# LIPID OXIDATION AND GLUTATHIONE PEROXIDASE CONTENT IN MEAT OF KACANG GOATS SUPPLEMENTED WITH DIETARY SELENIUM AND IODINE

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**Abstract – The study was carried out to examine the effects of supplementing inorganic selenium (Se), iodine (I) and a combination of both on serum and muscle glutathione peroxidase enzyme (GSH-Px) concentrations and meat oxidative stability in goats. Twenty four male Kacang goats were allotted randomly to basal diet without supplementation as control (T1), basal diet + 0.6 mg Se/kg DM (T2), basal diet + 0.6 mg I/kg DM (T3) or basal diet with combination of 0.6 mg Se +0.6 mg I/kg DM (T4) for 100 consecutive days. Serum samples were collected at day 95 for the determination of GSHPx concentration. *Semitendinosus* (ST) muscle for GSHPx (0 d) and lipid oxidation (0, 1 and 7) assessment were collected, snap frozen, and stored at -80°C until subsequent analyses. In comparison with the control animals (T1), the levels of malondialdehyde (MDA) were lower ($p$<0.05) in the ST of Se supplemented animals (T2 and T4). Higher concentrations of serum and muscle GSHPx ($p$<0.05) were also noted by the Se supplemented animals (T2 and T4). In our study, inorganic Se showed a high potential to improve oxidative stability and to increase the shelf life of goat meat.**

**Key Words – Antioxidants, Goat meat, Malondialdehyde, Serum**

## I. INTRODUCTION

Oxidative damage is the major non-microbial factor responsible for quality deterioration of muscle foods [1]. Meat oxidative deterioration during retail display and storage which could lead to damages of both nutritional value and eating quality is the main challenge in meat production chain [2]. Meat oxidative stability can be maintained through the balance between pro-oxidant and antioxidant components in the muscle [3]. In relation to that, selenium has been categorised as a constitutive component of the important antioxidant enzyme GSHPx [5] which plays vital function in defence mechanism by reducing lipid and hydrogen peroxides to less hazardous hydroxides through oxidation [6].

Previous studies reported a positive correlation between GSHPx activity and tissue Se content in goats [7], pigs [8], and broilers [9], and that will improve the oxidative stability and eventually increase the shelf life of meat. Studies related to effect of dietary I supplementation on the oxidative stability of fresh meat is very limited. This may be attributed to the low carry-over of I into meat compared to milk and egg [10]. Moreover, Winger *et al.* [11] documented that reactions in meat products involving iodine and its salts may potentially increase oxidative reactions, thus reducing shelf life. More recently, Hes *et al.* [12] reported no significant differences in the content of thiobarbituric acid reactive substances (TBARS) of iodized (KI) and non-iodized salt fresh pork after 60 d of storage. Currently, requirement of the antioxidants has been increased since the animal production approaches tend to increase the concentration of PUFAs and reduce SFAs in ruminant meats [13]. Studies in beef cattle [1] and lambs [4] demonstrated that the endogenous antioxidant and the adding of synthetic or natural antioxidants of dietary source were able to prolong meat shelf life by countering the oxidative reactions.

In goats, unlike selenium, the effects of I and combination of Se and I on meat shelf life is yet to be examined. Thus, the present study was conducted to determine the effects of dietary

supplementation of inorganic Se, I, and a combination of both on lipid oxidation and GSHPx content in muscle of Kacang crossbred male goats.

## II. MATERIALS AND METHODS

The study involved 24 indigenous Kacang crossbred male goats aged at 7-8 months old with mean initial body weight of 22 ± 1.17 kg. The animals were randomly assigned to four dietary treatments with each treatment consisted of six animals. Based on dry matter basis, the animals were given the same concentrate diet at 1% of their body weight with *ad libitum* amount of fresh guinea grass for 100 consecutive days prior to slaughter. The four dietary treatments were as follows: T1 (control) - basal diet without supplementation; T2 - basal diet with 0.6 mg Se/kg DM; T3 - basal diet with 0.6 mg I/kg DM; T4 - basal diet with combination of 0.6 mg Se/kg DM and 0.6 mg I/kg DM. The inorganic selenium was given in the form of sodium selenite (R&M Chemicals, U.K) while inorganic iodine was given in the form of potassium iodide (BHD Lab, U.K).

Serum samples were collected at day 95 for the determination of GSHPx concentration. Upon accomplishment of the feeding trial, the animals were slaughtered and samples of ST muscle were collected, trimmed off of any visible fat and connective tissue, snap frozen in liquid nitrogen, and stored at -80 °C until subsequent glutathione peroxidase (0 d) and lipid oxidation (0, 1 and 7 d) determinations. Lipid oxidation was evaluated using QuantiChrom™ TBARS Assay Kit (DTBA-100 BioAssay Systems, USA). Based on the reaction between thiobarbituric acid reactive substance (TBARS) and thiobarbituric acid (TBA), the intensity of the colour product measured at 535 nm indicated the concentration of malondialdehyde (MDA) in the sample. The activities of GSHPx in muscle and serum were quantified using EnzyChrom™ Glutathione Peroxidase Assay Kit EGPX-100, (BioAssay Systems, USA). The assay measured the consumption of nicotinamide adenine dinucleotide phosphate (NADPH) in the enzyme coupled reactions by recording the decrease in absorbance at 340 nm, and was expressed as U/l, where one unit (U) is the amount of GSHPx that produces 1μM of Glutathione disulfide (GS-SG) per min at pH 7.6 at room temperature.

The data were statistically analyzed using the GLM procedure of SAS [14] Version 9.2 software (Statistical Analysis System, SAS Institute Inc., Cary, NC, USA) and statistical significance was set at $p< 0.05$ for one-way analysis of variance (ANOVA). Repeated measurement in time was used for MDA measurement. Differences between the means were determined by Duncan's multiple range test.

## III. RESULTS AND DISCUSSION

The dietary I supplementation (T3) did not affect the concentration of MDA in ST muscle, (Table 1) and this was consistently observed at 0, 1 and 7 d of aging. In comparison with the control group, ST muscles from the animals supplemented with dietary Se (T2) and combination of Se and I (T4) presented a lower concentration of MDA ($p<0.05$) at day 7 of aging. At 24 h (1 d), there were no differences ($p>0.05$) in the concentrations of MDA among the dietary treatment groups. However, it was noted that the MDA concentrations in ST muscle were significantly increased at d 7 of aging for animals fed with control (T1) and I supplemented (T3) diets. Nevertheless, the MDA concentration in ST muscle of Se supplemented animals (T2) and those supplemented with combination of Se and I was significantly lower than the concentrations in T1 and T3 groups.

In line with our results, Zhan *et al.* [8] reported that the MDA concentrations in loin muscle of pigs received different sources of Se was significantly lower than the control. The authors showed negative correlation between the concentration of MDA and GSHPx activity. Increased GSHPx activity may protect the body from peroxidation and maintain low status of MDA in the muscle. Contrary to our results, Chung *et al.* [15] reported that dietary supplementation of different sources of Se did not influence the MDA level in the muscle tissue of Korean native goats. The inconsistent

findings on the effect of dietary Se on meat oxidative stability could be explained by differences in sources of Se and species of animals [9].

Table 1 Differences in malondialdehyde concentrations in *semitendinosus* muscle (at different aging time) of goats fed different dietary treatments.

| Dietary treatment* | Aging periods | | | | | |
|---|---|---|---|---|---|---|
| | 0 d | | 1 d | | 7 d | |
| | Mean | SEM | Mean | SEM | Mean | SEM |
| T1 | $0.47^{x}$ | 0.08 | $0.62^{x}$ | 0.12 | $1.44^{ay}$ | 0.10 |
| T2 | $0.38^{x}$ | 0.08 | $0.50^{x}$ | 0.12 | $0.95^{by}$ | 0.10 |
| T3 | $0.49^{x}$ | 0.08 | $0.63^{x}$ | 0.12 | $1.50^{ay}$ | 0.10 |
| T4 | $0.41^{x}$ | 0.08 | $0.54^{x}$ | 0.12 | $0.96^{by}$ | 0.10 |

*T1: control, basal diet without supplementation; T2: basal diet + 0.6 mg Se/kg DM; T3: basal diet + 0.6 mg I/kg DM; T4: basal diet + (0.6 mg Se/kg DM+0.6 mg I/kg DM).
[ab] Means with different superscripts within the same columns differ significantly ($p< 0.05$). [xy] Means within a row with different superscripts differ significantly ($p< 0.05$).
SEM: Standard error of means.

In this study, serum glutathione peroxidase concentration was significantly greater in T2 and T4 compared to T1 and T3 animals (Figure 1). However, GSHPx values of ST muscle obtained from goats of T2 and T4 were only greater ($p<0.05$) when compared with the T1 group (Figure 1). The present results indicate that the dietary supplementation of I has no effect on the concentration of GSHPx in ST muscle and serum.

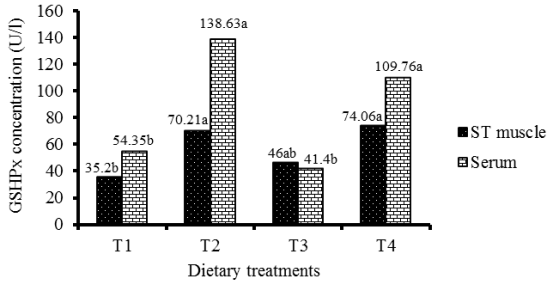


Figure 1. Differences in glutathione peroxidase concentration in serum and *semitendinosus* muscle of goats fed different dietary treatments.

T1: control, basal diet without supplementation; T2: basal diet + 0.6 mg Se/kg DMT3: basal diet + 0.6 mg I/kg DM; T4: basal diet + (0.6 mg Se/kg DM+0.6 mg I/kg DM).
[ab] Similar bars with different letters differ significantly ($p<0.05$).

In line with our findings, Shi *et al.* [7] and Yue *et al.* [16] and Daun & Akesson [17] reported significant increases in the activities of GSHPx following selenium supplementation in goats and lambs, respectively. Appropriate intake of Se particularly in the form of Na selenite can be incorporated into GSHPx, which in turn will improve the antioxidant status of the body [9].

Studies investigating the relationship between dietary iodine and antioxidant status in the farm animals are rather limited. However, Qin *et al.* [18] reported a decrease in the activity of serum GSHPx in Liaoning Cashmere goats subjected to excessive I supplementation.This could be due to the production of excessive free radicals during the metabolism of thyroid hormones which could have resulted in oxidative damage particularly in the thyroid gland.

## IV. CONCLUSION

The present study demonstrated that the dietary supplementation of inorganic Se and the combination of inorganic Se and I at the level of 0.6 mg/kg DM have improved GSHPx activity in the serum and muscle of goats as well as meat oxidative stability at various aging time.

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