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# THE RELATIONSHIP OF ERYTHROCYTE GLUTATHIONE PEROXIDASE TO BLOOD SELENIUM IN SWINE *

By

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SIVERTSEN, TORE, JAN T. KARLSEN and ARNE FRØSLIE: *The relationship of erythrocyte glutathione peroxidase to blood selenium in swine.* Acta vet. scand. 1977, *18*, 494—500. — The erythrocyte glutathione peroxidase activity and blood selenium have been investigated in swine fed a Se deficient diet with, and without, selenium supplementation. A highly significant correlation (r = 0.90) between erythrocyte glutathione peroxidase and blood selenium was found.

glutathione peroxidase; selenium; swine blood.

Since the discovery that glutathione peroxidase (Glutathione $H_2O_2$ oxido-reductase EC 1.11.1.9 — GSH-Px) is a seleno-enzyme (*Rotruck et al.* 1973, *Flohe et al.* 1973), much literature has been published on the GSH-Px—selenium relationship in organs of various species. Thus, a linear correlation between erythrocyte or whole blood GSH-Px activity and blood selenium has been demonstrated in the blood of sheep and cattle (*Allen et al.* 1975, *Oh et al.* 1976b, *Thompson et al.* 1976, *Wilson & Judson* 1976). In swine blood, however, *Thompson et al.* found no such correlation.

The aim of the present investigation was to study the GSH-Px —selenium relationship in the blood of swine fed a Se deficient diet with, and without, selenium supplementation.

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## MATERIALS AND METHODS

### *Experimental animals*

The data are derived from 3 experiments on vit. E-selenium deficiency in pigs. All pigs were fed at vit. E-selenium deficient diet from the age of 6 weeks. This diet, based mainly on Se poor barley and Toprina®* single-cell protein, is described in detail by *Teige jr. et al.* (1977).

Expt. 1 included 24 animals, in 4 groups. Groups 2 and 4 were given a supplement of 200 mg α-tocopherol and 0.2 mg selenium** per pig daily, while Groups 1 and 3 were unsupplemented. In addition, the diets of Groups 1 and 2 included 3 % tocopherol-stripped*** cod liver oil. The pigs were bled after 10 weeks of feeding.

Expt. 2 included 6 animals, fed the basic diet with an addition of 5 % tocopherol-stripped cod liver oil. Two of the animals received weekly injections of vit. E and selenium**** equivalent to approx. 0.15 mg Se and 50 mg α-tocopherol per kg feed, while the rest were not treated. The pigs were bled every 2 weeks for a period of 2 months.

Expt. 3 included 24 animals, arranged in 4 groups. They were fed the basic diet with no cod liver oil, and given the following supplements: Group 1: None. Group 2: 200 mg α-tocopherol per pig per day. Group 3: 0.2 mg selenium per pig per day. Group 4: 200 mg α-tocopherol and 0.2 mg selenium per pig per day. The animals were bled 3 times, at 2-weekly intervals.

### *Analytical procedures*

Erythrocyte glutathione peroxidase was determined according to *Beutler* (1975). A Beckman DB-G spectrophotometer with a temperature controlled sample compartment set at 37°C was used. The activity was calculated from the slope of the reaction curve during the first 30 sec. of the reaction, and expressed in i.u. per g Hb according to *Beutler*.

Blood selenium was determined by a fluorometric method

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* Produced by British Petroleum.

** As sodium hydroselenite.

*** Subjected to a silica earth absorption treatment, which reduces the tocopherol content (*Teige jr. et al.* 1977).

**** E-vimin® (Ferrosan) and Tokosel® (Agrivet).

(*Ihnat* 1974). The samples (1—2 ml) were digested by a wet-digestion procedure described by *Beal* (1975).

Serum α-tocopherol was determined by a spectrophotometric method (*Hashim & Schuttringer* 1966)*.

## RESULTS AND DISCUSSION

A highly significant correlation between erythrocyte glutathione peroxidase and blood selenium in swine blood was found (Fig 1). As seen in Fig. 2, the 2 variables almost parallel each other from week to week in the individual animals.

Separate vit. E supplementation had no effect on erythrocyte GSH-Px activity. On the other hand, the results indicate an elevating effect of selenium/GSH-Px on vit. E in plasma in the groups not supplemented with vit. E (Table 1).

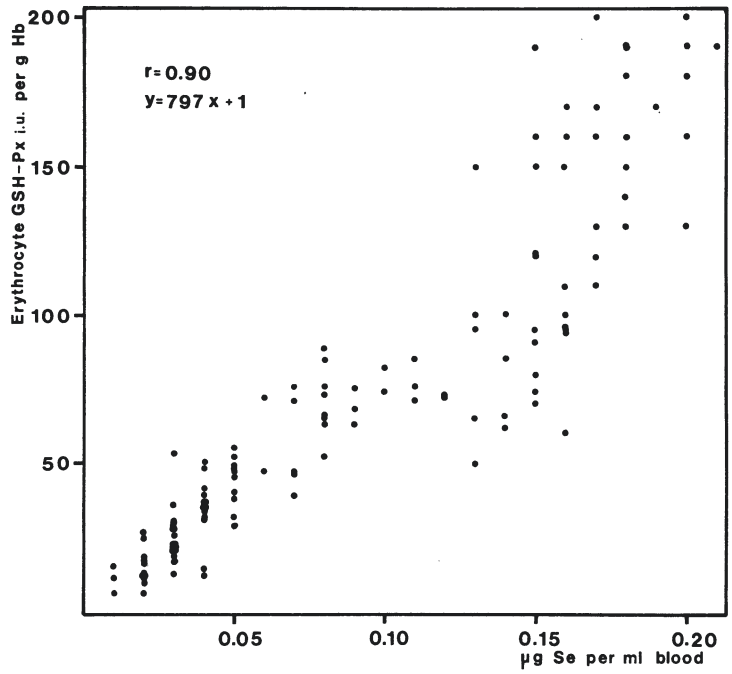


Figure 1. Relationship of erythrocyte GSH-Px activity to blood selenium in swine. The figure shows results of 127 blood samples from 3 experiments on Se-vit. E deficiency, comprising 54 animals.

* Analyses performed by J. U. Skåre, Veterinary College of Norway, Oslo.

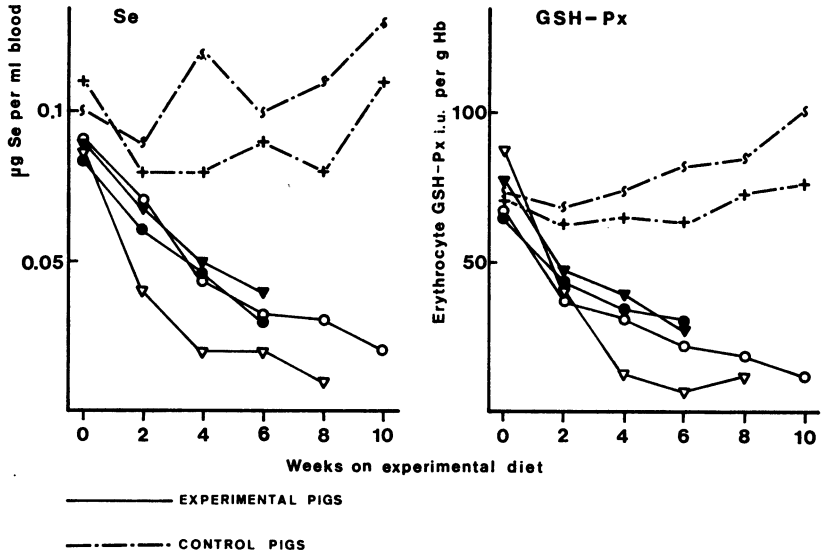


Figure 2. Levels of blood selenium (left) and erythrocyte GSH-Px activity (right) in 4 pigs fed a Se-vit. E deficient diet with 5 % tocopherol-stripped cod liver oil (Expt. 2). The 2 control pigs were given weekly injections of vit. E and selenium. Three of the experimental pigs died during the experiment, after 7, 8 and 9 weeks. The post-mortem findings were typical of Se-vit. E deficiency.

Table 1. Erythrocyte GSH-Px, blood selenium and plasma α-tocopherol in growing swine after 6 weeks on a Se-vit. E. deficient diet with, and without, Se/vit. E supplementation (Expt. 3). Group mean ± s.

| | Group 1 No supplements | Group 2 200 mg α-tocopherol per pig daily | Group 3 0.2 mg Se per pig daily | Group 4 200 mg α-tocopherol + 0.2 mg Se per pig daily |
|---|---|---|---|---|
| Erythrocyte GSH-Px, i.u. per g Hb | 28 ± 7 | 29 ± 8 | 150 ± 40 | 120 ± 40 |
| Blood Se, µg per ml | 0.04 ± 0.01 | 0.03 ± 0.01 | 0.19 ± 0.02 | 0.16 ± 0.02 |
| Plasma α-tocopherol*, µg per ml | 0.7 ± 0.4 | 2.8 ± 0.3 | 1.2 ± 0.2 | 3.1 ± 1.0 |

* These values will also be published elsewere (*Teige jr. et al.* in press).

The inclusion of 3 % cod liver oil in the diet (Expt. 1) did not influence GSH-Px activity.

The erythrocyte GSH-Px activity has previously been shown to be a useful indicator of the Se balance in rats (*Hafeman et al.* 1974, *Reddy & Tappel* 1974, *Smith et al.* 1974), chickens (*Omaye & Tappel* 1974) and sheep (*Oh et al.* 1976 a, b). As mentioned, several authors have reported a linear correlation between erythrocyte or whole blood GSH-Px and blood Se in sheep and cattle (*Allen et al.* 1975, *Oh et al.* 1976 b, *Thompson et al.* 1976, *Wilson & Judson* 1976). This indicates that GSH-Px activity can be used as a direct parameter for blood Se status. Based on these results, a simplified GSH-Px method has been developed for field tests for selenium deficiency in sheep (*Board & Peter* 1976).

Our results indicate that erythrocyte GSH-Px activity may be used as a direct parameter of blood Se status also in swine. This is in contrast to the findings of *Thompson et al.*

Recently, *Bengtsson et al.* (1976) reported a close correlation between serum GSH-Px activity and blood selenium in swine.

Selenium levels in the present material range from normal to extreme deficiency. This also applies to the other reports mentioned.

In a study in man, no correlation was found between GSH-Px and total Se in erythrocytes (*Schmidt & Heller* 1976).

The finding that dietary vit. E has no influence on pig erythrocyte GSH-Px activity corresponds with the results of *Fukuzawa & Tokumura* (1976) in the mouse, but not with those of *Scott et al.* (1976) in the rat.

The lack of influence of unsaturated lipids in the diet on erythrocyte GSH-Px activity does not correspond with the results of *Reddy & Tappel* in the rat. However, their experimental diet included as much as 15 % tocopherol-stripped corn oil.

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SAMMENDRAG

*Forholdet mellom glutathion peroksydaseaktivitet i røde blodlegemer og selenkonsentrasjon i blod hos svin.*

Aktiviteten av glutathion peroksydase (GSH-Px) i røde blodlegemer og konsentrasjonen av selen i blod er målt hos griser som ble satt på selen/E-vitaminfattig fór fra 6-ukers alder. Grisene fikk dels tilskudd av selen, dels av E-vitamin, dels både selen og E-vitamin, i tillegg til at noen griser fikk tilskudd av E-vitaminfattig tran.

Det ble funnet en positiv, lineær korrelasjon mellom blodkonsentrasjonen av selen og GSH-Px aktiviteten i blodlegemene ($r = 0{,}90$; $y = 797x + 1$; $n = 127$). Hverken trantilskudd eller E-vitamintilskudd alene hadde noen effekt på aktiviteten av GSH-Px i blodlegemene.

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