STUDIES ON THE NUTRITIONAL SIGNIFICANCE OF THE PORTAL BLOOD IN RUMINANTS II. ON THE MEASUREMENT OF THE PORTAL BLOOD FLOW BY MEANS OF THE ORIFICE FLOWMETER

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II. ON THE MEASUREMENT OF THE PORTAL BLOOD FLOW BY MEANS OF THE ORIFICE FLOWMETER

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As described in the previous paper (1), we attemped to estimate the total amount of the volatil fatty acids and other nutrients entering from the digestive tract and flowing into the liver, by multiplying the flow rate of the portal blood by arterio-venous differences of the nutrients in the portal blood.

Hereupon, we examined the technique of measuring the flow rate of the hepatic vein and the portal vein by means of the hepatic vein catheter technique. As the result, we measured the blood flow rate of the hepatic vein, but could not measure so accurately the flow rate of the portal blood because of the obscurity of the peaks of the hepatic venous blood of the evans blue as the marker in the dye dilution method.

In the present paper, we took the direct estimation of the flow rate of the portal blood by means of the orifice flowmeter technique.

Materials and Methods

a) Experimantal animals and feeding.

Goats of Saanen breed were used for the measuremet. The goats were grazed on the grass land and fed once daily with 200g of the concentrate. However the experimental animals were starved for 20 hours prior to the measurement, because the reduction of the volume of the rumen content brought by the fasting provide an easier approach to the portal region.

b) Orifice flowmeter

We made several orifice flowmeters of different sizes. Fig. 1 shows the size of the orifice flowmeter which was mostly used to measure the flow rate of the portal blood of the goat.

The principle of the estimation of the flow rate was based upon the system

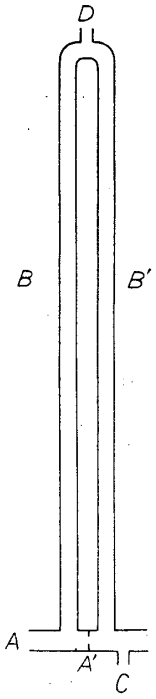

Fig. 1. Orifice flow meter
A is the pipe with orifice (A').
Diameter of the pipe: 0.8 cm
Length of the pipe: 3.0 cm
Slit of the orifice: 0.25 cm
B and B' is the manometer.
Diameter of the manometer: 0.6 cm
Height of the manometer: 45.0 cm
Interval of the B and B': 0.6 cm
C is the cock which introduced the saline into the flowmeter.
D is the cock which controls the level of the saline in the manometer.

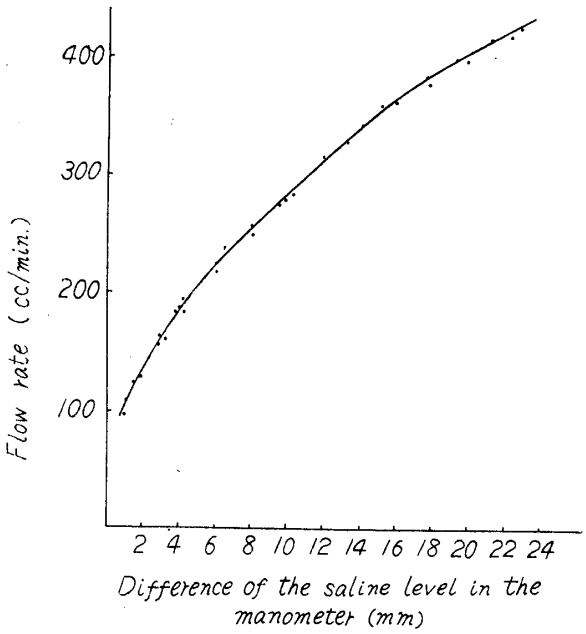

Fig. 2. The calibration curve of the orifice flowmeter.

of differential pressure. That is say, when a fluid flows through the pipe, the existence of the orifice in the pipe makes difference in pressure between the front and rear of the orifice, the degree of this difference of pressure is proportional to the flow rate of the fluid.

By using the heparinized blood and the physiological saline, the relationship between the flow rate of the blood or the saline and difference of the pressure in the manometer were examined.

As shown in Fig. 2, it is known that the measurement of the flow rate by means of the flowmeter is a technique of high reproducibility.

c) Application of the orifice flowmeter for the measurement of the flow rate of the portal blood.

The experimental animals were anesthetized with pentobalbital (25mg/kg), and the abdomen was opend along the last right lib. When the right leave of the liver was reverse, the portal vein is clad with the spleen and lies paralel with the vena cava. The portal vein was separated carefully over 1.5 inches from the spleen and other surrounding tissues. The blood flow of the portal vein

was shut off temporally and the orifice flowmeter was installed with the portal vein directly or through the polyethylen tube. The operation should be carried out promptly for the installation of the flowmeter. In the case which the time shutting the portal blood flow exceeds about three minutes, the physiological condition of the animal becomes bad and the animal was convulsed. After the installation, the saline solution was poured from cock C into the manometer of the flowmeter and readily the portal blood flow was reopened and the difference between the levels of the saline in the manometers were measured. In this case, it is best to make measurements of the portal blood flow rate keeping the saline level at a height of 8cm in the manometer.

Results and Discussion

We experienced the orifice flowmeter technique with about 20 goats and measured the flow rate of the portal blood of five goats.

Table 1. Th flow rate of the portal blood in the goat.

No. of goat	Body weight (A)	Flow rate of the portal blood (B)	$\frac{B}{A}$
1	18.5 kg	200 cc/min	10.8 cc/min/kg
2	22.0	185	8.4
3	24.0	185	7.7
4	12.5	253	20.2
5	12.5	296	23.7

As shown in Table 1, the range of the portal blood flow was 185 to 269 cc/min and 7.7 to 23.7 cc/min/kg of the body weight.

In the previous paper (1), we reported that the blood flow rate of the hepatic vein in the goat were 171 to 711 cc/min and 8.4 to 25.4 cc/min/kg to the body weight. It is reported in the dog that the flow rate of the portal blood is twice to seven hold larger than the flow rate of the hepatic arterial blood. In our estimation, though, the proportion of the flow rate of the portal blood to the flow rate of the hepatic venous blood is considerably large. This difference is probably due to the difference in technique of measuring the blood flow rate of the portal and hepatic vein. We think that measurement by means of the orifice flowmeter technique, which measures directly the rate of the successive blood flow, will give a more accurate value than that by means of the hepatic vein catheter technique, which measurements comply with several assumptions. However, in cases of measuring by the orifice flowmeter technique, attention must be given to that animals are anesthetized and that the measuring is carried out when the abdomen was opend. Bensadoun *et al.*(2) reported that the flow rate of

the portal blood is low in the fasted and anesthetized state.

Regarding the flow rate of the portal blood in ruminants, various estimations have been reported. Schambye (3) estimated 37 cc/min/kg of sheeps by means of the indicater dilution methods. Bensadoun (4) measured 0.5 to 2.37 *l*/min in sheeps by means of the thermodilution method. Conrad[4] estimated 7.3 to 17.4 cc/min/kg of calves by means of the isotope dilution method. Our data shown in Table 1 are similar to the flow rate by those estimations.

Summary

1) The orifice flowmeter was examined for the purpose of estimation of the blood flow rate of the portal blood and it was ascertained that this method has a high reproducibility.

2) The flow rate of the portal blood of goats was measured by means of the orifice flowmeter method and the range of 7.7 to 23.7 cc/min/kg of body weight was obtained.

Reference

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3) Schmbye, P. (1955). Nord. Vet. Med., **7**, 961.
4) Conrad, H. R. *et al.* (1958). J. Dairy Science, **41**, 1049.