

Effect of Stage of Gestation on Succinoxidase Activity of Fetal and Maternal Swine Hearts.*† (23441)

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(Introduced by T. J. Cunha)

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Sippel(4) has demonstrated that heart function and succinoxidase activity are closely related in rat and chick ventricles during embryonic development. Cooper(1) found that succinic dehydrogenase in the 20- and 21-day-old fetal rat ventricle was approximately 30% of that of the adult rat. The present study was made to determine (a) the rate at which swine develop this active enzyme system in the heart of the embryo, and (b) the influence of different stages of gestation on the maternal heart. In addition, two dietary levels of manganese and position of the embryos in the uteri were observed for their influence in the above tests.

Experimental. Eighteen Duroc gilts weighing 277 ± 20 lb. were divided into 2 equal lots. They were fed a basal ration containing 10% dried skim milk, 10% tankage (meat and bone), 76.5% ground yellow corn, 3% citrus meal and 0.5% iodized salt. The following components were also added per ton: 4 g riboflavin, 8 g pantothenic acid, 18 g niacin, 20 g choline-Cl, 0.12 g folic acid, 3.6×10^6 U.S.P. units of vit. A, and 0.45×10^6 units of vit. D. This ration contained 7 p.p.m. of manganese by analysis. One lot of 9 gilts received this ration; another lot received the same components but in addition sufficient $\text{MnSO}_4 \cdot 7\text{H}_2\text{O}$ to increase the manganese to 68 p.p.m. Since the level of manganese in the ration had no statistically significant influence on the succinoxidase activity of the heart, or on fetal growth, or maternal vigor, the data for this treatment are not separated in this report. The sows averaged 50 days on the rations before they began their gestation periods, of 112 days. The fetal heart begins to function at about 25 days of age.

Six pregnant sows were sacrificed at 60, 80, and 110 days of gestation, respectively. Determinations were immediately made of the succinoxidase activity of the fetal ventricles, and the left ventricles of the sows. Hearts of fetuses from the extremes and middle areas of the uteri were analyzed, but position was not found to influence enzyme activity; hence, individual values for hearts of fetuses in the various positions are not presented. Succinoxidase activity was determined by the method of Schneider and Potter(2). Nitrogen was determined in the homogenates by the Kjeldahl method. The succinoxidase activity was calculated as ml of oxygen uptake per mg of N per hour, and as ml of oxygen uptake per gram of wet weight per hour.

Results. The data obtained for the succinoxidase activity for the fetal and maternal hearts are presented in Fig. 1. The activity is expressed as ml of oxygen uptake per gram of wet weight, and per 10 mg of nitrogen per hour. Statistical evaluation was made of the data according to Snedecor(5). The increase in succinoxidase activity with increase in age of the fetuses was significant ($P < 0.01$) on both the wet weight and the nitrogen basis. The increase in activity was accelerated somewhat between 80 and 110 days over that between 60 and 80 days of gestation. This increase is not as marked as the 2 increases that Sippel(4) observed during 2 stages in the embryonic development of the rat; but it does show that in swine the greater function of the fetal heart near the end of gestation is accompanied by an increase in the succinoxidase activity. This was true on both the wet weight and the per unit of nitrogen basis.

The succinoxidase activity of the maternal hearts was approximately 6 times greater than that of the fetuses at 60 and 80 days, and about 4 times greater at 110 days of gestation, on the wet weight basis. On the basis of activity per mg of nitrogen the maternal hearts

* Florida Agri. Exp. Station Journal Series, No. 332.

† Supported in part by Grant by the National Heart Inst., U.S. Public Health Service.

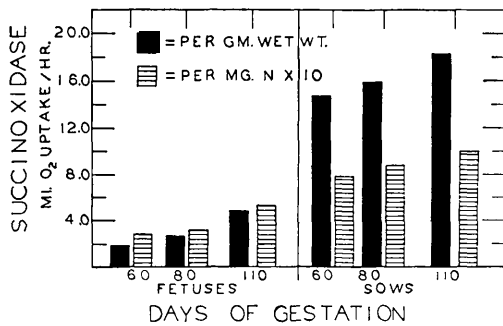


FIG. 1. Effect of 3 stages of gestation in swine on the succinoxidase activity of fetal and maternal heart ventricles. Significance: Fetuses ($P < 0.01$). Sows ($P < 0.05$) for data on wet wt basis; approaches significance on the nitrogen basis.

had only about 3 times as much activity at 60 and 80 days and approximately twice as much at 110 days of gestation as the fetal hearts. The greater activity of the maternal hearts on the wet weight basis checks quite closely with the relative values of the adult and fetal rat ventricles observed by Cooper(1). The "efficiency" of the 110-day swine fetal ventricle compared to the corresponding maternal ventricle is about doubled when the activity is expressed on the per unit weight of nitrogen basis instead of per unit of wet weight *i.e.* a ratio of 1:2 is obtained instead of 1:4. The increased succinoxidase activity of the ventricles of the sows with increasing stage of gestation was significant ($P < 0.05$) on the fresh weight basis, and approached significance on the basis of activity per mg of nitrogen.

Shirley, *et al.*(3) found that gilts fed a corn-soybean-tankage-alfalfa meal ration *ad libitum* had succinoxidase activity of 21 to 24 ml O₂ uptake/g fresh wt/hr in the left ventricles at 3 and 25 days of gestation which is somewhat greater than that found in the heavier sows at 60, 80 and 110 days of gestation in the present study. When the above gilts were limited to approximately one-half the normal dietary energy intake, succinoxi-

dase activity of 17.6 to 18.5 ml O₂ uptake/g fresh wt/hr was observed, which is in the range of that of the sows of the present study. These data indicate that advanced gestation results in a decrease of succinoxidase activity in the maternal heart to the extent observed when the sows were fed a low energy ration. Essentially no difference in enzyme activity occurred between 3 and 25 days of gestation in the gilts. The increase in activity observed in the present study with the sows at 60, 80, and 110 days of gestation, indicates that as gestation approaches termination, the physiological demands result in a greater capacity of the energy producing succinoxidase system of the maternal heart.

Summary. A significant increase in the succinoxidase activity of fetal swine ventricles was found to occur during the latter half of gestation, on both the wet weight and per unit of nitrogen basis. As gestation approached termination, an increase in activity occurred in the left ventricles of the maternal heart. These observations show that in large animals the fetal heart increases in succinoxidase activity with increased function, as previously demonstrated in the rat and chick; and that the later stages of gestation make increased requirements of the heart as indicated by greater maternal heart enzymatic activity. Two dietary levels of Mn and position of the fetuses in the uteri had no influence on the succinoxidase activity.

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Received July 12, 1957. P.S.E.B.M., 1957, v96.