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Losses of N and C in Drying Feces of Cattle.

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In respiration trials for the determination of the N and C balances errors may result from losses of N and C during the drying of feces for analysis.

The N losses can be avoided by determining the N in fresh instead of dry samples of the excreta. The N determination in fresh samples involves more work than the determination in a composite sample of the dried feces. This extra work is, however, justified since the N losses during drying are considerable.

In order to measure the N losses by drying, aliquot samples of the feces, that were removed daily from the respiration chamber, were immediately mixed with concentrated H_2SO_4 in Kjeldahl flasks. The digestion was either made at once or the flask was closed until the next day's sample was added to it. Aliquot parts from the same feces that had been analyzed fresh were dried at 100°C. The N determination was then carried out with a part of the composite dry sample. The official Kjeldahl-Gunning-Arnold method[1] was used for the N determinations.

The difference in the N content of the total feces of a 10-days' respiration trial calculated from the analyses of the fresh samples and the N content calculated from the analysis of the composite dried sample was considered the N loss by drying and expressed in per cent of the N content as determined in the fresh samples. For 12 respiration trials with beef heifers this N loss amounted to $7.19 \pm 0.49\%$. In a sample taken immediately after defecation only 4.48% of the N was lost by drying. A day's storage in the feces collector of the respiration chamber and possibly a slight

[1] Assn. of Official Agricultural Chemists, Methods of Analysis, 1931, p. 21.

contamination of the feces with urine seems thus to increase the N loss during subsequent drying.

The wet combustion of feces samples with dichromate could be employed for the determination of the C in feces in a procedure similar to that used for the N determination. The dichromate method of C determination did, however, not prove to be as reliable for the C determination in feces as the combustion of a dry sample in the calorimetric bomb under 25 atmospheres oxygen pressure and subsequent absorption of the formed CO_2. We therefore determine the C content of the feces in a dry sample but measure the C loss during the preceding drying process in the apparatus sketched in Fig. 1.

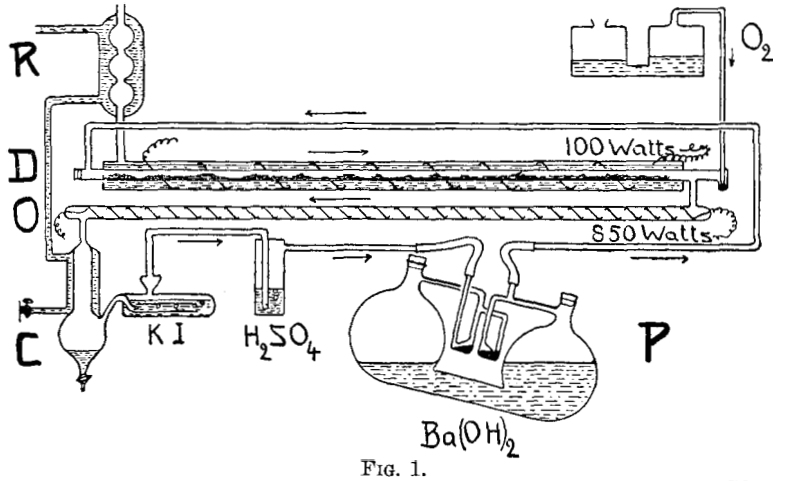

FIG. 1.
Apparatus for drying samples of feces and for determining the loss of CO_2 and other volatile C compounds during drying.

An aliquot part (½ to 1%) of the daily feces is spread into a Monel metal boat of approximately 1 cm. diameter and 1 m. length. This boat is placed in a tube of pyrex glass (D in Fig. 1) which is heated by water contained in an outer jacket. That water is kept boiling by an electric current of 100 Watts and condensed in the reflux cooler R. The drying tube D is connected to a silica combustion tube O that contains 20 gauge B and S Nichrome wire kept at dull red glow by an electric current of 850 Watts. The combustion tube is connected to a condenser C and this condenser to a wash bottle with neutral KI solution approximately 0.001 normal. Another washbottle connected to the first one contains concentrated H_2SO_4. A pair of connected 500 cc. bottles P containing 0.2 n Ba $(OH)_2$ solution completes the system. The bottle pair with the

$Ba(OH)_2$ solution is rocked (6 cycles per minute) and therefore acts as an air pump. A set of mercury valves as shown on Fig. 1 causes the air to flow in one direction only, as the battery rocks back and forth, so that a pulsating direct air current circulates in the system as indicated by the arrows in Fig. 1.

Function. The air from the drying tube D saturated with water-vapor passes the combustion tube O where any volatile C compounds evaporated during the drying process are oxydized to CO_2. The water-vapor is condensed in the cooler C. From there the air bubbles through the KI solution in order to absorb a volatile oxydizing agent which has been found to bleach the indicator* in the $Ba(OH)_2$ solution. After bubbling through the KI solution the air is again dried by concentrated H_2SO_4, then the CO_2 is absorbed in the $Ba(OH)_2$ solution of the rocking battery and the CO_2-free air flows to the drying tube D, completing its cycle. The oxydation of volatile C compounds causes a shortage of O_2, the drying tube is therefore connected to an O_2 supply (Fig. 1) from which O_2 is sucked into the system whenever a negative pressure develops.

As a result of the high rate of rotation of air in the system the drying process of the feces requires only approximately 3 hours. The amount of CO_2 absorbed in the $Ba(OH)_2$ solution is determined by titration,[2] and indicates the amount of C lost from the feces sample during drying.

The mean loss of C by drying the feces from 14 respiration trials (comprising 140 days of experiment) amounted to $1.36 \pm 0.08\%$ of the C content of the feces.

Drying experiments carried out without combustion of the volatile C compound indicated that 35 to 55% of the C lost from the feces by drying are given off as preformed CO_2, the rest as volatile combustible C compounds.

The method of drying aliquot parts of feces and determining the losses of C as described here has been found satisfactory and has been incorporated in the regular procedure of conducting respiration experiments at our institute.[3]

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* 1 part Cresol red-Na 0.1% in water.
3 parts Thymol blue-Na 0.1% in water.
Kolthoff, Die Mass analyse, p. 63, 1928.

[2] Kleiber, M., The California Apparatus for Respiration Trials with Large Animals, Hilgardia 9, p. 38 ff., 1935.

[3] See (2), p. 48.