</tr>
<tr>
<td>6</td>
<td>13.06</td>
<td>.74</td>
<td>172</td>
</tr>
</tbody>
</table>

The total solids were ascertained in every case by weighing out 5 grammes in a tared platinum dish and drying for three hours, as recommended by Trankley (Milk Analysis, page 16) so that the numbers in the above table express percentage and not per 100 cubic centimetres. The titrate holding 5 C.C. cannot be used in accurate investigations in this country. The average total solids of the teat milk was 14.226% and ash .7383 gms. %.  

In the following month of August two determinations were made at different times of the mixed milks of 18 cows.
The composition of the evening milk of a farm six cows, before referred to, analysed after being cooled in the sun below

<table>
<thead>
<tr>
<th>Description</th>
<th>Total Solids</th>
<th>Ash</th>
<th>Sp. Grav.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk of 16 cows</td>
<td>12.93</td>
<td>.650</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>14.00</td>
<td>.715</td>
<td>1030.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hea. Cow</th>
<th>Total Solids</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12.44</td>
<td>.70</td>
</tr>
<tr>
<td>2</td>
<td>13.94</td>
<td>.68</td>
</tr>
<tr>
<td>3</td>
<td>14.66</td>
<td>.67</td>
</tr>
<tr>
<td>4</td>
<td>16.14</td>
<td>.77</td>
</tr>
<tr>
<td>5</td>
<td>14.74</td>
<td>.74</td>
</tr>
<tr>
<td>6</td>
<td>16.10</td>
<td>.76</td>
</tr>
</tbody>
</table>

The average percentage of the total solids is 14.41, which is a little richer than the previous milk.

A few remarks on the process followed for ascertaining the composition of milk in the cold and hot seasons, respectively, will not be out of place here. The total solids. There are certain advantages in drying the total solids to a constant weight as has been already noticed.
by Dr. James Bell (The Chemistry of Foods, Pt. II, p. 9) and in the following analyses his recommendations, so far as the total solids, the fat and the non-fat solids are concerned, while the older method of Warburglya was adopted in estimating gravimetrically the lactose and casein. The proportions of these constituents of each sample of milk have been determined by gravimetric analysis and the figures are strictly comparable with the older analyses.

The only similar researches of which I have been able to find any record are those of Prof. T. H. Macnamara of the Calcutta Medical College. In his paper, the casein was determined by the Warburglya method of estimating the albuminoid in a solution yielded by a fixed quantity while the lactin was determined volumetrically by means of standard sugars solution but in his table there is no complete analysis of
a mixed milk the team samples of which the chemical composition is given were derived from individual cows (Indian Medical Gazette 1873 Patrick Calcutta milk).

The analyses recorded in this paper (their) were thus performed.

Five grammes milk were weighed into a platinum vessel and evaporated for three hours on the water bath then transferred to the hot-water-over till the weight became constant. The crucible was then weighed and incinerated at first by means of a gentle heat over an aspand lamp and finally over a Bunsen's burner, care being taken that the process was conducted so as not to force the ash or vitrificate the sodium fluoride vessel crucible, which was weighed as soon as cold and the amount of ash ascertained for the estimation of the fat, casein and lactin another portion of 10 grammes was weighed into a larger platinum dish.
and treated over the water bath with occasional stirring till the milk became toasty and adhered to the end of the glass rod in a mass. This degree of coagulation has been found most favorable for the extraction of the fat and the mass very quickly assumes the plastic condition described by Bell when treated with ether (Op. Cit. paper). The mass in this condition was then treated with ether and was broken up into several times with cold water with boiling ether, the fatty etheric solution being poured off carefully and filtered into a tared glass beaker. The contents which were finally evaporated in the hot-water-oven till a constant weight was obtained.

The residue in the platinum capsule treated with weak hot alcohol yielded milk sugar while the casein remained behind. The casein residue was dried and...
Constant weight the weight noted and the vessel with contents exposed to a strong heat so as carefully to incinerate. The weight thus obtained deducted from the total casein residue gives the amount of casein.

The lactose solution above referred to was evaporated to dryness in another platinum dish. This to a constant weight then burned on the ash ascertained and deducted from the total weight of lactose residue as recommended by Munkelys (Milk Analysis, p. 24-28) all the operations were done in duplicate so that the results of one observation might check those of the other.

The solids not fat were also determined directly and not by difference for according to Bell the direct way of estimating the non-fat solids is the only satisfactory one of arriving at the important lactose in milk analysis.
100 grammes of Average milk after Bengali cow-ancaini

<table>
<thead>
<tr>
<th></th>
<th>Hot Season's Milk</th>
<th>Cold Season's Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity (at 60°F)</td>
<td>1.0280</td>
<td>1.0326</td>
</tr>
<tr>
<td>Fat</td>
<td>6.0</td>
<td>7.6</td>
</tr>
<tr>
<td>Casein Alanurate</td>
<td>4.33</td>
<td>4.30</td>
</tr>
<tr>
<td>Milk Sugar</td>
<td>4.34</td>
<td>3.11</td>
</tr>
<tr>
<td>Ash</td>
<td>.68</td>
<td>.75</td>
</tr>
<tr>
<td>Water</td>
<td>87.07</td>
<td>85.33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

The average temperature for the whole year is 79.4°F, that of the hot weather months 84.5°F, and that of the rain 83.3°F, and the cold season 71.5°F. The analysis was made during the hot season on milk obtained from 18 cows, while that during the cold was from twelve of the same cows. The specific gravity of both samples was carefully taken by means of a chemical balance and a bottle holding exactly 100 grammes.

On comparing the figures in the above...
Table it will be seen that the milk given by the cows in the hot season is poorer in every constituent than that given during the cold. The same cows fed in exactly the same way having been under observation during the whole period. The total solids in the hot season milk was 12.93% and non-fat solids 8.68%. While in the cold season milk the same data respecting cream total solids 14.67% non-fat soloids 9.87%.

Table exhibiting the composition of the milk of English and Bengali cows in their respective countries.
<table>
<thead>
<tr>
<th></th>
<th>Stevenson</th>
<th>Macnamara</th>
<th>Bell</th>
<th>Hassall</th>
<th>Warklyn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sp. Gravity</strong></td>
<td>1032.6</td>
<td>______</td>
<td>1032.5</td>
<td>13.72</td>
<td>10.04</td>
</tr>
<tr>
<td><strong>Non-fat solids</strong></td>
<td>9.57</td>
<td>9.74</td>
<td>9.03</td>
<td>9.34</td>
<td>10.04</td>
</tr>
<tr>
<td><strong>Fat per centage</strong></td>
<td>4.80</td>
<td>3.33</td>
<td>3.76</td>
<td>3.93</td>
<td>4.00</td>
</tr>
<tr>
<td><strong>Casein Albumen</strong></td>
<td>4.01</td>
<td>4.82</td>
<td>3.60</td>
<td>4.14</td>
<td>5.01</td>
</tr>
<tr>
<td><strong>Sugar</strong></td>
<td>3.11</td>
<td>4.14</td>
<td>4.75</td>
<td>4.53</td>
<td>4.50</td>
</tr>
<tr>
<td><strong>Ash</strong></td>
<td>0.75</td>
<td>______</td>
<td>0.78</td>
<td>0.67</td>
<td>0.73</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td>85.33</td>
<td>86.93</td>
<td>87.21</td>
<td>86.73</td>
<td>85.96</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

* Analysis of sample of milk 1840 taken from Dr. Bell's table (Chemistry of Foods p. 3)

+ This analysis taken from Hassall's Food and its Adulteration is the mean of all the reliable analyses he could find.

++ Analysis of milk fed bull from Warklyn's mill. Analysis p. 2 converted into percentage statement by dividing by 1.029.

It will be seen on comparing the figures, the above table shows nearly the bull's milk in Bengal approaches that of the English Town fed cow in composition. The total solids are a little higher than that given by either Bell or Warklyn.
and this is owing mainly to the higher percentage of sugar and fat. It will be remembered that the cows are fed on the cane through all the year and that they receive little or no green food and only rice straw which is poor in nutritious material. It is well known that poor feeding increases the amount of milk sugar in the milk of the cow and to this percentage of this constituent is a little higher than in good English from fed milk while the casein and albuminous constituents as also the non-fatty solids are higher in the latter. In this connection it is well to remember that while the English cow gives about 8 gallons a day milk daily, the Bengal cow only gives 4 or 5 pounds daily. The annual crop in some measure accounts for this difference, but not taking for in the case of an English cow the daily yield stated was only 32 pints while an exceptionally large Bengal cow was said to give 11 pints.
The composition of this important food product is thus observed to be remarkably constant both in tropical and temperate climates. It is remarkable that irrespective of the heat of the climate, much more water per lb of body weight must be ingested daily. In cold climates, this fact enables the analyst to apply methods and standards used in other countries and of infinite value in enabling them to judge the result of the work.

Another kind of milk largely consumed amongst the native inhabitants of Bengal is that yielded by the Buffalo. Being about one third more costly than cow's milk, its use is restricted to the well-to-do native class, who use it for a variety of purposes. The Buffalo is a large powerful, long-haired animal somewhat larger than the beef cattle, possessing well-developed horns and black hides with...
little hair it appears to find great pleasure in standing for times at a time in the body of
waste nothing being visible but the animal nostrils. I not un frequently appear with
the hide plastered over with a secret fluid. The
waste altered much valued by the natives is
not used by the Europeans owing more
due to the repulsive appearance of the animal
in part another part also contributed to its
habit of rolling in filthy mud and water.
fall markets when opportunity offers.
Now this beast are retained the flesh and
bone is universally consumed by the natives.
The milk is eaten with rice and when
boiled and congealed with cream is called
Yyre. This Yyre or curd when cooked
with various kinds of fat and a little
genuine butter is made to Jury as butter.
The butter ordinarily found in the beasts
is thus produced and is remarkable for
its power of retaining water when milked.
5% or more ghee can be obtained from it. Ghee is also prepared from cow's milk. To prepare ghee or clarified butter, the Buffalo or Cow's milk is boiled, then churned and the butter collected. The latter milk and the fat removed by skimming. Ghee is largely used in preparing many kinds of food and especially of curries and in dressing sacrifices offered to the Hindu deities.

Cow: This is buffalo milk boiled then allowed to coagulate when the curd is taken cold. It is very much used as an article of food.

The food of the Buffalo consists of:

- Brown 14 lb. (7 seers) (Bacci)
- Indian Peas 4 lb. (2 seers) (Khal)
- Tamar 10 lb. (1 Tappa) (Bichali)
- Water 46 lb. (48 seers) (Pani)

It gives on the average about 12 lbs. milk for 4 to 6 months
The milk of two healthy good sized Buffaloes was chosen for analysis and drawn in the analyst's presence. Then freshly drawn the milk was observed to exhibit the amphoteric reaction in a marked degree.

The subjoined table shows the composition of these milks side by side with that of the Bengali Cow.

<table>
<thead>
<tr>
<th></th>
<th>Milk of Buffalo</th>
<th>Milk of Bengal Cow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Grav.</td>
<td>1033.3</td>
<td>1032.6</td>
</tr>
<tr>
<td>Total Solids</td>
<td>18.88</td>
<td>14.67</td>
</tr>
<tr>
<td>Non-fatty Solids</td>
<td>10.86</td>
<td>9.87</td>
</tr>
<tr>
<td>Fat</td>
<td>8.02</td>
<td>4.60</td>
</tr>
<tr>
<td>Casein Albumin etc.</td>
<td>4.72</td>
<td>4.01</td>
</tr>
<tr>
<td>Sugar</td>
<td>3.83</td>
<td>3.11</td>
</tr>
<tr>
<td>Ash</td>
<td>1.76</td>
<td>0.75</td>
</tr>
<tr>
<td>Water</td>
<td>81.12</td>
<td>85.33</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Comparing the composition of the two milks it will be seen from the above analysis that the total solids are large in buffaloes milk in amount and that this difference is mainly owing to richness in fat. Which these is nearly twice as much as it is also a little
In her in Casein, sugar and salt, these facts are borne out by the results of experience. For one pound of whey, milk is said to give 2.5 of butter, just double the quantity obtained from good cow's milk by the methods in use among the nation. In appearance, buffalo or milk resembles good cows' milk and under the microscope the globules of fat are smaller in proportion than in cream and a little larger in measurement (taken), it has a peculiar flavor, which is most likely due to some aromatic principle generated in the animal since the food is not different from that of the cow. The quantity of milk is said to be much the same in hot and cold seasons.
The Chemical Examination of Milk

For the purpose of ascertaining the quality of any given sample of milk, the最先 followed that of Prof. Munklyn, according to which a rigid standard is adopted. All departures from which are treated as sophistications. The one in which a minimum standard and composition is laid down and constitutes legalized and any milk which does not come up to the standard is regarded as adulterated. The latter plan has been made the basis of legislation in some of the states of America and France. Thus, there is a legal for minimum standard for New York State which states that the milk shall not contain less than 12% Total Solids and 8% Fat and that the maximum water shall not exceed 88%. (In Food Adulteration and its Detection by George P. Battershall M.D. F.C.S. N.York, 1869)
Each plan has advantages and disadvantages the latter very lucidly stated by Dr. Bell (Op. Cit. p.30) who regards the range of the quality of water as so intricate that it is impossible to fix a standard and he just alike to the tender and consumer.

For all practical purposes a well made analysis may be regarded as complete when the total solids, gas and ash have been ascertained and such plans that recommended and followed by Dr. Bennett & Davenport, analyst to the Massachusetts State Board of Health and which appears to be a modification of the Winkleye method accomplishes this with less expenditure of time and labor than any I have yet seen and is well adapted to this climate.

The following extract gives the process in detail:

* An Analyst for Missouri. 1869, Page 209
weighed off in a large flat-bottomed platinum capsule of full 2½ inch diameter with the bottom and about 3 inches across the top.

The half-inch high side turns up from the bottom not with a sharp angle but slightly rounding the being about the curve with which the milk runs up the rim of the capsule drawn by capillarity. The milk in drying down does
not thus form any thicker deposit at the angle of the side than elsewhere upon the about 5 square inches of bottom surface of the capsule. This relatively large amount of surface one sq. in. to each grain of sample taken causes each inch to be covered with only a little over a single grain of dried milk solids. The deposit is therefore so very thin as to be readily eliminated if the fat is its subsequent treatment with boiling petrolatum naphtha. When using such small dishes as were originally proposed by Kniberg, the heels would be so thick that is almost three times as
would naturally render any such rapid method of extraction as I employ impossible as the English analysts from learned each capsule has its serial number engraved upon it and they are made to weigh a little over 25 grams each, that the bottom may be steep enough to remain perfectly flat a matter of very great importance.

These capsules, containing their samples are placed upon a constant-level closed-water bath (of the peculiar construction described in page 264 of the Journal of Analytical Chemistry). This bath will hold 25 capsules all at once then being surrounded by an atmosphere not already nearly saturated with moisture as would be the case if they were upon a water bath with openings in it so that they quickly evaporate to apparent dryness. They are then transferred for their final drying to a constant weight in one of Vieney's large porcelain-lined air-bath regulated to the...
Constant temperature of 105°C. Line them up briskly about half an hour when they are cooled in a desiccator and each weighed immediately upon being taken over to guard against their rapid gain in weight from exposure to the air. Replace after the closed-topped water-bath the capsule is filled with petroleum napthene from a weak solution of benzine of the United States Pharmacopoeia (Revisio in 1880). This unlike others will dissolve oil instead.

Milk sugar was cast off from the brisk with solid residue. More or less gallowip costs about as much as the first of them could.

The ivadilhed in the capsule after being allowed to boil down about one half, decanted of again to a rod into a balance to guard against the remote possibility of some plate of milk residue being poured off with it. Replaced upon the bath the capsule is filled with ivadilhed. The boiling...
up and decanting off is repeated three or four times, when, after the last one the interior of the capsule is covered off with naphtha and thrown upon its surface a wash bottle to prevent any moisture of far being left there. The capsule then finally replaced upon the half to dry of the naphtha in thin coarsely weighed as before the matter being later determined by the loss in weight of the total solids than by the weight of the evaporated washing.

The ash is made by the ignition of the capsule over a red heat with Bunsen lamp. Which thus gives to widen a flame as not to sequestering to a high temperature at one point and thus a possible loss by the volatilisation of the potassium chloride.

The bulk sugar is determined by the use of the Wolff-Weidemeyer saccharimeter in conjunction with the atom process.

The peculiarity of the atom process as thus seen to be the use of a peculiar sign and construction of platinum wire, such
In fact as well as all over the formation of a thin crust of dried milk solids which can be readily exhausted 95% of fat by the method employed. It is claimed for the method that the fat is so completely removed that there is not as much as to 0.1 percent of fat as a maximum error truly accurate enough for all ordinary purposes of the analyst.

As practice of those learned Davenport process to yield very satisfactory results and when no steel vessels are an then described can be used. The platinum dishes used in determining quantitatively the residues give an answer very well. The following example will give some idea of the degree of accuracy attainable by the above method.

<table>
<thead>
<tr>
<th></th>
<th>Hanflin's Method</th>
<th>Davenport's Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Solids</td>
<td>14.678 Per Cent</td>
<td>14.680 Per Cent</td>
</tr>
<tr>
<td>Non-Fatty Solids</td>
<td>9.925</td>
<td>9.910</td>
</tr>
<tr>
<td>Fat</td>
<td>4.750</td>
<td>4.770</td>
</tr>
<tr>
<td>Ash</td>
<td>765</td>
<td>760</td>
</tr>
</tbody>
</table>

Such a statement as the above is usually regarded as a complete analysis for all practical
purposes and it is quite sufficiently accurate as well as seen. It occupies a very short time in execution, the liability to error from loss is small. Several samples can be attended to at once and what is more important still it is specially well suited for the humid climate where the process of En. M. Adams recommended by the Society of Public Analysts in England has drawbacks which render it difficult to carry out during the hottest part of the year.

In the Ready-means of judging of the quality of Milk. Specific Gravity. The refractometer is invaluable where its indications are considered in relation to that of the Creamometer.

It is by itself most invaluable guide from oon all the instruments made in England are graduated for 60°F and there is a close of relative degree of specific gravity or cream more for every 10 degrees of rise temperature.
Table showing density in density owing to rain in temperature (Parker Read).

Hygienic Page 267)

<table>
<thead>
<tr>
<th>Temp in degrees F</th>
<th>Density of Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>39°</td>
<td>1031</td>
</tr>
<tr>
<td>60°</td>
<td>1030</td>
</tr>
<tr>
<td>70°</td>
<td>1029</td>
</tr>
<tr>
<td>80°</td>
<td>1027.5</td>
</tr>
<tr>
<td>90°</td>
<td>1025.8</td>
</tr>
<tr>
<td>100°</td>
<td>1024</td>
</tr>
</tbody>
</table>

The Eactometer in use in this country are just the ordinary hydrometers made of glass and having the scale divided into four equal parts, the lowest marked "M" and indicating the density of pure water with the highest marked indicating added water \( \frac{4}{4}, \frac{3}{4}, \frac{2}{4}, \frac{1}{4} \). These instruments when placed in pure water then the low mark indicates that it contains one-eighth of the fourth part of water according as the instrument is lower during the cold or hot season. An instrument which might be made from serviceable is the Barometric Yalactometer described by Butterschall and Haskell. It is in use in New York State and is then graduated to \( \frac{4}{4} \), the percentage of pure water. In this country it might be found most convenient to graduate the thermometer to
indicate percentages of milk built at the average temperature of the hot season 84.5°F and of the cold season 71.5°F.

There is an immense variety of temperatures in such a large country as India and very great differences of climate depending on locality, elevation, etc. In the wetter regions, the temperature is often equable and uniform both in the north, with a small amplitude of yearly fluctuation while that in the south is intensely dry and hot during the hot season and cold during the winter months.

Instruments graduated to indicate percentages of milk at 62°F and 78°F would be found very useful in the large producing towns of Bombay, Calcutta, and Madras.

Estimation of the percentage of cream during the greater part of the year at any rate is impossible in the ordinary way. I have found that milk of the Bengali but will yield 2.5% cream in June.
And 6% after standing 20 hours and convection during the cold season the cream does not rise at all.

During the greater part of the year milk often becomes acid and shows signs of decomposition in about 12 hours after being drawn when boiled it keeps a little longer, but such is the boiled for in the case of a complex animal fluid such as milk it is in a climate where decay is so general and active as it is here.

The percentage of cream may be much more rapidly obtained and with considerable correctness by adding 3 & 1/2% of warm water to the previously treated milk and allowing it to stand undisturbed for 10 minutes. When a large proportion of the cream separates (Mossall) this nature along with the reading of the galactometer affords the only means whereby the quality of a sample of suspected milk may be rapidly estimated.
A sample of genuine milk having a specific gravity of 1033 was experimentally diluted and adjusted. Thus, reduced,唐 a time of observation 70°.

Genuine milk 1033 1031
water 10% added 1031 1029
   " 15% "   1029 1017
   " 20% "   1027 1015
   " 25% "   1025 1013
   " 30% "   1023 1011
   " 40% "   1021 1009
   " 50% "   1018 1006

There is thus generally a loss of 2-3 degrees specific gravity for every 10% of added water at 70° F.

Fat. The amount of fat can be determined more satisfactorily than by the method of A. D. and more accurate described but these are others which may under these circumstances be found useful. (1) Nasses's plan of detector with a known percentage of warm water and allowing to stand 40 minutes in soda water.
Thus reading off the amount of olein which has separated (%) by means of the lacto-casein as special instrument in which the milk fat is separated at a high temperature the acidified milk is placed in a graduated tube and caused to rotate in the machine with extreme rapidity as many as 12 samples may be done at a time and the operation is completed in from 3 to 5 minutes.

This instrument which will be found fully described in the Act of Noyes for its three composition and analysis page 242 et seq.

Two several peculiarities which seem to recommend it for use in a water climate when during the hot season it is an important matter to economize labour. It gives favourable and accurate results when compared with other methods.

Adams's Process recommended by the Society of Public Analysts although suitable for tropical climates when the air is fairly dry. The milk of brick bread is rich for milk,
for analysis is placed under weight from the moist-atmosphere so as to prevent such changes as may occur in ordinary times. It has been observed that it gained a little weight in one minute during weighing. A full description of the method will be found in Dr. A. H. Allen's Commercial Organic Analysis, Vol. 1, London, 1886.

Fatty Solids. An important datum is best determined in the usual way by placing a piece of a centimeter of the sample in a small shallow platinum dish and drying for 3 hours. When the total weight decreases the capsule gives the amount of total solids which, multiplied by 20, gives the percentage.

If the s.c.c. are measured after filling it with distilled water and weighing, contents at the usual temperature at which the measurements are made.

Non-Fatty Solids. This is best determined as before described by weighing the dried reeds.
From Donisthorpe's modification of Macbeth's process after it has had all the fat clear out by repeated washing with petroleum ether.

The ash estimated the 5 grammes used for the total solids he used to determine the ash of the total solids residue after saturation of fat free required to in the preceding paragraph it is well here to observe that a strong heat should not be employed at first in burning the substance. It will be best to burn cautiously and an argand lamp till all the volatile matter has been driven, and then gradually to increase the heat on a bunsen burner till all the carbon has been burned off, and a precipitate remains. Too strong a heat causes loss of the chiefly of potassium chloride.

Should it ever be required to estimate the sugar that can be used conveniently done by the saccharimeter. For an account of its various
Forms of this instrument Dr. W. Blight's "Ford and its adulteration" pp. 121-124 may be consulted. In the analysis of whey by means of standard Fehling's solution does not give as accurate results as the optical method.

Owen's lactoscope improved by Vogel. This instrument was fairly tested by me and found to be unreliable. The instrument was of the color system and belonged to Parkes' Chemical Cabinet supplied to H.M. Forces in India for the analysis of dairy products. It indicates the amount of fat by the number of cc. of milk required to obscurce the contents of a candle flame placed one metre distant from the eye the milk diluted with a fixed volume of water being contained in a vessel formed of two parallel glass plates distant from each other one half centimetre.

The instrument under consideration gave the fatty percentage 13.8% in a milk which by analysis was found to contain 4.8% of fat.
While in a sample of Buffalo's milk the lactoscope gave 5.8% fat and analysis 8%. This curious result I am inclined to attribute to the physical division of the Casein part of which constituent is suspended in a particulate form in the fluid and may be filtered off by passing the milk through a porcelain filter being in the form of extremely fine granules (by the test)

If the fluid of the fatless milk deflected soley on the cream and fat present then the Buffalo milk which contains nearly double the quantity of fat present in Casein milk would have been most opaque & showed the highest percentage of fat but the reverse was the case the opacity While must therefore depend in a large degree on the particulate condition of the Casein.

The London Dairy Supply Company's machines for the manufacture of fresh cream and butter from milk have lately been introduced.
into Calcutta. Some trials made there it has been shown that cream and butter may be made both more rapidly and profitably than by the methods in use amongst the natives.

1. Percentage of Butter
   Made by separator
   From good cream milk
   In Calcutta
   4.6%

2. Percentage of Butter
   Made by retten method
   From cream milk under
   From butter
   3.5%

C. Percentage of Shea
   Clarified butter fat
   Made from butter produced
   By separator
   3.2%

Adulterations of Milk

In view of the important aesthetic and sanitary relations of milk its adulteration became a matter of deep concern and it is to regret that so little has been done to regulate the supply and ensure its purity. In consequence there
Milk and disease is a subject which still remains to be worked out. Cholera, that greater scourge of Bengal, is not seldom thus conveyed as is obvious from many recorded outbreaks, the circumstances of which have received attention investigation.

Milk may be adulterated by abstracting the cream, adding to it either milk or water, other substances may be added to it to increase its specific gravity, increase its keeping qualities or alter its color. Bligh the (Page 273) states that in England the adulterations in order of frequency are addition of water, abstracting cream (or both combined), the addition of cane sugar to conceal waterying the addition of salt, borax, salicylic acid to make it look more and lastly the addition of Glycerine.

The form of adulteration most common in this country is the addition of water. The average action whether Hindu or Mussulman is not a scientific adulteration and is not
Bacterio have been traced to the source
of the same name. (Report of the Talanta
Municipal Commission for 1884-5.)

A practice not uncommon here is for
the vendor to boil the milk and heat
it again before selling it. This process
which such milk is boiled and afterwards
stored for sale is commonly an Earthenware
Clinton imperfectly glazed, and after
use is imperfectly cleaned, some of the
former droppings thus left to decompose
and is absorbed by the imperfectly glazed
surface which commences an unmistakable
disagreeable
state of smell and taste to the fresh milk.
All samples of milk purchased in native
Bazaars which have come under my notice
from this disquieting, dirty, flavour, and
even tasteful in the following Hospital
Hastings is no exception to the rule east
is purchased in quantity in the Bazars.
Doubtless many cases of stomatitis and aphtha occurring in European soldiers, children, and caused by unclean milk. The milk sold in the Bazaar of Fort William by H.M. Forces Britain and native countries contain almost 25% of water and is fairly offensive. It is only by filtrating a piece of a few pounds of time to treat that the milk salesman can be kept fairly honest.

Tests for nitrates and nitrites in milk. A large part of the milk supply of this city with its crowded population of 684,658 inhabitants is brought from the adjacent country districts by train. As hydrant water cannot be procured, tank or well water is used for diluting the milk, both buses especially the former is contaminated with nitrates and nitrites.
in abundance which result from the decomposition of organic matter in large part extraneous. As this milk arrives at the Railway Platform, it is informed by the Health Officer M. J. Simpson that the milk is tested for typhoid and diphtheria. If these are found it is regarded as proved that the milk is adulterated and the whole is seized and immovably destroyed. These extensive powers are conferred by the Bengal Council Act before referred to, but it is essential that the sample and destruction should be carried out in the presence of one of the Municipal Commissioners. The milk is also at the same time examined with the microscope and not infrequently is it found to contain vegetable cells containing chlorophyll, and other vegetable materials such as tank water would furnish.
The appearance of the food inspector with his microscope on the Railway Platform is enough to strike terror into the most hardened cowards (bullies) who may be seen flying in all directions, throwing away their chattels of milk in their anxiety to escape punishment they fear so much. Quite recently the medical officer in charge of the employees of the Eastern Bengal State Railway reported an outbreak of disease which had been traced to the adulteration of milk with stagnant fetid tank water. This led to a visit of the inspector to the railway station in the morning when 1,000 lbs of milk were destroyed after being tested for bacteria and disinfected as unfit for use. In this connection it may be worth to explain that the village tandoor of an Indian village is generally an artificial hollow in which people warm clothes, bathe, drink and with which they cook.

---

4.9
A strong solution of sewage and other
ubiquitous as sacred since it has been
blessed to some truly clean or other.

Nitrite is readily obtained with 0.1 M
0.5% to 10% of the aqueous nitrite.

To look for the presence of nitrites
and nitrites, this very useful test
is indeed for the food inspector. Deeply
thrice applied but it is essential that it
be prepared thoroughly before it is
for use or as some determine. Take equal
volumes of strong aqueous solution of
sulfanilic acid and hypobromite aqueous
solution. Heat to boiling and care
add in solution of the mixture to a little of
the suspected liquid, and then allow to stand
for 8 to 10 minutes, if nitrite or nitrite does
not form a brown red colour will be developed in the
liquid portion of the bellows, then it can be
eugulation is the sample is needed. It
I have found that on heating a sample of genuine milk with different percentages of table water the reaction for nitrite and nitrate is readily obtained with as little as 5% to 10% of table water.

A test for the presence of nitrite and nitrate - This very useful test is made for the food inspector. May be thus applied but it is essential that it be prepared shortly before it is required for use as it soon deteriorates. Mix equal volumes of a strong aqueous solution of sulphamic acid and very dilute aqueous solution of thymol blue, and add an excess of the mixture to a little of the suspected milk and allow to stand for 5 to 10 minutes. If nitrite or nitrate are present a rose red colour will be developed in the liquid portion of the milk. No preliminary coagulation of the sample is needed if the
Sulphuric acid solution is strong enough. As informed by Dr. Lenn Lenn, surgeon, assistant health officer to the municipality that the above test has been found more useful as a means of discovering adulterated milk. When it is remembered that in the suburbs of Calcutta the cholera death rate is nearly double that of the town and that the heavy rate of mortality is mainly owing to the necessity the people are under of using tank instead of hydrant water the importance of recognizing tank water in milk will be obvious.

The diphenylamine test recommended as so delicate a test for ribarins and tribars in milk and which develops a purple blue color is also useful. The diphenylamine is treated with a little water then dissolved in strong sulphuric acid and a few drops of this solution added to 10 C.C. of milk mixed with
20 cubic centimeters of sulphuric acid when
of nitrate or nitrite are present a purple
blue color appears. This is a very delicate
test (Blyth O. C. Op. Cit. p. 562)

Professor Macnamara in 1873 published
a partial analysis of 13 samples of
milk soured in the Calcutta Bazaars of
there are only was genuine, as the total solids
and ash alone are given in each analysis
in this table (Ind. medical Gazette 1873) the
most reliable basis for calculation of
the extent to which the samples were ad-
cultivated is the amount of ash using this
Adams it appears the sample contained
from 14 to 63 p.c. of water the mean being 37.8 p.c.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Total Solids %</th>
<th>Ash %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manickalota Bazaar</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>Lalla Baboo</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>Gobha</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Chitpore Road</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manchana</td>
<td>38</td>
<td>17</td>
</tr>
<tr>
<td>Trotta</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basori Raut Baboo</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>Madhup</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Dumencalota</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Naraynumba Pass</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Bodd</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Trotta</td>
<td>37</td>
<td></td>
</tr>
</tbody>
</table>

Calculated from Dr. Macnamara's Tables. Ind. Medical Gazette 1873
It is the practice to kindle fires and keep them burning for a couple of hours in the Crooked in the mornings during the cold season thus good milk is very often flavoured with anise from burning wood.

I have been informed that milk is sometimes thickened when poured by adding to it a ground nut sold in the bazaars as "tungara". I have procured some of these nuts and find that it is the fruit of the water chestnut "Ipapa Bispinosa" which grows abundantly in the tanks in and around Calcutta and in fact throughout Upper Bengal. It is boiled and eaten with salt and sugar by the natives and is so cheap that a large quantity can be had for (2-2) a piece. The sample of milk brought to me was certainly thickened with some vegetable matter.
The present paper can only be considered a small contribution towards the elucidation of an important subject and one which is likely in the future to receive more attention from the legislature than it has in the past.

Herman M.B. B.Sc. (Public Health)
Surgeon Army Medical Staff

Calcutta

Staff Surgeon
Fort William

4 February 1840

Certified that this thesis was compiled by the undersigned who has also acted as sanitary officer for the Garrison since June 1888 till the present time.

Calcutta

4 Feb. 1890

John Stevenson