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SYMPOSIUM

Genetics of glutathione peroxidase+

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ABSTRACT Glutathione peroxidase is a selenoenzyme responsible for elimination of reactive oxygen species. Since its first identification in 1957 five isoforms have been typified.Several environmental factors, like feed composition, trace element status and vitamin intake, are known to affect the activity of this enzyme, but there are some publications suggesting significant role of genetics, as well. There are some preliminary population level studies on genetic regulation of the enzyme. More recently its molecular genetics was studied primarily. As a result several regulatory elements were identified both on transcriptional and on translational level, but still the full mechanism is not known. Principals of the correlation between glutathione peroxidase activity and production traits is also unclear. This paper is a review of the studies of the authors on this correlation in different livestock species.
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KEY WORDS

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Glutathione peroxidase (EC. 1. 11. 1. 9) is an important part of the antioxidant defence system. Today five isoforms are known, therefore it is called more like an enzyme family than a single enzyme. They are present in almost every cell of animals, but the tissue distribution of the isoforms shows high variation.

There are several factors abrogating the activity of the enzyme. Some of these are internal, individual factors, resulting in significant variation in the enzyme activity of different organs, age groups and sex. Endocrine regulation can also control enzyme activity.

However, environmental factors have also definite effect on enzyme action. Nutrition is one of the most essential factors as fat content and fatty acid composition of feed, or trace element intake as well as vitamin status of the animal play crucial role in normal enzyme activity. Seasonal changes has also some effect on GSHPx activity as circannual changes have been reported in the literature (Erdélyi et al. 1999).

Recent publications also suggest that genetic regulation has important role in the control of enzyme action. Most of these studies are done on the population level. In some preliminary experiments glutathione peroxidase (GSHPx) activity was found to correlate with several production traits. In Finn sheep, for instance, negative correlation was shown between enzyme activity and body weight, weight gain (Atroshi and Sankari 1981). Similar results were obtained with chicken (Lavronga and Combs 1982), pig (Lingaas et al. 1991) and rabbit (Mézes et al. 1994). Some phenotypic variance of the enzyme activity and its correlation with genetic muscle dystrophy was reported in chicken (Hull and Scott 1976) and in mice (Bell and Draper 1976).

In this paper authors wish to present an overview of their experiments on population level correlations between GSHPx activity and production traits in some livestock species.

Materials and Methods

Animals and samples

Experiment 1

Pure-bred Landes, Pure-bred Hungarian White, Landes x Hungarian White and Hungarian White x Landes goose stocks were involved in the study. Liver samples (n=12/lines) were taken at 2nd and 70th days of age.

Experiment 2

Compact and control mice as well as their two different crossbred lines (in one mothers were compact in the other the father was compact genotype)were involved in the experiment. Liver samples were taken from mice at 14, 28, 42, 56 and 90 days of age.

Experiment 3

Liver samples were collected from day old chickens of six genotypes. The studied six genotypes were as follows: Plymouth Rock White (PRW), Naked Neck Plymouth (NNP), Naked Neck New Hampshire (NNNH), Hungarian

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+In memory of Professor Béla Matkovics

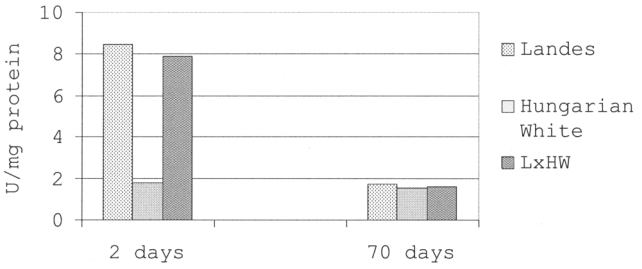

Figure 1. Glutathione peroxidase in goose liver in different age in different genotypes.

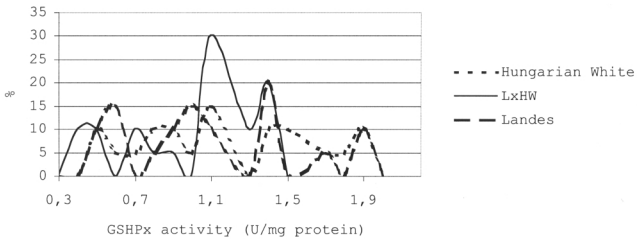

Figure 3. Distribution of GSHPx activity in the population of the three genotypes at 70 days of age.

Speckled (HS), Transylvanian Naked eck White (TNNW) and Hungarian White (HW).

All the experiments were prepared according to the guidelines of Hungarian Law for protection of animal rights.

Sample preparation for biochemical analysis

Liver samples were homogenised in 1:9 physiological saline solution. Homogenates were centrifuged and 10.000 g supernatant was used for further analysis.

Fat content of goose liver samples were removed after a preliminary centrifugation at 500 g for 5 min previous to the high speed centrifugation.

Glutathione peroxidase activity was measured with an end-point direct assay according to (Matkovics et al. 1988). Activity data were referred to protein concentration of the samples. To measure protein concentration Folin phenol reagent was used (Lowry et al. 1951).

Statistical analyses

The differences among different genotypes were calculated using analysis of variance and regression analysis (Snedecor and Cochran 1976) and the levels of significance were assessed with Duncan's test.

Results

Experiment 1

Hungarian White genotype has significantly (P<0.001) lower GSHPx activity in the liver of two days old gooslings, than pure bred Landes or the cross bred genotypes (Table 1). While no significant differences were found among the three latter groups.

The difference in the early postnatal age disappeares by 70 days of age (Fig. 1).

Studying the distribution of enzyme activity in the population, distribution peaks were well separated in the three genotypes and Hungarian White was quite far from the two other groups concerning enzyme activity distribution (Fig. 2).

These differences are faded away at 70 days of age as distribution peaks of the different genotypes more or less overlap each other (Fig. 3).

Experiment 2

There was significant difference between the control and compact group at 28 days of age (P<0.001) in the males, while enzyme activity of the crossbred lines were similar. It

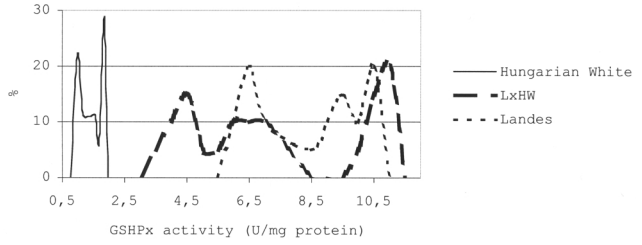

Figure 2. Distribution of GSHPx activity in the population of the three genotypes at 2 days of age.

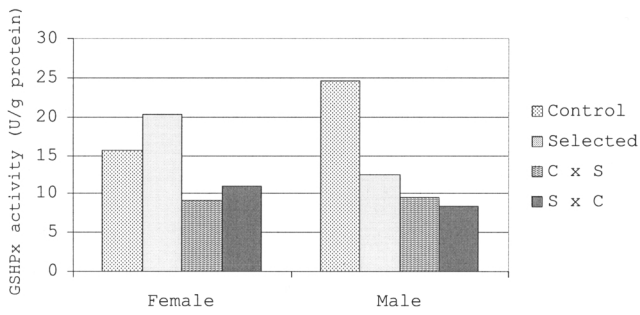

Figure 4. Glutathione peroxidase activity in the two sexes of mice at 28 days of age.

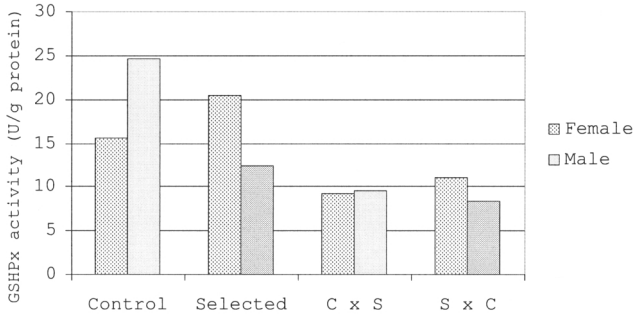

Figure 5. Glutathione peroxidase activity in the four lines of murine at 28 days of age.

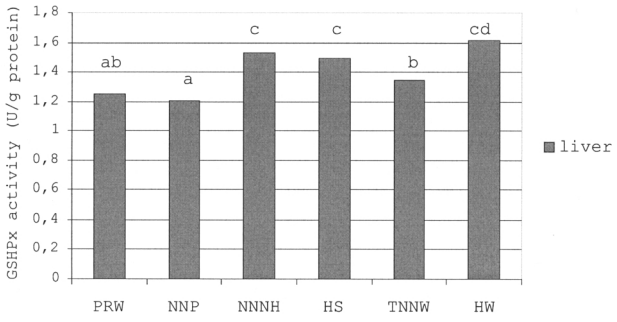

Figure 6. Glutathione peroxidase activity in the liver of different chicken genotypes (different letters mean significant difference at P<0.05).

is also important that these latter values were closer to that of the compact mice than the control (Fig. 4). There was no significant difference among the enzyme activity of the four lines in the females. While there were no significant changes at any other sampling period.

In the control line males had higher GSHPx activity than females, while in the compact line enzyme activity of the two sexes were the opposite. Comparing the data of the two crossbred lines controversial results were obtained in the two sexes. Glutathione peroxidase activity of males in the line having compact father was lower as compared to the values of males in the other crossbred line, while the same data for females were just the opposite. In the line having control father, glutathione peroxidase activity was almost the same in the two sexes. In the line having compact father, glutathione peroxidase activity of females were higher than that of the males (Fig. 5).

Table 1. GSHPx activity in the liver homogenates of two days old gooslings of different genotypes (different letters mean significant difference at P<0.001)

Genotype	GSHPx activity (U/mg 10.000g supernatant protein)
Hungarian White	1.47 ± 0.45 a
Landes	8.72 ± 1.85 b
Landes x Hungarian White	7.86 ± 3.44 b
Hungarian White x Landes	10.42 ± 6.33 b

Experiment 3

Concerning phenotypic variation of glutathione peroxidase activity in liver homogenates of the different genotypes NNP was found to have significantly lower enzyme activity than all the other groups except PRW phenotype. Highest enzyme activity was measured in the individuals of Hungarian White type (Fig. 6).

According to correlation analysis negative correlation was found between glutathione peroxidase activity and body weight. Strength of correlation increases with age from 4 weeks to sexual maturation. Also negative correlation was shown between enzyme activity and weight gain among each age group, except age of highest egg production, while positive correlation was found between liver GSHPx activity and egg production (Table 2).

Discussion

Experiment 1

Glutathione peroxidase has significantly higher activity at 2 days of age in the liver of Landes type geese. Cross bred variety has GSHPx activity more like Landes than the other parent variety.

Fatty liver production of Landes breed has very good genetic inheritance. Glutathione redox system, including glutathione peroxidase is thought to have importance in fatty liver production.

Therefore, our results suggest that glutathione peroxidase activity of the liver of 2 days old gooslings might be a

Table 2. Correlation between liver glutathione peroxidase activity and performance traits.

	WG 0-4	WG 4-8	WG 8-12	WG 12-SM	BW 4.w.	BW 8. w	BW 12. w	BW SM	BWHEP	Egg prod.
Liver GSHPx act. correlation	-0.49	-0.71	-0.31	-0.60	-0.49	-0.6	-0.77	-0.83*	-0.77	0.54

possible marker for prediction of lipogenetic activity of liver, hence it can be used as selection marker for early selection for liver production efficiency.

Differences of GSHPx activity among different varieties at early postnatal life were disappeared in adult animals, which shows the impotance of age as a criteria to give normal range in glutathione peroxidase activity in avian species.

Experiment 2

Phenotypic difference between control and compact mice is at least in part a result of biochemical processes related to lipid metabolism. According to the results, glutathione peroxidase might be a potential selection marker for compact characteristics, but the two sexes should be concerned separately as enzyme activity varied between females and males.The best study period is between 4-8 weeks of age in mice considering the largest variation of glutathione peroxidase activity at this time.

As compact caracteristics is a preferable one in livestock animals, measuring enzyme activity could be a good indicator of meat production performance even if compact phenotype is not present in a population.

Experiment 3

There is relatively high differences between genotypes in glutathione peroxidase activity and these correlate well with some of the performance traits even in one day old chicken. This provides a potential early selection marker for production traits, but to put this into practice further experiments are required.

Altogether, according to the results of experiments introduced above, glutathione peroxidase activity is a real potential selection marker as it shows correlation to special production traits, and changes in different genotypes. To determine the ways of its use further, large scale selection experiments should be done.

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