THE POLARISATION OF MILK.

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(Concluded from page 181.)

III.—COMPARISON OF RESULTS OBTAINED BY EXTRACTION WITH ALCOHOL AND POLARISATION.

By consulting table No. 10 it will be seen that the percentage of sugar obtained by extraction with alcohol is practically the same as that got by polarisation of the lead acetate filtrate.

Thus, the mean percentage of sugar by alcohol (65 analyses) is 4.32; by lead acetate, cold (53 analyses) is 4.34; by lead acetate, hot (64 analyses) is 4.38; by mercuric nitrate, cold (61 analyses) is 4.58; by mercuric nitrate, hot (24 analyses) is 4.63.

If now the milk-sugar, as has already been intimated, exists in an anhydrous state after extraction with alcohol, the percentage of it after the addition of the molecule of water would be increased. Thus molecular weight of anhydrous milk-sugar, 342: molecular weight of the hydrous 360 = 4.38 : x , whence the value of $x = 4.61$. This agrees very nearly with the number obtained by acid mercuric nitrate.

By a study of table No. 13 it is found that the mercuric iodide gives nearly the same rotatory power as mercuric nitrate, and also by combustion the filtrates from the milks clarified by lead acetate contain more albumen than those prepared with mercuric iodide. There is, therefore, every reason for believing that the numbers given by the mercury salts are nearer the truth than those from the lead.

It may be urged that the increased rotatory power observed by the mercury salts is due to the conversion of the dilute acids of a part of the lactose into galactose, which has a rotatory power greater than that of milk-sugar. But when it is remembered that the quantity of acid introduced is extremely minute, that the samples need not be warmed, that they can be filtered and polarised within a few minutes of the time of the introduction of the reagents, the suggestion is seen to be of no force.

For example, in the acid mercuric nitrate it was found that the percentage of sugar was the same whether one, five, or ten cubic centimetres of the reagent were employed, and whether it was polarised immediately or after heating and cooling. It is evident that 1 c.c. of the reagent, containing less than a half cubic centimetre of nitric acid and diluted in 100 c.c. of liquid, could not exert any notable effect on the rotatory power of the solution.

In the mercuric iodide solution 20 c.c. of acetic acid are used for every 660 c.c. of the reagent.

Thirty cubic centimetres of this reagent contain, therefore, about 1 c.c. of acid. This, in 100 c.c. of liquid, immediately filtered and polarised, could not affect in any marked degree the rotatory power.

Since combustion with soda-lime shows that the filtrate from the mercuric iodide sample is practically free from albumen, it is evident that the numbers obtained in this way must be a near approximation to the truth.

IV.—THE PROCESS OF ANALYSIS.

The reagents, apparatus, and manipulation necessary to give the most reliable results in milk-sugar estimation are as follows:—

Reagents.—(1) *Basic plumbic acetate*, specific gravity 1.97. Boil a saturated solution of sugar of lead with an excess of litharge, and make it of the strength indicated above. One cubic centimetre of this will precipitate the albumens in 50 c.c. to 60 c.c. of milk.

(2) *Acid mercuric nitrate*; dissolve mercury in double its weight of nitric acid, specific gravity 1.42. Add to the solution an equal volume of water. One cubic centimetre of this reagent is sufficient for the quantity of milk mentioned above. Larger quantities can be used without affecting the results of polarisation.

(3) *Mercuric iodide with acetic acid* (composition already given).

Apparatus.—(1) Pipettes marked at 59.5 c.c., 60 c.c., and 60.5 c.c. (2) Sugar flasks, marked at 102.4 c.c. (3) Filters, observation tubes, and polariscope. (4) Specific gravity spindle and cylinder. (5) Thermometers.

V.—MANIPULATION.

(1) The room and milk should be kept at a constant temperature. It is not important that the temperature should be any given degree. The work can be carried on equally well at 15° C., 20° C., or 25° C. The slight variations in rotary power within the above limits will not affect the result for analytical purposes. The temperature selected should be the one which is most easily kept constant.

(2) The specific gravity of milk is determined. For general work this is done by a delicate specific gravity spindle. Where greater accuracy is required use specific gravity flask.

(3) If the specific gravity be 1.026, or nearly so, measure out 60.5 c.c. into the sugar flask. Add 1 c.c. of mercuric nitrate solution, or 30 c.c. mercuric iodide solution, and fill to 102.4 c.c. mark. The precipitated albumen occupies a volume of about 2.4 c.c. Hence, the milk solution is really 100 c.c. If the specific gravity is 1.030, use 60 c.c. of milk. If the specific gravity is 1.034, use 59.5 c.c. of milk.

(4) Fill up to mark in 102.4 c.c. flask, shake well, filter, and polarise.

VI.—NOTES.

In the above method of analysis the specific rotatory power of milk-sugar is taken at 52·5, and the weight of it in 100 c.c. solution to read 100 degrees in the cane-sugar scale at 20·56 grammes. This is for instruments requiring 16·19 grammes sucrose to produce a rotation of 100 sugar degrees. It will be easy to calculate the number for milk-sugar whatever instrument is employed.

Since the quality of milk taken is three times 20·56 grammes, the polariscopic readings divided by 3 give at once the percentage of milk-sugar when a 200 m.m. tube is used.

If a 400 m.m. tube is employed, divide reading by 6 ; if a 500 m.m. tube is used, divide by 7·5.

Since it requires but little more time, it is advisable to make the analysis in duplicate, and take four readings for each tube. By following this method gross errors of observation are detected and avoided.

By using a flask graduated at 102·4 for 60 c.c. no correction for volume of precipitated casein need be made. In no case is it necessary to heat the sample before polarising.