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Supplementation of Selenium Enhanced Feed and its Effect on Biochemical and Antioxidant Parameters of Racing Pigeons

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Abstract

The purpose of this study was to investigate the supplementation of Compound Feed (CF) for racing pigeons with organic and inorganic forms of selenium and to observe the effect of Se supplementation by determining selected biochemical and antioxidant markers in pigeons before and after the 350 km race. The study included 30 racing pigeons divided into three equal groups (n = 10). During 30 days before the expected race, the first group (P1) was fed compound feed supplemented with natural organic Se at a dose of 0.3 g/kg Dry Matter (DM) while feed provided to pigeons in the Control Group (C) contained 0.1 mg Se/kg DM. At the same time the pigeons from the second group (P2) were fed compound feed containing an inorganic form of selenium (sodium selenite) at a dose of 0.3 mg Se/kg dry matter. Blood was collected from all pigeons before the mixing and feeding the supplemented feed and after the race to evaluate and compare the biochemical and antioxidant markers related to muscle damage. The results of the study showed that the post-race plasma selenium concentration and Glutathione Peroxidase (GPx) enzymatic activity were significantly higher in P1 and P2 supplemented groups compared to the control. Comparison of the activities of the enzymes Alanine Aminotransferase (ALT), Aspartate Aminotransferase (ASP), Alkaline Phosphatase (ALP), Creatinine Kinase (CK) and Lactate Dehydrogenase (LDH) at the beginning of the supplementation period showed no changes in all three groups. Increased activity of the afore mentioned enzymes that induce muscle strain and damage was observed in all three groups after the race. We can conclude that high feed supplementation with selenium can provide effective antioxidant protection by stabilizing blood levels and effective activity of antioxidant enzymes, thereby contributing to better performance and especially the rapid recovery of individual pigeons after their racing efforts.

Keywords: Races; Organic Sources; Selenium; Enzymes; Metabolism; Regeneration

Introduction

Shortened flying times at racing pigeon competitions and more races per season indicate higher performance and overload of birds which is reflected in their health and short periods of regeneration. Increasing stress is associated with weakened immunity, higher susceptibility to disease and absence of their expected performance [1]. One way to prevent this problem is to provide the birds vitamin-mineral supplements that have a strong antioxidant function. In general, the antioxidant system contains natural fat-soluble antioxidants (e.g., vitamin A, alpha-tocopherols, carotenoids), water-soluble antioxidants (e.g., ascorbic acid, uric acid), antioxidant enzymes (Glutathione Peroxidase GPx and other Se-enzymes, catalase CAT, Superoxide Dismutase Catalyst SOD) and thiol-redox system (glutathione system and thioredoxin system) [2,3]. One of the very effective but often deficient antioxidant nutrients is selenium. Selenium is a trace element important for animal health. It plays a major role in the body in fighting free radicals against free radicals – the atoms, molecules or ions containing highly active oxygen or hydrogen. This activity is caused by "excess" electrons that react readily with any compound they encounter, causing thus oxidation of the attacked compound or tissue (e.g., at disease or muscle load). This free radical activity frequently alters compound or tissues in a way, so they become unusable for the original purposes. In practice this means that the compounds that make up the cells are destroyed, thus their activity and all structures they are part of become damaged [4]. The antioxidant effect of Se is determined primarily by its role as an essential component of the active selenoenzymes center. Glutathione Peroxidase (GPx) is one of the 25 selenoprotein found in the body in which Se is the active component. Pigeon training or the race itself increases metabolism and the demands on oxygen, especially in the musculoskeletal muscles. As a result,

large amounts of Reactive Oxygen Species (ROS; free radicals) are produced during the performance. Excessive ROS production may exceed the capacity of the system of protective (antioxidant) enzymes, causing dysfunction of the cell membrane associated with oxidation of lipids, proteins, and nucleic acids. Cell damage due to increased free radical production triggers a cascade of other responses that ultimately result in muscle dysfunction and rapid exhaustion of the individual [5]. Due to the low concentration of Se in soil and plants in most EU countries, feeds are usually supplemented with various organic or inorganic sources of Se in the amount of 0.3-0.5 mg Se/kg DM [6].

The aim of this study was to evaluate the effects of oral supplementation of organic and inorganic selenium into compound feed to racing pigeons by determining selected biochemical and antioxidant markers before and after 350 km race.

Materials and Methods

Breeding equipment and supplementation of pigeon feed

A wooden birdhouse (garden type) housing 60 racing pigeons (Columba Livia dom.) was divided by a net into three main sections. Each section consisted of a pull-out box with a lamellar slatted floor and a feeder and drinker (Figure 1). During the flight season (May to July), the pigeons took part in a total of 14 races divided according to length from less demanding (120 km) to a very demanding (1200 km). From all housed pigeons, 30 were selected and divided into three equal groups (n = 10), 5 pigeons and 5 doves in each. For the period of 30 days before the expected race, they were fed a feed supplemented with organic or inorganic selenium in the amount of 20 g/head in the morning and evening. The first group (P1) was provided feed with a high content of natural organic selenium (0.3 mg Se/kg dry matter), while the Control Pigeons (C) received feed containing 0.1 mg Se kg dry matter [7]. The difference in Se content in the feed given to P1 (high content of natural organic selenium) and C groups was due to the selection of ingredients that were either high or low in Se content. The control group was fed a Compound Feed (CF) produced in the EU with a low Se content, while feed for P1 group with much higher natural Se content was imported from Canada (Figure 2). The second group (P2) was fed an inorganic form of selenium (Na_2SeO_3) that was added at a dose of 0.3 mg Se/kg DM of CF. In the control group, the natural Se content was up to 0.1 mg Se/kg DM of CF, while in groups P1 and P2 its content was identical, namely 0.3 mg Se/kg DM.

Figure 1: Loft with section for pigeons.
Photo: Zigo (2018).

Laboratory analysis

Blood was drawn from all three groups from the *tarso metatarsica* vein before administration of supplemented feed and after the race and used for evaluation of biochemical and antioxidant parameters related to muscle metabolism. After collection and centrifugation, all samples were stored at -54 °C until analysis. Plasma Se concentration was determined using a fluorimetric method of [8]. Blood GPx activity was determined spectrophotometrically by means of a commercial kit (Randox-Ransel, UK) according to [9]. And expressed and converted to grams of hemoglobin. The Se concentration in the samples taken from all three compound feeds before and after mixing was determined employing a Zeman 4100 atomic absorption spectrometer (Perkin Elmer, USA) according to [6]. Determination of enzymatic activities of ALT, AST, ALP, CK and LDH was performed by means of BIO-LA-TEST diagnostic test kits (Erba Lachema, Brno, Czech Republic) using a photoelectric calorimeter and the field method by [10].

Statistical analysis

The results were statistically processed using descriptive statistical analysis of data and statistical method of the student's t-test. Tukey ´s post tests were used to compare all three groups before and after race and significant effect of peroral supplementation was indicated by ANOVA. Values are means (M) and Standard Deviation (SD), and $P<0.05$ was considered as statistically significant.

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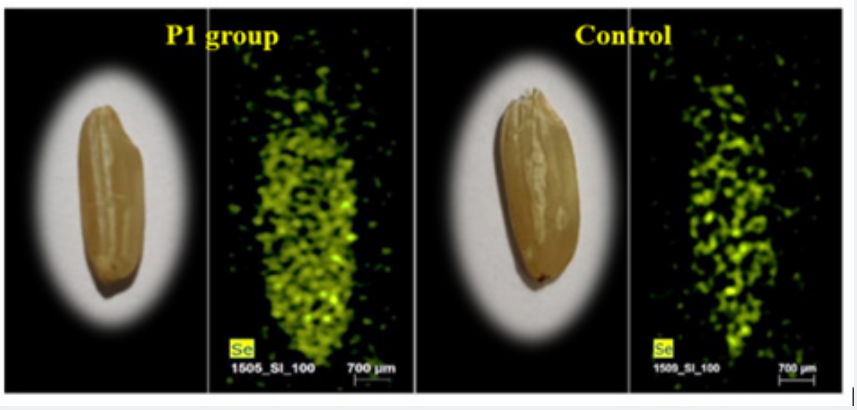
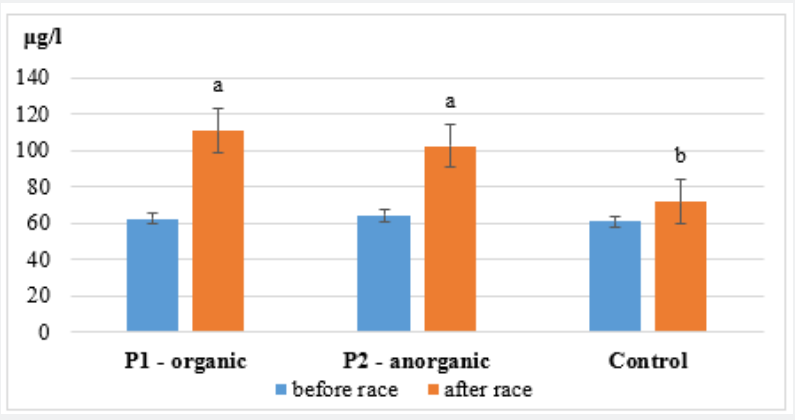


Figure 2: Comparison of natural Se content in feed by fluorescent radiation.
Note: P1 organic – pigeons were fed a high natural content of organic selenium (0.3 mg Se/kg of diet); C - control group fed a low natural content of Se (0.1 mg Se/kg of diet).
Source: Marquez et al. [7].

Results and Discussion

Metabolism of the ingested Se sources depends on the chemical form of Se in the feed as some forms (organic) are better for some activities than other forms. The diet may contain various amounts of Se in different forms. There are two main sources of Se for pigeons: organic Se, mainly in the form of proteins, SeMet, which is found in any feed ingredient in various concentrations, and inorganic selenium, mainly selenite or selenate, which is widely used as a feed supplement [4]. The effect of organic or inorganic Se supplementation of pigeon feed on Se concentration in blood plasma of pigeons before and after the 350 km race is shown in (Graph 1). In the groups consuming feed supplemented with natural organic or inorganic Se the plasma concentration and GPx enzyme activity were significantly increased after the race in comparison with the control group (Graph 2). A German study confirmed an increase in hydroxide radicals during a 2-hours flight stimulation of racing pigeons in flight tunnels. However, the authors reported faster degradation of hydroxide radicals and increased GPx activity in the group of pigeons fed a reduced amount of Se (195 µg Se/kg of DM feed) before the simulation compared to pigeons consuming feed containing 0.3 mg Se/kg of DM feed [11]. Muscle metabolism enzymes exhibit a broad spectrum of activity and variations of these enzymes are difficult to interpret. Nevertheless, these enzymes may be adversely affected by factors such as muscle injury, organ rupture, nutritional status, physical activity, haemolysis, or various infectious diseases and their treatment. Often, these enzymes serve as important diagnostic tools in veterinary medicine [12]. (Table 1) shows the activity of enzymes inducing muscle damage in the period before and after Se supplementation. No significant differences in the activity of the enzymes ALT, ASP, ALT and CK were observed at the beginning of the supplementation period. Increased activity of all enzymes was detected after the race in all observed groups.



Graph 1: Comparison of Se concentrations from pigeon blood before and after the race.
Note: P1 organic – pigeons were fed a high natural content of organic selenium; P2 an organic – pigeons were fed with addition of an organic selenium; C - control group fed a low natural content of Se
a, bSignificance level p <0.01 is presented by different superscribes in some columns between groups.

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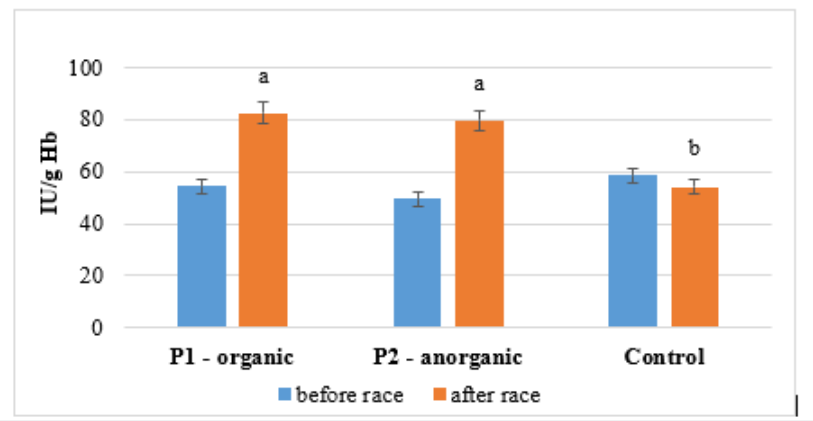

Graph 2: Evaluation of GPx enzymatic activity from pigeon blood before and after the race.
Note: P1 organic – pigeons were fed a high natural content of organic selenium; P2 an organic – pigeons were fed with addition of an organic selenium; C - control group fed a low natural content of Se
a, bSignificance level p <0.05 is presented by different superscribes in some columns between groups.

Table 1: Evaluation of enzymatic activity indicating muscle damage.

Parameter	Unit	Period	P1 Group	P2 Group	C Group
			M±SD	M±SD	M±SD
ALP	IU/L	Before	126.4 ± 10.1	119.3±12.4	133.6 ± 14.7
		After	374.2 ± 28.3	342.4 ± 27.1	383.2 ± 31.3
AST	IU/L	Before	107.0 ± 9.0	93.7 ± 8.2	111.5 ± 10.4
		After	258.0 ± 24.5	236.6 ± 19.5	268.3 ± 27.9
ALT	IU/L	Before	23.6 ± 2.8	18.7 ± 2.1	24.7 ± 4.2
		After	37.3 ± 4.8	35.7 ± 6.2	41.1 ± 5.1
CK	IU/L	Before	147.2 ± 22.1	178.3 ± 37.1	156.7 ± 31.3
		After	405.4 ± 49.2	447.2 ± 53.6	471.4 ± 44.9
LDH	IU/L	Before	128.7 ± 10.7	110.8 ± 11.1	117.5 ± 9.4
		After	267.3 ± 30.6	240.6 ± 32.7	258.9 ± 28.5

Note: P1 group-pigeons feed with high naturally organic selenium content, P2 group-feed with an organic form of selenium after mixing addition, C group – control group feed with low Se content.

Conclusion

Higher plasma Se levels and increased GPx activity in pigeons after the race were achieved by oral supplementation of organic and inorganic Se sources compared to the control group that consumed feed not supplemented with Se. The increased activity of the antioxidant enzyme GPx may be explained by in-flight physical muscle effort and release of free radicals but supplementation of feed with Se did not affect the levels of muscle load inducing enzymes as a factor affecting their activity. Racing pigeons are birds with high potential for frequent flights and competitions and are therefore exposed to strong oxidative stress. Supplementation based on the administration of Se to feed appears to be not only an effective way of antioxidant protection, but also as contribution to rapid regeneration of birds between individual races.

Conflict of Interest

Author declares that there is no conflict of interest.

Acknowledgment

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