ON THE
COLOSTRUM OF THE COW.

By JOHN DAVY, M.D., F.R.S.,
INSPECTOR-GENERAL OF ARMY HOSPITALS, L. R.

COMMUNICATED BY THOMAS HODGKIN, M.D.

Received January 10th—Read April 8th, 1845.

THE Colostrum,—the new milk of the cow after calving,—differs, as it is well known, from ordinary cow's milk, in being of a richer yellow colour, less liquid, of greater specific gravity, and in possessing the property of coagulating when heated.

Resembling in the last-mentioned property the serum of the blood, or the substance of the egg, it has been supposed by some physiologists to be more animalized than common milk, and to contain even serum, and that its being coagulable by heat, is owing to the presence of serum.

This inference not having appeared to me to be proved in a satisfactory manner, and, *à priori*, not very probable, I have been induced to subject it to some trials, the results of which I shall briefly describe, tending to show, as I believe they do, that serum does not enter into the composition of the colostrum, and that its coagulability by heat de-

depends on a peculiar modification of its caseous portion.

The milk, the subject of the experiments I am about to describe,—selecting, as is desirable, a particular instance,—was from a healthy cow that calved for the first time on the 19th of July, and was drawn about an hour and a half after, the udder having begun to be distended about three weeks previously.

Its appearance under the microscope differed principally from that of common milk, in presenting larger oil globules,—a very few irregular flakes, probably epithelium scales,—a little granular matter, like curd, and a small number of granular corpuscles,—the granular bodies of the colostrum first described by Mandl, the largest of which were about $\frac{8}{4000}$ of an inch in diameter.*

It reddened, slightly, litmus paper. Its specific gravity, carefully ascertained before any separation of cream had taken place, was found to be 1075, and as high as 1080 after a portion of its cream had risen, and had been removed.

* The nature of these bodies seems to be somewhat doubtful,—whether they are aggregation globules, formed chiefly of albuminous matter,—or large oil globules, with particles of curd, or even of oil attached to their surface: from their apparent specific gravity, and some other circumstances, I am disposed to adopt the first opinion; when colostrum mixed with water is put by in a cool place, after a few days, when the greater part of the cream has collected at the surface, a sediment is found at the bottom, consisting chiefly of these globules.

To determine the degree of temperature at which it coagulated when heated, a portion of it, contained in a glass tube, was immersed in water, the temperature of which was gradually raised. At 160 degrees, Fahrenheit, it was unaffected; at 163 deg. it coagulated: the coagulum was rather soft,—but admitted of being inverted without flowing; it yielded readily to gentle pressure. It did not become hard when boiled, nor was its consistence materially increased by boiling. It may be deserving of mention, that the neutralization of the little free acid it contained by the addition of sesqui-carbonate of ammonia, had no marked effect on its coagulation by heat.

It was coagulated by rennet, and more readily than common milk. In a comparative experiment, whilst the latter required a temperature of 110 deg., the former underwent the change at the temperature of the atmosphere,—then about 65 deg. The coagulum of the colostrum was much softer than that of common milk, and the proportion of whey which separated from it was very much less.

Mixed with ordinary milk and heated, the colostrum acted like rennet; twelve measures of the colostrum mixed with forty-six of milk, formed a soft coagulum when the temperature of the mixture was raised nearly to the boiling point.

The colostrum was coagulated by all the acids that I tried on it, and this at ordinary temperatures, as the acetic, muriatic, nitric, and sulphuric; and also by the citric, tartaric, and oxalic, when mixed

with it in the state of powder. The coagulum it formed with the acetic and the mineral acids was soft, and of a grumous consistence; that which it formed with the solid vegetable acids was firm, like strong jelly, and diaphanous. When the mineral acids were added in large excess, the coagulum was dissolved, leaving the butteraceous part, which rose to the surface: ammonia, in the form of aqua ammoniæ, added largely in excess, formed a gelatinous mass of pretty firm consistence, which did not dissolve on immersion in water.

The colostrum left at rest underwent change slowly. After three days it still retained throughout its yellow hue: a part only of its cream had risen to the surface. After seven days, the lower part had become of the colour nearly of ordinary milk, retaining its liquidity, and having acquired increased facility of coagulating when heated,* whilst its upper part was of a richer hue, and less fluid, being covered with a thick pellicle of the consistence of cream-cheese. This had the peculiar smell of cream-

* In this respect resembling common milk, which after keeping a time, varying with the temperature of the air,—coagulates even below 160 deg.;—as to coagulability indeed presenting a complete gradation; when quite fresh, resisting it, as is well known, at the boiling point; and after keeping some time, coagulating at a low temperature, not exceeding that of the warm hand; in this state offering a subject for a pleasing experiment: it may be poured perfectly liquid into a thin glass tube, and merely by grasping the tube with the hand the effect is produced,—rapidly, almost in an instant, the liquid is converted into an apparent solid, and that without the disengagement of heat.

cheese, and was spotted with mildew, consisting of that kind of byssus which forms on cheese. After thirteen days, the inferior white portion had coagulated, having acquired the consistence with the properties of soft curd—the part above it having undergone little apparent change, that immediately over the curd retaining its yellowness or semifluidity, and the butteraceous cheese-like crust preserving the appearance before noticed, with increased firmness and increase of mildew.

Mixed with water (about two parts of water to one of colostrum), and agitated, and then allowed to remain at rest, cream rose to the surface, and curd formed and subsided, leaving, after about a week, a transparent or nearly transparent fluid between the supernatant cream and the sediment of curd. This fluid was acid, and held some curd in solution. It had a cheesy smell, was not rendered turbid by boiling, nor by acetic or the citric acid, but yielded a precipitate with the three mineral acids; and when kept, a white crust formed on its surface. The formation of this crust was accompanied by a disagreeable smell, similar to that of decaying cheese, but rather more offensive, partaking of the putrid odour, owing probably to the presence of some granular corpuscles. When the crust was separated by filtration, a fresh one formed on the fluid in a few days, and this successively for many days. The crust, or pellicle, consisted chiefly of little cylindrical masses, rounded at their extremities, about $\frac{1}{1000}$ of an inch in length, by about $\frac{1}{2000}$ in width. After

the fluid had ceased to yield this pellicle, it was rendered turbid by nitric acid, as is also the whey of ordinary milk, whether coagulated by rennet, or spontaneously on its becoming sour by the absorption of oxygen.

Other specimens of colostrum which I have examined have afforded similar results. I may notice two in particular, the specific gravities of which were ascertained with care, and the degree of temperature at which they coagulated. The one was from a cow that calved in September, and was drawn almost immediately after : its specific gravity was found to be 1070. Whilst still warm, it reddened litmus. It was pretty firmly coagulated at 160 deg. ; at 150 deg. it formed a soft coagulum ; and at 140 deg. it became thicker. At the lower temperatures, a much longer time was required for the effect to be produced than at the higher. The other specimen was from a cow that calved in December, and was drawn about a quarter of an hour after. It was less thick than the colostrum usually is, was of specific gravity 1057, and coagulated at about 162 deg.

What are the inferences to be drawn from the preceding experiments ? Do they not show that the peculiarities of the colostrum are not dependent on the presence of serum, and, in brief, that the colostrum is destitute of serum ?—The effect of rennet on it, which I find does not coagulate serum,* the

* See *Researches Physiol. and Anat.* ii. p. 97 ; the experiments related there have been repeated with the same negative result.

effect of the vegetable acids on it, and the changes which it undergoes on keeping, when partially exposed to the action of the atmosphere, are the facts most to be insisted on. And, in corroboration, I may mention the results of trials on the heating of mixtures of common milk and serum in different proportions. Serum, in certain proportions, like the white of egg, I find does occasion the coagulation of milk,—giving rise to custard ; but it requires a pretty large proportion : five parts of serum with fifty-five of milk, even when boiled, had no effect ; and even when the former was increased to ten, and the latter reduced to fifty, the mixture did not coagulate till its temperature was raised to about 195.

Whilst all these results are opposed to the idea that serum forms a part of new milk, they favour the conclusion, that the caseous portion of the colostrum is in a state somewhat different from its ordinary condition in the milk of the cow, modified in some manner, either in consequence, it may be, of a slight difference in composition, or owing to the influence of the other ingredients of the milk with which it is mixed, especially the granular bodies, if admitted as aggregation corpuscles, which may perform the part of rennet, in promoting its coagulation, and the butteraceous ingredient, more abundant in it than in common milk, separating more slowly, and which must protect it more powerfully from the action of the atmospheric air, and from the changes consequent on the absorption of oxygen. And, that the caseous portion of milk

does admit of modification, and that not inconsiderable, is shown in a remarkable manner, on comparing it, as existing in the human milk and in cow's milk ; in the latter, even in its ordinary condition so readily coagulable, whilst in the former it resists this change, whether acted on by acids or rennet, and yet is easily obtained by means of evaporation, when freely exposed to the air, and without evaporation from the slow and long-continued action of atmospheric air.*

Physiologically considered, the most marked circumstances belonging to the colostrum, are the concentration of nutritive matter in it ; the greater facility of its coagulation by rennet, compared with older milk, and its greater power of resisting change when exposed to the action of atmospheric air. These are qualities which may be eminently serviceable, viewing it as the first food of the young animal. Its easy coagulation may suit it to the stomach, in which probably the gastric juice at first, is in small quantity and feeble. Its power of resist-

* A portion of milk from a healthy young woman, five weeks after delivery, of sp. gr. 1033, kept in a stoppered vial, to which air had access, a thin slip of paper having been placed between the stopper and its neck, and kept in a dark place, of about 55 deg. temperature, from November till May, had lost its milk-white hue, and deposited curd as well as thrown up cream. Strained, the whey was found of sp. gr. 1020 : 8·1 grains of dried curd were obtained from 312 grains of milk. The whey reddened litmus paper, and was not coagulated either by boiling, or by nitric acid. The curd was very like that which constitutes the chief portion of the alvine evacuation of infants at the breast.

ing change, and remaining semi-fluid, may adapt a part of it to the intestines, to promote the removal of the meconium. Whilst its concentration as nutritive matter may fit it to perform for the calf the same part that the substance of the egg serves which enters the intestine during the latter stage of foetal development in the instance of birds, reptiles and fishes.

The change which takes place in the cow's milk, watching it after calving, is not unfavourable to this view of the uses of the colostrum. Recurring to the first example, the milk of the cow which calved in July, that drawn after 24 hours, was of sp. gr. 1039; was less thick and less coloured, and coagulated when heated to about 180 deg. The milk of the following morning, of sp. gr. 1038, did not coagulate even when boiled, subjecting it to heat five hours after it was drawn; but after having been kept thirty hours, then it coagulated like the preceding, at about 180 deg. Milk of the following morning, drawn on the 21st July, about 60 hours after calving, was of sp. gr. 1033, differed hardly perceptibly from common milk in appearance, and did not coagulate on boiling, even after having been kept about fifty-four hours, at a temperature little below 70 deg., and by day amounting to that.

If the special use of the colostrum of the cow is such as I have inferred, it may be expected that the first milk of other animals will be found to be similar in its properties,—at least, of all those the young of which, like the calf, are born fully formed and

vigorous, with good use of their limbs almost immediately after birth. And so far as I have been able to learn, this is so. The new milk of the ewe, of the mare, and of the sow, I am informed by intelligent farmers, is as rich and thick, and, in the instance of the two first, coagulates when heated. But whether the milk of the sow has the same property, I have not been able to ascertain.* I may mention another instance—it is the milk of the giraffe. My friend Mr. Gulliver informs me that a small quantity “drawn within an hour after the young one was born, (May 20th, 1841,) was excessively rich in fat-like cream, not rendered clearer by any quantity of ether, and became thicker or clotted in a watch glass over a candle.”

Whether the first milk of those animals, the young of which are born helpless and feeble, as of the carnivora, is also like the preceding, cannot, that I am aware of, be at present determined, for want of facts. I am disposed, however, to conjecture that it is similar. This conclusion is founded on analogy, having found that the first milk of the bitch is so,—coagulating when heated, and yielding a large proportion of animal matter (35·2 per cent.)

* Since the above was written, I have examined the first secreted milk of the ewe and sow, and have found them very like that of the cow. The ewe's was of sp. gr. 1060, reddened, slightly, litmus, coagulated at about 165 deg., and yielded, when evaporated to dryness, 35·7 per cent. solid matter. The sow's was of sp. gr. 1057, and coagulated at 160. Milk from another sow, the first drawn also, was found of sp. gr. 1062.

when evaporated to dryness. I could not procure sufficient to determine its specific gravity. In the instance of the carnivora, it may be requisite for the first milk to be rich, from the manner in which these animals feed, having to leave their young to procure food, and to be absent, it may be, an uncertain time. And, in accordance with this, is the fact, that the human milk, the first drawn, is not unusually rich, and does not coagulate when heated; at least these are the results of the few trials of it that I have made. The milk of a healthy young woman, who had been confined five weeks, nursing her first child, I found of the sp. gr. 1033; it yielded on evaporation 10·22 per cent. of solid matter. The first milk of a healthy woman, ætat. 40, after giving birth to her sixteenth child, was of sp. gr. 1033, and yielded on evaporation 12 per cent. solid matter. The first milk of another woman, of whose age or condition I omitted to make a note, was of sp. gr. 1022. Examined four days after, this woman's milk was found to be of sp. gr. 1035, and to yield on evaporation 11·6 per cent. solid matter. This peculiarly dilute state of the human colostrum, if proved to be general, seems equally suitable to the condition of the offspring and mother, the one helpless and feeble, not requiring concentrated nourishment, the other commonly, from a certain degree of exhaustion during labour, ill fitted to yield such a supply;—and, moreover, being designed for domestic life and support, and not under the necessity of separating herself from her offspring to

go in quest of precarious food ; offering in this point of view, another instance to the vast number of examples of harmonious adaptation ; and it may be also one circumstance more, by which man as an animal is distinguished from every other.